Part 3

WILD RELATIVES OF DOMESTIC LIVESTOCK & SOME SUGGESTIONS FOR NEW DOMESTICANTS

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Big Horn Sheep, wild relatives of domestic sheep, persist in diverse environments; from deserts to mountain peaks.

Part 3 documents the wild species that are presumed to be the ancestors of present-day domestic livestock. Since some of the species are undergoing a process of domestication and are currently being bred in captivity, there is some overlap between Parts 2 and 3.

Part 3 details the geographical distribution of the wild relatives, their current status in the wild, threats to survival, and economic importance. Where appropriate, prospects for the use of their genetic attributes for the improvement of the productivity of their domestic counterparts are presented. The development of extensive ranching and intensive farming of some of these wild relatives is already underway. Some speculations are made for species that are not related to domestic animals but which are, or could be, in the process of being domesticated for the benefit of humankind.

Feral populations of domestic animals, i.e. domesticants that have returned to the wild, are covered in Part 4. Others that do not concern this list are fur-bearers, domestic dogs and cats and other species considered to be companion animals.

The information presented, especially that on status in the wild is variable in quality. This is understandable when one remembers that the status of many wild species is changing rapidly and in some cases estimates may not be very accurate if recent surveys have not been made. Only in the case of high profile, large or easily seen, and thus easily counted animals, can any degree of precision be expected. Trends, however, can be assessed reasonably accurately.

Past and present domestication achievements are discussed. The development of innovative husbandry techniques which may overcome the difficulties that have constrained the management, taming and breeding of non-social and territorial species are described.

Finally, suggestions are made for the utilisation of the genetic diversity contained in the wild relatives of domestic livestock. The need for co-operative action by rural and national communities is highlighted.

Note that wild relatives are categorized by the IUCN threatened species categories which differ from the FAO definitions of risk for domestic animals. See section 1.6 for definitions.

3.1 CATTLE, BISON AND BUFFALOES

Order *Artiodactyla*/Family *Bovidae*

1 Kouprey
2 Gaur
3 Banteng
4 Wild yak
5 Wild Asiatic buffalo
6 Tamaraw
7 Anoas
8 European bison or Wisent
9 North American bison
10 African buffalo

Wild cattle are bovids belonging to the tribe *Bovinae*. There are 12 species in four genera. Domestic cattle are descended from a group of races of the now extinct Aurochs, *Bos primigenius*. The Aurochs, the last specimen of which died in a Polish park in 1627, was once common throughout Europe and had a range that extended through North Africa and the Middle East to Southeast Asia and China.

There are a number of theories to explain how such a diverse range of breeds of modern domestic cattle has been derived from various races of wild cattle. Inter-specific crossing may also have contributed to the development of some eastern breeds. Exceptions are the American and European bison, now regarded as conspecific, which belong to the genus *Bison*; the two anoas (which may also be conspecific) to the genus *Bubalus*; the wild Asian buffalo, *Bubalus*; and the African buffalo, *Syncerus*. These so-called genera are very closely related and while some of them can inter-breed, producing fertile offspring, others produce sterile male hybrids. The true cattle of the genus *Bos* are most closely related to the Asian gaur and banteng from which they appear to have become separated during the Upper Pliocene (Zeuner, 1963).

FIGURE 3.1.1: WILD AND DOMESTICATED SPECIES WITHIN THE GROUP BOVINI (FAMILY BOVIDAE, SUBFAMILY BOVINAE) AFTER PAYNE, 1991.

Group	*Genus*	*Wild species*	*Domesticated species*
Bovini	*Bos*	*Bos primigenius* Aurochs (extinct)	*Bos taurus* *Bos indicus* Domestic cattle
		Bos javanicus Banteng	*Bos javanicus* Bali cattle/
		Bos frontalis Gaur	*Bos frontalis* Mithan/Gayal/ Drung Ox/Dulong
		Bos sauveli Kouprey	
		Bos grunniens Yak	*Bos grunniens* Domesticated yak
	Bison	*Bison bison* American bison	
		Bison bison European bison	
	Bubalus	*Bubalus bubalis* Wild Asian buffalo	
		Bubalus mindorensis Tamaraw	*Bubalus bubalis* Domestic water buffalo
		Bubalus depressicornis Lowland Anoa	
		Bubalus quarlesi Mountain Anoa	
	Syncerus	*Syncerus caffer* African buffalo	

There are two major types of domestic cattle; zebu (*Bos indicus*) which have a marked thoracic hump and taurine (*Bos taurus*) which do not. Although the two types are designated as separate species, due to their complete interfertility they are generally considered to be subspecies. There is molecular evidence to suggest that there were two separate domestication events, the two cattle types arising from different subspecies of the Aurochs (Loftus *et al*., 1994). Molecular studies suggest that European and African breeds of domestic cattle have one mitochondrial lineage type (taurine), while Indian breeds have another (zebu). Molecular analysis of the bovine Y chromosome suggests a major zebu influence in African humped cattle populations. This indicates a predominantly male-mediated introgression of zebu blood into African cattle populations, presumably facilitated by introducing zebu bulls to taurine herds.

The *Bovinae* tribe achieved great diversity in the Pliocene (about five to three million years ago) when it inhabited the warm plains of Eurasia. Some forms, such as the yak and the bison, evolved to become cold-resistant and are adapted to live at high altitudes. Only the bison, *Bison bison*, managed to migrate from Eurasia into North America across the Bering Strait and to extend its range as far south as El Salvador.

See: Hedges (1999).

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1 KOUPREY

Bos sauveli *ENDANGERED*

The kouprey, also known as the forest ox or the grey ox of Indochina, is the most primitive of living cattle. Its features are typical of some forms that existed during the Pleistocene era. Discovered by western scientists only in 1937, the kouprey was one of the last large mammals to be scientifically described. It is closely allied to *Bos primigenius namadicus*, the wild ancestor of zebu cattle. In 1964, the kouprey was declared Cambodia's national animal but is now perilously close to extinction.

The kouprey is a large animal. Bulls stand 1.5 to 2 m at the shoulder and may weigh up to 900 kg. Cows are somewhat smaller. The shoulder hump is smaller than that of the gaur but larger than that of the banteng. The body appears more slender and longer-legged than both the gaur and the banteng. A marked and unique feature is the pendulous dewlap that hangs from the throat to the lower sternum. Old bulls are black with white stockings. Cows and juveniles are mouse-grey or light brown, also with white stockings. The horns of the bull kouprey are long and spread wide, the tips often frayed like a brush. The cows' horns are slender and lyre-shaped. When kouprey move they are less ponderous than other wild cattle, more reminiscent of a large antelope. The kouprey is a denizen of the forest edge and is primarily a browser, although it will graze in forest glades when the monsoon stimulates a fresh growth of grass following the fires of the dry season.

DISTRIBUTION AND CURRENT STATUS

The kouprey is now found only in northern and eastern Cambodia and may possibly be found in southern Laos, eastern Thailand and western Vietnam. In Cambodia the most optimistic estimate suggests that less than 200 animals remain. In Vietnam it is estimated that only about 27 kouprey occur in the wild, while in Laos very few, if any, survive. The most recent kouprey sightings have been in eastern Cambodia, along the western border of Vietnam. An aerial survey covering 6 500 sq. km in eastern Cambodia and a smaller area in north central Cambodia, carried out in March 1994, failed to detect the presence of any kouprey. However, reports of recent sightings by local hunters (if true) would suggest that the animal still persists in Cambodia's forests, albeit in greatly reduced numbers (Olivier and Woodford, 1994). The world population is unknown, but is thought to be between 100 and 300 (MacKinnon and Stuart, 1989).

THREATS TO SURVIVAL

The main causes for the continuing decline in numbers of the kouprey are said to include a low reproductive rate, uncontrolled hunting and a demand for its lyre-shaped horns as trophies. Another major cause of the kouprey's decline has been the succession of wars within its range that included the widespread laying of land-mines by warring factions.

CAPTIVE BREEDING

There are no koupreys in captivity at present (1999). The gestation period of the kouprey is thought to be about 250 days.

DOMESTICATION AND ECONOMIC IMPORTANCE

Although it is generally believed that the kouprey has never been domesticated, domestication may in fact have occurred during the period of the Khmer culture, 400 to 800 years ago (Wharton, 1957). Furthermore, National Research Council (1983a) reports that in both Vietnam and Laos there are cattle breeds that resemble the kouprey and that a kouprey bull, reported to be a domestic animal of the Stieng tribe, was exhibited in the Paris Menagerie in the mid-nineteenth century. National Research Council speculates that there may be domestic kouprey in parts of Indo-China today. It is alleged that the species may be resistant to Rinderpest, but there is no direct evidence of this. The animals' well-developed and extensive dewlap may indicate enhanced heat tolerance, this characteristic being potentially valuable for domestic cattle in the moist tropics.

REMARKS

In January 1988 an international workshop chaired by Professor Vo Quy, Dean of Biology, was held at the University of Hanoi. This workshop was attended by scientists and resource managers from Vietnam, Cambodia,

Laos, Thailand, Malaysia, Sri Lanka, the United States of America and the United Kingdom. Members of the zoological community from the United States of America and officers from the International Union for the Conservation of Nature (IUCN) and the World Wide Fund for Nature (WWF) also attended.

The workshop drew up and published later that year, an Action Plan for the conservation of the kouprey. The delegates agreed that the conservation of the kouprey is a matter of great urgency and is one of the region's highest conservation priorities. All parties agreed that the primary responsibility for saving this species rests with the people and authorities in each country where it may occur. The search for the kouprey in the wild continues and an expedition was made to search an area in southern Laos in May 1992 but no sign of the animal was found. Eastern Cambodia, along the western border of Vietnam, now seems to be the most likely place to find the last population of kouprey, but the aerial survey carried out in March 1994 (reported above) was unsuccessful.

Until individuals of this species are actually located few effective conservation measures can be carried out. Investigations to locate relict kouprey populations in eastern Cambodia have been recommended (Olivier and Woodford, 1994) and if these are successful, attempts may be made to capture some animals for the establishment of a captive-breeding programme. The feasibility of the declaration of a protected area for the kouprey in Cambodia is also to be explored once the political situation is stabilised.

The generic name *Novibos* is sometimes used instead of *Bos* for the kouprey (Coolidge, 1940).

2 GAUR

Bos frontalis *VULNERABLE*

Photo 3.1: Gaur (India): Wild progenitor of semi-domestic mithan, gayal or drung ox.

The gaur is believed to be the wild progenitor of the semi-domestic mithan (gayal, drung ox or dulong), *Bos frontalis*, a ceremonial ox of the hill tribes of Assam, Bhutan, Bangladesh and Myanmar. The gaur is the largest and most powerful of the surviving wild bovids. Two subspecies are recognised, *B.f. gaurus*, which occurs in India and Nepal, and *B.f. laosiensis* found in Myanmar, Thailand, Laos, Vietnam and peninsular Malaysia. Average-sized gaur bulls stand 1.75 m to 1.98 m at the shoulder and there is one record of a gaur bull shot in Myanmar which stood 2.1 m at the shoulder (Pollok and Thom, 1900). Gaur cows are somewhat smaller. Bulls weigh 600 – 940 kg and cows weigh about 150 kg less. Adult bulls are black with white stockings while cows and young bulls are dark brown with similar stockings. Gaurs produce an oily skin secretion that has a characteristic odour and allegedly acts as an insect repellent (Simoons and Simoons, 1968). The gaur is considered to be both a grazer and a browser (Schaller, 1967).

DISTRIBUTION AND CURRENT STATUS

The gaur ranges eastwards from India to Myanmar and southern China and south-east to Thailand, Laos, Vietnam and peninsular Malaysia, where it is sometimes called the Seladang. A shy, forest animal, it still numbers some thousands but is becoming less numerous throughout its range largely due to increasing habitat loss. Reasonable sized populations occur in many national parks and protected areas. Outside these it tends to survive only in isolated and fragmented populations. The species is reported to have at one time been present in Sri Lanka but to have become extinct there some 300 years ago.

THREATS TO SURVIVAL

There are three main causes for the decline in numbers: habitat destruction, indiscriminate hunting and diseases such as Rinderpest, Foot-and-Mouth disease, malignant catarrhal fever transmitted by domestic stock and anthrax which is enzootic in many parts of Asia. Gaurs are extremely sensitive to disturbance and will not survive in country continually disturbed by man. In India, Rinderpest severely affected herds in the Mudumalai and Bandipur Sanctuaries in August 1968 when between 300 and 500 animals are said to have died (Krishnan, 1972).

In Thailand, during the Second World War, gaurs were also greatly affected by disease, transmitted to them by domestic buffalo that grazed in the forests. In Myanmar, anthrax was said to be a major cause of their disappearance from many areas in the north and centre and surveys in the early 1980s found that poaching and agricultural encroachment were also widespread and presented a threat to the gaur population (Salter, 1983).

CAPTIVE BREEDING

The global captive population of gaur is 175 in 24 institutions (ISIS, 1993). In 1980 the New York Zoological Society successfully bred a gaur from an embryo transfer experiment in which a gaur embryo was surgically implanted in a domestic Holstein cow (Stover *et al.*, 1981). A successful non-surgical embryo transfer between

these two species was also made in 1987 by Pope *et al.* (1988) at Cincinnati Zoo. The cryopreservation of gaur semen has been described by Gross (1991). The gestation period of the gaur is 270 days and its chromosome number is n = 58.

DOMESTICATION AND ECONOMIC IMPORTANCE

The gaur has not been domesticated, but a semi-domesticated hybrid form, the mithan or mithun (*Bos frontalis*), is thought to have been derived from it (National Research Council, 1983a; Simoons and Simoons, 1968). The name gayal is sometimes used as a synonym for the mithan. Although the mithan is a semi-domestic animal, it has a curious role among hill peoples of Southeast Asia, according to Simoons and Simoons (1968):

"It is a free-ranging animal, used for sacrifice on festive occasions, intimately involved in ritual and religious belief and in the prestige structure; figuring in the exchange system and used in payment of political, legal and social obligations yet having a minimal role in the realms of traction and dairying, for which common cattle are so valued among Hindu Indians."

The mithan is widely distributed in the hill country of northern Myanmar, Arunachal Pradesh, Manipur, Nagaland and Bhutan. It may also occur in northern Yunnan where it is called the drung ox or dulong (Tan, 1983). The mithan is a woodland animal and is usually found at elevations of 600 – 2 500 m asl. However, in the Chittagong Hill Tracts it descends to 300 m and in Bhutan it is maintained as high as 3 500 m asl. At lower elevations, the mithan overlaps with domestic cattle and at higher elevations, in the Himalayas, it overlaps with the yak. In general, the mithan prefers a shady, humid environment at about 1 000 – 2 000 m asl.

The mithan is a browser and prefers the forage provided by secondary forest, which springs up in the abandoned fields of shifting cultivators. In this respect, it follows closely the habits of its gaur progenitor and does not require forests to be cleared to provide pasture as is needed for domestic cattle. The mithan is smaller than the gaur, similar in colour, but the horn shape is strikingly different, being more cow-like.

In India there are some 90 000 head of mithan in the jungles of Arunachal Pradesh and in the Chin Hills of Myanmar there are some 34 000. In Bhutan there are 60 000 head of mithan-cattle hybrids. The Naga Hill Tribes encourage interbreeding with gaur and mithan (always gaur bulls on mithan cows) regarding it as an improvement on the breed. Arunachal Pradesh tribal people crossbreed the mithan with domestic cattle. The male F_1 progeny obtained by crossing male mithan with female cattle are called Jatsa and are used for ploughing. These hybrids are very strong and docile. The females are called Jatsamin and yield more milk than pure mithan cows. In the F_2 generation animals (male mithan x F_1 female), the males (called Nupsa) are used for ploughing and the females,

Photo 3.2: Mithan or gayal (India, Myanmar, and Bhutan). Semi-domesticated gaur, frequently crossed with zebu cattle and yaks to produce hybrids for milk and traction.

Nupsamin, are reared for the increased milk production. Crosses between mithan and zebu are also encouraged in certain districts and the hybrid females are fertile while the males are sterile. This hybrid fertility/sterility pattern prevails in all mithan/domestic cattle, mithan/yak crosses and in all gaur/domestic cattle crosses. It is unclear whether both sexes of the gaur/mithan crosses are interfertile. In the eastern Himalayas mithan are crossed with yaks and with dzo (the product of a yak/cattle cross). Such crosses evince the usual hybrid fertility/sterility pattern and are used for traction and milk production.

REMARKS

The Bhutan Government has established two mithan herds by purchasing animals from Arunachal Pradesh and is breeding them on government farms for distribution to private farmers (National Research Council, 1983a). The Indian Council of Agricultural Research (ICAR) has recently instituted the National Research Centre for Mithan in Arunachal Pradesh. For a full description of the gaur see Gee (1964), Hubback (1937) and Tun Yin (1967), and of the mithan, Simoons and Simoons (1968).

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3 BANTENG

Bos javanicus *VULNERABLE*

The banteng is a Southeast Asian bovine and is the wild relative of domestic Bali cattle. Wild banteng are the most elegant of wild cattle. The bulls are dark brown or black, while in Myanmar and Indo-China the bulls are a golden reddish-brown like the cows. The cows are a foxy red. Both sexes have white stockings and a large white rump. Wild banteng are larger than their domestic cousins. Bulls stand 1.6 – 1.9 m at the shoulder and weigh 635 – 825 kg. Cows average 1.4 m in height and weigh about 400 kg. The Bornean race is a little smaller.

DISTRIBUTION AND CURRENT STATUS

Wild banteng occur in small, increasingly fragmented populations in Myanmar, Laos, Thailand, Cambodia, Vietnam and Sabah Indonesia. Three subspecies are recognised: *B.j. birmanicus* on the Asian mainland, *B.j. lowi* in Borneo and *B.j. javanicus* in Java and Bali. The mainland race numbers a few thousand and is declining. The Bornean race in Sabah totals about 300 – 550. Some 700 – 1 000 occur in Java and 30 – 40 in Bali.

THREATS TO SURVIVAL

Loss of habitat to an ever-increasing human population, uncontrolled hunting pressure for meat and trophies, military operations in much of the range and hybridisation with domestic cattle are all serious threats. Diseases such as Rinderpest and intestinal parasites present a threat, especially where contact with domestic cattle is frequent. Malignant catarrhal fever, blackleg (*Clostridium chauvei*) and mucosal disease have also been reported as seriously affecting banteng, especially those kept in zoos.

CAPTIVE BREEDING

The global captive population of banteng is 245 in 23 institutions (ISIS, 1993). The gestation period of the banteng is 280 days.

DOMESTICATION AND ECONOMIC IMPORTANCE

The wild banteng shows great promise for improving the domesticated banteng and for crossing with cattle. Sir Stamford Raffles, founder of Singapore, noted 170 years ago that in Java the degenerate domestic cows were sometimes driven into the forest to couple with the wild banteng for the sake of improving the breed. Domestic banteng, known as Bali cattle, are found in parts of Southeast Asia, principally Indonesia.

They are particularly important on the islands of Bali, Kalimantan, Lombok, Sulawesi, Sumbawa and Timor. Small numbers of domestic banteng have also been introduced to Sumatra, Malaysia, Papua New Guinea and northern Australia and there are experimental herds in Texas and Hawaii, United States of America. The domestic banteng differs little from the wild banteng, although it is smaller in size. Banteng and domestic cattle have the same number of chromosomes and will cross-breed. However, while the female hybrids are fertile, most of the hybrid males are sterile. Banteng/domestic cattle crosses are very food-efficient, able to maintain body condition on poor forage, are heat-tolerant and fatten readily with high carcass quality. They are intelligent and easily trained to the plough. However, they tend to be nervous and difficult to manage under extensive conditions and are poor milk producers. A particularly successful cross is that between banteng and zebu to produce the Madura. This breed, native to the Indonesian island of Madura, where there are some 575 000, probably came into being about 1 500 years ago when Indian invaders brought zebus of the Sinhala type to Madura. Surprisingly, though originally hybrid in origin, both sexes of the Madura cattle are fully fertile. The Madura is the swiftest of all bovines and is able to run as fast as a horse. Race meetings are a regular feature on the island.

However, the domestic banteng (Bali cattle) have some serious limitations. They need close contact with humans or within three or four months they may revert to the wild state. Cows and calves are very timid. They panic easily and, when frightened, may run into fences causing themselves severe injuries.

Bali cattle are poor mothers, often failing to protect their calves against predators and allowing other calves in the herd to suck their milk to the extent that their own calves starve.

In Indonesia, malignant catarrhal fever and jembrana disease (tick-borne rickettsiosis), to which Bali cattle are particularly susceptible, have caused severe losses (Sweatman, 1984). Bali cattle appear to be the only animals to be affected by Bali ziekte, a disease that produces a dry eczema followed by extensive necrosis of the skin and exposed mucous membranes. Research is badly needed on the prevention and control of both this disease and jembrana.

REMARKS

The name *Bos sondiacus* has also been used in the past for the banteng. For a description of the banteng see Lekagul *et al.* (1977), National Research Council (1983a) and Medway (1978).

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4 WILD YAK

Bos grunniens — *ENDANGERED*

The wild yak is classified as *Bos grunniens* (it is also called the grunting ox or horse-tailed buffalo), as is the domestic yak. The wild yak thrives on the scanty herbage found at an elevation of 4 000 – 5 000 m where the mean annual temperature is near 0ºC and where the winter temperature may fall as low as -50ºC.

Wild yaks are much larger than their domestic counterparts. Mature bulls may stand up to 1.5 m at the shoulder and may weigh over 500 kg. Sexual dimorphism is marked, the female being much smaller than the male. The wild yak has very large horns, up to 90 cm long, which are often made into containers for milk by the nomadic herdsmen. All wild yaks are dark brown to nearly black with a silver grey dorsal line and a grey edge to the muzzle. The animals are fierce and wary. At high altitudes where horses quickly become short of breath, yaks can easily outrun them (Epstein, 1974).

DISTRIBUTION AND CURRENT STATUS

The species inhabits remote areas of the Tibetan Plateau and adjacent highlands in China. It may still occur in the more remote areas of Kashmir and possibly in Bhutan. No population size estimates exist and the species is probably reduced to the low hundreds. Sightings made by Academia Sinica in China in 1973 - 76 total approximately 800 animals but recent reports from Tibet suggest that wildlife in that country has drastically declined and that the wild yak has been decimated. Miller *et al.* (1994) estimated that the wild yak population of all ages and both sexes may still have numbered around 15 000 in the early 1990s but this may be an over-estimate. Wild yak are protected by the Chinese wildlife protection legislation but according to Miller *et al.* (1994) the departments concerned have inadequate resources for enforcement.

Photo 3.3: Yak (Tibet). Wild yaks breed freely with domestic yaks on the Tibetan plateau.

THREATS TO SURVIVAL

Yak populations have suffered a marked reduction as a result of uncontrolled hunting, partly for food. The herds that remain have become scattered and isolated in the remotest parts of their former range, due to the encroachment of roads and increasing competition for grazing land from domestic livestock.

CAPTIVE BREEDING

Domestic yaks are kept in small numbers in zoological gardens in many countries of Europe and elsewhere, where they are reported to survive and breed successfully. However, there are no wild yaks in captivity anywhere in the world.

The chromosome number for the wild and domestic yak is 2n = 60. This is the same number as for *Bos taurus* and *B. indicus,* both of which interbreed freely with wild and domestic yaks. The female hybrids are fertile and the males are sterile. Yaks will also interbreed with bison (*Bison bison*) again producing fertile female hybrids and sterile males.

The gestation period for the yak is 258 days.

DOMESTICATION AND ECONOMIC IMPORTANCE

It is generally considered that wild yaks were first domesticated in Tibet or on the northern slopes of the Himalayas about 2 500 BC. It is likely that there has been a close interaction between man and the yak ever since the first human migrations into the high mountains of Asia. The domesticated yak differs little in appearance from the wild animal except that it is smaller, has shorter and thinner horns and may be variable in colour (Clutton-Brock, 1981). National Research Council (1983a) suggests that there are more than one million domestic yaks in the world, but Li and Wiener (1995) estimate that there are around 14 million domestic yaks in the world. Of these, 13 million are in Chinese territories, 0.5 million in Mongolia and the rest in other countries, notably those bordering the Himalayas and the countries of the Commonwealth of Independent States (CIS).

On the high plateau of Tibet during the breeding season, from July to September, wild yaks are said to be seen mixing with herds of domestic yaks in order to mate. Cross-breeding between the two species produces a hybrid with normal fertility (Zhang Rong-Chang, 1985), and there is some interest in the use of the larger wild yak to improve the productive performance of the domestic type. Zhao and Zhang (1994) noted that, historically, herdsmen in the Gannan region of Gansu drove their female yaks into the region where wild yaks were to be found so as to encourage mating with the wild yak bulls. The crossbred progeny would later be selected to improve the domestic yak population. Based on this experience more systematic studies are now in progress using frozen semen from wild yak bulls.

Domestic yaks are excellent pack and riding animals and can carry up to 150 kg. At high altitudes, of up to 6 000 m, a yak can carry a pack or a man at a steady pace for days at a time and remain in good condition. In some regions the yak is the only pack animal available whilst in others it is also milked and occasionally slaughtered for meat. The milk has a very high fat content and in some areas yak butter is used in great quantities as a food and as a lighting fuel. The long silky hair is also used for textiles. Yaks are the only bovines able to thrive at such high altitudes. In cold high areas they can work and produce milk and meat more efficiently and more cheaply than cattle. In lower regions they sometimes interbreed with cattle. The sires are usually domestic cattle bulls and the dams yaks. The hybrid, the females of which are fertile and the males sterile, are called dzo. The dzo are preferred for ploughing in Tibet because the pure domestic yak is said to be too stubborn (Epstein, 1977). The Government of India has set up national research centres to investigate important wild species, including the yak (Bhat, 1981). This research should investigate the role that the wild yak may play in future yak husbandry.

REMARKS

Wild and domestic yak are both classified as *Bos grunniens*, although they were previously classified as either *Bos mutus* (wild yak) and *Bos grunniens* (domestic yak) or *Poephagus mutus* and *Poephagus grunniens*. For a full description of the wild yak see Allen (1940), National Research Council (1983a) and Li and Wiener (1995).

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5 WILD ASIAN BUFFALO

Bubalus bubalis *ENDANGERED*

The wild Asian buffalo is the ancestor of the domestic water buffalo. The domestic water buffalo now numbers at least 130 million, one-ninth of the total number of cattle in the world and upon which more human beings depend than any other domestic animal.

DISTRIBUTION AND CURRENT STATUS

The wild Asian buffalo is highly endangered and will become extinct in the near future unless effective conservation action is taken immediately. Wild Asian buffalo are now only found in a very small part of their former range. The total world population of wild Asian buffalo is now almost certainly less than 4 000 animals and may well be less than 200 animals. Indeed, it is possible that no pure-bred wild Asian buffalo remain. Small isolated populations are thought to remain in the Bastar and Raipur Districts of Madhya Pradesh and Manas WS/Project Tiger Reserve (India), Kosi Tappu WR (Nepal), Royal Manas NP (Bhutan), and Huai Kha Khaeng WS (Thailand). These are the populations believed to have been least affected by interbreeding with domestic and/or feral buffalo.

The marked differences in the estimates for the extant population of wild Asian buffalo reflect the difficulty of distinguishing between pure-bred wild buffalo, feral buffalo, domestic buffalo and hybrids between them.

Translocated or feral buffalo of domestic origin also occur in Australia, Brazil, India, Indonesia, Laos, Thailand, Vietnam, the Philippines, Timor, Italy and Sri Lanka.

THREATS TO SURVIVAL

The chief reasons for the decline of the wild Asian buffalo have been the loss of suitable habitat and excessive hunting. These remain serious threats today. The preferred habitat of the buffalo is easily traversed by vehicles and/or trained elephants and this has facilitated hunting. The coastal and riverine plains, which once supported large wild herds, have largely been claimed by farmers for agricultural purposes and livestock production. Competition with domestic livestock and especially the loss of genetic integrity as a result of interbreeding with domestic and feral buffalo are also very serious threats.

In addition, the wild Asian buffalo is highly susceptible to a number of domestic livestock diseases, particularly Rinderpest (now believed to have been eliminated from the Indian subcontinent). In the past, Rinderpest was believed to have been responsible for the near extinction of Asian buffalo in Madhya Pradesh during the 1920s, and for the precipitous decline of the species in Sri Lanka at the end of the nineteenth century (Stockley, 1928; Phillips, 1935; Daniel and Grubh, 1966). The spread of infectious diseases from domestic and feral livestock to wild Asian buffalo is considered to be a constant threat.

Development projects, particularly hydroelectric and irrigation schemes, have contributed to the decline of the species and remain a threat in Nepal and in parts of India (Thornback, 1983; Heinen, 1993a).

Trade in wildlife parts is probably a minor threat to the wild Asian buffalo but there have recently been reports of wild buffalo horns being offered for sale in Southeast Asia.

CAPTIVE BREEDING

To date, captive breeding has made no contribution to the conservation of the wild Asian buffalo because of the uncertain genetic status of the captive animals. It has been suggested that some or all of the captive animals may be hybrids (Read *et al.*, 1994).

In 1983 a team of researchers at the University of Florida succeeded in transferring embryos from Asian buffalo into a recipient of the same species and a male calf was produced after a 10.5 month gestation period (Drost *et al.*, 1983; Dresser, 1985; Sidhu and Guraya, 1985). It has been suggested that embryo transfer and similar manipulative techniques could play a valuable role in the management of captive endangered wild animals including the wild Asian buffalo.

There are no true wild Asian buffalo in zoological gardens. The wild Asian buffalo does not voluntarily interbreed with domestic cattle to which they are less closely related than are the yak, gaur, banteng and bison. The chromosome number for the wild Asian buffalo is 2n = 48, for the domestic swamp buffalo, 2n = 48, and the domestic river buffalo, 2n = 50. The gestation period of the wild Asiatic buffalo is 300 - 340 days. Domestic cattle of genus *Bos* have 2n = 60 chromosomes, but although copulation between these domestic cattle and buffalo of all types is common, hybrids from this union are unknown. In contrast, crossbreeding between the wild Asian buffalo and the two domestic types produces fertile hybrids.

DOMESTICATION AND ECONOMIC IMPORTANCE

Two types of domestic buffalo are recognised: the swamp buffalo and the river buffalo. The swamp buffalo is found in the eastern half of Asia from the Philippines westwards to India. They wallow in any water or mud they can find. They are exploited primarily as a work animal, but they are also used for meat. They are almost never used for milk production.

River buffalo occur in the western half of Asia, from India to Egypt and Europe. They prefer to wallow in clean water.They are of the dairy type and produce much more milk than the swamp buffalo.The milk is used in Italy to produce a special, highly sought-after quality cheese called Mozzarella.

Buffalo are or have been used as currency and for wife purchase, hunted for sport, regarded as sacred animals, sacrificed to placate spirits and deities and ritually slaughtered at weddings, funerals and cremations. Buffalo horns, skulls, blood and milk are thought to have religious significance or magical powers in some countries. Belief in the aphrodisiac properties of buffalo meat and milk is also widespread. Buffalo races and fights are still staged in many areas.They have also been employed as mounts for cavalry and used to pull both chariots and heavy ordnance (Kreemer 1956; Cockrill, 1968a and FAO, 1974).

There is increasing interest in the potential for the development of the domestic water buffalo especially since the promises offered by mechanisation in many developing countries appear increasingly unattainable. The importance of conserving the wild genetic stock is recognized as it may well offer added diversity (Choudhury, 1994).

REMARKS

For a description of this animal see Daniel and Grubh (1966), Prater (1965) and FAO (1974). For a full account of the wild Asian buffalo see Hedges (1999).

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6 TAMARAW

Bubalus mindorensis *ENDANGERED*

Tamaraws resemble miniature water buffalo of the Southeast Asian swamp type. They are however, more solidly built, darker in colour and have a thicker coat. They evolved as an independent island form and in common with many island-dwelling species they are of small size.Tamaraws are about one metre in height at the shoulder and weigh up to 300 kg.

DISTRIBUTION AND CURRENT STATUS

Endemic on the Philippine island of Mindoro, the tamaraw is now probably restricted to three small areas: Mount Iglet/Mount Baco, Mount Calavite and Sablayon in Occidental Mindoro (Cox and Woodford, 1990). There is no accurate estimate available of the present population size of the wild tamaraw. However, in 1987, an estimate quoted by Petocz (1989) indicated a figure of 356.

THREATS TO SURVIVAL

Hunting for meat has been the main cause of the decline of the tamaraw. Increasing human numbers, timber operations, farming and cattle ranching have all combined to restrict the animal's habitat and to reduce its numbers.

Photo 3.4:Tamaraw (Mindoro, Philippines). In common with other island-dwelling species, the tamaraw has evolved to be small..

The ranching of cattle in and around the national parks of Mindoro is probably one of the major threats to the recovery of the tamaraw.

CAPTIVE BREEDING

There is a small captive population of about 16 tamaraws maintained in a fenced enclosure of 2.8 km^2 inside the southern border of Mount Iglet/Baco National Park on Mindoro. This enclosure is covered with thick secondary forest and the exact number of tamaraws, all of which have been captured outside the enclosure and translocated into it, is difficult to estimate. However, the animals are breeding and calves have been seen. Two more animals, one male and one female, are held in a smaller fenced enclosure of 0.75 ha inside the main fenced area. These two tamaraws are tame and have recently had a calf. There are no tamaraws in captivity anywhere else in the world. The gestation period of the tamaraw is 276 – 315 days (Grzimek, 1990).

DOMESTICATION AND ECONOMIC IMPORTANCE

The tamaraw has never been domesticated. However, it is considered to have food and agriculture potential, since both its hide and meat are held in high regard by the local people on Mindoro. It appears that its habitat requirements are flexible; it is very hardy and can exist on poor quality forage. Although its genetic relationship with the water buffalo is unclear, it is certainly close and the tamaraw may thus be a reservoir of genetic material which could be used to improve the quality of the domestic water buffalo resource. A proposal has been made that some of the captive tamaraws on Mindoro should be transferred to the University of the Philippines at Los Banos on Luzon where they could be studied in depth (Cox and Woodford, 1990), but the Mindorese are unwilling to permit this to occur at present.

REMARKS

The tamaraw is frequently considered to be related to the two anoas of Sulawesi, all three often being placed in the genus *Bubalus*, subgenus *Anoa*. Groves (1969) conclud-

ed that the tamaraw is more closely related to the Asian buffalo, *Bubalus bubalis*, and that it should be named *Bubalus mindorensis* in the subgenus *Bubalus*. For a description of the tamaraw see Alvarez (1970); Lydekker (1898) and National Research Council (1983a).

7 ANOAS

Mountain Anoa *Bubalus quarlesi*
Lowland Anoa *Bubalus depressicornis*
ENDANGERED

The two anoas are small bovines that are related to the water buffalo but are scarcely bigger than goats. They are thus the smallest of the wild cattle species. There is some controversy over whether there are in fact two species of anoa. It has been suggested that the differences in horn shape which are an important means of distinguishing the two species may simply be a function of age (Wind and Amir, 1978).

DISTRIBUTION AND CURRENT STATUS

Anoas are endemic in the dense mature forests of the Indonesian island of Sulawesi where they once were abundant and well-distributed. There are several large nature reserves on the island which have been declared to protect the anoas but no census has been carried out and total numbers are unknown. MacKinnon (1982) thought it probable that each species numbered a few thousand, although the trend is believed to be downward. MacKinnon (1979) also reported the lowland anoa to have disappeared, or to have reached low numbers, near towns and villages where it was heavily hunted, but that healthy populations still occurred in large forest blocks. At the same time he reported the mountain anoa to be very rare. The Indonesian transmigration policy which has resulted in large numbers of people being moved from Java and Bali to the outer islands including Sulawesi, is bound to have a marked effect on the anoas outside protected areas as habitat destruction and hunting increase.

THREATS TO SURVIVAL

Anoas are heavily hunted and snared and soon desert an area if disturbed. Their forest habitat is shrinking due to human activities and increased logging. However, it is reported that although they are disturbed by logging, anoas may benefit from the regeneration of the secondary vegetation.

CAPTIVE BREEDING

The global captive population of both species of anoa is 60 in 18 institutions (ISIS, 1993). The gestation period of the anoas is 275 – 315 days.

DOMESTICATION AND ECONOMIC IMPORTANCE

Anoas have never been domesticated. Anoa meat, horns and hide are valued throughout Sulawesi and the animals are hunted for sport. Despite their aggressive and nervous temperament, it has been suggested that the anoa might make potentially valuable livestock animals. Their small size makes them relatively easy to handle and they have been bred and reared successfully in captivity. However, according to Whitten *et al.* (1988) anoas used to be caught by the Toraja people who attempted to breed them for meat but their aggressive nature, even after several years in captivity, prevented them from being used as domestic animals. It has been suggested that the offspring of an anoa/water buffalo cross could produce a useful domestic animal.

REMARKS

For a description of the anoas see Groves (1969) and National Research Council (1983a).

For a full account of the distribution and status of wild Asian cattle see Hedges (1999).

8 EUROPEAN BISON OR WISENT

Bison bison *VULNERABLE*

The European bison or wisent survived in the wild until the beginning of the twentieth century but only in the Bialowieza Forest in Poland (subspecies *B.b. bonasus*) and in the Caucasus (subspecies *B.b. caucasicus*). The last bison in Bialowieza was killed in 1919 and the last in the Caucasus died in 1927. The only surviving animals were those in zoos and those belonging to private owners. Only one animal, a bull of the *B.b. caucasicus* race, survived in captivity where he died in 1925 after siring some calves from *B.b. bonasus* cows. Now, most of the existing bison in Europe are *bonasus/caucasicus* hybrids.

DISTRIBUTION AND CURRENT STATUS

The wisent is extinct in the truly wild state, but semi-wild herds have been established in Russia and Poland. The largest herd is in the Bialowieza Forest which straddles the Polish and Russian border. There is a herd in the Caucasus National Park which contains some genes of the American bison (*Bison bison*). In the early 1980s there were about 800 wisent in the then USSR and 560 in Poland, of which 242 were in Bialowieza. By the late 1980s, as a result of successful breeding programmes, the species had increased to over 2 000 animals and 24 herds had been established in the wild.

THREATS TO SURVIVAL

The almost complete felling of the forests of Europe during the Middle Ages was the main cause of the disappearance of the wisent. Hunting and warfare also took a toll and the extinction of the wisent in the Caucasus is said to have been accelerated by outbreaks of Foot-and-Mouth disease and anthrax brought into the mountains by domestic stock (USSR Red Data Book, 1978).

CAPTIVE BREEDING

The global captive population of the European bison or wisent is 191 in 31 institutions (ISIS, 1993). All the extant European bison are essentially captive bred. The European Bison Pedigree Book is maintained at the National Council for Nature Protection, ul WaWelska 52/54, 00-922 Warsaw, Poland. The chromosome number for the European bison is 2n = 60 and the gestation period is 270 – 280 days.

Photo 3.5: European bison or wisent (Poland). Conspecific with the American bison - now under domestication.

DOMESTICATION AND ECONOMIC IMPORTANCE

The European bison has never been domesticated but there is perhaps some potential for commercial meat and hide production as is carried out with the congeneric American bison. The European bison interbreed freely with the American bison and the offspring are fertile. It is therefore becoming accepted to treat the two forms as conspecific under the name *Bison bison* (Clutton-Brock, 1987).

REMARKS

For a description of the wisent see Nowack and Paradiso (1983).

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9 NORTH AMERICAN BISON

Bison bison *NOT THREATENED*

The ancestors of the North American bison were the only members of the *Bovinae* tribe which managed to migrate from Eurasia into North America across the Bering Strait and to extend their range as far south as El Salvador. The bison of the Great Plains of North America was counted in tens of millions when the Europeans arrived in the continent, but by the 1890s had been reduced to but a few hundred. A century later their numbers had recovered to more than 100 000. Two subspecies of the American bison are usually recognised. These are the plains bison, *B.b. bison*, and the wood bison, *B.b. athabascae*.

DISTRIBUTION AND CURRENT STATUS

The two subspecies of the North American bison are found in the United States of America and north-west Canada. *B.b. athabascae* occurs only in Canada, whereas *B.b. bison* occurs in both the United States of America and Canada. By the 1980s the number of bison in North America was probably in the region of 100 000 of which 75 000 were in the United States of America and 25 000 in Canada. Numbers in both countries are increasing and the species is no longer considered to be threatened. The wood bison was, however, of some conservation concern and in the early 1980s numbered only about 900 animals. In the 1940s it was considered extinct as a subspecies. This supposed extinction was due to hybridisation with the plains bison which were introduced in large numbers into the Wood Buffalo Park in 1925 - 1928. Not only did the two subspecies hybridise but the plains bison brought with them tuberculosis and brucellosis. Fortunately, during an aerial survey in 1957, a small herd of pure wood bison was discovered in an isolated sector of the Wood Buffalo National Park. Animals taken from this pure, disease-free herd are the founders of herds of the wood bison in the MacKenzie Bison Sanctuary (now over 2 000 head) and on Elk Island, Canada.

THREATS TO SURVIVAL

Today there are no great threats, other than accidental disease introduction, to the survival of the species. The tuberculosis and brucellosis issue concerns the largely hybrid plains bison/wood bison herd in the Wood Buffalo Park in Canada. A recent decision to cull the infected herd of some 3 200 animals has been deferred in the face of hostile public opinion. Anthrax has also been reported in the bison of the Slave River lowlands and the Wood Buffalo National Park (Northern Diseased Bison Report, 1990).

CAPTIVE BREEDING

The global captive population of North American bison is 613 in 108 institutions (ISIS, 1993). The chromosome number for the North American bison is 2n = 60 and the gestation period is 270 – 280 days.

DOMESTICATION AND ECONOMIC IMPORTANCE

The North American bison may be described as undergoing domestication. Bison ranching is underway in the United States of America and Canada and private herds exist in nearly every state in the United States of America. The main characteristic of bison that makes them desirable as a source of meat is their ability to be productive under range conditions that are suboptimal for cattle. Bison have been cross-bred with many cattle breeds and also with the yak. However, the hybrids have not proven to be more productive than their pure parents are. The American Bison Company is now successfully marketing fur-on hides and fur garments and hopes to expand mar-

kets for meat and skulls. The latter are in demand by native American artists.

REMARKS

For a description of the North American bison see Jennings (1978) and Rowe (1970), also Hutchinson, A.D.

10 AFRICAN BUFFALO

Syncerus caffer *NOT THREATENED*

There are two subspecies of African buffalo: *S. caffer*, the large black buffalo of southern Africa, which ranges north to Ethiopia and Somalia; and the smaller red type, *S.c. nanu*s, which occurs in western Uganda and south-west through the Democratic Republic of Congo, Gabon and the Republic of Congo to northern Angola.

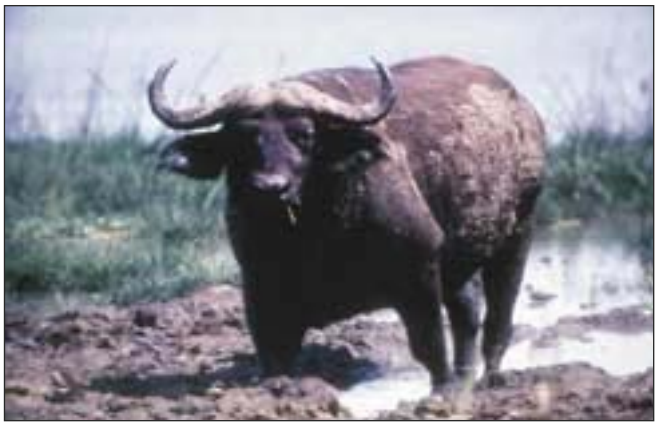

Photo 3.6: African buffalo (Uganda).

DISTRIBUTION AND CURRENT STATUS

One of the most widely distributed ungulates in Africa, it occurs throughout the continent south of 15ºN. Buffalo distribution is limited by the 250 mm isohyet and the species is confined to areas where the annual rainfall is higher than twice the potential annual evaporation. There are no buffalo in arid areas (Stewart and Stewart, 1963). The total population size is probably around one million and it is not threatened as yet as a species. Nevertheless, the African buffalo has declined markedly in parts of its range and numbers fluctuate due to hunting pressure and disease outbreaks.

THREATS TO SURVIVAL

Buffalo are highly susceptible to Rinderpest, which is still endemic in parts of the Sudan and Ethiopia (Woodford, 1983). Bovine tuberculosis is a serious problem in the buffalo in the Queen Elizabeth National Park in Uganda and in the Kruger National Park in South Africa. Buffalo have long been considered carriers of SAT strains of FMD virus and as a result have been eliminated from large areas where disease-free cattle are raised. Recent work in Zimbabwe, however, seems to indicate that cattle may be the main carriers of FMD virus and that the strains which infect and are carried by buffalo are less infective for cattle. African buffalo are also symptomless carriers of the haemo-parasite *Theileria lawrencei*, the casual agent of Corridor disease, a fatal disease of domestic cattle, which is transmitted by the tick *Rhipicephalus appendiculatus*.

CAPTIVE BREEDING

The global captive population of African buffalo is 135 in 36 institutions (ISIS, 1993).

DOMESTICATION AND ECONOMIC IMPORTANCE

African buffalo have not been domesticated although attempts are being made in Zimbabwe to train them to the yoke. Wild buffalo are currently being exploited in various countries for meat and hides. South Africa in particular has a cropping scheme in Kruger National Park and Mozambique had a major scheme at Marromeu in the Zambezi Delta before uncontrolled hunting and civil war resulted in the reduction of the buffalo population by almost 90 percent. There is considerable demand in southern Africa for FMD virus-free buffalo to stock game farms and ranches, usually for trophy hunting purposes. FMD virus-free buffalo are produced by taking young calves away from their infected mothers and raising them in isolation. Under wild conditions, the calves first acquire infection with FMD virus when they are a few months of age, when their colostral immunity wanes.

REMARKS

For a description of the African buffalo see Smithers (1983) and Sinclair (1977).

Also widely consulted in this section: Thornback (1983) and National Research Council (1983a).

3.2 SHEEP AND GOATS

Order *Artiodactyla*/Family *Bovidae*

1 Wild sheep
2 Wild goat or Bezoar
3 Nubian ibex

1 WILD SHEEP

SOME SPECIES AND RACES VULNERABLE

Mouflon-Urial are the wild sheep considered to be the ancestors of domestic sheep. The diploid karyotype number of wild sheep varies from 52 to 58 but despite this, given the opportunity (usually in captivity), they will interbreed amongst themselves and amongst domestic sheep to produce fertile offspring. The taxonomic status of the members of the genus *Ovis* is open to dispute (Schaller, 1977). For Asian mouflon and urial some authorities distinguish a single species, *O. orientalis*, while others distinguish two separate species; mouflon, *O. gmelini* and urial, *O. vignei*. However, some of those who support distinguishing two species also suggest that there are naturally occurring, self-sustaining hybrid populations, e.g. Alborz red sheep, *O. gmelini gmelini* x *O. vignei arkal* and Kerman sheep, *O.g. laristanica* x *O.v. blanfordi*. Despite this, most of the several subspecies recognised are accepted by both camps. Finally, *O. severtzovi* is sometimes classified as an urial and others as argali (Schaller, 1977).

DISTRIBUTION AND CURRENT STATUS

Today, autochthonous populations of mouflon are found on the Mediterranean islands of Corsica and Cyprus, while on the mainland their distribution begins in Turkey and spreads eastwards as far as Armenia and Iran. The European mouflon, *O. musimon*, has been introduced into many areas in continental Europe as a game animal, including the Czech Republic, the Slovak Republic, France, Germany, Italy, Spain, the Balkans etc. The current distribution of urial extends from Iran eastwards into Pakistan and Afghanistan. Southeast Pakistan represents the southern limits, while the northern extent of their range is in Uzbekistan. Urial, like mouflon, primarily inhabit the lower mountain slopes and foothills of the higher mountains. Some of the isolated and local populations of the urial and mouflon are classified as vulnerable and endangered by IUCN. Total population sizes are generally not known.

THREATS TO SURVIVAL

Their use of low elevation habitats brings the wild sheep into closer contact with humans than most other *Caprinae*. As a result, they are especially vulnerable to overhunting, habitat loss and competition for food with domestic stock. Disease transmission from domestic livestock may also be a threat. For many, their small population size makes them vulnerable to stochastic events and possibly to inbreeding depression. Civil disturbances, and warfare have had a negative impact on the wild sheep and goat populations of the world.

Photo 3.7: Mouflon (France). Believed to be the ancestor of most breeds of domestic sheep.

CAPTIVE BREEDING

The global captive population of mouflon-urial is 392 in 32 institutions (ISIS, 1993). Iraq has established wildlife breeding centres but there is no evidence that mouflon are being bred in captivity there. All the domestic breeds of sheep have 2n = 54 chromosomes and their karyotype is identical to that of the European mouflon, the Asiatic mouflon, *O. orientalis*, and the Bighorn and Dall sheep of North America, *O. canadensis* and *O. dalli*. The Snow sheep, *O. nivicola*, of eastern Siberia has only 52 pairs of chromosomes whereas the urial, *O. vignei*, of Iran, Tajikistan and Afghanistan has 58 pairs. Whether these chromosomal differences represent the cause or a consequence of speciation and domestication is open to question (Short, 1976). Almost all the European, Asiatic and North American wild species of sheep will produce fertile hybrids when crossed with domestic sheep (Gray, 1971). The main exception is the Barbary sheep or Aoudad, *Ammotragus lervia*, 2n = 58, which is more of a goat than a sheep and can produce live offspring when crossed with the domestic goat, *C. hircus*.

DOMESTICATION AND ECONOMIC IMPORTANCE

The mating of wild Argali/Arkhar, *O. ammon kaselini*, rams of Tibet, Kazakhstan and Mongolia (which have 2n = 56 chromosomes) with fine-wool domestic ewes results in a unique high-producing mutton/wool Arkhar-merino sheep which is well adapted to the high mountain pastures of some eastern countries of the former Soviet Union (Gray, 1971).

Present evidence suggests that while some interspecific ovine hybrids are fertile, others are not even carried to term. It has been suggested by Short (1976) that it might be possible to produce a third class of sterile hybrid, an 'ovine mule'. Such an animal could be of great agricultural significance since it would obviate the need to castrate the males as a husbandry procedure. Sterile hybrids could

be produced for fattening by crossing two species maintained as straight-breeding populations. Although all domestic sheep may have been derived from the mouflon, there could be some benefit from back-crossing to the ancestral stock, since records show that *O. orientalis* has a very long breeding season in the United Kingdom; births extending from January to November, with a peak in April (Zuckerman, 1952).

The very large Marco Polo sheep, *O. ammon poli*, said to number 3 000 in 1972 and 1 300 in 1997, thrive at elevations up to 6 000 m asl in the Afghan Pamirs (Petocz, 1973, Habibi, 1977). These impressive animals, which weigh up to 136 kg, have developed a very rapid growth rate and food conversion efficiency so that their lambs can make the most of the transient high-altitude summer. These attributes, along with large body size, might be extremely useful for incorporation into new domestic sheep breeds for highland environments where a larger sheep would have a survival advantage. Disadvantages would be the absence of wool and the very short mating season of *O. ammon poli*, but even these problems might be overcome by judicious genetic manipulation (Short, 1976).

REMARKS

A full account of the wild sheep and goats and their relatives can be found in Shackleton (1997).

2 WILD GOAT

Capra aegagrus — *SOME RACES VULNERABLE*

The goat was the first ruminant to be domesticated and the Cretan wild goat or Bezoar, *C. aegagrus cretica*, is believed to be the ancestor of the domestic goat, *C. hircus* (Clutton-Brock, 1981). Fertile offspring arise from crossing wild and domestic goats. Although various subspecies have been named, the taxonomic status of subspecies of the wild goat, as with many other *Caprinae*, is open to debate and requires study.

DISTRIBUTION AND CURRENT STATUS

Wild goats inhabit forested mountains and are currently found in scattered, often fragmented populations from Crete eastwards through Turkey and Iran as far as southwestern Pakistan. Their northern limits are the Caucasus Mountains of Georgia, Daghestan, Azerbaijan, Armenia and the Kopet Dag Mountains of Turkmenistan. In the recent past they were also found in Lebanon and Syria but they are extinct there now. Their status in Iraq is unknown. Some small isolated populations are classified as vulnerable or endangered. Only in Turkey is the population of *C. aegagrus* not threatened; elsewhere it is indeterminate, vulnerable or endangered.

THREATS TO SURVIVAL

Although there are several thousand wild goats, most populations are small and scattered, and the majority do

TABLE. 3.2.1: THE CHROMOSOME NUMBERS OF DOMESTIC AND WILD SHEEP AND RELATED SPECIES (NADLER ET AL. 1973).

SYSTEMATIC NAME	TRIVIAL NAME	LOCALITY	CHROMOSOMES
Ovis nivicola	Snow sheep	East Siberia	52
Ovis aries	Domestic sheep	Europe	54
Ovis musimon	European mouflon	Europe	54
Ovis orientalis	Asiatic mouflon	Asia	54
Ovis dalli	Dall sheep	North America	54
Ovis canadensis	Bighorn sheep	North America	54
Ovis ammon	Arkhar or Argali	Asia	56
Ovis vignei	Urial	Asia	58
Ammotragus lervia	Barbary sheep	North Africa	58
Capra hircus	Domestic goat	Europe	60
Capra aegagrus	Wild goat	Europe/Asia	60

not occur in protected areas. The Turkish and Iranian populations may be the most secure. Threats come primarily from poaching although habitat loss and competition for forage from domestic livestock are problems in some areas. In Greece, most populations have hybridised with domestic goats and the only remaining true wild goat populations are on Crete and the Island of Theodorou. Hybridisation with domestic goats is a major threat to the survival of the wild goat in many countries.

CAPTIVE BREEDING

The global captive population of wild goats is 97 in 14 institutions (ISIS, 1993). A joint captive breeding programme has been proposed between Syria and Lebanon, with the objective of re-introducing the species into both of these countries where it has recently become extinct. Wildlife breeding stations have been established in Iraq, but it is not clear if the wild goat is being bred there. The chromosome number for the domestic and wild goat is 2n = 60.

DOMESTICATION AND ECONOMIC IMPORTANCE

While hybridisation of wild goats with domestic goats sometimes presents a conservation problem, interspecific crosses, when intentional, may have economic advantages. The development of a population of domestic goat x *Nubian ibex* hybrids is described in the next section. Hybrids between domestic goats and wild markhor, *C. falconeri*, are sometimes produced by chance in Chitral and the offspring, when raised to maturity, are much heavier than the pure domestic goats of the area (100 kg versus 30 kg). These hybrids command high prices as domestic stud animals. Such crosses may have economic potential in the northern mountainous areas of Pakistan (Rasool and Hussain, 1993).

REMARKS

None.

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3 NUBIAN IBEX

Capra ibex nubiana *INDETERMINATE*

The Nubian ibex is not thought to be the descendant of wild goats, but may prove a useful source of genetic material in arid environments. The status of the Nubian ibex as a separate species or subspecies of ibex, *C. ibex*, is currently open to question.

DISTRIBUTION AND CURRENT STATUS

Today this ibex is found in the Middle East from Israel south through Egypt and the Sudan as far as Ethiopia and to the east into Jordan, Saudi Arabia and Oman. It has recently become extinct in Lebanon and Syria and its status in Iraq is unknown. Total numbers are largely unknown and while there may be a few thousand, since they are distributed in many small, isolated and scattered populations, they are threatened everywhere throughout their range.

Photo 3.8: Nubian Ibex (Jordan). Crosses with domestic goats are interfertile and drought tolerant.

THREATS TO SURVIVAL

Poaching, habitat loss and competition for food with domestic livestock are the major threats. However, the fact that most populations are small and isolated makes them especially vulnerable to stochastic events.

CAPTIVE BREEDING

The global captive population of the Nubian ibex is 182 in 18 institutions (ISIS, 1993). In Egypt a captive breeding programme exists at Giza Zoo but there are no immediate plans to re-introduce the animals into the wild. In Jordan there is a similar captive breeding programme and the ibex will soon be released into a national park on the Dead Sea. The gestation period is 150 – 180 days.

DOMESTICATION AND ECONOMIC IMPORTANCE

A population of domestic goat x *Nubian ibex* hybrids (ya-ez) has been developed by the Institute for Animal Research at Lahav in northern Negev, Israel. The Sinai Desert goat was the domestic breed that was used. This animal ranks next to the camel in its ability to sustain long periods without water, but its meat has such a strong flavour that most people consider it inedible. On the other hand, the ibex produces tender, mild meat. It is hoped that the product from cross-breeding these two animals will be able to endure extreme temperatures and drought and make use of poor pasture while producing edible meat. Both sexes are fertile and they can be bred with each other or with either parent.

In the northern areas of Pakistan, one-day-old male ibex kids (and markhor) are fostered by lactating domestic goats. When mature, they are crossed with their foster mothers to produce healthy hybrids.

Apart from the greater body weight of these hybrids, their fecundity is greater too, and they sometimes produce two kids in a year, whereas the local domestic goats usually kid only once.

It is also claimed that the markhor and ibex/goat hybrids are resistant to the common diseases to which domestic goats are susceptible. However, a note of caution is necessary. If these hybrids are able to invade the rugged mountain environment and live alongside the wild markhor and ibex, not only would they compete with the wild species for grazing, they might also introduce domestic goat diseases and damage them genetically by further cross breeding (Rasool and Hussein, 1993).

REMARKS

For a full bibliography and further information on the status of the wild sheep and goats see remarks at the end of the section on wild sheep.

For a full bibliography and further information on the status and conservation of the wild sheep and goats see Shackleton (1997).

3.3 HORSES AND ASSES

Order *Perissodactyla*/Family *Equidae*

1 Przewalski's wild horse
2 African wild asses
- Nubian wild ass
- Somali wild ass
3 Asian wild asses
- Onager
- Kulan
- Kiang
- Dziggatai
- Indian wild ass

1 PRZEWALSKI'S WILD HORSE

Equus przewalskii *EXTINCT*

Photo 3.9: Przewalski's wild horse (Ukraine). The only remaining true horse (other than the domestic horse). Extinct in the wild.

The Asian wild horse, *E. przewalskii*, is the only extant species of true horse other than the domestic horse, *E. caballus*. There have been no confirmed sightings of wild Przewalski's horses since 1966 (Ryder and Wedemeyer, 1982), but the species has been maintained in captivity for the last 90 years. The worldwide captive population now numbers about 1 300 and is entirely descended from 13 wild-caught individuals. The last wild-caught founder entered the pedigree in 1948 at Askania Nova in the Ukraine, where the most important of the captive herds is maintained. About 200 horses are kept at Askania Nova under semi-domestic conditions. There is a plan afoot to reintroduce a number of captive-bred Przewalski's wild horses back into the wild in part of the species' original range in Mongolia. A major constraint to this ambitious project is the risk of hybridisation with the ubiquitous domestic horses of the nomadic Mongolian herdsmen (Ryder, 1993).

THREATS TO SURVIVAL

The long-term threat to the relatively small captive population of Przewalski's wild horse is continued loss of genetic diversity. The numbers cannot be increased much more because the carrying capacity of zoos and ranches is limited as the horses compete with other large mammals for space (Seal *et al.*, 1990).

The global captive population of Przewalski's wild horse is 580 in 59 zoological gardens (ISIS, 1993) – this does not include herds maintained outside of zoological gardens. The chromosome number for Przewalski's wild horse is 2n = 66; domestic horses have 2n = 64 but the genetic material of the two species is so similar that their hybrids are fertile (Ryder *et al.*, 1978). Embryos of Przewalski's wild horse have been successfully transferred to domestic mares (Summers *et al.*, 1987).

REMARKS

For a full account of Przewalski's wild horse see Mohr, (1971).

2 AFRICAN WILD ASSES

Wild equids (African wild asses and Asian wild asses) are said to possess unique behavioural, morphological and physiological characteristics which allow them to exploit grasslands more effectively than other ungulates.

The true wild asses, as distinct from the half-asses or onagers, are of purely African origin. Up to the Roman period there appear to have existed three wild races. One, *Equus asinus asinus*, from which the domestic donkey is probably mainly derived, occurred in Northwest Africa and became extinct in the wild during the Roman era. A second true wild ass lived in the mountainous deserts of Nubia and in eastern Sudan from the Nile to the Red Sea. This subspecies, *E africanus africanus*, which also contributed genomes to the domestic ass, is now reported as extinct in the wild. The third and only surviving subspecies is the Somali wild ass, *E. africanus somalicus* (Zeuner, 1963). However, geographical variations amongst the races of African wild ass may be continuous (clinal) and there may be only one subspecies. This is the currently accepted opinion and the different populations are described by their common geographic names. Mason (1981) draws attention to the paucity of information on all aspects of the domestic donkey, an animal which he points out comprises 47 percent of the world's domestic equines.

NUBIAN WILD ASS

Equus africanus africanus *EXTINCT (IN THE WILD)*

The Nubian wild ass used to occur in Africa north of the Sahara and southwards into the Sudan. It is considered to be extinct in the wild as a result of over-hunting and extensive hybridisation with domestic donkeys. The Nubian wild ass is thought to be one of the main ancestors of the domestic donkey. The wild asses on Socotra Island may be the descendants of Nubian wild asses introduced many centuries ago by the ancient Egyptians (Harper, 1975).

The global captive population of Nubian wild asses is two in one institution (ISIS, 1993).

SOMALI WILD ASS

E. africanus somalicus *ENDANGERED*

This surviving subspecies of the African wild ass is the only wild ancestor of a domestic animal now to be found in Africa. However, according to Zeuner (1963) there is no evidence that this subspecies played a major part in the domestication of the donkey, although the Maasai donkey, which lacks the shoulder stripe, may be descended from it.

DISTRIBUTION AND CURRENT STATUS

The Somali wild ass survives in small numbers in northern Somalia and in the Danakil Depression and Yaugudi-Rassu National Park in Ethiopia. Current numbers, recently depleted further by war and drought, are probably less than 300.

Photo 3.10: Somali wild ass (Israel). Endangered wild relative of the domestic donkey.

THREATS TO SURVIVAL

Although protected on paper in both countries where it occurs, the Somali wild ass is relentlessly hunted for its meat and hide. In Somalia the fat of the wild ass is in great demand as a cure for tuberculosis. Other threats include hybridisation with domestic donkeys, competition for grazing, exclusion from water sources by domestic stock and agricultural development. Political instability, military activities and persistent droughts all present severe threats to the survival of the Somali wild ass.

CAPTIVE BREEDING

The global captive population of the Somali wild ass is 23 in eight institutions (ISIS, 1993). This ass is difficult to breed under captive conditions. The only two captive herds of pure Somali wild asses are at Basle Zoo in Switzerland and Hai Bar in Israel where there were 18

in 1992. These animals were showing signs of inbreeding depression, characterised by birth defects in foals and a depressed breeding rate (Duncan, 1992).

DOMESTICATION AND ECONOMIC IMPORTANCE

It is clear that the Somali wild ass is on the brink of extinction and in view of the agricultural importance of the much-neglected donkey and mule in the semi-arid areas of the world, the genes of this wild ancestor may be of crucial importance for genetic improvement experiments. While the survival of most domestic stock is severely compromised in times of drought, the wild asses may be able to tolerate harsh drought conditions. However, their ability to survive climatic stress may be due to their freedom to move long distances in search of grazing and water.

REMARKS

For references see the end of the section on African and Asian wild asses.

3 ASIAN WILD ASSES

There are eight subspecies and several more geographically distinct populations of the wild ass in Asia. One, the Syrian, *E. hemionus hemippus*, which has been extinct for more than sixty years, is believed to have once been domesticated. The last Syrian wild ass was shot coming for water at the Al Ghams Oasis at Azraq in 1927.

In China and Mongolia, equids (kiang and dziggatai) are harvested for their skins and meat, but unfortunately the economic importance of the trade in these resources is largely undocumented.

ONAGER

Equus hemionus onager — *ENDANGERED*

DISTRIBUTION AND CURRENT STATUS

The range of the onager has now been reduced to Israel and the northern desert plateau of Iran. Within this range less than 400 onagers are said to survive in three protected areas.

THREATS TO SURVIVAL

The main threats to survival are overhunting and competition with domestic stock for forage and water. In Iran onagers are shot from vehicles for meat and medicine.

CAPTIVE BREEDING

The global captive population of the onager is 98 in 15 institutions (ISIS, 1993). There are about 50 onagers at Hai Bar in Israel, but these may have some kulans among their founders. This herd is to be used to produce animals for re-introduction into Makresh Ramon (central Negev) to replace the extinct Syrian wild ass. There are now at least 30 free-ranging onagers in the Negev.

Photo 3.11: Onager (Jordan). Has a reputation of great endurance under climatic extremes.

DOMESTICATION AND ECONOMIC IMPORTANCE

Onagers are believed to have been domesticated by the Sumerians at Ur where they were used for pulling chariots in 2 500 BC. They are said to have a reputation for great endurance in the climatic extremes under which they live. Cross-breeding with domestic donkeys might be investigated, but the male hybrid would be sterile (Ryder *et al*, 1978).

KULAN

Equus hemionus kulan — *ENDANGERED/ INSUFFICIENTLY KNOWN*

DISTRIBUTION AND CURRENT STATUS

The kulan is now confined to Turkmenistan and Kazakhstan where it survives in small isolated herds. Total numbers are probably around 2 000. Since 1941 kulans have been protected in Badkhyz Nature Park, in southern Turkmenistan. An increase in the population in this park has allowed some kulans to be translocated to other areas to create new populations (Wolfe, 1979). The new populations of kulans were maintaining themselves in the 1980s, but their small sizes render them endangered.

THREATS TO SURVIVAL

Excessive hunting and competition with domestic stock are the main causes of the kulan's decline.

CAPTIVE BREEDING

The global captive population of the kulan is 94 in 12 institutions (ISIS, 1993).

DOMESTICATION AND ECONOMIC IMPORTANCE

The kulan is another wild ass with remarkable powers of endurance. It is said to be impossible to out run a kulan with a domestic horse. This ass has never been domesticated and is now threatened with extinction.

KIANG
Equus kiang *INDETERMINATE*

DISTRIBUTION AND CURRENT STATUS

The Kalamaili Mountain Ungulate Fauna Nature Reserve in Xinjiang, China is reported to contain a large population of western kiangs, *E.k. kiang*, and some 2 000 are found in Jammu/Kashmir and Sikkim (Gao and Gu, 1989). The eastern kiang, *E.K. holdereri*, occurs in considerable numbers in Xinjiang and Tibet. As many as 30 000 are reported in the Arjin Mountain Nature Reserve in China (Butler *et al.*, 1986). Further survey work using modern techniques is badly needed in these remote areas. About 25 survive in the eastern part of Khunjerab National Park, Pakistan (Rasool, 1992).

THREATS TO SURVIVAL

Overhunting and extreme weather conditions contribute to the continuing decline of the kiang. The breakdown of law and order in Jammu/Kashmir and competition with increasing livestock numbers both present a threat to the kiang.

Photo 3.12: Kiang (China). Still present in some numbers in China and Tibet.

CAPTIVE BREEDING

The global captive population of the kiang is 23 in seven institutions (ISIS, 1993).

DZIGGATAI
Equus hemionus luteus *ENDANGERED/ INSUFFICIENTLY KNOWN*

The last dziggatai in Kazakhstan was shot in the 1930s, but today Gobi dziggatais still occur in some thousands in the Great Gobi Desert National Park. The decline in their numbers in China and Mongolia is probably due to overhunting and competition with domestic stock for forage and water (Gao and Gu, 1989).

CAPTIVE BREEDING

There are no dziggatais in captivity.

INDIAN WILD ASS
Equus hemionus khur *ENDANGERED*

DISTRIBUTION AND CURRENT STATUS

This subspecies which is probably one of the more numerous of the Asian wild asses is confined to the Rann of Kutch in the north Kathiawar Peninsula of India. Some seasonal migration northwards into southern Pakistan may take place. Total numbers are said to be about 2 000 (Smielwski and Raval, 1988).

THREATS TO SURVIVAL

The local inhabitants of the Rann of Kutch are vegetarian so hunting is not a major threat. It is believed that surra, due to infection with *Trypanosoma evansi*, brought to the Rann by domestic camels and other livestock, may have a negative impact on the wild ass population. Competition with domestic stock for grazing is also a factor, as is exclusion from water sources and habitat due to human settlement, cultivation and salt extraction.

REMARKS

The African wild asses and the Asian wild asses will interbreed, but their hybrids are infertile (Ryder *et al*, 1978). ISIS (1993) does not record any Indian Wild Asses in captivity. The gestation period of all the equids is 335 – 420 days.

For a full account of the status and conservation of wild horses and asses see Duncan (1992).

3.4 WILD PIGS

Order *Artiodactyla*/Family *Suidae*

1 Eurasian wild pig
2 Sulawesi warty pig

The wild ancestor of the majority of domestic breeds of pig is the Eurasian wild pig, *Sus scrofa*. There is evidence that *S. scrofa* has been independently domesticated in several widely separated geographic locations and times, using different founder stocks which originated in local subspecies or races. The Sulawesi warty pig, *Sus celebensis*, has also been domesticated on the island of Sulawesi, probably in the early Holocene.

1 EURASIAN WILD PIG

Sus scrofa *NOT THREATENED*

Photo 3.13: Eurasian wild pig (Eurasia). Ancestor of the majority of breeds of domestic pigs.

DISTRIBUTION AND CURRENT STATUS

The Eurasian wild pig occurs throughout southern Europe, Asia, northern Africa and southwards to the Sudan. It is present in large numbers. The failure of the species to extend further into Africa may be due to the presence of the African Swine Fever (ASF) virus to which this pig is very susceptible, but which is an inapparent infection of the indigenous warthogs, *Phacochoerus aethiopicus*, and bush pigs, *Potamochoerus porcus*.

THREATS TO SURVIVAL

There are few threats to the survival of the Eurasian wild pig. However, the introduction of ASF virus into Portugal, Spain and Italy has had a marked impact on local populations of Eurasian wild pigs in these countries.

CAPTIVE BREEDING

The global captive population of Eurasian wild pigs is 105 in 32 institutions (ISIS, 1993).

DOMESTICATION AND ECONOMIC IMPORTANCE

Wild pigs, or their domestic and feral derivatives, have been widely distributed by man as a source of food. Populations have become established, often in large numbers, on all continents except Antarctica. Most naturalised populations are regional variants of the Eurasian wild pig. Some of these are considered to be of interest in terms of the regional genetic diversity of *Sus*, with possibilities for further domestication of this most important source of animal protein. In some countries, especially in non-Muslim Southeast Asia, pigs also have cultural and religious importance for the local people.

REMARKS

Introduced and feral pigs have had a profound and usually negative impact on wildlife, forestry and agriculture in the eco-systems to which they have been introduced. In many places attempts are made to eradicate them but their feeding habits, fecundity and cryptic behaviour render this extremely difficult.

2 SULAWESI WARTY PIG

Sus celebensis *NOT THREATENED*

DISTRIBUTION AND CURRENT STATUS

This wild pig occurs as a native form only on Sulawesi and some adjacent islands. It has been introduced onto some of the Lesser Sunda and West Sumatran Islands as a domesticated or feral form. On the Moluccas, whence it was translocated, it has hybridised with *Sus scrofa* and has given rise to *S. papuensis*, the domestic and feral pig of Papua New Guinea. On many islands of Indonesia the Sulawesi warty pig is common and in some places, abundant.

THREATS TO SURVIVAL

In the wild, overhunting, deforestation and disturbance due to human settlement are the main threats. Overall, Sulawesi warty pig populations are declining and in some areas have been greatly reduced by uncontrolled hunting.

CAPTIVE BREEDING

There is a wealth of unrecorded indigenous experience about the domestication of this animal, but the information needs to be collected and appraised. The genetic variability within the species, as well as the karyotypic differences from other *Sus* species and hybrids, needs definition. There are no Sulawesi warty pigs in captivity (ISIS, 1993).

DOMESTICATION AND ECONOMIC IMPORTANCE

As a source of meat the Sulawesi warty pig has been exploited since prehistoric times. The presence of feral specimens far beyond the species' natural range indicates that traders or migrants have translocated it either in

domesticated form or as wild animals to be released later for hunting. The tusks can be carved like ivory and the wild Sulawesi warty pig is considered a suitable trophy for sport hunting. There is some potential for hybridisation with domestic pigs for the improvement of the common pigs of tropical regions.

REMARKS

It has been suggested but not proven that the Sulawesi warty pig may possess resistance or tolerance to many of the diseases prevalent in its native habitat. However, the diseases themselves have not yet been investigated.

The Pigs and Peccaries Specialist Group at SSC/IUCN considers that wild pigs of any species or subspecies (or their domestic or feral derivatives) should never be deliberately released to range freely outside their known, recent or original distribution and that all possible efforts should be made to prevent the accidental naturalisation of domestic or wild populations of these animals.

A full account of the status and conservation of wild pigs can be found in Oliver (1993).

3.5 CAMELIDS

Order *Artiodactyla* / Family *Camelidae*

1 New World Camelids
- Vicuña
- Guanaco

2 Old World Camelids
- Wild camel

The Camelids originated in North America during the Pliocene Period, at the end of which, three million years ago, they migrated to Africa and west Asia, across the Bering Strait. Here they evolved into the *Camelini,* which include the modern Bactrian, two-humped camel of Asia and the Dromedary or one-humped camel, which is distributed throughout the Middle East and North Africa. The camelids also migrated southwards over the Panama Isthmus and spread into South America where they evolved into the *Lamini* tribe. Finally, the ancestral camelids became extinct in North America.

1 NEW WORLD CAMELIDS

At present the wild South American camelids are represented by the vicuña, *Vicugna vicugna*, and the guanaco, *Lama guanicoe*, which is the ancestor of the domesticated llama, *Lama glama*, and alpaca, *Lama pacas*. The South American camelids belong to the order, *Artiodactyla*, suborder *Ruminantia* and family *Camelidae*.

VICUÑA

Vicugna vicugna *VULNERABLE*

Two geographic subspecies of vicuña have been described. The first, *V.v. vicugna* is found south of latitude 18ºS. It is larger and lighter in colour than the more northerly *V.v. mensalis*.

DISTRIBUTION AND CURRENT STATUS

The vicuña inhabits the High Andes, at an altitude of between 3 000 and 4 000 m asl. Present distribution range is from 9º30'S to 29º00'S in Argentina, Bolivia, Chile and Peru. Peru supports more than half the total vicuña population in those countries that protect the species, however, very serious difficulties face its present conservation in that country. The vicuña population of Argentina is said to be recovering despite problems of poaching and erratic law enforcement. In Bolivia, the population is very unstable due to lack of continuity in protection policies instituted a few years ago. In Chile, the vicuña population shows a marked recovery and the danger of extinction which threatened it until very recently has been averted. Current population estimates, based on censuses carried out in 1990 (Argentina and Peru) and in 1989 (Bolivia and Chile), are as follows:

Peru	97 670
Argentina	23 000
Bolivia	12 047
Chile	27 921
Total	**160 638**

The world population is stable but could rapidly fall if conservation efforts were to be relaxed.

Photo 3.14: Vicuña (Peru). Producer of very high quality wool. Crossed with alpaca to improve wool quality.

THREATS TO SURVIVAL

The most important threats to the survival of the vicuña in the wild include illegal hunting, increasing competition with domestic llamas and alpacas for grazing and lack of funds for long-term conservation activities. Illegal hunting has intensified in Bolivia and Peru, overwhelming the ability of the authorities to control it, especially in areas where guerrilla activities have escalated. The recent conspicuous increase in the vicuña population achieved as a result of protection, will render long term conservation of the species difficult unless the local people on whose land the vicuña live receive some tangible benefits. Bad weather and predation by the puma, *Felis concolor*, are also said to influence the vicuña's recovery in some areas.

CAPTIVE BREEDING

The global captive population of vicuña is 49 in 15 institutions (ISIS, 1993). The gestation period is about 330 days.

DOMESTICATION AND ECONOMIC IMPORTANCE

Semi-domestication will follow the establishment of adequate protection of the wild resource from uncontrolled utilisation. The sustainable utilisation of the vicuña, together with well-defined participation of local communities, could greatly supplement village economies by enabling them to transform vicuña fibre into cloth of the best quality in the world.

The wool, hides and meat are all resources of great importance to local communities. Although the vicuña populations of Peru and Chile have reached a viable size, utilisation of the species at an industrial level has not yet begun. At present, experiments to improve techniques for capturing, shearing and releasing individual animals are taking place.

In Argentina, there are no sustainable vicuña utilisation prospects for the immediate future. It was originally thought that the vicuña is the ancestor of the alpaca, but now it is widely believed that both the llama and the alpaca derive from the guanaco. Hybrids produced between a male vicuña and a female alpaca (or vice versa) are called paco-vicuña and are bred in order to obtain finer wool than that of the pure alpaca.

REMARKS

"The courtship of the llama embarrasses the farmer but it copulates far sooner than the kinkier vicuña."

Stuart Piggott

GUANACO

Lama guanicoe — *NOT THREATENED*

The guanaco is the largest South American camelid. Four geographic subspecies have been described; *L.g. guanicoe* is found in Argentina and Chile south of 38ºS, *L.g. huanacus* is restricted to Chile, *L.g. cacsilensis* occurs in the High Andes of Peru, Bolivia and northeastern Chile and *L.g. voglii* is restricted to the eastern slopes of the Andes between 21ºS and 32ºS in Argentina.

DISTRIBUTION AND CURRENT STATUS

The guanaco occurs along the Andes from approximately 8ºS to Tierra del Fuego at 53ºS. In Argentina the distribution of the guanaco is characterised by rapid changes due to the species interaction with human communities. It has a migratory tendency and its ability to utilise a wide range of habitats allows it to travel long distances. In Bolivia the current distribution of the guanaco is not known, but it appears to be concentrated between 19º– 22ºS and 62º– 65ºW, ranging from 300 m asl in the Chaco to 3 800 m asl in the Andes. In Bolivia the guanaco is on the edge of its natural range. Chile has a large population of guanacos on Tierra del Fuego Island and another along the eastern border with Argentina. The guanacos of Peru are scattered throughout five departments, most of them in the south. Population estimates for the four countries are (1989 and 1990):

Argentina	550 000
Bolivia	54
Chile	19 836
Peru	1 347
Total	**571 237**

The exact distribution and population densities of the guanaco in South America are unknown. However, while the current numbers are thought to be stable they are vulnerable to sudden decline.

THREATS TO SURVIVAL

Intense, unsustainable commercial hunting is the main threat. Sheep farmers in Argentina and Chile vigorously oppose the guanaco because they believe it competes for food with their sheep and presents a disease risk. In fact, the disease risk is to the guanaco from the sheep (Karesh *et al.*, 1998).

CAPTIVE BREEDING

The global captive population of guanaco is 313 in 71 institutions (ISIS, 1993). The gestation period is about 330 days.

DOMESTICATION AND ECONOMIC IMPORTANCE

Both the domestic llama and alpaca are believed to derive from the wild guanaco which was domesticated by the Incas and their predecessors. Trade in guanaco hides has shown reasonable economic potential for several decades and there is an increasing demand for guanaco meat at the local level. In Argentina guanacos are hunted for their skins for export, but the meat is not consumed or used commercially. Experimental, semi-captive breeding is in progress, while utilisation of wild populations has concentrated on live capture, shearing and release. The practice of periodic shearing of live animals enables a recovering population to be utilised for profit without affecting its growth. Mixed guanaco/domestic animal farming is an option that may be profitable in marginal areas. However, the tendency of the guanaco to migrate renders the necessity for semi-captivity and presents an additional management cost.

REMARKS

For a full account of the present status, conservation and utilisation prospects for the vicuña and the guanaco in South America see Torres (1992) and FAO (1985).

2 OLD WORLD CAMELIDS

There are two camelid species in the Old World. One, the single-humped dromedary, *Camelus dromedarius*, which has no extant wild ancestor and the other, *C. bactrianus* which has two humps and is represented by a wild progenitor, *C. ferus ferus*. There is, however, a large feral population of C. *dromedarius* in Australia.

WILD CAMEL

Camelus ferus ferus *VULNERABLE*

The wild, two humped (misnamed Bactrian) camel was once thought to be native to Bactria in northern Afghanistan hence the name Bactrian. In fact, it never occurred in the wild anywhere near Bactria.

Photo 3.15: Bactrian camel (Afghanistan). Two small populations of the wild relative of this camel survive in Mongolia and China.

DISTRIBUTION AND CURRENT STATUS

The wild camel is now confined to two areas between the lakes of Lob Nor and Bagrach Kol at 1 500 – 2 000 m asl in south-western Mongolia and north-western China. This is a remote part of the Transaltai Gobi desert and the wild camel population there is probably less than 500 and declining.

THREATS TO SURVIVAL

The main threats to survival of the wild camel are hunting pressure, competition for food with domesticated stock, hybridisation with the domesticated Bactrian camel and disturbance by nomadic herdsmen.

CAPTIVE BREEDING

There are few records of *C. ferus ferus* having been bred in captivity (ten in two institutions) (ISIS, 1993). However, there is believed to be a small semi-domesticated herd in the Gobi Altai in Mongolia. The wild camel and its domestic relative can be cross-bred with the dromedary to produce fertile offspring. In inter-specific hybridisation it is difficult to maintain hybrid vigour by breeding the first generation hybrids among themselves or by grading to either of the initial species, but maintenance of heterosis through criss-crossing has given positive results. The gestation period is about 400 days.

DOMESTICATION AND ECONOMIC IMPORTANCE

The wild camel is able to survive in the extremely harsh climate of the Gobi Desert. It has great powers of endurance and its domestic relatives are used as pack and riding animals in Mongolia and Afghanistan. The wool of the domesticated wild camel is used to make the felt of which the yurts of the nomads are made.

REMARKS

See FAO (1989).

3.6 DEER

Order *Artiodactyla*/Family *Cervidae*

1 Red deer
2 Sika deer
3 Wapiti
4 Sambar
5 Rusa, Timor or Javan deer
6 Hog deer
7 Fallow deer
8 Chital or Axis deer
9 Reindeer/Caribou
10 Musk deer
11 Pere David's deer
12 Moose/Elk

The wild relatives of the several deer species which have been domesticated or semi-domesticated in recent years are in most cases still present in the wild in considerable numbers. Some local geographic subspecies are, however, classified as endangered or vulnerable by IUCN.

Deer of various species have long been exploited by man as mobile sources of meat. On military expeditions the Romans herded fallow deer as a source of meat and more than a thousand years ago, red deer were driven down from the Scottish Highlands for winter meat supplies.

In recent years there has been much interest in the domestication and farming of different species of deer under varying degrees of intensification. The main countries where this is taking place are as follows: red deer in New Zealand, Australia, Taiwan, Korea, Russia, China, United Kingdom and the United States of America; wapiti (elk) in New Zealand, Canada and the United States of America; fallow deer in New Zealand, Australia, United Kingdom, Denmark, Sweden, Switzerland, Germany and the United States of America; rusa deer in Australia, Mauritius, New Zealand and Papua New Guinea; sika deer in Taiwan and New Zealand; musk deer in China and India; and Pere David's deer in New Zealand. Although not yet truly domesticated, the European elk, *Alces alces*, has been tamed by bottle-raising the calves in Scandinavia and Russia. The number of farmed deer in the world is difficult to estimate because the industry is expanding at 20 percent per annum, however, in 1993 the international herd stood at well over five million (Chardonnet, 1993).

Hybridisation of deer of temperate zone origin with other species of tropical origin is becoming a common practice, especially on New Zealand deer farms, in an attempt to maximise production by manipulating the changes in the time of the mating season and gestation length which are displayed by the hybrids.

Wapiti, sika and Pere David's deer all hybridise with red deer and produce fertile offspring. Tuberculosis is proving to be a considerable problem in domesticated deer herds especially in New Zealand, United Kingdom and the United States of America.

New Zealand now has over 5 000 deer farms carrying more than a million deer. New Zealand has declared so-called farmed deer to be domestic animals and these must now be slaughtered in Deer Slaughter Premises that comply with the standards for export abattoirs. The export of velvet (dried developing antlers) is subject to export protocol standards and to health regulations relating to the processing of a food product. These regulations are primarily hygiene-based. Deer of several species are undergoing various degrees of domestication in several European countries, the United States of America, Canada, Southeast Asia and Australia.

TABLE. 3.6.1: SOME REPRODUCTIVE PARAMETERS OF THE WILD RELATIVES OF FARMED DEER.

SPECIES	GESTATION PERIOD (DAYS)	DIPLOID CHROMOSOME NO.
Red deer	231	68
Sika deer	228	64 – 68
Wapiti	238	68
Sambar	240	58, 64, 65
Hog deer	225 – 230	68
Fallow deer	225	68
Rusa or Javan deer	250	60
Chital or Axis deer	210 – 225	66
Reindeer/Caribou	240	70
Musk deer	178 – 198	?
Pere David's deer	190	68
Moose/Elk	216 – 231	?

Source: *(Hsu and Benirschke, 1977)*

1 RED DEER

Cervus elaphus *NOT THREATENED*

The red deer survives as at least five subspecies and several geographic races whose status ranges from critical to not threatened. The subspecies under domestication throughout the world are the nominate species, *C.e. elaphus* (the red deer of United Kingdom), *C.e. sibiricus* (the maral of Iran, Turkey and Russia) and *C.e. canadensis*, (the wapiti of North America). The maral is considered not threatened and under domestication is often hybridised with the wapiti (which is also considered not threatened).

C.e. elaphus has been introduced into Morocco, United States of America, Argentina, Chile, Australia and New Zealand. The wapiti (also called elk in North America), which is the largest race of the red deer, has been introduced into New Zealand and the Ural mountains of Russia. Deer farms, often largely populated with *C.e. elaphus*, are

springing up all over the temperate world, especially in the Antipodes, Europe, North America and European Russia (in Russia there are 40 000 wild and 46 000 domestic maral). The wapiti and the maral are frequently crossed with the red deer and produce fertile offspring.

2 SIKA DEER

Cervus nippon nippon — *NOT THREATENED*

The sika deer is native to Japan and survives globally as at least 13 subspecies. The status of these varies between critical and not threatened. Only the Vietnamese race (*C.n. pseudaxis*) is truly tropical. The Taiwanese race (*C.n. taioanensis*) and the Kopschi Sika (*C.n. kopschi*) are sub-tropical. The sika species under domestication is the nominate, *C.n. nippon*, which has been introduced into the United Kingdom, Ireland, Madagascar, Denmark, France, Germany, Czech Republic, Azerbaijan, United States of America and Oshima Island in Japan. In Russia there are 15 000 wild and 65 000 domestic sika deer. Sika deer comprise 78 percent of the deer farmed in Asia (excluding Russia and the reindeer). The Taiwanese sika deer has disappeared from the wild, but survives in large numbers on deer farms from which it is now possible to reintroduce this subspecies back into its former wild habitat (Chardonnet, 1993). The sika deer is well suited to domestication since it is gregarious and polygamous, withstands high densities and close confinement, is easily tamed and is a rough grass grazer.

3 WAPITI OR ELK

Cervus elaphus canadensis — *NOT THREATENED*

See Red Deer, *C.e. elaphus* above.

Photo 3.16: Sambar (India). Now under domestication.

4 SAMBAR

Cervus unicolor unicolor — *NOT THREATENED*

This large deer is present in some numbers in India, Sri Lanka, Myanmar, Thailand, Cambodia, Laos, Vietnam and China. Other geographic races occur locally in China, Taiwan, Sumatra and Malaysia. It has been introduced into Australia, New Zealand and the United States of America. Its status varies. The nominate race is not threatened but some geographic subspecies are vulnerable or endangered. Sambar are farmed on a small scale in Vietnam, Taiwan and Thailand.

5 RUSA, TIMOR OR JAVAN DEER

Cervus timorensis russa — *NOT THREATENED*

This small deer species is native to Indonesia where it occurs as six geographic races, the status of which are largely unknown. Rusa have been introduced into the Indonesian island of Ambon, Sulawesi, Mauritius, Comoro Islands, Madagascar, Brazil, Australia, New Caledonia and New Zealand. Most of these introductions have been for the purpose of establishing deer farms in the tropics where the rusa, a truly tropical deer, is ideally adapted. It hybridises with the red deer to produce fertile offspring.

6 HOG DEER

Axis porcinus — *NOT THREATENED*

This small forest deer is a relatively common inhabitant of Southeast Asian forests and is not threatened. It breeds freely in captivity and is kept on a small scale in Thailand and Australia. The hog deer has some potential for domestication and will probably be farmed in larger numbers in the future.

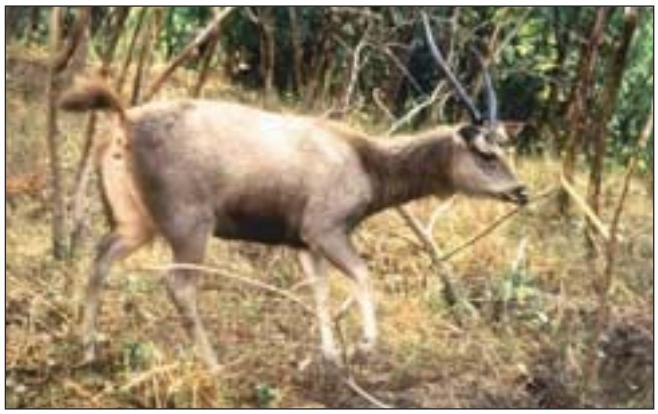

Photo 3.17: Hog deer (Thailand). A small Asian forest species with potential for domestication

7 FALLOW DEER

Dama dama — *NOT THREATENED*

The natural distribution of *D. dama* in historic times has not been defined, but probably includes most European countries and Turkey. A subspecies, *D.d. mesopotamica*, whose status is critical, occurs only in Iran. *D. dama* has been introduced into South Africa, Australia, Fiji, United States of America, Argentina, Chile, Peru, Uruguay and the Leeward Islands. It is a popular species for semi-domestication for deer parks in Europe, some of which have main-

tained it for hundreds of years. Artificial insemination has been successful in farmed fallow deer (Asher *et al.*, 1988). It is not threatened in the wild.

This species is highly susceptible to tuberculosis and is believed to have been the source of a tuberculosis outbreak in the animal collection of the late King Khalid of Saudi Arabia. The collection contained numerous valuable native oryx and gazelles and years of work and huge sums of money were required to clear these animals of tubercolosis. This case is a cautionary tale on how expensive it can be not to follow sound health and hygiene procedures with captive animals. It also indicates that the susceptibility of deer to tuberculosis is a very important management issue.

8 CHITAL OR AXIS DEER

Axis axis *NOT THREATENED*

The chital is a native of Sri Lanka, Bangladesh and India and is not considered to be threatened. It has been introduced into the Hawaiian Islands, New Guinea, Australia, Brazil, Argentina, Balkans, United States of America and the Andaman Islands. Axis deer are non-seasonal breeders and come into oestrus throughout the year, regardless of the latitude at which they are kept. Thus the date of the birth of the fawns can be programmed by controlling the time of access of the bucks. If it is arranged for the does to fawn in the early spring this would give their fawns a two-month advantage over red deer and fallow deer which, being seasonal breeders, rut in the autumn and give birth the following summer (Kyle, 1990).

9 REINDEER/CARIBOU

Rangifer tarandus *NOT THREATENED*

The caribou is the wild relative of the domestic reindeer, an animal of great economic importance in northern Scandinavia and Russia. Reindeer farming in these harsh northern climes is said to be more profitable than fur farming, fishing or farming other domestic species for meat.

The main differences between the wild caribou and the domesticated reindeer are believed to be behavioural. When reindeer are threatened by wolves, they herd or form a compact group. When wild caribou are so threatened they scatter in all directions. It seems possible that today's domestic reindeer have been selected for the herding propensity, which, of course, renders them much more manageable than if they scattered like the caribou. If this is the case, it might take a long time to domesticate Canadian caribou satisfactorily, as suggested by Mason (1981). So far the caribou has never been domesticated. Domestic reindeer have been introduced into Canada and South Georgia, Malvinas. When domestic reindeer were introduced into western Greenland from Norway, they brought with them two important parasites, a warble fly and a nasal bot fly, which have had a severe impact on the native, wild caribou (Thing and Thing, 1983; Woodford and Rossiter, 1993).

DISTRIBUTION AND CURRENT STATUS

The reindeer/caribou is widely distributed in northern Scandinavia, Russia, Kazakhstan, the Greenland coastal areas and northern North America. There are estimated to be two million wild caribou in Canada and 900 000 wild reindeer in Russia. With about 2.3 million domestic reindeer, Russia has 74 percent of the world's domestic reindeer stock.

Photo 3.18: Reindeer (Norway). Domestic counterpart of the conspecific wild caribou, this animal is of great economic importance in Scandinavia and Northern Russia.

THREATS TO SURVIVAL

There are no immediate threats to the survival of the wild reindeer in the Old World or the caribou of the New World. In northern Russia (Taimyr Peninsula) outbreaks of anthrax have taken a heavy toll. On occasion, Rinderpest and Foot-and-Mouth disease have also caused considerable losses in northern Russia. Wolf predation may be significant in some areas.

CAPTIVE BREEDING

Reindeer breed freely in captivity. The chromosome numbers for reindeer and caribou are n = 72 to 74.

DOMESTICATION AND ECONOMIC IMPORTANCE

Domestication of reindeer is believed to have originally taken place in northern Russia. It is commonly assumed that reindeer domestication was achieved by group or herd taming rather than by habituating individuals. Primitive hunters probably followed the wild herds and gradually took over management of them, rather than undertaking the laborious task of catching and rearing individual young animals. The economic importance of reindeer husbandry in northern latitudes cannot be overestimated and several national minorities are totally

dependent on this animal. Reindeer products provide humans with all they need for survival in the rigorous northern conditions. Reindeer produce high quality venison, skins, fur and velvet (unossified developing antlers) which contains biologically active substances used in oriental medicine. Reindeer are also used as transport animals.

Four native domestic reindeer breeds have been identified in the Commonwealth of Independent States (CIS). These differ in productivity and conformation as well as in adaptation to environmental and climatic conditions. These breeds are the result of selection by various northern tribes.

10 MUSK DEER

Moschus moschiferus moschiferus *ENDANGERED*

There are at least five subspecies of musk deer. The musk deer, which is not a true deer but belongs to its own family, the *Moschidae*, is a very small animal, standing 50 – 60 cm at the shoulder and having a mature weight of 6 – 11 kg. Neither sex has antlers but the males have long upper canine teeth, which project downwards well below and over the lower lips. Musk deer mainly occur in dense upland woodland. In the Himalayas their upper limit coincides with the tree line which is at about 4 600 m at the eastern end.

DISTRIBUTION AND CURRENT STATUS

The musk deer is widely but irregularly distributed in small numbers throughout the forested mountainous parts of most of Asia. There is a population that extends from just north of the Arctic Circle southwards to the northern edge of Mongolia and Korea. Others occur in China, Vietnam, Bhutan, Assam, Tibet, Indian Himalayas, Nepal, northern Pakistan and Afghanistan. With the exception of China and Bhutan, where the numbers are probably stable, populations are very localised and declining. In south China, a recent estimate puts the musk deer population at 100 000 head, while in western and north-western China between 200 000 and 300 000 are said to occur.

THREATS TO SURVIVAL

The main threat to the musk deer is uncontrolled hunting which in most places is driving the animal to extinction. Livestock and deforestation are increasingly eroding their habitat. The hunting methods employed are particularly unselective and wasteful. Most are snared in traps, caught in nets or killed by poisoned stakes set in their trails. These methods kill all animals indiscriminately, even females and fawns which do not produce musk. This waste of young and reproductive animals is extremely destructive to the population.

CAPTIVE BREEDING

Musk deer farms have existed in China since 1958. Most of these are in Sichuan, Shanxi and Anhui Provinces. Despite heavy initial losses, mainly during transportation and acclimatisation, the Chinese now breed musk deer in considerable numbers. The gestation period of the musk deer is 178 - 192 days and the female bears one to three fawns per year.

DOMESTICATION AND ECONOMIC IMPORTANCE

The important product of the musk deer is the thick waxy secretion of small glands in the inguinal region of the male deer. This is called musk and is one of the most valuable substances in the animal kingdom. Musk is used in oriental medicines as well as in European perfumes and in recent years it has sold, by weight, for three times the price of gold. Musk is traditionally obtained by killing the deer and removing the glands.

The dried glands, called pods, contain about 30 g of a reddish brown waxy powder that is used as a fixative in the perfume industry and as an ingredient of more than 200 Japanese medicines. The international trade in musk originating from both northern and southern sides of the Himalayan divide amounts to 200 kg of musk per year which represents an annual slaughter of 20 000 – 30 000 male deer plus a similar number of females and young.

The musk deer being farmed in China are kept under primitive conditions, but non-lethal techniques for extracting musk using a curved spoon have been developed. However, so far the yield of musk has been small and the life of the captive deer short. In India small collections of musk deer have been established by the Forest Departments of Himachal Pradesh and Uttar Pradesh. At least one perfume factory in France is known to be interested in the domestication of musk deer in order to obtain a legal, humane supply of musk.

Trade in the Himalayan musk deer and its products is banned by all countries that are parties to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). However, products from musk deer from Russia, the CIS and China can be traded under license. Unfortunately, buyers of musk often require the whole pod (which can only be obtained after killing the animal) because the musk removed from the living animal can easily be adulterated and this creates market resistance to the farmed product.
The conservation of the remaining wild population of the musk deer will be difficult, so valuable is the product and so well organised are the poachers and smugglers. Nevertheless, conserving sufficient numbers in the wild is of great importance, if stocks are to be available for further domestication trials.

REMARKS

A full account of the musk deer and its biology can be found in National Research Council (1991).

11 PERE DAVID'S DEER

Elaphurus davidianus *ENDANGERED*

Pere David's deer has been extinct in the wild for 800 years but has recently been reintroduced into China from captive sources in the United Kingdom. It is now maintained under semi-domestic conditions near the region in China where it originally occurred in the wild in the twelfth century. There is some experimental farming of Pere David's deer being undertaken in New Zealand.

One of the dangers of domestication projects is the possibility of genetic contamination of wild species by escaped domestic forms. Deer which are confined and are undergoing domestication often escape. These escapees can establish feral populations and in some cases can hybridise with local wild, indigenous species. For these reasons every care must be taken to prevent the escape of captive deer. Intensively farmed deer under domestication are also often infected with dangerous diseases like tuberculosis and escapees can transmit these diseases to local wild deer or other susceptible wild species.

12. MOOSE/ELK

Alces alces *NOT THREATENED*

The European moose (sometimes also called the elk in Europe) is a common wild ungulate in Norway, Sweden, Finland, Russia, the Baltic States, Belarus and in the northern Commonwealth of Independent States (CIS). Small numbers also occur in some East European countries. For the species, the moose population density in Scandinavia is the highest in the world, with densities of up to three animals per square kilometre and a total number of almost one million. The moose is an important game animal in Europe and approximately 25 percent of the moose population of Scandinavia is harvested (shot) each year.

In North America, the moose occurs from Alaska to northern Colorado and extends into the central Rocky Mountains. Secondary vegetation growth following logging has provided a food source to allow a population expansion of moose northwards into Alaska and Canada. Moose have been introduced into Newfoundland and are becoming established there. The moose population of North America was estimated to be about one million in the 1970s and by now is probably considerably more.

The moose or elk, has been subjected to periodic attempts at domestication over many years. In Sweden, as far back as the seventeenth century, there are many accounts of such activity. Attempts at domestication of moose continued in Russia and similarly of conspecific moose in North America. In Russia there are experimental farms on which moose have been divided into three groups – meat producers, milk producers and draught animals (Whitehead, 1993).

Photo 3.19: The Anderson moose team at the Manitoba Provincial Exhibition (Canada 1905).

Moose were also used in battle. After his eventual victory, one Russian general, whose horses had been terrified and consequently routed by moose-mounted cavalry, attempted to erase all memory of moose-training methods by widespread slaughter of both the animals and their owners (Stott, 1993; Whitehead, 1993). In Finland the private ownership of moose was once banned because bandits on mooseback could be certain of escaping from police officers mounted on slower horses.

In North America, Seton (1910) considered that moose were: "…much more tractable and valuable than reindeer…they are docile, easily trained, exceedingly swift and, being natural trotters, are well suited for light travel…". However, moose/elk are extremely difficult to maintain in captivity, owing to their very exacting nutritional requirements and their failure to meet Galton's (1865) basic criteria for hardiness has prevented them from becoming established as ranched or farm species. They are concentrate selectors (Hoffman, 1985) and do not thrive on grass and hay diets. On Russian experimental farms this problem has, to some extent, been circumvented by raising young moose and training them to go out each day to forage for their own food in their natural environment and to return in the evening to be milked (Syroechkovsky *et al.*, 1989). The best milk yields obtained from free-range moose were 430 litres per lactation at six litres per day.

Moose are susceptible to a variety of intestinal worms, winter tick infestation and malignant catarrhal fever. While the Russians have succeeded with animals that can range freely over the tundra, North American game farmers are likely to have many problems if they try to keep a number of these remarkable animals for any length of time. (Haigh, 1995).

The gestation period of the moose is 216 – 231 days.

3.7 ANTELOPES

Order *Artiodactyla*/Family *Bovidae*

1 Eland
2 Oryx
3 Springbok
4 Impala
5 Duikers
6 Blackbuck
7 Nilgai
8 Saiga

The ranching of wild antelopes is now well established in eastern and southern Africa, often in association with domestic cattle.

1 ELAND

Taurotragus oryx — *NOT THREATENED*

This large antelope is probably the most suitable African species for experimental domestication.

DISTRIBUTION AND CURRENT STATUS

The wild eland is widespread throughout the savannahs of eastern and southern Africa. It occurs in herds of up to 200 and is not at present threatened.

THREATS TO SURVIVAL

The main threats are overhunting, competition with domestic stock and disease transmission, particularly Rinderpest, by cattle.

CAPTIVE BREEDING

Eland breed freely in captivity.

DOMESTICATION AND ECONOMIC IMPORTANCE

There are small herds of domesticated eland in the Ukraine, Kenya, Zimbabwe and Nyae Nyae Farmers Cooperative in Bushmanland, Namibia. A very important, and to some extent successful, attempt at domesticating the eland is being made at Askanya Nova in the Ukraine. Here a large herd of eland, all descended from four bulls and four cows brought from Africa in 1892, is being selected for improvements in the quality of the meat and the quantity of milk production. The milk from about 50 milking eland cows is used in a local hospital for the treatment of gastric disorders and tuberculosis. In 1991, Askanya Nova was still very active in developing its herd of domesticated eland. In Africa, eland are generally kept on ranches for their very popular meat or as hunting trophies.

REMARKS

For further information see Kyle (1972) and Posselt (1963).

Other antelopes of interest for domestication:

Photo 3.20: Eland (Tanzania). This large antelope is the most suitable African species for domestication.

There are a number of other African and Asian antelopes which may have potential for domestication or semi-domestication. These come from diverse habitats ranging from moist rain forest to arid savannah and semi-desert. They are thus adapted to some environmental conditions that are marginal for the production of conventional livestock because of drought, heat, disease, altitude, humidity and other constraints. Even if not subjected to the long process of domestication they may well prove to be more productive and less damaging to the environment than conventional livestock in marginal areas, once practical and sustainable management regimes have been developed. With the exception of the Saiga antelope, none of these animals are currently threatened with extinction. The animals concerned are:

2 ORYX

Oryx spp. — *Eastern Africa*

Two species, *O. beisa* and *O. callotis*, occur in Kenya and Tanzania and another, the gemsbok, *O. gazella*, in South Africa, Botswana and Namibia. *O. callotis* has been experimentally herded on the Galana Ranch in eastern Kenya where the meat has been sold at premium prices to hotels on the Kenya Coast. Thresher (1981) described the economics of this attempt to domesticate the oryx.

Photo 3.21: Oryx. An east African antelope undergoing domestication in Kenya.

The last herd of semi-domesticated oryx in East Africa is located on Baobab Farm, on the south-east Kenya coast.

3 SPRINGBOK

Antidorcas marsupialis — *Southern Africa*

Springbok are widely distributed throughout arid environments in South Africa, Botswana and Namibia, in terrain, which is unsuitable for conventional livestock. Meat is exported to Europe from areas that are free from Foot-and-Mouth disease.

4 IMPALA

Aepyceros melampus — *East and Southern Africa*

Impala are common woodland antelopes occurring throughout eastern and southeastern Africa, south of the Equator. Large numbers are harvested for meat in Zimbabwe and South Africa.

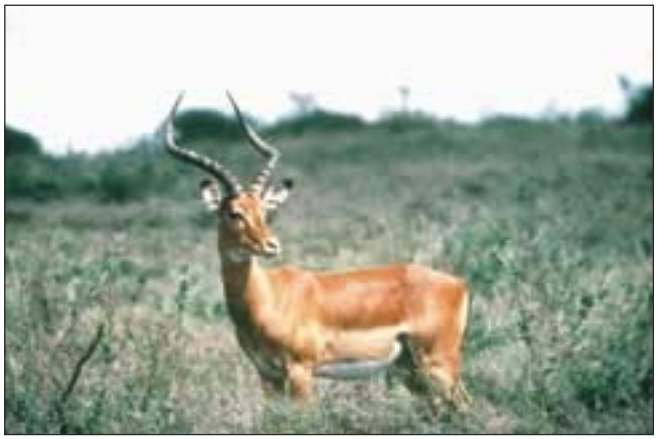

Photo 3.22: Impala (Kenya). An African woodland antelope of high productivity.

5 DUIKERS

Cephalophus spp. and Sylvicapra spp. — *sub-Sahelian Africa*

These small forest-dwelling antelope are harvested in great numbers in the forests of West and Central Africa where they provide a major source of protein, in the form of so-called bush meat, for the local people. Many species are now becoming scarce due to habitat destruction and over-harvesting.

6 BLACKBUCK

Antilope cervicapra — *India (Australia, United States of America, Argentina)*

Blackbuck are widespread in north-western India (Rajasthan) and are well represented in protected areas throughout peninsular India. Total numbers in India exceed 10 000 and are stable or increasing. Blackbuck are farmed for meat in Texas, United States of America (more than 20 000 are kept on 326 ranches (1988)), on the pampas of north-west and central Argentina (more than 10 000 head in the mid-1980s) and in New South Wales, Australia (East, 1993).

Blackbuck are capable of a very high level of productivity. With a gestation period of only five months and with post-partum conception occurring one month later, two fawns can be produced each year. Blackbuck were domesticated by the Mogul emperors who kept them as fighting animals.

Photo 3.23: Blackbuck (India). A very productive antelope currently undergoing domestication.

7 NILGAI

Boselephas tragocamelus — *India, Nepal (United States of America)*

The nilgai or bluebuck is endemic on the Indian subcontinent where it is widespread outside areas of high or low extremes of rainfall. The total population in India is more than 10 000 and is stable or increasing. The nilgai is well represented in protected areas throughout India where at least three parks have a population in excess of 1 000. The nilgai's status is also good in Nepal.

Introduced populations are well established on ranches in Texas, United States of America (East, 1993). This large Indian antelope weighs up to 250 kg and regularly produces twins each year. It is the largest antelope in the world capable of such a level of production. With twice the annual output of calves compared to the similar-sized red deer, the nilgai could well compete with that species when farmed for meat (Kyle, 1990).

8 SAIGA

Saiga tartarica — *THREATENED Kazakhstan, Kalmykia and Mongolia*

The saiga antelope is an inhabitant of the dry steppe and semi-deserts of Kazakhstan and the Autonomous Russian Republic of Kalmykia. There is also a small population in Mongolia.

By the end of the nineteenth century and during the first

20 years of the twentieth century the considerable saiga populations in the then Soviet Union underwent a marked decline and were hunted to extinction in many areas. The cause of the decline was the export of saiga horns to China for pharmaceutical purposes. One customs post alone recorded the export of 3.95 million pairs of horns.

Recovery of the saiga population began following the Russian Revolution when vast areas of the arid zones were cleared of human settlement, and by the end of the 1950s the Kazakhstan population had reached 2 million. Since then another decline has set in due to the resumption of the poaching of horns for the Chinese market, intensive agricultural development, competition with domestic sheep for forage and water and obstruction of migration routes by irrigation canals and farm fences.

Disease, possibly acquired from contact with domestic livestock, may also present a hazard to the saiga. Anthrax, Foot-and-Mouth disease, brucellosis, yersiniosis and pasteurellosis have all been documented. Predation by wolves is considered to be significant in some areas.

Today the saiga populations of Kalmykia are reduced to about 15 - 20 percent of their peak in 1958, when their estimated number was almost one million. When conditions of nutrition are good and disturbance is minimal the productivity of the saiga is high and an average of 1.6 fawns per female of all ages per annum is reported.

Photo 3.24: Juvenile saiga (Russia, Kazakhstan). A small antelope with considerable potential for management as a sustainable source of meat, skins and horns.

Saiga antelopes have considerable potential for management as a sustainable resource (meat, skins and horns), provided poaching can be controlled and competition with domestic livestock reduced (Milner-Gulland, 1994).

About 200 saiga antelopes are currently being raised under extensive, fenced conditions at Askanya Nova in the Ukraine and plans are being made to determine the feasibility of producing saiga under semi-intensive conditions or on game farms on the Kalmykian Steppe. Saigas are listed amongst the ten most endangered species by the World Wide Fund for Nature (United States of America).

3.8 MUSK OX

Ovibos moschatus Order *Artiodactyla/*
Family *Bovidae/*Tribe *Ovibovini*
NOT THREATENED

The musk ox is an arctic bovid belonging to the subfamily *Caprinae*. While it resembles the ox, serologically it is closer to the sheep. It has the most northerly distribution of all ungulates.

Musk oxen are large animals with compact bodies, thick necks and short legs. In the wild males stand 1.35 m at the shoulder and weigh about 300 kg. Females are smaller by one-third. The heaviest known wild male musk ox weighed 408 kg. In captivity, adult males of six years can weigh about 650 kg.

Musk oxen have a long coat of dark brown hair but the saddle and legs are light cream. Mature males have a large reddish mane which stands out and makes the animal look bigger. The coat of the musk ox consists of long coarse guard hairs which hang down almost to the ground. Beneath the guard hairs is a woolly undercoat called quiviut. The quiviut which is very fine, soft and curly, accounts for 60 – 80 percent of the fleece and covers the entire body. The combination of guard hairs and quiviut provides such efficient insulation that the musk ox can survive a critical ambient temperature of -70ºC while maintaining a body temperature of 38.4ºC.

DISTRIBUTION AND CURRENT STATUS

The wild musk ox is found only on the tundra of Canada, Greenland and in Taimyr and Vrangel Island in Russia. The population in Canada (including those on some small experimental farms) is now estimated at 107 600, but in Greenland there are far fewer. Some musk oxen in Greenland have recently been translocated further up the western coast from Kangerlussuaq in order to establish a new population near Illulissat.

Photo 3.25: Musk ox (Greenland). An arctic bovid with high potential for the production of meat and fibre.

THREATS TO SURVIVAL

There are few threats to the musk ox population. Extremes of weather, predation by wolves and polar bears and in the past, overhunting have all taken a toll but the world population is now healthy and increasing. The musk ox is a protected species throughout the Arctic.

CAPTIVE BREEDING

The global captive population of musk ox is 86 in 21 institutions (ISIS, 1993). There are also several experimental musk ox farms in Canada, Alaska, Norway and Siberia. Introduced herds of translocated musk oxen have increased at over 30 percent per annum in western Greenland and do not, so far, appear to be damaging their environment. The chromosome number for the musk ox is 2n = 48.

DOMESTICATION AND ECONOMIC IMPORTANCE

The musk ox is a prime candidate for domestication in the tundra areas of the world. It is easy to tame, gregarious, docile, sedentary and can be herded. Domestication of musk oxen on experimental farms began in the United States of America and Canada in the 1950s. In 1969, a musk ox farm was set up at Bardu in northern Norway and in 1974/75 a group of musk oxen were shipped from Canada and the United States of America to Taimyr and Vrangel Island in Siberia. The chief resource of the musk ox is the very fine and abundant under-wool or quiviut that is shed by the animals in the spring. This product is spun into a fine, uniform yarn, which is easily dyed different colours. Garments made from quiviut yarn are warm, attractive and very expensive. For example, even in 1981, quiviut was being sold for US$ 170/kg. In Greenland the musk ox is harvested by the Inuit in autumn as a meat supply for the winter.

REMARKS

For further information see Wilkinson (1974 and 1975) and FAO (1989).

3.9 ELEPHANTS

Order *Proboscidae*/Family *Elephantidae*

1 Asian elephant
2 African elephant

The two species have been placed in two separate genera, *Elephas* being the Asian genus and *Loxodonta* being the African genus. Elephants are probably the only animals employed by man that have never been bred selectively.

1 ASIAN ELEPHANT

Elephas maximus *ENDANGERED*

DISTRIBUTION AND CURRENT STATUS

Today the Asian elephant occurs in Bangladesh, Bhutan, Myanmar, Cambodia, China, India, Indonesia, Laos, Malaysia, Nepal, Sri Lanka, Thailand and Vietnam. The total population of the Asian elephant is estimated to be between 50 000 and 63 000, of which between 36 000 and 46 000 remain in the wild. Country populations vary from less than 100 in Bhutan and Nepal to possibly over 20 000 in India - but these numbers are the maximum - the minimum could be far less. Table 3.9.1 shows that there are about 15 000 elephants in captivity in Asia. This represents between one quarter and one third of the estimated total population, wild plus captive. A further consideration is that in some wild populations the sex ratio is now believed to be 1:3 to 1:5 adult males to adult females, due to selective killing of bull elephants for their ivory. The captive herd also contains a preponderance of cow elephants because these tend to be more docile and are easier to train. Imbalances in the sex ratio of the adults in the wild result in a decrease in the effective population size. Sex ratios in wild juveniles are likely to be 1:1 but as remarked above, females are selectively captured for domestication. This would seem to help to redress the adult sex ratio imbalance in the wild in those places where elephants are captured. The capture of wild elephants is now illegal in India and has ceased in Myanmar.

THREATS TO SURVIVAL

The main threats to the wild Asian elephant population are habitat destruction, illegal hunting, unsustainable capture quotas for recruits for domestication, warfare and the pressure of expanding human populations. Land mines left by various armies have taken a heavy toll on wild elephants (and other large wild mammals) in Southeast Asia.

CAPTIVE BREEDING

The global captive population of Asian elephants is 412 in 147 institutions (ISIS, 1993). In the past captive breeding of domesticated elephants has been discouraged because the young elephant is of no use for work until it

is about 12 years old, and it has been easier and cheaper to capture animals of that age from the wild. However, the annual attrition of the domestic elephant herds is about seven percent and the number of recruits needed to offset this loss is too great for the accessible wild herds to sustain. It is now recommended that, where capture is still permitted, not more than two percent of the most reliable estimate of the wild population should be captured each year for domestication and that breeding of replacements in captivity should be undertaken to make up the shortfall (Caughley, 1980).

Photo 3.26:Asian elephant (India, Myanmar).An indispensable source of traction in Southeast Asian forestry operations.

DOMESTICATION AND ECONOMIC IMPORTANCE

Domesticated for several thousand years, the Asian elephant is still of great value in the timber industries of several Asian countries where it can be used in implementing the policy of selective felling rather than clear felling. Selective felling is a much more sustainable way of forest exploitation and is far less damaging to the environment.

The economic and environmental advantages of using trained elephants in forestry operations are many. A trained elephant, 20 years old, costs about US$ 6 000 in Thailand and has a working life of 30 years. A crawler tractor to do similar work costs US$100 000, has a working life of six years and requires skilled and expensive maintenance. Trained elephants are environmentally and user friendly. Their use obviates the need to cut the expensive logging roads that are essential for the use of heavy machinery. Trained elephants can negotiate rough, hilly country where no machinery can go. Unlike machinery, elephants do not rust, corrode or pollute the environment. They do not depend on expensive spare parts and their dung acts as both a fertilizer and as an agent of seed dispersal in the forest. The use of elephants in the extraction of timber greatly reduces the environmental damage caused by heavy machinery and thus reduces soil erosion and compaction (Santiapillai, 1992). Asian elephants are increasingly used as viewing platforms by tourists in Asian National Parks and are becoming a feature of many eco-touristic enterprises.

REMARKS

Only male Asian elephants carry tusks and some of these do not. The percentage of males carrying ivory varies by region from only seven percent in Sri Lanka to 90 percent in South India.

For a full account of the status of the Asian elephant and its conservation see Santiapillai and Jackson (1990) and FAO (1997).

2 AFRICAN ELEPHANT

Loxodonta africana *VULNERABLE*

Domestication and training of the African elephant was attempted with some success by the Belgians at Gangala-na-Bodio in the north-eastern reaches of the Democratic Republic of Congo at the beginning of this century. The motive for this effort was to provide transport to move the cotton crop from the fields to the distant roadhead. At one time there were over 100 trained elephants in the Democratic Republic of Congo. There are now four and these are not very reliable. However, there are plans to restore the Gangala-na-Bodio elephant training station to provide riding elephants for the adjacent Garamba National Park. Trained African elephants are also being used as tourist platforms in Botswana.

CAPTIVE BREEDING

The global captive population of African elephants is 905 in 107 institutions (ISIS, 1993).

Photo 3.27: African elephant (Uganda). Under experimental domestication for tourist transportation in the Democratic Republic of Congo, Botswana and South Africa.

TABLE 3.9.1: ESTIMATED NUMBERS OF WILD AND CAPTIVE ELEPHANTS IN ASIA.

COUNTRY	WILD	CAPTIVE	TOTAL
Bangladesh	281 – 348	50	331 – 398
Bhutan	up to 60	0	up to 60
Myanmar	3 000	5 400	8 400
Cambodia	2 000	500 – 600	2 500 – 2 600
China	250	15	265
India	17 310 – 22 115	2 200 – 2 800	19 510 – 24 915
Indonesia	3 300 – 5 300	50-100	3 350 – 5 400
Laos	2 000	1 000 – 1 300	3 000 – 3 300
Malaysia (Peninsular) (Sabah)	 825 500 – 2 000	 below 50 0	 below 875 500 – 2 000
Nepal	25 – 38	60 – 80	85 – 118
Sri Lanka	3 051 – 3 435	400 – 500	3 451 – 3 935
Thailand	2 600 – 3 650	3 500 – 5 000	6 100 – 8 650
Vietnam	1 000	600	1 600
Totals:	**36 202 – 46 021**	**13 825 – 16 495**	**49 527 – 62 516**

Source: *IUCN*

Order *Carnivora*/Family *Ursidae*

1 Asiatic black bear (*Ursus thibetanus*) *VULNERABLE*
2 Brown bear (*Ursus arctos*) *NOT THREATENED*

Bears have been valued for centuries in Asia for medicine and food. In some Asian countries they are also favoured as pets and in some Buddhist cultures the keeping of a bear as a pet is a way of earning religious merit. There are eight bear species, worldwide. Of these, two, the Asiatic black bear and the brown bear are farmed in China and North and South Korea for their bile which is believed to have curative properties for many human diseases.

DISTRIBUTION AND CURRENT STATUS

The distribution of the Asiatic black bear extends through most of southern Asia. The western edge of its range was formerly Afghanistan and it still ranges across Pakistan, extending eastwards over northern India, southern China, Southeast Asia, eastern Russia, Korea and Japan. It is believed to prefer to live on forested hills and in tropical moist forests, below alpine elevations. The exact status of the Asiatic black bear is uncertain throughout much of its range, except for the dense forests of Laos, Myanmar and eastern Russia. It is the favoured species for traditional medicine and unusual cuisine and is the most available species in the three countries where these uses are prevalent - China, Japan and Korea. The Asiatic black bear is listed among the ten most endangered species by the World Wide Fund for Nature (United States of America).

The brown bear is the most widespread of any bear species, occurring in Europe, Asia and North America from the northern arctic tundra to the dry southern deserts. This range is now becoming reduced by the spread of firearm use, human encroachment and habitat destruction. Many brown bear populations are now isolated and face extinction due to loss of genetic diversity. Worldwide, all bear species except the American black bear (*U. americanus*) and the polar bear (*U. maritimus*) are thought to be in decline (Servheen, 1990).

THREATS TO SURVIVAL

The future for both the Asiatic black bear and the brown bear remains uncertain. The major threats facing both species are uncontrolled hunting (because of the increasing commercial demand for gall bladders for medicine and bear parts for food) and deforestation (causing habitat loss and fragmentation). The demand for bear gall bladders for traditional medicine is linked to the increasing affluence of China, Japan and South Korea. It is unlikely that bears will be able to maintain viable wild populations given the escalating prices, asked for and received, for gall bladders, bile and edible parts (Mills and Servheen, 1991).

CAPTIVE BREEDING

Bears breed freely in captivity. The global captive population of the Asiatic black bear is 131 in 48 institutions and of the brown bear 170 in 38 institutions (ISIS, 1993). In captivity, usually in Asia, Asian black bears and brown bears occasionally cross-breed to produce fertile hybrids. The gestation period of the Asian black bear is 200 - 240 days and of the brown bear 180 - 210 days but bears undergo delayed implantation for a variable period and the embryonic gestation is actually about 60 days. Twin cubs are produced annually by both species.

DOMESTICATION AND ECONOMIC IMPORTANCE

Bears have achieved such a high economic value that in China and North and South Korea they are now being farmed for their parts and milked of their bile while alive. Since the mid 1980s the government of China has encouraged the establishment of bear farms. There are now over 30 bear farms in China each holding over 100 bears – one, in Sichuan Province, has more than 450 – and many smaller farms which keep a few bears. Farmed bears, of which China has a total of about 10 000 (1995) lack one of the main bile salts (cholyl-taurine) which is found in wild bear gall. This may account for the popularity of wild bear gall and thus the extensive illegal killing of wild Asian black bears (United States Fish and Wildlife Service Forensic Laboratory report). China now milks enough bile from captive live bears to satisfy the country's domestic needs, but it has a state-mandated goal of ultimately having 40 000 bears in captivity for the commercial production of bile salts, according to statements made at a recent bear conference in Harbin, China. The Sichuan Province farm extracts more than 500 kg of dried bile salts from living bears by means of catheters surgically implanted in their bile ducts. A bear can produce 3 kg of dried bile salts annually which sell for about US$ 5/g. South Korea had 14 bear farms in 1989 and there bear gall bladders, mostly imported from China, are priced, gram for gram, at up to 18 times the price of gold (US$ 11.53/g in 1991). North Korea has been farming bears for bile for more than 20 years and at least one bear park in Japan proposes to begin extracting bile from its bears.

Bear gall bladders (from slaughtered bears) and bile (from living bears) are valuable and powerful medicines used throughout Asia for the treatment of high fever, convulsions, burns, swollen eyes, jaundice, hepatitis, haemorrhoids, cirrhosis of the liver, diabetes, high blood pressure, heart disease, palsy and tooth decay. Bear gall is used in Japanese medicine for children to relieve night crying, colic and diarrhoea. Bear meat, especially the paws, is increasingly a novelty dish in Japan, where it has great status appeal. The consumption of bear meat is said to aid rheumatism, weakness, beri-beri with paralysis and general strength of mind and body (Read, 1982; Mills and Servheen, 1991). A live bear is worth US$ 1 400 – 2 700 in China, US$ 2 000 - 4 000 in Thailand and US$ 7 100 in South Korea (1993). Most bear parts originate in Malaysia

and Thailand (and increasingly in the United States of America, Canada and Russia). The main consumer countries are Hong Kong, China, Taiwan, Singapore, South Korea and Japan.

REMARKS

For information on the status of the bears of the world and the Asian trade in bears see Servheen (1990); Mills and Servheen (1991) and Brown (1993).

3.11 RODENTS

Order *Rodentia*

1 Agouti
2 Capybara
3 Coypu
4 Wild guinea pigs
5 Hutia
6 Mara
7 Paca
8 Vizcacha
9 Giant rat
10 Grasscutter or Cane rat
11 Other rodents

Rodents are the world's most adaptable and prolific animals. They reproduce well, grow fast, learn quickly and adapt to a wide variety of local conditions. Many convert coarse vegetation into meat efficiently even though their stomachs are simple.

Previous domestication of the guinea pig, laboratory rat and mouse, gerbil and hamster supports the notion that other species might be similarly utilised. Already much rodent meat is consumed throughout the world. In Latin America, especially in Peru and other Amazonian regions, about 85 percent of the total protein in the human diet comes from hunted rodents. In tropical West Africa and Botswana the annual harvest of the springhare (*Pedetes capensis*) exceeds 3.3 million kg. Peru has 20 million domestic guinea pigs that produce annually between 16 000 and 17 000 tons of meat. The killing-out percentage (dressed weight) of many rodents often exceeds 60 percent, yet rodents are seldom included in livestock programmes or economic development plans.

The wild animals briefly described in this section have either been domesticated, are undergoing experimental domestication or have potential for exploitation.

The source of much of the information in this section can be found in National Research Council (1991).

1 AGOUTI

Dasyprocta spp. Family *Dasyproctidae*

NOT THREATENED

Prolific, hare-sized, diurnal rodents, highly valued for their meat and relentlessly hunted throughout their range. Adults weigh 2 – 5 kg.

DISTRIBUTION AND CURRENT STATUS

The agouti is found throughout the lowland tropical forests of Latin America, from southern Mexico to Paraguay and on many islands of the Caribbean. It is becoming rare in Mexico and Costa Rica. Hunting of agoutis is prohibited in Brazil, but nevertheless still continues.

THREATS TO SURVIVAL

The main threats are excessive hunting for sport and food and habitat destruction. Agoutis are said to be highly susceptible to Foot-and-Mouth disease.

CAPTIVE BREEDING

Agoutis breed freely in captivity and a research project on captive breeding of two local agouti species, *D. mexicana* and *D. punctata*, for food has been set up at Tuxtla Gutierrez, Mexico. The gestation period of the agouti is 3.5 – 4 months. Twins are usually born.

DOMESTICATION AND ECONOMIC IMPORTANCE

Although wild agoutis are very shy, when taken young they tame easily. Domestication would appear to be possible once a system of husbandry has been worked out. Since agoutis are popular game animals, their meat is widely accepted. However, the agouti has two very active anal glands that produce a strong odour. This can taint the meat unless they are carefully removed after slaughter. Agoutis in captivity are very smelly and unpleasant to work with (Smythe and Brown de Guanti, 1995).

REMARKS

Agoutis often save nuts and seeds by digging holes in scattered places and burying them. This behaviour helps disperse the seeds of many tree species and provides a degree of reforestation. The dispersal and germination of Brazil nut seeds is entirely dependent on the forest-dwelling agouti which is the only rodent able to open the hard shell which encases the nut (World Bank Information Brief, 1993).

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2 CAPYBARA

Hydrochoerus hydrochaeris Family *Hydrochoeridae*

NOT THREATENED

The capybara is the world's largest rodent and is as big as a sheep. It often weighs over 50 kg. These reddish-brown rodents move freely on dry land and having webbed feet are good swimmers. They dive with ease and can remain submerged for about 5 minutes.

DISTRIBUTION AND CURRENT STATUS

The capybara occurs in flooded grasslands from Panama to Paraguay, mainly in the watersheds of the Orinoco, Amazon, Paraguay and Parana Rivers. Large populations live in the Pantanal of western Brazil and on the llanos flood plains of Venezuela and Colombia. While capybaras occur in large numbers (one ranch in Venezuela had 47 000 capybaras on 50 000 ha) in many areas they have been deliberately exterminated by farmers who think they compete with cattle and transmit diseases. The capybara is rarely found more than 500 m from water in which it takes refuge when pursued.

THREATS TO SURVIVAL

The main threat is illegal hunting especially in the dry season when the animals concentrate around waterholes. Disease hazards include Foot-and-Mouth disease, brucellosis and trypanosomiasis. The latter of which may present a constraint to captive production *in situ*, since in one area 55 percent of the capybaras died of the disease, which was shown to have been due to infection with *Trypanosoma evansi* (Schaller and Crawshaw, 1981).

CAPTIVE BREEDING

Capybaras were bred in captivity in Brazil as early as 1565. Confining capybaras at high densities may create serious problems of intra-specific aggression. Nevertheless, capybara farming is considered to be very feasible (Ojasti, 1991). The animal is large, has a high reproductive potential, grows fast, eats grass, has few major health problems, lives in groups and is easy to handle. Production systems for capybaras have been developed and tested in Brazil (Alho, 1986), Colombia (Fuerbringer, 1974) and Venezuela (Sosa-Burgos, 1981) and the feasibility of raising capybaras in captivity has been demonstrated beyond any doubt. The gestation period of the capybara is 100 - 110 days and one or two litters of 4 - 6 young are produced annually.

DOMESTICATION AND ECONOMIC IMPORTANCE

The Institute of Animal Production in Venezuela started a captive-breeding programme in 1970. A similar project is in progress in Colombia and guidelines for raising capybara have been published. In Brazil, research has been carried out into capybara nutrition, genetics, management, reproduction and social behaviour in captivity. This research is being conducted by the University of Sao Paulo at its Wildlife Research Centre (CIZBAS). Young capybaras can reach a live weight of 35 kg in 10 months (Parra *et al*, 1978) and annual productivity is said to exceed that of cattle in many parts of their range. Kyle (1987) compares the meat production of Venezuelan capybaras with cattle production and concludes that a female capybara can produce 60 kg of meat a year as compared to 40 kg produced by a cow under the current Venezuelan production systems.

Photo 3.28: Capybara (Argentina). The largest rodent in the world with high potential for ranching for meat and skins.

The species is widely eaten in South America and in Venezuela more than 500 tons of meat are sold each year. The hide of the capybara is considered excellent for glove making and is sold for high prices on the European market, where the leather is known as Carpincho. Rennet from the stomachs of capybaras is used for the production of a starter for cheese. The meat of this semi-aquatic animal has long been approved by the Vatican for consumption on traditional Roman Catholic meatless days. It is now an important food during Holy Week in Colombia and Venezuela. Another commercial product of the capybara is oil, which is extracted from subcutaneous fat and yields up to 4 litres per adult animal. Capybara oil is valued as a popular medicine for asthma (Ojasti, 1991).

REMARKS

The rising price of beef throughout South America is providing a new incentive to develop a capybara industry and is forcing many *campesinos* to eat more wild meat.

For information on productivity of capybara, see Gonzalez-Jimenez (1995).

3 COYPU

Myocastor coypus — Family *Myocastoridae*

NOT THREATENED

The coypu is an aquatic rodent the size of a small dog. A native of South America, it produces fur of considerable commercial value. Its meat is consumed in many regions of South America and in parts of Europe. The live weight of the coypu averages 7 – 10 kg but may go as high as 17 kg.

DISTRIBUTION AND CURRENT STATUS

The coypu is widely distributed throughout Brazil, Paraguay, Uruguay, Bolivia, Argentina and Chile. It has been introduced into North America, Europe, northern Asia and eastern Africa. As a result of escapes from fur farms it is now feral in all these areas including Japan. In the United States of America it is abundant in Louisiana, Oregon, Florida and Chesapeake Bay. In various countries the animal's status ranges from rarity to pest. Wild coypus are protected by law in Argentina because of overhunting and there are over one hundred coypu farmers in that country. Elsewhere coypus are destroyed *en masse* to reduce damage to dams, irrigation ditches and crops.

THREATS TO SURVIVAL

In areas where the animal is considered a pest, extermination policies may be carried out. Coypus are susceptible to rabies and can carry the virus of equine encephalomyelitis. In captivity they are susceptible to a number of density-dependent infections such as salmonellosis, leptospirosis and toxoplasmosis. They are also susceptible to bacterial pneumonia and strongyloides infection.

CAPTIVE BREEDING

Captive breeding of coypu began in Argentina in 1922. Wild coypus are shy animals but tame easily in captivity. They are difficult to confine and when they escape, can become a serious agricultural pest. The gestation period of the coypu is 128 - 140 days and two or three litters of 5 - 6 young are produced annually.

DOMESTICATION AND ECONOMIC IMPORTANCE

There is a huge literature on farming coypus. While the meat is highly acceptable, the main product of coypu farming is the fur, known as nutria. The guard hairs are also used to make felt. In Chile, 80 commercial coypu farms maintain 48 000 breeding females and produce 500 000 skins a year. The coypu provides 50 percent of the total exports of native mammal skins from Argentina.

REMARKS

Feral coypus have recently been eliminated from the eastern counties of the United Kingdom where they had escaped from fur farms (National Research Council, 1991).

4 WILD GUINEA PIGS

Cavia spp. — Family *Caviidae*

THREATENED

Three species of wild cavies, close relations of the domesticated guinea pig, occur in South America. They are *Cavia aperea*, *C. fulgida* and *C. tschudii*. All are declining in numbers rapidly and action to preserve them is urgently needed. *C. aperea* is still widely used as a food item in rural Brazil and elsewhere in South America.

DISTRIBUTION AND CURRENT STATUS

The range for wild guinea pigs includes the central highlands of Bolivia and Brazil, but it is not well known. The current status of wild cavies is unclear and no accurate estimates are available.

THREATS TO SURVIVAL

Over-exploitation and habitat destruction.

CAPTIVE BREEDING

Domestic guinea pigs breed freely whether they are confined in small cages or, as in a few regions of Peru, they are herded on the open range and confined at night in small adobe coops. There are no data on captive propagation of the wild species. The gestation period of the domestic guinea pig is 65 - 70 days and four litters of 2 - 3 young are produced annually.

DOMESTICATION AND ECONOMIC IMPORTANCE

The wild guinea pig was domesticated for food use in the central highlands of Peru and Bolivia at least 7 000 years ago and its descendants are still widely used as a meat source throughout South America. Peru alone has about 20 million which produce 16 000 to 17 000 tons of meat a year, almost as much as is produced in that country by the domestic sheep population. Improved guinea pigs have been developed by La Molina National Agrarian University in Peru, which has raised the average weight of domestic guinea pigs from 0.5 kg to nearly 2 kg. Guinea pigs are raised for food in Nigeria, Cameroon, Ghana, Sierra Leone, Togo and the Democratic Republic of Congo. In southern Nigeria, at least 10 percent of all households raise guinea pigs for food, often in colonies of up to 30 animals. Small-scale farmers in the Philippines also raise them in cardboard boxes. It is estimated that 20 females and two males can produce enough meat year round to provide an adequate protein diet for a family of six (Huss, 1982). An FAO study at Ibarra in Ecuador showed that on small mountain farms guinea pigs provided more profit than either pigs or cows, largely because their meat sold for such high prices. The food conversion efficiency is high: 3.3 – 5.7 kg of forage produces 1 kg of meat. Guinea pigs are also used worldwide for biomedical research. The domestic guinea pig did not spread beyond the Inca Empire until after the Spanish Conquest, when being small and easily transported, it appeared in Spanish Equatorial Guinea. From here it became known in the English-speaking world, as is suggested by its name (Zeuner, 1963).

REMARKS

Domestic guinea pigs can be carriers of the trypanosome of Chaga's disease (*Trypanosoma cruzi*) and also of *Salmonella spp.* Coccidiosis and internal parasites are also common. Research on domestic guinea pig husbandry is underway in universities and government research stations in Colombia, Ecuador, Venezuela, Peru and Bolivia. Domestic guinea pigs have been implicated in a recent outbreak of bubonic plague in Peru.

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5 HUTIA

Capromys spp. Family *Capromyidae*

THREATENED/ENDANGERED

The hutia is a short-legged rodent, varying in size according to species, from that of a guinea pig to that of a small dog. Hutias of some ten species are hunted for food throughout the Caribbean islands. Caribbean Indians used to carry hutias on long voyages as a semi-domesticated food source. Live weight of the various species of hutia varies from 1 – 9 kg and their habits vary, too. The Cuban hutia is a diurnal forest dweller and can weigh up to 7 kg. The Jamaican hutia weighs up to 2.5 kg and is nocturnal.

DISTRIBUTION AND CURRENT STATUS

Hutias are found only in the Caribbean Islands (Greater Antilles and Bahamas). Most species are endemic on a single island. The Cuban hutia is found only on Cuba and is the only hutia considered not to be threatened. All others are rare, over-exploited by hunters and in danger of extinction.

THREATS TO SURVIVAL

Several island-endemic hutia species are already extinct and those that remain are seriously at risk from overhunting, habitat degradation and predation by introduced domestic cats, dogs and mongooses. All hutia species, except the Cuban hutia, are classified as endangered by IUCN.

CAPTIVE BREEDING

Cuban and Jamaican hutias breed freely in captivity and are over-produced in many zoos so there is no shortage of stock for domestication trials. Colonies might be established on uninhabited Caribbean islands, as has already been done with the Bahamian hutia (*Geocapromys ingrahami*), a species that was a regular food source of the pre-Colombian Indians. The gestation period of hutia species is 16 – 20 weeks. Two litters of 1 – 4 young are produced annually.

DOMESTICATION AND ECONOMIC IMPORTANCE

Hutias are kept in barns in Cuba, fed on bananas and harvested for the table. They tame easily and show promise for domestication, which if successful, might provide an incentive for their conservation. Hutia meat is especially relished in Jamaica where the animals are hunted and killed after being treed by dogs.

REMARKS

Hutias are carriers of the virus of equine encephalomyelitis, a serious disease of horses. The Jamaican hutia (*Geocapromys brownii*) has one of the highest diploid chromosome numbers of any animal, 2n = 88.

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6 MARA

Dolichotis patagonum Family *Caviidae*

NOT THREATENED

The mara is a large wild relative of the domesticated guinea pig that lives in the dry country of Patagonia in the southern half of Argentina. Average live weight is about 8 kg, but some specimens can weigh up to 16 kg (Taber, pers. com.).

Photo 3.29: Mara (Argentina). A large relative of the domesticated Guinea pig whose meat is widely consumed in South America.

DISTRIBUTION AND CURRENT STATUS

The mara is found in the thorn-scrub desert and Patagonian steppe of Argentina, between 28ºS and 50ºS. It is now scarce everywhere and is extinct in many eastern parts of its former range.

THREATS TO SURVIVAL

These animals, once plentiful, are now threatened by the introduction of the European hare (*Lepus europaeus*) which competes successfully with the mara for food. Maras used to be shot for their hair which was used to make fishing flies. The animal is now protected throughout Patagonia.

CAPTIVE BREEDING

Maras have been bred successfully in many zoos. The gestation period is 77 days and litters of 1 – 3 young are produced several times a year.

DOMESTICATION AND ECONOMIC IMPORTANCE

Maras are social animals and can be maintained in groups in captivity. They tame easily and at 8 kg are a suitable size for domestication. The meat is said to be dry and flavourless but nevertheless is widely consumed in South America. The yellowish-grey hair used for making fishing flies could be a valuable by-product of domesticated maras.

REMARKS

Captive maras are said to be very susceptible to tuberculosis when kept in humid conditions.

7 PACA

Agouti paca — Family *Agoutidae*

NOT THREATENED

Pacas are also known as lapa. They are large, spotted, tailless, nocturnal rodents with the potential to become a source of protein for the American tropics. Paca meat is said to taste like a combination of pork and chicken. Adult pacas weigh 6 – 14 kg, the males being larger than the females.

DISTRIBUTION AND CURRENT STATUS

Pacas are found throughout most of lowland Latin America from central Mexico to northern Paraguay, Argentina and Brazil. The animal has also been introduced into Cuba. Unfortunately, expanding human populations have exterminated this very popular game animal within hunting range of almost all cities, towns and villages. Hunting and marketing paca meat is prohibited by law in some countries, but this is rarely enforced. Hunting takes place at night using dogs and spotlights. The paca has become extinct or greatly reduced in certain areas of Venezuela due to hunting for human consumption in restaurants.

THREATS TO SURVIVAL

Intense hunting pressure for sport and food and habitat and habitat destruction.

CAPTIVE BREEDING

Captive breeding is not very easy, but some zoos have been successful. Intra-specific aggression is a serious impediment to captive reproduction. Tamed female pacas are said to be difficult to breed because they are unreceptive to the male, whereas wild pacas while being much less manageable are easier to breed. This problem might be solved by careful selection of breeding stock since the females show considerable individual variation. Smythe (1991) describes novel artificial socialisation procedures that have been successful in breaking down and modifying the characteristic social intolerance and aggressive nature of the paca. His results show that artificially changed social behaviour is adopted by subsequent captive-bred generations and he is optimistic that in future, when opportunities for the selection of desirable characteristics occur, a truly domesticated strain of paca will be developed within a few generations. However, whether or not this will happen depends largely on the economic feasibility of paca farming.

The gestation period of the paca is 138 – 173 days and a single, precocious offspring can be produced twice a year. Twins are occasionally born.

DOMESTICATION AND ECONOMIC IMPORTANCE

In Belize and Mexico pacas are kept in cages and fattened on kitchen scraps. In Costa Rica pacas are bred on farms, under houses and even in apartments. Research on raising pacas in captivity is under way at the Universidad Nacional in Heredia, Costa Rica, at the Smithsonian Tropical Research Institute in Balboa, Panama and at the Instituto de Historia Natural at Tuxtla Gutierrez, Mexico. In Turrialba, Costa Rica, a farmer is already breeding pacas commercially and paca meat fetches very high prices in Costa Rican restaurants. The potential yield of meat from farmed pacas has been compared to that of ranched cattle. During the 4 – 5 years for a steer to reach slaughter weight, a female paca could produce 10 young with a total weight of 60 kg or about 14 kg/year. If the meat is 65 percent of the carcass weight, the yield would be 9 kg/year. This would be much below the potential yield from cattle (40 kg/cow/year) but a *campesino* keeping a single group of one male and five female pacas could expect to produce 45 kg/year which compares favourably with one steer (Smythe, 1991). Cattle ranching in the humid lowlands of the tropics is a major cause of deforestation. Paca farming would encourage the preservation of the forest and provide a source of high-quality protein from forest products.

REMARKS

Pacas can harbour leishmaniasis and Chaga's disease. For full information on domestication and husbandry of the paca, see Smythe and Brown de Guanti (1995) and FAO (1995).

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8 VIZCACHA

Lagostomus maximus Family *Chinchillidae*

NOT THREATENED

Vizcachas are soft-furred South American rodents with some promise for producing meat and skins in marginal areas within their natural range. They weigh up to 8 kg.

DISTRIBUTION AND CURRENT STATUS

Vizcachas were once abundant all over the savannahs of southern Paraguay, Bolivia and Argentina. Now they are being systematically exterminated because they are believed to compete with cattle for grazing and because their acidic urine kills grass. The plains vizcacha has been greatly reduced for this reason and has almost disappeared from Tucuman Province in Argentina (Ojeda and Mares, 1982). Today they inhabit isolated areas of north, central and western Argentina and southern Paraguay.

THREATS TO SURVIVAL

Ranchers have mercilessly hunted these animals since 1907. A bounty system used to be in operation in Argentina, but this is not now necessary because the numbers of vizcachas have been greatly reduced.

CAPTIVE BREEDING

The gestation period of the vizcacha is 154 days. In the wild one or two litters of one or two young are produced annually.

DOMESTICATION AND ECONOMIC IMPORTANCE

Vizcachas have not been domesticated, but in marginal areas they may be much more productive than conventional livestock. The meat is often consumed in the pickled form in South America. One slaughterhouse in Rio Cuarto in Argentina handles 10 tons of vizcacha meat a week, harvested from the wild, and vizcacha dishes can be found in any restaurant.

REMARKS

None.

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9 GIANT RAT

Crycetomys spp. Family *Muridae*

NOT THREATENED

The giant rat, also known as the pouched rat, is one of Africa's largest rodents. There are two species, *C. gambianus*, which lives on savannahs and at the edge of the forest and C. *emini* that lives mainly in rain forest. Both are highly prized as food for human consumption. Although the giant rat is vegetarian, in captivity, it eagerly consumes dry or canned dog food. Adult rats weigh 1 – 1.5 kg.

DISTRIBUTION AND CURRENT STATUS

The giant rat is found in suitable habitat from Senegal to Sudan. It can live at high altitude, being found up to 2 000 m asl in West Africa and to 3 000 m asl in East Africa. The rain forest species occurs in the forests of the Democratic Republic of Congo and adjacent Central African countries. It is abundant but has been exterminated where human populations are dense, such as in parts of eastern Democratic Republic of Congo.

THREATS TO SURVIVAL

Over-hunting is the main threat.

CAPTIVE BREEDING

The giant rat usually breeds easily in captivity, but the project at the University of Kinshasa, Democratic Republic of Congo, reports problems getting giant rats

to mate. When introduced, the male and the female tend to fight viciously. The gestation period of the giant rat is 28 – 42 days. Females can reproduce six times a year and the average litter size is four.

DOMESTICATION AND ECONOMIC IMPORTANCE

The University of Ibadan in Nigeria has a programme for domesticating the giant rat. Breeding stocks were established in 1973 and this population is now considered domesticated. Commercial-scale giant rat farming is now being established in southern Nigeria. The project, at the University of Kinshasa reports that the rain forest species seems more docile and sociable than *C. gambianus*. Wild giant rats form a large component of bushmeat in West Africa and successful domestication would produce a valuable and acceptable meat supply. The giant rat also has some potential as a laboratory animal in nutritional, clinical and pharmacological research.

REMARKS

A few African tribes have taboos against consuming rat meat. Giant rats are omnivorous and are thus easier to feed in captivity than the grasscutter or cane rat.

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10 GRASSCUTTER OR CANE RAT

Thryonomys spp. Family *Thryonomyidae*

NOT THREATENED

Two species occur, *Thryonomys swinderianus* and *T. gregorianus*, both found in the forests and savannahs of the humid and subhumid areas of Sub-Sahelian Africa. Grasscutters weigh up to 8 kg and in Africa their meat is more valuable than chicken.

DISTRIBUTION AND CURRENT STATUS

Grasscutters or Cane rats occur throughout Sub-Sahelian Africa wherever the grass species they prefer for food is available. They do not inhabit rain forest, dry scrub or desert but often live in forest clearings where adequate grass is present. Despite intense hunting, this animal survives and is not threatened. Nevertheless, many populations are well below carrying capacity due to local over-exploitation.

THREATS TO SURVIVAL

Over-hunting and habitat destruction. Captive animals have died of clostridial infections.

CAPTIVE BREEDING

Experimental work is in progress. The gestation period of the grasscutter is 152 days. Litters normally contain two to four young, but in Benin and Togo litters of 11 and 12 are reported.

DOMESTICATION AND ECONOMIC IMPORTANCE

The Wildlife Domestication Unit of Ibadan University in Nigeria reports the potential of domesticated grasscutter colonies. Research on grasscutter husbandry is also being carried out by the Ministry of Rural Development in Benin and at Lacena in Côte d'Ivoire. In areas where cattle raising is constrained by the tsetse fly and trypanosomiasis, bushmeat is a very important source of protein for the local population. In Accra, Ghana during one year, 73 tonnes of grasscutter meat were sold in one local market. This represents more than 15 000 animals. In Côte d'Ivoire the meat sells for the equivalent of US$ 9 per kg. The demand for grasscutter meat exceeds the supply and a market exists for it all over Africa.

The agricultural extension services of Cameroon, Ghana, Côte d'Ivoire, Nigeria, Togo and Benin are encouraging farmers to rear grasscutters as backyard livestock. A bilateral co-operation project is under way in Benin to study improved breeding methods. A new project has recently been set up in Gabon by the French Non-governmental Organization (NGO) Veterinaires sans Frontieres. This project will test the economics and technical viability of farming grasscutters and the brush-tailed porcupine (*Atherurus africanus*).

The nervous disposition of the grasscutter may interfere with successful domestication. Thus there is a need for selection for docility because even after several generations in captivity the grasscutter must be handled with care. This animal might respond to the socialisation techniques that have been successful for the domestication of the paca.

Although domestication of the grasscutter would provide a useful supply of meat, wild populations could also be managed to maximise and sustain production by habitat management.

REMARKS

For information on the grasscutter, see Asibey (1974) and FAO (1996). In francophone African countries, the grasscutter is referred to as agouti which means an animal from the bush. It is not a true agouti.

NOTE

The ten rodent species described in this section all show some promise as specialised food sources for humans. Some are more productive than domestic livestock in marginal or degraded areas and some are adapted to thrive where, for one reason or another, conventional livestock do not. Many valuable rodent species are classified by IUCN as endangered or vulnerable and some have already been hunted to extinction. If the considerable productive potential of these members of the Order *Rodentia* was more widely known in development and agricultural economic circles, an important incentive would be provided for the conservation actions needed to maintain these genetic resources

and develop their food producing potential.
There are a few more rodents, which may have potential for domestication in localised situations, or for management in the wild for sustainable exploitation by habitat manipulation. These include the following:

CHINCHILLAS (ANDEAN REGION OF PERU, CHILE, BOLIVIA AND ARGENTINA)
Chinchilla brevicaudata and C. Lanigera — *INDETERMINATE*
C. Lanigera is probably extinct in Argentina and Peru

Both valuable furbearers.

PACARANA
Dinomys branickii. — *ENDANGERED*

The third largest living rodent.

SPRINGHARE (SOUTHERN AFRICA)
Pedetes capensis. — *NOT THREATENED*

An important bushmeat species in southern Africa.

ROCK CAVY (SOUTH AMERICA)
Kerodon rupestris — *NOT THREATENED*

Closely related to the guinea pig. Subject to intense hunting pressure and for its stomach contents which are used as a starter for cheese. Lacher (1979) deals with *K. rupestris* as a potential human food source.

SALT DESERT CAVY
Dolichotis salinicola. — *NOT THREATENED*

An inhabitant of dry, salty deserts. Eats halophytic vegetation.

NEW GUINEA GIANT RAT
Mallomys rothschildi. — *NOT THREATENED*

A forest dweller which exhibits very rapid growth.

PORCUPINES
Hystrix spp. — *NOT THREATENED*

Distantly related to guinea pigs and widely consumed throughout Africa and Asia.

KIORE
Rattus exulans. — *NOT THREATENED*

Formerly an important Polynesian food source.

SOFT-FURRED RAT
Praomys spp. — *NOT THREATENED*

Has been successfully raised in Malawi as a food source.

SQUIRRELS
Callosciurus spp. — *NOT THREATENED*

At present a pest on cocoa, oil palm and mixed fruit plantations in Southeast Asia. Could be raised in captivity as a food.

CLOUD RAT
Phleomys spp. — *NOT THREATENED*

Southeast Asian animal also found in the Philippines. Has potential for exploitation in forest situations but now becoming scarce in some areas due to deforestation.

CAYENNE SPINY RAT
Proechimys guyannensis — *NOT THREATENED*

A popular food animal in Colombia.

BAMBOO RAT
Rhyzomys spp. — *NOT THREATENED*

The largest rodent on Sumatra where it is hunted and eaten.

REMARKS

For further information see Lidicker (1985).

1 IBERIAN RABBIT

Oryctolagus cuniculus huxleyi

Order *Lagomorpha/*
Family *Leporidae*
NOT THREATENED

The ancestral form of the domestic rabbit is now thought to be the *Oryctolagus* subspecies *O.c. huxleyi* that occurs only in Spain and Portugal and some Mediterranean and Atlantic islands. All other wild rabbits in Europe belong to the subspecies, *O.c. cuniculus*, and are believed to be descended from semi-domesticated rabbits introduced by the Romans, who relished eating foetuses and new-born rabbits, which they called laurines. Thus, perhaps *O.c. cuniculus* should be considered feral (Fitter, 1959). Morphometric and DNA studies have confirmed the subspecific differences.

DISTRIBUTION AND CURRENT STATUS

The wild relative of the domestic rabbit is confined to southwestern Spain and Portugal and some Mediterranean and Atlantic islands. Its numbers are declining and there are fears for its long-term survival. It is noticeably smaller (max. weight: 1 kg) than the much more widespread feral *O.c. cuniculus* (max. weight: 2 kg).

THREATS TO SURVIVAL

The main threats to *O.c. huxleyi* are over-hunting, habitat destruction and the appearance in Europe of first, myxomatosis, and more recently, of the rapidly fatal viral haemorrhagic disease of rabbits.

CAPTIVE BREEDING

The rabbit is notoriously prolific. The gestation period is 28 – 32 days. Even under subsistence conditions, a female can produce four or five litters of 5 – 8 young each year.

DOMESTICATION AND ECONOMIC IMPORTANCE

Conservation of this true ancestor of the domestic rabbit is of scientific and economic importance, since almost nothing is known of its biology. Monks in the Middle Ages were in the habit of eating laurines during Lent as they were classified as an aquatic dish. Controlled breeding and thus domestication of rabbits began in the sixteenth century and was probably mainly the work of monks (Lebas *et al.*, 1986).

REMARKS

Rabbits (and hares) are the subjects of many translocation projects, mostly to Europe from places as far away as Argentina and Poland and usually for sporting purposes. Several important diseases of humans and domestic stock, e.g. tularaemia and *Brucella suis*, have been spread in this way.

If it is true that the domesticated rabbits, introduced all over continental Europe by the Romans, were the real ancestors of wild *O.c. cuniculus* of today, then this must represent the best example of the successful return to the wild of any domesticated mammal. Unfortunately, elsewhere in the world the fecundity and colonising ability of the rabbit has had disastrous results. In 1859, 24 wild rabbits were brought from England and released on Thomas Austin's farm in Australia. These animals were cross-bred with domestic rabbits of the same species and the progeny were released into fenced enclosures with the intention of creating a new industry for the settlers. As is frequently the case with such imports of exotic species, escapes occurred and the rabbits quickly established themselves in the wild. The rabbit invasion of Australia was the fastest ever recorded for any mammal on any continent. Now rabbits are devastating environmental pests that cost Australian farmers US$ 90 million a year and millions of hectares of grazing land have been destroyed.

After the failure of conventional methods of population control (shooting, trapping, poisoning, fencing and the release of exotic predators), biological control was attempted in 1950 with the introduction of the virus of myxomatosis. This initially produced a mortality rate of 99 percent of those affected and the rabbit population plunged from 600 million to less than 100 million. Host-virus selection pressures subsequently caused the most pathogenic myxomatosis virus strains to die out and the more resistant rabbits to survive. In response the Australian Government has established a Cooperative Research Centre for the Biological Control of Vertebrate Pest Populations within the Commonwealth Scientific Industrial Research Organisation (CSIRO). This research group has now identified immunocontraception as a potential new approach to the control of rabbit populations.

Rabbit Viral Haemorrhagic Disease (RVHD) escaped from trials on Wardang Island, South Australia in March 1995. The disease spread slowly throughout Australia and by mid 1998 had killed over 95 percent of the rabbits over extensive areas of the continent, particularly in the semi-arid regions. RVHD has also been observed in wild rabbits in France, Germany, Spain, Sweden, Ireland and the United Kingdom where mortality has been high in some places.

REMARKS

For further information see Chapman and Flux (1990).

1 Red jungle fowl
2 Other jungle fowl
3 Ducks
- Mallard
- Whistling duck
- Black bellied whistling duck
- Greater wood duck
4 Geese
- Greylag
- Swan goose
- Greater snow goose
- Red breasted goose
- Canada goose
- Egyptian goose
- Ne-ne
- Bar-headed
5 Guinea fowl
- Grey-breasted guinea fowl
- Tufted guinea fowl
- Mitred guinea fowl
- Vulturine guinea fowl
6 Turkey
7 Ostrich
8 Emu
9 Rhea
10 Cassowary

Chickens, ducks, geese, guinea fowl, quail, pigeons and turkeys help to meet the protein needs of some of the poorest people in the world and also make important contributions to developed world diets through the commercial poultry industry. These birds are often raised as scavengers, i.e. at little cost, in areas where cattle cannot survive, such as those infested by the tsetse fly (*Glossina* spp.). Ostriches, emus, rheas and cassowaries are all at various stages of domestication for their skins, meat and other products.

1 RED JUNGLE FOWL

Gallus spp. Order *Galliformes*/ Family *Galliformidae*
NOT THREATENED

The red jungle fowl and its close relatives within the genus *Gallus*, some of which are threatened, are the ancestors of the domestic chicken, *G. domesticus*, and are the source of its genetic diversity.

DISTRIBUTION AND CURRENT STATUS

The jungle fowl is present throughout a wide crescent stretching from Pakistan to Indonesia. It is a highly adaptable species and can thrive in many habitats from sea level to 2 000 m asl. Most, however, are found in damp forests, secondary growth, dry scrub, bamboo groves and small woods. The species is not rare but is under some hunting pressure.

THREATS TO SURVIVAL

In some areas over-hunting and habitat destruction are significant and in others there is a risk of disease transmission by domestic poultry.

CAPTIVE BREEDING

Jungle fowl are easy to raise in captivity and a number of subspecies are kept in various parts of the world.

The urgency for action to preserve genetic variability is greater in poultry, especially chickens and turkeys, than in any other form of domestic stock. North America, for example, which some years ago had 50 or more common breeds of domestic chicken, now has only two for meat production. The others have been largely lost. The ancestral jungle fowls contain much potentially important diversity, particularly in respect of heat and humidity tolerance since their home is in the hottest and most humid parts of Asia. They may also be resistant to some diseases and parasites but this has yet to be investigated. Conservation of germplasm from representative jungle fowl species is thus a matter of some priority.

2 OTHER JUNGLE FOWL

GREY OR SONNERAT'S JUNGLE FOWL

G. sonnerati *NOT THREATENED*

The Grey or Sonnerat's jungle fowl is a native of India that produces feathers that are used for tying trout and salmon flies. The demand for these is so great that some populations have been seriously depleted. Since 1968 India has banned the export of all birds and feathers, but there are many jungle fowl in captivity in various other countries.

LA FAYETTE'S JUNGLE FOWL

G. lafayettei *NOT THREATENED*

La Fayette's jungle fowl is a native of Sri Lanka. It is little known in captivity and only in the United States is a small number kept.

GREEN JUNGLE FOWL

G. varius *NOT THREATENED*

The Green jungle fowl is a striking bird, native to Java, Bali and other Indonesian islands as far south-east as Timor. The species can be raised without difficulty and there are about 90 in various parts of the world.

ARAUCANIAN CHICKEN

G. inauras *NOT THREATENED*

The Araucanian chicken still occurs in the wild in southern Chile and on Easter Island. It is generally agreed to be of pre-Colombian origin and there is archeological evidence that it is native to the Americas. In addition to Chile and Easter Island, it is reported to have occurred in the past in Ecuador, Bolivia, Peru and Costa Rica. The Araucanian has been called the Easter Egg chicken because it lays light green, light blue and olive coloured eggs. The high degree of genetic variability in this unusual bird is borne out by the selection and creation of breeds, such as the White Araucanian, Black Araucanian and Barred

Araucanian. These breeds are homozygous and breed true.

REMARKS

Other species of jungle fowl and wild chickens may also harbour useful genetic material, which could prove valuable in marginal or specialised habitats. Almost everywhere they are considered culinary luxuries and their meat commands premium prices. Several of the more colourful species have feathers that add to their commercial value. Some species are vulnerable or threatened.

Globally, domestic chickens contribute more protein (eggs and meat) to the human diet than any other animal species and yet knowledge about the existing poultry genetic resources of the world is only fragmentary, lagging behind that of other livestock species, especially cattle and sheep (Crawford, 1992). The conservation of the germplasm of the wild progenitors of the domestic chicken must therefore be a matter of great concern.

3 DUCKS

Order *Anseriformes*/Family *Anatidae*

Many species of wild ducks adapt readily to captivity and several wild tropical species would seem to have potential for semi-domestication in developing countries where they are indigenous. Domestic ducks have great importance as a food source in Asia, especially in the south-east. Here, eggs are more important, while further north, meat production assumes greater significance. Ducks are, as yet, of only minor significance as a food source in Africa, Latin America and the Near East.

If not managed carefully ducks can become pests to some crops, especially cereals. Against this, ducks are useful in that they seek out and eat the snail hosts of important human and livestock diseases (Bilharzia and fascioliasis). Ducks are susceptible to a number of infectious diseases, some of which can cause severe losses to both wild and domestic species. The most important of these are aflatoxin poisoning from mouldy grain, botulism, duck plague and duck virus enteritis.

In Asia and in one or two places in Central Africa ducks have been integrated into fish-farming systems where the excreta of 4 000 ducks on a one hectare pond can provide 30 000 tilapia with 20 percent of their feed. Integrated pig and duck farming, largely in Asia, is thought to be a factor in the worldwide emergence of new strains of the influenza virus.

A survey of all duck species having domestication potential is needed to determine their status in the wild.

MALLARD

Anas platyrhyncos *NOT THREATENED*

The wild mallard, a very widespread species, is the ancestor of the present day domestic duck breeds. Kear (1975) has pointed out the disadvantages of the domestic duck. These include a monogamous mating system, the deposition of large amounts of fat below the swimline, a large bone:meat ratio in the carcass, a long incubation period of 28 days and a breeding season confined to the spring.

WHISTLING DUCK

Dendrocygna spp. *NOT THREATENED*

These are long-necked, perching ducks found throughout the tropics. They are gregarious, sedentary and vegetarian, all positive traits for a potential domestic species. In latitudes of uniform day length they tend to breed all the year round.

BLACK-BELLIED WHISTLING DUCK

D. autumnalis *NOT THREATENED*

This species is common throughout tropical America from the south-western United States of America to northern Argentina and is sometimes kept in semi-captivity (Guatemala). They eat grain, require no swimming water and will use nest boxes. In the wild they dump large numbers of eggs so that even if substantial numbers were collected for artificial hatching or eating, the wild population would not be affected. In Mexico a census of nest boxes showed that out of 22 000 eggs laid, 80 percent were not hatched. This species would seem to have marked domestication potential.

GREATER WOOD DUCK

Cairina spp. *VULNERABLE*

The white-winged wood duck, *C. scutulata*, is found from eastern India to Java. Hartlaub's duck, *C. hartlaubi*, occurs in forests and wooded savannahs from Sierra Leone to the Democratic Republic of Congo. Both of these ducks are rare in captivity but might prove to be future tropical resources. Both are similar to the domestic Muscovy duck in size and habit, being large, phlegmatic, sedentary and omnivorous, all positive attributes for domestication.

The Muscovy duck, *Cairina moschata*, (also known as the Barbary duck, and in Latin America, as the Criollo duck), is a unique species from the South American rain forest. It belongs to the small group of waterfowl that perch in trees. The Muscovy duck was domesticated by South American Indians long before the Europeans arrived. It is now widespread in all equatorial countries of Africa and Asia. It is particularly prevalent in Southeast Asia where it is kept for eggs and meat and plays a minor role in household insect control. In Europe and Taiwan, Province of China, a sterile hybrid, the Mallard, has been produced by crossing the Muscovy with the common domestic duck (Crawford, 1992).

It is important that the wild relatives of the domestic Muscovy duck, which belong to the same genus, *Cairina*, should be conserved and studied in Latin America, where the Muscovy itself has a very long history of domestication.

4 GEESE

Order *Anseriformes*/Family *Anatidae*

The domestic geese of today are descended from two species: the western European breeds from the Greylag, *Anser anser*, and the Asian breeds from the Swan goose, *Anser cygnoides*. Both these wild relatives of domestic geese are native to the northern temperate zone.

GREYLAG

Anser anser *NOT THREATENED*

The Greylag goose, the most southerly species of grey goose to breed in Europe, has been kept by humankind since Neolithic times. It is the ancestor of most of the European breeds of domestic goose.

Two races of Greylag are recognised, *A.a. anser*, in western Europe, and *A.a. rubirostris*, which intergrades with the nominate species in eastern Europe and Russia. Greylags breed across the north-western Palaearctic region from Iceland and the United Kingdom, through Scandinavia, eastern Europe and central and southern Russia, into Mongolia and China.

Numbers of *A.a. anser* have been much reduced by excessive hunting and drainage of wetlands. However, in northern Europe, and especially in Iceland, the population has recently staged a remarkable recovery. *A.a. rubirostris* has not been able to recover its numbers and is undergoing a decline due to shooting and destruction of the marshes in which it nests.

SWAN GOOSE

Anser cygnoides *NOT THREATENED*

The Swan goose is a native of China and Mongolia. In spite of having been domesticated as the so-called Chinese goose for some 3 000 years, in the wild it remains the least studied of all the Palaearctic waterfowl. The population of nesting wild swan geese in eastern Russia is said to be between 300 and 400. In 1977, a summer congregation of over 1 000 was observed in north central Mongolia. This goose is in urgent need of study and conservation. The main threats to the survival of the swan goose in the wild are excessive hunting and habitat destruction in eastern and southern China.

Unlike chickens, geese have the great advantage that they can be reared solely on grass protein. Geese are willing to eat more than is strictly necessary, a propensity which has been exploited since very early times, both for the purpose of fattening and in order to render the birds too heavy to fly. Since tame geese will mate freely with wild individuals when these are available, domestication has not resulted in the development of many divergent breeds (Zeuner, 1963). Most of the remaining 15 temperate wild goose species will adapt to captivity. Two of these, which might be hybridised with domestic geese to improve their productivity in temperate areas, are:

GREATER SNOW GOOSE

Anser caerulescens *NOT THREATENED*

This species is native to North America and breeds in the high Arctic. It has a very short incubation period of 23 – 24 days, a very rapid growth rate and a high food conversion efficiency. Its genes may be of value for improving the productivity of the domestic goose (Short, 1976).

RED-BREASTED GOOSE

Branta ruficollis *INSUFFICIENTLY KNOWN*

This goose is another species that breeds in the Arctic and has a short incubation period. It also has a very rapid growth rate, attaining 17.7 times its hatching weight by three weeks of age. This is double the growth rate of the domestic gosling. The world population of the red-breasted goose is estimated to be about 75 000 (Bird Life International, 1993). These geese nest in Siberia and winter on the Black and Caspian Seas.

CANADA GOOSE

Branta canadensis *NOT THREATENED*

This species is unlikely to be of value for hybridisation with domestic geese. Many local Canada goose flocks have become sedentary (and no longer migrate) in North American and European city parks and wildlife reserves. These flocks are increasing in numbers each year and the geese are on the way to *de facto* domestication. The flesh of the Canada goose is not considered to be very palatable unless grain-fed.

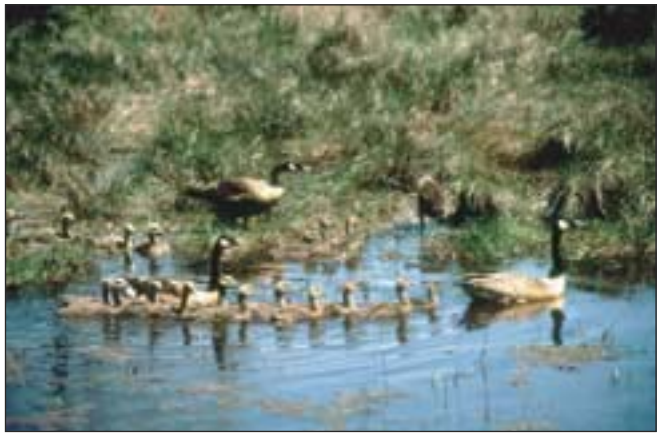

Photo 3.30: Canada goose (North America and Europe). Under self-domestication.

The geese of the tropics have seldom been considered for domestication. They are expected to be heat-tolerant and have less subcutaneous fat than the Palaearctic ancestors of domestic geese. Examples of species, which might be domesticated in tropical areas, are:

EGYPTIAN GOOSE

Alopochen aegypticus — *NOT THREATENED*

This goose is a native of tropical Africa. It is already semi-domesticated but it is said that its bad temper and quarrelsome nature limit its usefulness.

NE-NE

Branta sandvicensis — *VULNERABLE*

Native to the Hawaiian Islands, this is a highly endangered species. If it could be shown to be amenable and useful for domestication, the possibility of an economic future might result in a more rapid build-up of its currently small wild population. The Nene is unique in that it lays its eggs in winter, when day-length is short and that it is the only wholly land-dwelling goose. It can copulate on land and probably has little subcutaneous fat. These could be valuable traits for infusion into domestic goose breeds.

BAR-HEADED GOOSE

Anser indicus — *NOT THREATENED*

Occurs in India and Central Asia. Despite heavy hunting pressure the species is still abundant and breeds well in captivity if the parent stock is hand-reared. It is characterised by a very long breeding season.

The wild goose species listed in this section all have some potential for the enhancement of domestic breeds. Careful selection might shorten incubation periods, improve growth rates, increase efficiency of food conversion and thus improve production under specific climatic conditions.

5 GUINEA FOWL

Numida meleagris — Order *Galliformes*/ Family *Phasianidae*

The domestic guinea fowl is descended from only one of the nine wild species. Other wild subspecies closely related to the domestic guinea fowl might have some potential for domestication. Guinea fowl were domesticated in Egypt and Greece about 1475 BC and 400 BC, respectively. The guinea fowl was the last bird to be added to the Roman menu (Pliny, 72 AD). Later the guinea fowl died out in Europe but was reintroduced by Portuguese navigators returning from Africa in the late 1400s (Belshaw, 1985).

GREY-BREASTED GUINEA FOWL

N.m. galeata — *NOT THREATENED*

This subspecies is the true ancestor of the domestic guinea fowl. It thrives under semi-domestic conditions and needs little special care having retained the hardiness and social habits of its wild ancestor. It is found throughout West Africa and probably has many valuable genetic traits. There is much variation in size and other characteristics amongst individual birds. These birds have long been semi-domesticated by the people who live along the Gambia, the Volta and the Niger rivers. Very large numbers of guinea fowl (55 million in Nigeria alone) are kept as semi-domestic producers of meat and eggs in the dry regions of West Africa. The wild populations are large and are not threatened. Various subspecies of guinea fowl are native to the grasslands and woodlands of most of Sub-Sahelian Africa. They have an inherent adaptability to both heat and cold. However, in cool climates, regardless of day length, they will not come into lay until the mean ambient temperature exceeds 15ºC. In West Africa egg production is largely confined to the rainy season but can be induced by spraying the birds with water. In Queensland, Australia, many farmers keep a few so-called guineas to help control grasshoppers in crops and gardens as well as ticks around the cattle sheds (National Research Council, 1991).

TUFTED GUINEA FOWL

N.m. meleagris — *NOT THREATENED*

This subspecies is probably the ancestor of the birds domesticated by the ancient Egyptians and in the Roman Empire. Hill farmers in southern Sudan sometimes breed this subspecies in captivity.

MITRED GUINEA FOWL

N.m. mitrata — *NOT THREATENED*

This subspecies is a popular game bird in East Africa. It was once common but is now in decline through over-hunting. The Mitred guinea fowl has been kept in semi-domestication on Zanzibar for several centuries and is now most numerous in the Maasai lands of Kenya and Tanzania.

VULTURINE GUINEA FOWL

Acryllium vulturinum — *NOT THREATENED*

The largest of all the guinea fowls belongs to a different genus and is found in the dry areas of Ethiopia, Somalia and northern Kenya. It is famous for its long neck and saddle feathers that are much sought after for making fishing flies.

Photo 3.31: Vulturine guinea fowl (Kenya). The largest of the guinea fowls, which produces valuable feathers for fishing flies.

6 TURKEY

Meleagris gallopavo — Order *Galliformes*/ Family *Phasianidae*

NOT THREATENED

The indigenous domestic turkeys of Latin America were domesticated from *Meleagris gallopavo gallopavo*, the wild species of Mexico. These spread through Central and South America and have persisted as indigenous domestic turkeys. Their plumage is largely black. Some Latin American turkeys were taken to Europe in the sixteenth century and subsequently to eastern North America in the eighteenth and nineteenth centuries. Here they hybridised with another wild subspecies, *M.gallopavo sylvestris*, to produce the bronze turkey, forerunner of all commercial turkeys in developed countries. Thus, the indigenous Latin American turkeys derive exclusively from *M.g. gallopavo*, while all other domestic turkeys derive from the hybrid *M.g gallopavo / M.g. sylvestris* (Crawford, 1992). Some authorities, however, postulate that the domestic turkey derives from Merriam's Turkey (*M.g. merriami*), which is found in the south-western United States of America.

Another wild turkey, the Ocellated turkey, *Agriocharis ocellata*, occurs in Yucatan, Belize and Guatemala. This bird does not appear to be an ancestor of the domestic turkeys of Europe and North America, but may have been domesticated by the Mayans. Today, in Guatemala, ocellated turkeys are sometimes kept in a semi-domestic state as scavengers around houses. The ocellated turkey is classified as Insufficiently Known by IUCN and its status is under review.

A French company has developed a strain of self-reliant farm turkeys for export to developing countries as a scavenger and meat producer. The wild Mexican turkeys and some of the primitive, domesticated strains in the uplands of central Mexico may now be scarce since their numbers and distribution have been greatly reduced. The need for the conservation of the genetic variability of this species is urgent and the wild and unimproved domestic turkeys of Mexico should be collected and assessed before it is too late. A separate type, independently domesticated by the Pueblo Indians of the south-western United States, has already entirely disappeared.

7 OSTRICH

Struthio camelus — Order *Struthioniformes*/ Family *struthionidae*

NOT THREATENED

Ostriches are the largest living flightless birds. The head and neck are almost naked, but are sparsely covered with downy feathers. The eyes are exceptionally large, the largest of any terrestrial vertebrate (50 mm in diameter) and are protected by long eyelashes. Males are conspicuously black and white, the females a uniform dull grey and brown. The thighs are almost naked. The legs, adapted for swift running, are also used for attack when fighting among themselves and for defense against predators. The male has a grooved penis, which is unusual in birds.

DISTRIBUTION AND CURRENT STATUS

The ostrich is now endemic only to Africa, but formerly extended to the Arabian Peninsula before becoming extinct there in about 1968. The ostrich now ranges throughout eastern and central Africa, from southern Morocco, the northern Sudan and southern Egypt to the Cape. Its distribution in central Africa is broken by the Brachystegia woodlands of southern Tanzania, Zambia, Angola and Mozambique. Throughout most of its range the ostrich is locally common and is even abundant in some protected areas.

Of the four races of the ostrich, the northern and western nominate race, *S.c. camelus* has been severely persecuted during the twentieth century and is believed to be rapidly decreasing. The two east African races, *S.c. molybdophanes*, and *S.c. massaicus,* are under less pressure. The southern race, *S.c. australis*, is extinct throughout most of its former range and is now confined to Namibia and to some national parks. This is the domesticated race in South Africa, but has hybridised with introduced *S.c. camelus* and the hybrid has become feral on some farms.

THREATS TO SURVIVAL

Throughout its range the ostrich is hunted for its meat, skin, feathers and eggs. Egg predation by jackals, *Canis mesomelas*, hyaenas, *Crocuta crocuta* and especially Egyptian vultures, *Neophron percnopterus*, may be significant in some areas. Where these predators are abundant the nests are guarded at all times, by the female during the day and the male by night. Although greatly reduced in numbers by hunting and destruction of habitat through overgrazing by domestic livestock, no living race of the ostrich is threatened with imminent extinction.

CAPTIVE BREEDING

Ostriches breed freely in captivity when well fed and properly managed.

The National Wildlife Research Centre in Saudi Arabia plans to release the red-necked ostrich, *S.c. camelus*, from the Sudan into the Mahazat as Said protected area in south-western Saudi Arabia to replace *S.c. syriacus*, which has been extinct since 1968 (SSC/IUCN, 1994).

DOMESTICATION AND ECONOMIC IMPORTANCE

Domestication, which started in Algeria in about 1860, has been in progress in South Africa for more than 100 years. The current annual world demand for ostrich skins approaches one million. At present world production of ostrich skins, mainly from South African farms, is less than 250 000 skins a year. Small numbers of skins are also produced in Zimbabwe, Tanzania and Texas. Australia has more than 35 000 farmed ostriches (1995) and the industry intends increasing its flock to 200 000 birds by the year 2000. In 1995 ostrich meat was selling locally in Australia for A$40 a kilogramme (US$ 29) and a pair of breeding ostriches was selling for A$ 60 000 to 120 000.

Almost nothing produced by the ostrich is wasted. There is a market for the feathers as feather dusters and the meat is saleable as human food (fresh or dried). Even broken eggshells can be made into attractive necklaces and bracelets. Recently the corneas from ostrich eyes, being HIV-free, have been used for transplantation into human eyes. The most valuable product, however, is the skin, which is harvested at 14 months of age. High quality, unprocessed ostrich skins are worth about US$ 200 each wholesale. In South Africa, in 1979, a domestic ostrich was worth R 150 of which 48 percent was for the skin, 40 percent for the feathers and 12 percent for the carcass. In Texas in 1994 the productive value of an ostrich was estimated to be US$ 900. Ostrich skins are processed in South Africa and Germany and are made up into ladies handbags, shoes, briefcases and wallets in France and Italy. The greatest demand for these articles is from Japan.

Ostriches can be farmed in areas where the climate is hot and dry in the summer and cool and relatively dry in the winter. Attempts have been made to farm ostriches in Italy, but these are understood not to have been successful because the climate in winter is too damp.

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8 EMU

Dromanius novaehollandiae Order *Casuariiformes*/ Family *Dromaiidae*

NOT THREATENED

The emu is a flightless Australian bird, which reaches up to 2 m in height and 50 kg in weight. It is fully protected as native fauna in all Australian states and territories, but it is considered to be an agricultural pest in Western Australia (WA) where the Government can authorise the killing of emus for pest control. However, products from emus killed on damage permits cannot be sold.

DISTRIBUTION AND CURRENT STATUS

Emus are still common throughout most of Australia, the highest densities being in the pastoral zones.

THREATS TO SURVIVAL

Predation by dingoes (*Canis dingo*) is believed to have a marked effect on population densities in some areas. Severe drought also probably has a negative effect on emu populations.

CAPTIVE BREEDING

Under good management, emus breed freely in captivity.

Photo 3.32: Emu (Australia). An emerging domesticant with potential for production of skins, meat and oil for cosmetics.

DOMESTICATION AND ECONOMIC IMPORTANCE

There is no commercial harvest of wild emus in Australia but farming is now permitted in a number of States. Emu farming was first attempted in 1976 by an Aboriginal community in WA, using breeding stock captured from the wild. Commercial emu farming was authorised by the WA Government in 1987. All emu farms are licensed by State conservation agencies and farm size, stocking densities and fencing requirements are regulated. In 1994 there were 38 emu farms in WA. Farms are also being established in Tasmania, New South Wales and Queensland. The Australian national flock in 1994 numbered over 30 000 birds.

The emu farming industry aims to supply meat, skins and byproducts, such as oil and feathers, to markets both in Australia and overseas. Tourism also provides a source of income for some farms. Slaughter of farmed emus began in 1991 in WA with an estimated 85 000 birds being available for slaughter in 1995. The key export markets for emu products are the United States of America, Japan, France and Southeast Asia for meat, leather and oil.

Emu meat is low in fat and cholesterol, with a pleasant

gamey taste. The industry is seeking to establish this product on the domestic market with emphasis on the regions that attract tourists. However, export markets are eventually likely to absorb most of the emu meat produced in Australia.

Emu fat is rendered to produce oil that is used in cosmetics and is reputed to be an effective treatment for muscle and joint pain, but these claims are as yet unproven.

The productive value of an emu in Texas, where in 1994 there were about 30 000 under domestication, is US$450. The emu industry is still in its infancy in Australia and markets continue to be developed. If production and processing costs can be lowered, the outlook is considered to be very optimistic (Ramsay and English, 1991; Ramsay, 1994).

9 RHEA

Rhea americana — Order *Rheiformes*/ Family *Rheidae*

NOT THREATENED

Rheas are large, flightless birds found in South America. Five subspecies are usually identified, however these differ from one another by only subtle morphological differences and some authorities recognise only two subspecies, which overlap with one another in the Chaco Region (Short, 1975). The species enjoys total protection in Uruguay and Argentina. Bolivia, Brazil and Paraguay have generic bans on trade in their wild species, including rheas.

DISTRIBUTION AND CURRENT STATUS

Rhea americana is extensively distributed throughout south-eastern South America. It occurs in Brazil, Bolivia, Paraguay, Uruguay and Argentina. In Argentina the southern range limit is in the ecotone between the Pampa and Patagonia, close to the Rio Negro. Little population data exists in any of the range states. In Argentina complete censuses have been taken only on some private estancias. It is generally agreed, however, that the species is less widely distributed than in former times.

THREATS TO SURVIVAL

The main threats are habitat loss due to agricultural expansion and illegal hunting, mostly in the Pampas region of Argentina, in Uruguay and in southeastern Brazil. On some cattle ranches, the rhea has been wiped out by hunting.

CAPTIVE BREEDING

Rheas can be bred in captivity. A small member of the family *Rheidae*, *Pterocnemia pennata* (the Lesser or Darwin's rhea) is the subject of an Argentine Government experimental project at the Instituto Nacional de Tecnologia Agropecuaria, Bariloche, Argentina. *Rhea americana* is also under investigation at this Institute.

DOMESTICATION AND ECONOMIC IMPORTANCE

Throughout its range the species has always been harvested for its meat, eggs, feathers, skin and oil, with very diverse applications for the aboriginal and creole cultures (Fauna Argentina, 1984; Sick, 1986). In Argentina, rhea skin is used to make leather goods and the feathers are used for dusters. The meat, especially from the thighs, called Picana, is eaten locally along the Argentine coast and in southern Brazil. The eggs are also eaten. Tanned skins are traded internationally by Argentina which exported 18 000 in 1990 (CITES Data). Skins are worth US$ 24 – 28 per sq. ft. There is a significant volume of illegal international trade, especially with dealers in Japan. The farming of rheas for skins, feathers and meat would appear to be a distinct economic possibility, but in Texas where 3 – 4 000 are under domestication at present, farmers are finding rheas to be nervous and difficult to manage, when compared with ostriches or emus. There are no commercial rhea farms at present in South America but it is expected that many will soon be set up in Argentina, Uruguay, Brazil and Chile, in an attempt to diversify away from the traditional sheep farms of Patagonia.

10 CASSOWARY

Casuarius spp. — Order *Casuariiformes*/ Family *Casuariidae*

NOT THREATENED

Cassowaries are large, flightless birds that live in the forests of Papua New Guinea. Three species are recognised, the Double-wattled, *C. casuarius*, the Single-wattled, *C. unappendiculatus*, and the Dwarf cassowary, *C. bennetti*.

DISTRIBUTION AND CURRENT STATUS

The cassowary species are widely distributed in the highland forests of Papua New Guinea and are still relatively abundant. There is no immediate risk of extinction.

THREATS TO SURVIVAL

In the past, Papuan villagers hunted cassowaries with bows and arrows and by trapping. Now modern weapons, such as shotguns are being used and the cassowary population is in decline. Demands for traditional uses are increasing and there are few controls on trade in the young birds captured from the wild.

CAPTIVE BREEDING

Hatching cassowary eggs is very difficult. The birds are extremely sensitive to disturbance and males and females are often aggressive towards one another

when in captivity. The females only lay four to five eggs a year and do not breed every year. As a result, very few are bred in captivity and captive propagation is unlikely to be economic at present.

DOMESTICATION AND ECONOMIC IMPORTANCE

Many villages in the highlands of Papua New Guinea have cassowary farms. The villagers get their chicks from the wild birds in the forests or buy them from neighbours. The chicks are reared by hand and become very tame. Nevertheless, when adult the tame cassowary is unpredictable and very dangerous. When roused, the bird is capable of killing a human by leaping into the air and striking down with its long, sharp toenails.

In some areas of the highlands the cassowary has a very important economic status. Like the pig, it is used in the settlement of disputes, for bridal dowries, as a political gift and for feasts. The feathers are used for headdresses, the bones for tools and the toenails for spear tips. Again, like pigs, cassowaries are a sign of wealth. The price of an adult bird can be between 200 – 1 000 Kina (1 Kina = 1US$) depending on size.

The Wildlife Division in Papua New Guinea has set up an experimental cassowary farm at Was, near Mendi in the southern highlands, to teach the villagers to propagate the birds for domestic production.

Order *Sauria*/Family *Iguanidae*
and Family *Crocodylidae*

1 Green Iguana
2 Black Iguana
3 Crocodilians

Large lizards have been important food animals for man since prehistoric times. Some, such as the monitor lizards, *Varanus spp.*, are frequently seen trussed-up in the markets of Indo-China. They are carnivorous and may be difficult to raise economically for meat. However, they may be very valuable to raise for medicine for the Chinese pharmacopoeia, as is done on a small scale in Thailand. Their skins also make fine leather. Iguana meat is popular in Latin America and the lizards are hunted relentlessly everywhere. As a result they are now becoming scarce and their decline is accelerated by habitat destruction as the tropical forests are felled and the land is turned over to cattle ranching. Iguanas are forest-edge species and will thrive on farms and ranches as long as some patches of woodland are left standing.

1 GREEN IGUANA

Iguana iguana *THREATENED*

This large arboreal lizard is herbivorous and, although it takes three years to reach market size, it is easily tamed as a hatchling. If released into the wild, it will remain in nearby trees as long as it regularly receives a small amount of supplementary food in the form of house scraps. Iguanas can thus provide an important incentive for keeping the tropical forest trees standing, while still providing people with meat and income. These lizards weigh 2 – 4 kg and mature males may reach 6 kg.

DISTRIBUTION AND CURRENT STATUS

Indigenous from Mexico to northern Peru, green iguanas were formerly abundant in Central America but are no longer so. In most places where they used to be common, such as in the mangrove forests of Mexico's Pacific coast, only five percent of the former population remains. In the Guatemalan Pacific lowlands and in El Salvador, green iguana density is less than one percent of what is was a few years ago and in Panama and Costa Rica the species is classified as endangered.

THREATS TO SURVIVAL

Intense commercial hunting and deforestation are the main causes of population decline throughout the green iguana's range. Conservation education is badly needed in Central America, where people catch gravid females and rip out the eggs to eat, under the widely held misconception that the lizards can survive this brutality. Where this occurs iguana populations have been devas-

tated. In most countries where the green iguana still survives, it has been declared an endangered species by the government (Fuller and Swift, 1984).

CAPTIVE BREEDING

Sexual maturity is reached at two to three years of age and the females lay one clutch each year of 10 - 85 eggs, on average about 35 each year. There is a green iguana research farm in Costa Rica where thousands of lizards have been raised. Research on the green iguana is being carried out at the National Institute for Renewable Natural Resources of Panama (Cook, 1981).

Photo 3.33: Green Iguana (Belize). A large arboreal lizard with potential for semi-domestic management for meat and skins.

DOMESTICATION AND ECONOMIC IMPORTANCE

The green iguana has been a source of protein for humans for over 7 000 years. Many rural poor throughout central and northern South America still depend on the iguana for protein (Fitch *et al.*, 1982). Iguana meat and eggs are considered to be aphrodisiacs in many areas. Iguanas are best semi-domesticated since they normally inhabit the treetops, feeding on leaves, shoots and fruit in the forest canopy. Few other herbivores are able to convert such forest foliage into food for human consumption. Research indicates that 200 – 300 kg of iguana meat can be produced each year from one hectare of forest. The main constraint to iguana farming, however, is that while it takes as much food to produce a 3 kg iguana as it does to produce a 3 kg chicken, it takes three years to produce the iguana and four months to produce the chicken. Iguana skin has barely been exploited as yet. It sells on the international reptile leather market as chameleon lizard and is used for making ladies' accessories.

REMARKS

Green iguanas adapt well to secondary forest growth and to backyard conditions and unless grossly overstocked they are unlikely to affect the productivity of the trees. Werner (1991) gives a full account of the rational use of green iguanas.

2 BLACK IGUANA

Ctenosaura spp. *THREATENED*

Four species of black iguana have been exploited for food in Latin America for centuries. Black iguanas differ from green iguanas in that their young are insectivorous and carnivorous during their first few weeks of life. Later on they become herbivorous like the green iguana and feed on vegetation. Adult black iguanas weigh up to 3 kg.

DISTRIBUTION AND CURRENT STATUS

The four black iguana species range from northern Mexico along both coasts of Central America to Panama and Colombia's Caribbean islands. They tolerate human presence well and have become almost suburban, often thriving on town garbage dumps and in cemeteries where they feed on coarse vegetation. As recently as 16 years ago black iguanas were shipped to market in Central America by the truckload. Today they are much reduced in numbers and have disappeared over much of their range. Nevertheless, they are still plentiful enough to be considered the major wild animal human food source over extensive areas in Central America.

THREATS TO SURVIVAL

Overhunting and the killing of gravid females for their eggs have had a disastrous impact on the once plentiful black iguana populations. Excessive insecticide spraying, too, is thought to be significant in some areas, probably because it kills the insect food source of the young iguanas.

CAPTIVE BREEDING

Black iguanas are much less arboreal than green iguanas. They are also more aggressive and territorial. The insectivorous nature of the hatchlings renders feeding them difficult and expensive since, like most lizards, they require living, moving prey. Females lay one clutch of 20 – 90 eggs each year.

DOMESTICATION AND ECONOMIC IMPORTANCE

In 1981 the Centro de Recursos Naturales (CENREN) in El Salvador started a black iguana farming project. Since then many data have been accumulated and the project produces large numbers of hatchlings for restocking depleted areas. Latin Americans believe that the flesh of these lizards has medicinal properties and they are willing to pay well for it. Where green iguana and black iguana occur together the flesh of the black species is preferred. Marketable size is not reached before two years of age. If sustainable harvesting programmes are not soon developed both iguana species are likely to be hunted to extinction.

REMARKS

Certain parasitic worms found in the flesh of black iguanas can make the meat inedible and unsaleable.

3 CROCODILIANS

Order *Sauria*/Family *Crocodylidae*

Crocodiles, alligators, caimans and gavials have existed on Earth for some 200 million years - far longer than mammals - but all are now fast disappearing. Of the 22 species of crocodilians distributed in the warm waters of the world, at least 18 are threatened with extinction in most of the countries in which they are found in the wild. Many species now survive only in national parks, protected reserves or in breeding stations. Habitat destruction (dams, marshland drainage, riverine forest destruction and estuary reclamation) and illegal poaching, by both tribal people and by professional hunters, have all contributed to the widespread decline of crocodilian populations over most of their range (National Research Council, 1983b).

Since the Second World War, almost all crocodilians have been over-exploited for their skins. The extent to which each species has been affected has depended on the economics of commercial hunting. The species with valuable skins have been hunted the most intensively. In spite of this, no species has yet become extinct in the wild as a result of over-hunting, although the Siamese crocodile (*Crocodylus siamensis*) and some of the South American crocodilians may be approaching that state.

The worldwide decline of wild crocodile stocks has provided the stimulus for the establishment of commercial crocodile farms and rearing stations. Captive-breeding programmes, established or promoted by the Governments of South Africa, United States of America, Zimbabwe and Papua New Guinea, have been able to encourage the conservation of wild crocodiles, while legally providing skins for commercial use. Today, commercial crocodile farms are operating with varying degrees of success in a large number of countries including Australia, Greece, Israel, Kenya, Malaysia, Mexico, Mozambique, the Philippines, South Africa, Singapore, Thailand, United States of America, Zimbabwe and the island of Taiwan, Province of China. Some countries, such as India and China, have captive-breeding programmes for endangered species, with the objective of restoring viable populations to the wild (Jenkins, 1987). Some crocodile farms, notably in Malaysia, are operated in conjunction with duck and pig farms that supply offal to feed the crocodiles.

The world trade in crocodilian skins peaked in the 1950s and early 1960s when 5 – 10 million skins, mainly those of the Nile crocodile (*C. niloticus*), were traded. Since then the annual number of skins has declined to about 1.5 million (Hemley and Caldwell, 1986). During this time the species harvested has changed from a predominance of classic skins (Nile crocodile) to an increasing number of those of the South American caiman. At present the genus *Caiman* supplies some two-thirds of the crocodilian hides in trade worldwide (Hemley and Caldwell, 1986). The spectacled caiman (*Caiman crocodilus*) is the most widely distributed and ecologically adaptable of the New World crocodilians and substantial wild populations remain in Venezuela and Colombia. Most caiman skins are harvested from the wild, but the farming and ranching of spectacled caimans has recently started in South America.

The majority of farmed crocodiles are derived from five wild species. These are:

NILE CROCODILE

C. niloticus *VULNERABLE*

This species is widespread throughout Sub-Sahelian Africa, but is absent in much of the extreme south and south-west. It extends northwards along the Nile to Lake Nasser and is present in Madagascar. The wild Nile crocodile is much depleted by intensive, uncontrolled hunting for skins, but it is now farmed on a large scale in Zimbabwe and South Africa where a proportion of the artificially-hatched hatchlings are returned to the wild to augment the free-living population.

ESTUARINE (SALTWATER) CROCODILE

C. porosus *ENDANGERED*

A widespread species occurring from Sri Lanka, through eastern India to the Philippines and western Carolines and south through Indonesia, Papua New Guinea and northern Australia to the Solomon Islands and Vanuatu. This crocodile is very severely depleted, rare and declining through most of its range. It is the largest living crocodilian and is reported to sometimes attain 9 m in length. It has the most commercially valuable skin of all the farmed crocodiles. Four crocodile farms have been established in Australia where this species is raised but to date only the Edward River farm, operated by the Government as an aboriginal development project, has developed a successful breeding programme and is producing eggs from its own captive breeding stock.

NEW GUINEA CROCODILE

C. novaeguineae *VULNERABLE*

A moderate-sized crocodilian occurring mainly in freshwater habitats in Papua New Guinea and Irian Jaya, Indonesia. This species has been the subject of an FAO crocodile farming project in Papua New Guinea where hatchling crocodiles collected from the wild have been raised in captivity by villagers for their skins.

SIAMESE CROCODILE

C. siamensis *ENDANGERED*

Very rare in the wild. Formerly this species inhabited the lowland freshwater lakes of Vietnam, Cambodia, Laos and Thailand, also Kalimantan, Java and maybe

Sumatra, Indonesia. It is now extinct throughout much of its previous range due to intensive hunting for skins and habitat destruction. It is, however, now captive-bred on a large scale, primarily for skins, on a farm near Bangkok where hybridisation with *C. porosus* has taken place. The hybrid offspring are said to be commercially superior to the pure-bred stock.

AMERICAN ALLIGATOR

Alligator mississippiensis *NOT THREATENED*

Now listed by IUCN as out of danger. Relatively widespread in various wetland habitats in the southeastern United States of America, the wild population now stands at over 300 000. There are about 20 alligator farms in the United States of America, mostly in Florida and Louisiana where the animals are kept for skin and meat production and as a tourist attraction. There is an alligator farm in Israel, using animals supplied by a Florida farm, which is at present run as a tourist attraction but expects soon to begin producing skins on a commercial scale.

At least 12 other species of crocodilian are the subject of captive-breeding operations, usually, but not always, in their native country. In most cases the aim is to conserve the stocks and to return them to the wild when circumstances permit.

The meat of farmed crocodiles and alligators is becoming an increasingly valuable by-product of the crocodile skin industry. Crocodile meat dishes are now served in many restaurants near the farms and croctail cocktail is a popular starter. In Louisiana, alligators are classified as seafood by the meat inspection services. Meat not sold for human consumption can be fed back to the crocodiles provided it is fresh. There is also a market in the East for the gall bladder and the penis of the crocodile for oriental medicine (National Research Council, 1983b; Groombridge, 1987; FAO, 1989). In The Dominican Republic, Haiti, Venezuela and Bolivia crocodilian fat is sought after for the treatment of asthma, burns and skin ulcers (Ross, 1992). Medem (1983) reports that during the commercial hunting of Orinoco crocodilians, musk collected from the cloacal glands was sold as a base for making perfume.

Crocodiles held under farm conditions are very prone to escape and when this occurs can establish a feral population. While this may be of little consequence when it happens in the species' native country, within the species' natural range, it can cause serious problems of competition and hybridisation if it occurs within the range of indigenous species in other countries. It is therefore recommended that crocodilians should be farmed only in their native countries or where there are no indigenous crocodilians in the wild.

Much of the material summarised in the Sections on Rodents, Poultry and Reptiles has been gleaned from National Research Council (1991) and National Research Council (1983b).

3.15 CIVET CATS

Order *Carnivora*/Family *Viverridae*
NOT THREATENED

1 African civet
2 Small Indian civet

Two civet cats, one African and one Asian, are currently exploited in captivity for the very valuable musk secreted by their anal glands.

1 AFRICAN CIVET

Viverra civetta

The African civet, *Viverra civetta*, has been kept in captivity in Ethiopia for hundreds of years. Civet musk, a foul smelling scent produced by the anal glands of the male civet cat, has powerful holding properties for other scents and is used in the manufacture of expensive perfumes. Today there are estimated to be more than 200 civet farmers in Ethiopia with about 4 000 civets in captivity. The farms are mostly to be found in the lower parts of the western highlands and in the Sidamo region.

TRADITIONAL CIVET FARMING IN ETHIOPIA

Most civet farmers keep 10 – 15 civets in individual cages made from eucalyptus poles. The design of these cages has not changed since the 1870s, when the engraving above was etched from a sketch by Cardinal Gugliemo Massaia, an Italian missionary.

The cages are placed in rows on trestles in dark rooms. Smoke is used to reduce fly-worry. Hygiene is usually very poor and there is a strong smell of urine and faeces, which are left to decay on the floor.

The civets are fed on a mixture of fruit and vegetables, maize meal and meat (1 kg/civet) or four eggs, every five days. The musk is collected using a horn spoon every 11 – 12 days during the rainy season and every 9 – 10 days during the dry season. Musk collection apparently causes no discomfort to the civet, which is restrained by using a stick to hold the head. The hind legs and tail are stretched out by an assistant whose hands are protected from injury by sacking gloves.

The musk is collected in horns and taken to agents in Addis Ababa every three or four months. The musk is then passed to the Pasteur Institute were it is tested for purity and packed in lead-sealed glass containers for export.

The measurement traditionally used for buying and selling civet musk is the wocket (also used for gold) and 23.6 wockets make 1 kg. One wocket is worth 40 Ethiopian birr (ETB), thus 1 kg of musk is worth 950 ETB or US$ 450 (1990).

In one year a civet will yield about 300 – 400 g of musk, worth to the farmer about US$ 200.

Ethiopia has an almost worldwide monopoly for civet musk production and annually exports some 2 000 kg of musk worth about US$ 900 000.

Civets are trapped in the wild using a noose with a bell attached. Traps are place on the known so-called middens, which are commonly found near footpaths or tracks. The trappers charge between 120 and 150 ETB for a civet, payable after two months to ensure survival. Unfortunately, captive civets often die of a disease resembling canine parvovirus infection.

The Ethiopian Wildlife Conservation Organisation has outlined a programme for civet research and plans to set up an experimental civetry to study captive management (Woodford, 1990).

2 SMALL INDIAN CIVET
Viverricula indica

The Small Indian civet, *Viverricula indica*, is similarly farmed in Thailand and India. The musk produced by this species in Thailand is exported to China for the Chinese pharmaceutical industry. The Thai civet farms are run in association with chicken hatcheries and the civets are fed on boiled dead-in-shell chicks.

Small Indian civets are also kept in cages in many households in Kerala State in southern Indian for the collection of civet produced by the animals' anal glands. The civet and the ketone compound Civetone are sold to Ayurvedic physicians for medicinal use. Currently about 250 households keep some 500 civets in captivity, but as the practice is illegal the animals are kept in secret. Mortality, in the absence of any veterinary care is said to be high. Captive breeding of replacements is not generally undertaken (although it is possible) as replacements are easily obtained from the wild. Average longevity in captivity is 8 – 10 years. Viral diarrhoea and endo-parasites are major causes of mortality (Xavier and Balakrishnan, 1993; Xavier, 1994). The wild population of the small Indian civet is declining in southern India due to habitat loss and the Conservation of Nature Trust believes that if civet farming was made legal and farmers were registered welfare would improve and veterinary care would become available. Recently the Forest Department of the Government of Kerala has started issuing ownership certificates to civet farmers.

Both the African civet and the small Indian civet are widely distributed throughout sub-Saharan Africa and Southeast Asia respectively and neither species is judged to be threatened.

"Give me an ounce of civet, good apothecary
- sweeten my imagination"

King Lear. W. Shakespeare

3.16 DISCUSSION

The loss of biodiversity within wild faunas and floras that has been steadily increasing since the first spread of agriculture, has now become evident in domesticated species, too. The apparent accompanying reduction in diversity in domestic livestock species is particularly dangerous for those species whose wild progenitor is already extinct, for once the genetic material of the wild form is lost, it is gone for ever. Recourse to captive-bred stocks of wild relatives for genetic material may not be satisfactory since some wild species have been held in captivity for many generations and are based on a very small, so less flexible and responsive, gene pool.

Domestication itself – and one may call captive breeding, whether in zoological collections or in more extensive conditions, a form of creeping domestication – may be an irreversible genetic process that will inevitably follow the removal of some species from the selective pressures of their natural environment. Any human interference with the multifarious influences that shape wild behaviour can result in genetic changes which may lead to differing degrees of behavioural and genetic domestication (Ryder, 1993).

In view of this, genetic material from wild animals, whether for storage in cryopreservation or for the production of hybrids with domesticated types, whenever possible should be taken from a healthy, wild population occupying the environment to which it has become adapted.

There is the question as to whether we should be attempting to domesticate new species of wild animals. We have already exploited the indigenous genes of our temperate-based domestic stock substantially. It has even been suggested (Short, 1976) that apart from the romantic appeal it may have for conservationists there may be little point in preserving rare domestic breeds for their genetic potential. Their very scarcity may be an indication that they have lost their usefulness and become museum pieces. Maybe what we should be doing now is collecting and evaluating the genes of more tropical and polar species for infusion into existing domestic livestock of temperate origin and evaluating the potential of some completely new species for domestication, to feed a world increasingly crowded with humans, many of which live or will live in the tropics.

Tropical species are not usually seasonal breeders and even when transported to temperate zones their reproduction may continue to be non-seasonal. Examples are the chital or axis deer, *Axis axis*, of India, the Barbary sheep, *Ammotragus lervia*, of North Africa and the eland, *Taurotragus oryx*, of southern Africa, all of which breed throughout the year in their natural habitats and continue to do so even when translocated to northerly latitudes such as the United Kingdom (Zuckerman, 1952). The introduction of these tropical genes into a domestic species might therefore be expected to extend its mating

season. In contrast to this, animals living in polar regions or at high altitudes in the temperate zone would be expected to have a very restricted breeding season, perhaps an undesirable characteristic in some advanced agricultural situations. Nevertheless, they could well have a number of highly desirable attributes, such as large body size – evolved to minimise heat loss – a rapid growth rate and a high food conversion ratio, both associated with the need to reach maturity in the short summer growing season. Thus the introduction of polar genes or high altitude genes into a suitable domestic species might be expected to increase body size, accelerate growth rates and improve efficiency of food conversion. The new and more productive domestic animal could thus be a blend of desirable genes selected for under environmental extremes and infused into stock of proven domestic temperament (Short, 1976).

The concept of cross-breeding to produce designer domestic animals is not new. The Greeks believed that the minotaur was the result of a union between a bull and a woman, while Pliny in his Natural History suggested that ostriches were the products of giraffes mated with insects. Fundamentally, we must expect that changes in the genetic make-up of populations taken from the wild will be required to ensure their sustainable use for food and agricultural production in the organised (less chaotic) farming environment.

The question of what wild relatives of domestic stock should be given priority, both for *in situ* and *ex situ* conservation, must be addressed. From the documentation it would seem that those wild cattle which are classified as vulnerable or endangered should receive some priority. The wild cattle of Asia include several potentially valuable species: the kouprey, *Bos sauveli*, of Vietnam and Cambodia; the gaur, *Bos frontalis*, of India and the forests of Southeast Asia; two species of anoa, *Bubalus spp.*, from Indonesia and the tamaraw, *Bubalus mindorensis*, on Mindoro in the Philippines. The productive and economic potential and unique characteristics of these tropical, forest-dwelling bovids are almost unknown. A little more is known of the banteng, *Bos javanicus*, of which a domesticated form, known as Bali cattle, is kept for draught and meat production in Indonesia and for the production of hybrids when crossed with zebu cattle, on the island of Madura. Yaks, *Bos grunniens*, are domesticated in the high country of the Himalayas and hybrids with both humped and hump-less cattle (yakows) are also produced in central Asia. The mithan, *Bos frontalis*, is believed to be a semi-domesticated form of the gaur. However, some authorities think that it is the progeny of a gaur/cattle cross, others favour a gaur/banteng cross. Whichever is correct, the mithan has the valuable attribute of great docility and could be further developed for meat and traction in hilly, forested areas unsuited to conventional cattle.

Most of the wild Asian cattle species are threatened with extinction and attention to their conservation is urgent. All inhabit tropical forests and savannahs, regions which are subject to those environmental extremes to which conventional livestock is poorly adapted and in which more than half the world's human population subsists. While the wild cattle of Asia may be resistant to some of the diseases and parasites which occur in their native environment, there is no doubt that diseases of domestic cattle are a serious threat to their continued existence in some areas.

Those wild species which are truly relatives of domesticated forms (yak, banteng, gaur) are important genetic reservoirs and yet others may have potential for the production of new domesticates (anoa, tamaraw, kouprey).

The African Cape buffalo, *Syncerus caffer*, is not threatened with extinction and the European and American bison, *Bison bison*, (now thought to be conspecific) are safely conserved by governments and individuals. These animals have some potential for the production of high quality, low fat meat when ranched in areas marginal for domestic beef cattle.

The mouflon-urial, *Ovis orientalis*, is considered to be the ancestor of the domestic sheep. Almost all European, Asiatic and North American wild sheep species will produce fertile hybrids when crossed with domestic sheep (Gray, 1971) and there may be some advantages, especially in the production of extended breeding seasons, of back-crossing to the ancestral stock (Zuckerman, 1952).

The production of ovine mules, as suggested by Short (1976) could be of considerable agricultural significance since it would obviate the need to castrate surplus males as a husbandry procedure and might thus allow better food conversion rates and enhanced weight gains.

The wild goat species believed to be the ancestor of the domestic goat is *Capra aegagrus*. This species is well distributed throughout the Middle East but the populations, often small and isolated, occur mainly outside protected areas. Only in Turkey is the wild goat population not threatened. A hybrid between the Sinai Desert goat, and the wild Nubian ibex, *C. ibex* nubiana, has been developed in Israel with the object of improving the palatability of the desert goat's meat. Hybrids between domestic goats and wild markhor, *C. falconeri*, are sometimes produced by chance in Chitral, Pakistan. The males of this cross, which are much heavier than their domestic mothers, are greatly prized as stud animals.

Przewalski's horse, *Equus przewalskii*, is now probably extinct in the wild but is safe in captivity. Plans are being made to return this species to its native environment in Mongolia. The wild asses of the world are in a critical state, especially the one surviving African species, the Somali wild ass, *Equus africanus somalicus*, thought to be one of the progenitors of the domestic donkey. With the exception of the now extinct Syrian wild ass, no representative of the eight subspecies of the Asian wild ass has been domesticated and all are now considered either endangered or vulnerable by IUCN. The Somali wild ass

will interbreed with its Asian cousins but the hybrids are infertile. An infusion of Asian wild ass genes into the domestic donkey might produce a mule with the characteristic endurance of its wild parent.

The wild ancestor of the majority of the domestic breeds of pig is the Eurasian wild pig, *Sus scrofa*. The Sulawesi warty pig, *Sus celebensis*, has also long been domesticated on the island of Sulawesi and elsewhere in Indonesia. The species occurs only in its wild, native form on Sulawesi and some adjacent islands. Pigs are likely to be of increasing importance to humankind as a source of protein and the regional genetic variants of the Eurasian wild pig and those of the Sulawesi warty pig (and other Asian wild pigs) are of great interest.

Of the three wild camelids, two occur in Latin America and one in central Asia. The Latin American wild camelids are the vicuña, *Vicugna vicugna*, and the guanaco, *Lama guanicoe*. The latter is the ancestor of the domesticated llama and the alpaca. The largest population of vicuña is in Peru where political unrest threatens the species. The world population of the vicuña is stable but could rapidly fall if conservation efforts were to be relaxed. The development of management techniques for the capture, shearing and release of vicuña could bring about semi-domestication of the species and provide a valuable source of income for the hill villages of Peru.

The guanaco is present in considerable numbers in Argentina but everywhere in Latin America it is over-hunted and persecuted by farmers who believe that it competes for grazing with their sheep and presents a disease risk.

The wild two-humped, so-called Bactrian camel, *Camelus ferus*, is now reduced to about 500 head and is confined to two small areas Mongolia and China.

Some deer species are now officially considered to be domesticated and others will follow them. Their wild relatives, although often under pressure, are generally not immediately threatened but in a world in which the human population is increasing by one million every five days this can hardly be a matter for complacency. Musk deer, *Moschus spp.*, are over-exploited throughout their range, which extends from Afghanistan through northern India to China, for their musk which is used by the European perfume and Asian pharmaceutical industries. Pere David's deer, *Elaphus davidianus*, has been extinct in the wild for 800 years and has recently been returned to its original habitat in China from captive sources in the United Kingdom.

Hybridisation of deer of temperate zone origin, with other species of tropical origin, is becoming a common practice, especially on New Zealand deer farms. The aim is to maximise production by manipulating changes in the time of the mating season and the length of the gestation period displayed by the hybrids. Wapiti, *Cervus canadensis*, sika, *C. nippon*, and Pere David's deer all hybridise with red deer, *C. elaphus*, and produce fertile offspring. The world domestic deer herd now comprises more than five million head, of which more than a million deer are raised on over 5 000 deer farms in New Zealand. This total excludes reindeer that has been domesticated on an extensive scale for a long time in the sub-Arctic.

The Russians have had some success in domesticating the European elk, *Alces alces*, for meat and milk production and as a beast of burden in the Taiga, an environment unsuitable for most domestic animal transport. The Russians report that marked differences in the milk yield of individual elk suggest that selective breeding might result in an increase in productivity.

There are a number of African and Asian antelopes which may have potential for domestication or semi-domestication. These come from diverse habitats ranging from moist rain forest to arid savannah and semi-desert. They are thus adapted to some environmental conditions which are marginal for the production of conventional livestock because of drought, heat, disease, altitude, humidity and other constraints. Even if not subjected to the long process of domestication, they may well turn out to be more productive and less damaging to the environment than conventional domestic livestock in marginal areas.

The most important of the African candidates for domestication are the eland, *Taurotragus oryx,* springbok, *Antidorcas marsupialis*, and impala, *Aepyceros melampus*, and in Asia, the nilgai, *Boselephas tragocamelus*, and the blackbuck, *Antilope cervicapra*. The nilgai, which produces twins annually, could compete with the red deer as a meat producer in suitable environments but, of course, would not provide velvet as an additional product. The saiga, *Saiga tartarica*, which 40 years ago roamed the dry steppe of Kalmykia in Russia and what is now Kazakhstan in millions, has great potential for extensive management as a sustainable producer of meat and skins. Unfortunately, this small antelope is currently undergoing a marked decline as the populations are decimated for their horns to supply the Chinese market.

The Asian elephant is an extremely useful, semi-domestic animal in the logging camps of the Asian forests where it is extensively employed to drag teak logs weighing up to 1 000 kg. In Myanmar, where about 4 500 elephants (and 10 000 domestic buffalo) are employed in the timber industry, the annual losses of trained elephants from old age, accidents, disease etc. are about 7 percent (= 315). To be sustainable, annual offtake from the wild herds, conservatively estimated in Myanmar not to exceed 6 000 head, should not be more than 2 percent (= 120). But the wild herds are not all equally accessible to capture operations and as a result those that are within easy reach, in suitable terrain, tend to be exploited every year to supply as many of the required recruits as possible. In the past, working elephants have been discouraged from breeding because the young elephant is of little use as a work ani-

mal until it is about 12 years old and it has always been easier and cheaper to capture a wild recruit of the right age. Now, if environment-friendly working elephants are to continue to play a part in the timber industries of Southeast Asian countries, some attention must be given to selection for docility, trainability and intelligence in captive breeding stations, while the wild resource is permitted to recover.

Among the other wild species which have potential for future domestication are the musk ox, *Ovibos moschatus*, Asian bears and some Latin American and African rodents. The musk ox, a denizen of the northern tundra, has the most northerly distribution of all ungulates. It has great potential for domestication as a producer of meat and fibre in an environment which, with the exception of the caribou and reindeer, cannot support any other ruminants. There are some areas in northern Canada, western Greenland and northern Russia which could support populations of musk oxen.

The wild populations of the Asiatic black bear, *Ursus thibetanus*, and the brown bear, *U. arctos*, throughout Asia, from Pakistan to Japan, are unlikely to survive the current onslaught on them brought about by the great demand and high prices for their gall bladders and bile. Other bear species in Asia (sloth bear, *Melursus ursinus*, and sun bear, *Helarctos malayanus*) are also likely to be over-exploited for their medicinal products. China's stated intention to increase the number of farmed bears to 40 000 may result in a fall in the price of bear bile and other parts as supply catches up with demand, but before this can happen, the Asiatic black bear and the brown bear may find themselves extinct in the wild and fully domesticated in captivity.

Rodents are particularly likely to become extremely important as a source of future domesticants. They are the world's most adaptable and prolific animals. They reproduce well in captivity, grow fast and adapt to a wide variety of local conditions. Many convert coarse vegetation into meat efficiently even though they have only simple stomachs. Much rodent meat is already consumed throughout the world, especially in Latin America and West Africa. Peru alone has 20 million domestic guinea-pigs and several other species are undergoing experimental domestication. Some of these, like capybaras, *Hydrochoeris hydrochaeris*, the intensive farming of which has been shown to be feasible, are more productive than domestic livestock in marginal or degraded areas and others are adapted to thrive where for one reason or another conventional livestock do not.

Many valuable rodent species are classified by IUCN as endangered or vulnerable and some have already been hunted to extinction. If the considerable productive potential of these and other members of the order *Rodentia* was more widely known in development and agricultural economic circles, an important incentive would be provided for the conservation actions needed to maintain these genetic resources and develop their food producing potential. Under semi-domestication few have been selectively bred for docility or productivity, nor have the characteristics of the various races of those species which occupy a variety of different habitats been characterised.

There are several important factors to be considered before recommending the introduction of a newly domesticated rodent (or indeed any exotic genetic resource) into a new country or culture. Largely because of their fecundity many rodents are agricultural pests in their natural range and since some species have a remarkable propensity for escape there is a danger, supported by a number of unfortunate past experiences, that an alien species could establish itself as a feral population in a new environment. For this reason, rodents may be appropriate for raising only in countries where they are already indigenous. Such potentially invasive animals should not be introduced into another environment where they could escape and become a liability to agriculture and the eco-system as a whole.

The subject of disease carriage has also been mentioned. Some rodent species are carriers of dangerous human diseases, e.g. Chaga's disease, leishmaniasis, trichinellosis, tuberculosis, bubonic plague and tularaemia. This also must be borne in mind when the introduction of a new domesticated animal into a new area is considered.

In the case of poultry, the genes of the high Arctic breeding species, such as the greater snow goose, *Anser caerulescens*, and the red-breasted goose, *Branta ruficollis*, will surely be needed for the improvement of the domestic goose. The bar-headed goose, *Branta indicus*, and the Ne-Ne, *Branta sandvicensis*, (Kear, 1975) will also be important for this purpose. The first two of these wild geese are high Arctic nesters, have incubation periods of only 23 – 24 days (the domestic goose incubates for 33 – 35 days), have a very rapid growth rate and an excellent food conversion efficiency. The red-breasted goose, for example, attains 17.7 times its hatching weight by three weeks of age, which is about twice the growth rate of the domestic gosling. The bar-headed goose nests at high altitudes and has an advantage over the high latitude species in that it has a long breeding season. The endangered Ne-Ne from Hawaii actually lays its eggs on a decreasing day-length in winter. It is also a truly terrestrial goose, is able to copulate on land and has little subcutaneous fat, all useful attributes for infusion into domestic goose breeds.

Ostriches, *Struthio spp.*, have been domesticated for more than 100 years and large numbers are now kept under increasingly intensive conditions. The domesticated ostrich population of Oudtshoorn District in South Africa alone is over 90 000 (1990s) and in the United States of America in 1994, about 100 000. At present, ostrich skins are under-produced and there is some scope for development in the industry by selection and back-crossing to the wild stock.

Emu, *Dromanius novaehollandiae*, domestication is a very new activity, having been first attempted in Australia in 1976 it is now also underway in the United States of America. Experimental rhea, *Rhea americana*, domestication is a recent development in Argentina and in Texas, United States of America. Care must be taken to ensure that successful domestication of these large, productive birds does not distract attention from the need to maintain their parent stocks in the wild.

Large lizards have been important food animals since prehistoric times. Some, such as the monitor lizards, *Varanus spp.*, frequently seen trussed-up in the markets of Indo-China, are carnivorous species and may be difficult to raise economically for meat. However, they may be very valuable to raise for medicine for the Chinese pharmacopeia, as is done on a small scale in Thailand. The meat of the green iguana, *Iguana iguana*, is popular in Latin America and the lizards are hunted relentlessly. As a result they are now becoming scarce and their decline is accelerated by habitat destruction as the tropical forests are felled. But iguanas are forest-edge species and will thrive on farms and ranches as long as some patches of woodland are left standing.

Green iguanas are better semi-domesticated rather than wild, since they normally inhabit the treetops, feeding on leaves, shoots and fruit in the canopy. Few other herbivores are able to convert such forest foliage into food for human consumption. Research indicates that 200 – 300 kg of iguana meat can be produced each year from one hectare of forest. The meat tastes like chicken and the eggs are also consumed throughout Latin America where they are believed to possess aphrodisiac properties. Iguana skin has barely been exploited as yet. The main constraint on iguana farming is that the lizards take three years to reach marketable size.

The five crocodilians, *Crocodylus spp.*, which are in the process of domestication, support a multi-million dollar industry based on the demand for their skins. At present, crocodile eggs or hatchlings are collected from the wild and hatched or raised in captivity. Where eggs are taken, under licence issued by the appropriate national wildlife authority, it is usual to require that ten percent of the resultant young crocodiles are returned to the wild. Unfortunately, this laudable conservation activity carries with it a disease risk because diseases such as crocodile pox, acquired in the hatchery, can be transferred to the wild population with the returned hatchlings. Efforts are being made to complete the domestication process by maintaining adult crocodilians in captivity for the production of captive-laid eggs and already some farms have had success in producing a supply of eggs from their own captive crocodile stocks.

Two civet cats, one African and one Asian are currently exploited for the very valuable musk secreted by their anal glands. The African civet, *Civettictis spp.*, is kept semi-domestically by small-scale farmers in Ethiopia solely for its musk production, which is exported for the perfume industry. The Small Indian civet, *Viverricula indica*, is similarly raised in Thailand and India. The musk produced by this species is exported to China for the Chinese pharmaceutical industry. The Thai civet farms are run in association with chicken hatcheries and the civets are fed on boiled dead-in-shell chicks. Both these civet cats are common and are widely distributed throughout Africa and Asia respectively. At present, these two civet-musk industries are sustained by adult civet cats, caught in the wild, but in future attempts will probably be made to breed the animals in captivity.

The success of domestication of wild animals by humans in the past may have been fortuitous and seems to have depended largely on the degree of social development of the species concerned and to some extent to that of humans as well. It has been suggested by Zeuner (1963) that domestication is rarely possible before a certain level of social evolution has been reached. In the case of those animals already domesticated, the only notable exception to this being the domestic cat, it is not by chance that the majority have been gregarious ungulates. This might imply that to attempt the domestication of nervous, solitary animals or those that exhibit fiercely territorial habits and socialise only in small family groups would be a waste of time. However, studies at the Smithsonian Tropical Research Institute in Panama have shown that, in the case of the fearful and aggressive paca, careful husbandry involving the early removal of the young from their natural mothers and suckling them on tame surrogate mothers, which have been previously imprinted to humans, results in docile, non-aggressive animals in which fierce territoriality never develops. This remarkable research has shown that, after a single generation, pacas trained to be non-aggressive and social adopt the desired behaviour patterns and these become progressively fixed. After three generations the animals need no further training and can be considered domesticated. The African cane rat or grasscutter is very nervous and aggressive and may require these special husbandry techniques to overcome what at first appears to be a serious constraint to domestication. A similar technique enables the bar-headed goose to breed freely in captivity, provided that the parents have been hand-reared and are imprinted to their human attendants.

The findings of Hagedoorn (1950) might well be applicable to the domestication of productive rodents. In his experiments he crossbred several races of the supposedly untameable black rat, *Rattus rattus*. From the resultant hybrids he raised a large second generation which was extremely variable. By a process of fortuitous selection – some pairs bred more easily in the small cages and were more inclined to become tame – a strain of tame yellow rats was produced. Whilst generalising across species is not without risk, these results provoked Bigalke and Neitz (1954) to suggest that Hagedoorn's work might indicate that the domestication of the eland should start by hybridising the common eland, *T. oryx oryx*, of eastern Africa with Lord Derby's (Giant) eland, *T. derbianus gigas*, of central Africa. Posselt (1963), however, noted that

hand-reared young eland varied considerably in temperament and this probably indicates that selective breeding for tameness and tractability could be achieved without recourse to hybridisation. Other authors have noted that when selecting canid pups for training, those with the darkest skin and eye colour are easier to tame and show less instinctive timidity than their lighter coloured siblings (Kagan, 1994). If proven, the existence of such marker traits for complex behaviour responses such as ease of domestication, may help to identify desirable wild types.

If the human population of the world increases by at least 50 percent in the next few decades and if sustainable agriculture is to be achieved across the whole range of production environments, as is required, humankind is going to need all the genetic diversity available. In particular, those genes which confer disease and drought resistance, life cycle productivity and the ability to thrive in degraded and inhospitable environments. The expected world human population increase will almost certainly be a major factor in contributing to global warming. Shifts in climate zones, changes in weather patterns and the inundation of low-lying coastal areas will place great stress on conventional agriculture and livestock production. Action is needed because most of today's farm stock has been derived from temperate ancestors and in 50 years time two-thirds of the world's human population will be packed into the tropical zones where production of livestock of temperate origin is often less than satisfactory.

The development of new techniques for incorporating the desirable genetic traits of the remaining wild relatives into their domestic counterparts and the production of new, innovative domesticants will be essential. There are two basic ways of conserving the genetic diversity exhibited by the wild relatives of domestic stock.

1. ***In situ* conservation**

   in which the stock is preserved by protecting the ecosystem in which it occurs naturally, by the establishment and maintenance of national parks and reserves. In which natural selection is allowed to continue.

2. ***Ex situ* conservation**

   - of the whole animal: by the maintenance of captive populations in zoos. Although this is undoubtedly expensive and could lead to problems of inbreeding, because numbers kept are inevitably small and further genetic change is almost solely the result of random genetic drift and inbreeding depression: both products of small parent numbers.

   - of part of the animal: by cryopreservation techniques enabling the storage of ova, embryos and sperm, freezing the gene pool as sampled at its current generation.

Ideally all three measures should be taken, however in practice this may not be possible for financial and/or technological reasons.

There remains the question of how to make animals available for utilisation in genetic resources programmes. The numbers required for this will vary even within a species, depending on whether a new development initiative is to commence using the sample alone or, at the other extreme, whether interest lies only in a unique gene or allele in the wild relatives. In practice it is likely that captive herds and flocks will provide the animals, these being supplemented from time to time with wild specimens. Some important species are represented in zoological collections, but by no means all and it is for those of potential value as wild genetic resources that this situation needs attention. Within zoos there is also the need to be more aware of the importance of maintaining the genetic variation of the captive stock. This will only come about with increased genetic monitoring of captive populations and breeding programmes.

Animal scientists will increasingly advise on the modern techniques of embryo storage and transfer and semen dilution, storage and insemination. These methods have already been employed for one bovine species: In 1980 the New York Zoological Society successfully bred a Gaur calf from an embryo surgically transferred between a Gaur and a Holstein cow. Clearly reproductive biotechnology offers the potential for increasing the captive stocks of many species without recourse to further depletion of wild populations.

The wild relatives of domestic livestock have travelled by very different evolutionary pathways from those taken by their captive cousins on the farm. The forces of natural selection have fashioned their morphology, physiology and behaviour to produce unique evolutionary advantages, the value of which are only now being appreciated and the techniques for their exploitation developed.

The collection, preservation, characterisation and utilisation of the genetic resources of the wild relatives of domestic animals require the joint endeavours of both environmentalists and agriculturists: The environmentalists by increasing awareness of the animals' potential and by focussing on *in situ* conservation of wild relatives; the agriculturists by providing expertise in storage and utilisation of these genetic resources. The wild relatives of domestic stock must be accorded high priority when national conservation action plans are made and strategies implemented. Wild taxa with potential for domestication must be studied and maintained so that techniques for their conversion for human use can be investigated and adopted.

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ANNEX 3.1 FURTHER INFORMATION ON WILD RELATIVES

The author is grateful for the help of the compilers of the following IUCN/SSC Action Plans.

To learn more of the international Action Plans for these wild relatives, contact the IUCN Publication Services Unit, 219 Huntingdon Road, Cambridge CB3 0DL, U.K.

Draft or completed Action Plans have been developed for:

Asian Wild Cattle Action Plan

Caprinae Global Survey and Action Plan

Pigs, Peccaries and Hippos. Status Survey and Conservation Action Plan

Action Plan for the Conservation of the South American Camelids

Action Plan for the Conservation of the Cervidae, Moschidae and Asian Tragulidae

Asian Elephant Action Plan

Rabbits, Hares and Pikas; Status Survey and Conservation Action Plan.

Zebras, Asses and Horses - an Action Plan for the Conservation of Wild Equids