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On the breeds of cattle

Their history, classification and conservation

Over runderrassen

Geschiedenis, indeling en behoud

(met een samenvatting in het Nederlands)

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Chapter 1

General Introduction

General Introduction

With an estimated 1.3 billion animals worldwide and an average body weight of 500 kg, cattle are, in terms of biomass, probably the most important species of the animal kingdom [1]. In this General Introduction we describe their worldwide distribution, their adaptation to various environments, their many roles in human society and the development of breeds. Then we define the scope of this thesis: in the context of a wide inventory of the diversity of cattle we focus on the role of breeds in the conservation of cattle genetic resources.

Cattle everywhere

Cattle are kept on all inhabited continents in contrasting climatic zones under very different conditions [2]. They thrive in the meadows of the temperate zone, but also live in the sticky swamps of the North American Gulf Coast, the marshes of the Brazilian Pantanal [3] and Bolivian Chaco, as transhumants in the African Sahel [4], on the edge of the Thar Desert in Pakistan and India and on severely cold and windy Alaskan islands [5]. Crossed with the Tibetan yak they tolerate altitudes of 4,000 metres [6,7].

Their global distribution has created a wide diversity of both morphology and genetic constitution. A few examples of their versatile adaptation [8]:

- Yakut cows in Siberia north of the Polar circle withstand temperature of -60°C with a long thick coat that covers the udder [9].
- Kalmyk cattle survive in Kazakhstan the scorching summers, while knowing during the bleak winters how to dig under the snow for grass and to take snow for watering.
- Vechur cattle in the South Indian state of Kerala, averaging 89 cm at the withers, are completely adapted to a hot climate and poor feed conditions [10].
- Kuri cattle are fully adapted to living in Lake Chad. In search for grazing they cover distances by swimming between islands and shores while surviving only with difficulty away from the lake [11].
- Trypanotolerant West-African Shorthorns thrive in tsetse-infested forests and lagoons where other cattle perish [12].
- Ethiopian Boran zebus are able to walk long distances in search of grass and water, requiring watering only once every three or four days [13].

This is in stark contrast to the large and single-purpose breeds, such as the Holstein, which completely depend on abundant high quality and quantity food and water as well as great care in order to produce 10,000 kg milk per lactation, or the extreme double-musled Belgian White-Blue beef breed that depends on caesarean surgery for delivery of the calf.

Cattle in human society

In all their environments cattle are an integral part of the human communities. Milk and beef are the most important cattle products, followed by hides, horns, hooves and other carcass parts. Dairying even led to an adaptation of human DNA by mutations in the lactase gene, which confer lactose tolerance in adults and is most prevalent in northern and central Europe and in parts of Africa [14]. When far from home,

the family boma, Turkana, Karamojong, Masai and other East African herders regularly take blood from their cattle in order to complement their diet with proteins [15]. Manure of cattle is used as fertilizer, as fuel and in Africa and Asia even as house construction material. Cow's urine is a medicine in Hindu culture and a hair dye for Nilotic boys. Cattle are in West and East Africa for pastoralists also currency for bride prices and penalties [16].

In many agricultural and urban regions the community still relies on cattle for providing traction, tilling soil and paddy fields, trashing grain, hauling water from wells, and transporting heavy loads. In India and Madagascar oxen are used for light carts and fast road transport. Azaouak, Red Bororo and Fulani cattle in the Sahel may also serve as

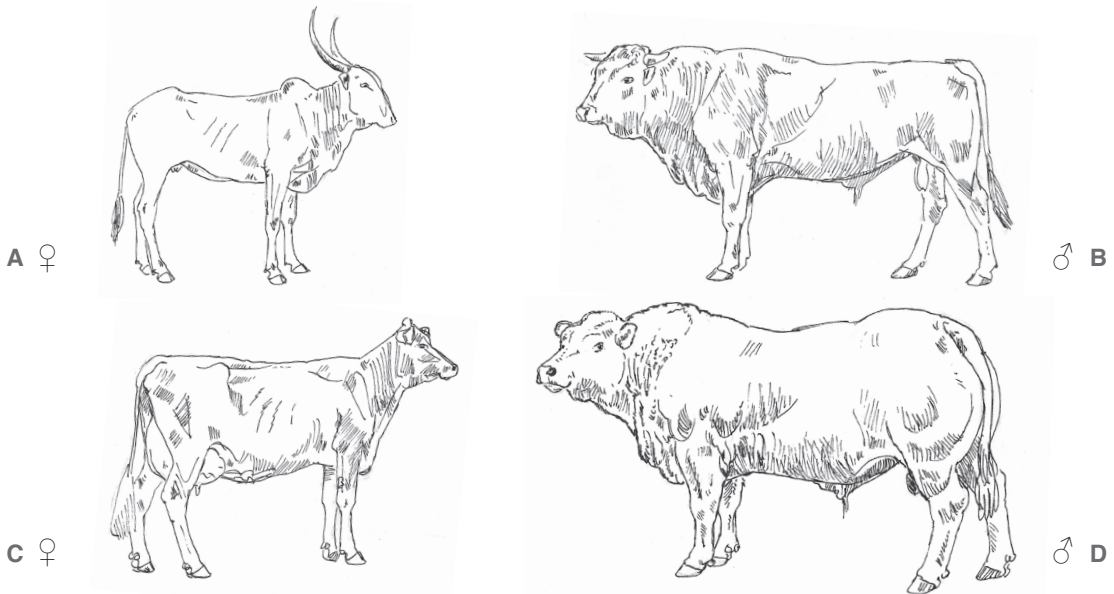


Figure 1. Shapes of cattle

pack animals and mounts.

Selective breeding for different purposes resulted in various shapes in cattle: (A) the long-legged fast-trotting type of the Indian Hallikar breed; (B) the characteristic heavy front and light hindquarters conformation in strong draught cattle still seen in the French Marachine, contrasting to (C), the inverted wedge shape in dairy cattle with well-developed udders; and (D) deep, square or long bodied beef types. With the development of herd books, recognizable 'trade marks' had to be standardized in addition to the desired productive traits. This led to coat color, coat pattern, and length, shape or absence of horns as being characteristic for a breed.

However, cattle are more than just livestock.

First, they are also aesthetic objects with in several breeds special decorative traits determining the worth of an animal. A few examples [8]:

- The extremely long, white horns in combination with mahogany brown color of the Rwandan Inyambo and Ugandan Ankole cattle [17].
- The length and curve of the horns of the Texas Longhorn [18,19].

- The sharply drawn white belt of the Dutch Belted and Belted Galloway [20].
- The small size of the Dexter and miniature zebus bred in America and Australia [21].
- The large, leaf-like hanging ears of the Indubrasil [22].
- Black-pied oxen in the mainly white herds of the Western Dinka are five times more valuable than other oxen [23].

Second, cattle play an important role in religion, representing deities, participating in ceremonies or having a holy status [24-26]:

- The Sumerian cow-goddess Ninhursag and bull god Anu.
- The Akkadian bull god Adad.
- The Egyptian holy bull Apis and the goddess Hathor.
- Bulls sacrificed in the Mithraic ceremonies during the Roman Empire.
- The bull Nandi, mount of the Hindu deity Shiva.
- The holy cows in Hinduism [27].

Third, cattle were and still are used for several sports and games with varying degrees of animal-friendliness (see the references to hyperlinks for video recordings).

- Jumping over cattle was a game during the Minoan culture of ancient Crete, as it still is in the Courses Landaises in southwest France [28,29].
- In the Camargue snatching a cocarde from between the horns of a charging ox or bull is a popular sport, only dangerous for the performing men [30,31].
- In the streets of the Spanish city of Pamplona young men prove their valor by trying to escape the running bulls, with deadly casualties almost each year [32].
- During Eru tzazhuval (bull vaulting) or Jallikattu, part of the Indian harvest festivity in southern Tamil Nadu, unmarried men wrestle and hang on to the hump of an angry running bull [33].
- Racing with pairs of bulls pulling carts is popular in various regions of India and Pakistan. On the Indonesian island of Madura the Karapan sapi races with pairs of bulls hitched to a light sledge with a jockey are an important part of the local culture [34,35].
- During show cattle competitions, trained cows walk slowly and elegantly. These are organized in all forms on all continents (e.g., the sonok, also on Madura) and play a role in breeding.
- Decorated and adorned with large wooden bells, teams of young Bali bulls perform in grumbungan contests during which they trot in a Hackney horse style with their heads and tails held high.
- Controversial because of their cruelty are the Spanish and Portuguese variants of bullfighting, also introduced in South America [36].
- Vaquejada (steer-tailing) in the north of Brazil is also a cruel event, during which horsemen grab a running animal by its tail and pull it over [37].
- American rodeos consist over several types of competitive games with cattle: calf roping, steer wrestling and the spectacular bull riding [38].
- Bull-to-bull fights are organized in many parts of Asia and the Iberian Peninsula [39].
- In the Swiss Valais canton, neighboring Italian Aosta and French Chamonix valleys tournaments of cow-to-cow fighting have evolved from a local tradition for the selection of the best cow to lead the village herds into the high Alps into a popular touristic attraction [40].
- Pulling contests are popular in the New World. On Guadeloupe, teams of Creole bulls pull a traditional two-wheeled cart loaded with 2.6 tons of metal within 6 minutes up a 25% sloping hill [41].

- During the yearly Yawar Fiesta in the Andes of Peru, a condor is captured and tethered to a bull, which runs around before being slaughtered, symbolizing the fight against the Spanish conquerors [42].

In spite of a low visibility in urban environments and their inspiring a less affectionate relationship with humans, in western culture, than pets or horses, cattle are arguably the most important domestic animal species.

Breeds of cattle

Since the 18th century many local landraces of cattle have been developed into more or less standardized breeds [8,43]. Over time the perception of these populations varied from being 'true' or 'authentic' to just varieties and derivatives. The most productive and therefore successful West and Central European breeds absorbed neighboring landraces and breeds already during the 19th century. Export to other countries and continents led to outcrossing of many local breeds and varieties. Since the second half of the 20th century a few highly specialized taurine breeds have been expanding faster than ever, even to developing countries where they turned out not to thrive. In the last century, new synthetic (stabilized crossbreeds of cattle from different origins) zebu and taurindicine (mixed taurine-zebu) beef and dairy breeds have been developed in America and Australia, which are increasingly popular in tropical Asia and Africa [8]. The most productive and popular breeds replace or threaten the local breeds, which everywhere have become adapted to local conditions and are suitable for extensive management. This development may threaten our ability to keep cattle for different purposes in a large variety of environments and also reduce future breeding options.

Since the 1970s there is a growing awareness of the loss of diversity in domestic livestock [44]. This is reinforced by a new respect for local and regional traditions all over the world. According to the DAD-IS list 130 European cattle breeds have disappeared and 40-50% of the local European breeds can be considered 'at risk' [45]. Currently, livestock genetic conservation measures are focused on the maintenances of breeds and the extinction of a breed is considered as a significant loss of farm animal genetic resources.

This policy, however, ignores that it is not at all obvious how the concept of a 'breed' should be defined. The various definitions currently in use [45] refer to common descent, distinctiveness and/or genetic isolation. A single and sharp definition seems impossible, since in livestock there are too many exceptions that can undercut any rule. The official definition of the FAO [45] is conceived rather broadly by using two alternative criteria: "Either a subspecific group of domestic livestock with definable and identifiable external characteristics that enable it to be separated by visual appraisal from other similarity defined groups within the same species or a group for which geographic and/or cultural separation from phenotypically similar groups has led to acceptance of its separate identity". Basically this agrees with the definition we use in this thesis: a breed is any group of domestic animals under some form of separate reproductive management, regardless of the degree of genetic isolation or uniqueness. This immediately raises the question why we should conserve breeds without any

apparent uniqueness. Moreover, even for many breeds with a clear identity of their own their contribution to the available genetic resources is presumed rather than proven [44-47].

Scope of the thesis

The central question we try to answer in this thesis is the following: **what is the unique contribution of individual cattle breeds to the farm animal genetic resources?** Are breeds really the 'units of conservation', implying that they are all important for maintaining the genetic diversity of cattle? Or should we consider breeds as 'units of management': largely overlapping portions of the cattle genetic diversity that are the result of management by breeding societies, who set breeding objectives and select breeding sires from their own or another breed? In spite of a vast body of literature on cattle breeds, these questions are largely avoided. Only few experts have a comprehensive view of the diversity of cattle breeds that is still available on the global level and how this has been shaped historically. Studies of diversity on the DNA level have been tremendously helpful in reconstructing aspects of the history of cattle, but comparisons of breeds are based mostly on genetic drift (random changes in allele frequencies), which is at best merely indirectly informative for the uniqueness of breeds.

We approach our main question via an original and comprehensive examination of various aspects of the present diversity of cattle: the contribution of various bovine species to various Asian breeds, the breeds' history, classification and categorization, topography and nomenclature. In this examination, we combine zoological, archaeological, historical, agricultural and molecular-genetic information. This allows us to give in Chapter 6 an answer to our main question.

An inventory of the genetic diversity of a domestic species should start with a discussion of the wild ancestors that contributed to its genetic make-up. **Chapter 2** summarizes the domestication of bovine species and their hybrids. The extinct aurochs was the ancestor of both taurine and zebu cattle, while less numerous populations have been derived from yak, gaur and banteng. Furthermore, we survey the hybridization of the cross-fertile bovine species, which has contributed importantly to the genesis of a number of mainly Asian cattle breeds.

In **Chapter 3** we analyse the dynamic history of taurine and zebu cattle from their first domestication in West Asia and South Asia to the present situation, combining archaeological, pictorial, documentary and molecular-genetic evidence. We propose three main periods during which the input of wild ancestors, adaptation to the environment and breed formation, respectively contributed to the development of the diversity of cattle. The recent and consequential changes in the genetic composition of European taurine cattle are illustrated by an appendix listing (i) local varieties and former breeds absorbed by the present breeds, (ii) the worldwide dispersal of breeds by exports, (iii) the several new synthetic breeds, mainly in the New World, and (iv) extinct breeds. This puts into perspective the common appreciation of breeds as unique contributions to cattle genetic resources and suggests that such unique contributions cannot be assumed, but have to be demonstrated.

In **Chapter 4** we elaborate on a different aspect of diversity: the classification of breeds. By grouping breeds according to objective criteria, a classification also gives a systematic typology, indicating the uniqueness of each breed and thus its contribution to the genetic resources. We review the various classifications that have been developed during the last two centuries and that were based on skull and horn shape, coat color, geography, integrative approaches or molecular markers. Several early classifications used a Linnaean-style Latin nomenclature, which still lingers on in recent literature. However, these classifications all turn out to be seriously incomplete and by using a single feature do not represent adequately the diversity of cattle. A comprehensive and systematic classification by the author of this thesis integrates geography, known history and morphology [8] and correlates well with the clustering of breeds revealed by molecular-genetic analysis.

This classification proves useful in **Chapter 5**, which adds a cartographic description of global cattle genetic resources and shows, per continent and per breed group, the geographic origin of breeds. The survey of the 16 proposed breed groups shows interesting patterns of diversity, and gives our main question a geographical context. It also shows that many local breeds have dispersed over several continents, which relieves their endangerment.

Chapter 6 deals directly with our main question about the uniqueness of breeds. We first propose a categorization of breeds according to their mode of emergence; the appendix lists the breed categories per country. Then we analyse the breed concept in the context of the breed's dynamic history and note how the perception of a breed is influenced by breeding societies and breed nomenclature, a dictionary of which is presented in the appendix. Finally we answer our main question about the role of breeds in the conservation of genetic resources of cattle.

Chapter 7 (Summarizing Discussion and Conclusions) recapitulates chapters 2-6. With respect to Chapter 3, we expand on methodological aspects of historic inference, mention future perspectives and elaborate on the parallels of human and bovine history. The conclusions of Chapter 6 are contextualized in a surveying discussion on the conservation of cattle genetic resources.

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Chapter 2

On Domestic Cattle and Buffaloes

Shortened after Lenstra, J.A., Feliuss, M. & Theunissen, B. (2013). Domestic cattle and buffaloes. Chapter 3 in Ecology, Evolution and Behaviour of Wild Cattle: Implications for Conservation. (M. Melletti, ed.), Cambridge University Press, pp. 30-38.

On domestic cattle and buffaloes

Abstract: Several bovine species have been domesticated: taurine cattle, zebu, banteng, gayal, yak and the swamp and river types of water buffalo. Here we examine their history, geographic range, ecological and agricultural aspects and their interspecific crosses. Although not as numerous as taurine and zebu cattle, the domestic derivatives of banteng, gayal and yak as well as the several interspecific crosses have contributed to a number of exotic breeds and thus have considerably expanded the genetic repertoire of domestic cattle.

1. Domestic bovine species

As indicated in the General Introduction, an inventory of the genetic diversity of a domestic species should start with a discussion of the wild ancestors that contributed to its genetic make-up. As shown in Table 1, taurine and indicine cattle are numerically the most important, followed by river and swamp buffalo. These species have spread to several continents, while the domestic forms of the yak, banteng and gaur are concentrated near the distribution areas of their wild ancestors. Domestication of the extinct kouprey (*Bos sauveli*) has been proposed after finding kouprey mtDNA in a museum specimen of a Cambodian bull (Hassanin et al., 2006).

In line with molecular phylogenies (Buntjer et al., 2002; Verkaar et al., 2004; Nijman et al., 2008; MacEachern et al., 2009; Decker et al., 2009), taurine and zebu cattle can be crossed with other bovines except the buffaloes (Lenstra & Bradley, 1999). Interspecific breeding may occur spontaneously or is carried out for terminal crossing or upgrading of breeds (Table 2). Hybrid taurine-zebu offspring are fertile, but crossing of zebu or taurine cattle to other species results in fertile cows and sterile bulls.

Because of their complete cross-fertility, taurine and zebu cattle should both be considered as subspecies of the wild ancestor *Bos primigenius*. However, because they resulted from different domestications, they are described here separately. The same applies to the swamp and river types of water buffalo, the cross-fertile subspecies of the wild *Bubalus arnee* (Yindee et al., 2010; Groeneveld et al., 2010).

2. Domestication, ecology and cultural aspects

For all domestic species the wild ancestor has been identified by DNA comparison with wild species. For narrowing down the region and period of domestication, we rely mainly on paleontological findings. Skeletal remains are identified as belonging to domestic animals on the basis of their relatively small size, distorted age and gender distributions, reduced sexual dimorphism and morphological changes associated with the domestic status (Hall, 1994; Zeder et al., 2006).

Since textual or pictorial documentation is scarce, our understanding of the early history of domestic bovines is based mainly on analysis of mitochondrial, Y-chromosomal and autosomal DNA (Groeneveld et al., 2010). Diversity of the MHC regions indicates that

Table 1. Cattle species. Population sizes have been estimated on the basis of the data of Wint and Robinson (2007)

Species	Ancestor species	Approximate domestication time (years BP)	Estimated population size (million, 2007)
Taurine cattle (<i>Bos taurus</i>)	Aurochs (<i>Bos primigenius</i>)	10,000 - 8000	600
Zebu (<i>Bos indicus</i>)	Aurochs (<i>Bos primigenius namadicus</i>)	8000	721
Bali cattle (<i>Bos javanicus</i>)	Banteng (<i>Bos javanicus</i>)	5000	4
Gayal or Mithun (<i>Bos frontalis</i>)	Gaur (<i>Bos gaurus</i>)	Not known	0.2
Yak (<i>Bos grunniens</i>)	Wild yak (<i>Bos mutus</i>)	4500	13
River buffalo (<i>Bubalus arnee bubalis</i>)	Wild water buffalo (<i>Bubalus arnee</i>)	5000	122
Swamp buffalo (<i>Bubalus arnee carabanesis</i>)	Wild water buffalo (<i>Bubalus arnee</i>)	4500	38

Distribution range

Main distinctive traits

Agricultural purpose

Worldwide

High dairy and beef productivity

Dairy, beef and hide production, draught power

Tropical zones of Asia, Africa, America and Australia

Adaptation to hot and dry climate

Dairy and beef production, hides, draught power

Bali, East Java, southeast Sulawesi, Kalimantan, South Sumatra, Lampung, North Australia (feral)

High fertility, adaptation to low-quality fodder and extensive management, meat quality

Draught power, beef production

India-Myanmar border region, easternmost India near Himalaya, Bhutan

Size, adaptation to steep hills, friendliness, semi-feral

Beef production; terminal crossing with zebu

Central Asia above 2000 m, Tibetan plateau

Adaptation to high altitude

Dairy, beef, hide, wool and dung production, draught power; terminal cross with zebu and taurine cattle

Brazil, Italy, Balkan, Egypt, Southwest Asia, South Asia west of Indochina, North Australia (feral)

Fat content of milk, dairy productivity, extensive management, compulsive wallowing

Dairy production, draught power

Brazil, China, Indochina, Indonesia, North Australia (feral)

Extensive management, strength, compulsive wallowing

Draught power for rice cultivation.

Table 2. Examples of hybrid cattle (Felius 1995)

Name	Paternal origin/sire	Maternal origin/dam	Geographic range	Breeding status	Agricultural purpose
taurindicine	zebu	taurine	worldwide near tropical zones	established breeds	as zebu
sanga	zebu or taurine	taurine	Africa	established breeds	as zebu
Canchim, Ibagé, etc. Girolando ¹	taurine (beef type)	zebu (Nelore)	Brazil	established breeds	tropical beef
	taurine (Holstein)	zebu (Gir)	Brazil	established breed	tropical dairy
Thai, Indonesian cattle	zebu	banteng, Bali cattle	Indochina, Indonesia	established breeds	as zebu
Selembu, jatsa/ jatsun	zebu/gayal	gayal/zebu	Malaysia	terminal crossing	dairy, work
Dulong ²	gayal	zebu, taurine	Yunnan, China	semiferal	as gayal
Yakow, khainag ³	zebu, taurine/yak	yak/zebu, taurine	near yak at 1,500-2,000 altitude	terminal crossing	as yak
Beefalo	bison/taurine	taurine/bison	USA	breed (3/8 bison)	low-fat beef
American breed	bison, taurine	taurine, zebu	USA	breed (1/8 bison)	low-fat beef
Zubron	wisent/taurine	taurine/wisent	Poland	experimental herd	extensive management

¹ Also used for other Brazilian taurine-zebu crossbreeds

² Gou et al. (2010)

³ Tumennasan et al. (1997)

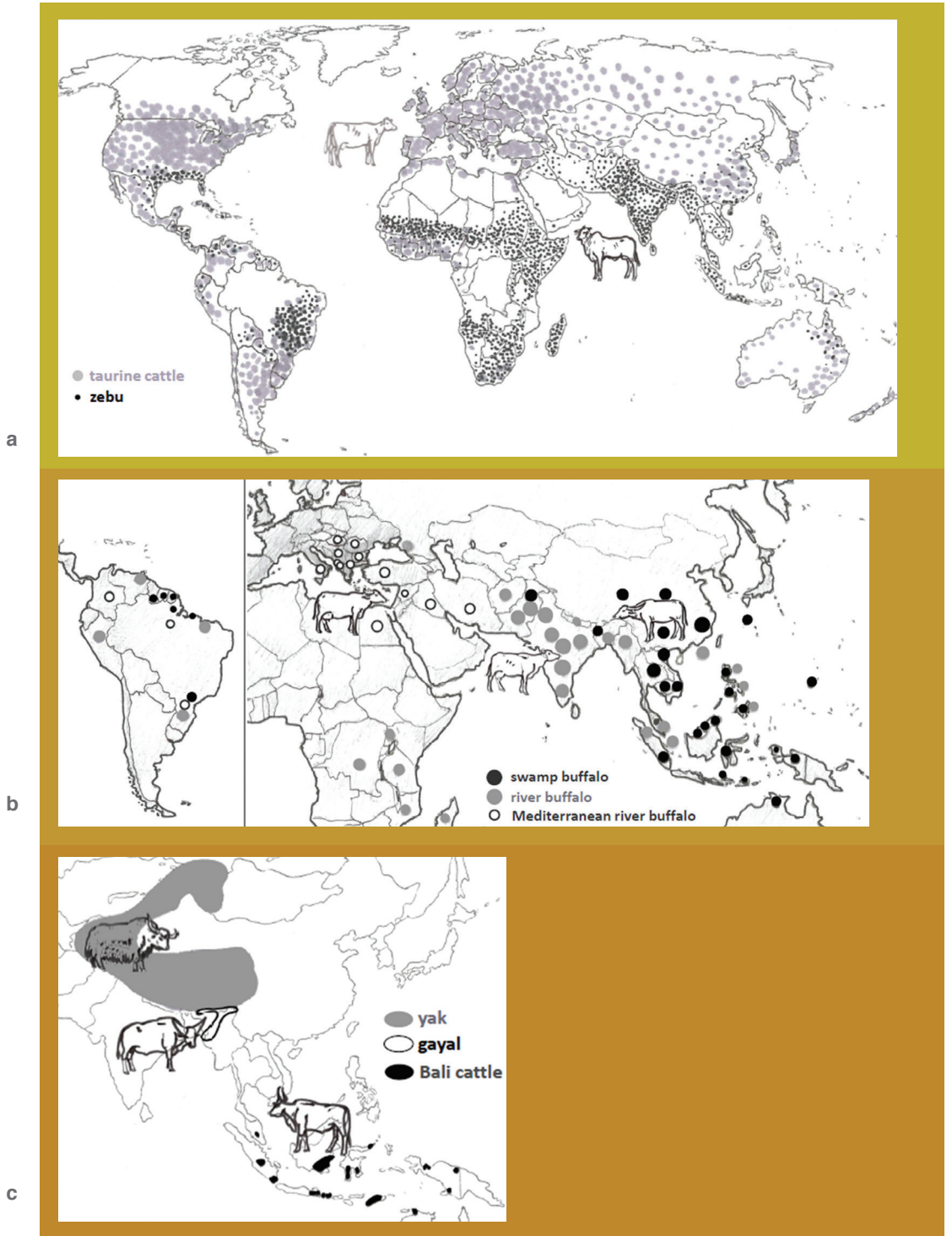


Figure 1. Global distributions of (a) taurine and zebu cattle, (b) domestic yak, gayal and domestic banteng (Bali cattle), and (c) swamp, river and Mediterranean river buffalo.

backcrossing of the earliest domestic animals with their wild ancestors contributed to the genetic diversity of livestock (Vilá et al., 2005).

In addition to the skeletal changes, domestication attenuated behaviour and increased the intramuscular fat deposition. Other changes relative to the wild ancestor also increased the within species-diversity. First, the dispersal of domestic taurine cattle and to a lesser degree zebu and river buffalo led to the development of several ecotypes, which differ in adaptation to their local environment. For instance, African N'Dama cattle have developed a trypanotolerance and Siberian Yakut and Scottish Galloway and Highland cattle adapted their hair coats to the cold.

Second, human selection generated many different “agrotypes”, which preceded the formation of breeds and differ in coat colour, horn development, docility (with aggression promoted in fighting cattle), other morphological traits or productivity. Since ca. 200 years, diversity has been accentuated by systematic selection within genetically isolated uniform populations - the breeds. This initiated for taurine cattle, as well as for other livestock species, a new and consequential phase in their evolution (Ajmone-Marsan et al., 2010) and was accompanied by a further growth of the domestic population. With the increase of the dairy production (Barker, 1985), many cattle have acquired a wedge shape and oversized udders at the expense of the animal charismatic appeal.

In spite of the variety of species, ecotypes, agrotypes and habitats, a specific ecological niche of cattle can be defined. Like the smaller ruminants sheep and goat, cattle utilize the energy stored in cellulose from grass and foliage, which is not directly accessible to humans. Depending on the species and breed, this energy is converted to milk, meat, hide, dung and draught power.

From the beginning, most bovine species also participate in religious rituals, festivals, races and fighting games. As in all domestic species, breeding has been governed by both subjective and objective criteria (e.g., see Theunissen, 2008). Even in modern agriculture, breed traditions are kept alive via agricultural shows, the interest of which goes beyond the rational requirements of agricultural production.

3 Domestication and history

3.1 Taurine cattle

Around 10,500 BP, after the domestications of sheep and goat, taurine cattle (*Bos primigenius taurus*) were domesticated in the Southwest Asian Fertile Crescent by taming the wild and now extinct aurochs (*Bos primigenius*) (Bollongino et al., 2012). From Southwest Asia, taurine cattle spread to a large variety of habitats (Figure 1a) ranging from tropical Africa to the more temperate Mediterranean and Central-European climates and the harsh winters of North Siberia (Ajmone-Marsan et al., 2010). Male introgression by Asian, African or European aurochs may very well have contributed to the local adaptation and changed the nuclear, but not the mitochondrial genome. Remains of Neolithic farms in Europe revealed that cattle and other livestock arrived at the North Sea coast around 5000 BP (Barker, 1985). North Asia may have been populated via the Caucasus or via Europe. From 7000-6000 BP cattle migrated into Africa (Payne & Hodges, 1997b). The first domestic cattle were long-horned,

a phenotype that still is common in several British, French, Mediterranean and African breeds. Three thousand years BC the first short-horned cattle appeared in Mesopotamia and, fitting better the domestic habitat, became predominant in Europe from ca. 3000 BP. In Scotland and the Nordic regions the necessity to house cattle during the winter period even favored the polled phenotype (Feliuss, 1995).

Central- and North-European aurochs carried mtDNA P haplotypes, which have a low frequency (ca. 1/1000) in European domestic cattle (Ajmone-Marsan et al., 2010). This, as well as the sporadic finding of R haplotypes (Bonfiglio et al., 2010), indicates a rare recruitment of cows from the European aurochs population.

Domestication of taurine cattle resulted in a decrease of size, which continued until the Middle Ages. A selective disadvantage of large cattle may have been imposed by (1) castration of the strongest bulls for use as work animals, (2) slaughtering of the largest animals just before the winter, and (3) food shortages during the winter period in the temperate zones, likely to become acute during the frequent periods of unrest. In post-medieval society, improvements in the husbandry practices and a better infrastructure allowed larger cattle to be kept.

The 18th century saw the first breed formation, which especially in the Western world had a profound influence on the exterior, productivity and genetic constitution of cattle. Systematic and selective breeding and genetic isolation eventually led to the development of hundreds of specialized breeds. Europe has the largest diversity of cattle with hundreds of well-separated breeds, while differentiation of indicine and taurine breeds in Asia and Africa is more gradual.

Since the second half of the last century a growing demand for food led to a focus on breeds that are in a given environment the most productive. For instance, the Holstein-Friesian is the first choice for industrial dairy production, but the Swiss Brown mountain cattle are often used for dairy production under more extensive conditions. Large-sized continental beef breeds such as Limousin, Charolais and Piemontese are used for intensive fattening, while British Angus and Hereford are kept for traditional pasture fattening and the hardy Galloway, Highland and Salers for extensive grazing. Spotted cattle (Fleckvieh) as Simmental and related breeds serve as dual-purpose cattle in Central-Europe, where the landscape is less suitable for large-scale dairy farming than in Northwestern Europe.

Export of Iberian cattle to America and limited introgression of zebu gave rise to the Criollo cattle (Ginja et al., 2010). Several North-European, Central-European and Italian breeds became cosmopolitan by export to North American and Australia. For at least three breeds the American breeding regime led to allopatric development and differences with the European ancestors (Feliuss et al., 2011): systematic selection turned the Dutch-Friesian in the highly productive Holstein-Friesian; the brown dual-purpose Swiss Brown became the light colored dairy Brown Swiss; and after crossing to Angus the dual-purpose red-pied Simmental changed for a large part into black and polled beef cattle. In addition American as well as Australian breeders created several taurine or taurindicine synthetic breeds as original contributions to the diversity and productivity of cattle (Feliuss, 1995; Payne & Hodges, 1997b).

3.2 Zebu

About 8000 BP, domestication of the related *Bos primigenius namadicus* in the Indus valley resulted in the zebu (*Bos primigenius indicus*), which acquired its characteristic hump only after domestication (Magee et al., 2007; Chen et al., 2010). Several traits contribute to their heat adaptation: a low metabolic rate, many large sweat glands, a large skin surface, intramuscular instead of subcutaneous fat, a short smooth coat, a low susceptibility to insects, ticks and protozoa and good utilization of low-quality fodder (Turton, 1991).

From the Indus Valley zebu moved to the tropical zones of all continents (Payne & Hodges, 1997a; Ajmone-Marsan et al., 2010). Migrating eastward zebu reached China, Indochina and Indonesia, which led to crossing with taurine cattle from North China or with banteng and gayal cattle (Payne & Hodges, 1997a).

A westward movement from 4000 BP brought zebu to the Southwest-Asian region of taurine domestication and to Africa. The exclusive finding in African zebu breeds of taurine mtDNA demonstrated that zebu expanded via incrossing of zebu bulls (Bradley, 2006). Hybridization of zebu and indigenous taurine cattle resulted in the sanga, which reached South Africa around 500 AD and were around 1500 AD the dominant type of cattle in East and Central Africa. Because of a higher resistance to rinderpest, zebu largely replaced sanga in East Africa after the epidemic of 1887-1897.

A minority of the Brazilian Nelore and Gyr cattle that descends from Indian cows may be the only zebras outside Asia with the original indicine mtDNA (Meirelles et al., 1999). Zebu now occupies the tropical zones of all continents and may numerically surpass taurine cattle (Table 1).

3.3 Banteng

Banteng may have been domesticated in Southeast Asia as early as 7000 BP (Felius, 1995; Higham, 2002). Although Indochinese cattle are now almost exclusively zebu, Thai cattle is said to have resembled Indonesian Bali cattle, which is essentially pure Indonesian banteng. Continental bantengs (tsine) are fawn-colored, while in Indonesia the banteng or Bali cows are slightly darker and the bulls dark-brown. Bali bulls are smaller than wild bulls (Felius, 1995).

As evidenced by the finding of banteng mtDNA in most Indonesian zebu breeds, banteng-derived cattle used to be widespread. Replacement by zebu started already 1500 years ago and was accelerated by imports of Ongole cattle since the end of the 19th century. This zebu was required as draught animal on paved roads for which the banteng hoofs are too soft (Mohamad et al., 2009).

Bali cattle have been kept pure since 1913 by a ban on crossbreeding on the Isle of Bali. They are used for plowing rice paddy fields. Advantages of Bali cattle relative to zebu are their disease resistance, high fertility (McCool, 1992), ability to adapt to low-quality fodder and stressful climatic conditions (Martoyo, 2012; Purwantara et al., 2012) and the tenderness of the meat from young animals; traits that may very well be exploited in other countries and continents (Mohamad et al., 2009). However, susceptibility to malignant catarrhal fever precludes rearing them together with sheep, while their

deer-like temperament makes banteng most suitable for small-scale farming (Martoyo, 2012).

Bali cattle populations are being kept on several Indonesian islands (Figure 1c) and have been exported to Papua New Guinea, Australia, Malaysia and the Philippines. A Malaysian population was clearly introgressed with zebu (Nijman et al., 2003). The viability of a feral population in the Australian Coburg peninsula (Bradshaw et al., 2007) shows that Bali cattle, like goat, cat and horse, have retained the fitness of their wild ancestors (Bradshaw et al., 2007).

3.4 Gayal

In Assam and Myanmar (Figure 1b) the semiferal gayal or mithun (*Bos gaurus frontalis*) was derived from the large wild gaur (*Bos gaurus*). Gayal and gaur have the same mtDNA, Y-chromosomal DNA (Verkaar et al., 2004; Nijman et al., 2008; Tanaka et al., 2011) and karyotype. Introgression from wild gaur bulls is supposed to take place frequently, although gayal has different horns and a more friendly character. Only a minority of the gayals in Myanmar and Bhutan carry taurine or zebu mtDNA (Tanaka et al., 2011), but Chinese Yunnan gayal, also named Dulong cattle, has a zebu maternal origin (Gou et al., 2010). Gayal confers social status to their owners within their tribal society. The primary use of gayal is for ceremonial sacrifices, after which their meat is consumed (Mason, 1984).

Of more economic importance is the use of gayal for terminal crossing with zebu for producing in Malaysia the Selembu and in India and Bhutan the dairy Jatsun cows and Jatsa bulls, which are strong draught animals in a cold and dry climate unsuitable for the parental gayal. Jatsun cows are backcrossed to Siri bulls to rejuvenate the Bhutanese taurindicine cattle (Hickman & Tenzin, 1982; Felius, 1995).

3.5 Yak

About 4500 BP a domestic form (*Bos grunniens*) of the wild yak (*Bos mutus*) was developed and now occupies a large area on the Qinghai-Tibetan Plateau and adjacent areas above 3000 m (Mason, 1984; Wiener et al., 2003, Fig. 1b). The current gene pool is supposed to have resulted from reuniting predomestic populations that during Pleistocene glacial periods were in several refugia. This would explain the observation of two major deeply divergent mtDNA haplogroups in a single gene pool (Qi et al., 2008; Wang et al., 2010). In China 12 breeds are recognized, which form 3 clusters (Wiener et al., 2003; Zhang et al., 2008). Differentiation of breeds is weak, but clear geographic trends were observed (Zhang et al., 2008; Qi et al., 2008). Maternal introgression of taurine cattle was observed in less than 2% of the animals, while taurine-specific microsatellite alleles indicated a taurine introgression of up to 7% in the northern and eastern extremes of the yak distribution range (Qi et al., 2010).

The yak is since long intricately involved in the pastoral Himalayan economy, culture and religion. It produces milk, meat, dung and fibres, serves as draught and pack animals in impassable terrain, and participates in cultural and ritual activities. In Tibet and Nepal at altitudes of 1500-2000 m terminal crossing of taurine or zebu bulls with yak cows is carried out to breed hybrid yakows, large animals and excellent dairy producers (Felius, 1995; Wiener et al., 2003).

3.6 Swamp buffalo

The swamp buffalo (*Bubalus arnee carabanesis*) or carabao emerged by domestication of the wild water buffalo (*Bubalus arnee*). Analysis of microsatellites and mtDNA diversity (Groeneveld et al., 2010; Yindee et al., 2010; microsatellite (Zhang et al., 2010)) combined with archaeological evidence (Higham, 2002) indicates domestication in South China and/or Indochina around 4500 BP. The domestication of the swamp buffalo coincides with the start of the wet rice cultivation, which requires strong draught power for ploughing the rice paddies.

Subsequent migrations brought the swamp buffalo to central China, the Malaysian peninsula and Indonesia (Figure 1c). Swamp buffaloes are supposed to have been brought to the Philippines by Malaysian immigrants 2300-2200 BP (Mason, 1984), whence they were taken to Guam at the end of the 17th century. In both countries water buffalo are now a national symbol. Imports to Australia from 1826 led to the establishment of a feral population. This grew to 350,000 animals by 1980, but was then culled and reduced in size. Swamp buffalo brought to Brazil from 1896 appeared to be less suitable for extensive management than river buffalo due to a tendency to become feral, but small populations still exists (Wilkins, 1991).

The swamp buffalo may still be considered as the living tractors of South-East Asia and China. It has adapted to hot and humid environments by compulsive wallowing and surpasses zebu and taurine cattle in strength, ability to thrive in marshy areas, utilization of coarse fibrous feed and disease resistance (Turton, 1991). Fertility is lower than in cattle, which is compensated by a longer life span.

MtDNA with two well separated lineages A and B as well as Y-chromosomal sequences indicated a higher nucleotide diversity than in the river buffalo (Groeneveld et al., 2010; Yindee, 2010; Yindee et al., 2010). There are no recognized breeds, but microsatellite (Zhang et al., 2010) and especially Y-chromosomal sequences in Thailand (Yindee et al., 2010) indicated spatial trends.

3.7 River buffalo

River buffalo (*Bubalus arnee bubalis*) and swamp buffalo are cross-fertile, but are at least as divergent as taurine and zebu cattle (Yindee et al., 2010) and even have different karyotypes. The river buffalo has generally the same characteristics as the swamp buffalo, but has smaller horns and prefers clear water for wallowing (Cockrill, 1981). It has been domesticated 4500 BP in the Indus valley (Mason, 1984; Kumar et al., 2007). Water buffaloes were not known in the Roman Empire, which indicates that river buffalo migrated westwards well after domestication (Figure 1c). Available evidence suggests that river buffalo were in Palestine by 723 AD, entered Egypt with the Arabs or later and were numerous in the 9th century in Anatolia, in 1154 in the Campania and in the 13th century in Thrace and Macedonia (Mason, 1984).

The generally accepted notion that returning crusaders brought water buffalo to Italy is not supported by contemporary documentation. Alternative routes of import are from Sicily by its Norman rulers, from the Balkans by invading Goths or Lombards or from Byzantine Greece across the Ionean Sea. However, it is not clear yet if water buffaloes

were present in the postulated regions of origin at the time of the supposed import. In contrast to swamp buffaloes, most river buffaloes are primarily kept for the milk. Because of its high fat content, buffalo milk can be processed into butter, which can be stored without cooling. The most well-known buffalo product is the Italian mozzarella cheese.

Although 70% of the Indian river buffaloes are nondescript, 12 breeds are recognized, which differ in appearance and dairy production. Mediterranean river buffaloes have larger horns than Indian, but are not kept as separate breeds. From the beginning of the 20th century, river buffaloes were exported to several South American and African countries (Figure 1c). Brazil has now 1.5 million animals, most of which are from the Mediterranean or Indian Jafarabadi and Murrah breeds. Breeding for beef on Trinidad resulted in the Buffalypso type, which in turn has been exported as a dairy-beef breed to other countries and even continents (Cockrill, 1981; Mason, 1984).

Although several local studies have been carried out (Groeneveld et al., 2010) there is no global-level picture of breed relationships and patterns of diversity. As already demonstrated for other livestock species, modern genomic investigations of a comprehensive sample would complement our present knowledge about the history and genetic constitution of both buffalo species.

4. Future perspectives

The future of cattle unfolds along two main lines. For the most industrial breeds, selective breeding is going to be intensified by genetic selection of desired traits and genomic selection for a high breeding value. This is to be based on genome-level research that mainly targets taurine cattle with a growing emphasis on Holstein-Friesian dairy cattle, but other dairy and beef taurine and indicine breeds are being investigated as well. Genetic improvement is facilitated by artificial insemination and multiple-ovulation-embryo-transfer (MOET). Other options of modern biotechnology are animal cloning, for farm animals still too expensive, and genetic manipulation, which is not even on the agenda for large-scale applications in livestock. It is to be expected that a genetic increase in production will erode further the genetic diversity within the breeds. This will have to be balanced by outbreeding and crossbreeding in order to restore disease resistance and fertility.

A second development is the growing interest in local breeds, many of which are suitable for a more extensive type of management than is required for the highly productive breeds. Such breeds help to maintain the diversity of the genetic resources, and also preserve a potential adaptation to other environments and changes in the climate.

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Chapter 3

On the History of Cattle Genetic Resources

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On the history of cattle genetic resources

Abstract: Cattle are our most important livestock species because of their production and role in human culture. Many breeds that differ in appearance, performance and environmental adaptation are kept on all inhabited continents, but the historic origin of the diverse phenotypes is not always clear. We give an account of the history of cattle by integrating archaeological record data, pictorial and written sources, which are all scarce until about 250 years ago, with the recent contributions of DNA analysis. We analyze the domestication of their wild ancestors, their migration to all inhabited continents, their development during Prehistory, Antiquity and the Middle Ages, the relatively recent formation of breeds, the rise of industrial cattle husbandry in the Old and New World and the current efforts to preserve the cattle genetic resources. Surveying the available information, we propose three main and overlapping phases in the development of the present-day genetic diversity: (i) domestication and subsequent wild introgression; (ii) natural adaptation during thousands of years to a varied agricultural habitat; and (iii) breed development, which redistributed the diversity and accentuated the differences between breeds. While efforts at conservation of the cattle breeds tend to focus on the diversity generated during the most recent phase, we argue that the first two phases were more important.

1. Introduction

The introduction of domesticated crops and livestock initiated our cultural development. Cattle were among the 14 large wild terrestrial species meeting the conditions for successful domestication [1]: an herbivorous diet, fast growth, ability of captive breeding, genetic temperance of aggressive or panicky behavior in captivity, and a social behavior that facilitates handling. Cattle have been domesticated later than the smaller and easier to manage sheep and goat [2]. As cattle husbandry required a distribution of tasks and thus imposed a social stratification, its impact on the pastoral society was considerable [2-5]. Cattle were also one of the earliest forms of capital [6].

Accompanying humankind since the dawn of civilization, cattle in various environments became an integral part of human society. Supplying milk, meat and hides and plowing the fields [3], they have become the most important domestic animal species. Their role in social networks, ceremonies, rituals and games also gives cattle a central place in human culture, even though a less affectionate human-animal relationship has been established than, for instance, with horses or dogs.

Over time a large diversity of cattle has emerged, which now may be threatened by the prevailing industrial approach to cattle husbandry and a focus on high productivity. Previously, we have described the bovine breeds and their nomenclature, classification and relevance for conservation [7-9]. To contribute to a rational evaluation of conservation values of existing breeds and populations, we here consider the diversity of cattle in a historical context. After describing the history from the initial domestication of cattle in the Neolithic to the creation of modern breeds and combining archaeological, historic and molecular genetic information, we try to answer the question when and how the current diversity of the cattle genetic

resources has emerged. We argue that three phases can be discerned. It is generally assumed that the most recent phase, which began some 250 years ago with the creation of the modern breeds, has been the most important one in this respect. In our view, however, the two earlier phases were more important. The second phase was especially important, as it witnessed the creation of most of the environmental adaptations that are found in local breeds. The third phase was predominantly characterized by an ongoing redistribution of the diversity created earlier and accentuation of the differences between breeds. This type of information is indispensable for decisions on breed conservation.

After Sections 2-4 on domestication and the dispersal of taurine and zebu cattle, Sections 5 to 12, 13, 14 and 15 describe the histories of cattle in Europe, Asia, Africa and the New World, respectively. Sections 16 and 17 describe recent global developments since WWII. Section 18 summarizes the developments influencing the cattle genetic resources from domestication until present time.

2. Wild Ancestors and Sites of Domestication

Several bovine species have been domesticated [10,11], but taurine cattle (*Bos taurus*, Figure 1a) and zebu (*Bos indicus*, Figure 1b) account for almost all cattle. Both descend from the wild aurochs (*Bos primigenius*), which at the end of the last glacial period (12,000 BP) was endemic over most of Asia, Europe, North Africa and the once green Sahara (Figure 2). This huge and reputedly fierce species has been extinct since 1627, when the last animal died in Poland. Only few contemporary pictures of aurochs exist (Figure 3), but skeletal remains allow reconstructing its morphology (Figure 4). The subspecies *B.p. primigenius* in Southwest Asia and *B.p. namadicus* in India were the ancestors of taurine and zebu cattle, respectively.

The most recent molecular estimates of the divergence time of these aurochs subspecies and thus of taurine and zebu cattle are 147,000 BP [12] or 335,000 BP [13] and 350,000 BP [14]. These estimates have large intervals, but indicate that taurine and zebu cattle have been domesticated separately. In contrast to the wide distribution of the aurochs (Figure 2) these domestications took place in restricted areas, reflecting the difficulty of sustained managing and breeding of these large wild animals [15].



Figure 1. Major domestic cattle species: (a) Spanish Tudanca taurine and (b) Pullikulam zebu bull (photographs by Marleen Felius and Anno Fokkinga, 2008, 2005).

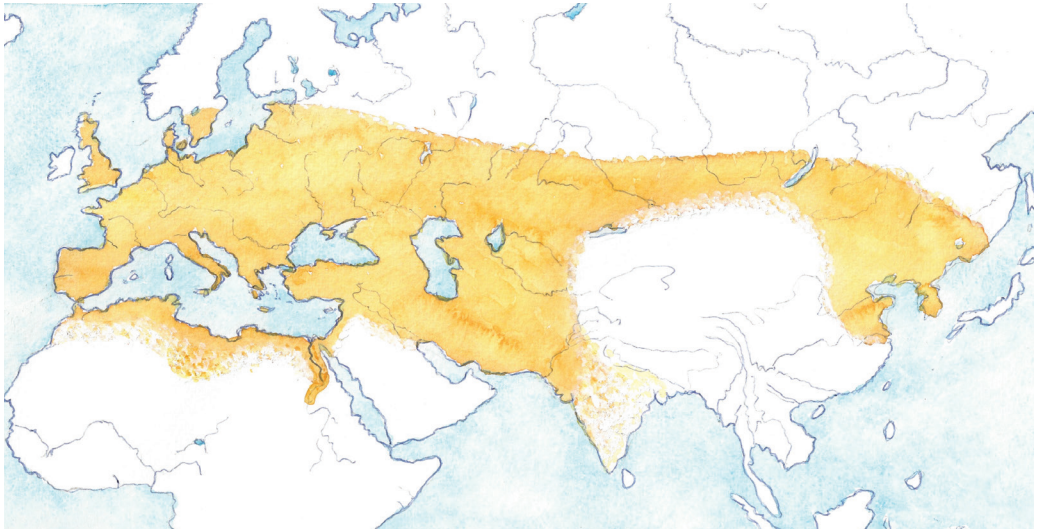


Figure 2. Distribution of *Bos primigenius* ca. 12,000 BP [16,17] (Map by Marleen Felius).



Figure 3. Contemporary pictures of the aurochs: (a) Painting in the Lascaux caves; (b) Rock engraving of African cattle showing a captured aurochs bull (Messak, Lybia, 6000 BP) [10]; (c) the Augsburg aurochs, woodcut 1826 after a lost 16th century painting [11]; and (d) 16th century picture by Philip Galle (Museum Boymans Van Beuningen, Rotterdam, courtesy Rolf Zeegers). Two Latin hexameters in the caption (not shown) suggest how the aurochs became extinct, in translation: Thus everywhere, with spears, light arrows and swords, in pitfalls they drove the aurochs, strong with horns.

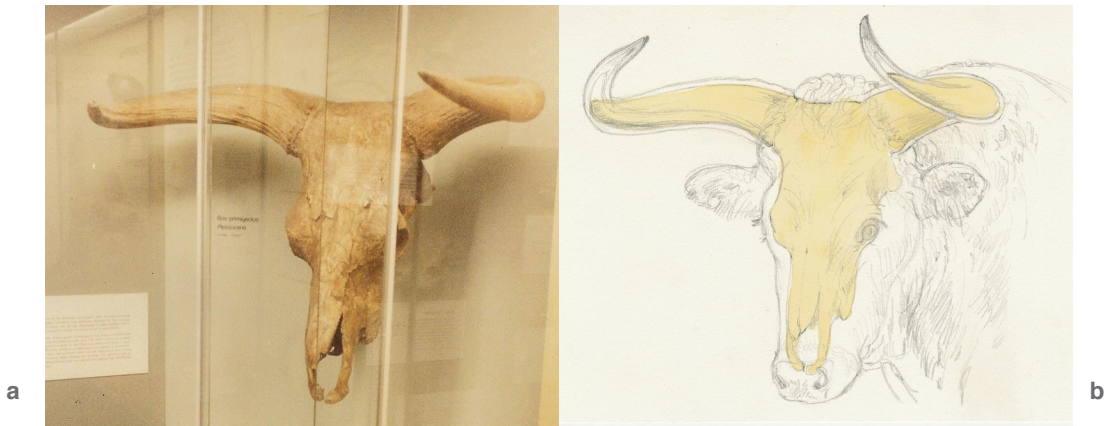


Figure 4. (a) Skull of an aurochs bull (The British Museum) and (b) reconstruction (drawing by Marleen Felius).



Figure 5. Archaeological sites that bear witness to the domestication of taurine cattle (Middle Euphrates [18,25] and zebu (Mehrgarh, [26]), their early dispersal (Catal Hüyük [27]) and the arrival of taurine cattle in Greece (Argissa-Magula, Nea Nikomedeia [2]) and Egypt (Fayum [28-31]). Domestication in Nabta Playa and Bir Kiseiba in South Egypt is not generally accepted [30,32,33]. In addition to the skeletal remains excavated at these sites, cave and wall paintings as well as sculptural objects found at several other sites have evidenced the presence of long-horned, short-horned or zebu cattle [7,28].

Archaeological data indicate that taurine cattle have been domesticated between 10,300–10,800 years ago in the Fertile Crescent, most probably on the western Turkish-Syrian border (Figure 5) [18,19]. The size, shape or gender ratios allow a differentiation of fossil remains from wild and domestic cattle [20,21]. In addition, isotope analysis of organic material reveals traces of milk in excavated pottery, indicating the storage of dairy products already 9000 BP [22].

Bayesian analysis of 15 mtDNA sequences from Neolithic to Iron Age Iranian cattle yielded an estimate of around 80 female aurochs being the maternal ancestors of almost all present day taurine cattle [15]. Modern cattle populations in Southwest Asia still have high haplotype diversity with appreciable frequencies of haplogroups T, T1, T2 and T3 [5,23,24].

Around 2000 years after the taurine domestication, zebu was domesticated in the Indus Valley at the edge of the Indian Desert [5,34]. Fossil remains attributed to zebu have been found in Mehrgarh, a proto-Indus culture site in Baluchistan in southwest Pakistan and were dated at 8000 BP [26]. Taurine cattle arrived in China about 5000 years ago. However, a bovine jaw dated 10.500 BP recently found in Northeast China shows clear signs of stereotypical bar biting often displayed by captive animals and contains taurine mtDNA from a hitherto unknown mtDNA haplogroup, suggesting an independent and early domestication [35]. This domestication would have been abortive, since there is no evidence of domestic cattle in the period between 10,500 and 5000 BP.

Paleontological remains found in the western Egyptian Desert dating from 9000 BP suggested an independent African center of domestication, but the domestic origin of the bones is disputed [30,32,33,36]. Initially an African domestication seemed in line with the predominance of the T1 haplogroup in Africa [37]. However, complete mtDNA sequences have shown that this haplogroup is closely related to the common Southwest-Asian haplotypes [38].

Thus, most of the diversity of domestic cattle has been derived from two cross-fertile species, *Bos taurus* and *Bos indicus*. However, separate domestications of related bovine species did occur in Asia [12,13]. In Tibet and surrounding regions the adaptation of the yak (*Bos grunniens*) to high altitudes [39] has been exploited since ca. 4500 BP. The habitats of the gayal or mithun (*Bos frontalis*) in Assam and Myanmar and of the domestic banteng or Bali cattle (*Bos javanicus*, domestic since ca. 5000 BP) overlap with the range of zebu [40]. Because all three species hybridize with taurine and zebu cattle, several Asian cattle populations are of mixed species origin and are unique contributions to the cattle resources.

Expansion of the first agricultural societies introduced cattle eventually to most parts of Asia, Africa and Europe [5] and replaced hunter-gatherer societies by sedentary pastoralism. However, if during the winters the available pasture could not feed the herd, this led to the adoption of seasonal transhumance [40]. Seasonal migrations are still common in Alpine Europe, and several parts of Africa and Asia. It may have preceded nomadic pastoralism, which until recently was common in central Africa and focused on cattle husbandry [40].

3. Early Taurine Dispersal

As is typical for successful innovations, agriculture and livestock husbandry spread to other populations, most likely by expansion of the first agricultural societies [41]. The demographic events that have led to the present distribution of taurine cattle in Asia, Europe and Africa can be reconstructed on the basis of archeological evidence combined with comparison of mtDNA, autosomal DNA [5] and Y-chromosomal DNA [42,43]. A westward expansion of agricultural societies brought domestic taurine cattle, together with other livestock and crops, to central Anatolia around 10,000 BP and from 8500 BP into Europe [2,19,27,29,44].

An eastward migration reached northern China or Mongolia between 5000 and 4000 BP [40]. This is supported by mtDNA analysis of cattle remains from five archaeological sites in Northern China, aged 4500 to 2300 BP, showing mtDNA haplotypes from the T2, T3 and T4 haplogroups just as is observed in modern East-Asian taurine cattle, including the Northern Siberian Yakut [45]. The T4 haplogroup is a subtype of the common haplogroup T3 exclusive to eastern Asia [38] and most likely emerged by a founder effect during the eastward expansion [24]. The presence of cattle in eastern Asia clearly predates the Silk Route, after 200 AD the major link of Europe and China and proposed as the migration route of cattle to East Asia [46].

Paleontological findings as well as pictorial and sculptural representations reveal the presence of early domestic cattle in Africa [7,28,30,31,40,47,48]. Cattle remains dated 6800–3500 BP have been found in Egypt, Libya and the Sahara. Around 7000 BP dairying pastoralists reached the then green Sahara [49,50] and left rock engravings showing long-horned cattle, which probably were the ancestors of the present West-African cattle. Around 5500 BP a climate change leading to desertification of the Sahara forced pastoralists to leave. Remains of short-and long-horned cattle at several sites in Northeast Africa were dated 5600 to 3000 BP [40,48] before the immigration of zebus (see below). From 2500 BP cattle herding spread to the south [40]. It is likely that taurine cattle also spread from Egypt westward along the North-African Mediterranean coast and then along the West-African Atlantic coast.

A strong maternal founder effect during the colonization of Africa is indicated by the predominance of the T1 haplotype (see above). A frequency of T1 of ca. 15% in Spain and Portugal [37] and ca. 11% in Sicily [51] indicates immigration of African cattle in Europe across the sea straits (Figure 6), which is confirmed by SNP profiles [46]. This may have occurred as early as the Bronze Age or later during the Muslim occupation [52].

The Mesopotamian provenance of the maternal lineages does not exclude an African origin of Y-chromosomal Y2 haplotypes by male introgression of the African aurochs [33,42,43,53]. This would explain the divergent 50K SNP genotypes of African haplotypes [46] and imply that the African aurochs is an additional source of the diversity of cattle.

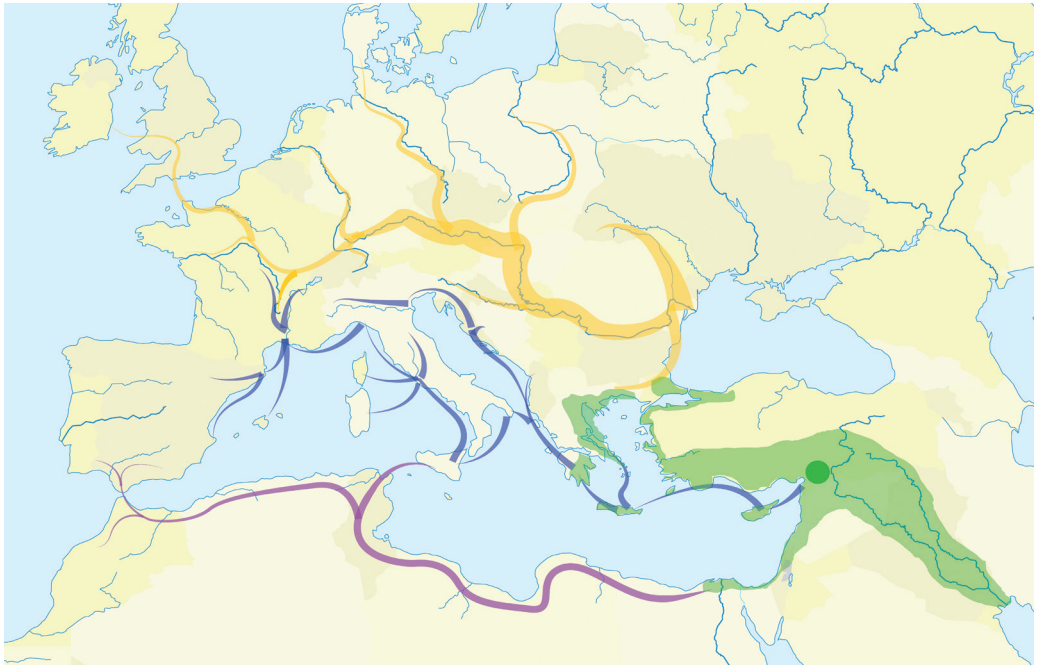


Figure 6. Neolithic migration of domestic cattle in Europe.

● Domestication center ■ Early range ■ Danube route ■ Mediterranean route ■ African route

The earliest signs of domesticated cattle in Europe are the bones found in Pre-Pottery Neolithic at Argissa-Magula, in Thessaly, Greece, dated 8500 BP [2,54]. The remains of the earliest European farms suggest two routes of migration: via the Mediterranean coasts and along the Danube river, respectively (Figure 6). Via the first route farming was introduced in Corsica, the Languedoc, southwest France and the eastern Spanish coast ca. 7900 to 7700 BP [55-58]. Approximately 7500 BP domestic cattle reached Central Europe via the Danubian route and Northern Europe 1000 years later [57,59,60]. The migration from Southwest Asia to Northwest Europe led to a clear decline in the autosomal diversity [57].

Isotope analyses of traces of bovine dairy fat products in ceramic remains indicate the milking of cattle by European farmers in 7500 BP in southeast [22] and northern [61] Europe and in 6000 BP in Great Britain [62]. This is confirmed by $^{15}\text{N}/^{14}\text{N}$ ratios in calf teeth from ancient French calves as evidence of early weaning [63]. However, milking of cattle may have been restricted to central and northern Europe. This has been suggested because of a low frequency of the human lactose tolerance allele in Mediterranean populations [64,65] and a lack of cattle dairying tradition in the Italian peninsula during the Roman empire [20].

Rare recruitment of cows from European aurochs populations is suggested by the occurrence of low frequencies of the P, Q and R mtDNA haplotypes in European domestic cattle [23,66]. In European cattle west and north of the Balkans the T3

haplogroup is dominant, probably indicating a founder effect during the Danubian migration [23,24]. A clear north-south distribution of two predominant Y-chromosomal Y1 and Y2 haplotypes has been linked to founder effects accompanying the development of dairy cattle in the northern part of the continent and in the Alpine region, respectively [43]. Awaiting genomic information of European aurochs, it is not yet clear if wild bulls have contributed to the diversity of cattle by introgression in the domestic population, as has been suggested for the Hungarian Grey (see below).

4. Early Zebu Dispersal

Zebu cattle are with 721 million head about as numerous as the taurine population [67]. However, their distribution has remained restricted to regions with a climate similar to that of the earlier domestication site in the Indus Valley. Dispersal may have started around 4500 BP when Rig Vedic Aryan invaders from Central Asia descended into the Indus valley via the northern passes. The original occupants of the region then moved eastward with their livestock into the Ganges valley. Around 3500 BP cattle were introduced in Bihar and Bengal ([40]. Terracotta figurines and fragmented bones of zebu cattle [26,68,69] were excavated from Neolithic settlements at three sites in Karnata-



Figure 7. Pictorial evidence of the origin and dispersal of zebu. (a) Harappan seal (National Museum, India, [70]), 5000–3500 BP; (b) detail of cylindrical chlorite vessel (Mesopotamia (mid-5th millennium BP, The British Museum, London); (c) detail of conic object from Tarut Island near the Eastern coast of the Arabian peninsula (Metropolitan Museum, NY) and (d) detail of a painting: inspection of cattle belonging to Nebamun, Thebes, ca. 3400 BP, The British Museum, London).

ka on the Deccan plateau of Central India. The Harappan seal (Figure 7a) shows a well developed thoracic hump and a large, folded dewlap, although other contemporary seals show that in the period 5000–3500 BP humped and humpless cattle coexisted.

Zebu entered China from the south or southwest from 3000 BP onward [40,70]. Mixing with the taurine cattle from the north generated a genetic North-South gradient of zebu-aurine mtDNA [71] and Y-chromosomal DNA [72]. In South China admixture of bibovine cattle (banteng, gaur or gayal) occurred, which may have been the dominant cattle species until 4500 BP [40,46].

In the east, zebras reached Indonesia at least 1000 years ago. DNA analysis showed sporadic, substantial or even complete maternal banteng ancestry of Indonesian zebu breeds, suggesting that zebras were crossed into herds of previously domesticated banteng (*Bos javanicus*) [73].

Early migration of zebu also took place in western direction. Evidence of the presence of zebras in Mesopotamia comes from figurines of humped bulls excavated in northern Iraq and dated 6500 BP and from Sumerian vase fragments dated 4750 BP [40]. At numerous sites on both sides of the Persian Gulf zebu bulls have been depicted with high cervico-thoracic (neck-shoulder) humps with dates between 5000 to 3000 BP (Figure 7b,c). A shift to a more arid climate in Mesopotamia ca. 4000 BP [74] probably stimulated the immigration of zebu. At present the most northwestern true humped zebu is the Caucasian Zebu in Azerbaijan [7]. Appreciable maternal, paternal and autosomal zebu introgression has been observed in the present taurine cattle from Iraq and Anatolia [24,46,75]. Low levels of introgression of zebu in Europe are indicated by the presence of zebu alleles in South-European cattle [46,57,76].

DNA studies suggest that zebras were first introduced into East Africa about 4000 years ago [40,77]. Egyptian pictures from 3400 BP show humped cattle (Figure 7d) [28], and zebu-type dished vertebrae found in Egypt and Somalia date back to ca. 3500 BP and 3500-2500 BP, respectively [78]. Arabian traders probably stimulated import of Indo-Pakistani zebu via the Persian Gulf and South Arabia into the horn of Africa after 700 AD. Only zebu bulls were introduced, since mtDNA data showed that all African zebu and taurine cattle are maternally of taurine descent [37,78]. The later history of African zebu is described in Section 14.

5. Short-Horned and Small Taurine Cattle in the Bronze and Iron Age

Long horns serve wild bovines by warding off predators and competitors, but in the domestic habitat hinder the handling of animals and the stabling of the herd. Short-horned taurine cattle appeared in Mesopotamia in the early Bronze Age (5100-2580 BP). Several wall paintings in Egypt bear witness to the gradual replacement of long-horned animals from 5000 BP onward [28]. Short-horned cattle also spread to southern and central Europe (5000-4500 BP) and arrived in Britain between 4000-3000 BP [80]. In the late Bronze Age short-horned cattle became dominant in central and northern Europe [54,80], even though many Mediterranean as well Hungarian cattle remained long-horned. This is in line with the notion that during the Bronze Age in

northwestern Europe it became common to stable cattle during the winter [81,82]. A subsequent but less universal adaptation to the North-European domestic environment was the breeding of hornless (polled) cattle, the first remains of which date back to 6000 BP [54].

The size of cattle decreased continuously since the Bronze Age, presumably a further adaptation to domestication and to food scarcity during cold winter periods. While aurochs bulls had wither heights of 180 cm and cows of 160 cm, Bronze and Iron Age cattle in France, the Netherlands, Germany, Italy and Central Europe, typically reached 110 cm [20,59,83,84], agreeing with contemporary descriptions of the Friesian and Batavian cattle during the Roman era [85].

6. Large Greek and Roman Cattle

With the advanced literacy during the Greek and Roman civilization came the first detailed accounts of cattle husbandry. In Greece during the Hellenistic period (ca. 330–63 BC), cattle were used for traction, sacrifice, beef production and also milking. According to Aristotle, the rich pasturelands of Epirus were famous for the large size of their livestock with cattle producing 30 L milk per day [86]. Skeletal remains in Kassope in Epirus revealed the development of large cattle in the 7th and 8th century BC with withers heights ranging from 115 to 135 cm [87]. These Epirote cattle were exported to several regions in Italy and southern France. In Italy, these cattle were probably the ancestors of the large Roman cattle. In 200 BC three different coat colors (white, black and yellow) and a spotted pattern were described for Sicilian cattle [88].



a



b



c

Figure 8. Reliefs showing large Greek or Roman cattle. (a) Greek cows, Parthenon frieze, 5th century BC (b) Wine transport, Roman, 3th century AD (The British Museum) and (c) Roman bull (1st century, Pompeii, Musée du Louvre).

Cattle also flourished during the Roman Empire [89] as described in detail by Cato, Varro, Columella and Pliny [90]. Cattle provided traction in agriculture and for hauling heavy loads, for which horses, for want of collars (yet to be invented), were not suited. Roman cattle were not milked [64], but Columella and Pliny praised the dairy qualities of the Alpine cows [64,90,91]. Roman writers were the first to describe the diversity of regional cattle with various sizes, colors and performance [90]. Large Roman cattle, ranging from 120 cm to 135-140 cm, with distinctive large horns were found in Etruria [54,84,87]. From the Greek and Roman era also many naturalistic cattle sculptures survived (Figure 8).

Paleontological evidence indicates that cattle in various parts of the Roman Empire varied widely in size, for example in Britain [92,93] and southern Germany [54,83]. Germanic cattle stood 95-125 cm; those in the Roman provinces 100-150 cm [59]. A survey of 20 sites showed that cows dating from the Empire averaged a withers height of 130 cm and bulls 138-144 cm [87]. The Pax Romana and infrastructure of the Roman Empire probably facilitated export of large Italian cattle to the distant provinces, where these cattle lived in the same areas as the small indigenous cattle [54,84]. Strikingly, the large cattle disappeared soon after the fall of the Roman Empire, suggesting that smaller animals fitted better in a husbandry system that had regressed to more primitive practices.

7. Medieval Cattle and Catastrophes

The collapse of the Roman Empire was followed by periods of unrest and large-scale migration of several Germanic and eastern European peoples and their livestock during the fifth and sixth century AD.



a



b

Figure 9. Present-day small cattle. (a) Albanian Prespa cattle, a dwarf variant of Busha cattle kept in Albanian mountain areas with wither heights of 95–105 cm (photograph by Dr. Kristaq Kume, SGP Small Grants Programme) and (b) African Dahomey bull, withers height 90 cm (photograph by Marleen Felius).



Figure 10. *Ploughing with oxen, Luttrell Psalter, circa 1335-1340, detail (The British Library).*

This initiated a significant cultural regression, a disuse of technology and a decay of the Roman infrastructure. The migrations probably led to a considerable mixing of cattle populations from various European regions. Throughout the rest of the Middle Ages raiding, wars, famines, cattle plagues [94] and inundations decimated local cattle populations. Restocking by importing animals from neighboring regions is likely to have caused intensive gene flow.

During the early Middle Ages small cattle with withers heights of 95-105 cm were dominant in most parts of Europe [54]. Cattle stands in medieval Dutch farming houses were only 75 to 84 cm in width, which is 40 cm smaller than in the Bronze Age [81]. This has been explained by the negative consequence of poor nutrition [95] or of the castration of the largest and strongest young males [93], but the small body size was probably also a genetic adaptation to the subsistence farming typical for undeveloped economies. In addition, large animals were most likely to be selected for slaughtering before the winter [93,96] as they were more vulnerable to an uncertain supply of fodder. The role of genetic factors is illustrated by the small size of present-day cattle from four different continents that share an adaptation to marginal rural areas: the Illyrian dwarf cattle in Albania [97], Tibetan cattle in the Himalaya, the West African Shorthorns in the forests and lagoons and several original American Criollo populations (Figure 9).

Sparse documentation suggests an appreciable color diversity of medieval cattle [98]. White cattle with colored ears were mentioned in pre-Christian Irish epics [99]. Medieval paintings and illustrations of cattle suggest cattle show mostly unicolored brown or black animals (Figure 10). A stock inventory of the Marckerhoeft monastery provides information on the color and pattern of a sample of 115 Dutch cattle in 1344: 71 animals were completely black, red or dun, 20 were white-headed, 12 were white-backed and 12 were pied [100].

The introduction of the heavy plough allowed tillage of heavy clay soils and plausibly initiated an agricultural revolution around 1000-1300 [101]. After the introduction of the horse collar around 1000 AD, horses were more and more used for plowing, depending on the region and the resources of the farmer [102,103]. Although still a source of draught power, cattle as well as other livestock decreased in number by the growing importance of grain cultivation (cerealization or Vergetreidung [103-105]).

The agricultural revolution allowed the human population to grow. However, in the 14th century European agricultural development suffered two serious setbacks. First, a number of crop failures caused the Great Famine (1315-1317), causing millions of deaths and reducing the North-European population by 10% to 25%. This was followed by the Black Death epidemics (1349-1351), by which a third of the population is believed to have perished. In several regions cultivation was almost abandoned and cattle keeping became extensive [106].

8. Recovery of Cattle

After the catastrophic 14th century the human as well as the livestock populations recovered rapidly. This accompanied the remarkable cultural and technological development of Renaissance society, which was promoted by the earlier invention of the printing press and a growing urbanization [103]. The manorial farming that characterized the Northwest-European feudal society became more and more replaced by tenant farming on rented land [93,103]. Fencing off pastures and cultivation of animal feed became common and storage methods improved, allowing the survival of larger cattle during the winter and a selection of sires to enhance productivity. Since this was done using locally preferred sires, this promoted a differentiation of cattle.

Cattle increased in size, while even long-horned cattle appeared in English Midlands [93,104]. However, local farms could not meet the demand for beef in the growing cities, which came to depend on the transport of cattle on the hoof from regions where they could be reared in large numbers under extensive management: the North-western coastal regions, the Alpine regions and the steppes of Eastern Europe [107]. Since the late Middle Ages so-called “drovers” moved Welsh beef cattle to London [108]. Danish cattle went in huge herds to the Netherlands for fattening [109]. In 1450 the export of Dutch dairy products and fattened cattle was already of considerable importance [110].

In the Swiss Alps triple-purpose cattle were developed, which from the 15th century were exported in large numbers to surrounding countries. In the late 14th century deeds from the Swiss monastery of Einsiedeln refer to export of Braunvieh to Vorarlberg in present-day Austria [91]. Cattle were exported as well from the Swiss Simme and Saane valleys to Italy during the 15th and 16th centuries [111].

Since the 14th century a grey colored long-horned cattle of the so-called Podolian type appeared on the pusztas in the Carpathian basin and replaced the local small cattle during the 14th and 15th centuries [54,106,112]. From the late 14th to the early 18th century Hungarian Grey cattle, the major Podolian breed, were driven for slaughtering to Austria, South Germany and Venice [106,112-114] and then southwards as far as Naples [115]. Import into Italy from Hungary and from Bosnia and Croatia via the Dalmatian port of Zadar continued during the 18th century [115].

Podolian cattle have been named after the region in South Ukraine where the breed was kept in the Middle Ages, but its origin is uncertain. Since no remains of long-horned steppe cattle dating before the 12th century have been found, it is assumed that long-horned Podolian cattle resulted from a late-medieval local selective breeding. Influence of wild aurochs have been excluded [54,106,112]. It is plausible that



Figure 11. Contemporary depictions of preindustrial Dutch cattle. (a) *The Milkmaid*, engraving by Lucas van Leyden, 1510 (Prentenkabinet, Kunsthistorisch Instituut, Leiden) and (b) *The Bull*, Paulus Potter, ca. 1647, detail (Mauritshuis, Den Haag). When the cattle industry flourished in Holland, scenery with cattle became a popular subject in art. Oxen and dairy cows, symbolizing wealth, were often depicted in Dutch paintings. White-backed and -headed cattle (like the cow on the left) are overrepresented in paintings, since the convenient contrast facilitates the composition. On the other hand, black-pied animals do not blend easily with the color of the landscape and may therefore be underrepresented [120].

documented large-scale imports into Italy of oxen as well as fertile animals [106] explain the clear similarities with Italian Podolian breeds (one of which is even named Podolica). MtDNA has shown that Italian and Balkan cattle differ in haplogroup distribution [23,24], indicating that the maternal lineages are still of local descent and that the Podolian gene flow into Italy was male-mediated.

In an alternative or complementary scenario [54,116] the Podolian cattle descend from the large cattle living in the Italian peninsula during the Roman era, which probably descended from Epirote cattle [84]. The giant Chianina, which differs from other Podolian cattle in its small horns, may have retained traits of earlier Italian cattle. With the exception of the crossbreeding in the 20th century of Maremmana sires with Hungarian Grey cattle [112], there is no documented gene flow from Italy eastward.

While everywhere in Western Europe cattle were still kept as part of a mixed farming system, mainly for the purpose of traction and dairying, a very different development took place in Spain. The Reconquista of Moorish territory in Castilia and Andalusia (900-1492) led to the development of a thriving and highly organized cattle ranching economy where large herds of 1000-15,000 work and beef cattle were kept under extensive management [117,118].

The independent developments of cattle in separate regions stimulated a further geographic differentiation of appearance and performance.

9. Preindustrial Progress

In the mid-16th century prices for dairy products soared. The cows in the Northern Netherlands became famous for their milk production. While in other parts of Europe an annual yield was at most 800 L, Dutch cattle yielding 2000 L were no exception [119]. Dutch cows (Figure 11) were exported to England, France and Germany.

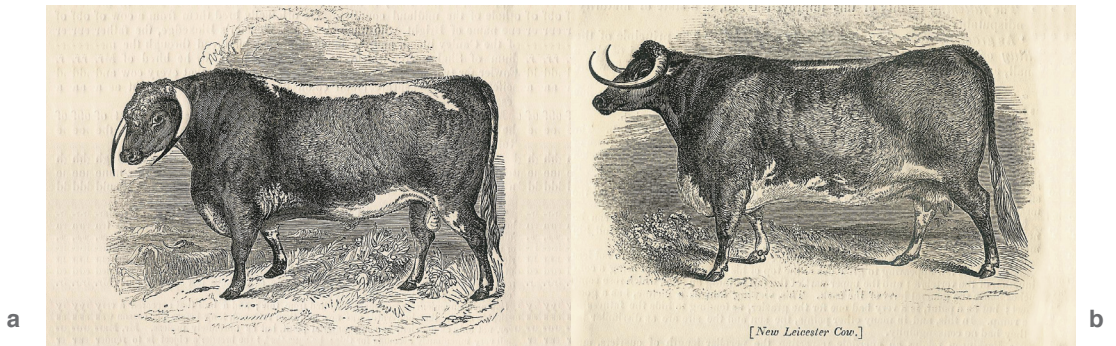


Figure 12. New Leicester bull and cow [139].

Written accounts of cattle and husbandry, which after the Roman era had become sporadic, became available again thanks to growing literacy. In the last quarter of the 16th century a number of books on farming were published in France and translated into English, German, Italian and Dutch. These books contained material from Virgil's *Georgica* and described the putative relations between color and performance: a good milking cow is black with tiny white spots or black pied [121] and dark red and black cattle were the best [122]. In 1627 and still in 1782 red was the most desirable color [123,124]. For breeding, a red bull, with or without spots, was recommended. A publication in 1789 described 22 types of cattle in France named after their region of origin [125].

In England in 1614, Black Longhorns were found in Yorkshire, Derbyshire, Lancashire, Staffordshire and the dairy regions of Cheshire [126]. Tall, lean and pied cattle with strong hooves and small crooked horns, suggested to be of Dutch origin, were kept in Lincolnshire. In contrast to Longhorns these were not apt to put on weight. Somerset, Gloucestershire and some parts of Wiltshire were noted for blood-red cattle [126,127].

Throughout Europe the migrations of cattle (see above) continued [107,110,128,129]. Beef cattle reared on Scottish pastures were driven to London and other cities from the early 17th to the early 19th century [130]. The preference of drovers for hornless animals led to the emergence of the polled Galloway [93]. In Central Europe the export of Hungarian Grey cattle to Vienna, Nurnberg, Strasbourg and Venice involved tens of thousands of cattle per year in the 15th and 16th centuries and after 1700 even 100,000 animals [112]. Around the same time Ukrainian cattle moved via Krakow to the west [131]. The Hungarian export decreased when the Viennese court imposed a monopoly in 1622 and was also seriously affected by the wars with Turkey in the 17th century. Export to Venice by Austrian and Ottoman traders continued during the 18th century ([115], see above).

Eventually, West-European cattle husbandry improved and met the demand for beef of the urban populations. The growth of cattle farming also had a downside when the higher density of animals invited outbreaks of cattle plague, which was introduced by Hungarian steppe cattle and in the 18th century harassed continental Europe [115,132-134].

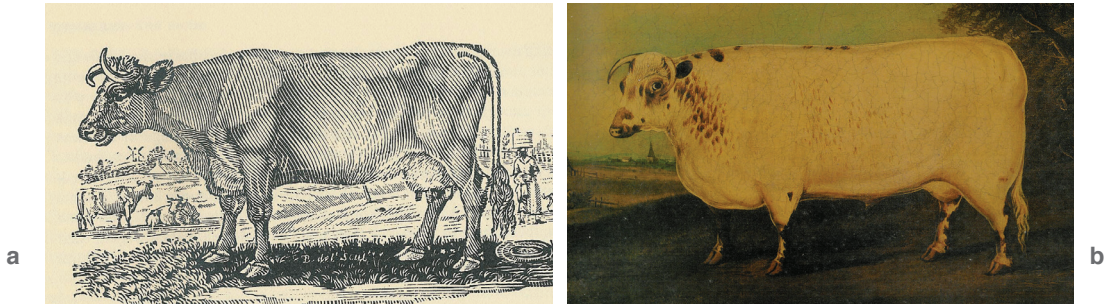


Figure 13. English cows: (a) Cow, 1790 [141]. This animal seems of a solid color. In the 1790 edition the figure caption mentions Common Cow, but in the second edition of 1791 The Holstein or Dutch Breed, illustrating the recent introduction of the breed concept; (b) Idealized beef type Durham cow from an unknown 19th century artist. This and many similar paintings portray the animals with a square body, with lumps of fat, an unrealistic small head and thin legs.

Thus, the cattle types that existed in 18th-century Europe were regionally adapted with clear differences in appearance and performance between regions, but very likely also within herds. Mating was still more or less random, sires from nearby being the most readily available. Until 1760 natural selection and adaptation of landraces to local circumstances prevailed rather than selection for utility or a certain trait [135]. However, the stage was set for an unprecedented and human-controlled acceleration of the evolution and diversification of cattle.

10. The First Breeds

The industrial revolution started in England around 1760. It led to further urbanization and increased demand from the cities for agricultural products. This encouraged the so-called British Agricultural Revolution [136] and a fast acceptance of an important innovation in livestock husbandry: the development of breeds with a deliberate choice of sires and documentation of pedigrees in herd books. The oldest known herd book for cattle was kept between 1775 and 1782 at the Monastery of Einsiedeln in the Swiss canton Schwyz, where the grey-brown mountain cattle (Braunvieh) evolved. In 1795 the cattle from Schwyz were described as the largest and most beautiful of Switzerland thanks to the attention given to keeping and breeding [91].

In 1760, the Englishman Robert Bakewell started improving cattle, sheep and horses [137]. His breeding records have not survived, but it is likely that he started with local long-horned animals that were close to his ideal and that he fixed the desired traits by inbreeding. He selected for beauty of form, quality of flesh and disposition for fattening. He also paid attention to early growth and -by then a novelty- well-being. His cattle were also renowned for their extreme docility. By the turn of the century his improved Longhorn, initially called New Leicester or Dishley (Figure 12), had become the most widely distributed breed in the midland counties [138].

Around 1785, Durham cattle, later called the Shorthorn [93,127], was developed by the brothers Charles and Robert Colling. They selected local cattle, mainly Teeswater, which were at least partially of Dutch ancestry (Figure 13a). They applied the same breeding



Figure 14. Other British breeds [142] (a) Hereford cow (1855) and Hereford bull (1856); (b) Aberdeen-Angus cow (1855) and bull (1856); (c) Ayrshire cows without (1855) and with (1856) the current spotted pattern.

strategy as Bakewell with close inbreeding (Like engend'ring like [127]). The Durham soon outnumbered the Longhorn and since 1822 their breeding has been recorded in the Coates Herd Book, the first cattle herd book that lasts to this day. Portraits of extremely fattened animals were published and live animals were widely displayed (Figure 13b). Thus, the Durham stock became the most fashionable breed of the first half of the 19th century, influencing most British and many European breeds (see below).

Following the successes with the Longhorn and Shorthorn, several other British breeds were developed, such as the Hereford (Figure 14a) and Aberdeen-Angus (Figure 14b), both beef cattle, and dairy Ayrshire (Figure 14c) [138]. Breeding was mainly an occupation of the gentry, who emphasized pure bloodlines to the point that purebred cattle with long pedigrees became a symbol of the British ruling class [135,140]. The island breeds Jersey and Guernsey were reputed dairy producers and were kept pure by forbidding the import of other cattle as early as 1789 [7,138].

Together with other inventions such as the steam engine and the power loom, systematic breeding spread quickly through Europe and North America, although on the European continent the developments were more gradual. Breeding sires were already selected on the basis of strict criteria in several regions in the 18th century. During the 19th century more and more herd books were established for authentic regional types, the so-called landraces, especially in regions with intensive agriculture. Later on in the 19th century, cattle exhibitions catalyzed an exchange of sires between neighboring regions with similar types of cattle, leading to an amalgamation of local populations with more uniform breeding objectives and a common herd book. Table S3.1 shows that this was a Europe-wide development

Since the mid-19th century international agricultural exhibitions and fairs were organized in the major European cities. This promoted the export of successful sires from western and central Europe to Eastern Europe for incrossing into local breeds. Except for the Pechora and Yakut, North Russian polled and Great Russian land cattle were eventually completely outcrossed.

Systematic breed development with explicit breeding objectives and the keeping of herd books is largely restricted to the Western countries. However, on the Indian subcontinent several Mysore zebu breeds have a history dating back to the late 16th century [143] and most Indo-Pakistani zebu breeds were described in the 19th century. In addition, for many local non-registered breeds in Africa, sires are selected according to breeding objectives with partial or complete genetic isolation from other cattle with oral history effectively replacing formal herd books.

An encyclopedia [7], a dictionary [144], a list of breed names [9] and the DAD-IS database [145] mention more than 1000 breeds worldwide.



Figure 15. European continental dairy and dual-purpose breeds in the 19th century. (a) Durham-Mancelle ox, 1856; (b) Normande cow, 1856; (c) Bretonne cow, 1856; (d) Flamande bull, 1856; (e) Comtoise cow, 1855; (f) North Holland (Dutch) bull, 1855; (g) Angeln cow, 1890; (h) Harz cow, 1855 and (i) Kholmogory cow, 1888. Sources: (a–f) [142]; (g) [147]; (h,i) [148].

11. European Breeds of the 19th Century: Tour of the Continent

In the northwestern European lowland and Scandinavia, where traction was done with horses, cattle were bred for dairy production (Figure 15). During the period of Anglomania from 1825 to 1860, the successful English Shorthorns were crossed with North-west-European continental cattle, especially in Belgium and North France [146]. Most Belgian breeds have been influenced by the Shorthorn, such as the dairy red Flamande (recognized in 1857, also kept in northern France) and the dual-purpose White-Blue, after 1890 also influenced by the French Charolais. Further development of this breed during the 20th century made the double-musled beef type an international breed [7].

In Normandy, Brittany and northwestern France regional varieties amalgamated (Table S3.1) and were selected mostly for dairy production. Thus three mainly dairy breeds were developed, the Normande (Figure 15b), the Bretonne Pie Noir (Figure 15c) and the red Flamande (Figure 15d) with herd books established in the 1880s [7]. The incrossing of British Shorthorns resulted in the dual-purpose Durham-Mancelle (Figure 15a), later developed as the Maine-Anjou beef breed and still closely related to the Shorthorns, and in three mainly dairy breeds.



Figure 16. Central-European breeds in the 19th century [142]. (a) Charolais bull; (b) Limousin cow; (c) Schwyz (Swiss Brown) cow, 1856; (d) Simmental-Saanen cow, 1855.

In eastern France spotted dairy cattle (see below) are represented by the Montbéliarde, originating from Switzerland and the related alpine Abondance. The blond and pied Comtoise landraces (Figure 15e), became absorbed into the Montbéliarde and French Simmental. More to the south, several French beef breeds were developed. In 1842 a registry was established for the Charolais beef breed (Figure 16a), which also underwent Shorthorn influence before a separate herd book for “pure” animals was established in 1890. The Limousin (Figure 16b), in 1854 officially recognized as a draught breed, was after 1886 selected towards a beef type and recorded in a herd book. Another well-known French beef breed, Blonde d’Aquitaine, emerged in the 20th century by amalgamation of several local breeds.

In the Netherlands the cattle population suffered considerably from the rinderpest epidemics in 1768 and 1786. Afterwards, the cattle population was replenished with cattle from Denmark and within a few generations regained its dairy productivity [133] (Figure 15f). In 1874, the first Dutch herd book was established and in 1879 the second in the province of Friesland. This documented the provenance and was useful for exported cattle as was required by foreign buyers. Dutch exports to European countries and America began to flourish after 1880, which led to the emergence of the highly productive Holstein-Friesian. The black-pied color, at that time most common in the north of the Netherlands, became an international trademark of the Dutch dairy cattle.



Figure 17. Iberian cattle. (a) Pyrenean ox team from Puigcerda, N.W. Spain, 1920s postcard; (b) Serrana Negra or Negra Iberica bull; Spain (c) Minhota cow, Portugal 1960s; and (d) Barrosã bull, 2006 (c,d: photographs by Marleen Felius).

In 1920 half the Dutch national cattle population consisted of Black Pied Dutch-Friesians and their numbers kept increasing. Within this population the red color gene variant was suppressed but, being recessive, did not disappear. Red-pied breeds such as the Dutch Meuse-Rhine-Yssel (MRY) were more developed as dual-purpose cattle, but were in the late 20th century influenced by red-pied Holstein sires.

In Germany the dairy cattle in the north are often indicated as *Niederungsvieh*, (lowland cattle) this as opposed to the central and southern *Höhenvieh* (highland cattle), a contrast that correlates with the Y-chromosomal haplotype (see below, [43]). The German black- and red-pied lowland dairy cattle are closely related to Dutch cattle and also to the red lowland dairy cattle. After 1830, the North-German Angeln (Angler) cattle (Figure 15g) and the closely related Danish Red reformed many local red highland breeds of central and eastern Europe (Figure 15h) as well as in the Baltic countries and Ukraine. The desired dairy type was described in 1841 and its first herd book published in 1885.

In Scandinavia and Finland cattle were kept since the Middle Ages mainly for dairy production [149]. In the 19th century several breeds were developed on the basis of crosses of local populations to imported sires. Ayrshires were imported on a large scale because of their proven hardiness. In addition, in Russia local cattle have been crossed



Figure 18. Chianina draught cattle. (a) *The Autumn*, Jacob Philipp Hackert, painted ca. 1784 in Italy, detail (Wallraff-Richartz-Museum, Cologne) and (b) *San Gimignano*, 1967 (photograph by Veronica Hekking).

with various imports, such as Dutch Black-pied, Groningen Whiteheaded, Danish Red, Shorthorns and Herefords. The most important of the early-improved breeds is the black-pied Kholmogory (Figure 15i), which spread across the provinces of Archangelsk and Vologda and to the surroundings of St Petersburg, where dairy products were in great demand. Kholmogory sires were widely used for improving Northern Russian polled land cattle, which all became extinct, except the Pechora cattle [7].

In Central Europe most breeds were triple purpose. In remote Alpine valleys productivity was improved only late in the 19th century by better feeding and management. In 1875 Schwyz cattle and two other Braunvieh varieties from different Alpine altitudes were recognized, which were combined as the Swiss Brown with a common herd book in 1879 (Figure 16c). These cattle became the ancestors of several Alpine, Italian and Spanish brown cattle and later of the American Brown Swiss. In the same year a herd book was established for Bernese Fleckvieh, now better known as Simmental (Figure 16d). This type of cattle influenced several spotted cattle breeds in Central Europe and was also outcrossed to local breeds in Eastern Europe, including Russia [7,150].

In Central Germany crosses of imported sires, mainly Bernese and Schwyz to red land cattle (Rotes Höhenvieh, Figure 15h) resulted in several local yellow breeds, which eventually were combined in the German Yellow (Gelbvieh). Incrossing in the amalgamated Austrian blond breeds resulted in the Austrian Yellow.

In regions where ox traction was the main purpose, such as the larger part of the Iberian Peninsula and southern Italy, herd books were established only after 1920 or 1930. Spanish and Portuguese cattle breeds developed in many different types with relatively little influence from outside (Figure 17). Dairying was only important in the northwestern Asturiana cattle. For the breeding of fighting bulls several genetically isolated castas (strains) of fighting cattle evolved from a mixture of Iberian races, including the central and southern black or red cattle of central and southern Spain and the northwestern Chestnut breeds.

During the 1950s, Iberian breeds were upgraded with exotic sires having matching coat colors, such as English South Devon, Austrian Yellow and Swiss Brown for the Northwest-Spanish Galician Blond (Rubia Gallega) and German Yellow for the Portuguese Minhota. About 20 years later French Salers was crossed into the central Spanish Retinta and the South-Portuguese Alentejana. Upgrading was not extensive, however, so the Iberian breeds retained genetically their regional identity [8] with the exception of the Minhota, which became largely identical to the German Yellow (Figure 17c).

Spotted, brown and grey Alpine cattle have influenced several North-Italian breeds. The Piemontese was developed into a large beef breed by combining grey local strains and incrossing of several Swiss and French cattle; a herd book was established in 1887. Central and South Italy harbor several Podolian draught and beef breeds, such as the large white Chianina (Figure 18) and the semi-feral Maremmana in Tuscany, the grey Romagnola around Bologna, the Marchigiana in the Marche, the Podolica in the south and the work-dairy red Modicana in south Sicily.

The breed formation changed the partitioning of the diversity in three ways. First, groups of herds constituting a breed became uniform and differences between breeds were emphasized. Second, successful breeds spread beyond their region of origin and were even, as detailed below, exported to other countries or continents. In contrast, locally adapted but less productive breeds declined in number or disappeared. Third, genetic isolation of breeds decreased the diversity at the molecular level, which can be monitored via an increase in homozygosity.

At the same time, breed also became a social concept. Through breeding societies and cattle exhibitions breeds grew into club icons with inherent, if unrealistic, perceptions of their history and conservation value [9]. However, cattle breeds were from the outset never static, but new phenotypes were developed that improved productivity [7]: several landraces were upgraded by crossbreeding with breeds from the same country or with foreign imports and other breeds were split or amalgamated (Table S3.1). Changes in the 20th century were even more consequential (see below), leading to a perception that breeds imported during the 19th-century belong to our past and are as authentic as the landraces of older local origin.

12. Breed Groups and Clusters

On the basis of a genetic survey of the present European and Turkish breeds analyzed with microsatellites and in agreement with SNP analysis [151], five major groups of breeds and several clusters of related breeds can be distinguished [8]:

(1) North-European cattle, comprising the following breed clusters:

- (a) Four clusters corresponding to the expansion of popular dairy breeds (black-pied, red-pied, Baltic red and Nordic Ayrshire);
- (b) Three regional clusters of related but diverse breeds (British, Nordic and Russian-Siberian);
- (c) A loose cluster of Shorthorn with several Belgian and North-French, dairy-beef and beef breeds influenced by the Shorthorn, including the Maine-Anjou and Charolais.

(2) Central European cattle, with many dual purpose (beef-work or dairy-work) and triple-purpose breeds, comprising three major and two minor breed clusters:

(a) Two breed clusters corresponding to the expansion of the Simmental and Swiss Brown breeds, respectively. The Simmental cluster also contains related Swiss, French and Italian cattle from the western Alps, the German and Austrian yellow and blond breeds and the German Hinterwälder and Vorderwälder;

(b) The unicolored beef and beef-work breeds from South France;

(c) Two minor clusters of Alpine Grey cattle and of the spotted dairy cattle from the eastern Alps (Pinzgauer, Pustertaler and Čika). The Piemontese beef breed also belongs to the Central-European cattle, but does not belong to a breed cluster.

(3) Iberian cattle, with a large variety of coat colors and horn morphology and mainly used as beef, work and fighting cattle.

(4) The mostly long-horned and grey Podolian cattle, primarily developed as beef and work animals.

(5) The genetically diverse breeds of the Balkans and Anatolian breeds, still representing the undeveloped taurine cattle.

Cattle from the first group predominantly carry Y-chromosomes from the Y1 haplogroup. All other breeds have an Y2 Y-chromosome with the exception of a few Spanish breeds. The molecular-genetic classification is largely in agreement with the integrated geographic-morphological classification [7,8]. The development of dairy cattle in northern (group 1) and central Europe (group 2) may have narrowed the diversity of the paternal lineages. This would explain the geographic contrast of two dominant Y-chromosomal haplotypes from the Y1 and Y2 in group 1 and 2, respectively [43].

A correlation of genetic clustering with geographic origin indicates that isolation by distance governs the molecular divergence of the breed clusters. Most alleles of neutral markers are shared by a majority of the breeds, do not correspond to the breed-specific traits and are via linkage disequilibrium only informative for a small part of the genome.

13. Asian Cattle

The history of cattle in Asia has not been as dynamic as in Europe. Anatolian cattle that live close to the domestication site of taurine cattle have retained a high genetic diversity [152], but now require protection [153]. Other indigenous Southwest Asian cattle consist of small, triple purpose local landraces (Baladi) and larger, elegant dairy type Damascus breeds. Due to outcrossing and replacement by temperate-type dairy and beef breeds these are declining very rapidly [40]. The Israeli Holstein has been developed since 1922 and comprises strains that are adapted to temperatures of 40–45 °C [154]. Near the cities of other Southwest-Asian countries and especially in Saudi Arabia Holstein-Friesian cows are kept on large farms in climate-controlled stables.

Siberian, Mongolian and Central Asian taurine cattle have since the 1920s been outcrossed by imported West European dairy, beef and dual-purpose breeds such as dairy Black Pieds, Simmental, Swiss Brown, Shorthorn and Hereford. Recently the Kazakh Aulyakol has been developed by continuous crossbreeding with Charolais without taking measures to protect the extremely hardy local breeds [155]. Since 2001 a conservation program in the Sakha Republic protects the Yakut as the only surviving authentic Siberian landrace [156].

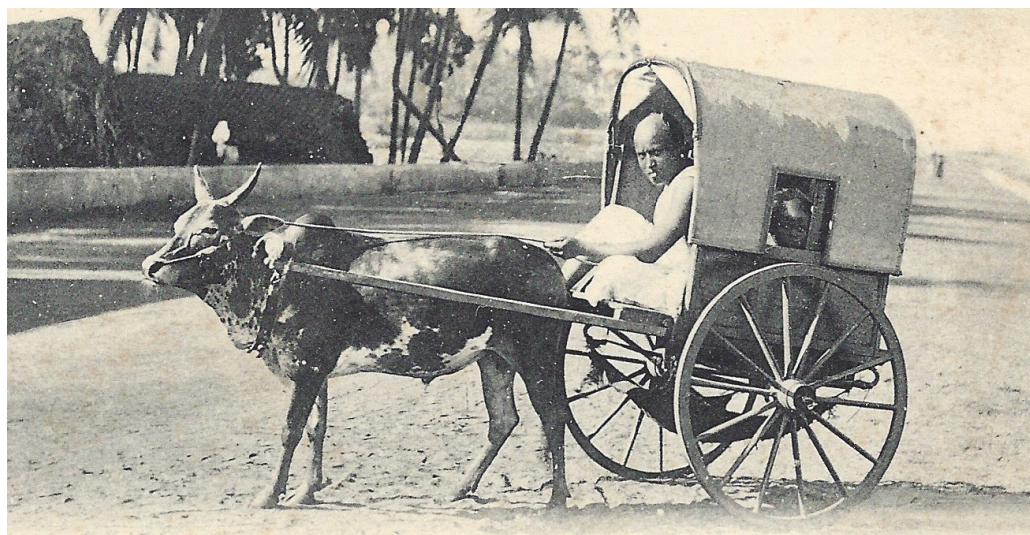


Figure 19. Tamil Nadu dwarf zebu, Madras (postcard, probably from the 1930s).

In China, the Central and South Chinese Yellow cattle were developed as work cattle [7]. Dairy cattle have been developed since the early 19th century by crossbreeding with European or American cattle and recently with purebred Holsteins.

In 1867, the ban on meat consumption in Japan was lifted. At the same time, the consumption of dairy products was stimulated. In order to convert the Japanese working cattle into beef types in 1872 West-European breeds were introduced [157]. The Japanese Black was developed by incrossing with Devon and Shorthorn [158]. In 1994 it accounted for 90% of the national beef cattle population and is the source of the Kobe beef, the most expensive beef of the world [159]. In America, Australia and Europe the exported Japanese beef cattle populations are collectively known as Wagyu, the name for the original Japanese cattle. Japanese beef cattle have a high frequency of the mtDNA T4 haplogroup (see above). Since 1889, milk has been produced by imported Holsteins [7].

In India and Pakistan the vast majority of cattle are desi, local non-descript animals [160], also including the nadudana dwarf zebus (Figure 19). However, these countries also count 35 recognized zebu breeds. A large variety of Indo-Pakistani zebu breeds and landraces were described in the 19th century [161]. For several breeds herd books were established in the early 20th century. Since the 19th century a few breeds were exported to Southeast Asia and the Americas [162]. Most zebu breeds are developed as draught

cattle [160], but Sahiwal, Red Sindhi and Gir are specialized dairy cattle and the Kankrej and Ongole are dairy-work cattle. The southern Indian Mysore breeds were already bred in the 17th century for fast road transport [161].

Several factors contributed to the recent decrease of the Indo-Pakistani zebu populations: increase of mechanized agriculture, dwindling grazing areas in densely populated regions, exclusion of herds from forest grazing, crossbreeding programs and increase of the number of dairy river buffaloes. Dwarf zebus adapted to extreme conditions almost vanished by crossbreeding with taurine imports, but the small northwestern Pakistan Achai was described in 2012 [163] and the miniature Vechur breed was reestablished [164]. Further, new pure zebu breeds are being developed or have been recognized [165-168].

In Indochina and on the Philippines the swamp buffaloes outnumber cattle [169]. As in China, Indochinese cattle were used for work and eventually slaughtered but not milked. After 1950 European, American and Australian production cattle were being imported. At the end of the 19th century Ongole zebus were imported in Indonesia for traction on paved roads, for which the soft hooves of the water buffaloes were not suitable. Domestic banteng is still kept pure as Bali cattle on the island of the same name and has been exported to other Indonesian isles [73].

The gayal or mithun, the domestic form of the gaur, is kept as semi-feral cattle in the forests at 1000-3000 m in eastern India, Bhutan, the western part of Myanmar and in the southeastern Chinese Yunnan province (Dulong cattle). Although crossing with gaur occurs, gaur and gayal bulls have remained clearly different in size, behavior and morphology, most notably of the horns of the bulls. Mainly reared for meat the animal plays an important role in the socio-economic and cultural life of the local tribal populations [170]. Dulong gayals carry zebu mtDNA [171], indicating a hybrid origin. The Malaysian Selembu is the first-generation offspring of gayal and zebu. The sterile males are strong work cattle and the females excellent dairy producers [7].

14. African Cattle

As described in Sections 3 and 4, both taurine and zebu cattle immigrated into Africa. As in Europe, long-horned preceded short-horned taurine cattle [40]. Cross-breeding in East Africa led to the development of taurindicine cervico-thoracically humped sanga cattle, which expanded southward and reached South Africa 250-500 AD [40]. Most sangas have retained a taurine Y-chromosome, indicating that male zebu introgression in these cattle was only partial. By around 1500 AD sanga cattle were the dominant form of cattle in East and Central Africa [40].

Zebus gradually migrated to the west after 700 AD [28,172] or even earlier [40]. The presence of zebu in West Africa in the early 19th century is testified by the export of Senegal zebu in 1828 to the Lesser Antilles [173].

At the end of the 19th century a devastating cattle plague spread throughout the African continent [174]. The rinderpest epidemic started in Eritrea in 1887 and



Figure 20. Rinderpest epidemic in South Africa, 1897 (Onderstepoort Collection).

reached the Atlantic Ocean in 1893 and South Africa in 1898, according to some accounts killing 90% of all African cattle [175,176] (Figure 20). The partial resistance of zebu to rinderpest with a mortality of only 10%–30% led to a drastic replacement of many taurindicine sanga populations by thoracically humped zebu with substantially more indicine ancestry in West, Central and East Africa. Zebu is now the dominant species in West and East Africa, but is not kept in the coastal regions infested with tsetse flies. In those areas the trypanotolerant African taurine cattle have remained the most pure, especially the Lagune [46,79]. The miniature West African short-horned taurines lost ground, mainly by the increasing Fulani zebu influence. On the other hand, the larger and long-horned taurine N'Dama expanded from Guinea over most of West Africa.

Y-chromosomes of West-and East-African zebus have haplotypes of indicine origin due to the exclusive use of zebu bulls [78,177]. Autosomal DNA shows for most tropical African cattle a mixed ancestry with variable taurine-indicine ratios. Zebu alleles still have the highest frequency in East Africa [77,178]. Evidently, the separate domestications of taurine and indicine cattle, two interfertile species with different environmental requirements, created the opportunity to breed, in addition to the pure species, many intermediate taurindicine breeds, expanding the adaptive repertoire of domestic cattle. Adding further to the diversity of African cattle, Friesian cattle were introduced in 1850 into South Africa and in 1908 into Kenya, in South Africa followed by other productive European and North American cattle. Crossbreeding European and African breeds in South Africa resulted in several successful new breeds, such as the Bonsmara and Drakensberger. In Kenya the Sahiwal zebu, first imported in 1939, spread as purebred or crossbred dairy cattle. Conversely, African N'Dama, Boran, Tuli, Afrikander and Bonsmara are exported to the tropical and subtropical regions in America and Australia and crossed with cows of British origin.

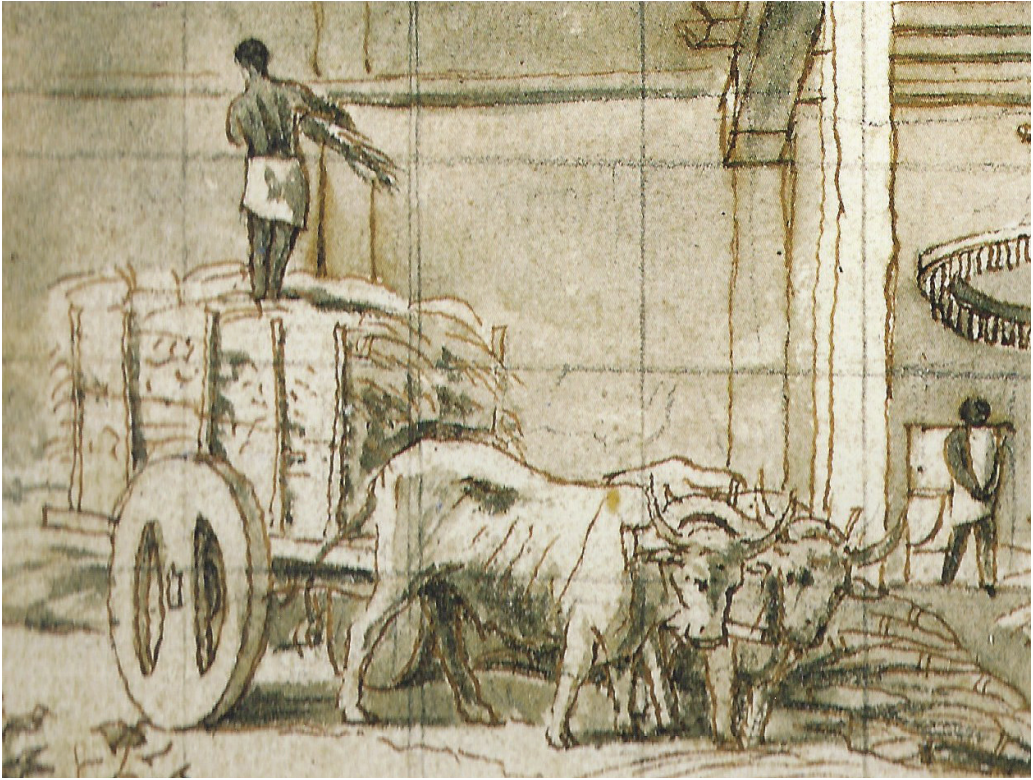


Figure 21. *Brazilian cattle Sugar Mill, Frans Post, detail, 1640 (Royal Museum of Fine Arts, Brussels).*

15. Cattle in the New World

The arrival of the Spanish explorers in the Americas in 1492 opened up a new world for Europeans and their cattle. On his second voyage in 1493 Columbus took cattle to the Caribbean island of Hispaniola [40,118]. For the next fifty years, every Spanish ship sailing for America carried five or six young cattle, only two or three of which were expected to survive. It is estimated that at most 300 Spanish cattle entered the Americas via this route. Many of these came from the Canary Islands on the northwest coast of Africa, in Spanish possession since 1479 and the last port of call before the long voyage west. By 1525, already more than 1000 cattle populated the Caribbean colonies, from where they spread to the Spanish colonies in America (Figure 21). The mtDNA haplotype distribution in the present-day Caribbean cattle with T3 and T1 haplotypes is compatible with a Spanish and possibly also African origin [179,180].

Cattle entered Mexico in 1521. In 1540 the first herd of 500 Spanish cattle crossed the Rio Grande as “meat on the hoof” for the “conquistadors” of present-day Texas [119] and became the ancestor of the Texas Longhorn. In 1524 Spanish cattle entered Santa Marta in the present-day Colombia and more imports to the coast of Central and South-America were to follow.

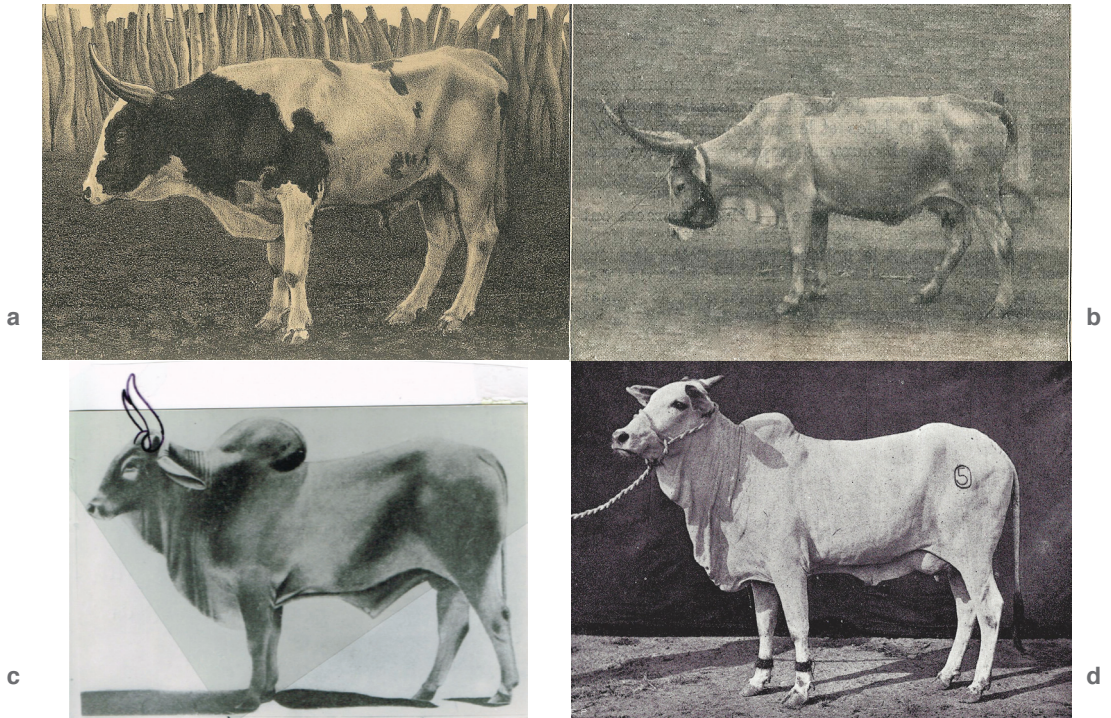


Figure 22. Criollo and zebu breeds. (a) Mexican Criollo bull [149]; (b) Brazilian Franquiereo cow, 1913 [183]; (c) the zebu bull Lontra, probably of the Kankrej breed, imported in 1889 and one of the most important founders of the Brazilian zebu breeding (picture reconstructed); (d) Ongole heifer sent to Brazil [143].

In North America, the present-day Canadienne cattle descend from animals imported from Normandy and Brittany between 1608 and 1660 [181]. English colonists appeared in 1607. The first traceable import of English cattle to Virginia dates back to 1609. In 1610 a few animals were imported to Jamestown from the West Indies. Dairy cattle arrived in North America with colonists from the Netherlands (1620s), Denmark (1633) and Sweden (1638) and mixed with the other cattle [181]. Importation of cattle stopped after the financial crisis of 1640 and was only resumed at the end of the 18th century. The influence of the original imports in America, commonly called Native Cattle [118], persisted until the 20th century [182].

Thus, at the end of the 18th century the cattle population in North America consisted of animals of North-European or Iberian descent variants (Figure 22a,b) and mixtures of these two [46,118]. The Texas Longhorn was at that time the only North American beef breed. The demand for food of the growing populations was met by import of specialized British dairy and beef breeds, starting with the arrival in 1783 of a few Shorthorns. In the 19th century herd books for cattle started to become established, initially only for dairy cattle. The first black-pied Dutch Friesian cattle were imported in 1852. It turned out to be the most productive dairy cattle and soon became popular under the name Holstein.

Since 1830, beef cattle from the southern states were transported to the northern cities. After the American Civil War (1861-1865), the prairies in Texas harbored an expanding population of about five million crossbreeds of British beef cattle and Texas Longhorn, living under semi-feral or feral conditions. Starting in 1866, large herds were rounded up and driven north as meat-on-the-hoof. The now romanticized era of the cowboys ended after the disastrous winter of 1886-1887, when 90% of the prairie cattle perished. British Hereford and Angus cattle then became the predominant beef cattle. These were kept under more intensive management with breeding recorded in herd books as already common for dairy breeds [181,184].

A subsequent development in both North and South America was the import of Indian zebus. The first of these came to Brazil in 1813 from Malabar, India's southwest coast. In 1835 or 1849 the first zebus were imported into North America [185,186]. After a few more sporadic imports into Bahia, larger numbers of various Indian breeds were imported in the 1870s (Figure 22c,d; Table S2). Most imported animals were from the Kankrej (Guzerá in Brazil), Ongole (Nelore in Brazil) and later also the Gir breeds. These were bred pure, crossed with other zebus in order to develop the synthetic Indubrasil zebu breed or used to upgrade Criollo taurine cattle. Thus, most Criollo became admixed with zebu as shown by microsatellite [187] and Y-chromosomal genotyping [180].

In the 1880s several Texan breeders imported zebus from Brazil and Mexico. Between 1882 and 1906 zebus were imported directly from India to Texas (Table S3.2). In the Gulf coast states, from a mixture of these zebus the Brahman and several taurindicine beef breeds were developed, which in the 20th century became popular in tropical countries around the world. In tropical and sub-tropical America zebu and the new taurindicine breeds have largely replaced Criollo cattle.



Figure 23. Hereford cow with black baldy calf on the plains, Nebraska, 2007 (photograph Marleen Felius).

From the beginning New World breeders have created synthetic taurine, taurindicine and zebu breeds (Table S3.3). In addition, gaining in popularity is crossbreeding, which exploits the first-generation heterosis [188,189]. The most popular crossbreds result from a Holstein × Jersey cross (Kiwi in New Zealand) or from Hereford × Angus crosses (black baldy in North America, Figure 23). A minor development is the breeding of several types of miniature cattle for small-scale farming. Thus, the phenotypic repertoire was expanded by recombining the cattle genetic resources and new breeding objectives.

In Canada and the USA, the Angus has surpassed the Hereford as the preferred beef breed. The Beef Shorthorn lost much terrain in the USA but is still important in Argentina and Australia. Since 1967 the North-American beef cattle industry was transformed by the so called exotic cattle boom, starting in Canada: large scale imports of continental-European beef breeds, especially of Limousin, Gelbvieh, Charolais and Simmental. In comparison with the British beef breeds these cattle offer leaner meat and a faster growth rate [181,190]. However, Angus and Hereford still have the highest registration numbers. Branding campaigns like Certified Angus Beef emphasized Angus breeding and black-hided cattle again became popular, even for the imported European breeds. Hence, over the last 25 years it is common to find in the USA black Limousin, Simmental, Gelbvieh, Salers or Chianina cattle.

In Australia, similar developments took place [191]. In the 19th century mainly British breeds were imported; zebus arrived from India at the end of the 18th century and after 1843 in larger numbers; and Dutch-Friesian were introduced from 1885, followed after 1890 by the Holstein. Many Shorthorns, Herefords, Angus and taurindicine cattle are kept under extensive management or live in feral populations. In 1896 the cattle tick became endemic and subsequently tick-borne diseases seriously threatened the productivity of beef cattle in Queensland, still of British descent. The gradual incrossing of Indian and American zebus, which are resistant against tick-borne diseases, continued until after WWII and restored cattle husbandry in the tropical parts of Australia. New Zealand imported only taurine cattle, mainly dairy breeds of English and Dutch origin [192]. In this country, 36% of the dairy cattle are now crossbreds of Jersey and Holstein.

16. Cattle without Borders

Since the 19th century the breeds that were developed in Europe, Asia and Africa were not only exported to the New World, but also to many other countries [7,9,193]. Table S3.2 shows that a fair part of the diversity of European cattle dispersed to other continents, although Iberian and Nordic breeds are underrepresented.

During World War I the development of breeds temporarily stopped in most European countries and a few breeds in the combat zone did not survive at all. After the war, agriculture in Europe, Australia and America became more and more focused on production. Accustomed to continuous technical progress, government programs stimulated the development of the most productive breeds, established national herd books, regulated the keeping of breeding bulls and stimulated animal health care. Local breeds, if considered non-productive, were either marginalized or upgraded with

neighboring or even exotic stock. Genetic development of cattle breeds became thoroughly influenced by technological progress. The tractor became popular since the First World War and gradually replaced cattle and horses as source of draught power in agriculture. Consequently, during the 1950s the triple-purpose cattle of central Europe were converted to dairy-beef types and the Mediterranean work-beef breeds changed into single-purpose beef types. The introduction of milking machines in the 1960s intensified the development of specialized single-purpose dairy breeds, which were also selected for an udder and teat morphology fitting the machinery.

Application of modern breeding techniques [194] began in the 1930s with artificial insemination (AI), which soon became widespread. Since the 1970s AI is complemented by multiple ovulation and embryo transfer (MOET). Both AI and MOET allow desirable genetic material to be moved over the globe. In that way several breeds of European origin, such as the Dutch-Friesian, Swiss Brown, Hereford and Aberdeen-Angus were bred in America into production types that differ from the original stock (allopatric development [8]). When subsequently American sires were repatriated, mostly in the form of semen, the European ancestor populations became Americanized (Table S3.2).

Since the 1960s, the breeding of cattle has been supported by intensive research. A comprehensive study compares the performance of nearly 40 American, British, European, zebu and Criollo beef breeds [195,196]. Worldwide progress in quantitative and molecular genetics intensifies the selective breeding with genomic selection, which becomes more and more realistic for several traits [197,198].

A further increase of productivity was accomplished by an increase in scale of both dairy and beef production. Modern dairy farming requires intensive management with an automated feeding system, veterinary care, close monitoring, year-round stabling and even climate control. Holstein-Friesians are by far the most popular dairy breed. Beef cattle are kept either under semi-intensive management, as the American calf-cow operations combined with grain feeding in large-scale feedlots, or under extensive management with herds grazing freely on natural pastures.



Figure 24. (a) Sahiwal cow, Pakistan, 1990 In 2014, a Sahiwal cow in Pakistan was reported to give 39 L per day [201]. (b) Sukuma cow, Tanzania, 2005. (photographs by Marleen Felius).



Figure 25. Exotic crossbreeds and Friesian cow in India, 2005 (photographs by Anno Fokkinga).

These developments have an obvious disadvantage. The focus on the most productive breeds is at the expense of the less productive local landraces. Many of these were either replaced or crossbred to the point that they have effectively disappeared (Table S3.4). However, local breeds have often developed adaptation to local, sometimes extreme conditions and are able to thrive under extensive management (Figure 24). Although the diversity of the current cosmopolitan cattle is still large enough to belie the claim that cattle become an endangered species [199], loss of local breeds does erode genetic resources that are difficult to replace [200].

Although in America and Australia crossing of indicine and European taurine cattle has led to successful breeds (Table S3.3), this is generally much less successful in developing countries where cattle are kept under traditional extensive management. Incrossing of cosmopolitan productive cattle, vigorously promoted by the Western breeding industry and supported by national governments, is as often as not counterproductive as the exotic breeds and their crossbreeds do not thrive in the harsh environment (Figure 25). Crossbreeds are generally considered a failure in India as well as Africa [202].

17. New Life for Local Breeds

Following a general skepticism since the 1960s regarding the side effects of technological progress, scientists, breeders and government agencies in Europe became aware of the disappearance of old local breeds and the ensuing loss of genetic variety. Local rustic breeds are now valued as more frugal, healthy and hardy than the industrial cattle. Their adaptation and suitability for extensive management, natural grazing and vegetation management may even be economically advantageous by allowing production in conditions where modern breeds would perish (Figure 25). Furthermore, these breeds belong to our cultural heritage and are of local cultural importance, even if most breeds are only one or two centuries old [9]. This is a major stimulant for conservation, even if breeders and owners of animals are not always realistic in their perception of the uniqueness of a breed and of its history.

The growing realization that genetic diversity may get lost led to several initiatives. The first association that raised public awareness to the conservation of farm animal genetic resources was the Rare Breeds Survival Trust, established in 1973 in the United Kingdom, the cradle of selective breeding. Similar associations were established elsewhere in Western Europe and in the USA, such as the American Livestock Breeds Conservancy (ALBC). These collaborate in international organizations as Rare Breeds International (RBI) and Safeguard for Agricultural Varieties in Europe (SAVE). Since the 1980s the European Association for Animal Production (EAAP) and the Food and Agriculture Organization (FAO) of the United Nations have compiled together the “Global Data Bank of Domestic Livestock” [203]. An international management policy has been formulated in the Global Plan of Action for Animal Genetic resources [204].

Although many developing countries still put their trust in technological progress, African and Indian scholars now advocate avoiding of or at least being careful with the introduction of highly productive breeds into their local, well-adapted breeds: *“What we should do in Africa is to ignore the use of exotic breed for crossbreeding because the resulting hybrids cannot be as adapted to the local environment as the zebu and will therefore need a lot of costly input for survival”* [202].

The following examples illustrate that local breeds are now acknowledged in breed surveys:

- Whereas the French breed catalogue of 1963 [205] listed only 27 French breeds and four imported ones the 2010 version [206] mentions 48 French breeds, 10 imported, as well as five extinct breeds.
- In the breed catalogues compiled by the Spanish Ministry of Agriculture the number of indigenous cattle breeds described has increased from 25 in 1981 [207] to 40 in 2009 [208].
- In the 1960s the Greek Shorthorn was described as a single landrace population [209], but by 2010 eight distinct local varieties were recognized [210]. In addition to the 33 recognized indigenous breeds of Ethiopia, several more have been identified and reported in recent years [211-216].
- For Fipa cattle, a zenga type of southwest Tanzania, two varieties were described in 2011 [217].
- Recently the formal national recognition of several Indian desi (local) breeds has increased the number of zebu breeds in India to more than 30.
- For the all but vanished Florida Cracker and Pineywoods cattle of the southern United States, 5 and 15 distinct local lines and herds, respectively, are now recognized [218].
- In Ecuador four local types of Sierra Criollos, kept at different altitude, have been differentiated [219].

On the other hand, recognition of various varieties with different names does not imply as many independent contributions to the genetic resources [9]. Several strategies for conservation of endangered breeds or varieties are followed:

- Rescue and maintenance of the remaining populations (on the hoof). An extreme example is the rescue of the feral cattle on Enderby Island [220]. Using oocytes and clones from the single surviving cow and semen collected from one of the bulls shot in 1991, resulted in six calves being born in 2006.

- Sustainable conservation, for instance by advertising (branding) presumed unique qualities of a local breed (e.g., grass finished beef or slow food): “If you want to save a breed, they have to have a job.” [221].
- Cryoconservation of semen samples in the USA and several other countries [222, 223].
- Selection of animals from related breeds that resemble the animals from the endangered breed. Examples:
 - In 1986 the Austrian Tux-Zillertaler was reconstituted by crossings the approximately 30 remaining females with Swiss Hérens sires.
 - Rebreeding of the Ansbach-Triesdorfer, which had vanished in 1940, began in 1987 by selection of German Fleckvieh cows from the Ansbach region with the characteristic speckled color patterns on head and feet.
 - The French Bordelaise was considered extinct in 1960, but has been reconstituted since 1987 by using crossbred animals descending from the original breed.

Breed conservation is supported by molecular-genetic investigation of farm animal genetic resources, both at the national and the global level. Molecular diversity studies, which often allow reconstruction of the history of livestock [224], have now been recognized in animal genetics as a new field of research, complementing the analysis of genotype-phenotype relations.

DNA analysis with panels of genetic markers invariably finds that most breeds contain a large portion of the total diversity of the species, typically 80% or more. Most alleles have broad breed distributions and breeds differ mainly in allele frequencies. Paradoxically, breeds that clearly contribute to the phenotypic diversity by a unique phenotype tend to be inbred and thus carry little diversity in their DNA. Breed-specific molecular traits are rare and several breeds also share functional mutations [225]. Genomic studies now offer new approaches to characterize into more detail the differences between breeds as well as the diversity within breeds [226]. This information may very well be useful for an effective protection of genetic resources, anticipating future market demands, new diseases and climate changes.

18. On the History and Future of Diversity

Our chronicle of the history of cattle integrates archaeological, pictorial, documentary and molecular-genetic information. Compared to previous accounts [5,79,80], our text elaborates in more detail on the period between the domestication of cattle and the development of the first breeds in the 18th century.

The relevance of this study may be illustrated by several publications [46,116,227,228] in which historic scenarios are proposed that are not compatible with plausible historic evidence mentioned in this chapter. For example, taurine cattle has been proposed to have arrived in East Asia via the Silk Road (46). However, this trade route was in operation from 130 BC to AD.1453, while archaeological findings date the arrival in China at about 5000 BP [71]. The history of Podolian cattle in Italy provides a second example. These have been postulated to have a local origin [116] or, for the Tuscan breeds, to have accompanied a supposed immigration of the Etruscan people

from Anatolia around 3000 BP. This discounts the evidence for importation of large Epirote cattle before and during the Roman Era and the documentation of import of Hungarian cattle via Venice from the 14th to the 18th century [115]. Finally, an arrival of South-French cattle via a maritime route is not compatible with their genetic affinity with Alpine cattle [8].

On the basis of our survey of the complex history of cattle through time on different continents, we claim that during three overlapping phases different processes acted on the development of the cattle genetic resources:

- (I) Domestication and subsequent interaction with wild populations;
- (II) Migrations followed by natural adaptation to agricultural habitats in diverse environments and during the subsequent periods of human history;
- (III) A relatively recent systematic breed-oriented selection.

This may well be generalized to other livestock species, but the particular events and processes acting on the animals' genetic diversity during the three phases are species-specific.

(I) Domestication of cattle and subsequent interaction with wild populations. As revealed by archaeological investigations complemented by DNA analysis, especially the sequencing of mtDNA, this involved the following:

- A partial sampling of the diversity of the ancestor species, followed by introgression of wild animals during the dispersal of the domesticates [229]. The taurine domestication was estimated to involve only 80 females [17], but later introgression of aurochs males on different continents probably introduced additional diversity. For African taurine cattle this is now accepted [33].
- Zebu and taurine cattle are the domestic forms of two clearly divergent but cross-fertile aurochs subspecies from Southwest Asia [79] and the Indus Valley [34]. These subspecies were adapted to different environments and together with their many intermediate crossbreeds ensured an adaptation of the domestic animals to climates ranging from temperate to tropical.
- In addition to taurine and zebu cattle, Asia harbors also domestic cattle descending from other bovine species with many combinations of mixed-species origin.

(II) Migrations followed by ecological adaptation to agricultural habitats in diverse environments and during subsequent periods of human history. This governed the distribution of the taurine and zebu genotypes and brought about several changes in phenotype [5]. Especially taurine cattle adapted to a wide range of climates, even including Siberian conditions. The acquisition of adaptive traits can now be investigated by studying the breed distribution of their causative mutations [230-231]. A survey of the events preceding the development of specialized breeds:

- Europe remained completely taurine with mere traces of putative zebu introgression, while Asia, Africa, America and Australia harbor both taurine, zebu and taurindicine breeds in different climatic zones.
- In Africa, the diversity pattern has been determined by consecutive immigrations of short-horned taurine, long-horned taurines and zebus, by introgression of African aurochs, by disease resistance (trypanotolerance, resistance to rinderpest),

by the wide range of management systems (sedentary, transhumance, nomadic pastoralism).

- The modulation of horn development illustrates an early and flexible adaptation to local requirements or preferences, short-horned or hornless animals being convenient for stabling.
- Coat color and color patterns are post-domestication features [232] that make animals visibly distinct, easily invoke perceptions of the animals' value and are obvious targets of selection. Several of these existed as early as Antiquity [88].
- The decrease in size is a domestic adaptation, but may also reflect the difficulties involved in feeding cattle during the winter period. During Antiquity the large Epirote cattle and its Roman descendants contrasted clearly with the more common small cattle, but disappeared after the fall of the Roman Empire [54]. European cattle started to regain their size from the 15th century onwards.
- In the Roman era, production purposes were multiple as evidenced by the preponderance of draught cattle in Italy and of dairy cattle in central and northern Europe [90].
- Because the migration of the Germanic tribes were the last major movements of European people, it is plausible that from the Middle Ages differentiation of European cattle was mainly due to isolation by distance. This process was only partially undercut by trading of cattle causing gene flow between neighboring regions and is still reflected by the genetic clustering of the present breeds [8].
- In the tropical zones, diversity patterns were decided largely by the tropical adaptation and resistance to rinderpest. This has led to widespread incrossing of zebu in African and American taurine populations.
- Cattle were introduced in America only after 1492 with the import of Iberian and Northwest-European cattle, followed in the 19th century by English, Dutch and zebu breeds and in the 20th century by European continental beef breeds.

(III) Systematic breed-oriented selection. Although this started only 250 years ago, it has been most consequential and may be considered as the most dynamic period in the evolution of cattle:

- After the Middle Ages, cultural and technical progress and the growing demand for food rationalized the European cattle husbandry. Starting in the 18th century this led to an organized management of regional breeds: genetically isolated groups of phenotypically homogeneous animals. This took place all over Europe, where cattle exhibitions soon catalyzed the merging of early breeds from neighboring regions. This improved the productivity of European breeds, changed appreciably their appearance and emphasized the differences between breeds.
- Since the 19th century several highly productive breeds spread to other countries and continents (Table S3.2), where separate herd books were kept. Thus, several groups of closely related breeds were formed differing mainly in nationality.
- A less productive and often abortive development was the introduction of highly productive European breeds in tropical countries where the intensive management required for these cattle cannot be ensured.
- In the New World, a creative attitude to breeding led to a number of taurine or taurindicine synthetic breeds, the result of crossing cattle from different origins. Several of these are highly successful (Table S3.3).

- A focus on productive breeds diminished the population sizes of local breeds, several of which disappeared by crossing with sires from productive breeds. This is being counteracted by successful conservation efforts.

We conclude that the development of the cattle genetic resources has been a multifaceted and continuously dynamic process that kept pace with human history on the local and global level. It has resulted in a worldwide population of cattle with a considerable phenotypic and molecular diversity. Concerns about genetic erosion tend to focus on the loss of diversity generated by the breed development during the third phase [9]. In our view, this neglects the genetic diversity that was created in the two earlier phases that we proposed above. It is important to realize that this diversity has become scattered over the many breeds created subsequently in the third phase. This happened not in such a way that each breed became an equally rich repository of a unique portion of the diversity built up in the earlier phases, but much more haphazardly, primitive breeds ending up with relative much adaptive variation and the highly developed breeds now depending on a controlled environment and intensive management. The most consequential threat, in terms of loss of unique hereditary material, is the loss of cattle breeds that have adapted to local conditions and extensive management. Future management of the diversity will benefit from a further genome-wide characterization of DNA variation that can be linked to valuable phenotypes.

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Chapter 3 Appendix

Table S3.1. Landraces, varieties, pre-breeds and breeds absorbed into current breeds (Felius, 1995; Porter 2002). Breeds are ordered according to the classification of Felius (1995). Populations listed in the first four columns have been absorbed in the current breed (in red). Names on the same line indicate continuation of a population under a different name. Landraces, former (pre)breeds and their varieties that are listed below the current breed have been absorbed after establishment of the current breed. Years underlined indicate the establishment of a herd book with for a few breeds also the ending; HB, herd book established but year unknown; BS, breed society with year of establishment if known; BP, protective breed program with year of establishment if known. populations in the sixth column have been absorbed after the current breed was established. “x breed X”: incrossing of breed X; “breed Y x breed X”: indicates upgrading or incrossing of breed X by breed Y; “+ breed Y”: influence of breed Y; “»” establishment of new breed.

landrace / variety	pre-breed / former breed / variety	current breed	absorbed variety	remarks
SUBGROUP 1A				
Westland Polled Lyngdal	South and Westland (1947)	Westland Red Polled		1968 into NRF, 1980s restarted
Blacksided Trondheim Northland		Blacksided Trondheim and Northland (1943)	Roros	close to Fjällras crossbred cattle
		Swedish Mountain (Fjällras) (1892)	Herjeadals Rorbottenland	
Estonian land		Estonian Native (1914)		West Finn and Jersey influence now Kholmogory variety
		Petsjora	Komi	
SUBGROUP 1B				
		Telemark (1926)	Valdres Hallingdal	Ayrshire and NRF influence
Gudbrandsdal Osterdal		Doela (1909)		1963 into NRF, 1970s restarted
Westland Grey Möre		Western Fjord (1947)		into NRF 1968, 1980s restarted
Coastal land cattle (dwarfed) Tronder	Red Trondheim (1951) Malselv			since 1890 x Ayrshire»
	»Red Trondheim and Malselv (1960)			Dutch Friesian, Ayrshire x Tronder 1860-1900 x Ayrshire, 1900s + Swedish Red-and-White, Dutch Friesian, Shorthorn, into pre-breeds

landrace variety	pre-breed / former breed variety	current breed	absorbed variety	remarks
	Horned Lowland (1923) Hedmark »Norwegian Red and White (1939)	Norwegian Red (NRF) (1961)		Dual purpose dairy type pre-breeds amalgamated » more breeds joined, open synthetic population after 1850s x Shorthorn, Ayrshire, Dutch Friesian since 1847 x Jersey, Shorthorn, Ayrshire very mixed dairy cattle then absorption of: + Dutch, German Red Pied + German Red Pied + Shorthorn + Shorthorn + Shorthorn 1927 + Swedish Ayrshire
Smaland				
Gotland, Oland				
Herrgard				
Scanian	Red Pied Swedish (1892)			
Sabyland Waldholm Frovidal Amasa Jonströp		Swedish Red-and-White (1928)		
SUBGROUP 1C				
Brae-Glen Aberdeenshire				small hill cattle + Teeswater, Longhorn
Forfarshire	Buchan Humlie Angus Doddie	Aberdeen-Angus (1862)		similar to Highland polled dairy-beef type large, polled type 1835 recognized; 1909 name official
	Suffolk Dun Norfolk Horned			grey-brown dairy type red, dairy-beef type, Devon influence
		Red Poll (1873)		
SUBGROUP 1D				
White cattle				
	Cadzow: Park herd			South Scotland;, thought to be of ancient origin, dispersed 1970s
	Dynevor: Park herd			South Wales; thought to be of ancient origin; still kept separately
	Chartley Park herd			Central England, dispersed 1905
	Woburn: Park herd			Chartley x Longhorn 1905-1970s
	Faygate: Park herd			Sussex, 1908-1950s also x Dynevor Park herd
		White Park (1918, renewed 1974)		
Longhorned Black cattle				
	North Wales Black Anglesey			work type most important variety
	Pembroke (South Wales: Black) Castlemartin Dewsland	Welsh Black (1874)		dairy type

landrace
— variety

pre-breed /
former breed
— variety

current breed

absorbed variety

remarks

SUBGROUP 2A

Ballum

Red Danish Dairy 1970 (1885)
Old Red Angeln (1885)

critical
closely related to Red
Danish; both : strong
influence on East
European
Red breeds
+ Shorthorn
x Angeln, Danish Red
»

Red North Schleswig
Estonian land cattle

Estonian Red (1885)

Silesian red landrace

since 1830s x
Bernese,
Schwyz, Angeln,
since 1850s x Dutch
and North German
lowland, in 1870
Shorthorn,
Wiltsermarsh, Angeln,
since 1880s x
Simmental, Red
East-Friesian, Danish
Red, Red Pied
Swedish »

Silesian Red (1893)
Rawicka
Wilna
Lowland (Dolinowa)

Polish Red (1893)

polled, fawn variety
red to fawn

Red Colonist

absorbed Red
Highland varieties
imported German
lowland
Red and red pied x
Steppe;
since 1850s x Brown
Mountain, Zillertal,
Red Tronder, East
Friesian,
Polish Red;
1917 amalgated
1917 amalgated
1917 amalgated
1945 + Estonian
Red

Odessa
Taurien
Crimean
Kuban Red

Red German

Dobrogea Red

Romanian Red

1814 Red Highland x
Romanian Grey
1927-40 x Angeln
1950s x Danish Red
since 1814 x German
Red Highland »
1930s + Angeln,
renamed »
1940s + Estonian
Red »
critical

Bessarabian Grey

Bessarabian Red

Moldavian Red Steppe

Moldovian-Estonian Red

landrace variety	pre-breed / former breed variety	current breed	absorbed variety	remarks
	Red Sadovo (BS 1914)			since 1885 Angeln, Simmental, Dutch Friesian composite » + Angeln since 1945 Danish Red, Red Steppe, Latvian Brown, Simmental, Kulska, Swiss Brown, Sofia
	Bulgarian Red Sadovo	Bulgarian Red		Brown, Iskar composite » 1967 renamed » critical
Majdaner				× Angeln, Danish Red, German Red, Polish Red, Estonian Red, Latvian Brown
Goralen Mountain	Goryn			× Polish Red, Bernese/Simmental »
		Belarus Red (1967)		critical
Perm (North Russian polled)	Tscherdian			since late 19th century × Danish Red, Angeln, 1930s × Red Steppe, Estonian Red, Latvian Brown » rare
		Suksun (1941)		only type surviving WW I
Casselaise	Artésienne Namponnaise Saint Poloise			
Berguénarde	Picarde Guisarde			Normande – Flamande intermediate
Bailleuloise	Bournaisienne Boulonnaise			+ Durham, Ayrshire
		Flamande originelle (1886)		
Yeurne-Ambacht Cassel		West Flemish Red (1920)		only semen left + Durham dairy type as French Casselaise critical
SUBGROUP 2B				
Latvian Dairy		Latvian Blue (BS 2005)		+ Lithuanian Ash Grey, Latvian Brown, Tyrol Grey; critical
Lithuanian Dairy		Lithuanian Ash Grey		critical
(Northwest Dutch) Lowland Groningen		Groningen Whiteheaded (1874)		
(Northwest Dutch) Lowland Friesian black pied and red pied (1897)		Black Pied Dutch-Friesian (1874)		since 1966 black pied sires from other Dutch provinces accepted crossed into all Black Pied breeds listed below
			Friesian type	

landrace variety	pre-breed / former breed variety	current breed	absorbed variety	remarks
	(Northwest German) Lowland East Friesian:		North-Holland type South Holland Island Groningen black pied type	
		Pied East Friesian (1885)		black-, red- or blue-pied
		Unicoloured Red-brown East Friesian (1885-1904)		+ Shorthorn
	Jeverländ (1878) Wesermarsh (1880) Oldenburg-Wesermarsh (1880) Black Pied Holsteiner (1879)	German Black Pied Lowland Dairy (1970)		amalgamated 1945
	East German Black Pied			+ Fleckvieh, Red Highland x Jersey, British Friesian, Holstein (almost out-crossed by Holstein) until 1966 2 varieties:
	Belgian Black Pied			
	Polders Black Pied Hervé Black Pied	Belgian Black Pied-Holstein (HB)		
	Fribourg (1878)			Since 1960 x German Black Pied; later x Holstein »
	Campine	Swiss Holstein (HB)		+ Durham x MRY » remains rebred »
	Red Pied Campine	Red Pied Campine (2012)		
	Red pied Campine			x MRY »
	Eastern Red Pied-Ardennes Red Pied Eastern Belgian Red Pied Belgian (1919-2012)	Belgian Holstein (HB)		x Holstein, Red Holstein, absorption since 1980s
	Polish White-back (not completely absorbed) Zulawka: (Polish Marsh)	Polish Black-and-White Lowland (1878)		x Dutch Friesian, German Black Pied Lowland since heavy WWII losses replenished with Swedish, German, Dutch Black Pied + (limited) Holstein Jersey x Hungarian Pied (4F)
	Dairy Hungarian Pied			x Swiss Brown; since 1950 x Danish Jersey; + Hungarian Pied (4F) »
	Hungarian Brown			Jersey, Holstein x Hungarian Pied (4F)
	Dairy Hungarian Brown Hungarofries	Hungarian Holstein-Friesian (HB)		
	Local			x East Prussian Black Pied »
	Menno-Fries	Belarus Black Pied (HB)		x European Black Pies »

landrace variety	pre-breed / former breed variety	current breed	absorbed variety	remarks
Podolian steppe	Podolian Black Pied			× Oldenburg Black Pied »
		Ukrainian Black Pied (HB)		× European Black Pieds
Great Russian land cattle				recent + Holstein × Yaroslavl, Kholmogory, Schwyz, Bernese, since 1920s East Friesian »
Oka	Oka Black Pied	Central Russian Black Pied (1940)		also in Gorbatov Red (3C) since 1952 × East Friesian and/or Kholmogory-Simmental cross, Swiss Brown, Jersey »
				possibly partially or completely absorbed by Siberian Black Pied
Ukrainian Whitebacked Polesian Marsh	Whiteheaded Colonist (1925)	Ukrainian Whiteheaded		+ Groningen Whiteheaded 1945 renamed up to 1973+ Groningen Whiteheaded
		Kholmogory (1927)		+ Dutch/German Friesian largely absorbed: also in Yaroslavl and Russian Black Pied
Great Russian land cattle	Kargopolian Ilmen Dwina Schenkursk			
North Russian Polled	Murmansk Olonets Wijtegras Vychedgo-Vym Waldais Lenfa Syrjänen Ssuchona Rokschenka			
Great Russian land cattle		Yaroslavl (1924)		1870-83 × several exotics since 1917 purebred
SUBGROUP 2C				
Dender		East Flemish White-and-Red (1897)		+ Durham » after 1914 × MRY, Belgian Red Pied; rare combined with poor developed black pied
Famenne, Condroz Ardennes	Limon Blue	Belgian White-Blue dual-purpose		1850-90 × Durham, 1890-95 × Friesian, up to 1945 dairy type » since 1975 separate type

landrace variety	pre-breed / former breed variety	current breed	absorbed variety	remarks
Ciney (=Hesbaye+Condroz)	Central and Upper Belgian (1919)			1850-95 x Durham, Friesian 1890 + Charolais » 1920-50 heavy dual-purpose 1950s remains double-musled beef
Ardennes		Belgian White-Blue (1973)		
Ardennaise	Bleue du Limon			same as Limon Blue 1919-1922 rebuilt with Belgian White Blue »
		Bleue du Nord (rameau mixte) (1923-1953)		1982 again recognized 1991 separate from beef type heavy beef pled beef/dairy dairy/beef dairy
Eiderstedt Ditmarsh Wilstermarsh Krempmarsh Breitenburg Tondern Bramstedt	Red Pied Schleswig-Holstein (1875) Red Pied South Oldenburg (1880)			related to Angeln heather land type + Shorthorn
Münster runts	Red Pied Westphalian (1892)			also into early MRY
Cleve	Red Pied Lower Rhineland (1878)	German Red Pied Dual Purpose		x Shorthorn; x Dutch Red Pied 1892 collaborating pre-breeds: x MRY
Silesian Red	Red Pied East Friesian (1878)			x Allgäu, Bernese, Fribourg, Mürtztal, Schwyz, Zillertal, East Friesian red pied » x German Red pied lowland, MRY since 1945 » x Holstein since 1970
	Silesian Whiteback / Kodzka (1910)	Polish Red-and-White Lowland		
SUBGROUP 2D				
Holderness (Yorkshire)				since 17th century local x Dutch, evolved into: 18th century early 18th century local x Dutch, evolved into:
New Yorkshire Teeswater				
Durham (improved Teeswater) Shorthorn (1822)		Beef Shorthorn Dairy Shorthorn (1959)		Coates HB (first cattle HB) + Galloway separate from Beef Shorthorn; since 1969 x Red Holstein (50-75%), + Danish Red, MRY; any other dairy breed permitted
		Blended Red and White		

landrace variety	pre-breed / former breed variety	current breed	absorbed variety	remarks
Simbirsk		Bestuzhev (1928)		Great Russian Land cattle breed × Friesian, Simmental, Shorthorn » 1850 recorded; early 1900 × Wilstermarsch, Oldenburg
SUBGROUP 2E				
Craven long-horns				West Riding, Yorkshire, best developed type
Lancashire long-horns				Larger type, also in Westmoreland
	Warwickshire (Canley breed)			developed by Webster in the first half 18th century
	Dishley breed (New Leicester)			developed by Bakewell in the second half 18th century
Staffordshire long-horns		Longhorn (1878)		course dairy type, absorbed by Longhorn
SUBGROUP 2F				
	Alderney	Guemsey (1878)		incorporated during WWII
Léonnaise		Froment du Léon (1907)		1939 largely absorbed by Armoricaïne; 1964 reconstructed with Guemsey
Augeronne				around 1730 Dutch origin
Cotentine				× Augeronne, + Durham, Jersey; heavy and light types
	Bessine Valognaise			Durham-Normande cross
Cauchoise				× Durham
Brayonne		Normande (1883)		× Dutch; Cauchoise type
			Solognote Merlerault Mayennnaise Beauceronne	
Brune de Guingamp				probably ancestor of Canadienne
Pie Rouge de Carhaix				+ Parthenaise, Nantaise
Brettonne Rouge et Pie Rouge (1910)				
Léonnaise				
	Durham-Brettonne	Armoricaïne		since 1840 developed 1962-70 together with Maine-Anjou
	Rouge de l'Ouest			1962-70 Maine-Anjou- Armoricaïne amalgate

landrace variety
 pre-breed / former breed variety
 current breed
 absorbed variety
 remarks

Pie Noire Morbihannaise Mancelle		Bretonne Pie Noir (1885)		+ MRV, German Red Pied Lowland
	Durham-Mancelle			Bernese /Fribourg/ Durham x Augeronne, Bretonne, Parthenaise 1839-1860 Durham; x Mancelle
	Rouge de l'Ouest	Rouge des prés (1924) = Maine-Anjou		former and international name; 1962-70 Maine-Anjou-Armoricaine amalgate + MRV, German Red Pied Lowland (See above) + Maine-Anjou, Normande Percheronne non-registered, transitional to Normande
Mancelle		Saônoise (BS 1939; new BS 1997)		
SUBGROUP 3A Münster		Vosgienne (1918; 1955)		1947 no longer recognized 1955 new HB small type until 1970s
Bas-Rhin				
SUBGROUP 3B Odenwäld (1899) Waldeck (BS 1890)	Hesse Red			short headed type still recognized as breed line
Sauerland (1894)	Westphalian Red			still recognized as breed line
	Vogelsberg (BS 1885)			still recognized as breed line
	Tanus			
	Harz Red (BS 1878)			still recognized as breed line
	Branntager			
	Vogtland Red (BS 1991)			reconstructed breed line rebred with sires: 4 Yellow Franconian, some Czech Red, 1 Polish Red, 1 Tux-Zillertal, 1 Pinzgauer, 1 Salers, and 1 Braunvieh-Angler-Gelbvieh crossbred; numbers increasing small, triple-purpose
		German Red Highland (BS 1911)		
Bohemian Red				
	Cheb (Egerland)			close to German Vogtland whitebacked, mountain type
Moravian-Carpatian Red				
Lisna Red		Czech Red		critical

landrace variety	pre-breed / former breed variety	current breed	absorbed variety	remarks
SUBGROUP 3C				
Tyrolese	Brixental Durtal Landl Tux Zillertal	Tux-Zillertal (1986)		popular first half 19th cent. disappeared around 1900 disappeared around 1900 disappeared around 1900 dark brown-black red-brown since 1980 rebred with Hérens
Oka		Gorbatov Red (1921)		1800-1870 × Zillertal Gorbatov Zillertal × Oka Vladimir Zillertal × Oka Gorbatov-Vladimir amalgamate since 1990 + Angeln, Danish Red × Zillertal, Devon, Bernese »
Great Russian land cattle	Pashkov	Tambov Red (BP 1989)		until 1924 since 1980 + Danish Red
Chuwash-Mari		Yurino (1937)		1812-80 × Zillertal, Gorbatov 1860-1908 + Swiss Brown, Simmental
Jochberg		Jochberger Hummel		yellow and grey pied, polled × Pinzgauer polled Pinzgauer type × Bernese »
Spotted Mountain (Bergscheck)	Rauris Kitzbühl Pongau Tyrolese Pinzgauer	Pinzgauer (HB)		from Rauris valley from High Pinzgau near Sastein from Salzburg, main type since 1870 varieties unified since 1820 × Pinzgauer and Pustertal »
Mölltal: landcattle	Mölltal (1925) Kampeten (Bergscheck variety)			from Carinthia into Trento × Mariahof and Pinzgauer »
Mölltal, Drautal: landcattle	Lungau Red Pied Norica	Italian Pinzgauer (HB)		in Carinthia 1820 × Tyrolese Pinzgauer » × Pinzgauer »
Upper and Lower Bavarian	Bishopric Volmau New Miesbach Berchtesgaden	German Pinzgauer (HB)		work/beef type dairy/work type partly absorbed by German Fleckvieh

landrace
— variety

pre-breed /
former breed
— variety

current breed

absorbed variety

remarks

Slovenian Busha
Goricka

Bohinj Cika
Tolmin Cika

Cika (1906)

1869 × Mölltal,
Pinzgauer

vulnerable

SUBGROUP 3D

Red Highland

since 1762 × Schwyz,
Since 1773 +
Friesian, Bernese;
1803-15 + Charolais
»

Glan

1890 fused with
Donnersberg»
1906-14 + Yellow
Franconian, 1953
into German
Gelbvieh, 1950s +
Angeln.

Glan-Donnersberg (1880);

1961 fused with
German Red; Glan
reconstructed
since 1985

Hesse Red

Lahn

× Schwyz, Bernese »

1960s × Glan, Glan-
Donnersberg,
Yellow Franconian,
Red Danish.
reconstructed with 1
Hesse Red x Yellow
Franconian

Swabian-Hall
Lower Swabian

Limpurger (1987)

all bred to Allgäu,
Bernese
BS 1835,
reconstructed
× Grey Mountain,
Limpurg, Glan,
Ansbach-Triesdorf,
Heilbronn (3E),
East-Friesian

Old Franconian Red

Hassberg
Schweinfurt
Itsgründ
Baunach

combined with
Itsgründ

Ochschen für
» Röhn-Spessart
» Franconian

× Neckar-Heilbronn
(3E)

Altmüh valley

Scheinfeld

× Schwyz,
Allgäu (4D) »

Aischgrund
Mainland
Schwälm

Ellingen-Weissenburg

+ Friesian
3 varieties combined
»

Obermain valley

Middle German Yellow Highland
(1872)

+ Simmental, Devon,
Shorthorn; Charolais;
1953 + Glan
Donnersberg,
Limpurg;
1960 + Danish Red,
1980s + Red

1953 renamed

German Yellow

landrace variety	pre-breed / former breed variety	current breed	absorbed variety	remarks
		renamed	Yellow Franconian	Flemish; Glan-Donnersberg, Limpurg again separate
Mürztal	Murboden	Murboden-Mürztal (BS 1898)		local shorthorn x Grey Steppe Mürztal x Mariahof absorbed Mürztal, 1960s amalgamated with Austrian Yellow, remnant renamed: conservation herd 1986
			Murboden	
Red Highland (of Lower Austria)	Gföhl-Zwetteln			x Mariahof, Mürztal, Scheinfeld »
Red Highland (of Lower Austria)				x Gföhl-Zwetteln, Mürztal, Murboden, Montafon (4D), Allgäu (4D) »
	Raabs			
Viennese landcattle	Stockeraur	Waldviertel Blond (BP)		x Mariahof, Mürztal »
				1933 amalgamation of varieties; since 1980s remnant rebred
Helmet				
Light Helmet				
Brown Helmet				
Helmer Blazed				
South Styrian-Carinthian land cattle				
Carinthian Blazed				
	Mariahof-Lavanttal	Carinthian Blond (BP 1988)		1890 amalgamated » 1900 + Simmental 1950 with Waldviertel Blond into Austrian Blond, in 1951 renamed Austrian Yellow; remnant rebred
	Mariahof-Lavental			
SUBGROUP 3E				
Bernese	Berner Fleckvieh (1878)	Simmental-Saanen		best developed valley type
		Frütig-Adelboden		
		Jura		
		Illiez		
		Lötsch	Swiss Simmental	
Bernese (Alsace)		Montbéliarde (1890)		since 1872 named:
Comtoise				partly absorbed
Tourache				partly absorbed
Fémeline				partly absorbed
	Dauphinoise (BS 1912)			

landrace
variety

pre-breed /
former breed
variety

current breed

absorbed variety

remarks

landrace variety	pre-breed / former breed variety	current breed	absorbed variety	remarks
Jura		Dauphinoise (BS 1912)		x Simmental since 1886 » partly absorbed in Simmental Française
Comtoise				
Tourache				x Bernese, Simmental absorbed in Gesienne
Haut Bugey				most widespread variety
Fémeline				x Bernese, with Aubrac, possible ancestor of Villard-de-Lans and Mézenc
Bressane				
Bresse Dombes				
Gesienne				Simmental x Bressane
Micahaille				
Simmental d'Alsace (1906)				Simmental x Bressane
Bouquemon				
Tachetée de l'Est (1929)				amalgamation of Bressane, Fémeline, Simmental pure, 1940 Montbéliarde (until 1950), 1945 Gesienne, 1947 Simmental d'Alsace
		Pie Rouge de l'Est (1960)		
	1992 renamed	Simmental Française		
Friulana				red Podolian type from Venice
Carniella				
Friulana pezzata rossa (BS 1831)				1880-1900 x Simmental
		Pezzata rossa Italiana (1957)		
Red and Pied Highland				
Rhineland				18 th cent x Bernese
Neckar-Heilbronn (Heilbronn)				
Baden landrace				
Messkircher				+ Neckar-Heilbronn, Messkircher, Ansbach-Triesdorf x Simmental
Württemberg Spotted				absorbed by Württemberg Spotted
Alb				absorbed by Württemberg Spotted
Teck				absorbed by Württemberg Spotted
Bayreuth Spotted				Simmental x Vogtland
Rottal				
Bavarian land cattle				
Miesbach or Upper Bavarian Spotted				x Pinzgauer, Simmental » amalgamate of spotted landraces and derivatives until 1926 x Simmental
Höhenfleckvieh (1892)				
renamed		German Fleckvieh		

landrace
variety

pre-breed /
former breed
variety

current breed

absorbed variety

remarks

Swabian-Hall Brown blazed

Triesdorf

Ansbach-Triesdorf (1897)

Red and Yellow Moor, Tiger

in Württemberg
since 1740s x
Friesian;
since 1757 x Bernese
since 1757 x Bernese
Fribourg »
1800 almost extinct,
rebuilt since 1801 x
East Friesian,
Bernese/Simmental,
Mürztal, Allgäuer,
since 1851
Simmental,
Breitenburg »
in 1900 2 color types

1940 extinct,
reconstructed
since 1987

Pied Moutain (Bergscheck)

Inntal Spotted

Innviertel Spotted
Wels Spotted

Bernese spotted

Feldsberg
Immendorf

Fleckvieh (1870)

Danube Fleckvieh
East Styrian Fleckvieh

Innviertel Fleckvieh

Tyrolese Fleckvieh

Austrian Fleckvieh

x Pinzgauer,
Bernese/Simmental,
Austrian Blond
breeds »
x Bernese/
Simmental »

Bernese/ Simmental,
Austrian Blond
breeds
Bernese x
local spotted
Bernese x Stockeraur
Fribourg, Bernese/
Simmental x local

in Burgenland
in Upper Styria,
Carinthia
former Spotted,
see above
amalgated 1950+

Sudeten Red

Kravarsky

Moravian Red

Berno-Hana

Hrbinecky

Bohemian Wood

Bohemian-Berne
Czech Red Pied

Budweiser
Stitary
Sumava

Manhartsberg

Moravian Red Pied

1950 amalgate
x Bernese/
Simmental,
Zillertal, Pinzgauer,
Swiss Brown,
Groningen
Whiteheaded »

x Bernese »

Bernese,
Berno-Hana,
Kravarsky x
local red »

x Bernese »

1918 amalgamation
of the 4 pre-breeds

absorbed by Czech
Red Pied
established in 1918

landrace — variety	pre-breed / former breed — variety	current breed	absorbed variety	remarks
local red	Opotchno	Czech Fleckvieh		× Bernese and Schwyz » 1969 amalgamated Czech and Moravian Red Pied × Simmental »
Serbian Podolian	Podolian Simmental	Serbian Domestic Spotted		purebred and crossbred Simmental × Fribourg, Bernese/Simmental recognized until 1950s
Bonyhádi	Bonyhádi-Simmental Landrace Red Pied Landrace of Allföld Magyartarka	Hungarian Pied (Tarka, 1896)		Bonyhádi, Simmental × Steppe 1940s amalgamated with purebred Simmental »
SUBGROUP 3F				
Charolais Nivernaise	Nivernais-Charolais (1864) Charolais pure (1882)	Charolais (1919)		Auvergne beef type; 18th cent × Charolais, 1830s-1880 × Durham »
Morvanelle				prime work cattle × Dutch, Swiss; 1825-40 × Salers 1850-60 × Durham, later × Nivernais, Charolais
Bourbonnaise				Jurassic type, partially absorbed by Limousin
SUBGROUP 4A				
		Limousin (1886)	Poitevine Marchoise Berrichonne Brennouse Saintongeoise Angoumoise Meysac Meymac Treignac Vendonnaise	originally a Parthenaise variety originally a Parthenaise variety Marchoise-Parthenaise cross Marchoise-Parthenaise cross related to Limousin almost identical to Limousin Limousin variety Limousin × Maraichine and Marchoise non-descript variety non-descript variety
Auvergnate	Bessardé Forézienne Mont d'Or			19th century × Salers, Aubrac, Charolais, Bressane, Bernese, Fribourg, Normande, Breton line-back Salers type poor type, black pied

continued on the next page

landrace
— variety

pre-breed /
former breed
— variety

current breed

absorbed variety

remarks

SUBGROUP 4C

Bionda Tortonese
Cabellota
Ottoneze
Varzese

Montana rossa

amalgamated in 1994

SUBGROUP 4D

Bergamo

Grigia di Val d'Adige (Etschtaler)
Grigia di Val d'Ultimo
Wels Tyrol

Rendena-Adige
intermediate

Rendena Etschtal
intermediag

Meran
Vintschau
Passei
Grigia di Val di Fiemme
Bellune
Carnia

+ Voralberg, Wipptal
+ Voralberg, Wipptal

Oberinntal Grey (1924)

Grigia Alpina (1949)

beef type
1931; + Tyrol Grey

Schwyz (1775-82)

Tyrol Grey
Swiss Brown (1878)

+ Grigia Alpina
late 19th (sub)types:

Schwyz

best developed
valley type

Appenzel
Toggenburg
Oberwalden
Glarus
Interlaken
Oberhasli
Uri
Bryenz
Feldis
Livin
Goms

higher valley
higher valley
higher valley
higher valley
higher Alps
higher Alps
higher Alps
higher Alps
highest Alps
highest Alps
highest Alps

Allgäu

Württemberg Brown (BS: 1883)

German Original Brown (BS 1988)

x Swiss Brown »

Montafon

Klostertal
Paznaun

Walsertal

Thandberg

Bregenz Grey-yellow

Voralberg Grey-Brown Mountain (BS 1893)

=Voralberg Brown

Lechtal (Grey Mountain)

Wipptal (Grey Mountain)

Tyrol Grey-Brown Mountain

=Tyrolese Brown (BS 1939)

Styrian Brown (BS 1922)

Austrian Original Brown

dark brown-Wallis
type breed, 1800-
1850 + Allgäu
Montafon variety
Montafon-Tuxer
transitional type
Montafon-Allgäu
transitional type
Montafon x Lechtal
absorbed by
Montafon and Allgäu
Schwyz x
Montafon/Allgäu
1923 renamed
x Montafon
x Montafon
including most Tux,
Zillertal,
renamed

Bryansker Forest,
other landraces

Russian Swiss

Schwyz x Allgäu,
Oberinntal
after 1945
amalgamated
x Swiss Brown,
German
Brown
recent + Brown Swiss

landrace
variety

pre-breed /
former breed
variety

current breed

absorbed variety

remarks

Great Russian land cattle
Miskov
Babaev

Kostroma (1944)

Yaroslav, Kholmogor,
Ayrshire x local
Allgäu, Swiss Brown
x local
recent + Brown Swiss

SUBGROUP 4E

Romanian Mountain

Mocanitsa
Polim Busha

critical
critical

Pester Busha

Imljani black

Serbian Brown

x Montafon
critical
x Tyrol Grey,
Montafon »

Lika Busha

Dalmatian Grey (1945)

x Tyrol Grey »

Neretva Busha

Gacko

Carpathian Mountain
Valachian Dwarf
Mandans
West Galizian-Carpathian
Bukowina Mountain
Podhalañer

Slovakian-Carpathian Brown

x Allgäu, Montafon,
Swiss Brown »

Werschowen
Hutzul

Ukrainian-Carpathian Brown (1973)

+ Allgäu, Montafon,
after 1980 Brown
Swiss, Jersey

SUBGROUP 4F

Chernigov

Dnieper

Ukrainian Beef (1999)

since 1961 breed
lines
1979 combined
multiple composite of
Charolais, Chianina,
Ukrainian Simmental,
Ukrainian Grey;
new lines: +
Aberdeen-Angus,
Limousin, Hereford,
Red Steppe,
Ukrainian Black Pied

SUBGROUP 5D

Morenas del Noroeste
Alistana
Sanabresa

Alistana-Sanabresa (HB)

1941 first described
1986 amalgamated

Morenas del Noroeste
Limiana
Verinesa

Limia (1990)
Mirandesa (1977)

1976 amalgamated

Mirandez estremenho
Jarmelista

spotted dairy type

SUBGROUP 5E

Spanish land cattle
Casta Cabrera
Casta Carriquirris
Casta Castellana
Casta Espinosa y Zapata
Casta de la Tierra

established 1775

established
end 1800s

continued on the next page

landrace — variety	pre-breed / former breed — variety	current breed	absorbed variety	remarks
	Casta de los Gallardo			founded 1750, Navarra bulls × Andalusian cows
	Casta Jijona	Ganado Bravo (1980) (Lidia, Fighting cattle)		contains many more castas
Serrana	Avileño Piedrahitense Barqueño Guadameño Negra Ibérica (1970) Avileña-Negra (1970)	Avileña Negra Ibérica (1980)		
SUBGROUP 5F				
Andalusian type				
	Colorada extremeña Rubia andaluza	Retinta andaluza (1933)		
SUBGROUP 5G				
Murciana				
	Huertana Almanzoreña Calasparreña Lorquina	Murciana-Levantina		medium large, nearly extinct large, lowland type highland type highland type critical
SUBGROUP 6A				
Camandona				
Ossolane Susa				partly absorbed in Italian Bruna Alpina grey mountain type wheat to red, black eye blazes pearl grey lowland type
Pinerlo	Canavese Piemontese ordinaria (1887-1891) Demonte: Racconigi Carmagnola	Piemontese (1958)		landrace × Bernese × Swiss Brown, + Charolais small mountain type hill type plains type, Chianina influence amalgamation of subtypes hill type lowland type endangered dairy-beef type
Carpigiana Modenese di pianura		Modenese (1957)		
Tuscan land cattle Perugiana Valdarno: Val di Chiana		Chianina (1956)		largest valley type main ancestor of Chianina 1932 beef selection programme + Maremmana, outcrossed by Romagnola gentile + Chianina, Reggiana »
Romagnola di montagna		Romagnola (1956)		

landrace variety	pre-breed / former breed variety	current breed	absorbed variety	remarks
Local cattle	Collina delle Marche Brina Pianura delle Marche Marchigiana gentile	Marchigiana (1957)		hill type, absorbed by Pianura intermediate type, absorbed by Pianura lowland type recognized in 1850, 1850-1900 x Chianina; 1900-1928 x Romagnola »
SUBGROUP 6B				
Maremma local:	Grossetana (1932 breed plan) Romana (1932 breed plan)	Maremmana (1953)		+ Chianina, Romagnola, Marchigiana » varieties still in Puglia, Basilicata, Campania, Calabria
South Italian local		Podolica Italiana (1931)		1930-40 + Swiss Brown, Romagnola, Maremmana, 1940- 50 + Chianina, Marchigiana
Labin (Blue cavallo)			Abrussese Murgeze	blue-grey, fast work type crossbred to Busha, similar to Pugliese after 1800 + Romagnola, Marchigiana; 1886- 1931 x Romagnola, Maremmana
Istar-Karst (Blue indigeno bianco) Buje				
Siciliana piccolo Modicana primitivo Siciliana Grande	renamed 1954: 2000 renamed:	Istrian (1988); Boskarin		renewed interest small Busha type intermediate type large Podolian type rebuild + Chianina, Reggiana, Calabrese Podolica + Danish Red
SUBGROUP 6C				
		Hungarian Grey (1900)		1930/1970 + Maremmana
Moldavian		Romanian Grey (1924)	Karst	1950 no longer in national breed programme, in 1980s remains gathered, BP 1989
SUBGROUP 7A				
Khuzestan landrace		East Anatolian Red	Cildir Göle Eleskirt	possibly absorbed varieties: possibly extinct possibly extinct extinct x Jersey, Red Sindhi »
		Nejdi		

landrace — variety	pre-breed / former breed — variety	current breed	absorbed variety	remarks
Armenian landrace				× Swiss Brown, Kostroma, Lebedin
	Lori	Caucasian Brown		1934-40 × Swiss Brown
Dagestan mountain				× Carpathian, Swiss Brown»
	Dagestan Brown			1960 into Caucasian Brown
Azerbaijan Red		Azerbaijan Brown		1930-60 × Swiss Brown, Kostroma, Lebedin
SUBGROUP 7B				
Messaoria		Cyprus		lowland type
Paphos		Native Southern Yellow		hill type critical critical
			Cukurova Dörtyol Karaisali Siverek	
		South Anatolian Yellow-Red		
			Halep Seferihisar	Halep × Simmental
		Lebanese		improved Lebanese, × Damascus
			Beirut	
SUBGROUP 8B				
Las Bela		Red Sindhi (HB) Gir (HB)		from Baluchistan
Vadhya				south Kathiawar east of Kathiawar
SUBGROUP 8C				
		Hariana		
			Hissar-Hansi	Hissar × Hariana crossbred
SUBGROUP 8D				
		Kankrej (HB)		
			Gujerat Vadhiyar Nagar Konkan	
		Malvi (BS)		
			Agar Mandsur Deccan	not a fixed type North Uttar Pradesh
Kheri		Kherigarh		
			Bhur Dhaurahra Manjra Singhai	Southern area in Dhaurahra Kherigarh-Pnwar transitional in Pilibhit
		Kenkatha		
			Parehar	
			Goranea Bagondha	commonly red polled
Patha				
SUBGROUP 8E				
Geonti		Krishna Valley		1880 × Ongole, 1980s × Gir Early 20th cent. × Kankrej since 1960s × Khillari

landrace variety	pre-breed / former breed variety	current breed	absorbed variety	remarks
Lingadahalli	Bettadapur Hagalvadi Chitaldrug	Hallikar		important S Indian breed Hallikar x desi outstanding pack bullocks noted for spirit and endurance noted for speed
	Gujamavu Hagalvadi Chitaldrug			almost absorbed original a Hallikar part foundation
	Ajjumpur Molvally Benne Chavadi	Amritmahal	Swanta Gosu	Amritmahal noted for symmetric horns strongest type 18th century prime breed Amritmahal x nadudana
		Alambadi	Masti dana Nundi dana	
SUBGROUP 8F				
Bengali	Dacca-Faridpur			Hariana type x Sahiwal, Red Sindhi, Friesian
	Munshiganj (still existing)			Sahiwal since 1915 Hariana, Red Sindhi, Dutch Friesian, Jersey »
Kerala dwarf zebus (desi)		Pabna		remains left
Kasargod dwarf (still existing)				
Kuttanbula kullian				
Vattakari				
Kapila				
Iduki (still existing)				
Vechur		Sunandini Vechur		x Brown Swiss, Jersey, Holstein, since 1965 » recorded 1979 after 1989 reconstructed on the basis of remnants and recognized as breed
SUBGROUP 9A				
Zarizyner		Lower Volga		Kalmyk variety x East Friesian
Don				x Black Pied since 1929 developed
Kalmuck		Siberian Black Pied		since 1890 x Bestuzhev, Tagil, Red Steppe, Yaroslavl, Dutch and Swiss cattle; since 1901 x Shorthorn
Siberian				
Altay				
West Siberian		Kurgan (1949)		

landrace — variety	pre-breed / former breed — variety	current breed	absorbed variety	remarks
Buryat		Siberian Simmental		× Simmental »
Transbaikalian Yakut (still existing)		» Far Eastern Simmental		× Simmental × Simmental
Kyrgyz (still existing)		Ala Tau (1950)	Ala-Almata	× Dutch Friesian, Simmental Brown Swiss, Kostroma » in Kyrgyzstan and Kazakhstan + Ayrshire and Jersey
SUBGROUP 10A				
Wanniü		Qinchuan	Zaosheng	ancient Chinese
Pingchuan		Pinglu Mountain		1960-1980s absorbed miniature work type
SUBGROUP 10B				
Taiwan Yellow		Taiwan Zebu		since 1910 × Red Sindhi, Kankrej » not fixed, possible including
Taiwan Black				
SUBGROUP 10C				
Sumatra cattle		Sumatra Ongole		banteng origin, × Ongole »
SUBGROUP 11A				
Oulmès Blond Blond Zaërs		Blonde d'Oulmès et des Zaërs		small mountain type large plateau type BP 1988
Brune de l'Atlas Beni-Ashene Branes Demnat Fez-Meknès Zemour		Moroccan Brune de l'Atlas		
Brune de l'Atlas Aïn-Beïra Chélif Beni Sliman Oran Tiaret		Algerian Chaouia Algerian Guelma Tunisian Guelma	Biskra Kef	endangered landrace miniature type critical landrace dairy type
SUBGROUP 11C		Somba	Pabli	taurine landrace red colored
SUBGROUP 12A				
Oudalan		Azaouak		taurine, after 1900 outcrossed by:
SUBGROUP 12B		Adamawa Gudali	Yola Gudali	zebu × Muturu
SUBGROUP 13A				
Nuba Shorthorn		Nuba Mountain Zebu		taurine, outcrossed by zebu

landrace variety	pre-breed / former breed variety	current breed	absorbed variety	remarks
SUBGROUP 13B		Garre	Bimal Singhi	
SUBGROUP 13C		Masai Zebu	Masai Grey	
SUBGROUP 13D Unguja Shorthorn		Pemba Zebu		
SUBGROUP 14A		Aradó	Keren, Eritrea	
Bileri		Raya-Azebó	Arusi-Galla	
SUBGROUP 14B		Nganda		taurine taurine taurine, both x Ankole »
Sesse Shorthorn Kigezi Shorthorn Karagwe Shorthorn		Kigezi		taurine x Ankole »
Bantu cattle		Bashi Sukuma		Tanganyika zebu x Ankole gigantic horns
Ugoi sanga SUBGROUP 14C Damara-Herero		Damara		remnants of Setswana cattle after late 19 th century plague + other sangas remains: x Barotse remains: x Barotse
Govuvu (Setswana type) Binga (Setswana type)		» Tonga		Remains: x Angoni »
Makalanga (Setswana breed)		Mashona (1954)		since 1946 selected for beef 1961-69 called Mangoni
Matabele (mixed Setswana cattle)		Nkone (BS 1967)		
Ngwato (Setswana type) Amabowe (Setswana type)		Tuli (1961)		since 1942 selected for golden brown, polled, beef Setswana gigantic long, lateral horns longhorned or polled + Afrikander
Amabowe (Marigwato) Ngami		Tswana	Sekgatla	Southern Tswana x Afrikander
Ngwato (Bamangwato) Southern Tswana		Nguni (BP 1950)		being absorbed being absorbed being absorbed sacred herd sacred herd
Shangan Bapedi Bavenda			Bolowana Ondongolo Pondo Zwazi Zulu	

landrace
— variety

pre-breed /
former breed
— variety

current breed

absorbed variety

remarks

Setswana Mangwato				partly founded Afrikander purchased since 1652
Namaqua	Cup-Shape-Horn Long-Twisted-Horn Notch-Neck			large type, long horns large type, gigantic horns short-legged type, most important founder of:
Vaderlanders	Uysbees Kemp Tintern Black	Afrikander (1907)		Dutch cattle Friesian, Groningen x Afrikaner, Nguni, Basuto Friesian x Afrikaner, Basuto Afrikaner x black Nguni combined in 1947
SUBGROUP 15A				
Marks line Woods line Wright line				
Griffin line Poppel line Robinson cattle		Texas Longhorn (BS:1964)		consists of more breed lines tracing to French cattle from Georgia crossbred from Mississippi
Tornhill line		Pineywoods		consists of other lines and herds
SUBGROUP 15C				
Guatemalan Criollo		Barroso		one herd left, endangered
Costa Rica Criollo Nicaragua Criollo		Criollo lechero tropical		bred since 1950, endangered
SUBGROUP 15D				
Perijanero		Mestizo perijanero		zebu x Sierra Criollo crossbred population
SUBGROUP 15 F				
Beni Criollo		Curraleiro	Crioulo leiteiro de Irecé	only Crioulo Nordestino left dairy type
Franqueiro		Yacumeño		selected since 1961
		Crioulo Lageano		since 1960 reconstructed Crioulo do Sul variety
SUBGROUP 16-1A				
Native cattle		Randall Lineback		
Native cattle Holderness Columbian		Lineback (1987)		Shorthorn pre-breed Holstein, Ayrshire, Shorthorn crossbred white-backed American G (Gloucester) or color-sided type

landrace variety	pre-breed / former breed variety	current breed	absorbed variety	remarks
	Australian Milking Shorthorn	Illawarra		mainly based on Shorthorn
SUBGROUP 16-1B			Darbalara	
		Milking Shorthorn (1846)		
SUBGROUP 16-2A			Polled Durham (BS 1889)	
		Murray Grey (BS 1962)		Shorthorn × Aberdeen Angus
	Tasmanian Grey (BS)			Shorthorn × Aberdeen Angus, absorbed in 1979
		Adapteur		
			Belmont Adapteur	discontinued breed line

Table S3.2. Export of breeds (Feliuss, 1995; Valle Zárate et al., 2014). The year of the first import is given for the major importing countries Canada, USA, Brazil, Australia and New Zealand with, if known, abbreviations for the US or Canada states. Grey cells indicate 19th century imports. Breeds are ordered according to the classification of Feliuss, 1995. * year of first entry.

Breed	Origin	Five major importing countries, Year(s) or Century of First import			
		Canada	USA	Brazil	Australia
GROUP 1					
Aberdeen-Angus	Scotland	1876	KS 1873	1906	1840s
Ayrshire	Scotland	QC 1821	CT 1822	1937	1848
Belted Galloway	Scotland	ON 1939	20 th	1952	1950s
British White	UK		1940s		
Dexter	Ireland	from USA	NY 1905		1979
Galloway	Scotland	ON 1853	1866		1952
Highland	Scotland	MA 1885	1948		
Kerry	Ireland	ON 1971			
Kerry/Dexter	Ireland		1818		
Luing	Scotland	1975	20 th		20 th
Norwegian Red	Norway		1973		1990s
Red Poll	England	NB 1880s	NY 1873	1920 *	1850s
Shetland	Scotland				
Swedish Mountain	Sweden				
Swedish Red-and-White	Sweden				1990s
Viking Red	Denmark, Sweden, Finland				
Welsh Black	Wales	From USA	NV 1966		>1973
White Park	UK	ON 1940s	NY 1941		1958
GROUP 2					
Angeln	Germany				1986
Beef Shorthorn	Scotland	From USA	OH 1854		
Belgian White-Blue	Belgium	1986	1988	1994	21 th
Bretonne Pie Noir	France				
British Dane (Danish Red)	UK			1990s	1990s
Danish Red	Denmark				1990s
Devon	England	NB 1855 ON 1968	MD 1817 NH 1929	1906	1873
Dutch Friesian; renamed Holstein (GROUP 16)	Netherlands; USA, Canada	1881	MA 1852	1907 >1945	1886 1890
Estonian Red	Estonia				

		Other importing countries	Remarks (New Names of Imports in italics)
	N.Z.		
	1863	worldwide major beef breed	1971 repatriated <i>Angus</i> , except in Brazil
	1884	19th: major imports in Nordic Europe	1970 repatriated
	1947	Germany, Netherlands	<i>Galloway</i> in Brazil
	1979	worldwide	<i>American White Park</i> , crossed with White Park, Angus, etc.
	1947	worldwide	<i>Mini Dexter</i> in USA, Canada
	1973	worldwide	
		South Africa	
	20 th	Germany, Uruguay Latvia, Albania, Madagascar	from Canada to USA in Australia only for crosses
	1898	worldwide 1983 Falkland Islands	
	21 th	Germany N.W. Europe, Russia, Pakistan Argentina	for crossbreeding in dairy breeds synthetic cross, used for upgrading dairy breeds
		UK	
	1973	Germany, Uganda, Jamaica	<i>Ancient White Park</i>
		Belgium, Turkey Baltic countries, Eastern Europe Germany, Japan, South Africa, Papua New Guinea	crossed into Aussie Red crossed into new red dairy breeds
		Europe, North America, Namibia Madagascar	<i>Belgian Blue</i> crossed into Rana and Amsterdam Island cattle
		Mauritius Morocco, Algeria, Tunisia	crossed into Mauritius White only for crosses
	1990s	worldwide	for pure and crossbreeding,
		Baltic countries, Eastern Europe	crossed into new red dairy breeds
	1838	worldwide	1855 import in Canada extinct <i>Milking Devon</i> , <i>Beef Devon</i>
	1884	worldwide top dairy breed	1968 repatriated <i>New-Zealand Friesian</i> ;
	~1900	Poland, Ukraine, Moldova Rep.	In Brazil <i>Holandês Preto e Branco</i> for Dutch-Friesian + Holstein crossed into new red dairy breeds

Breed	Origin	Five major importing countries, Year(s) or Century of First import			
		Canada	USA	Brazil	Australia
Flamande	France			1945	1945
German Red Glan	Germany Germany				
Guernsey Heck	Guernsey Germany	1878	NH 1830s	1889	~1900
Hereford Polled Hereford (GROUP 16)	England Canada/USA	ON 1860	NY 1839	1906 1928	1826 1920
Irish Friesian	Ireland		1971		
Jersey	Jersey	Q 1868	CT 1850	1896	ca. 1900
Jutland	Denmark				
Lakenvelder	Netherlands		NY 1838		
Dutch Belted (GROUP 16)	USA	20 th			
Latvian Brown	Latvia				
Lincoln Red	England	1825 1866		20 th 20 th	~1900 ~1900
Lithuanian Red	Lithuania				
Longhorn	UK				
Maine-Anjou	France	1969	1969		20 th
MRY	Netherlands		2004		2004
Normande	France	1973	1885 1970s	1890s	
Polish Red	Poland				
Red Holstein (GROUP 16)	Canada/USA			>1945	
Red Pied Friesian	Netherlands			1907	
Shorthorn [dual purpose]	England	NB 1825	NY 1817	1906	1825
South Devon	England	1969	1936	1948 *	1986
Sussex	England		TN 1884 TX 1947	20 th	1970s
GROUP 3					
Abondance	France	1969–1975			
Charolais	France	1953	TX 1934	1883	1971
Fleckvieh	Germany	1971	1971	1971	1988
French Simmental	France	1967	1967		
Gelbvieh	Germany, Austria	1972	1971	20 th	20 th

	N.Z.	Other importing countries	Remarks (New Names of Imports in italics)
	1945		<i>Flamenga</i> in Brazil; in Canada only for crosses; in Australia into Aussie Red
		Latvia	
		Netherlands	
	~1900	worldwide	1990s repatriated
		UK, France, Netherlands, Belgium, Latvia, Austria, Czech Rep., Hungary	
	1800s	worldwide major beef	1970s repatriated;
		worldwide	In Brazil <i>Hereford Mόcho</i>
			<i>Beef Friesian</i>
	1862	worldwide major dairy breed	2008 repatriated
		Netherlands	<i>Heidevee, Westergaard</i>
		Belgium, England	1979 repatriated
			<i>Dutch Belted</i>
	20 th		
		Poland, Ukraine, Bulgaria	crossed into new red dairy breeds
	~1900	Germany, Hungary, Puerto Rico, Argentina (1887), Chili	1825 in Shorthorn HB
	~1900	Romania	1866 new import
		Germany, Netherlands	crossed into Romanian Red
		UK, Belgium, Netherlands, Germany, Japan	
	2004	NW Europe	<i>Dutch Shorthorn</i> in Australia
		Cameroon, South America	1885 import extinct,
			<i>Normando</i> in Brazil
		Romania	crossed into Romanian Red
		worldwide	<i>Holandés Vermelho e Branco</i> for Red-Pied Friesian + American Red Holstein amalgamate
		UK	
	1825	worldwide	<i>Milking Shorthorn</i> in USA, in Australia founder of beef and dairy types 1975 repatriated
		worldwide	
		southern Africa, Argentina	1884 import extinct
		Côte d'Ivoire	in Canada only for crosses
	1960s	worldwide top beef breed	<i>Charolés</i> in Brazil
		central-eastern Europe	
		worldwide	

Breed	Origin	Five major importing countries, Year(s) or Century of First import			
		Canada	USA	Brazil	Australia
Hérens	Switzerland	20 th	WV 1980		
Hinterwald	Germany				
Montbéliarde	France	1969-1 975		20 th	
Pinzgauer	Austria	1972	1976	1970	
Pustertal	Italy				
Simmental	Switzerland	1969	TX 1886	1905	1973
	UK, Canada	1969	TX 1886	1905	1973
Tux-Zillertal	Austria				
Valdostana	Italy			>1995	
Vosgienne	France				
GROUP 4					
Aubrac	France	20 th			
Bazadaise	France				1991
Blonde d'Aquitaine	France	1971	MN 1971	1994	1970
Gasconne	France				
Limousin	France	1968	1968	1872	1973
Maraîchine	France				
Parthenaise	France	1970			
Salers	France	1972	1974	1986 *	1980s
Swiss Brown	Switzerland	1888	MA 1869	1918	1980s
		1968	1983	1946	
Brown Swiss	USA			1970s	
(GROUP 16)					
Tarentaise	France	1972	1972	1972 *	
Tyrol Grey	Austria				
GROUP 5					
Cachena	Portugal/Spain				
Retinta	Spain				
Rubia Gallega	Spain			21 th	
Sayaguesa	Spain				
Toro de Lidia	Spain				
Tudanca	Spain				
GROUP 6					
Chianina	Italy	1971	1971	1956	20 th
Hungarian Grey	Hungary				
Marchigiana	Italy	1972	1972	1960s	
Maremmana	Italy				

	N.Z.	Other importing countries	Remarks (New Names of Imports in italics)
	20 th	Switzerland, Israel, Uganda, Namibia worldwide worldwide Germany, Austria	in Canada only for crosses
	20 th	worldwide	<i>Simental</i> in Brazil
	20 th	Germany	experimental crossing
		Germany	
		Europe-wide, Northwest Africa, Mexico UK worldwide UK, Netherlands, Czech Rep., Japan	
	20 th	worldwide Netherlands UK, Ireland, Belgium, Netherlands	<i>Parthenay</i>
		worldwide worldwide	1976 repatriated as Brown Swiss original dual purpose <i>Braunvieh, Beef Brown Swiss, Pardo Cuiço Corte, Zuizo Europeao Pardo Suíço, Pardo Suizo Americano</i>
		worldwide Denmark, Latvia, Germany, Bulgaria, Serbia, Bosnia-Herzegovina, Macedonia, Israel	
		Germany Argentina	
		Netherlands, Germany France, Mexico, Colombia, Equador, Peru, Venezuela Netherlands	pure and for building Tauros
	20 th	worldwide Germany, Netherlands, Austria UK, Belgium, Netherlands, Albania, South Africa Albania, Netherlands	<i>Marky</i> in USA, Canada in Netherlands for building Tauros

Breed	Origin	Five major importing countries, Year(s) or Century of First import			
		Canada	USA	Brazil	Australia
Modicana	Italy				
Piemontese	Italy	1980	1984	1974	
Romagnola	Italy	1974	1971		20 th
Ukrainian Grey	Ukrain				
GROUP 8					
Alambadi	India				
Amritmahal	India				
Caucasian zebu	Azerbaijan				
Gir	India		TX 1882	1911	
Hallikar	India				
Hariana	India				
Hissari	Pakistan/India				
Kangayam	India			1963	
Kankrej	India		TX 1906	1870s	
Khillari	India				
Krishna Vally	India		1906		
Miniature zebu	India		1980s		1995
Mysore	India				
Ongole	India		TX 1885	1874	
Red Sindhi	Pakistan		1946	1952	1954
Sahiwal	Pakistan				1954
Tharparkar	India				
GROUP 9					
Ala-Tau	Kazakhstan				
Japanese Black/ Brown	Japan		1976		1990s
GROUP 10					
Bali Cattle	Indonesia				NT 1849

N.Z.

Other importing countries

Remarks (New Names of Imports in italics)

Tunisia	crossed into Thibar
worldwide	<i>Piedmontese</i> in USA, <i>Piemontês</i> in Brazil
South Africa, Argentina	
Latvia	
Indonesia	with other zebu breeds crossed into Aceh
Indonesia	
Germany, Netherlands	<i>Dwarf Zebu</i>
worldwide (sub)tropical	in USA mainly crossed into Brahman
Malaysia, Philippines	in Malaysia with other zebu breeds crossed in Local Indian Dairy
Bangladesh	with other zebu and taurine breeds crossed into Pabna Milking Cow
Myanmar, Cambodia	with other zebu breeds crossed into Pyar Sein
Indonesia	with other zebu breeds crossed into Aceh
Jamaica	with other zebu breeds crossed into <i>Brahman Jamaicano</i>
Indonesia, Senegal,	Guzerat in USA mainly crossed into Brahman; <i>Guzerá</i> in
Togo, Mauritius	Brazil
Sri Lanka	
Indonesia	crossed in zebus
	crossed into Brahman
European zoos	<i>Nadudana</i>
Indonesia	Discontinued
Jamaica	with other zebu breeds crossed into <i>Brahman Jamaicano</i>
worldwide (sub)tropical	<i>Nellore</i> , in USA mainly crossed into Brahman; <i>Nellore</i> in Brazil
worldwide (sub)tropical	<i>Sindi</i> in Brazil
worldwide (sub)tropical	
Sri Lanka	<i>White Sindhi</i>
Afghanistan	
Malaysia, Myanmar,	with other zebu breeds crossed in Local Indian Dairy
Philippines, Taiwan, Dem. Rep. Congo	
Kyrgyzstan, Mongolia	
Ireland, Belgium, Germany,	<i>Wagyu</i>
Netherlands, South Africa	
	Cobourg Peninsula, <i>banteng</i>

Breed	Origin	Five major importing countries, Year(s) or Century of First import			
		Canada	USA	Brazil	Australia
Madurese	Indonesia				
GROUP 11					
Baoulé	Côte d'Ivoire				
Lagune	Benin Dem. Rep. Congo				
N'Dama	West Africa		VI 1860		
GROUP 12					
Adawama	Nigeria				
Azaouak	Nigeria				
Senegal zebu	Senegal				
Shuwa Arabe	Nigeria				
Sokoto Gudali	Nigeria				
White Fulani	Nigeria				
GROUP 13					
Angoni	Zambia				
Boran	Kenya				20 th
Butana	Sudan				
GROUP 14					
Afrikander	South Africa		TX 1931		1953
Ankole	Central Africa		1960		
Barotse	Zambia				
Bonsmara	South Africa			late 1990s	
Nguni	Zambia				
Tonga	Zambia				
Tuli	Zimbabwe		1991	1990s	1990
GROUP 15					
Jamaice Hope	USA				
Romano Rojo	Dominican Republic				
Texas Longhorn	USA				
GROUP 16					
Australian Braford	Australia				
Australian Frieswal	Australia				

N.Z.

Other importing countries

Remarks (New Names of Imports in italics)

Papua New Guinea

Cameroon, Centrafrique, Gabon, Congo, Dem.Rep.Congo, Liberia, Togo

Congo, 1904 Dem.Rep.Congo

Mayombe

Belgium, then to Germany, Netherlands

Dahomey

Gabon, Angola.

Dahomey, Daomé

West-, Central Africa, Kenya, Angola, South Africa; St. Croix Virgin Islands

× Red Poll: *Senepol*

Ghana

Ghana

Lesser Antilles 1828

Togo

Shuwa Aral

Ghana

Togo, Centrafrique, Ghana

Zimbabwe

1990

Ghana, Tanzania, South Africa, Zambia, Mexico

From Zambia to Australia and from there to USA; from USA to Mexico

Nigeria

Africa, Philippines

in USA crossed into Barzona and Africangus, in USA -and Australia *Africander*

From European zoos to USA

Ankole-Watusi

Dem. Rep. Congo

Botswana, Rwanda; via Australia to Brazil

Gabon

Dem. Rep. Congo

Botswana, Gabon, Namibia, South Africa, Argentina, Mexico

in USA and Australia only for crosses; into Brazil via Australia

Central, South America

probably discontinued

Guiana

1989

Germany, Netherlands

20th

Papua New Guinea.

Samoa, Malaysia, China

Papua New Guinea, Indonesia,

Samoa, Malaysia, Philippines, Pakistan,

Sri Lanka

Breed	Origin	Five major importing countries, Year(s) or Century of First import			
		Canada	USA	Brazil	Australia
Australian Lowline	Australia				
Australian Milking Zebu	Australia				
Australian Shorthorn	Australia		~1990s		
Beefalo	USA			1991	
Beefmaster	USA			1992	
Braford	USA			1994	20 th
Brahman	USA			1994	1933
Brangus	USA				
Brangus Plus	USA			late 1990s	
Canadienne	Canada				
Charbray	USA			20 th	
Droughtmaster	Australia			late 1990s	
Illawarra	Australia				
Indubrasil	Brazil		1946		
Murray Grey	Australia	1972	TX 1969		
Range Maker	USA			late 1990s	
Red Angus	USA			1936 *	20 th
Rojo Jamaicano	Jamaica				
Santa Gertrudis	USA	1952		1953	1952
Senagus	USA			late 1990s	
Senepol	USA			late 1990s	
Simbrah	USA				
Stabilizer	USA /Australia, N. Zealand			late 1990s	
Weebollabolla	Australia	20 th			

N.Z.		Other importing countries	Remarks (New Names of Imports in italics)	
1995			<i>Mini Angus</i>	
		Papua New Guinea, India, Sri Lanka, Pakistan, Indonesia, Malaysia, Tanzania, Panama, Trinidad and Tobago, Surinam		
			only for crosses	
		Argentina, South Africa Argentina, Ghana worldwide (sub)tropical Panama, Dominican Rep., Bolivia, Argentina, South Africa		
			<i>Brangus Plus Vermelho</i>	
		France Central and South America, Morocco, South Africa		
		Papua New Guinea, Indonesia, Samoa, Malaysia, China, Taiwan, Vietnam, Pakistan, Ghana, Nigeria		
		Papua New Guinea, Pacific, Indonesia, Southwest Asia, Philippines, Japan, Pakistan, Central America, Cuba, UK		
		Central America, Paraguay, Peru, Surinam, Venezuela		
	20 th		Sri Lanka, Japan, UK	
				only for crosses
			UK, Thailand Domin. Rep., Trinidad and Tobago, Venezuela, Panama worldwide (sub)tropical	
		South Africa Philippines, Botswana, Namibia, South Africa		
			only for crosses	
		South Africa	In Canada only for crosses	

Table S3.3. Synthetic breeds (Felius, 1995; Mason, 2002; Buchanan and Lenstra, 2014).
BS breed society; CC continuous cross; HB herd book.

Input breeds	Breed Name	State, Country	Establishment HB, BS
EUROPE			
Dairy			
Ukrainian Red Steppe × Red Holstein	Ukrainian Dairy Red	Ukraine	1989
CC dairy/dairy-beef			
Norwegian landraces and breeds × Ayrshire, Swedish Red-and-White, Dutch Friesian, Holstein	Norwegian Red	Norway	1961
Finnish Ayrshire, Swedish Red, Danish Red, Norwegian Red, Holstein	Viking Red	N.W. Europe	early 2000's
Holstein, Montbéliarde, Swedish Red-and-White	ProCross	N.W. Europe	2014
Ramo Grande × Dutch-Friesian, Danish Red, Ayrshire, Jersey, Guernsey, Normande, Brown Mountain	Madeire Mixed	Azores	
Beef			
Highland × Whitebred Shorthorn (Parton Herd)	Luing	Scotland	1949–1965, HB 1966
German Black Pied, German Red Pied, Fleckvieh × Aberdeen-Angus, Angus	German Angus	Germany	1950s, HB 1956
German Fleckvieh × Charolais	Uckermärker	Germany	1975, HB 1992
Hungarian Pied × Polled Lincoln Red	Scentes Red	Hungary	recognized 1992
Ukrainian Grey, Ukrainian Simmental × Charolais, Chianina	Ukrainian Beef	Ukraine	1961, HB 1999
Swiss Brown, Simmental, Salers, Limousin, Maine-Anjou	Belarus Synthetic	Belarus	
Red Steppe × Hereford, Charolais, Cuban zebu	Askian Meat	Ukraine	
Kalmyk × Aberdeen-Angus, Charolais	New North Caucasian	S.E. Russia	
CC beef			
South Devon, British Limousin, British Holstein × Australian Stabiliser (= Gelbvieh, Hereford, Red Angus, Simmental)	Stabiliser	England	1999
Park management/ rewilding			
Shorthorn, Highland	Wilseder Red	Germany	
Burnt Red × Salers	Red Beggar	Netherlands	2005
Danish Red, Holstein, Danish Red Pied, Aberdeen-Angus, Galloway, Hereford, Simmental, Charolais, Limousin, Blonde d'Aquitaine, Romagnola, Chianina	Danish Forest	Denmark	

Input breeds**Breed Name****State,
Country****Establishment
HB, BS****Park management/ rewilding cont.**

Angeln, German Black Pied, Allgäuer, Murnau-Werdenfels, Highland, Hungarian Grey Steppe, Corsican, Camargue, Spanish Fighting cattle

Heck cattle

Germany

1921-1940s,
HB1934

Heck × Highland

Ecoland

Netherlands

1990s

Heck cattle × Sayaguesa, Chianina, Hungarian Grey, Watusi, CC

Taurus

Germany

1991

Highland × Maremmana primitivo, Podolica, Pajuna, Tudanca, Limiana, Sayaguesa, Maronesa, CC

Tauros

Netherlands

1990s

ASIA**Taurine dairy/dairy-beef**

Georgian Mountain, Dagestan Mountain, Mingrelian Red × Brown Mountain

Caucasian Brown

Georgia and Dagestan

1930–1960

Azerbaijan Red × Swiss Brown, Kostroma, Lebedin

Azerbaijan Brown

Russian Azerbaijan

1930–1960

Kyrgyz × Dutch Friesian, Simmental, Swiss Brown, Kostroma

Ala-Tau

Kyrgyzstan and Kazakhstan

1929–1940
HB1950

Mongolian × Milking Shorthorn

Caoyuan Red

N. and N.E. China

1950

Taurine beef

Mongolian × Hereford

**Mongolian
Whiteheaded**

Mongolia

Altay (Hazake) × Hereford

Altay Whiteheaded

N.W. China

Kalmyk × Hereford

Byelagolova

N. Kazakhstan

1928–1939, HB

Kalmyk × Hereford, Charolais, CC

Aulieakol

N. Kazakhstan

BS

Taurindicine dairy/dairy-beef

Central Asian zebu × Dutch Friesian, German Friesian, Swiss Brown, Simmental

Bushuev

Uzbekistan

1907–1948

Tadzhik zeboid × Russian Brown

Schwyz-Zeboid

Tajikistan

1937

Tadzhik zeboid × Swiss Brown

TSSH-1

Tajikistan

1985

Red Sindhi × Jersey

Jersind

N. India

1950

Sahiwal × Dutch Friesian, Holstein

Frieswal

Uttar Pradesh, India

1987

Sahiwal, Red Sindhi × Swiss Brown

Karan Swiss

Haryana, India

1963

Gir × Holstein, Jersey

Phule Triveni

Maharashtra, India

Tharparkar × Holstein, Brown Swiss, Jersey

Karan Fries

Haryana, India

1971

Hariana, Ongole, Gir × Dutch Friesian, Jersey, Swiss Brown

Kamaduk

India

Input breeds	Breed Name	State, Country	Establishment HB, BS
Bengali × Sahiwal, Red Sindhi, Hariana, Dutch Friesian, Jersey	Pabna	Bangladesh	1915–1975
Nadudana × Jersey, Swiss Brown, Brown Swiss, Holstein	Sunandini	Kerala, India	1981–1987
Hazake × Swiss Brown	Xinjiang Brown	Xinjiang, China	1952
Vietnamese × Red Sindhi	Laisind	Vietnam	
Local Indian Dairy × Holstein, Australian Friesian-Sahiwal, CC	Mafriwal	Malaysia	
Taurindicine beef			
Azerbaijan Zebu × Estonian Black Pied, Aberdeen-Angus	Azangus	Azerbaijdzjan	
Bhagnari × Droughtmaster	Nari Master	Pakistan	1969
Kedah-Kelantan × Brahman	Brakmas	Malaysia	
Kedah-Kelantan × Charolais	Charoke	Malaysia	
Simmental × Hereford and Red Angus, St. Gertrudis, Brahman	Israeli Red	Israel	
AFRICA			
Local triple purpose (dairy, work, beef) N'Dama, Gobra	Bambey	Senegal	1921
N'Dama, Gobra	N'Damaza	Côte d'Ivoire	
N'Dama, Ghana Sanga, Sokoto Gudali	Ndagu	Ghana	1923
Taurindicine dairy-beef (local × exotic)			
Malawi Angoni × Friesian	Mikolongwe	Malawi	1971
Madagascar Zebu × French Brown Mountain	Manjan 'i Boina	Madagascar	1980s
Nguni × Jersey	Tauricus	Kwa-Zulu Natal	
Nguni × Pustertal	Supertaler	South Africa	
N'Dama × Fleckvieh, Abondance	N'Damance	Côte d'Ivoire	1980
Egyptian × Holstein/Jersey, CC	Khalit	Egypt	
Egyptian × Holstein/Jersey, CC Tanganyika Shorthorn Zebu, Ankole × Red Sindhi, Sahiwal, Kenya Boran, Ayrshire, Jersey, CC	Mpwapwa	Tanzania	1940s
Taurindicine beef			
Tuli, Nguni	Okuma	Gabon	
Afrikander, Nguni	Sanganer	South Africa	BS 1997
Nguni × Kenya Boran	Borguni	South Africa	2005

Input breeds**Taurindicine beef cont.**

N'Gaoudéré × Brahman
Madagascar Zebu × Afrikander, Limousin
Tswana, Tuli × Brahman, Bonsmara, Simmental
Afrikander × Hereford, Shorthorn
Yellow Afrikander × Brown Swiss
Afrikander × Simmental, Hereford
Afrikander × Charolais
Afrikander × Angus
Afrikander × any other beef breed, CC
Afrikander × Simmental
Afrikander × any other beef breed, CC
African × European, CC
African × European, CC

CENTRAL AND SOUTH AMERICA**Taurine dairy/dual-purpose**

Criollo × Holstein
Criollo × Durham
Hartón × Holstein, Milking Shorthorn

Taurine beef

Criollo × Limousin
Caracu × Blonde d'Aquitaine
N'Dama × Red Poll
Aberdeen-Angus, Limousin

Taurindicine dairy/dual-purpose

Criollo × Shorthorn, zebu
Limonero, mestizo × Swiss Brown
Dutch Friesian/Holstein × Gir
Holstein × Cebú Cubano
Holstein × Cebú Cubano

Breed Name

Wakwa
Renitelo
Musi
Bonsmara
Holmonger
Nuras
Huguenot
Afrigus
Africame
Afrisim
Veldmaster
Bovelder
Symons cattle

Taino**Doran****Lucerna****Crimousin****Aquitânica****Senepol****Limangus****Achiote****Caroreña****Girolando****Siboney de Cuba****Mambi****State,
Country**

Cameroon
Madagascar
Botswana
South Africa
Namibia
Namibia
South Africa
South Africa
South Africa
Zimbabwe
South Africa
Kwa-Zulu Natal

Cuba**Costa Rica****Colombia****Cuba****Rio Grande
do Sul, Brazil****St Croix,
Caribbean
(USA)****Argentina****Guatemala****Venezuela****Brazil****Cuba****Cuba****Establishment
HB, BS**

1952
1930–1972
1983
1936–1955, HB 1972
1949
1960s
recognized 1995

1850s**1937–1956****1975****1918–1949, BS
1976****1935–1975 BS****early 1900,
HB 1989****1965**

Input breeds	Breed Name	State, Country	Establishment HB, BS
Taurindicine dairy/dual-purpose cont. Holstein × Santa Gertrudis	Caribe	Cuba	
Holstein × Guzerá	Riopardense	São Paulo, Brazil	1953
Holstein × Guzerá	Guzolando	Brazil	HB 1984
Holstein × Nelore, Guzerá	Xingu	Goiás, Brazil	1970
Holstein × Indubrasil, Guzerá	Santa Mariana	Brazil	
Holstein, Jersey × Sahiwal	Jamaica Hope	Jamaica	1920–1952, HB 1953
Jersey × Gir	Girseya	Brazil	1980
Jersey × Red Sindhi	Jerdi	Brazil	
Red Poll × Guzerá, Gir	Pitangueiras	São Paulo, Brazil	1940, HB1976
Red Poll × zebu	Rojo Jamaicano	Jamaica	1880, HB 1952
Brown Swiss × Indubrasil	Itapetinga	Bahia, Brazil	1960s
Brown Swiss × Guzerá, recently Nelore	Lavínia	São Paulo, Brazil	1954, HB
Pinzgauer × Girolando	Jaguanês	Brazil	
Girolando, Pitangueiras	Pitalanda	Minas Gerais, Brazil	1977
Girolando, Guzerá	Guzerolando	Brazil	1966
Taurindicine beef, 2 breeds Curraleiro × zebu	Casteado	N.E. Brazil	
Hereford × Brahman	Herebu	Argentina	
Hereford × zebu	Braford brasileiro	Brazil	
Hereford × zebu	Pampiano-Braford	Rio Grande do Sul, Brazil	1970s
Aberdeen-Angus × Brahman Jamaicano	Negro Jamaicano	Jamaica	BS 1954
Aberdeen-Angus × Nelore	Brangus-Ibagé	Rio Grande do Sul, Brazil	1945, HB 1981
Aberdeen-Angus × Nelore	Natura	Brazil	
Charolais × Cebú Cubano	Chacuba	Cuba	
Linousin × zebu	Indusin	Argentina	
Simmental × Guzerá	Simbrasil-Cariri	Brasil	1960s
Chianina × Nelore	Caiúá	São Paulo, Brazil	1978

Input breeds**Breed Name****State,
Country****Establishment
HB, BS****Taurindicine beef, 2 breeds cont.**

Marchigiana × Nelore

SuiáMatto Grosso,
Brazil

Piemontese × Nelore

PiemonelSão Paulo,
Brazil**Taurindicine beef, 3 breeds**

Caracú, Mocho Nacional × zebu

Carazebú

Romosinuano × Red Poll × zebu

La Velásquez

Colombia

Devon, Nelore, Tabapuã

Bravon

Brazil

Normande × Nelore, Tabapuã

BranorSão Paulo,
Brazil

1950

Charolais × Nelore/Tabapuã

Charbray

Brazil

Taurindicine beef, multi-breed

Charolais × Nelore, Indubrasil, Guzerá

CanchimSão Paulo,
Brazil

1940, HB 1971

Criollo × Mysore, Nelore, recently Charbray,
Charolais**Romano Rojo**

Dominican Rep

1922

Red Angus × Tabanel, later: Limousin, Santa
Gertrudis**Red Norte**Minas Gerais,
BrazilPolled Hereford × Brahman, later: Nelore,
Tabapuã, Zebu mocho**Santa Clara**Rio Grande do
Sul, Brazil

1968

Simmental × Nelore, Guzerá, Gir, Indubrasil,
Tabapuã**Simbrasil**

Brazil

Senepol, Charolais × Barzona, Brahman

Tropicarne

Mexico

BS 1986

Red Angus, Charolais, Simmental, Chianina
× Nelore**Bos Certus**

Brazil

Caracú, Romosinuano × Senepol, Red Angus,
Devon, South Devon, Gelbvieh, Simmental ×
Bonsmara, Tuli, Belmont Red × Nelore, Boran**Montana**

Brazil

Zebu beef

Mysore, Hissar, Kankrej, Gir, Ongole

Brahman Jamaicano

Jamaica

1860, HB 1949

Gir, Nelore, Indubrasil

Cebú venezolano

Venezuela

BS

Guzerá, Nelore, Hissar, Gir

IndubrasilMinas Gerais,
Brazil

1911, HB 1936

Nelore × non-specified polled zebu

TabapuãSão Paulo,
Brazil

1940s, HB 1961

Tabapuã, Nelore

Tabanel

Goiás, Brazil

HB 2003

Input breeds	Breed Name	State, Country	Establishment HB, BS
NORTH AMERICA			
Taurine dairy			
Holstein, Brown Swiss, Simmental	Dairy Synthetic	Alberta	
Taurine, beef, 2 breeds			
Texas Longhorn × Salers	Salorn	Texas	1983, BS 1988
Texas Longhorn × Gelbvieh	Geltex	USA	BS
Texas Longhorn × Devon	Texon	Texas	1989
Shorthorn, Devon	Makaweli	Kauai, Hawaii	19th century
Hereford, Chianina	Chiford	USA	1988
Angus, Maine-Anjou	Black Maine-Anjou	USA	BS 1969
Angus, Beef Friesian	Amerifax	Nebraska	1971, HB 1977
Angus, Gelbvieh	Balancer	Colorado	
Angus, Chianina	Chiangus	USA	1975
Angus, Wagyu, CC	Wangus	USA	
Red Angus, Charolais	M4 (Heyster)	USA	1960s
Lincoln Red, Charolais	Fort Cross	Ontario	
Brown Swiss, Charolais	Char-Swiss	Nebraska	BS 1961
Maine-Anjou, Chianina	Chimaine	USA	1987
Romagnola, Marchigiana	Romark	Canada	1970s
Taurine, beef, 3 breeds			
Hereford, Holstein, Brown Swiss	Hays Converter	Alberta	1952, BS 1975
Hereford, Angus, Brown Swiss	Better Idea	North Dakota	
Hereford, Red Angus/Angus	Regus	Wyoming	
Hereford, Red Angus, Red Holstein	RX3	Iowa	HB 1974
Hereford, Shorthorn Charolais	Burwash	Ontario	1957
Angus, Galloway, Charolais	Kinsella	Alberta	1955
Angus, South Devon, Tarentaise	Range Maker	Florida	
Taurine, beef, multi-breed			
Hereford, Angus, Red Poll, Beef Friesian Brown Swiss, Simmental	Beef Machine	New Mexico	
Shorthorn, Jersey, Highland, Angus, Galloway	Speckled Park	Alberta	
Hereford, Angus, Galloway, Charolais	Pee Wee	Alberta	
Hereford, Angus, Brown Swiss, Charolais	Cash	Montana/ Colorado	1960

Input breeds**Breed Name****State,
Country****Establishment
HB, BS****Taurine, beef, multi-breed cont.**

Hereford, Angus, Charolais, Braunvieh,

MARC I

Nebraska

Limousin, CC 1978-1991 Hereford, Red Angus,
Charolais, Gelbvieh, CC**MARC II**, probably
identical to **Stabilizer**

Nebraska

Hereford, Angus, Red Poll, Pinzgauer, CC
1980-1991**MARC III**

Nebraska

Hereford, Red Angus, Galloway,
Welsh Black, Longhorn, Brown Swiss, Jersey,
Holstein**Beefbooster**

Canada

1993

Angus, South Devon, Salers, Tarentaise

Range Maker

Florida

Angus, Continental beef breeds

Black Maximizer

Montana

Angus, Galloway, Brown Swiss, Charolais

Beef Synthetic

Alberta

Angus, Dutch Belted, Shorthorn, Belted
Galloway, later Highland, Chianina,
Limousin, Salers**BueLingo**

North Dakota

1945 - 1970,
BS 1989White Park, British White + Shorthorn,
Holstein, Angus**American White Park**

USA

HB 1975

Devon, Galloway, Highland, Lincoln Red
South Devon, Blonde d'Aquitaine, Gelbvieh,
Maine-Anjou, Salers**Shaver Beefblend**Saskatchewan/
Alberta**Taurindicine, beef, 2 breeds**

Shorthorn × Brahman

Santa Gertrudis

Texas

1910 - 1940,
HB 1951

Hereford × Brahman

Braford

Florida

HB 1945

Hereford × Brahman

Victoria

Texas

1946

Angus × Brahman

Brangus

Louisiana

1932, BS 1949

Angus × Africander

Africangus

Louisiana

1952–1963

Lowline Angus × Brangus

Mini Brangus

USA

Red Angus ×
Santa Gertrudis**Polled
Santa Gertrudis**

Texas

Red Angus × Red Brahman

Red Brangus

Texas

BS 1956

Red Angus × Brahman

Angus/Brangus Plus

Texas

Susse × Brahman

Sabre

Texas

1950

Devon × Brahman

Bravon

Texas

South Devon × Brahman

South Bravon

Southern USA

Input breeds	Breed Name	State, Country	Establishment HB, BS
Taurindicine, beef, 2 breeds cont. Brown Swiss × Brahman	Brah-Swiss	Texas	
Charolais × Brahman	Charbray	Texas, Louisiana	1936, HB 1949
Maine-Anjou × Brahman	Brah-Maine	USA	BS 1985
Limousin × Brahman	Brahmousin	Southern USA	1969, BS 1984
Polled Limousin × Red Brahman	Bravado	Oklahoma	1986
Salers × Brahman	Bralers	Texas	
Normande × Brahman	Branor	Texas	
Simmental × Brahman	Simbrah	Texas, Oklahoma	HB 1977
Taurindicine, beef 3 breeds Shorthorn, Hereford × Brahman	Beefmaster	Texas	1931–1949, BS 1961
Shorthorn, Hereford × Brahman	Beefmaster	Colorado	BS 1971
Hereford, Charolais × Brahman	Charford	Arizona	1952
Charolais, Chianina , Shorthorn	Cuprem Hybrid bulls	Nebraska	1960–1976
Angus, Limousin , Santa Gertrudis	Kenesaw cows	Texas	
Hereford, Simmental × Brangus	Simbrangerford	Oklahoma, Texas	
Angus, Gelbvieh × Brahman	Noble Line	Texas	1990
Red Angus, Gelbvieh × Santa Gertrudis	Santa Cruz	Texas	
Red Angus, Senepol, Simmental	Hotlander	USA	HB 1981
Gelbvieh × Brahman, recently Red Angus	Gelbray	USA	
Taurindicine, beef, multi-breed Hereford, Red Angus, Senepol × Barzona	South Poll	Alabama	1989
Angus, Charolais, Limousin, Chianina × Santa Gertrudis	Cuprem Hybrid	Nebraska	1960–1976
Maine-Anjou, Charolais, Tarentaise, Limousin, Salers, Gelbvieh × Beefmaster	Beefbooster	Canada	1993
Red Holstein, Brown Swiss, Milking Shorthorn, Beef Shorthorn, Hereford, Red Angus, Highland, Simmental × Beefmaster, Brahman	Ranger	Wyoming, California	1950
Shorthorn, Hereford, Angus × Africander Brahman	Barzona	Arizona	BS 1968
Shorthorn, Hereford, Angus, Brown Swiss Charolais × Brahman	Beefmaker	Nebraska	1960s

Input breeds

Taurindicine, beef, multi-breed cont.

Taurine × zebu, CC

Gir, Ongole, Kankrej, Red Sindhi, Krishna Valley

Unknown origin, beef CC

CC

Texas Longhorn × others

Miniature

Dexter × Jersey

Belted Galloway, BueLingo, Dutch Belted, Dexter

Dexter × Angus, Hereford, Highland, Belted Galloway, Jersey or others, CC

small zebus CC

Texas Longhorn × Dexter

Lowline Angus × Brangus

taurine × Miniature zebu CC

taurine × small zebus CC

Cattle × bison, beef

taurine beef breeds × bison

Hereford, Simmental × bison

Shorthorn, Charolais, Brahman × bison

Angus, Brown Swiss, Simmental, Brahman × bison

AUSTRALIA, NEW ZEALAND

Taurine dairy

Jersey, Friesian, Ayrshire

Jersey, Friesian / Holstein CC

Nordic and Red Pied Lowland breeds, CC

all dairy breeds, CC

Taurine, beef

Shorthorn, Aberdeen-Angus

Shorthorn, Aberdeen-Angus, grey cattle

Breed Name

Bucking Stock

American Brahman

Magnum
El Monterey

Mini Belmont/
Mini Belfair

Mini American Beltie

Happy Mountain/
Mini Grad-Wohl

Miniature Zebu

Miniature Spanish
Las Manchas

Mini Brangus

Sundog

Little Rowdy

Beefalo

Simmalo

American Breed

Hybridmaster

Kiwi

Kiwi

Aussie Reds

Australian
Commercial Dairy

Murray Grey

Australian Grey

State, Country

USA

Southern USA

Iowa
California

Washington

USA

Washington

Washington

USA

USA

Texas

USA

Wyoming

California

New Mexico

Oklahoma

North Island,
New Zealand

New Zealand

Australia

Australia

Victoria

Australia

Establishment HB, BS

1880s, HB 1924

1965, HB 1983

1948–1974,
HB1971

1965

1986

1985

1905, BS 1962

BS 1979

Input breeds	Breed Name	State, Country	Establishment HB, BS
Taurine, beef cont. Shorthorn, Hereford	Adapteur	Queensland	1953
British White, White Galloway	Australian White	New South Wales	1958, BS 1983
Murray Grey × Charolais	Chargrey	Victoria	
Hereford, Simmental	Simford	New South Wales	1970s
Hereford, Simmental	Beefmaker	New South Wales	1973
Red Angus, South Devon, Salers, Simmental, Gelbvieh, CC	Leachman Hybrids	Australia, New Zealand	
Hereford, Red Angus, Simmental, Gelbvieh	Stabilizer	New Zealand	
Taurindicine dairy Jersey × Sahiwal	Australian Milking Zebu	New South Wales	1950s, BS 1973
Holstein × Sahiwal	Australian Frieswal	Queensland	1961, HB 1983
Holstein × Sahiwal	Taurindicus	New Zealand	cont. cross
Taurindicine, beef Beef Shorthorn × Sahiwal	Quasah	Queensland	1972
Hereford × Brahman	Australian Braford	Queensland	1946–1952, HB 1956
Hereford, Shorthorn, Africander	Belmont Red	Queensland	1953–1968, HB 1968
Angus × Brahman	Australian Brangus	Australia	1951, HB 1956
Murray Grey × Brahman	Greyman	Queensland	1970s
Charolais × zebu	Charbray	Australia	
Red Poll, Shorthorn, Hereford, Devon × Santa Gertrudis, Red Brahman, possibly Afrikander	Droughtmaster	Queensland	1931, HB 1956
Aberdeen-Angus/Hereford, Friesian, Charolais × Brahman	Wokalup	West Australia	1965, BS
Poll Shorthorn, British White, Charolais × Brahman	Mandalong Special	New South Wales	
Miniature Dexter, Murray Grey, Later Friesian, Hereford, CC	Kyrhet Australian Miniature	Australia	
Shorthorn, Aberdeen-Angus	Aussie Miniature Grey	Queensland	HB 2003
Australian Lowline × Brahman	Bramalow	Australia	
unknown	Sundogs	Australia	

Input breeds

Miniature cont.
small Indian zebus

PACIFIC ISLANDS
Taurindicine beef

Hereford, Shorthorn × Droughtmaster, Santa Gertrudis, Brahman

unknown

Breed Name

Nadudana

Solomon Red

Yalavou

**State,
Country**

Australia

Solomon
Islands

Fiji, Melanesia

**Establishment
HB, BS**

1970–1980s

1984

Table S3.4. Extinct breeds (Feliuss, 1995; Porter, 2002).

Country	Breed	Remarks	Year/period of extinction
GROUP 1			
Lithuania	Polled Lithuanian land cattle	from west Lithuania	
Scotland	Orkney Fifeshire	Orkney island, comparable to Shetland Highland × South English and Dutch, from Fife peninsula	late 19 th century
England	Lord Caernarvon's breed	Hampshire	
	Earsham Polled Montgomeryshire	Belted cattle from Bungay district, extinct Welsh	late 19 th century 1919
Ireland	Irish Dun Donegal Reds Drimmon Polled Irish	grey to dun variety red variety possibly still existing black or roan landrace	1974
GROUP 2			
England	Cheshire long-horns	mixed origin, outcrossed by Durham	19 th century
	Derbyshire long-horns	course, longhaired dairy type	19 th century
	Shropshire long-horns	course dairy type, improved by Holderness	19 th century
	Dorsetshire long-horns	large, ill-shaped, red	19 th century
	Glamorgan	South Welsh	late 19 th century
	Beevilde	Lincoln Red, Shorthorn, Aberdeen-Angus composite	1950s
	Black Beevilde	Polled Lincoln Red, Polled Shorthorn, Aberdeen-Angus composite	1960s
	Sheeted Somerset	descending Lakenvelder	1934
Ireland	Irish Longhorn	possibly British Longhorn variety	
Netherlands	Sand and heather cattle	adepted to poor circumstances	early 20 th century
France	Maroillaise or Ardennais-Flamande	transitional Flamande-Bleue du Nord	
	Solzerienn Bretonne de Saint Brieux	from forests in department Nord from Bretagne, resembled early Jersey	
	Rennaise Bazougers Sarlabot	Poitevine × Bretonne cows Maine-Anjou type Suffolk Polled × local French in Normandy, recognized in 1852	2010 one cow left 1907
	Durcet	Normande type cattle × early Swiss Brown bred since 1825, outcrossed with Durham since 1838	
	Cornouailles Meusienne Eifel breed	Pied landrace in S.W. Bretagne N. French × Comtoise, Fribourg, Bernese Ardennes cows × Glan	late 19 th century
Latvia	Latvian Red Pied Latvian Light red	from Livonia	

Country	Breed	Remarks	Year/period of extinction
GROUP 3			
Netherlands	Bovian	Charolais × Blonde d'Aquitaine (experimental)	1990s
Germany	Schönwäld Westwäld Bavarian Red Sechsamt Weida Chamau Wittgenstein Blazed Siegerland Röhn Spessart Kellheim	comparable to Hinterwäld Blazed red triple-purpose Breed society 1898-1940 Bavarian Red mountain variety Bavarian Red variety Bavarian Red poor variety work breed, HB 1899 Red Highland variety Red Highland variety Red Highland variety Bavarian red blazed work breed, HB 1902	1945 late 1960s 1945
Austria	Maltein	Red land cattle × Grey Steppe origin, with curled yellow coat	
Czech Republic	Sudeten Red Kladsko-Sudeten Red Mariadvur	poor type triple-purpose highland improved crossbred Austrian Mariahof bred in Bohemia	
Slovakia	Slovakian Red	poor type from West Carpathians	
Poland	Sandeck Kreuzberg	Yellow to red and dun triple-purpose from West Carpathians small, short-headed, brown to black, outstanding work breed	
Slovenia	Pomurska Slovenian White Koruska Blond	Murboden type Austrian Blond type Austrian Blond type	1980
GROUP 4			
France	Angavine Gâtinaise Gâtinaise-Choletaise Solognote Berrichonne-Brennouse Mézensc Vivardaise Albanaise Beafort	Vandéenne work-beef variety Vendéenne beef type Vendéenne beef type Vendéenne small, poor type Marchoise × Parthenaise cross Comtoise blond breed, early 19th century Cévennes cattle-Aubrac-Quercy-Limousin crossbred landrace from Ardèche landrace from Haute-Savoie Tarentaise-Abondance intermediate or Tarentaise × Albanaise crossbred	1975 last bull slaughtered; 1975 last cow alive
Germany	Dachau Moor	from Bavarian high moorlands	
Italy	Bardigiana Cornigliese Valtarese Valtellina	from Parma, similar to Pontromolese Bardigiana variety Bardigiana variety miniature Grey Alpine	
Switzerland	Graubünden-Oberland	miniature Grey Alpine type from Swiss-Austrian border	
Austria	Bündner Mountain See	small Grey type from Albulah high Alps small Grey type from Tyrol	

Country	Breed	Remarks	Year/period of extinction
Austria cont.	Lechtal	Grey dairy type transitional between Allgäu and Montafon	
	Wipptal	Etchtal (Grey Adige) type, popular triple-purpose breed	
	Kematen	Grey type with Tuxer influence	
	Sterzing	Grey type with Tuxer influence	
	Selrain	Grey type with Tuxer influence	
	Stubai Brenner	Grey type with Tuxer influence Grey type with Tuxer influence	
Poland	Polish Brown	from Carpathian Mountains	
Romania	Obstesc	Busha type	
	German Rosie	presumed Romanian Mountain × German Red	
	Risca	Highland from high mountains fine, blond dairy type	
Croatia Bosnia- Herzegovina	Kranjsko	Busha type	
	Imljani Black	Busha type	
Serbia, Montenegro	Pester Busha		
Greece	Kerkyra/Corfu	island breed, work-dairy, in 1930s considered best dairy cattle of Greece	
	Epiros	stocky mainland type	1806-1809 reported
	Corinthian	superior breed in Peloponnesos	1806-1809 reported
	Elis/Elia	small type in Peloponnesos	
	Pieira	from Central Macedonia	
	Skópelos	from Vóreioi Spórades island	
	Skýros	from Vóreioi Sporades island	1970s
	Alonissos	from Vóreioi Sporades island	
	Giura	from Vóreioi Sporades island	
	Kyra Panagia	from Vóreioi Sporades island	
	Sifnos	from Kyklades island	
	Kythnos	from Kyklades island	
	Samos dwarf	from Kerkis mountain	1985 last observed
	Arki	from Arkoi island	
Nisyros dwarf	from Dodekánisos island	early 2000	
Cretan lowland	from central Crete	1980s	
Gávdos	Island cattle, probably related to Cretan	1990s	
GROUP 5			
France	Provençale	Camargue type around Saint-Tropez	
Spain	Agrupación Eo	from N. Asturias, small, long-horned, yellow or pied dairy-beef type	
	Leonesa	triple purpose breed from southern slopes Cantabrian Mountains, HB	around 1986 bred out by Swiss Brown
	Campurriana	Cantabrian valley	
	Lebaniega	type small hill type from West Santander	
	Marinera	early Galician type	
	Llanura	large dark colored work breed from North and Central Spain	
	Agrupaciones-Serrañas	mountain cattle from East Spain	

Country	Breed	Remarks	Year/period of extinction
GROUP 6			
Italy	Berciana Bolognese Pugliese del basso Veneto	Transitional between Grey Alpine and Podolian type comparable to Romagnola Descending of Hungarian Grey	Early 20 th
Romania	Ialomita		1960s last state herd abandoned
	Danube miniature Transylvanian Steppe	fast trotting cattle Herd book 1924	1962 last state herd abandoned
	Bucsana	Podolian-Illyrian from Carpathians	
Bosnia- Herzegovina	Tolmeind Wocheind	Podolian-Illyrian dairy cattle Podolian-Illyrian mountain dairy cattle	
Croatia/ Serbia	Posavina	Podolian-Illyrian from Sava river valley, backward curled horns	
Bulgaria	Stara Planina	Podolian-Illyrian mountain type	
Albania	Mursi	descending Bulgarian Podolian	
Greece	Greek Steppe Thessaly Piperi dwarf	from Northeast Greece akin to Katerini Steppe From Voreiroi Sporades island	2008 last herd slaughtered
Turkey	Malakan	from Northeast Anatolia, dairy type, entered from Russia, unclear descent	
Russia	Tschernomeridian Kuban-Black Sea	from Kosak region, presumed some zebu influence, neck-wither hump, long, waved coat from North Caucasus, triple-purpose	
Dagestan	Cherkassy	light built, yellowish-brown, medium long horns	
GROUP 7			
Turkey	Diyarbakir Karacadag	Anatolian Black × zebu Anatolian Black outcrossed by West European breeds	
Greece	Tinos Paros Amorgos dwarf Naxos Kos	from Kyklades island , Damascus dairy type from Kyklades island, Tinos type from Kyklades island, Tinos type from Kyklades island, Tinos type from Dodekanisos islands, descending from Tinos cattle	1980s
	Tilos dwarf Asguru	from Dodekanisos islands, Damascus type from Rhodos, large dewlap, dairy, also for work	1980s
Turkey	Urla	from Urla peninsula	
GROUP 8			
Turkmenistan	Kuramin Fergana	bred out by exotic breeds bred out by exotic breeds	
India	Brownsind	Brown Swiss × Red Sindhi (experimental)	1960s

Country	Breed	Remarks	Year/period of extinction
India cont.	Kangam Madras Red Malabar	akin to Naattukuttai South Indian dwarf zebu from Kerala	
Bangladesh	Kamdhino Maradipur	dwarf zebu Bengali dwarf zebu	
GROUP 9			
Russia	Russo-Siberian Kemerovo Siberian White	land cattle Multiple composite	1950s
China	Gaotai Yangba Tangjiao Meiniu	comparable to Menggu from Gansu from Qinhai dwarf cattle in ancient China	
Japan	Shusuku Tsuru Yoshi Tsuru Fuki Tsuru Atsuta Tsuru	Authentic Wagyu type breed variety of Shusuku Tsuru variety of Shusuku Tsuru variety of Shusuku Tsuru	
GROUP 10			
China	Bainio Jiniu		
GROUP 11			
Tunisia	Béja Ichkeul Mateur Djerba	Guelma × Brown Mountain Guelma × Charolais Guelma × Tarentaise and zebu Guelma miniature from Jerba island	
Ethiopia	Gimira	longhorned taurine type	
Togo	Avétonou	N'Dama + WAS × Gelbvieh (experimental)	
Senegal	Senegambian Shorthorn	in Casamanca extinct 1970s (experimental)	
Ghana	Ghana Dwarf Muturu	possible some left in S.E. Ghana	
Guinee-Bissau	Manjaca	West African Shorthorn	
Nigeria	Biu	taurine shorthorn bred out by Fulani zebu	
Cameroun	Bamiléké	taurine shorthorn	
GROUP 13			
Oman	Socotra	from Suqutrá island	
Malawi	Taurindicus	Tanganyika Shorthorn zebu × European	
South Africa	Ama-Xhosa	Nguni type; slaughter of complete Xosa cattle herd	1856
GROUP 14			
D.R. Congo	Wadai Dinka	Nilotic sanga type	
Zimbabwe	Pecanite	taurine shorthorn (possible European)	

Country	Breed	Remarks	Year/period of extinction
GROUP 15			
California, USA	Californian cattle		mid 19 th century
Jamaica	Creole Jamaicano	descending early Spanish import	
Costa Rica	Mysol	zebu × Criollo	
Ecuador	Costa Criollo varieties: El Oro and Esmeraldes		1970s
Venezuela	Ocampo	Brown Swiss × Criollo	
Uruguay	Colônia		
Brazil	Legítimo Mineiro Pedreiro Igarapé Angola Guadamar Malabar China Quinhentão	Crioulo do Sul type Crioulo do Sul type Crioulo do Sul Franqueiro variety, in Mato Grosso dwarf type from São Paulo possible from Portuguese colonial Angola Ongole bulls × Curaleiro tracing zebu import since 1813 from Kerala, S.W. India zebu, possible Red Sindhi bulls × Crioulo zebu, possible Red Sindhi bulls × Crioulo	
GROUP 16			
USA	Cream Pot Yellow Dane Polled Albion Single Standard Polled Shorthorn Single Standard Polled Hereford	Native cattle × Shorthorn Danish, late 18 th century Breeding Society Herd Book 1894-1918, discontinued after introduction of Double Standard since 1893, BS 1900, discontinued after introduction of Double Standard	late 19 th century
Brazil	Javanês Guzerando Suisbú Indo-europeu leiteiro Santa Gabriele	name of zebu bull, bred to Crioulo, 19 th century Guzerá × Friesian Swiss Brown × zebu zebu × taurine programme Red Pied Friesian, Devon × zebus	
Argentina	Tropicana Tropical Tarquinos	Guernsey × zebu (experimental) Holstein × zebu (experimental) Shorthorn × Criollo (experimental)	
New Zealand	Campbell Island	feral European since 1902, clones from last cow alive	1990s

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Chapter 4

On the Breeds of Cattle - Historic and Current Classifications

Felius, M., Koolmees, P.A., Theunissen, B., European Cattle Genetic Diversity Consortium & Lenstra, J.A. (2011) Diversity 3, 660-692, adapted..

On the breeds of cattle -historic and current classifications

Abstract: In a classification, breeds are described according to explicit criteria. By indicating for each breed unique features vs features that are shared with other breeds, a classification decomposes the genetic diversity into its constitutive traits. Here we review the various classifications of cattle breeds that have been proposed over the last two centuries and compare the most recent classifications with genetic data. The classifications devised during the 19th to the late 20th century were in line with Linnaean taxonomy and emphasized cranial or horn morphology. Subsequent classifications were based on coat color, geographic origin or molecular markers. Several theories were developed that linked breed characteristics either to a supposed ancestral aurochs subspecies or to a presumed ethnic origin. Most of the older classifications have now been discarded, but have introduced several Latin terms that are still in use.

A classification that integrates geographic origin, history and morphology was proposed by Felius in 1995. This classification has a worldwide coverage and proves largely consistent with the breed clusters indicated by biochemical and molecular genetic analysis, which represent either groups of breeds with a common geographic origin or single breeds that have expanded by export and/or crossbreeding. A few discrepancies indicate that the molecular classification puts more emphasis on geographic origin than the integrative classification.

1. Introduction

Represented by a worldwide population of about 1.4 billion animals, cattle are our most important livestock species. As the major source of milk, meat, hides and draught power, cattle may be considered as multi-purpose livestock. In addition, since their domestication, they have played a major role in human culture by participating in fighting games, racing and religious ceremonies. Because of the animals' size, the husbandry of cattle requires a more organized management than the keeping of other livestock, which may well have made a major contribution to the growing complexity and stratification of early agricultural societies. As with other domestic species, their dispersal over different continents and adaptation to various environments has led to the development of many types of cattle [1]. This wide variety of characteristics evolved over thousands of years, but was accentuated by the development of well-defined, specialized and genetically isolated breeds during the last centuries.

After World War II and even more so in the last quarter of the 20th century, this process has resulted in the global use of only a few of the most productive of these specialized breeds, which expanded at the expense of local, seemingly less productive populations. There is now a growing awareness that the diversity of cattle should be conserved and local breeds should be protected from extinction, although commercial interests still promote the 'industrial' breeds. However, the modern breeding techniques such as artificial insemination, cryopreservation and cloning by which the productive breeds expanded may also contribute to the conservation of local breeds. In order to make

an optimal choice during conservation programs, it is essential to describe both the uniqueness and the shared features of breeds in the form of a consistent and comprehensive classification.

Here we provide for the first time a complete review and comparison of the various classifications of cattle that have been proposed since the 19th century. The first classifications were inspired by Linnaean taxonomy and emphasized cranial and horn morphology. Subsequent classifications were based on coat color, geographic origin and molecular markers. Several theories were developed that linked breed characteristics either to a supposed ancestral aurochs subspecies or to a presumed ethnic origin. Most of the older classifications can now be shown to have serious shortcomings, but introduced several Latin terms that are still in use. The most systematic and consistent classification was proposed in 1995 by Felius [2], which has now been widely accepted (scholar.google.com/scholar?cites=12320527679514250366&as_sdt=2005&sciodt=0,5&hl=n). It emphasizes the geographic origin of breeds and turns out to be largely in agreement with the breed clusters indicated by biochemical and molecular genetic analyses.

2. On the Classification of Organisms

In general, classification is an attempt to devise a well-defined ordering of the objects that are being studied. For living species this is achieved by grouping similar organisms together in a non-overlapping hierarchical arrangement. This is the core activity of the science of systematics, which by classifying organisms describes the diversity of organisms and infers their evolutionary relationships. The first classification of living creatures was developed by the classical scholar Aristotle, who distinguished species by habitat and means of reproduction and divided animals into higher and lower classes [3]. Linnaeus in 1735 [4] laid the foundation of the modern biological classification with the introduction of a binary nomenclature (genus name followed by species name) and a definite species concept. By creating a hierarchy of orders, families, tribes, genera, species and subspecies for all sorts of organisms known at the time, Linnaeus founded the sciences of systematics and taxonomy.

The concept of evolution as proposed by Darwin was to be accepted only after 1859 and the Linnaean classification was meant to be static: all species were as created by God, essentially: "Thus the man gave names to all cattle, to the birds of heaven, and to every wild animal" (Genesis 2:20 [5]). However, several pre-Darwinian scholars had already separated biblical and natural history. As early as 1749 Buffon [6] proposed that the 200 to 300 mammalian species known by that time had evolved over a 10,000 year period by a process of degeneration of about 40 basic forms, and in 1809 Lamarck [7] published an evolutionary theory involving the inheritance of acquired properties. After the Darwinian revolution, it became common to interpret the classification of a group of organisms in the same group as a reflection of common ancestry.

Thus domestic animals were grouped together with their wild ancestor species. In the case of cattle *Bos taurus* and *Bos indicus* were classified with *Bos primigenius* and *Bos namadicus*, respectively. As we will show below, the lower-level classification of the various types of cattle is less unambiguous.

3. Why it is Useful to Classify Cattle

Classification of the hundreds of cattle breeds orders a large, seemingly chaotic variety in both appearance and performance into a consistent scheme. Placing breeds and varieties into well-defined groups reveals relations between types, subtypes, breeds and varieties. This information may be relevant for various reasons:

1. Relationships between breeds allow a reconstruction of their history. Lack of documentation on the history of cattle breeding has created room for unfounded fiction, which, once printed, has often been amplified into a general belief. For instance, the longhorned Salers cattle are assumed to have descended directly from local aurochs that are depicted with similar horns in the nearby caves of Lascaux, but molecular evidence shows a close relationship with Alpine cattle.
2. A classification may point out the uniqueness of a breed, which may be relevant to conservation. For some 20 years there has been an increasing interest in the preservation of local breeds, not only because genetic diversity may become irreversibly lost, but also because the breeds are perceived to belong to the cultural and historic heritage.
3. Breed classification will also promote a better appreciation of the value of local breeds, often adapted to their environment and suitable for extensive management. This would prevent a counterproductive introduction of highly productive breeds in regions suitable only for extensive management, which has been practised since the mid-20th century on a wide scale. Rehabilitation and revaluation of locally adapted breeds will not only result in sustainable conservation, but also improve agricultural production under local conditions.

4. Why it is Difficult to Classify Cattle

During the last two centuries several kinds of classifications have been developed in order to identify types and breeds of cattle. Several criteria have been used, such as coat color, horn size, cranial types, geography, (presumed) origin, and purpose or combinations of these. However, this nearly always resulted in a simplification that only described part of a complex reality. This not only makes such classifications largely arbitrary, but also diminishes their usefulness as described above.

Several factors complicate the classification of cattle. Most of these apply to any subspecies classification, but for domestic animals the continual intervention of humans and our perceptions of breeds introduce additional complications.

4.1. Unknown History

Written records on the history of cattle older than the 18th century are scant or do not exist. We do know that most European breeds are not older than the period of the industrial revolution, when systematic selective breeding started. Many so-called 'land cattle breeds' or 'land races' are ascribed an ancient origin, or advertised as 'known in the region since times immemorial', but are actually relatively young. Early records are available only for a few breed types, such as the English White Park Cattle and possibly

the Chianina, similar to the cattle from Lucania described by Virgil in the first century AD [8]. However, there is little documented information on the diversity of cattle before breed formation in the late 18th century, on the influence of migrations [1] and on the genetic roots of the current breeds. Presumably, genetic exchange among cattle populations was common and depended on their geographic proximity.

4.2. Gradual Differences between Breeds

Differences between breeds are not as absolute as between species, as for instance the clear-cut difference between cattle, yak and bison. Breeds not only originated relatively recently from a common gene pool, but genetic isolation is rarely absolute (see below). Even the demarcation of zebu and taurine cattle, which evolved from two different sources and are clearly different in morphology, adaptation and behavior, is arbitrary since many intermediate types are known and several breeds have been developed by taurine-indicine crossbreeding [2].

4.3. Genetic Exchange between Breeds

As mentioned already, gene flow between neighboring regions was likely to be common before breed formation in the 18th century, but clearly did not stop when cattle were partitioned into breeds. More often than not, the history of breeds mentions deliberate upgrading in order to improve production characteristics by using bulls from other populations from the same or a different country [2]. For instance, the British Shorthorn was a popular breeding sire for many European breeds in the 19th century. Now the Dairy Shorthorn has itself been crossed with Red Holstein and Danish Red, resulting in the Blended Red and White Shorthorn, while only few traditional Beef Shorthorn lines have remained pure. In other cases upgrading was minimal and transitional, like the use of British Shorthorn in the French Charolais, now one of the foremost beef breeds, or the introgression of Brown Swiss in Danish Red.

4.4. Multiple Origins of Breeds

Several breeds have absorbed other breeds or local varieties. A few examples:

- The well-known Southwest-French Blonde d'Aquitaine and the Swiss-German Simmental-Fleckvieh were both formed by amalgamating several local strains.
- Heck cattle, claimed to be a revival of the wild aurochs, were developed by a few generations of crossbreeding of dairy, dual-purpose and primitive-looking breeds.
- American and Australian cattle breeders, who are less inhibited by traditional preferences than their European colleagues, have created numerous synthetic breeds by combining European and Asian breeds from different origins [2].

4.5. Variation Within a Breed; Allopatric Development

Varieties within breeds may be more important than differences between separate breeds. For instance, the Belgian White-Blue breed includes an extremely heavy double-muscled type, a less heavy double muscled type and a dual-purpose type. For a few 'cosmopolitan' breeds, systematic breeding has led to 'allopatric development': populations are taken to another region, such as the New World, are developed in their new environment and then pass on their newly acquired characteristics to the original ancestor population. In North America the dual-purpose Swiss Brown was reformed into a single-purpose dairy breed, called Brown-Swiss, and has now influenced its parental stock. The most well-known example is of course the American development of the

black-pied dairy Dutch-Friesian, reputed because of its high milk production, into the even more productive Holstein, which then was brought back to Europe and changed the Friesian-type cattle into the Holstein-Friesian.

4.6. Changes over Time

Several breeds are different now from what they were only 20 years ago. In fact, selective breeding has accelerated the evolution of cattle to the point that the last two centuries saw more changes in appearance and production than the preceding millennia [1]. Breeding objectives are not fixed, but follow changes, for example new preferences and requirements of consumers. By the late 19th century, Dutch-Friesian cattle were of a large, refined, single-purpose dairy type; in the 1930s they were mainly of a stronger, coarser type; and in the 1950s they were of a small, deep bodied dual-purpose type. Today pure Dutch-Friesians are of a medium, milky dual-purpose type. In Holstein-Friesians, selection for extremely high quantities of milk has changed into selection for high protein content.

5. Historic Classifications

5.1. Overview

In the early 19th to the late 20th century, the Linnaean style of taxonomy with its emphasis on differences in morphology led to classifications that were based on cranial shapes and the length and curving of the horns. This could be linked to comparisons of excavated fossilized cattle skulls by archaeologists and zoologists of the 19th century. In this period presumed basic forms were granted Latin names, several of which are still in use. The lexicon of Latin designations on page 221 lists the many Latin terms that have been introduced by various authors. The most influential cranial classifications were from the German-speaking school.

Coat color was used as a criterion for classifications from 1896 and this continued until 1993. Around 1900 the morphological classifications of cattle were correlated with a supposed ethnic or historic origin, assuming that different peoples or tribes kept their own types of cattle.

For Iberian cattle breeds, standards were hardly defined until the mid-20th century with the Lidia fighting cattle being the only exception. Breeds were classified according to external type, color pattern and regional origin. Iberian authors assumed a descent from various types of aurochs in order to explain the different types of cattle [9-11].

In the 20th century the attention shifted to the economic importance of breeds. European breeds were described per country or continental region and those considered of little value were ignored. A limited number of highly productive breeds expanded at the cost of many local breeds. It was not before the late 1960s that new interest arose in local breeds and the conservation of genetic resources. This led to the compilation of livestock breed databases (reviewed by Groeneveld *et al.* [12]). In 1995 Felius published a nearly complete cattle breed encyclopedia with a classification based on a combination of geographic origin and morphological type [2].

Meanwhile, progress in genetics led to molecular classifications. After the biochemical studies of Baker and Manwell from 1980 [13], based on limited numbers of genetic markers, the last decade of the 20th century saw the analysis of more comprehensive breed panels with DNA-based markers [12]. These are now being superseded by high-throughput SNP genotyping and even genomic sequencing.

Below, the various classifications of cattle are discussed in more detail. These are not only interesting from a historical point of view, but also reflect the various regional or national perceptions of the diversity of cattle.

5.2. Cranial Horn-Type Classifications

From the late 18th century archaeozoologists became interested in the origin of domestic cattle. Assuming that the crania of cattle had stayed relatively unchanged in the course of history, different cranial types of Neolithic cattle were considered as archetypes of domestic cattle. In what probably was the first book on British cattle breeds, Youatt [14] presented in 1834 a classification based on the length of the horns as the most convenient classification: the long-horns, the middle-horns, the short-horns and polled cattle. Irish Cattle were added as a geographical group.

In 1843 Owen introduced the term *brachyceros* for shorthorned cattle [15], but in 1846 renamed it *Bos longifrons*. The Neolithic shorthorned cattle type was described in great detail by Rüttimeyer (1867) [16] who is considered as the founder of domestic animal archaeozoology. Rüttimeyer examined many cattle fossils and identified two aurochs species: *Bos primigenius* [17] and an early form of Indian aurochs denoted as *Bos namadicus* [18], which he (incorrectly) presumed to be the parental form of the *Bos primigenius*. He also proposed that shorthorned cattle represented the oldest and most widespread form of domestic cattle (*Bos taurus*) of Neolithic Europe, the origin of which had to be sought in Asia. On the contrary, Adametz [19] considered in 1898 the *brachyceros* as a genuine European wild form, but in 1926 Leithner ([20], cited in [21]) assumed a descent from local *primigenius* animals. In the course of time it became clear that all European cattle have predominantly an Asian origin and that the *brachyceros/longifrons* phenotype emerged after domestication.

Crania excavated in Norway by Nilsson (1849, [22]) were considered as yet another type of aurochs, *Bos frontosus*. However, Rüttimeyer [16] considered it as a domestic variation and reserved the term *frontosus* for a cranial form in domestic cattle as observed in Swiss Fleckvieh (Simmen-

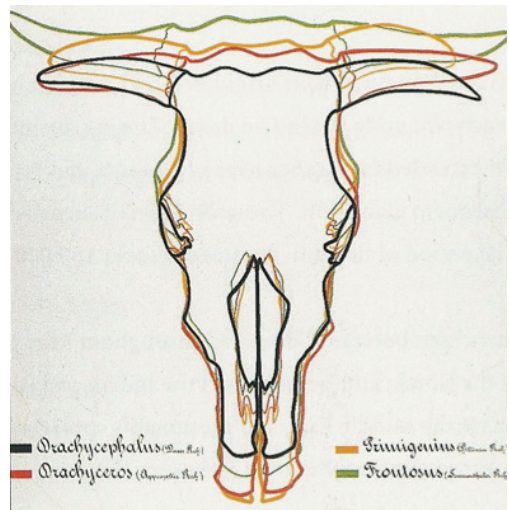


Figure 1. Basic types of cattle skulls, according to Wilckens [26]. Black, brachycephalus; orange, primigenius; red, brachyceros; green, frontosus.

tal): *Bos taurus frontosus*. Although Dawkins in 1866 pointed out that several *Bos taurus frontosus*—*brachyceros* (*longifrons*) intermediates coexisted during the Neolithic period [23], Rüttimeyer's work initiated the skull type theory as an instrument for the determination of evolutionary origin and breed classification. This was adopted particularly by the authors of the German-speaking school, who developed their classifications on the basis of the most characteristic skulls, but ignored the intermediate types of crania [24].

In 1876, inspired by Rüttimeyer [16] and Nathusius [25], Wilckens [26] based the first classification of cattle breeds on measurements of the skulls. He compared the bones of the skull and summarized his results in schedules and tables. He also introduced the term *brachycephalus* after the *Bos taurus brachycephalus*, a cranial type excavated in Italy and dating back to the Roman period. His survey covered only Central-European breeds, a few Dutch and German lowland breeds, the Galloway, Ayrshire and Shorthorn and classified cattle into strictly separate breed groups, according to four basic cranial types (Figure 1, Table 1(A) and Appendix Table S1).

Several scientists elaborated or modified this classification. In 1912 Werner [27] used the term *B.t. longifrons* (long-headed) instead of *brachyceros* and elaborated the classification of Wilckens with a detailed regional subdivision in *Rasse* and *Unterrasse*, each given a Latin name (Table S2). Note that in agreement with Rüttimeyer [16], Wilckens [26], Werner [27], Adametz [30] and Dürst [32] classified the productive lowland dairy breeds in the same *primigenius* group as the steppe cattle.

In 1898, after having excavated a hornless cranium, Arenander [33] proposed another ancestral type, *Bos akeratos* for hornless aurochs, which he assumed to be the original European aurochs and the ancestor of both polled and horned cattle. This was still referred to in 1928 by Auld [34], but was not generally accepted (*e.g.*, see [35]).

(A)			
German name	Latin name	Description	Typical breed
Primigeniusrind	<i>Bos taurus primigenius</i>	aurochs type	Podolian Grey Steppe cattle, lowland dairy breeds, Galloway
Langstirnring	<i>Bos taurus brachyceros</i>	shorthorned	Grey and brown mountain breeds
Grossstirnring	<i>Bos taurus longifrons</i>	broad-headed	Simmental
Kurzkopfrind	<i>Bos taurus frontosus</i>	short-headed	Hérrens, Tuxer
	<i>Bos taurus brachycephalus</i>	crossbred	Pinzgauer, Mariahofer
	none	land cattle	
(B)			
	Latin name	Description	Typical breed
	<i>Bos taurus akeratos</i>	hornless	All polled cattle
	<i>Bos taurus macroceros</i>	longhorned	African zebu, sanga breeds Iberian Barrosa, Minhota, Alentejana, Brava

Table 1. (A) Classification according to Wilckens [26] and Werner [27] and (B) additional types according to Dürst [28], the first of which was also adopted by Keller [29], Adametz [30] and Holecek Holleschowitz [31].

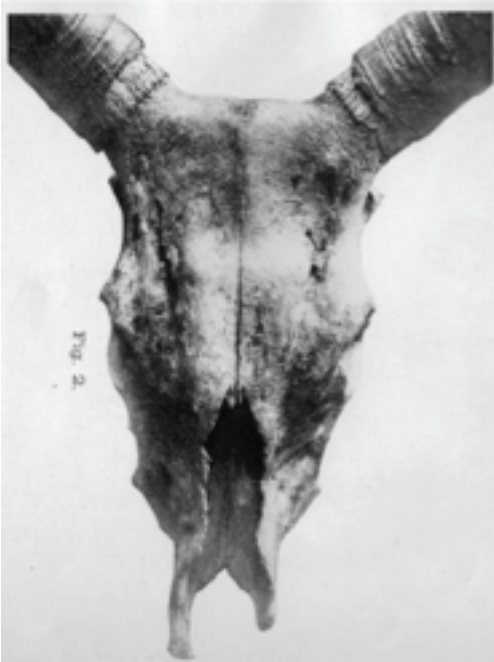


Figure 2. Cattle skull of the *macroceros* type, according to Dürst [28].

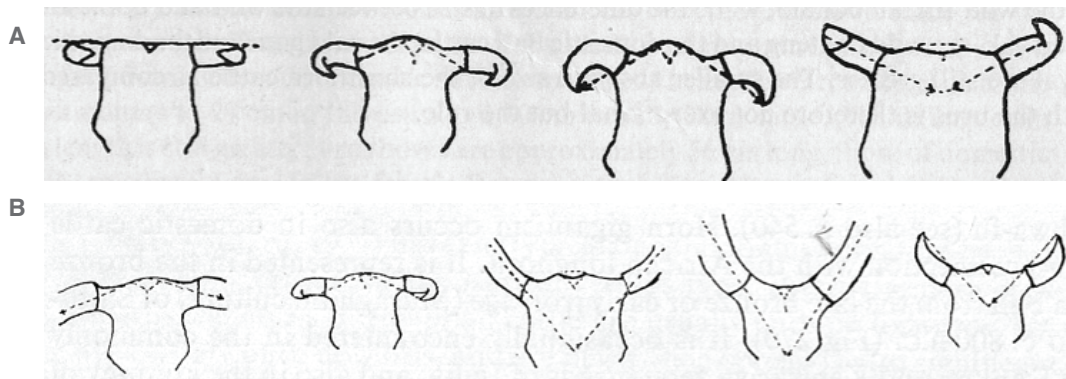
The term *akeratos* was adopted in 1931, not as an aurochs variant, but as a basic form by Dürst [32], who examined a large number of ancient and modern crania from Europe, Egypt and Mesopotamia. Dürst [28,36] also added a long-horned *B.t. macroceros* type to the classification of Wilckens (Figure 2 and Table 1(B)). This included both Western and Eastern African together with Iberian crania, all of which he found to be similar.

Keller [29] in 1905 combined the type of cranium and horns with coat color and geographic origin. Like Rüttimeyer [16] he believed that the *primigenius* type of cattle descended from the European aurochs and shorthorned cattle have an Asian origin. Also in agreement with Rüttimeyer [16], the *primigenius* group included in addition to the steppe and lowland cattle the *frontosus* type. In his system (Table S3), the *brachyceros/longifrons* (shorthorned), *brachycephalus* (short-headed) and *akeratos*

(hornless) types were sister taxa of the *indicus* (zebu), *africanus* (sanga) and *longicornis* (longhorned sanga), all preceded by *Bos sondaicus*, as he believed these types to be of banteng origin. This idea, as well as the belief that the *brachyceros* type had lost its hump in the course of time, did not gain much ground, but the proposed close relationships between the short-headed and shorthorned types were later confirmed by molecular evidence (see below). Further, Keller did not believe in the existence of an African aurochs.

The resemblance of early African crania to those of modern European breeds noted by Dürst [28] was also observed by Adametz in 1926 [30], who compared crania of Apis bulls from the Egyptian culture with those of modern cattle. Adametz [30] applied the term *Bos primigenius* var. *Hahni Hilzheimer* to presumed Egyptian wild cattle, which he considered to be the ancestor not only of northern, eastern and southern African cattle, but also of several European breeds: Andalusian cattle, the Salers from Auvergne, other South-French breeds, Scottish Highland, the British Devon, Longhorn, Hereford and Welsh Black and short-headed Walliser type cattle (Hérens, Tux-Zillertaler, Pustertaler and Pinzgauer). Like Keller [29] and Duerst [32], Adametz [30] recognized Arenander's *akeratos* [33] as main cattle type and included within this group the shorthorned specimens from the polled northern Swedish Fjell (mountain) breed. Further, he believed that *brachyceros* cattle were descended from a wild *Bos europaeus* (*brachyceros*) closely related to *Bos primigenius*. He stated that this was the most widely accepted classification among livestock scientists.

Figure 3. Types of crania and horn implant after Duerst (shown in [15], pp 239, 320). (A) Variation in the shape of the Torus frontalis and intercornual ridge as depending on the direction of the horns. (B) Horn shapes combined with a long processus cornu ossis.



In 1926 Duerst [28] differentiated several different cranial types ([15], Figure 3). He pointed out that variation in the region of the poll (*Processus cornu ossis frontalis/Torus frontalis*) is determined by the horn. Long and heavy horns result in a stretched, flat line between the horns; light weight horns result in a vault. This is more pronounced if horns are lighter and becomes a bump in polled cattle.

In 1939 Holecek Holleschowitz [31] accepted the same five basic types of European cattle as Adametz (Table 1), but without the *macroceros* (Table S4). Following the example of French authors (see below) he linked cranial types of cattle to ethnic origin.

In 1963 Zeuner [21] proposed that in several modern breeds the *primigenius* or *longifrons* type was relatively well preserved, but that most breeds had become mixed types. However, he chose other prototype breeds [38]: Brown Mountain, Jersey,

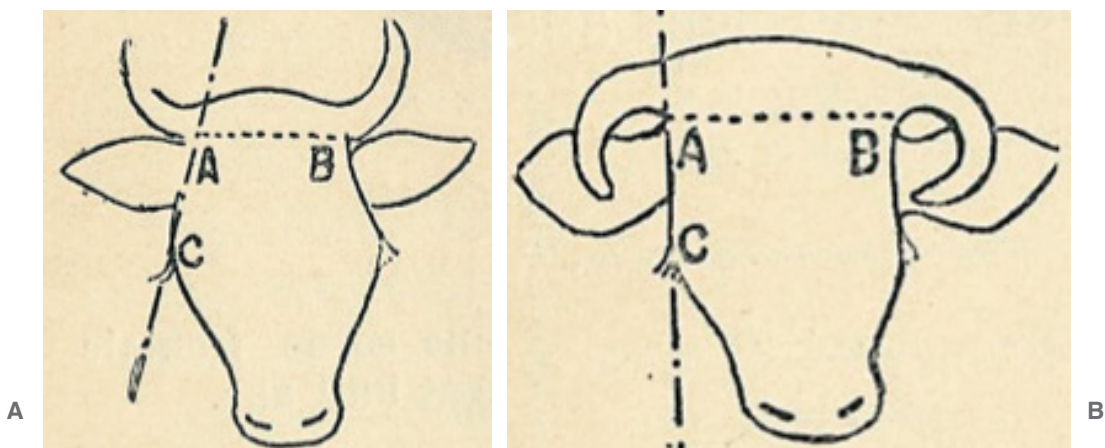


Figure 4. Basic types after Sanson [39] and Diffloth [40], (A) dolichocéphale: $AC > AB$; (B) brachycéphale: $AB \geq AC$

and Shorthorns showing the *longifrons* type and Hungarian-Podolian steppe cattle, Romagnola, Scottish Highland and Spanish fighting bulls of the *primigenius* type. In Black-Pied Lowland cattle he found the full range from *primigenius* type to *longifrons* type.

A different line of thought was developed in France. Sanson in 1884 [39] and Diffloth in 1914 [40] classified cattle according to their cranium, the form of the poll and horn implant and the length and form of the horns. These cattle skull types (Figure 4) were linked to human skulls types: *dolichocephalus* (long-headed) people were accompanied by long-skulled cattle and *brachycephalus* (short-headed) people by short-skulled cattle. Both the long- and short-headed ethnic groups were subdivided into six tribes that belonged to a certain region.

Thus Sanson [39] recognized 12 geographical types of cattle, the *dolichocéphale* types *B.t. batavicus* (Dutch), *germanicus*, *hibernicus* (Irish), *britannicus*, *alpinus* and *aquitanicus* and the *brachycéphale* types *B.t. asiaticus*, *ibericus*, *liguriensis* (Ligurian), *arvernensis* (Auvergnat), *jurassicus* and *caledoniensis* (Scottish) (Table S6). Diffloth [40] replaced the *liguriensis* with the cattle from *le bassin de la Loire* (Table S7).

Also McKenny Hughes (1896, [41]), Kaltenecker (1904, [42]) and Wilson ([43], 1909) linked the cattle cranium types to ethnic origin. Kaltenecker [42] replaced the term *brachycephalus* (short-headed) by *latifrons* (broad-headed), *frontosus* by *grandifrons* (large-headed) and *primigenius* by *planifrons* (flat-foreheaded) and kept the term *longifrons* for long-headed cattle. By referring to the form of the crania only, Kaltenecker tried to maintain a consistent nomenclature (Table S8). Wilson [43] only recognized the *primigenius* and *longifrons* as basic types, but also considered coat colors (see below).

Dechambre (1913, [44]) combined the ethnic origin hypothesis from Sanson [39] with a classification proposed by Baron, the so-called *coordonnées baroniennes* [45]. In this system cattle breeds were arranged according to three main criteria: morphology (body profile, proportions, size), color (coat, muzzle, mucosa), and production type (Table S9). Dechambre [44] recognized three frontline silhouettes of the skull; each of these having three different sizes of horn, which were subdivided into medium long and long horns and then divided into three types of bending (Table S10). This classification was adopted by the Larousse encyclopedia ([46], Table S11).

5.3. Coat Color

Coat color and pattern are the most obvious characteristic of cattle, at least for non-experts. Coat characteristics were also considered to indicate genetic purity and are relevant for the 'branding' of a breed. For instance, different color patterns of early 20th century cattle in the Netherlands were instrumental in the formation of Dutch breeds. The important role of color and pattern is reflected in several breed names and provides an easy key for classification. This was adopted particularly by British scientists, who largely ignored the German cranium theories. Probably inspired by their island status, they emphasized supposed contributions of various immigrant peoples to their cattle stock as a key for classification. McKenny Hughes [41], as the Aistrian Kaltenecker [42] and Wilson [43] had strong, albeit unfounded ideas on the relation

between the coat color of cattle and different ethnic groups that successively entered the isles. Celtic cattle were supposed to have been black, the Roman white, the Anglo-Saxon red and the Scandinavian light dun (brownish grey), while the broken colors were thought to originate from Dutch imports during the 17th and 18th century [43].

Kaltenegger [42] as well as Müller in 1957 [47] linked coat color of Austrian breeds to immigrations of ethnic groups with cattle of a specific type (Table S12).

Dechambre [44], who based his classification on the profile of the head and type of horns (see above) used coat color as a secondary criterion, specifying many types of color, patterns and marks as well as the different pigmentations of the muzzle and extremities. So far classifications tended to neglect the Iberian breeds. Most German, French and British authors differentiated Andalusian and north-western blond-brown cattle types, but only described a few breeds from these regions. Duerst [32] classified the Barrosa, Minhota, Alentejana and Brava as African longhorned breeds in Europe. In 1907 Miranda do Vale [48] added more ethnic types, 'truncos', to the list of Sanson [39], among which were *B.t. aquitanicus*, *B.t. ibericus* and *B.t. atlanticus*. In several publications after 1945 Spanish and Portuguese authors recapitulated the 19th century classifications according to skull and presumed origin. Again a descent from a wide variety of hypothetical aurochs was proposed with a liberal use of Latin names.

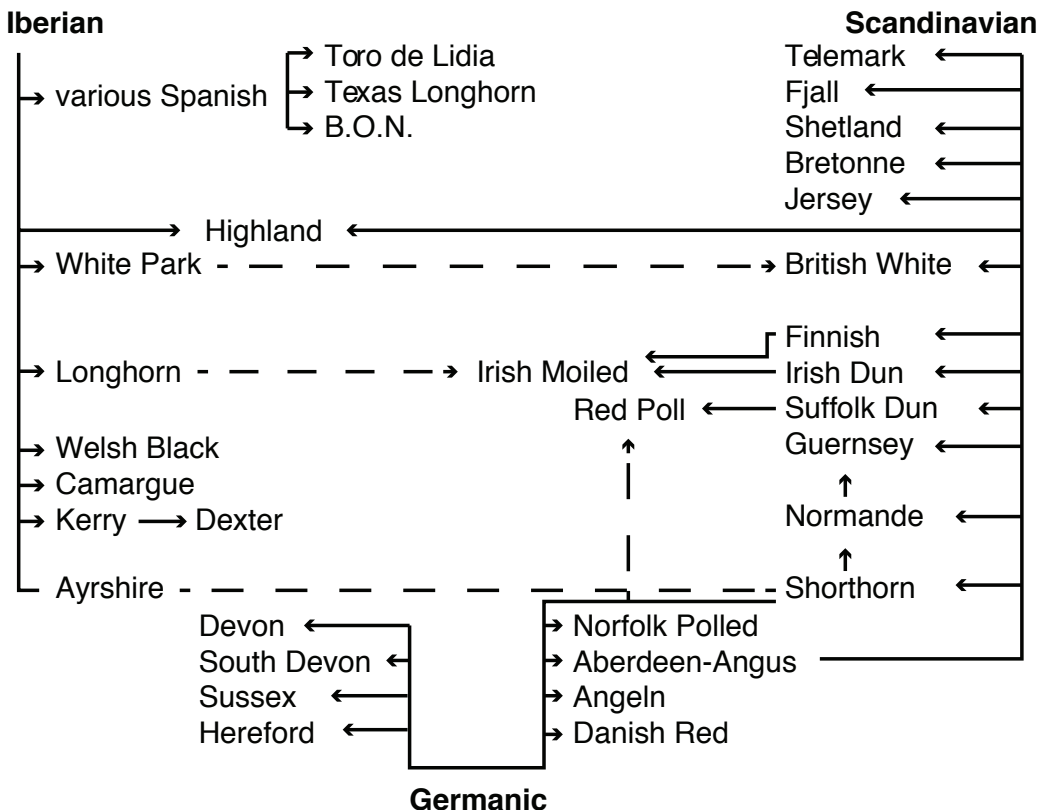


Figure 5. The three branches of Alderson [53]. Broken lines indicate slight or possible influence.

Aparicio Sánchez [49] in 1946 designed a phylogenetic tree for a number of Spanish breeds in which each cluster of breeds was supposed to originate from a hypothetical aurochs variety, such as *B.t. ibericus*, *B.t. desertorum hispanico*, *B. braquiceros Europeo* and *B. braquiceros Africano*. A more modern classification in Sanchez-Belda in 1981 and 1984 [50,51] combined skull, coat color and region and recognized four branches of Iberian cattle, one of which is supposed to be related to North-African Atlas cattle (Table S13). All this did not result in a generally accepted classification or an agreement about the aurochs types to which the breed clusters were linked. Although none of the theories is consistent with molecular evidence, a catalogue of the recognized indigenous Spanish domestic breeds of 2008 [52] still mentions many of the hypothetical aurochs and derived bovid forms as the forebears of the color branches and even of certain breeds.



Figure 6. White-backed patterns in cattle of different origins. (A) Tux-Zillertal (white finched); (B) Black Berrenda (Pinzgauer type white-backed); (C) Blacksided Trondheim and Nordland (color-sided); (D) Dagestan Mountain (white headed, color sided); (E) Ennstal Bergscheck (half white, color-sided) and (F) North Finncattle (color pointed).

Coat color was also important in the first classification of European cattle by Alderson from 1977 [53]. He followed the British tradition (see above) of linking the classification to prehistoric and historic immigration of people and their cattle. His chart (Figure 5) shows three branches: Iberian, Scandinavian and Germanic. However, DNA analysis did not confirm an Iberian-British connection [54,55]. Furthermore, a Scandinavian influence on British breeds would have implied that Scandinavian immigrants imported substantial numbers of their cattle into countries with a long tradition of cattle husbandry. In 1992 Alderson [56] proposed other historical connections on the basis of an integrative classification (see 6.2.1).

The first detailed report of the Animal Genetic Data Bank of the European Association of Animal Production (EAAP) in 1993 listed breeds of major animal species, with attention being drawn to the risk of extinction [57]. The breeds were classified in 10 main groups,

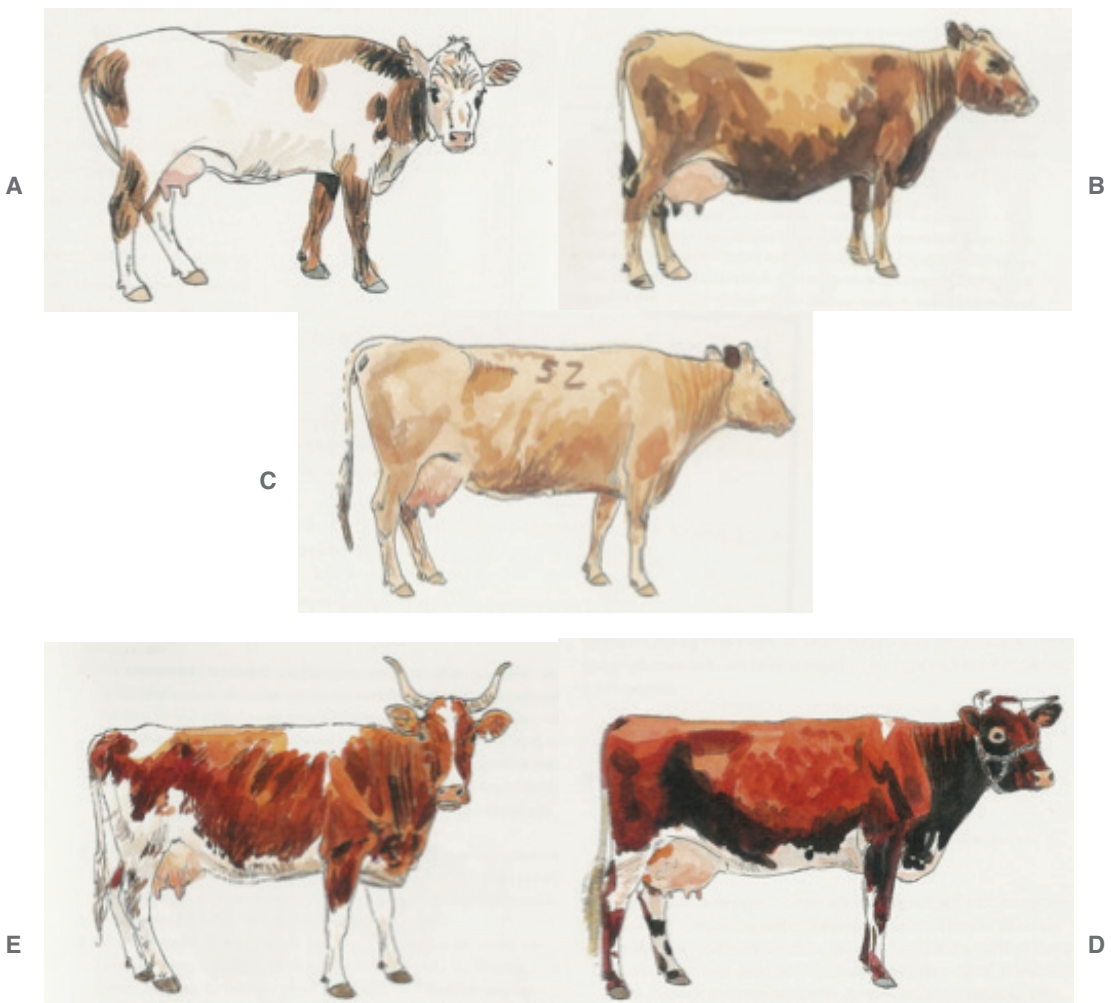


Figure 7. Different colors and patterns in Nordic-Baltic cattle. (A) Icelandic; (B) West Finncattle; (C) Estonian Native; (D) Norwegian Red and (E) Swedish Red-and-White.

mainly on the basis of coat color. Subgroups gave a more precise characterization of the color patterns, geographical origin and genetic relationship (Table S14). The emphasis on coat color is in several cases not plausible and makes this categorization inconsistent. A few examples follow:

- The Original Black-Pied group (1.2) contains the German, Estonian and Lithuanian Black-Pied breeds, all descending from Dutch-Friesians, but also the Italian Aosta Black-Pied and Bretonne Pie-Noir, which have no other link to the Friesian type of cattle than their color pattern.
- There is also no resemblance, even in coat color, of Faeroes cattle with the Spanish semi-feral brown mountain breed Albera and the crossbred population Marismeña (former Mostrenca) or with the crossbred Corsican island cattle and the French commercial breed line INRA95.
- The Austrian Tux-Zillertaler is considered similar to the North Finncattle, Norwegian Black-sided Trondheim and Nordland, the Spanish Black Berrenda and Dagestan/Georgian Mountain cattle. However, apart from sharing a white stripe on the back, there is no other similarity (Figure 6) or historical relationship.

A few breeds do not even have the color of the group into which they are included. Subgroup 4.4., Scandinavian Red, includes the multicolored Icelandic cattle, the yellow-brown West Finncattle and Estonian Native, the Norwegian Red (consisting of red-and-whites and black-and-whites) and the red-pied Swedish (Figure 7).

- Breeds of the Iberian Red groups (4.6) are as brown as the Iberian Brown cattle (5.4) group.
- In subgroup 2.2, Aberdeen-Angus and German Angus are either black or red, while the Australian Murray Grey is dun (brownish grey).

Phenotypic classification makes more sense with transboundary breeds of recent common origin. Dutch-Friesian Black-Pied is almost indistinguishable from Sortbroget Dansk Malkekvaeg [Jutland Black-Pied], Nizinna-Czerno-Biala [Polish Black-and-White], Prim'Holstein and Pie-Noire-Holstein as well as most other European Dutch-Friesian/Holstein-like breeds. However, other black-pied breeds have independent histories: the French Bretonne Pie Noir [Breton Black-Pied], the Italian Valdostana Pezzata Nera [Aosta Black-Pied], the Russian Kholmogory, the Syrian Jaulan, the Indian Ponwar and Deoni, the Baoulé of West-Africa, as well as subtypes of Fulani, the (multi colored) Nguni and several other African breeds. Another popular transboundary breed is the Swiss Simmentaler, which in other countries is known as Fleckvieh, Česky strakatý, Simentalska or Sychevka.

5.4. Geographic Origin

In 1860 Fitzinger [60] proposed that there were at least seven geographic forms of domestic cattle. Besides the Indian zebu and African humped cattle he recognized Alpine, valley, polder, steppe and Scotch types. Their Latin names (*Bos alpium*, *scoticus*, *friburgensis* etc.) even suggest separate species status and were cited in the influential standard work on zoology of Brehm, which appeared in several editions from 1860 to 1925.

In 1998 Bougler [58] presented a classification of French cattle with coat color as the most important criterion (Table S15), which in 2009 was still cited and considered *assez consensuelle* [59].

We have already mentioned the geographical subdivision of two cranial basic types described by Sanson [39] and Diffloth [40]. Ramm (1901, [61]) described a geographical classification according to both country or region and altitude (Table S16), which resulted in a practical inventory rather than a zoological classification. A similar geographic categorization was published in 1920 by the Belgian Zwaenepoel [62], who considered the division into mountain, lowland and in-between breeds dating from Thær [63] as the most simple and practical one (Table S17).

Hengeveld [64] classified the Dutch cattle in 1865; first according to soil type, by province. Thus he recognized cattle varieties from (1) clay and sandy clay, (2) peat-soil and cultivated sandy soil, and (3) poor sand soil and heather (moor). We note that only in 1906 three different strains of Dutch cattle were recognized [65], which in 1965 were considered to be separate breeds.

The need for developing agriculture after World War I inspired several German writers to classify according to region in combination with purpose ([66,67], Table S18). Thus breeds were divided into high productive dairy, beef and dual-purpose types, lowland or highland, or classed as low productive triple-purpose land cattle types. In the decades after WW II breeds that were small in number or regarded as unproductive were amalgamated, most notably in France, Germany, Austria and Italy. At that time interest in local breeds was at its lowest point.

Also the classification from 1966 of French breeds ([38], Table S19) is strictly geographical. The European breeds are described by country, disregarding their origin (local or imported):

- Scandinavian and North-European group
- United Kingdom and Ireland
- North Sea and Baltic Littoral
- Western Europe
- Alpine Europe
- The Iberian Peninsula and Italy
- The Balkans and Turkey
- U.S.S.R.

5.5. Cattle outside Europe

5.5.1. Africa

A first classification of humped cattle in Africa was proposed by Epstein (1933, [68]) and developed further by Curson and Epstein (1934, [69]). This classification has been generally accepted. Humped cattle were classed into true zebus of Asian origin and crossbred pseudo-zebus or sanga. This use of the term sanga was introduced by Keller [29] and came from designation *Bos Zebu africanus Sanga* for the Galla breed [60]. True zebus were sub-divided into the lateral-horned and the short-horned. Epstein [68] also quoted Bisschop (1937, [70]), for whom the anatomical structure and situation of the

hump provides one of the principal clues by which the parentage of crossed types can be traced. Curson and Epstein [69] divided taurine cattle into Longhorns (traced to the Hamitic Longhorn) and Shorthorns, which were thought to have entered through Egypt from Southwest Asia [71]. Although these views would change, this division of taurine cattle was generally accepted.

Table 2. Classification of African types and breeds.

Doutresoulle, 1947 [72]	Mason, 1951 [71]	Joshi et al. 1957 [73]
1. Taurine	1. Humpless a. Lake Chad cattle b. Small Humpless cattle c. Humped × humpless crosses	North-African and Egyptian humpless and vestigially humped (Egyptian, Libyan, Brown Atlas) Humpless with bulbous horns (Lake Chad cattle) Humpless, straight-backed West-African (N'Dama, West-African Shorthorn)
2. Zebu	2. Humped Cattle (zebu)	Sub Sahara (Indo-Pakistani type) zebu
a. Zebu with short horns (influenced by brachyceros) 5 tribal strains)	a1. Shorthorned zebu (North Sudan, a2. Medium-horned zebu	1. Medium and shorthorned
b. Lyre-horned zebu type (N'Dama × shorthorned zebu)	b. Lyre-horned zebu	
c. Long-lyre-horned zebu	2. Lyre- and longhorned (Fulani, M'Bororo) c. Sanga zebu (zebu × Hamitic longhorn)	Central and southern African Sanga (9 tribal named types) East-African cattle, predominantly zebu (9 tribal named types) Africander, Madagascar zebu

Doutresoulle [72] described in 1947 the breeds of the French territories south of the Sahara. He divided the region into climate zones and classed cattle into two main groups: taurine breeds (*les Taurins*) and the zebu (*le Zébu*), the latter all intermixed with taurine cattle and divided into three main types (Tables 2, S20). Mason [71] classified the breeds of West-Africa, covering the same area but with a more refined classification (Tables 2, S21). Joshi *et al.* [73] inventorized African types and breeds of the entire continent, using region and morphology as first and second criterion, respectively, for classification (Tables 2, S22). According to Joshi *et al.* [73], the East-African cattle are a heterogeneous population, composed of groups without clear demarcation. The Africander is a clear separate type, while the Madagascar zebu has a separate location. A publication by the British Colonial Office in 1957 also classified the cattle of 'British dependant Territories' according to geography followed by morphology. The zebu of East, Central and South Africa are divided into (a) the chest-humped or thoracic humped Indo-Pakistani or true zebu, and (b) the neck-humped or cervico-thoracic humped African zebu. The sanga is classified as a West-African type (as by Doutresoulle [72]), and indicated without a cervico-thoracic or thoracic placed hump (Table S23). In 1960 Mason and Maule [74] refined the classification of West-African and East- and

South-African humped cattle respectively. They emphasized the form and place of the hump and the horns. Rege and Tawah (1999, [75]) listed all recognized African cattle breeds and refined the previous classifications, also describing many more Ethiopian and Kenyan breeds than before and introducing the term zenga for zebu-sanga intermediates.

5.5.2. India-Pakistan

Olver (1938, [76]) related the different types of zebus on the Indian subcontinent to the migration of people into India in prehistoric times, as along the various migration routes characteristic zebu types are to be found. Some of these must have been in existence prior to these invasions. Thus he distinguished four types, consisting of different breeds and varieties, and one separate breed:

1. Large white cattle of the north.
2. The distinct Mysore type of the south.
3. The 'highly peculiar' Gir of Kathiawar and the west of India.
4. Small black, red or dun cattle found all over India, mainly in hilly tracts and forest areas.
5. The Dhanni breed of the Punjab.

Joshi and Phillips [77] based their classification of 1953 on these types and developed a listing of six groups (Table S24):

1. Lyre-horned; wide forehead with flat or dished profile; deep body; grey color; powerful animals.
2. Shorthorned; long, coffin-shaped skulls, slightly convex profile; white or grey color; the best dairy cattle.
3. Curled, often lateral horns; ponderous build, loose skin; red or red spotted
4. Mysore cattle: long, pointed horns, rising close together; prominent forehead; poor milkers.
5. A heterogeneous mixture found particularly in rugged mountainous areas of India and Pakistan.
6. The Dhanni breed from Pakistan.

5.5.3. China

In 1969 Epstein [23] published the first classification of Chinese cattle breeds in a western language, describing yak, water buffalo and the several breeds of 'yellow cattle' (Huang Niu for all forms of taurine or zebu cattle) as the most widely distributed bovines. Yellow cattle have the highest concentration in Inner Mongolia and the north-east. The cattle from northern, central and southern China differ mainly in body size, presence or absence of a hump, and, where a hump is present, in its size and position (see Table S25).

In 1986 Cheng [78] divided the 'Bovine Breeds' of China into Yellow Cattle, Developed breeds and Introduced breeds, as well as Yak and Buffalo. Indigenous (Yellow) breeds were classified according to regions and climatic zones:

1. Humpless:
 - a. highland cattle,
 - b. steppe cattle,
 - c. Manchuria cattle;
2. Central Chinese Yellow in a region of moderate climate;
3. Southern Chinese zebu in the sub-tropics and tropics.

5.5.4. Tropical and Subtropical Cattle

Classifications of tropical and subtropical cattle include in addition to African and Asian breeds also breeds from the Americas and Oceania. Payne (1970) and Payne and Hodges [79] classified the cattle of the tropics and subtropics according to continent and then according to region. Within a given region, the cattle are divided into (1) humpless, (2) humped, (3) crossbreds (stabilized indigenous, intermediate and recent) and (4) of Bovine origin (gaur-gayal, banteng-bali cattle). They [79] subdivided the humped cattle of the Indian subcontinent according to purpose, and the West-African humped cattle according to length and form of horns. The crossbreds were subdivided into old types, types which are still in progress of formation and recently formed. However, West-African crossbreds are sub-divided on the basis of their origin.

Maule [80] constructed a different classification with five groups (Table S26): zebu, sanga, humpless, humped × humpless and Bovine cattle. A subdivision into subgroups indicated the locality: (Indo-Pakistan, African, Brazilian, Middle and Far East, *etc.*) of a regional type or breed (Brahman, South-African Longhorned, Humpless Cattle of West and North Africa, *etc.*).

6. Modern Classifications

6.1. Biochemical Markers

Scientific progress after 1970 allowed a new approach to the classification of cattle: the comparison of molecular markers such as blood groups and other biochemical polymorphisms. Using data on 10 polymorphic proteins Baker and Manwell (1980) [13] compared allele frequencies in 196 breeds and proposed 10 well-defined groups of cattle breeds (Table S27), stating that “breed groups are alluded to frequently in both historical and modern writings on cattle. The groups usually infer relationship; but, in the absence of well-documented historical information, the breed groups largely depend on morphology or geography. The chemical data support the morphological and geographical division of cattle into major breed groups.... The coherence within the groups and the differences between groups are often impressive. In some cases paradoxical distribution of rare genetic variants can be explained by more detailed inspection of breed history”.

The names of the seven European breed groups: Baker and Manwell use [13] were clearly inspired by the German cranial classification and indicate a correlation with previous classification criteria: North-Scandinavian (geographic region); Pied Lowland (color pattern and altitude); European Red *brachyceros* (continental, color and type of origin); Channel Island *brachyceros* (geographic region and type of origin); Upland *brachyceros* (altitude and type of origin); *Primigenius-brachyceros* Mixed (a mix of presumed original types, although more likely a rest group of related or unrelated breeds); and *Primigenius* (aurochs, original type).

They left open the question of whether the Red Flemish belongs to the Pied Lowland from the same region or to the European Red *brachyceros*. In the 19th century this breed was spread over a much wider region than today. In the Ardennes they were connected to red cattle from Germany. Currently, remnants are confined to the west of Belgium (West Flemish Red) and northwestern France (Red Flemish) and have been

influenced by the pied cattle in the same region. All these breeds were also influenced by imported Durham, Dutch-Friesian and later MRY sires. The Baltic Red breeds, such as the Latvian Brown, were strongly influenced by Angler and Danish Red, but not by the French or Belgian Red breeds. So the breeds' history argues against a grouping of the red dairy cattle from Belgium and the Baltic coast. Baker and Manwell [13] further classified within the European group breeds from other continents with a recent history of crossbreeding: the Asian Ala-tau, several American Criollo breeds, Mexican Fighting cattle, Texas Longhorns and the Cuban Tinima breed.

Two authors applied the biochemical approach to Iberian cattle. Vallejo *et al.* in 1990 [11] typed 10 genetic blood markers in 13 native Spanish breeds, while Fernández *et al.* (1998, [9]) analyzed 11 blood proteins in 10 breeds from Galicia and northern Portugal. A number of breeds are shared by both studies, but with different outcomes (see Figure S1). Vallejo *et al.* [11] indicate that quantification is difficult because of the short evolutionary distances (Table S28). Although biochemical comparison provides evidence for a number of close relationships between breeds, their interpretation in prehistoric terms lacks scientific support.

Using 13 biochemical polymorphisms Grosclaude *et al.* [81] classified eighteen French breeds into three regional groups plus the Normande as a separate breed (Table S29). This classification is different from the coat-color based classification of Bougler [58] or the geographic classification of Denis and Avon [82] (see below). The biochemical classification from 1990 was in 2010 adapted by Gautier *et al.* [83], who recognize both the Normande and the Bretonne Pie-Noir and Parthenaise as separate breeds next to three previously recognized groups (Table S30).

6.2. Integrative Classifications

6.2.1. Alderson (1992)

In 1992 Alderson [56] integrated the color-based classification with archaeological, socio-historical, and morphological as well as biochemical evidence (Table S31). He included only (supposedly) pure representatives for categorizing types and breeds of cattle in Europe, thus excluding Rubia Gallega as it was influenced by the Shorthorn and South Devon. This rule was not applied rigidly however, as the German Yellow (Gelbvieh), the French Blonde d'Aquitaine and the Portuguese Minhota, recent breeds of mixed origin, were still included in his Central Europe Yellow-Brown group. Minhota is indeed related, if not identical, to German Yellow, because of the frequent use of German sires in Portugal [2,12].

6.2.2. Denis and Avon (2010)

In 2010 Denis and Avon [82] amended an earlier classification of French cattle which was clearly inspired by the classifications of Sanson [39] and Diffloth [40], but combined geography, morphology and origin. Denis and Avon [82] acknowledged the new insights offered by molecular-genetic comparison of breeds.

6.2.3. Felius (1995)

In 1995, Felius [2] developed a comprehensive classification of bovine domestic breeds, varieties as well as wild species and their hybrid forms (Table S33A, Figure 8). This classification is based on morphological, geographical and historical data

[15,23,74,84,85]. It also builds on the classifications developed for Indo-Pakistani zebu and African cattle zebu cattle [73,77]. After a previous classification of 470 breeds into 16 groups [86], the classification from 1995 puts more emphasis on geographical location and covers 700 breeds. It is supported by water colors made by the author, which for all breeds are on the same scale and focus on visible external differences and similarities. Water color paintings instead of photographs enable the use of a wide range of sources and the maintenance of a uniform standard of illustrations for all breeds throughout the book. Table S33B presents a slightly revised classification.

Of the three criteria for classification, geography is proposed to be the most important. The breeds have been arranged first according to continental origin, which is plausible because cattle from different continents are likely to have developed relatively independently (isolation by distance). Exceptions are made for breeds near the continental boundaries. For instance Podolian steppe cattle are found in south-eastern Europe and in the Asian part of Turkey, while Egyptian cattle seem to form a transitional type between the breeds of North Africa and Mediterranean Asia.

Next, breeds of each continent are classified on the basis of a subdivision of the continent into regions with different climates, altitudes and/or agricultural systems. For instance, the West-European Lowlands, the Central European Highlands, the Iberian Peninsula and the Balkan all harbor different types of cattle (Figure 8). As appropriate, regions were subdivided, but at this level history and morphology are becoming more important. All the groups and subgroups are arranged in a northwest-to-southeast order (Figure 8).

Within geographical groups, breeds were subdivided according to the breed history. Breeds are indicated to be old (local, authentic), modern or recently formed. The breed history often indicates a common origin of a group of breeds, which is a most evident criterion for classification. If the breed history involves crossbreeding to sires from other regions to the point that the breed characteristics reflect the paternal origin, the historic criterion overrides the geographical classification. For instance the Ayrshire, which is of mixed origin, is classified with the Scandinavian breeds whose development it has influenced. However, the Maine-Anjou, which essentially has become a Shorthorn type, is classified with the other breeds of Bretagne and Normandy as it was developed on the now extinct local Mancelle breed. Further, Portuguese Minhota, which was heavily influenced by the German Yellow, is still classified in the group of northwest Iberian blond breeds as it was founded on the Galician Blond.

For American and Australian import breeds that have well documented histories, geography and history are not considered and are replaced by production traits as classification criteria. However, in the subgroups, the country or region of origin as well as the period in which they were imported are also relevant for classification.

For the final subdivision, morphological criteria are taken into account. This recognizes that animals from most breeds can be identified by their appearance, which is also specified in the breed standards. If two or more recognizably distinct breed types are found within one region, separate groups or subgroups have been defined. However, only a few breeds are so unique in their morphology that they stand

Figure 8. Classification of European breeds of *Felius* [2] (Table S33). Only breeds are shown that also have been classified by genetic analysis (Figure 9). In the three-letter code, the color of the first letter indicates the group according to the color key and the second and third letter the subgroup.



Figure 8. Cont.

Groups	Subgroups
Northern Polled, Celtic	Nordic Polled / Longhorned Dairy / British Polled / Celtic
North-Western Lowland	Lowland Red / Lowland Pied Dairy / Lowland Pied Dual Purpose / British Shorthorn / English Lowland / Channel Island, NW France
Western-Central Highland	Vosges, Black Forest / Highland Red / Shorthorned Alpine / Central-European Yellow, Blonde / Broadheaded Spotted / Charolais
Highland Solid-colored	Middle France / SW French, Pyrenean Grey, Blonde / North-Italian Fawn-Brown / Central-European Brown, Gray / Illyric Shorthorn
Iberian	Isolated W Mediterranean / NW Iberian, Balearic Blond-Brown / NW Iberian Chestnut / Middle, SW Iberian Black / Middle, SW Iberian Red / SE Iberian
Podolian	Italian White / Italian, Croatian Podolian / E European / Balkan, Anatolian

Breed codes:

ABA Aberdeen-Angus	CHA Charolais	LHN Longhorn	REN Rendena
ABO Abondance	CHI Chianina	LIM Limousin	RET Retinta
AGE Agersoe	CIK Cika	LIR Lithuanian Red	RGa Rubia Gallega
ALB Alberes	CIN Cinesara	LLG Lithuanian Light Grey	RH2 Red Holstein dual purpose
ALE Alentejana	CNA Casta Navarra	LWB Lithuanian White-Backed	RHD Red Holstein dairy type
ALS Alistana-Sanabresa	DAR Danish Red	LMP Limpurger	RIN Ringamala
ANG Angler	DBP Danish Black-Pied	MAH Marinhoa	RMB Red Metohian Busha
ARQ Arouquesa	DEX Dexter	MAL Mallorquina	ROM Romagnola
ASM Asturia de la Montaña	DOL Doela	MAN Maine-Anjou	SAL Salers
ASV Asturia de los Valles	DUB Dutch Belted	MAR Maronesa	SAY Sayaguesa
AUB Aubrac	EFC Eastern Finn Cattle	MBE Montbéliard	SBV Serbian Busha
AVI Avileña	ENB Ennstal-Bergscheck	MBO Murboden	SBW Swedish Black-and-White
AYR Ayrshire (Scottish and Finnish populations)	ERI Eringer	MBU Macedonian Busha	SDE South Devon
BAR Barrosa	ESN Estonian Native	MCG Marchigiana	SFR Swedish Mountain (Fjällras)
BAZ Bazadaise	ESR Estonian Red	MEN Menorquina	SHI Scottish Highland
BBP Belgian Black-Pied	EVO Evolène	MER Mertolenga	SIM Simmental (Swiss, German and Austrian populations)
BDA Blonde-d'Aquitaine	FJA Fjällnara	MIN Minhota	SRP Swedish Red-Polled
BER Berrenda (Colorado And Negro)	FRH Friesian-Holland	MIR Mirandesa	SRW Swedish Red-and-White
BET Betizu	GAL Galloway	MMA Maremmana	STE Serrana de Teruel
BOH Bohuskulla	GAR Garvonesa	MNO Morena del Noroeste	SWB Swiss Brown
BOR Bohemian Red	GAS Gasconne	MOD Modicana	SYK Sykia
BPE Black-Pied Eastern Reserve	GGB Gray Gacko Busha	MON Monchina	TAR Tarentaise
BPI Bruna de los Pirineos	GLA Gian	MOR Morucha	TDL Toro di Lidia (Fighting Cattle)
BPB Bretonne Pie Noir	GRA Grigia Alpina	MOS Monstrenca	TGV Tyrolean Grey
BPW German Black-Pied Western Reserve	GSH German Shorthorn	MRY Meuse-Rhine-Yssel	TGY Turkish Grey
BRE Belgian (Flemish Red)	GUE Guernsey	MWE Murau-Werdenfels	TMK Telemark
BRG German Brown (Württemberg and Bavaria populations)	GWH Groningen White-Head	NAN Negra Andaluza	TUD Tudanca
BRO Original German Brown	GYE German (Franconian) Yellow	NFC Northern Finn Cattle	TXZ Tux-Zillertal
BRP Belgian Red-Pied	HAR Harz Red	NOR Normande	VAL Valostana (Castana Pezzata Rossa and Pezzata Nera)
BRU Bruna Alpina	HER Hereford	NVR Norwegian Red	VAN Vaneko
BST Backsided Troender and Nordland	HFR Holstein Friesian (several sampled populations)	ORP Red-Polled Eastland	VBE Vogelsberg Red
BUR Burlina	HGY Hungarian Grey	PAJ Pajuna	VLA Vogtland Red
BWB Belgian White-Blue	HIW Hinterwald	PAR Parthenaise	VOS Vosgiennes
BWR Belgian White-and-Red	ICL Icelandic	PBW Polish Black-and-White	WBL Waldviertel Blond
CAB Cabannina	ILB Illyrian Lowland Busha	PIG Pinzgaur	WFC Western Finn Cattle
CAR Cardena	ILM Illyrian Mountain Busha	PIM Piemontese	WFFJ Western Fjord
CBL Carinthian Blond	IST Iстриan	PIR Pirenaica	WFR Westphalian Red
CCH Cachena (Spanish and Portuguese populations)	JER Jersey	PMO Parda Montana	WHP White Park
	JUT Jutland	POD Podolica (Italian and Serbian populations)	WRP Western Red-Polled
	KER Kerry	POR Polish Red	
	LBL Latvian Blue	PRI Pezzata Rossa Italiana	
	LBR Latvian Brown	PRO Oropa	
	LBW Lithuanian Black-and-White	PRT Preta	
		PUS Pustertaler	
		RDE Devon	

completely apart, since genetic exchange between neighboring breeds makes differences often gradual. In a number of cases, the last representative from one group or subgroup may merge with the first of the next group.

In spite of its systematic approach, the classification of Felius [2] also needs exceptions in order to cover all breeds. For instance, the Danish Forest breed is a young synthetic breed, an amalgamation of 12 breeds from all over Europe; it is not specific in type, and fits the Northwest European group only because of its location. The Ukrainian Beef and Askian Meat breeds are Eastern European, but originate from Central European types of cattle.

Figure 10. Comparison of the biochemical classification from Baker and Manwell [13], the integrated classification from Felius [2] and the microsatellite-based classification of the European Cattle Genetic Diversity Consortium (ECGDC). The horizontal color bars indicate the groups of the genetic classification. Even colors denote clusters of breeds that are more related to each other than to breeds of other clusters. Hatched colors denote groups of neighboring intermediate or crossbred breeds. The horizontal blocks at the left containing the numbering indicate the five main genetic types of cattle: northern European (blue); central European (violet); Iberian (ochre); Podolian (grey); and Balkan with Anatolian (black).



6.2.4. DNA-Based Classification

The rapid development of DNA technology has had its impact also on the analysis of cattle breeds, which, like other livestock breeds, are now compared at the DNA level via several types of genetic markers. Mitochondrial and Y-chromosomal DNA variants are markers for the female and male lineage, respectively. Autosomal DNA markers as microsatellites and single-nucleotide polymorphisms (SNP) indicate the genetic similarity of animals or breeds [12]. Such studies have revealed the complexity of the domestication process, migration routes and relationships of modern cattle breeds [87-90]. A most important finding was the separate domestication of taurine and zebu cattle in Southwest Asia and the Indus Valley, respectively [1,12,91,92]. This confirmed, after 135 years, the theory of Rüttimeyer [16], although his ideas on where and when the two species had evolved were untenable.

Molecular studies also demonstrated that the Sanga did not develop in Northeast Africa, as a Y-chromosomal survey showed that zebu bulls spread gradually and changed original African taurine cattle into humped cattle on their way south. MtDNA haplotypes of African origin have been found in Iberian breeds, which confirmed an African-Iberian connection as already proposed by Dürst [28] and Miranda do Vale [48]. However, it was also shown that British breeds do not have their origin in Iberia, as was proposed by several British authors. Similarly, in several publications (e.g., [93]) the Italian Piemontese breed is presented as a mix of local aurochs × Indo-Pakistani zebu, which was supposed to have entered the region long before domestication. Molecular genetic analysis now confirms the 19th-century records of a recent origin of the Piemontese breed as a mix of several taurine breeds, discarding a link with the aurochs and zebu, one of the several urban legends on the history of cattle.

A collective effort of several European laboratories supported by the European Commission led to a compilation of a microsatellite data set of all major and several local cattle breeds (Table S34) [54,55,94,95]. Analysis of the data with phylogenetic networks (Figure S2) in combination with model-based clustering [96] indicated four major groups of breeds, Northern, Central, Iberian and Podolian cattle respectively, with the Balkan and Anatolian taurine cattle representing the less developed ancestor populations. A further subdivision yielded 16 geographical groups of genetically related breeds and a further differentiation of the Central-Western and Iberian breed clusters (Figures 9, S2; Table S35). The resulting clusters of genetically related breeds are consistent with AFLP [95] and 50K SNP analysis [83,97].

The regional Iberian subclusters (Catabrian, Morenas, South-Portuguese Red, Iberian Black and Andalusian) are consistent with previous analyses [98,99] and partially with the morphological classifications, disribed above.

In view of previous classifications, the most unexpected result was a consistent relationship of South-French beef breeds with the brown or spotted Alpine dairy breed clusters, which was also clearly supported by SNP genotyping [83]. This has been explained by repopulation of South France after the Gallic conquest or during the Middle Ages by Alpine cattle [55], but is not consistent with the proposed different migration routes for Alpine and South-French cattle, respectively [83].

Meta-analysis of several microsatellite datasets allowed an assignment of more breeds to the clusters and an extensive coverage of European cattle (Figure 9, European Cattle Genetic Diversity Consortium [94], unpublished results).

6.2.5. Comparison of Classifications

Figure 10 compares the biochemical [13], the integrative [2] and the molecular-genetic classification (Figure 9; Table S34). Most genetic breed clusters are within a single category of the other classifications, implying that these categories correspond to genetic realities, but there are a few exceptions. First, the Lowland pied cattle in the biochemical Red *brachyceros* group refer to the Red Flemish, for which the biochemical evidence was not conclusive (see above). Secondly, the classification of Felius [2] the Baltic Red cattle is divided between two groups, reflecting that the German Highland Red cattle descend from central European cattle but have been crossbred to Baltic Red. Thirdly, in both the biochemical [13] and integrative [2] classifications, the well diverged British breeds are divided between different groups.

7. Discussion

Classification of cattle is potentially most useful, but not straightforward. The origin of many breeds is lost in history and only the most recent period of systematic breeding has been documented. Defining a breed is partially arbitrary, because of gradual differences between breeds, crossbreeding, multiple origins, development of expatriate breeds and changing breeding objectives. Newly formed breeds are often denoted as ‘man-made’ or ‘synthetic’, but most of the older breeds originated in the same way.

In the course of time cattle breeds were classified via different approaches, which also reflected the state of the science of the era in which they were developed. A list of all scientists who proposed a classification is provided in the Appendix (pages 231-234). The first classification on the basis of skull and horns, the several attempts to link the different types of cattle with different types of aurochs and the liberal use of Latin denotations (see the list in the Supplemental Information) were inspired by the strictly hierarchical Linnaean classification.

The tendency of 19th and early-20th century scientists to summarize a complex genetic reality in simplifying schemes that were more based on personal ideas than on scientific support would not have been accepted in the more rigorous scientific practice of today. This applies especially to the theories of about 100 years ago that link cattle types and coat colors with human migrations and ethnic origins. Furthermore, the proposed classifications focused on national breeds with apparently little communication between the German, French and English schools. An overall preoccupation of most 19th century scientists with European cattle may reflect a more general tendency of western society of that time towards eurocentrism.

Although not universally accepted, the cranial typing from the German school persisted until the mid-20th century. Since Duerst [32] the form and length of the horns was more important for classification than the shape of the cranium. Accordingly, the term *primigenius* became used for all longhorned cattle breeds, and *brachyceros* for all shorthorned cattle breeds, irrespective of their origin or relationships. Early ideas of an independent domestication of the *brachyceros*, still mentioned in 2000 ([100],

are no longer followed [101] and the term *macroceros* from the German school for long-horned African and Iberian cattle did not find wide recognition. In time also the names *frontosus*, *brachycephalus* and *akeratos* became less popular as these terms can be used for non-related breeds from different regions.

These classifications allow us to discard several urban legends and unfounded theories on the origin of breeds (see Chapter 6 for more examples). We now also know that a common coat color does not imply a recent common origin. For example, Italian white breeds are claimed to have been imported into Britain during the Roman occupation and to have been the ancestors of the White Park and Chillingham. However, the colored ears of the British cattle show that these breeds have the 'color pointed' pattern: a color sided pattern form with only a few colored spots.

A systematic combination of geography, history and morphology, as introduced by Felius (1995) [2] appears to be more plausible and had in 2015 already 136 citations (https://scholar.google.com/scholar?cites=12320527679514250366&as_sdt=2005&scioldt=0,5&hl=nl) Biochemical clustering and a more recent genetic analysis confirm that geographical origin is indeed an important determinant of breed relationships [12,54,55,97].

The integrative and both molecular classifications confirm the separate positions of taurine and zebu cattle observed in the 19th century. The genetic subdivision into Northern, Central and Mediterranean cattle as main groups is also apparent from the molecular classifications, although only the genetic classification assigns a separate position to the primitive Balkan and Anatolian cattle. One group consistently recognized by all classifications is the Podolian, or Grey steppe cattle. The productive dairy breeds from the Northwest European lowlands are noted as a separate group by most, but not all classifications. Because of a large phenotypic variation in British and Iberian breeds, these are most often dispersed over different groups. Remarkably, relatively recent classifications [56,57] still combined cattle with different histories in one group on the basis of a few visible traits.

The British, Iberian, Nordic and the combined Central-European breed clusters identified by the genetic analysis each comprise breeds that are phenotypically different, yet are genetically related. This is explained by their common origin and/or gene flow between neighboring populations and makes geographical proximity a more reliable guide for relatedness of authentic landraces than morphology. This is of fundamental interest and also reflects that most breed names refer to geographical origin.

Other breed clusters, such as the Lowland Pied, Baltic Red, Nordic Ayrshire, West-Central, Central Brown and probably also the Podolian cattle correspond to successful breed types that expanded by migration and/or crossbreeding. Particularly the Lowland black-pied, Ayrshires and Central Brown now occur in European regions far from their region of origin. However, the contrast of Northern cattle, predominantly carrying the Y1-type Y-chromosomes, and the central and southern European cattle, mainly carrying Y2 Y-chromosomes, has been retained and has apparently an old origin [55].

We expect that new genome-wide approaches, such as high-density SNP genotyping and whole-genome sequencing, will further refine the classification with a more detailed

reconstruction of the demographic history of the cattle breeds, a finer resolution of paternal lineages and a better insight into the emergence and spreading of functional gene variants [102].

Another lesson already learned by analyzing DNA is that most breeds carry most of the genetic diversity of the whole species and that differences between breeds are relatively small. This complicates the assessment of the conservation value of breeds on the basis of molecular data. In addition, the current molecular diversity data sets do not indicate the phenotypic uniqueness of a breed, which may be also be a consideration for conservation. In practice, the perceived value of a breed mainly depends on its role in local tradition and history - the breed as social concept - even for breeds that have emerged only a hundred years ago or later.

Against this background, we propose that classifications have their main practical value as an instrument for managing the genetic diversity of cattle. In Chapter 3 we proposed that conservation of unique adaptive diversity generated during thousands of years is the most urgent. However, breeds that occupy a separate position in the classification are also likely to possess unique features. The classification may also be useful if crossbreeding for a breed is considered - either because of inbreeding or because of upgrading - by identifying the most related breeds that would thus maintain as far as possible the genetic identity of the original breed. Thus we conclude that insight into the classification of cattle is not only of scientific interest, but is also relevant for genetic management and conservation.

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References Chapter 4

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Chapter 4 Appendix

Classification Systems

Table S1. Classification according to Wilckens (1876) [1]. Numbered items indicate breed clusters (Rasse), and lettered items breeds (Schlag/Schläge). Breed names are translated according to Mason's World Dictionary of Livestock Breeds.

1. Original breeds

- A. East-European steppe breeds
- B. Dutch-North German Lowland breeds
 - a. Dutch-Friesian
 - b. East-Friesian-Oldenburger
 - c. Sleswig-Holstein polder
 - d. Sleswig-Holstein geest
 - e. Gdansk Lowland
 - f. British Lowland in Germany (Galloway, Ayrshire, Shorthorn)

Bos taurus primigenius
 Die Osteuropäische Steppenrasse
 Die niederländisch-norddeutsche Niederungsrasse
 Holländer-Schlag
 Ostfriesisch-Oldenburger Schlag
 Schleswig-holsteinische Marschschläge
 Schleswig-holsteinische Geestschläge
 Danziger-Niederungsschläge

2. Short-horned breeds

- a. Schwyzer
- b. Vorarlberger
- c. Algäuer
- d. Tyrol Grey
- e. Mürzthal
- f. Murboden
- g. Elling

Bos taurus brachyceros
 Schwyzer-Schlag
 Vorarlberger-Schläge
 Algäuer-Schlag
 Ober-Innthal-Schlag
 Mürzthaler-Schlag
 Murbodner-Schlag
 Ellinger-Schlag

3. Broad-headed breeds

- a. Bernese
- b. Fribourg
- c. Ansbach-Triesdorf
- d. Glan
- e. Scheinfeld
- f. Limpurg and other breeds of Württemberger Schläge
- g. Kuhländ

Bos taurus frontosus
 Berner-Schlag
 Freiburger Schlag
 Ansbach-Triesdorfer Schlag
 Glan Schlag
 Scheinfelder-Schlag
 Schwäbisch-Limpurger-Schlag und übrigen Württemberg
 Kuhländler Schlag

4. Short-headed breeds

- a. Hérens
- b. Tux-Zillertal
- c. Pustertaler
- d. Voigtland
- e. Egerland
- f. Devon

Bos taurus brachycephalus
 Eringer-Schlag
 Zillertal-Duxer-Schlag
 Pusterthaler-Schlag
 Voigtländer-Schlag
 Egerländer-Schlag

5. Crossed landraces

- a. *Tauern*
(1. Mölltal, 2. Pinzgauer)
- b. *Norische*
(1. Mariahof, 2. Lavanttal)
- c. Harz
- d. Kampeten

Tauern-, Möllthaler-, Pinzgauer- Schläge
Norische, Mariahofer-, Lavantthaler- Schläge
 Harzer-Schlag
 Kampeten-Schlag

Table S2. Classification according to Werner (1912) [2] Breed names are translated according to Mason's World Dictionary of Livestock Breeds. German names are added if they are fairly different from English translation.

(A) Bovini

Group I. Buffaloes

Group II. Wisents, *Bisontina*

1. European wisent: *Bison europaeus* Owen. Syn.: *Bos Bison* H. Smith
2. American bison: *Bison americanus* Gmel

Group III. Bibos cattle, *Bibovina*

1. Banteng (Sunda Ochse): *Bos sondaicus* Müller and Schlegel, Syn.: *Bos banteng* Raffl.
2. Gayal: *Bos frontalis* Lambert, Syn.: *B. Gavaeus* Roulin, *B. Sylhetanus*, *Bibos Subhaemachalus* Hodgs.
3. Gaur: *Bos gaurus* Hamilton, Smith, Syn.: *Bibos cavifrons* Hodgs.
4. Yak (*Grunzochse*): *Bos (Poëphagus) grunniens* Linnaeus, Syn.: *B. Poëphagus* Pallas
5. Zebu: *Bos Zebu*. Syn.: *B. indicus* Linnaeus, *B. sondaicus indicus*
 - a. Indian zebu: *Bos Zebu indicus* Linnaeus
 - Large Indian zebu: *Bos Zebu Indicus major* Fitzinger
 - Medium large Indian zebu: *Bos Zebu indicus medicus* Fitzinger
 - Dwarf zebu: *Bos Zebu indicus minor* Fitzinger
 - b. African zebu: *Bos Zebu africanus* Fitzinger
 - Galla zebu: *Bos Zebu africanus Sanga* Fitzinger (= *B. sondaicus africanus*, *B. sondaicus longicornis*)
 - Ethiopian zebu: *Bos Zebu africanus aethiopicus* Fitzinger
 - Afrikaner: *Bos Zebu africanus hottentottus* Fitzinger

Group IV. Common cattle, *Taurina*

1. Aurochs (*Urochse*): *Bos primigenius* Bojanus
2. Domestic cattle: *Bos taurus* Linnaeus

(B) Domestic cattle.

A. Primigenius *Bos taurus primigenius* Rüttimeyer

1. Breed group of steppe cattle

Grey Steppe (*Podolische Steppenrasse*), *B.t.pr. podolicus*
Kalmyk (*Kalmücken*) and Kazakh (*Kirgisen*), *B.t.pr. nomas*
Donube Steppe (*unterer Donau*), *B.t.pr. dacicus*
Balkan Mountain steppe-shorthorn, *B.t.pr. montanus*
Hungarian (*Siebenbürgische*) Steppe, *B.t.pr. hungaricus*
Romagnola, *B.t.pr. romanicus*

2. Breed group of Lowland cattle

Germanische Rasse, *B.t.pr. germanicus*
Friesian, *B.t.pr. germanicus* var. *frisius*
Unicolored Red-brown East-Friesian, (*Sächsische*) *B.t.pr. germanicus* var. *saxonicus*
Flemish Red, *B.t.pr. germanicus* var. *flandricus*
Normande, *B.t.pr. germanicus* var. *normannus*
[British] Anglo-Saxon breeds, *B.t.pr. germanicus anglosaxonicus*

3. Breed group of British cattle

White Park, *B.t.pr. ferus*

- Highland, *B.t.pr. scoticus*
- 4. Breed group of Russian cattle**
Great Russian Land cattle, *B.t.pr. sarmaticus*
 - 5. Breed group of Scandinavian cattle**
Swedish Mountain, *B.t.pr. suecicus* Fitzinger
Finnish
Norwegian Mountain [Telemark], *B.t.pr. norvegicus* Fitzinger
- B. Broad-headed cattle** *Bos taurus frontosus* Nilsson
- 1. Breed group of spotted lowland cattle**
Gotland [Småland-Gotland], *B.t.front. goticus*
Simmental (*Burgundisch*) breeds, *B.t. front. burgundicus*
 - 2. Breed group of unicolored valley cattle**
Yellow Franconian (*Fränkisch*), *B.t.front. franconicus* Fitzinger
Austrian Blond (*Norisch*), *B.t. front. noricus*.
Piemontese, *B.t.front. piemontanus*
- C. Long-headed cattle** *Bos taurus longifrons* Owen
- 1. Breed group of Alpine cattle** *B.t.long. alpestris* A. Wagner
Brown Mountain, *B.t.long. alp.var. brunneus*
Grey Mountain, *B.t.long. alp.var. griseus*
Gelbvieh, *B.t.long. alp.var. flavus*
 - 2. Breed group of French long-headed cattle**
Parthénais (*Vendéen*) and related breeds, *B.t.long. ligeriensis* Sanson
Gasconne, *B.t.long. vasconiensis*
Channel Islands cattle [Jersey, Guernsey], *B.t.long. isolanus*
 - 3. Breed group of long-headed cattle in southeastern-central Europe**
Polish Brown, *B.t.long. polonicus* Adametz
Illyrian and Busha, *B.t.long. illyricus* Adametz
- D. Short-headed cattle** *Bos taurus brachycephalus* Wilckens
- 1. Breed group of Iberian cattle**
Iberian, *B.t.brach. ibericus*
North- African [Algerian Brown Atlas] cattle, *B.t.brach. africanicus*
Italian island cattle [Sicily, Corsica] and Camargue, *B.t.brach. isolanus*
Pyrenean breeds, *B.t.brach. pyreneus*
Limousin and pre-Blonde d'Aquitaine breeds, *B.t.brach. aquitanicus* Sanson
 - 2. Breed group of Celtic highland cattle**
Celtic [Kerry, Welsh and Bretonne P.N.], *B.t.brach. celticus*
Longhorn, *B.t. brach. licestriensis* Fitzinger
British [Devon, Sussex, Hereford], *B.t.brach. britannicus*
Salers (Auvergne), *B.t.brach. alverniensis* Fitzinger
[Italian] Grey Alpine, *B.t. brach. italicus*
Tauern or Bunte Tiroler [Tuxer, Zillertaler, Pustertal, Herens, Vosges],
B.t. brach. tauricus
Salzburger [Pinzgauer, Pongauer, Lungauer, Mölltaler, East-Styrian Spotted]
B.t.brach.salisburgensis
German Red Highland, *B.t.brach. teutonicus*
Red Blazed (whiteheaded)
Middle German Red group
- E. Breeds of German colonies in Africa.**

(A) Survey

The European Stem

1. Steppe cattle or Podolian cattle (*Bos primigenius podolicus*)

The many strains of Steppe cattle are of strong constitution with heavy long to medium long horns, high withers, retracted belly and sloping rump. The hair color is commonly light, whitish grey, ash grey or dark grey; the hair course, bristly, sometimes curled. The skin is firm. The Steppe breed make good working cattle, on the other hand, the udder is small and the milk production low. The Steppe breed are spread south-eastwards from the Alps over Hungary, Romania, in Turkey, Greece, and south Russia. In the east it spread into Australia and also the South-Siberian cattle are related. Westward this type is found in Italy, where it was introduced in the 6th century by the Langobardian King Agiluf and penetrated from Hungary. Some scientist classify the heavy-horned and strong build cattle of the Iberian Peninsula also as Steppe breed, although this is incorrect as these are of a completely different origin.

2. Lowland cattle (*Bos primigenius hollandicus*)

In its most beautiful form we find it in the heavy polder cattle form Holland, furthermore in East Friesland, Schleswig-Holstein and Oldenburg. The primigenius-like head is long, but with rather short, forward curved horns; the neck long with a small dewlap, the withers low, the hips wide with extended pelvic bones. The thin skin is flexible, the hair fine and commonly shining. The coat color seems mostly pied in black or red. The work capacity and beef production are outstanding; however most lowland cattle are also exemplary concerning milk production.

3. Frontosus cattle (*Bos primigenius frontosus*)

Presumably these were introduced from northern Europe, but in their complete development they are currently found in west and north Switzerland. In their breed characteristics, they are most distinct from the original stem form, as the form of the skull has a roof like forehead. The medium long horns are flattened, grow downwards, then to the sides with the tips upturned, though often also downwards and sideways. The dewlap is well developed. The body conformation is varied with enormous animals among the highly bred strains. The coat color is black- or red-pied (*Fleckvieh*). Most well known is the red flecked *Simmental* strain, which is extensively exported for breeding purposes. Thereafter the black-pied *Freiburger* [Fribourg] strain, of which the horn form and skull are *primigenius*-like, and which in recent times is pushed back. The Longhorn breed, which is widely spread in England, can also be regarded as belonging to the *frontosus* group. According to Rüttimeyer the *Frontosus* breed is a culture product developed from the *Primigenius* breed.

The Oriental Stem

1. Zebu breed (*Bos sondaicus indicus*)

This breed is spread over southern Asia, but most frequently found and most characteristic in India. In a wide belt from the northeast Horn of Africa into the German East-African colonial territory the cattle are strong influenced by Indian blood, which can be explained by ancient commercial trade. The Indian zebu shows the most variation. Besides powerful strains dwarfed cattle are found, the body is somewhat low [on the legs]. The fat hump is often well developed; the thin dewlap hanging low from the neck.

The conformation of the head is very characteristic: commonly of strong concave profile, short horns, at the best medium, pointing backward in line with the forehead profile, with the tips turned inward. In shorthorned forms these point upward and backward, thus forming a 45 degree angle with the axis of the skull. The ears are peculiar, commonly hanging down. The color of the hair shows nuances, in milky white, grey-white, yellow, red-brown and pied; in pied animals the splashes are not sharply drawn.

2. Sanga breed (*Bos sondaicus africanus*)

An African form and most pure found in the Abyssinian Sanga, though also spread from the highlands of Habesha to the upper Nile and Lake Chad. The horns are larger than in the related Indian zebu, most common lyre-formed and not so strong pointing backward but more upward. The body is agile and high on the legs with a fat hump on the back; the tail is long. In the lowlands the coat color is whitish, grey white, reddish-brown or red-pied; in the highlands black is favored because the Abyssinians believe that this is warmer. As draught animal and beef producer these animals are of great importance; the milk production is low.

3. Giant horned breed (*Bos sondaicus longicornis*)

It obvious represents a breed, which originated from common Sanga cattle. Though, it seems to be ancient as we find these longhorned cattle already depicted during the earliest Egyptian dynasties. Currently they are pushed back to Central Africa, and to be met with in the Lake District with the agricultural colonies of Abyssinian descent as Watusi cattle. However populations are also found in southern Abyssinia. On the whole these peculiar African breed is diminishing. Medium strong, unicolored mahogany to dark brown-pied; in southern Abyssinia also brindled specimens can be found. The horns are mighty and are more than one meter in length, 40–50 cm in circumference at the bases; growing upward, bending backward and upward as in the Sanga; the tips bending backward, or more often inward; not uncommon the horns are closed [at the tips]. Scientifically the breed is not important.

4. Brachyceros breed (*Bos sondaicus brachyceros*)

On the contrary to the previous breed one finds *brachyceros* cattle in the periphery of the area where oriental domestic cattle are endemic, which encompasses East Asia, then West Asia, North Africa and more important Europe. The breed seems ancient, as it is found in the times of the pharaohs in the Nile valley and has a remarkable similarity with European *Braunvieh* [Brown Mountain cattle]. It holds small, elegantly build breeds. The fat hump has completely vanished. The horns are small, upward growing and upward bend, the forehead is pushed in between the eye sockets and the muzzle is fine. The back part of the head bulges in a hump which slopes sharp downward; the corners grow only seldom into horn roots (as for instance by Sardinian cattle). The color is commonly dark. Very good examples of this type are Algerian and Moroccan cattle. In Europe they must be put in the cattle groups which almost all are rooted in the *Torfrind* [Neolithic village cattle]. In the central Alps we find *Braunvieh*, which in its most pure form is kept pure in the region around the Gotthard Massive, but has also spread in Vorarlberg, the Bavarian Alps and Tyrol Alps. The coat is unicolored and, varies from dark brown to light mouse grey. Characteristic for the breed is a dark muzzle with light muzzle band and a light colored eel stripe. In Eastern Europe Albanian cattle, Illyrian cattle and wide spread Polish Red, also found in northern Russia, have to be regarded as belonging to the *brachyceros* stem. Well-bred and with famous dairy qualities are the small island cattle or Jersey cattle.

5. Brachycephalus breed (*Bos sondaicus brachycephalus*)

Closely related to the previous breed, and clearly developed from artificial breeding on European soil. In the Alps and especially in the north of the Alps their remains have turned up in great numbers. The short-headed type is characterized by its short head. The forehead is very wide between the eyes. The rounded horns are strong, often very heavy and lyre-formed, white with black tips, often pointed somewhat downwards. The color of the hair is blackish-brown with a light eel stripe, but may also be reddish brown or mahogany. As with Swiss Brown a mahogany muzzle band and eel stripe of the same color is seen in the darker variants.

We have observed heavy built, heavy boned short-headed cattle, besides small, elegantly built forms. Important for these breeds is the insular spreading. It is to be found in the southern, long stretched valleys of Valais and is in Switzerland known by the name of Eringer [Hérens] breed. These small cattle often had white parts, but are currently commonly unicolor black or dark brown with reddish tinge with mahogany muzzle band and an eel stripe. Related are the *Duxer* [Tuxer] and Pustertal strain, also the Voigtland and Egerland strains, as well as the Devon from the English counties Devon, Sussex and Hereford. Heavy short headed cattle with mighty lyre-formed horns and extreme short heads are found on the Iberian Peninsula.

6. Akeratos breed (*Bos sondaicus akeratos*)

These are completely without horns and apparently developed independently in several places in the Old World from shorthorned cattle. Outside Europe polled cattle already turned up in the times of the pharaohs of old Egypt. They are also found in Somalia, while in Unyoro in central Africa most cattle are polled and humpless. Polled cattle are presumed to have also been in the possession of the Scythians. Possibly they were spread to the north, as currently they are mainly spread over northern Europe, Scandinavia (*Fjellras*) [Swedish Mountain], Iceland, Scotland, England and Wales, in northern Russia and sparsely in Oldenburg. The coat color is commonly white; but yellowish-red, brown-red and black is also observed.

(B) Classification

Group name	Latin name	type description	typical breed
European Stem Steppe cattle	<i>Bos primigenius</i> <i>B.p. podolicus</i>	work type with heavy horns	Grey Steppe cattle, Italian white cattle.
Lowland cattle <i>Frontosus cattle</i>	<i>B.p. hollandicus</i> <i>B.p. frontosus</i>	dairy cattle with long head, broad head, horns downward	Dutch-Friesian, NW German, Simmental-Fleckvieh.
Oriental Stem Zebu Sanga	<i>Bos sondaicus</i> <i>B.s. indicus</i> <i>B.s. africanus</i>	humped, often hanging ears upward directed lyre horns, slim, long-legged	Indian, East-African zebu, Galla, Dinka, Fulani zebu.
Giant horned Brachyceros	<i>B.s. longicornis</i> <i>B.s. brachyceros</i>	giant horned sanga Watusi shorthorned, unicolor, dark muzzle, light muzzle band and eel-stripe	Swiss Brown, Busha, Polish Red, Jersey, Brown Atlas.
<i>Brachycephalus</i>	<i>B.s. brachycephalus</i>	very broad forehead Herens, brown-black to red-brown	Devon, Sussex, Hereford.
<i>Akeratos</i>	<i>B.s. akeratos</i>	naturally polled	European, African.

Table S4. Classification according to Holecek Holleschowitz (1939) [4]

I. Breed group of longhorn (aurochs) descent

A. Lowland breeds (*Die Rassen des Niederungsrindes*)

1. East-Friesian
2. Jeverländer
3. Wesermarsch
4. East-Prussian Lowland
5. Red-Pied Schleswig-Holstein
6. Red-Pied Lower Rhineland (*Niederrheiner*)
7. Red-Pied Westphalian
8. Dutch breeds:
 - a. Meuse-Rhine-Yssel
 - b. Dutch-Friesian
 - c. Groningen Whiteheaded
9. French Lowland breeds:
 - a. Flemish Red
 - b. Normande
 - c. Bordelais
10. Shorthorn
11. Ayrshire
12. Jutland Black-Pied
13. Swedish Lowland
14. Telemark
15. Trondheim

B. Broad-headed Fleckvieh en Blondvieh (*Gruppe der breitstirnigen Rassen*)

1. Simmental
2. Fribourg (*Freiburger*)
3. Miesbacher (*Oberbayrisches Alpenfleckvieh*)
4. South-German Fleckvieh (*Höhenfleckvieh*)
5. Tyrol Spotted (*Unterinntaler Fleckvieh*)
6. East-Styrian Spotted (*Oststeirisches Fleckvieh*)
7. Ennstaler Spotted (*Bergschecken*)
8. Bernese red spotted (*Berner-Rotschecken*)
 - a. Bonhyhádi
 - b. Kravarský (*Kuhländer*)
 - c. Hrbinecký (*Schönhengster*)
 - d. Hanna-Berne
9. French Simmental
 - a. Montbéliard
 - b. Comtois (*Tourache*)
 - c. Abondance (*Chablaisienne*)
10. Italian Simmental
11. Yellow Franconian:
 - a. Franconian (*Maintaler*)

- b. Glan-Donnersberg
 - c. Limpurg
 - d. Lahn
12. Carinthian Blond
 13. Murboden
 14. Fémeline, Bressane
 15. Charolais

C. West-European breeds of aurochs descent

1. Pinzgauer
2. Salers (*Auvergne*)
3. Limousin
4. Garonne
5. Pyrenean:
 - a. Bazadais
 - b. Lourdes
 - c. Gascon
6. Parthenais
7. Devon
8. Sussex-Rind
9. Hereford

D. Primitive, landraces of aurochs descent

1. Hungarian Grey
2. Romanian Steppe
3. Moldovian [Bessarabian] Grey
4. Ukrainian Grey
5. Italian White breeds
 - a. Romagnola
 - b. Maremmana
 - c. Chianina
 - d. Marchigiana
 - e. Bolognese
 - f. Italian [Apulian] Podolian
6. Andalusian
7. Barosso
8. Galician Blond
9. [Scottish] Highland

II. Breed group of shorthorned cattle

A. European shorthorn breeds

1. Jersey
2. Guernsey
3. Kerry
4. Bretonnte Pie-Noir
5. Red Danish
6. Angler
7. Middle German Red

- a. Bavarian Red
- b. Vogelsberg
- c. Vogtland Red
- d. Waldeck
- f. Harzer Red
- g. Odenwald
- h. Westphalian Red
- 8. Polish [Silesian] Red [Lowland]
- 9. Polish Red [Highland]

B. Alpine shorthorn breeds

- 1. Swiss Brown
- 2. German Brown [Allgäuer]
- 3. Vorarlberg Brown [Montafon]
- 4. Tyrol Grey [Oberinntal]
- 5. Waldviertel
- 6. Slovakian Red

C. Primitive, landrace shorthorns

- 1. Illyrian Shorthorns
 - a. Polim Busha
 - b. Busha and Illyrian Dwarf
- 2. Macedonian Busha
- 3. West-Macedonian
- 4. Greek Shorthorn
- 5. Rodope Shorthorn
- 6. North- African Shorthorn
 - a. Tunesian Guelma
 - b. Algerian Guelma
 - c. Kabyle
 - d. Moroccan Brown Atlas
- 7. Anatolian
- 8. Caucasian mountain cattle
- 9. Krim mountain cattle
- 10. Carpathian
- 11. Russian Landcattle

III. Breed group of short-headed cattle

- 1. Tux-Zillertal
- 2. Hérens (*Eringer*)
- 3. Tarentaise
- 4. Cheb (*Egerländer*).

IV Breed group of polled cattle

- 1. Swedish Mountain (*Fjällras*)
- 2. Finnish
- 3. North- Russian Polled

Table S5. Classification according to Amschler as described by Haring et al. (1961) [5].
Names of extinct breeds or types are in italics.

Type	Breeds
<i>Primigenius</i>	Hungarian Grey cattle Podolian Grey Steppe cattle <i>Egyptian longhorn Apis bull</i> English Longhorn Scottish Highland
<i>Brachyceros</i>	Tyrol Grey Jersey Guernsey Angler Red Danish Shorthorn Dutch-Friesian German Black-Pied German Red-Pied Double Purpose Red Highland (German and Polish)
<i>Primigenius</i> influenced by <i>brachyceros</i>	Simmental Fleckvieh Pinzgauer Murboden Carinthian Blond German Gelbvieh Telemark Limousin Tarentaise Hereford
<i>Brachyceros</i> influenced by <i>primigenius</i>	Swiss Brown Red-pied and Black-pied Lowland strains Ayrshire Swedish Red-and-White Kholmogory Yaroslavl Glan and Donnersberg Waldviertel Blond Aberdeen-Angus Breton Black-Pied Normande

Table S6. Classification according to Sanson (1884) [6]

Breed category, strain	Breeds
Longheaded (<i>Dolichocéphales</i>)	
Lowlands strain (<i>B.t. batavicus</i>)	Hollandaise [Dutch], Flamande [Flemish]
Germanic strain (<i>B.t. germanicus</i>)	Normande
Irish strain (<i>B.t. hibernicus</i>):	Bretonne, Froment du Léon, Jersiasse [Jersey] (Normande influence)
British strain (<i>B.t. britanicus</i>)	none
Alpine strain resembling the <i>brachyceros</i> (<i>B.t. alpinus</i> , analogue à <i>Brachyceros</i>)	Schwitz [Swiss Brown], Tarentaise, Gasconne
Aquitaine strain (<i>B.t. aquitanicus</i>)	Blonde d'Aquitaine, Limousine, Blonde des Pyrénées (Lourdaise)
Shortheaded (<i>Brachycéphales</i>)	
Asian strain (<i>B.t. asiaticus</i>)	Camargue
Iberian strain (<i>B.t. ibericus</i>)	Corse, Blonde des Pyrénées (Basquaise et Béarnaise)
Vendéenne strain resembling the <i>primigenius</i> (<i>B.t. liguriensis</i> , analogue à <i>primigenius</i>)	Parthenaise, Aubrac.
Auvergnate strain (<i>B.t. arvernensis</i>)	Salers, Ferrandaise
Jura strain (<i>B.t. jurassicus</i> , analogue à <i>B.frontosus</i>)	Pie-rouge de l' Est, Montbéliarde, Abondance, Charolaise
Scottish strain (<i>B.t. caledonensis</i>)	none.
Crossbreds	(French) Jersey, Maine-Anjou, Bazadaise, Mézenc, Villard-de-Lans, Vosgienne

Table S7. Classification according to Diffloth (1914) [7]. The breed groups are divided into short-headed and long-headed types as by Sanson [6].

1. Des Pays Bas [LowLand]	Black-pied, red-pied, blue-pied and unicolored red lowland type breeds of England, Holland, Germany, Denmark, France and Belgium (including the Shorthorns)
2. Germaniques [Germanic]	Normande, red-pied Holstein
3. Irlandais [Irish]	Bretonne, Bordelais, Kerry, Devon, Ayrshire, Jersey, Guernsey
4. Du bassin de la Loire [Vendéen]	Parthenais, Marchois, Aubrac, Anglès-Cevennes
5. d'Aquitaine [Aquitanian]	Limousin, Garonnais, Agenais, Lourdais, Pyrenean, Bazadais
6. Auvergnat [Auvergne]	Salers, Ferrandais, Mézenc, Central German Red Highland
7. Jurassique [Jura]	Swiss and French Simmental type breeds, the Charolais, East-French blond breeds, German and Austrian white-backed breeds, German Yellow and the Hereford
8. Des Alpes [Alpine]	Grey and Brown breeds of Switzerland, Germany, Austria, France including the Tarentaise and Gasconne), and Italy (including the Piemontese)
9. Ibérique [Iberian]	Les Landes, Corsican, North-African Atlas breeds, Sicilian, Sardinian, Podolian and Italian Podolian, Spanish and Portuguese breeds
10. Asiatique [Asian]	Camargue
11. Britannique or scythe [British or Scythian]	Aberdeen-Angus, Galloway, Suffolk, Norfolk, Norwegian, Russian, Icelandic
12. Écossais [Scottish]	Highland, White Park

Table S8. Group classification to cranium, according to Kaltenegger (1904) [8]

1. Long-headed type (syn. shorthorn) Montafon, Rendena	<i>Bos taurus longifrons</i> (= <i>brachyceros</i>)
2. Flat-fore-headed type Oberinntal, Lechtal, Etschtal, Wipptal, Murboden, Mürztal	<i>Bos taurus planifrons</i> (= <i>primigenius</i>)
3. Larg-headed type Maltein, Mariahof, Lavanttal, Pinzgauer, Mölltal, Ennstal	<i>Bos taurus grandifrons</i> (= <i>frontosus</i>)
4. Broad-headed type (= short-headed) Zillertal, Tux, Pustertal	<i>Bos taurus latifrons</i> (= <i>brachycephalus</i>)

Table S9. Classification system of Baron (1928) [9], Système Coordonnées baroniennes

1. Morphology (<i>La plastique</i>)	
(a) Profile (silhouet)	<i>Les variations du profil (silhouette)</i>
straight back and legs	<i>rectilignes</i>
crooked back and legs	<i>convexilignes</i>
hollow back and X type legs	<i>concavilignes</i>
(b) Types (proportions)	<i>Les variations des proportions</i>
medium (= non specific or dual-purpose)	<i>médiolignes (mésomorphes)</i>
large and long (= dairy type)	<i>longilignes (dolichomorphes)</i>
large and rounded (= beef type)	<i>brévilignes (brachymorpes)</i>
(c) Size	<i>Les variations du format</i>
large	<i>grand format (hypermétriques)</i>
medium (135 cm at the withers)	<i>format moyen (eumétriques)</i>
small	<i>petit format (hypométrique)</i>
miniature	<i>très petit format (ellipométrie)</i>
2. Coloration (<i>La phanéoptique</i>) of coat, muzzle and mucosa.	
3. Development (<i>L' énergétique</i>): production type (corresponds with 1b).	

Table S10. Coordinates (A) and classification (B) according to Dechambre (1913) [10].
Names of extinct and ancestor breeds are in italics.

(A) Coordinates according to Baron (*Coordonnées baroniennes*)

Skull

Frontline of the skull

Concave (*Front concave, proceros*)

Flat (*Front plat, orthoceros*)

Convex with high poll (*Front convexe chignon saillant, opisthoceros*)

Size of horn

Short (*Cornes courtes, brachyceros*)

Medium (*Cornes moyennes, mésoceros*)

Bend inward (crowned) (*Corne en couronne*)

Sickle-formed (*Corne en croissant*)

Bend sideward (*Corne en roue, trochoceros*)

Long (*Cornes longues, dolichoceros*)

Bend in a hook, upward (*Corne en crochet*)

Lyre-formed (*Corne en lyre, lyriceros*)

Long, upturned and twisted (*Corne en tire-bouchon, strepsiceros*)

Proportion

Size

large [long, tall] (*les formes longiligne [étiré, élané]*)

intermediate [average] (*médioligne [intermédiaire entre les deux précédents]*)

small [stocky, stout] (*bréviligne [trapu, ramassé]*)

Weight

heavy [more than average] (*hyperométrique*)

average [averaging 650 kg] (*eumétrique*)

light [less than average] (*ellipométrique*)

Basic types (*groupes plastique*)

Bos primigenius evolved into the rectilinear type (*type rectiligne*)

Bos frontosus evolved into the convex type (*type convexitigne*)

Bos brachyceros evolved into the concave type (*type concaviligne*)

(B) Classification

1. Rectilinear breeds, flat skull

Intermediate size

Heavy

Primitive form: *Bos primigenius*

Average

Vendéenne, *Parthenaise*, *Maraîchine*

Light

Ayrshire, *Kerry*, *Bretonne Pie Noir*

Small size

Primitive form: *Bos brachyceros*

Average

Brown breeds of Switzerland and central Europe

Swiss Brown, *German and Austrian Brown*,

Allgäuer,

Italian Brown, *Pontremolese*, *Piemontese*

French blond and grey breeds

Tarentaise, *Marchoise*, *Aubrac*, *Cévennes*,

Gasconne

Light

Carhaix pie rouge, *Corsie*, *Sarda*

Large size

Average

Large Grey Steppe breeds and derived breeds

Steppe breeds of Asia and Russia, *Podolian* and

Hungarian Steppe, *Romagnola*, *Pugliese* and

Italian derivatives.

2. I. Concave formed breeds, horned

Intermediate size		<i>Cotentine</i> , Normande
	Heavy	German red-pieds, <i>Breitenburg</i> , <i>Niederrhein</i>
	Average, light	Wild White Park and Scotch Highland.
Small size		Primitive form <i>Bos longifrons</i>
	Average	Lowland breeds of N. and W. Europe: Jutland, Dutch-Friesian, German Black-Pied, Flamande, Danish Red, Angeln, Devon
Derived small		<i>Durham</i> , <i>Bordelaise</i>
	Light	Jersey, Guernsey, <i>Cotentine</i>
Large size		Primitive form <i>Bos mauritanicus</i>
	Average	Spanish and Portuguese Brown breeds, Maronesa, Barrosa, Lidia, Franqueira, Camargue
	Light	Brown Atlas
2. II. Polled breeds		North Russia, Scandinavia and Island <i>Zyriane</i> , Swedish Mountain, Icelandic British breeds Galloway, Aberdeen-Angus, Red Poll, <i>Sarlabet</i> . West-African breeds. Brazilian, Mocha [= Mocho nacional]

3. Convex formed breeds

Intermediate size		Average and medium-large	German and Central European Blond breeds Yellow Franconian, Limpurger, Glan-Donnersberg, <i>Mainland</i> French Blond breeds: <i>Fémeline</i> , <i>Mezenc</i> , Villard de Lans, Limousine, Garonnais), derived: Bazadaise
		Light	Blond breeds of Spain and Portugal Pyrenean breeds Béarnaise, Lourdaise, <i>Landaïse</i> , Central-Pyrenean [= Casta]
Large size		Average	Salers, Ferrandaïse Red Spanish Rubia Gallega, Asturiana, Minhota, Arouquesa. derived: Caracu.
		Light	German Red Highland Harz Red, Voigtland Red
Small size	Primitive form	<i>Bos frontosus</i>	
	Light		Swedish Red-Pied, <i>Norfolk</i>
	Average and medium-large		Hereford, Longhorn Pied breeds of central Europe and Germany Pinzgauer, Hinterwalder and derivatives, Tux-Zillertaler Swiss pied breeds <i>Simmental</i> , <i>Fribourg</i> French breeds <i>Mancelle</i> , <i>Comtoise</i> , Montbéliarde, Vosgienne, Abondance, <i>Bressane</i> , <i>Morvandelle</i> , derived: Charolais, <i>Nivernais</i>

Table S11. Classification according to Chacrin and Dumont (1921) [11] in the Larousse Agricole [Larousse Agricultural Encyclopedia]. Extinct breeds are in italics.

Breeds	Sub-breeds
Group I: Flat (<i>Droit</i>) - forehead and poll flat, horns growing in line with the poll.	
Vendéene	Parthenaise, Maraichine, <i>Poitevine</i> , Nantaise.
Aubrac	<i>Laguiole</i> , <i>Angles</i> , <i>Montagne-Noire</i>
Swiss Brown	<i>Schwyz</i>
Tarentaise	
Gasconne	Mirandaise
Bretonne Pie Noir	<i>De Rennes</i> , <i>De Carhaix</i>
<i>Breton Pie Rouge</i>	<i>Des Côtes-du-Nord</i>
Froment du Léon	
Group II: Concave - forehead hollow, horns growing out in front of the poll.	
Hollandaise and derivates	Black-Pied Dutch-Friesian, Meuse-Rhine-Yssel, Groningen Whiteheaded, <i>Friesch</i> , Bleue du Nord, <i>etc.</i>
Flamande	<i>Artésienne</i> , <i>Picarde</i> , <i>Maroillaise</i> , <i>de Bergues</i>
Durham or Shorthorn	<i>Durham-Mancelle</i>
Normande	<i>Cotentine</i> , <i>Augeronne</i> , <i>Cauchoise</i>
Jersey	
Brown Atlas	[Tunisian] <i>Kef</i> , [Algerian] Geulma, Moroccan Brown Atlas
Group III: Convex - bulging poll, horns flattened and growing out behind the poll.	
Limousine	
Garonnaise	<i>Agenaise</i> , <i>Périgourdine</i>
Bazadaise	
Villard-de-Lans	
<i>Mézenc</i>	
<i>Fémeline</i>	
Béarnaise	<i>Basque</i> , <i>d'Urt</i>
Lourdaise	
Casta	<i>d'Aure</i> , <i>de Saint-Girons</i>
Salers	
Ferrandaise	
<i>Pie rouge de l'Est</i> and <i>Jurassique</i>	Simmental, <i>Bernoise</i> , <i>Comtoise</i> , Montbéliarde,
Abondance	
Vosgienne	
Charolaise	<i>Nivernaise</i>

Table S12. Group classification to region and color according to (A) Kaltenecker (1904) [8] and (B) Müller (1957) [12]

(A) Kaltenecker (1904) [8]

Western group

- Brown Mountain (*Braunvieh*)
 - Montafon, Rendena
- Grey Mountain (*Grauvieh*)
 - Oberintal, Lechtall, Etschtal, Wipptal

Central group

- Red-pied (*Rotbuntvieh*)
 - Zillertal, Pinzgauer, Mölltal, Ennstal
- Black-pied and Brown-pied (*Schwarz- und Braunbuntvieh*)
 - Tux, Pustertal

Eastern group

- Blond (*Blondvieh*)
 - Maltein, Mariahof, Lavantal
- Grey Mountain (*Grauvieh*)
 - Murboden, Mürztal

(B) Müller (1957) [12]

Region	Type of cattle
Western Rhetian zone	western unicolorated
Adjoining Norik zone	central group of pided
Eastern Pannonic zone	eastern group of unicolorated breeds

Table S13. Classification of Spanish cattle according to Sánchez Belda (1981, 1984) [13,14]

Group	Type	Presumed descent
<i>Tronco turdetano</i>	<i>Bóvido rubio turdetano</i> also <i>rojo convexo</i>	<i>Bos taurus turdetanus</i>
	Red and brown breeds with pink nose and convex head profile in France, Pyrenees, Balearic Islands, north-western and southern Spain, Canary Islands; several British red breeds, German and Austrian yellow breeds.	
<i>Tronco ibérico</i>	<i>Bóvido negro ortoido</i>	<i>Bos taurus ibéricus</i>
	Brown and black, elegant cattle in South Spain	
<i>Tronco cántabro</i>	<i>Bóvido Castaño concavo cántabro</i>	
	Chestnut colored breeds with black nose in Cantabrian Mountains, northwestern Spain and northern Portugal, subdivided into Castaña concavo and Moreno del Noroeste [15,16]	
<i>Tronco Castaño ultraconvexo</i>		related to African cattle
	Murciana and Pajuna.	

Table S14. Classification according to Simon and Buchenauer (1993) [17]

- | | |
|---|---|
| 1. Black-and-White Pattern group | <ul style="list-style-type: none"> 1.1. Holstein-Friesian 1.2. Original Black-Pied group 1.3. Russian Black-Pied 1.4. Other Black-Pied 1.5. White Belted group 1.6. Color Sided 1.7. Whiteheaded |
| 2. Black group | <ul style="list-style-type: none"> 2.1. Iberian Black 2.2. English Black |
| 3. Red Pattern group | <ul style="list-style-type: none"> 3.1. Red-Pied group 3.2. Simmental group 3.3. Black Forest 3.4. Pinzgauer group 3.5. Hereford group 3.6. Ayrshire group 3.7. White lineback |
| 4. Red groups | <ul style="list-style-type: none"> 4.1. English Red 4.2. Shorthorn group 4.3. Central-European,
Red Northern Central type,
German Red Hill group, Baltic type 4.4. Scandinavian Red 4.5. Russian Red 4.6. Iberian Red |
| 5. Brown group | <ul style="list-style-type: none"> 5.1. Brown Swiss group 5.2. Alpine Brown 5.3. Brown Mountain 5.4. Iberian Brown 5.5. Balkan Brown 5.6. British Brown |
| 6. Grey Cattle group | <ul style="list-style-type: none"> 6.1. Grey Steppe/Podolian 6.2. Grey Mountain |
| 7. Blue Cattle group | |
| 8. Blond Cattle | <ul style="list-style-type: none"> 8.1. Blonde d' Aquitaine group 8.2. Gelbvieh group 8.3. Limousin group 8.4. Channel Island Cattle group 8.5. Italian Blond 8.6. Iberian Blond |
| 9. British White | <ul style="list-style-type: none"> 9.2. Charolais group 9.3. Italian White |
| 10. Multicolored group | <p>“In this group are unimproved cattle breeds which vary in coat color. Relationships among these breeds are not documented”</p> |

Table S15. Classification according to Bougler (1998) [18]

Strain	Distribution, breeds
Grey Steppe	Russian steppe, through the Balkans and Italy as far as the Iberian Peninsula; in France represented only by the Gasconne.
Brown	Southern flanks of the Alpine arch and the borders of the Mediterranean; Brown Mountain, Corse, Tarentaise, Aubrac, Parthenaise.
Red-Pied Mountain	Flanks north of the Alpine arch; Simmental, Montbéliarde, Abondance, Charolais.
Red	From the North Sea to northern Russia: Flamande.
North Sea	today mainly dual-purpose and dairy breeds: Prim'Holstein, Pie Rouge des Plaines, Normande, Maine-Anjou (renamed Rouge des Prés), Armoricaïne.
Breton	Bretonne Pie Noir, Froment du Léon, Jersey.
Blond and Red	From the Massif central to the southwest and further into Spain; Blonde d'Aquitaine, Limousin and Salers.

Table S16. Classification according to Ramm (1901) [19]

Group I: Breeds and strains from the Netherlands, Denmark and Germany

Subgroups 1–3: Dutch, Danish, German Lowland strains

a: dairy type

b: dairy-beef type from the German low lands

Subgroup 4: Swiss Mountain and adjoining German strains

a: Simmental and Fleckvieh

b: Brown Mountain

Subgroup 5: white-backed landraces from the South-German highlands

Subgroup 6: heavy, yellow and red highland strains from central Germany

Subgroup 7: light build, unicolored red and red white-headed (blazed) breeds

Group II: Breeds and strains from Austria—Hungary

Subgroup 1: mountain strains from the Austrian Alps

a. Alpine grey

b. Fleckvieh

c. Blond and yellow

Subgroup 2: landraces in Upper and Lower Austria, Bohemia, Mähren, Galizien, Krain and Küstland

Subgroup 3: Hungarian breeds

Group III: Strains from Russia

Subgroup 1: Landraces from Russia, Poland, the Baltics and Finland

Subgroup 2: South-Russian Steppe cattle

Group IV: Breeds and strains from Sweden and Norway

Subgroup 1: Swedish breeds

Subgroup 2: Norwegian strains

Group V: Breeds from Belgium and France

Subgroup 1: Belgian breeds

Subgroup 2: French breeds

a. lowland breeds

b. land and mountain breeds south of the Loire and upper Rhone

c. breeds of central and eastern France

d. breeds from Tunisia and Algeria

Group VI: Breeds from Italy

Subgroup 1: North-Italian breeds

Subgroup 2: Central and South-Italian breeds

Subgroup 3: Italian islands breeds

Group VII: Breeds from Spain and Portugal

Subgroup 1: Spanish breeds

Subgroup 2: Portuguese breeds

Group VIII: Breeds from Great Britain and America

Subgroup 1: British breeds: a. beef type strains,

b. dairy type strains

Subgroup 2: American: a. Texas cattle.

b. 3 imported breeds

Table S17. Classification according to Zwaenepoel (1920) [20].
Names of extinct breeds are in *italics*.

I. Dairy breeds of the northern French lowlands

Rouge Flamande
Normande
Bretonne

II. Cattle belonging to the Swiss type

Pied breeds

Comtoise, Tourache, Montbéliarde, Gessiene, Abondance, Bressane, Vosgienne, Morvandelle, Mancelle

Brown breeds

Tarentaise, brown breeds of the Massif Central, *Marchoise, Aubrac, Anglès, Cévennes, Gasconne, Corse*

III. Cattle of the Midi (Pyrenees) belonging to Romagna (a) and Spanish cattle (b)

a. Lourdaise

b. *Basque*, Béarnaise, Casta, Camargue

IV. Cattle of the Centre

A. Central group

Charolais-Nivernais, Limousine, Féneline, Mézenc, Villard de Lans, Ferrandaise

B. Western group

Parthénaise, Garonnaise, Bazadaise, Bordelaise

V. Imported cattle and crossbreeds

Durham, *Durham-Mancelle* [pre Maine-Anjou] *etc.*, Jersey, Dutch-Friesian, *Flamande-Hollandaise*, Swiss Brown, *Race du Hainaut* [pre Belgian White-Blue]

Table S18. Classification according to Hansen (1927) [21]

Group 1. Germany, Holland, Denmark and Switzerland

I. Lowland strains

A. Dutch strains

B. German lowland cattle

1. Dairy and dairy-beef strains;
2. Beef strains

C. Danish lowland cattle

II. Mountain cattle in Switzerland and Germany

1. *Fleckvieh*
2. Brown Mountain

III Land cattle races in Germany

1. Unicolored yellow
2. Unicolored red and red-brown
3. Pied and white-headed

Group 2. Austria

Group 3. Hungary

Group 4. Czechoslovakia

Group 5. Poland

Group 6. Lithuania

Group 7. Latvia and Estonia

Group 8. Finland

Group 9. Russia

Group 10. Sweden and Norway

Group 11. Belgium and France

Group 12. Italy, Spain and Portugal

Group 13. Great Britain and Ireland

Group 14. North America

Table S19. Classification according to French et al. (1966) [22]**Scandinavian and North-European group**

Denmark	Red Danish, Danish Black-and-White, Danish Jersey, Shorthorn.
Finland	Finncattle, Finnish Ayrshire
Iceland	Icelandic breed
Norway	Norwegian Red, South- and Westland, Color-sided Trønder and Northland, Telemark, Døle, Målselv, Norwegian Jersey
Sweden	Swedish Red-and-White, Swedish Friesian, Swedish Polled, Swedish Jersey

United Kingdom and Ireland

Aberdeen Angus, Ayrshire, Blue Albion, North Devon, Dexter, British Friesian, Galloway, Belted Galloway, Old Gloucestershire, Guernsey, Hereford, Highland, Jersey, Kerry, Lincoln Red, Longhorn, Red Poll, Shetland, Shorthorn, South Devon, Sussex, Welsh Black, White Park

North Sea and Baltic Littoral

Netherlands	Dutch Friesian, Groningen White-headed, Meuse-Rhine-Ijssel
Germany	Black-and-White Lowland, Red-and-White Lowland, Angeln, Shorthorn, German Simmental, German Brown, German Yellow, German Red, Pinzgauer, Small Spotted Highland, Murnau-Werdenfels
Poland	Black-and-White Lowland, Polish Red, Red-and-White Lowland

Western Europe

Belgium	Red West-Flemish, Central and Upland, Red-and-White East-Flemish, Red and White Campine, Black-and-White Herve, Friesian, Meuse-Rhine-Yssel
France	Normandy, French Friesian, Eastern Red-and-White, Charolais, Limousin, Salers, Armorican, Maine-Anjou, Brittany Black-and-White, Gascony, Flemish, Pathenay, Brown Swiss, Aubrack, Blond Pyrenean, Garonne, Tarentaise

Alpine Europe

Switzerland	Simmental, Brown Swiss, Fribourg, Hérens
Austria	Austrian Simmental, Austrian Yellow, Pinzgau, Austrian Brown, Grey Tirolean, Black-and-White Lowland
Czechoslovakia	Czechoslovak Red-and-White, Slovakian Red-and-White, Pinzgau

Spain, Portugal, Italy

Portugal	Miranda or Ratinha, Turino, Barrosa, Aroucesa, Alentejo, Mértola, Minho, Algarve, Brava
Spain	Pyrenean or Basque, Tudanca, Asturian, Leonese, Retinta or Extremeña, Avila, Berrenda, Black Andalusian, Salamanca or Morucho, Zamora, Extremadura, Cáceres,
Italy	Murcia or Levantine, Black-and-White Lowland, Brown Swiss, Fighting bull Brown Swiss, Friesian, Red-and-White Valdostana, Black-and-White Valdostana, Rendena, Burlina, Romagna, Chiana, Marche, Maremma, Pugliese, Piedmont, Grey Alpine, Modena, Simmental, Reggio, Modica, Garfagnina, Pisa, Tarina, Modica-Sardinian, Sardinian

The Balkans and Turkey

Hungary	Hungarian Red-and-White, Simmental, Hungarian Brown, Hungarian Steppe
Romania	Romanian Buša, Romanian Steppe, Romanian Spotted, Maramures Brown, Transylvanian, Pinzgau, Romanian Red
Yugoslavia	Yugoslav Buša, Yugoslav Red-and-White, Pinzgau, Istrian, Brown Slovenian
Bulgaria	Grey Iskur, Sofia Brown and Montafon crosses, Kula and Simmental crosses, Shorthorned Rhodope, Red Sadova and Ukrainian Steppe
Greece	Greek Shorthorn, Greek Steppe
Turkey	Grey Steppe
U.S.S.R	Kholmogor, Friesian, Oldenburg, Tagil, Yaroslavl, Ukrainian Red, Angeln, Red Danish, Estonian Red, Latvian Red, Suksun, Polish Red, Ukrainian White-head, Gorbatov Red, Yurino, Istoben, Ayrshire, East-Finnish, Simmental, Tambov Red, Bestuzhev, Ukrainian Grey, Hereford, Shorthorn, Aberdeen-Angus, Kalmyk.

Table S20. Classification according Doutresoulle (1947) [23]

Taurine type

- (a) derived from longhorned cattle: N'Dama and the breed of Chad (Kuri)
- (b) derived from shorthorned cattle: cattle of the Lagoons (West-African Shorthorn)

Zebu type (after Curson and Epstein)

- (a) shorthorned zebu: zebu × *brachyceros*
- (b) sanga zebu: true zebu × Hamitic longhorn, with small, cervico-thoracic hump
- (c) West-African zebus with lyre-formed horns: N'Dama × shorthorned zebu

Table S21. Classification of West-African Livestock according to Mason (1951) [24]

Group I.	Lake Chad cattle	<ul style="list-style-type: none">1. Kuri2. Kuri × zebu crosses
Group II.	Small humpless cattle	<ul style="list-style-type: none">1. Dwarf Shorthorn2. N'Dama3. Intermediate types<ul style="list-style-type: none">a. Baoulé (Ivory Coast)b. Gold Coast
Group III.	Humped × humpless crosses	<ul style="list-style-type: none">1. Djakoré (Senegal)2. Bambara or Meré (French Sudan)3. "Sanga" (Gold Coast)4. Borgu (Dahomey and Nigeria)5. Biu (Nigeria)
Group IV.	Humped cattle (zebus)	
	Subgroup A. Short-horned zebus	<ul style="list-style-type: none">1. Maure2. Tuareg3. Azaouak4. Shuwa5. Fellata (Chad)6. Sokoto
	Subgroup B. Medium-horned zebus	<ul style="list-style-type: none">1. Diali2. Adamawa
	Subgroup C. Lyre-horned zebus	<ul style="list-style-type: none">1. Senegal Fulani2. Sudanese Fulani3. White Fulani (Nigeria)
	Subgroup D. Long-lyre-horned zebus	<ul style="list-style-type: none">1. Red Bororo

Table S22. Classification according to Joshi et al. (1957) [25]

Group I. Humpless or vestigially-humped cattle of the lower Nile valley and Mediterranean Africa. the cattle of Egypt, including the Damietta, Baladi, Saidi and Maryuti.

Group II. Zebus of the sub Saharan zone with many points of similarity with the Indo-Pakistan zebus. This group may be subdivided into

1. Medium (a) and short-horned (b) zebu
 - a. Adamawa zebu, Azaouak zebu, Maure zebu, Northern Sudan shorthorn zebu.
 - b. Shuwa zebu, Sokoto zebu
2. Lyre-horned (a) and long-horned (b) zebu
 - a. Fulani zebus (Nigerian , Senegal , Sudanese and White Fulani).
 - b. M'Bororo

Group III. Humpless, straight-backed cattle of West Africa

- a. N'Dama
- b. West-African Shorthorned cattle

Group IV. Kuri cattle of Lake Chad, humpless and with characteristic bulbous horns

Group V. Cattle of much of central and southern Africa from the flood plain of the Nile in the Sudan, through South-western Uganda, Rwanda and Burundi to the Rhodesias [Zimbabwe, Malawi], Bechuanaland [Botswana], Swaziland and Basutoland, characterized by large- or medium-sized lyre-shaped horns, small or vestigial humps and moderately sloping hindquarters

- a. Ankole cattle of Uganda, Ruanda-Urundi, eastern [Belgian] Congo and Tanganyika
- b. Barotse cattle of the western part of Northern Rhodesia [Zimbabwe]
- c. Basuto cattle
- d. Nguni cattle of Zululand and Swaziland
- e. Nilotic cattle of the southern Sudan
- f. Nioka cattle of the Eastern Province of the [Belgian] Congo
- g. Nganda cattle of Uganda
- h. Tonga cattle of the Southern Province of Northern Rhodesia [Zimbabwe]

Group VI. Cattle types of East Africa, a large heterogeneous population composed of often ill-defined groups merging into one another and, in some cases, into types which have been listed in group V, but which all appear to be predominantly derived from zebu stocks similar to those of the Indo-Pakistan peninsula.

- a. Angoni cattle of the Eastern Province of Northern Rhodesia [Zimbabwe]
- b. Boran cattle of southern Ethiopia, Somalia and northern Kenya
- c. Bukedi zebu of Uganda
- d. Galla, Jiddu and Tuni cattle of Somalia
- e. Lugware cattle of the Belgian Congo and Uganda
- f. Nandi cattle of western Kenya
- g. Southern Sudan Hill zebu
- h. Tanganyika shorthorned zebu
- i. Toposa-Murle cattle of Southeastern Sudan

Group VII. Africander [Afrikaner] cattle of southern Africa

Group VIII. The Madagascar zebu

Table S23. Classification of African cattle according to the Colonial Advisory Council of Agriculture, Animal Health and Forestry (1957) [26]

The cattle types of East, Central and South Africa

- I. Longhorn humpless
- II. Shorthorn humped
- III. Cervico-thoracic humped zebu (neck-humped)
- IV. Thoracic humped zebu (chest-humped)
- V. Sanga

The cattle types of West Africa

- I. Longhorn humpless
- II. Shorthorn humpless
- III. Cervico-thoracic humped zebu
- IV. Thoracic humped zebu
- V. Sanga (either Cervico-thoracic nor thoracic-humped)

The cattle of North Africa

- I. Shorthorn humpless

Table S24. Classification of Indian and Pakistan cattle according to Joshi et al. (1953) [27]

Group I. The breeds classified in this Group are lyre-horned grey animals with wide foreheads, prominent orbital arches and a flat or dished-in profile. They are deep bodied, powerful draft animals.

Breeds: Kankrej, Kenwariya (Kentkatha), Kherigarh, Malvi, Tharparkar (Thari).

Group II. The breeds classified in this Group are short-horned, white or light grey in color with long coffin-shaped skulls. The face is slightly convex in profile.

Breeds: Bachaur, Bhagnari, Gaolao, Haryana, Krishna Valley, Mewati, Nagori, Ongole, Rath.

Group III. Breeds classified in this Group are more ponderous in build and have pendulous dewlaps and sheaths. They often have lateral and curled horns, and usually red or some shade of red color, being occasionally spotted: the best dairy breeds among zebus are found in this group.

Breeds: Dangi, Deoni, Gir, Nimari, Red Sindhi, Sahiwal.

Group IV. Breeds classified in this Group, are popularly termed "Mysore cattle." They are characterized by prominent foreheads and long, pointed horns rising close together, and are, with few exceptions, poor milkers.

Breeds: Amrit Mahal, Hallikar, Kangayam, Khillari.

Group V. The breeds included in this Group are a heterogeneous mixture of distinct strains. They are found all over the Indo-Pakistan area and particularly in the Himalayas, in the hills of Baluchistan and in the rugged mountainous areas of North Pakistan.

Breeds: Lohani, Ponwar, Siri.

Group VI. The Dhanni breed is the only one included in this Group. It does not seem to fit into any of the other groups described, and therefore requires a separate classification.

Table S25. Classification of Chinese cattle according to Epstein (1969) [28]

1. **Mongolian cattle**
2. **Humpless cattle of Northeast China (Manchuria)**
3. **Pinchow and Sanho dairy cattle of China**
4. **Peking black-pied or Peking black-and-white dairy breed**
5. **Humpless dwarf cattle of Tibet**
6. **Cervico-thoracic-humped cattle of Central China**
7. **Chinchwan cattle**
8. **Nanyang cattle**
9. **Shantung cattle**
10. **Chowpei and Hwangpei cattle of Hupeh**
11. **Cattle of Szechwan, Hunan and Kweichow**
12. **Zebu cattle of South China**
13. **Cattle of Taiwan**

Table S26. Classification of tropical cattle according to Maule (1990) [29]

Group I Zebu (*Bos indicus*; thoracic humped cattle)

A. Indo Pakistan

1. Lyre-horned, grey
2. Shorthorned, white or grey coffin shaped skull
3. Lateral horned, red, red-and-white or black-and-white
4. 'Mysore' breeds: grey, long backward pointed horns
5. Small hill cattle
6. Cattle of Sri Lanka

B. African

1. North Sudan zebu
2. East-African shorthorned zebu
3. Madagascar zebu
4. West-African short- and medium-horned zebu
5. West-African lyre horned and long lyre-horned

C. Brazilian

D. Middle and Far East

1. Middle East
2. Southeast Asia
3. South China zebu
4. Taiwan zebu

E. Brahman

Group II Sanga (Cervico-thoracic humped cattle)

A. Sudan and East Africa

1. Nilotic
2. Danakil
3. Ankole

B. Southern African Longhorned

1. Setswana
2. Nguni
3. Africander

C. Southern African Shorthorned

1. Mashona

- 2. Tonga
- 3. Basuto
- 4. Drakensberger
- D. Sanga × zebu crosses
 - 1. Ethiopian
 - 2. East Africa

Group III Humpless

- A. Humpless cattle of West and North Africa
 - 1. West-African Longhorn
 - 2. West-African Shorthorn
 - 3. North-African Shorthorn
 - 4. Ethiopian Shorthorn
- B. Middle East Shorthorn
 - 1. Syria and Palestine
 - 2. Cyprus
 - 3. South-Anatolian Red
 - 4. Kurdi
- C. Criollo of Latin America
 - 1. South-American (except Brazil)
 - 2. Brazilian
 - 3. Central America
 - 4. Caribbean
- D. Far East

Group IV Humped × humpless

- A. Zebu × West-African Humpless
 - 1. Zebu × N'Dama / Dwarf
 - 2. Zebu × Kuri
- B. Zebu × Brachyceros
 - 1. Middle East
 - 2. Far East
- C. *Bos taurus* × *Bos indicus*
 - 1. North America
 - 2. Caribbean
 - 3. South America
 - 4. Asia
 - 5. Africa
 - 6. Australia

Group V *Bos bibos* (domesticated species)

- A. *Bos bibos javanicus* and crosses
 - 1. Banteng or Bali cattle
 - 2. Banteng × Ongole zebu
- B. *Bos bibos frontalis*
 - 1. Mithan or gayal
 - 2. Mithan × Siri zebu

Table S27. Classification and phylogeny according to Baker and Manwell (1980) [30] and Manwell and Baker (1980) [31]

(A) Classification	Abbreviation on map
I. European: <i>Bos taurus</i> L.	
A. North-European	N
1. <i>Scandinavian</i> : Finnish, Icelandic, Norwegian Red, Swedish Mountain, Swedish Polled, Swedish Red Polled, Swedish Red-and-White	
2. <i>Celtic</i> : Aberdeen Angus, Ayrshire, Belted Galloway, Dexter, Galloway, Highland, Kerry, Welsh Black, Wild White	
3. <i>Shorthorn</i> : Beef Shorthorn, Dairy Shorthorn, Milking Shorthorn, Northern Dairy Shorthorn	
4. <i>English Lowland</i> : Hereford, Lincoln Red, Longhorn, North Devon, Polled Hereford, Red Poll, South Devon, Sussex	
B. Pied Lowland	L
1. <i>Red-Pied Lowland</i> : Campine, East Flanders, German Red-Pied, Meuse-Rhine-Yssel, Polish Red- and-White Lowland	
2. <i>Black-Pied Lowland</i> : Belgian Black-Pied, Danish Black-Pied, Dutch Black-Pied, Estonian Black-Pied, Friesian, German Black-Pied, Gronigen White-headed, Kholmogor, Middle and Upper Belgium, Polish Black-and-White Lowland, Russian Black-Pied, Siberian Black-Pied, Swedish Lowland, Yaroslavl	
C. European Red brachyceros	R
1. <i>Lowland Red</i> : Danish Red, Flamande, Latvian Brown, Red Angeln, West Flanders	
2. <i>East- and Central European Red</i> : Bulgarian Red, German Red, Polish Red, White Russian Red	
D. Channel Island brachyceros	C
1. <i>Channel Island</i> : Guernsey, Jersey	
2. <i>French</i> : Brittany Shorthorn, Normande	
3. <i>Derived</i> : Canadian	
E. Upland brachyceros	U
1. <i>Pinzgau type</i> : Pinzgau	
2. <i>Spotted Mountain</i> :	
a. <i>Main group</i> : Fleckvieh, Fribourg, Hinterwald, Hohenfleckvieh, Simmental, Vorderwald, Yellow Franconian	
b. <i>Derived group</i> : Aosta, Montbéliarde, Red-Pied Friuli	
3. <i>Yellow Mountain</i> : Austrian, German Yellow, Carinthian Blondvieh, German Yellow, Murboden, Waldviertel.	
4. <i>Brown Mountain</i> : Austrian Brown, Brown Swiss, Bruna Alpina, German Brown, Mur-nau-Werdenfels, Rendena, Tarentaise	
5. <i>Grey Mountain</i> : Tyrolean Grey	
6. <i>Hérens type</i> : Hérens	
7. <i>Italian 'Mediterranean'</i> : Reggiana, Sarda	
8. <i>Balkan 'Mediterranean'</i> : Busha, Cika, Rhodope, Slovene Grey-Brown	
9. <i>Near-Eastern and North-African 'Mediterranean'</i> : Algerian Hill, Anatolian Black, Cyprus, Damascus, East-Turkish, Egyptian, Oksh, South-Anatolian Red	
F. Primigenius-brachyceros Mixed	M
1. <i>French</i> : Charolais, Garonne, Limousin, Parthenaise	

(A) Classification

Abbreviation on map

1. *Italian*: Agerola, Modica, Modica-Calabrian, Piedmont
3. *Lowland × Steppe*: Bestuzhev, Red Steppe, Ukrainian Whitehead
4. *Brown Mountain × Steppe*: Bulgarian Brown, Romanian Brown, Sofia Brown
5. *Simmental × Steppe*: Slovakian Pied, Slovene Light Red Spotted
6. *Eastern European*: Ala-tau, Kostroma

G. Primigenius

P

1. *Iberian primigenius*: Alentejo, Criollo, Mixican Fighting, Texas Longhorn, Tinema
2. *Italian podolic*: Calabrian, Chianina, Marchigiana, Maremma, Modena, Romaga
3. *Podolic*: Grey Iskur, Grey Steppe, Hungarian Grey, Istrian, Romanian Steppe, Yugoslavian Steppe

II. Turano-Mongolian: Kalmyk, Yakutian.

III. East-Asian

taurine types: Japanese Black, Japanese Brown, Japanese Shorthorn.

taurine-indicine intermediates: Korean

indicine (zebu): Mishima, Taiwan Yellow

IV. Zebu: *Bos indicus* L.

Z

1. *Mohenjodaro type zebu*: Kankrej, Malvi, Tharparkar
2. *Shorthorned zebu*: Hariana, Nagori, Ongole, Rath
3. *Dairy type zebu*: Dangi, Gir, Sahiwal, Sindhi
4. *Mysore type zebu*: Kangayam, Khillari
5. *Hill breeds*: Afghan, Kumauni
6. *Ungrouped zebu*: Bermejo, Desi, Gavathi, Indo-Brazilian, zebu

V. Modern major crosses

A. *Taurindicus*: Brahman, Droughtmaster, Santa Gertudis

B. *Taur-sanga*: Bonsmara, Drakensberger

C. *Three-way*: *derivation*: Renitelo

VI. African humpless

A. *Kuri type*: Kuri

B. *Longhorn*: N'Dama

C. *West-African Dwarf Shorthorn*: Baoulé, Ghana Shorthorn, Lagoon, Muturu

VII. African humped

A

A. African Humped:

1. *West-African zebu*: Adamawa Gudali, Cameroon Red
2. *West-African Shorthorned zebu*: Shuwa Arab, Sokoto
3. *East-African Shorthorned zebu*: Angoni, Boran, Garre, Kajiado, Malawi (North), Malawi zebu (South), Narok, North Sudan zebu, Tanganikan Shorthorned zebu, Teso
4. *Madagascar zebu*: Malagasy
5. *Fulani*: Foulbé, Gobra, Red Bororo, White Bororo
6. *East-African zebu-sanga intermediates*: Jiddu, Kenana, Nganda

B. African Humped (Sanga)

S

Africander, Angolan Café Cunene, Angolan Malanje, Angolan Quilenques, Ankole, Barotse, Caprivi-Sanga, Landim, Lesotho, Nguni, Manguni, Mashona, Nguni, Ovambo, Pedi, Sango, Tonga, Tuli

(B) Phylogeny

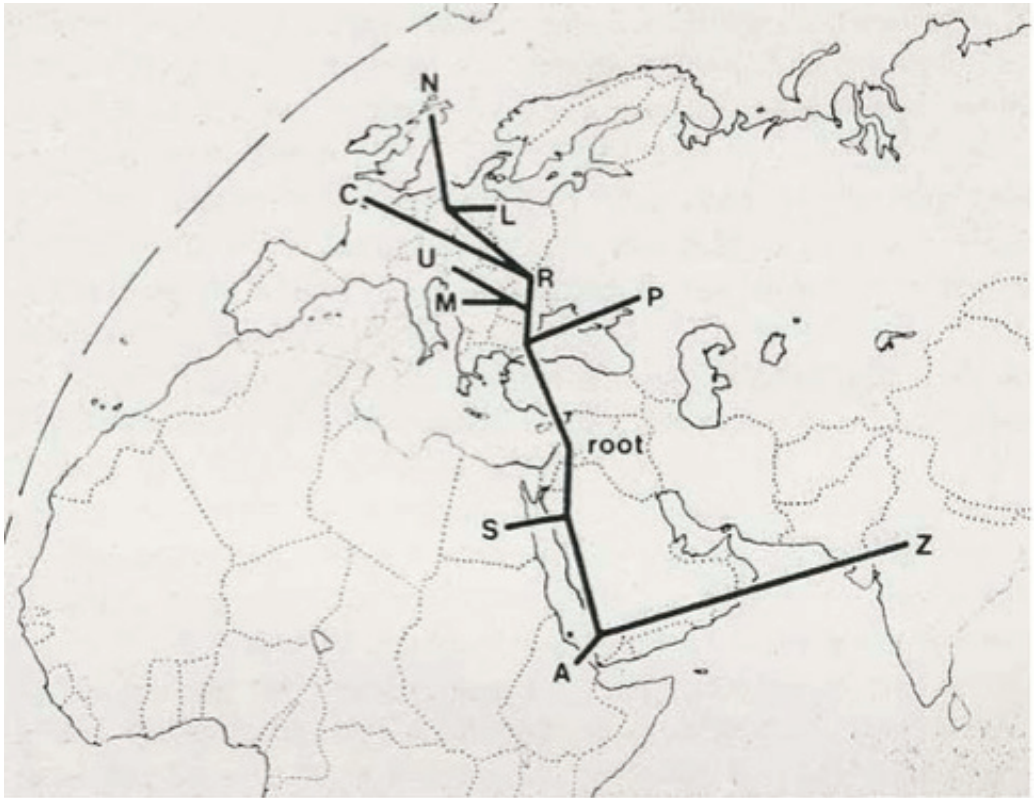
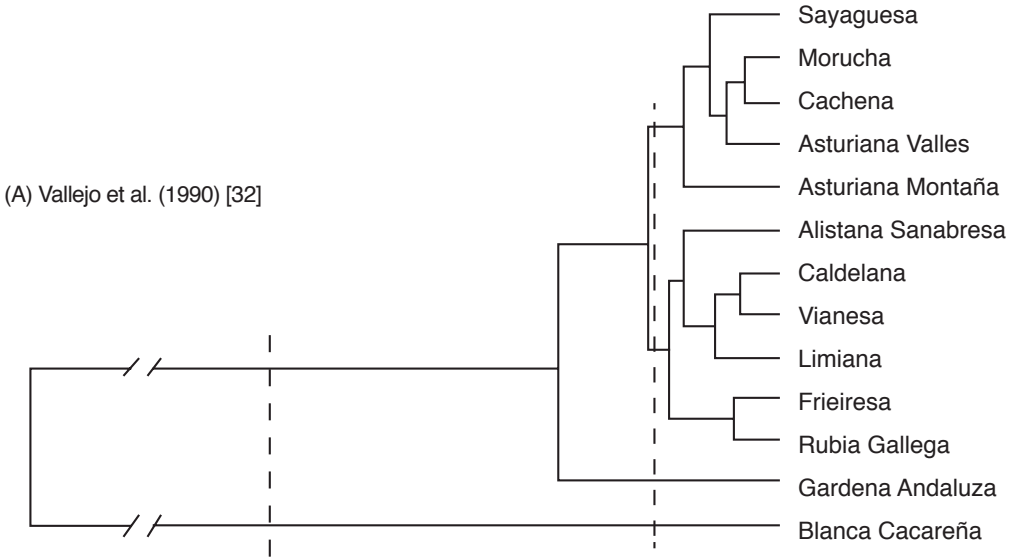


Table S28. Classification and origin of Spanish breeds according to Vallejo (1990) [2]

Group	Breeds	Mutant form	Prehistoric strain
I	Blanca Cacereña	<i>Bos desertorum</i>	
II	Cárdena Andaluza	<i>Bos primigenius Hahni</i>	
III	Rubia Gallega	<i>Bos t. Ibericus</i> or	<i>B.t. primigenius</i>
	Frieiresa	<i>Bos primigenius estrepisceros</i>	
	Limiana		
	Vianesa		
	Caldelana		
	Alistana Sanabresa		
IV	Asturiana Montaña	<i>Bos brachyceros</i> and	<i>B.t. brachyceros</i>
	Asturiana Valles	<i>Bos brachyceros europeus</i>	
	Cachena		
	Morucha		
	Sayaguesa		

Figure S1. Phylogenies of Iberian breeds



(B) Fernández et al. (1998) [33]

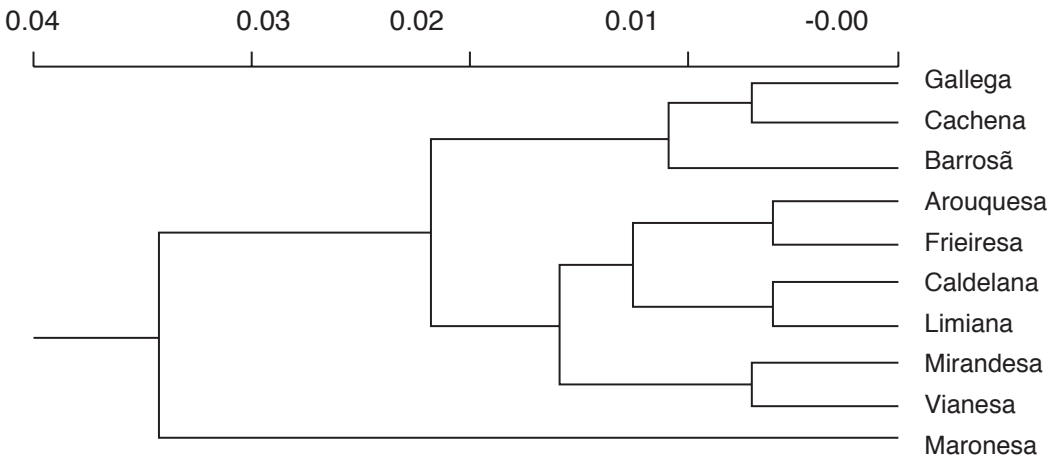


Table S29. Classification of French breeds according to Grosclaude (1990) [34]

1. **Northern breeds** (*Le groupe des races du Nord*)
Frisonne, Flamande, Maine-Anjou, Shorthorn
2. **Central and Southwestern breeds** (*Le groupe des races du Centre et du Sud-Ouest*)
Charolais, Ferrandaise, Limousin, Salers, Aubrac, Blonde d'Aquitaine
3. **Western and eastern breeds** (*Un groupe comprenant à la fois des races de l'Ouest*)
Eastern: Vosgienne, Montbéliarde, Pie-Rouge de 'Est, Brune, Abondance, Tarine.
4. **Normande** (*la seule race Normande*)

Table S30. Classification of French breeds and related breeds from other countries according to Gautier et al. (2010) [35]

1. **Northern breeds:** Holstein, French Red-Pied Lowland, Maine-Anjou (Rouges des Près), also related to Angus and Norwegian Red.
2. **Central and Southwestern breeds:** Aubrac, Blonde d'Aquitaine, Gasconne, Limousin, Salers, related to Charolais
3. **Eastern breeds:** Abondance, Montbéliarde, Tarentaise, Vosgienne, also related to Brown Swiss
4. **Parthenaise (Maraichine)**
5. **Bretonne Pie Noir**
6. **Normande**

The last 3 groups are separate, and intermediate between the Northern group and the others

Table S31. Classification according to Alderson (1992) [36]

Group	Distribution	Typical breeds
1. Podolic	Lower/Mid Danube, Balkans, Italy	Grey Steppe, Maremmana
2. North-European	Poland, Czechoslovakia, Germany, Denmark, Benelux, England	Angeln, Danish Red, Flemish, Friesian, Polish Red, Lincoln Red, Sussex, Shorthorn
3. Central Europe		
(a) Swiss group	Alpine region, northern Italy	Brown Swiss, Garfagnina, Pontremolese
(b) Pattern group	Germany, Austria, Switzerland, France	East-French Red-Pied, Pinzgauer, Spotted Cattle
(c) Yellow-Brown	Central Germany through France and northern Spain to Portugal	Murbodner, German Yellow, Tarentaise, Limousin, Blonde d'Aquitaine, Aubrac, Parthenaise, Villard-de-Lans, Leonese, Pyrenean, Asturian, Mirandesa, Minhota
4. Western Europe	Southwest Iberia, Wales, Scotland, Ireland	White Park, Kerry, Welsh Black, Negra Ibérica, Morucha, Retinta, Camargue

Table S32. Classification according to Denis (2010) [37]. Names of extinct breeds and types in italic. This classification is based on an earlier classification from 1983 with addition of the last group.

1. Race primaire Batave

Dutch-Friesian group *Française Frisonne*, Pie Rouge des Plaines, Flamande
 Durham derived Blue de Nord, Maine-Anjou (Rouge des Prés), Saosnoise, Armoricaïne
 Normande

2. Race primaire Jurassique

Jura group Charolaise, Montbéliarde, Simmental Française,
 Abondance, Vosgienne, Villard-de-Lans
 Auvergne group Salers, Ferrandaïse
 Aquitaine group: Limousine, Blonde des Pyrénées, Béarnaise, Lourdaïse, Bazadaïse, Casta

3. Race primaire alpine

Alpine group Brune de Alpes, Tarentaise, Aubrac, Gasconne, Mirandaise.
 Poitevin group Parthenaise, Maraîchine, Nantaise
 Breton group Bretonne Pie Noir, Froment du Léon, Jersiaïse
 Rustic and semi-wild breeds from South France: Camargue, Corse

Table S33. (A) Classification according to Felius (1995) [38] and (B) revised classification (2010)

Differences between the classifications of 1995 and 2010 are the following:

1. Changes in Group name For instance in Group 1 the name Celtic is now placed between quotation marks, since this would support the unfounded theory that these cattle are introduced by Celts.
2. Extended subgroup names. To subgroup 1A Northern Russia is added because a number of (mainly extinct) breeds from this region are here included, which were not described in the 1995 edition. In several subgroups of Groups 1 and 2 the region where the derived breeds are to be found are mentioned.
3. Change in subgroup names. Subgroup 2B now contains other than black-pied breeds, so the name is shortened to West- and Northeast-European Pied Lowland Dairy breeds. The name of subgroup 13A is shortened, indicating the whole region instead of separate countries. Zebus from subgroup 13A are indicated as 'large' in order to distinguish these from the small zebus in the same region.
4. Change in the order of subgroup interchange. In Group 1, the Subgroups B and C changed places in order to bring closer together the two Scandinavian groups and the British groups. Geographic classification thus overrules the morphological typing (polled and horned cattle groups) as was done in the 1995 publication.
5. New subgroup. To Group 2 a subgroup is added containing a recent Danish multi breed.
6. Splitting subgroups. The first three subgroups in the Group 5 are arranged differently. Several breeds and varieties of Iberian cattle are only recently recognized and added in this classification. This allowed a more refined grouping to region and type. Since more American, Australian and New Zealand breeds could be described than in 1995, the subgroups of Group 16 have been split up.
7. Change in classification. Because since 1995 more zenga breeds have been recognized, all zenga breeds have been moved from Group 13 to Group 14.
8. Modernizing language. In Group 7 the name Middle East is replaced by Southwest Asia. Further, 'blood' is replaced by 'influence'. African zebu x sanga types and breeds are now termed 'zenga'.

(A) Classification of 1995

Group 1 North-European Polled and Celtic breeds

- Subgroup 1A Polled breeds of Iceland, Scandinavia and the Baltics
- Subgroup 1B Polled breeds of Great Britain and derived breeds
- Subgroup 1C Longhorned dairy breeds of Scandinavia and Scotland
- Subgroup 1D Celtic breeds of Great Britain

Group 2 Lowland breeds of West and North Europe

- Subgroup 2A West-European red lowland breeds and derived breeds in Eastern Europe
- Subgroup 2B West- and North-European black-pied and red-pied Lowland dairy breeds and derived breeds in central and eastern Europe
- Subgroup 2C West-European red-pied and blue-pied Lowland dual-purpose and beef breeds and derived breeds in Eastern Europe
- Subgroup 2D British shorthorned breeds and derived breeds in Eastern Europe
- Subgroup 2E Lowland breeds of West and South England
- Subgroup 2F Breeds of the Channel Islands, and Northwestern France

Group 3 Shortheaded and broadheaded highland breeds of Western and Central Europe

- Subgroup 3A Vosges and Black-Forest breeds
- Subgroup 3B Central-European red highland breeds
- Subgroup 3C Shortheaded Alpine breeds and derived breeds in Eastern Europe
- Subgroup 3D Central-European blond and yellow highland breeds
- Subgroup 3E Western- and Central-European broadheaded red spotted mountain breeds and derived breeds in Eastern Europe
- Subgroup 3F Charolais

Group 4 Solid-colored highland breeds of Western Europe, the Alps and Eastern Europe

- Subgroup 4A Breeds of central France
- Subgroup 4B Grey and blond breeds of Southwestern France and the Pyrenees
- Subgroup 4C North-Italian fawn-brown breeds
- Subgroup 4D Central-European grey and brown mountain and derived breeds in Eastern Europe
- Subgroup 4E Illyrian shorthorn breeds of the Balkans and Greece and upgraded breeds

Group 5 Breeds of Southwest Europe

- Subgroup 5A Breeds of the Cantabrian mountains and primitive (semi-feral) breeds of the Pyrenees, the Camargue, Corsica and Sardinia
- Subgroup 5B Blond-brown northwestern Iberian, Balearic and Canarian breeds
- Subgroup 5C Chestnut NorthWest-Iberian breeds
- Subgroup 5D Central and Southern Iberian black breeds
- Subgroup 5E Central and Southern Iberian red breeds
- Subgroup 5F Southeastern Iberian breeds

Group 6 Podolian breeds of Italy and East Europe

- Subgroup 6A Large white breeds of Italy
- Subgroup 6B Podolian breeds of Italy and Croatia
- Subgroup 6C Podolian grey steppe breeds of Eastern Europe
- Subgroup 6D Podolian-Illyrian breeds of the Balkan and Anatolia

Group 7 Shorthorned breeds of the Caucasus and Southwest Asia

- Subgroup 7A Humpless breeds of the Caucasus, SW Asia and derived breeds with exotic blood
- Subgroup 7B Damascus type breeds of the Southwest Asia

and derived breeds with exotic blood

Group 8 Indo-Pakistani type zebu breeds

- Subgroup 8A Zebu and zeboid breeds of the central Asia, Afghanistan and northwestern Pakistan and derived breeds with European blood
- Subgroup 8B Heavily-built breeds with convex forehead and derived breeds with European blood
- Subgroup 8C Shorthorned grey-white zebu breeds
- Subgroup 8D Zebu breeds with lyre-shaped horns and derived breeds with taurine blood
- Subgroup 8E Mysore zebu breeds
- Subgroup 8F Small zebu breeds of Bangladesh, Northeast and South India and Sri Lanka and derived breeds with European blood
- Subgroup 8G Himalayan Hill zebu breeds

Group 9 Turano-Mongolian breeds of Central and Northeast Asia, the yak and yak-cattle hybrids

- Subgroup 9A Turano-Mongolian breeds of Central Asian and derived breeds with European blood
- Subgroup 9B Breeds of Northeast China, Korea and Japan and derived breeds with European blood
- Subgroup 9C Yak and yak-cattle hybrids

Group 10 Breeds of Central and Southern China and Southeast Asia, and bibovine cattle

- Subgroup 10A Central-Chinese Yellow breeds
- Subgroup 10B South-Chinese Yellow and Indo-Chinese zebu breeds and derived breeds
- Subgroup 10C Indo-Chinese, Philippine, and Indonesian breeds (influenced by banteng) and derived breeds with exotic blood
- Subgroup 10D Bibovine cattle and hybrids from bibovine cattle × taurine or zebu cattle

Group 11 North-and West-African taurine breeds

- Subgroup 11A North-African shorthorned breeds and derived breeds with exotic blood
- Subgroup 11B Breeds of Lake Chad
- Subgroup 11C N'Dama, derived breeds
- Subgroup 11D West-African shorthorned breeds

Group 12 West-African zebu breeds

- Subgroup 12A Shorthorned Sahel zebu breeds
- Subgroup 12B Medium-horned West-African zebu breeds
- Subgroup 12C Fulani zebu breeds with long lyre-shaped horns

Group 13 East-African zebu breeds

- Subgroup 13A Zebu and zebu-sanga breeds of Northern Sudan, Eritrea and Northern Ethiopia
- Subgroup 13B Small zebus of the Arabian peninsula, Somalia and the Abyssinian zebu
- Subgroup 13C East-African shorthorned zebu breeds
- Subgroup 13D Small East-African zebu including imported and derived breeds with exotic blood
- Subgroup 13E Zebu breeds of Madagascar and Mauritius and derived breeds with exotic blood

Group 14 African sanga and sanga-zebu breeds

- Subgroup 14A Sanga and sanga-zebu breeds of Ethiopia and Sudan
- Subgroup 14B Ankole and Ankole-zebu breeds

- Subgroup 14C Sanga breeds of Southern Africa and derived breeds with European blood
- Subgroup 14D Africander and derived breeds with European blood
- Group 15 American breeds of Iberian descent**
- Subgroup 15A Texas Longhorn, Gulf Coast cattle and Mexican Criollos and derived taurine breeds with exotic taurine blood
- Subgroup 15B Caribbean Criollo breeds and derived breeds with exotic blood
- Subgroup 15C Central-American Criollo breeds and derived breeds with exotic blood
- Subgroup 15D Criollo breeds of the Northern countries of South America and derived breeds with exotic blood
- Subgroup 15E Sierra Criollo breeds of the High Andes
- Subgroup 15F South-American Criollo breeds of Spanish-Portuguese descent and derived breeds with exotic blood
- Group 16 Modern cattle breeds of the Americas, Australia and New Zealand, and the genus *Bison***
- Section 1 Dairy breeds**
- Subgroup 16-1A Authentic American and Australian dairy and dual-purpose breeds
- Subgroup 16-1B Breeds descended from European dairy breeds, including zebu cross-breeds
- Section 2 Beef breeds**
- Subgroup 16-2A Breeds descended from British beef breeds, including zebu cross-breeds
- Subgroup 16-2B Continental breeds, including zebu cross-breeds
- Subgroup 16 2C Indo-Pakistani zebu and African zebu and sanga breeds and derived zebu breeds
- Section 3 Genus *Bison***
- Subgroup 16-3A Wisent, bison and bison-cattle hybrids

(B) Revised classification (2010)

- Group 1 Polled and ‘Celtic’ breeds of North and Northwest-Europe**
- Subgroup 1A Polled breeds of Iceland, Scandinavia, the Baltics and Northern Russia
- Subgroup 1B Horned dairy breeds of Scandinavia and Scotland
- Subgroup 1C Polled breeds of Great Britain and derived breeds in Western Europe
- Subgroup 1D Horned ‘Celtic’ breeds of Great Britain and derived breeds in Western Europe
- Group 2 Lowland breeds of West, North and Eastern Europe**
- Subgroup 2A West-European red lowland breeds and derived breeds in Eastern Europe
- Subgroup 2B West- and Northeast-European-pied lowland dairy breeds and derived breeds
- Subgroup 2C West-European red- and blue-pied dual-purpose and beef breeds and derived breeds
- Subgroup 2D British Shorthorn breeds and derived breeds in Central and Eastern Europe
- Subgroup 2E Lowland breeds of West and South England
- Subgroup 2F Breeds of the Channel Islands and Northwest France
- Subgroup 2G West-European multi breed
- Group 3 Short-headed and Broad-headed highland breeds of West and Central Europe**
- Subgroup 3A Vosges and Black-Forest breeds
- Subgroup 3B Central-European red highland breeds

- Subgroup 3C Short-headed Alpine breeds and derived breeds in Eastern Europe
- Subgroup 3D Central European blond and yellow highland breeds
- Subgroup 3E West-European and Central European broad-headed red spotted mountain breeds, and derived breeds in Western, Central and Eastern Europe
- Subgroup 3F The Charolais and derived breeds
- Group 4 Grey and blond to brown breeds of France, Northern Italy, the Alps and the Balkans**
- Subgroup 4A Breeds of Central France
- Subgroup 4B Grey and blond breeds of Southwest France and the Pyrenees
- Subgroup 4C North-Italian fawn-brown breeds
- Subgroup 4D Central European grey and brown mountain and derived breeds in Eastern Europe
- Subgroup 4E Illyrian Shorthorn breeds of the Balkans and Greece and upgraded breeds
- Group 5 The Breeds of Southwest-Europe**
- Subgroup 5A Isolated breeds of the Camargue, Corsica and Sardinia and derived breeds in Northwest-Europe
- Subgroup 5B Feral Pyrenean and Cantabrian breeds
(Tronco (Castaña) Cántabrio)
- Subgroup 5C Galician, Balearic and Canarian Blond breeds
(Rojo convexo (turdetano))
- Subgroup 5D NorthWest-Iberian Brown breeds
(Morenas del Noroeste and Castaña concavo)
- Subgroup 5E Iberian Black breeds *(Negro Iberica)*
- Subgroup 5F Central and South-Iberian Red breeds *(Andaluza Rojo convexo)*
- Subgroup 5G Southeast-Iberian breeds *(Castaño ultraconvexo)*
- Group 6 Podolian breeds of Italy and Eastern Europe**
- Subgroup 6A Large White breeds of Italy
- Subgroup 6B Podolian breeds of Italy and Istria
- Subgroup 6C Podolian grey steppe breeds of Eastern Europe
- Subgroup 6D Podolian-Illyrian breeds of the Balkan Countries and Anatolia
- Group 7 Shorthorned breeds of the Caucasus, Anatolia, the Levant and Egypt**
- Subgroup 7A Humpless breeds of the Caucasus and Southwest Asia and derived breeds with exotic influence
- Subgroup 7B Damascus type in West Asia and Egypt and derived breeds with exotic influence
- Group 8 Indo-Pakistani type zebu breeds**
- Subgroup 8A Zebu and zeboïd breeds of the Central Asia, Iran, Afghanistan, Northwest Pakistan and derived breeds with exotic influence
- Subgroup 8B Zebu breeds with convex forehead and derived breeds with taurine influence
- Subgroup 8C Shorthorned grey-white zebu breeds
- Subgroup 8D: Zebu breeds with lyre-shaped horns and derived breeds with taurine influence
- Subgroup 8E: Mysore zebu breeds
- Subgroup 8F: Small zebu breeds of Bangladesh, Northeast and South India, and Sri Lanka and derived breeds with taurine influence
- Subgroup 8G: Himalayan Hill zebu breeds and hybrids

Group 9 Turano-Mongolian breeds of Central and Northeast Asia, yak and yak-cattlhybrids

- Subgroup 9A: Central-Asian Turano-Mongolian and derived breeds with European influence
- Subgroup 9B: Breeds of Northeast China, Korea and Japan and derived breeds with European influence
- Subgroup 9C: Yak and yak-cattle hybrids

Group 10 Breeds of Central and Southern China and Southeast Asia, and Bibovine cattle

- Subgroup 10A: Central-Chinese Yellow breeds (Huanghuai Group)
- Subgroup 10B: South-Chinese Yellow breeds (Changzhu Group), Indo-Chinese zebu breeds and derived breeds with zebu influence
- Subgroup 10C: Indo-Chinese, Philippine, and Indonesian breeds (influenced by banteng) and derived breeds with exotic influence
- Subgroup 10D: Bibovine cattle and hybrids

Group 11 North- and West-African taurine breeds

- Subgroup 11A: North-African Shorthorn breeds and derived breeds with exotic influence
- Subgroup 11B: Lake Chad breeds and populations
- Subgroup 11C: N'Dama, derived taurindicus populations and breeds with exotic influence
- Subgroup 11D: West-African shorthorned breeds, derived taurindicus breeds and populations

Group 12 West-African zebu breeds

- Subgroup 12A: Shorthorned Sahel zebu breeds
- Subgroup 12B: Medium-horned West-African zebu breeds and derived taurindicus breeds
- Subgroup 12C: Fulani zebu breeds with long, lyre-shaped horns

Group 13 East-African zebu breeds

- Subgroup 13A: Large zebu breeds of Northeast Africa
- Subgroup 13B: Small zebus of the Arabian Peninsula and the Horn of Africa
- Subgroup 13C: East-African shorthorned zebu breeds
- Subgroup 13D: Small East-African zebu and derived breeds with exotic influence
- Subgroup 13E: Zebus of Madagascar, Mauritius and Ocean Islands and derived breeds with exotic influence

Group 14 African sanga and zenga breeds

- Subgroup 14A: Sanga and zenga breeds of Northeast Africa
- Subgroup 14B: Central-African Ankole sanga and zenga breeds
- Subgroup 14C: Sanga and zenga breeds of southern Africa and derived breeds with exotic influence
- Subgroup 14D: European, American and Australian purebred populations and derived breeds in Southern Africa

Group 15 American breeds of Iberian descent

- Subgroup 15A: Texas Longhorn, Gulf Coast cattle, Mexican Criollos and derived taurine breeds
- Subgroup 15B: Caribbean Criollo breeds and derived breeds with exotic influence
- Subgroup 15C: Central-American Criollo and derived breeds with exotic influence
- Subgroup 15D: Criollo of the northern part of South America and derived breeds with exotic influence
- Subgroup 15E: Sierra Criollo breeds of the High Andes and derived taurine breeds
- Subgroup 15F: South-American Criollo of Iberian descent and derived breeds with exotic influence

Group 16 Modern cattle breeds of the Western Hemisphere

(Americas, Australia and New Zealand) and the genus *Bison*

- Subgroup 16-1A Authentic populations and breeds of the Western Hemisphere: the 'originals'
- Subgroup 16-1B Western hemisphere dairy and dual purpose breeds derived from European breeds
- Subgroup 16-1Bb Western hemisphere taurindicus dairy and dual-purpose breeds
- Subgroup 16-2A Western hemisphere beef breeds descended from British beef breeds
- Subgroup 16-2Ab Western hemisphere taurindicus beef breeds descending from British breeds
- Subgroup 16-2B Western hemisphere beef breeds descending continental and Japanese breeds
- Subgroup 16-2Bb Western hemisphere taurindicus beef breeds descending from continental breeds
- Subgroup 16-2C Western hemisphere humped breeds of Indo-Pakistani descent, African sanga and zebu
- Subgroup 16-3A American hybrids, genus *Bison* and yak

Table S34. Source of microsatellite data used in Figure S2. Names and addresses of laboratories are mentioned in the cited publications. N, number of animals; INRA, Institut des Recherches Scientifiques Agronomiques.VHL, Van Haeringen Laboratory (Wageningen).

Breed	Country	N	Laboratory	Reference
Aberdeen Angus	Great-Britain	50	Roslin	[39,40]
Agersoe	Denmark	41	Copenhagen	[40,41]
Alistana-Sanabresa	Spain	50	Madrid	[40]
Anatolian Black	Turkey	49	Munich	[42]
Angeln: Sleswig-Holstein (old and modern), Hessen, Rhine-Westphalia	Germany	189	Giessen, Gottingen	[40,43]
Asturiana Mountana	Spain	50	Madrid	[40]
Asturiana Valles	Spain	50	Madrid	[40]
Aubrac	France	50	INRA	[40][44]
Avileña Negro Iberica	Spain	50	Madrid/Barcelona	[40]
Ayrshire	Great-Britain	48	Roslin	[39,40]
Bazadaise	France	47	INRA	[40]
Belgian Blue	Belgium	50	Malle/Viterbo	[40]
Berrenda (black- and red-pied)	Spain	100	Cordoba	[45]
Bestuzhev	Russia	66	Jokioinen	[46]
Betizoa	Spain	23	Zaragoza	[40,47]
Blonde d'Aquitaine	France	50	INRA	[40]
Bohemian Red	Czech Republic	25	INRA/Giessen	[40]
Bretonne Pie-Noire	France	31	INRA	[40]
British Holstein	Britain	50	Roslin	[39,40]
Bruna Pirineus	Spain	50	Madrid/Barcelona	[40]
Busha: Kosovo, Macedonia, Albania	Busa	146	Jokioinen, Munich	[42]
Byelorussian Red	Byelorussia	20	Jokioinen	[46,48]
Cabannina	Italy	26	INRA/Piacenza	[40]
Cardena	Spain	14	Cordoba	[45]
Carinthian Blond	Austria	60	Vienna	[44]
Casta Navarra	Spain	50	Zaragoza	[40]
Charolais	France	50	INRA	[40]
Chianina	Italy	36	INRA/Piacenza	[40]
Cinesara	Italy	30	Catania/VHL	[49]

Breed	Country	N	Laboratory	Reference
Danish Red	Denmark	32	Copenhagen	[40,41]
Dexter	Great-Britain	46	Roslin	[39,40]
Dutch Belted	Netherlands	24	INRA/Utrecht	[40]
Dutch Friesian	Netherlands	34	INRA/Utrecht	[40]
Eastern Finncattle	Finland	31	Jokioinen	[46,48]
Ennstal-Bergscheck	Austria	41	Vienna	[44]
Eringer	Switzerland	50	Berne	[40,50]
Evolenard	Switzerland	15	Berne	[40,50]
Finnish Ayrshire	Finland	43	Jokioinen	[46,48]
Gasconne	France	50	INRA	[40]
German Brown (Bavaria, Württemberg)	Germany	50	Giessen	[40]
German Brown Original	Germany	25	Giessen	[40]
German Original Black-Pied, Western reserve	Germany	20	Giessen	[40]
German Simmental	Germany	50	Giessen	[40]
German Yellow	Germany	50	Giessen	[40]
German, Polish Black-Pied	Germany, Poland	50	Giessen, Krakowa	[40]
Grey Gacko Busha	Bosnia	41	Göttingen/Hannover	[42]
Grigia Alpina	Italy	28	Milano	[40]
Groningen Whiteheaded	Netherlands	25	INRA/Utrecht	[40]
Guernsey	Great-Britain	50	Roslin	[39,40]
Hereford	Great-Britain	48	Roslin	[39,40]
Hinterwälder	Germany	30	Giessen	[40]
Holstein-Friesian	Switzerland, Russia	80	Jokioinen, Berne	[40,50]
Hungarian Grey	Hungary	60	Vienna	[44]
Istoben	Russia	48	Jokioinen	[46,48]
Istrian	Croatia	45	INRA/Giessen	[40]
Jersey	Great-Britain	47	Roslin	[39,40]
Jutland (from 1950)	Denmark	44	INRA/Tjele	[40]
Kalmyk	Russia	28	Jokioinen	[46,48]
Kazakh Whiteheaded	Russia	40	Jokioinen	[46,48]
Kholmogor	Russia	42	Jokioinen	[46,48]

Breed	Country	N	Laboratory	Reference
Limousin	France	50	INRA	[40]
Longhorn	England	44	Roslin	[51]
Maine-Anjou	France	49	INRA	[40]
Mallorquina	Spain	28	Zaragoza	[40,47]
Menorquina	Spain	50	Zaragoza	[40,47]
Modicana	Italy	37	Catania/VHL	[49]
Monchina	Spain	50	Zaragoza	[40,47]
Montbéliarde	France	31	INRA	[40]
Morucha	Spain	50	Madrid/Barcelona	[40]
Murbondner	Austria	47	Munich	[42]
Murnau-Werdenfelser	Germany	52	Munich	[42]
N'Dama	Africa	30	INRA	[40,52]
Normande	France	50	INRA	[40]
Northern Finncattle	Finland	26	Jokioinen	[46,48]
Pajuna	Spain	50	Cordoba	[45]
Parthenaise	France	37	Roslin	[51]
Pechora (type of Kholmogory)	Russia	31	Jokioinen	[46,48]
Piemontese	Italy	49	INRA/Piacenza	[40]
Pinzgauer	Austria	44	Dublin/Utrecht	[44]
Pirenaica	Spain	50	Madrid/Barcelona	[40]
Podolica	Italy	50	Campobasso	[40]
Polish Red	Poland	48	INRA/Giessen	[40]
Pustertaler	Austria	44	Vienna	[44]
Red Holstein dairy type	Germany	25	Giessen	[40]
Red-Pied: Meuse-Rhine-Yssel, Red Holstein dual-purpose	Netherlands, Germany,	139	Utrecht, Giessen	[40]
Red Steppe	Ukraine	36	Jokioinen	[46,48]
Rendena	Italy	34	Milano	[40]
Retinta	Spain	50	Madrid/Barcelona	[40]
Romagnola	Italy	32	INRA/Piacenza	[40]
Rubia Gallega	Spain	50	Madrid/Barcelona	[40]
Russian Black-Pied	Russia	30	Jokioinen	[46,48]
Salers	France	50	INRA	[40]
Sayaguesa	Spain	48	Madrid	[40]
Shorthorn	Great-Britain	43	Roslin	[51]

Breed	Country	N	Laboratory	Reference
Serrana de Teruel	Spain	44	Zaragoza	[47]
Simmental/Pezzata Rossa Italiana	Germany, Austria, Italy	139	Giessen, Vienna, INRA,	[40,44]
South-Devon	Great-Britain	44	Roslin	[51]
Suksun	Russia	40	Jokioinen	[46,48]
Swedish Red-Polled	Sweden	32	INRA/Uppsala	[40]
Swiss Brown	Switzerland, Austria	93	Berne, Vienna	[40,44, 50],
Swiss Simmental	Switzerland	50	Berne	[40,50]
Tarentaise	France	43	Tarentaise	[42]
Toro de Lidia (Fighting cattle)	Spain	44	Zaragoza	[40]
Tudanca	Spain	50	Madrid	[40]
Tyrolean Grey Cattle	Austria	48	Munich	[42]
Ukrainian Grey	Ukraine	30	Jokioinen	[46,48]
Ukrainian Whiteheaded	Ukraine	10	Jokioinen	[46,48]
Waldviertler Blond	Austria	60	Vienna	[44]
Western Finncattle	Finland	39	Jokioinen	[46,48]
Yakutian cattle	Russia	60	Jokioinen	[46,48]
Yaroslavl	Russia	44	Jokioinen	[46,48]
Zebu Peul	Africa	100	INRA/Milano	[40,52]

Figure S2. NeighborNet graph [53] of Reynolds' DR genetic distances of 103 European breeds analyzed with 30 FAO-recommended microsatellites. Except for the NW Intermediate breeds, the breed groups are also revealed by model-based clustering by the Structure program [54]. The coloring of the border indicate the four major groups of European cattle, which also are in agreement with model-based clustering: blue, North-European; violet, Central-European; ochre, Iberian; grey, Podolian. Exported (Finnish Ayrshire), recently crossbred (Asturian Valley, Istoben), extremely inbred (Mallorquina, Menorquina) as well as the French Gasconne (spuriously associated with British breeds) and Central-Eastern (Pinzgauer and Pustertaler, converging with Iberian breeds) breeds have not been plotted.

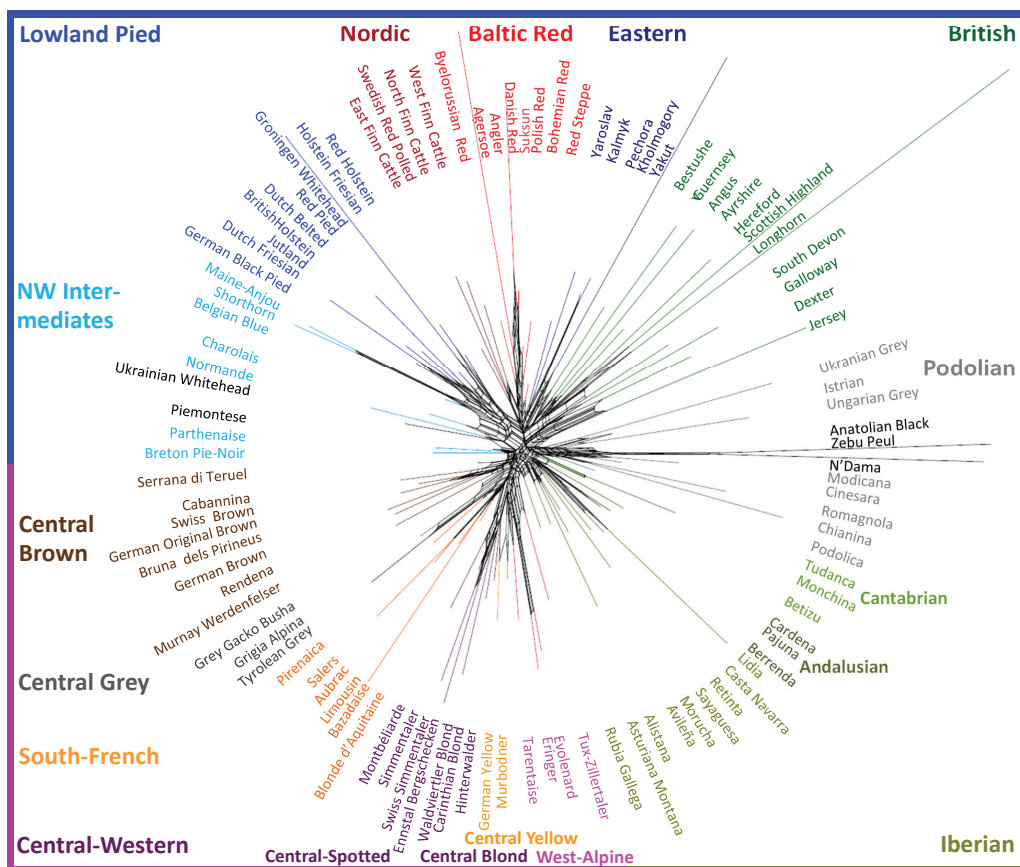


Table S35. Classification of Eurasian taurine breeds based on molecular genetic analysis ([55], Figures 9 and S2; [35,40-43,46,47,48,50,55-57]). Breed clustering was inferred from model-based clustering and/or genetic distances between breeds. This may assign crossbred breeds either to a specific group or to a rest-group of unassigned breeds, depending on both the degree of crossbreeding and on the molecular dataset.

I North-European breeds

- I.1 British British dairy and beef breeds, including also the Channel-Island breed (Jersey, Guernsey), but not the Shorthorn. Jersey tends to be different from the other breeds in this group and may have apparent affinity to Podolian or Alpine grey breeds.
- I.2 Nordic Authentic Norwegian, Swedish, Finnish and Baltic breeds, including both polled as longhorned (Døle, Telemark) breeds.
- I.3 Nordic Ayrshire Imported Finnish Ayrshire and Ayrshire crossbreds: Norwegian Red, Swedish Red-and-White, Ringamåla, Väne.
- I.4 Lowland-Pied Black- and red-pied dairy cattle originating from the north-western lowlands of the European lowlands. Also includes the solid Red Flemish.
- I.5 Baltic Red Solid red dairy cattle from the Baltic coasts and the German Highland. Also includes the Russian Suksun, Byelorussian Red and Ukrainian Red Steppe.
- I.6 Northwest Intermediate
Cattle from north-western Europe that are not closely related to each other, but are influenced to different degrees by surrounding breeds: Shorthorn, Maine-Anjou (similar to Shorthorn), Bretonne-Pie Noir, Normande, Parthenaise (close to Southern-French breeds), Vosges, Charolais. Charolais clustered with South-French breeds and Vosges with Central-Western breeds in a 50K SNP analysis [35,57].
- I.7 Eastern crossbred
Russian breeds heavily influenced by Western breeds: Istoben (influenced by Lowland Pied), Kazakh Whiteheaded (influenced by Hereford), Ukrainian Whitehead (influenced by Groningen Whiteheaded), Bestushev (influenced by several breeds).
- I.8 Eastern Russian and Siberian breeds: Kholmogory, Pechora (both influenced by I.1), Kalmyk, Yaroslav, Yakut.

II Central-European cattle

- II.1 Central-Western Includes four subtypes (II.1.1-3) and Hinterwald; SNP data suggest inclusion of Charolais and Vosges.
 - II.1.1 Central Spotted: Central-European spotted dairy cattle with Simmentaler as prototype breed from which several other breeds have been derived.
 - II.1.2 Central Blond: Carinthian and Waldviertel Blond, genetically close the

Central Spotted.

II.1.3 West-Alpine: French-Alpine Swiss Valais (Wallis) and Italian Valdostana breeds, Austrian Tux-Zillertaler.

II.1.4 Central Yellow: German Yellow breeds, Murbodner, Portuguese Minhota.

II.2 South-French Southern French beef breeds and the Spanish Pyrenaica, which is also influenced by Iberian cattle.

II.3 Central Brown Swiss Brown dairy cattle and derived breeds in Germany, Italy and Spain; including Murnau-Wersenfelder.

II.3.1 Spanish Brown: Spanish breeds derived from Central Brown: Bruna Pirieus, Parda Montana and Serrana de Teruel.

II.4 Central Grey Tyrolean Grey, Grigia Alpina.

II.5 Central-Eastern Pinzgauer, Pustertaler, Cika.

III Iberian cattle

Authentic and morphologically diverse Spanish and Portuguese breeds. Relationship with the Mallorquina and Menorquina unclear by the high degree of inbreeding of both Balearic breeds. The feral Betizu is genetically between the Iberian and Southern-French cattle. Contains regional clusters of breeds:

III.1 Cantabrian Tudanca, Monchina, Betizu.

III.2 Andalusian Andalusian breeds: Berrenda, Cardena, Marismeña, Mostrenca, Pajuna, Fighting cattle (Lidia, Brava, Casta Navarra)

III.3 Iberian Black Avileña, Morucha, Negra Andaluza, Preta.

III.4 Morenas Alistana, Barrosa, Cachena, Frieiresa, Caldelana, Limiana, Marinhoa, Maronesa, Mirandesa, Vianesa.

III.5 South-Portuguese Red

Alentejana, Garvonesa, Mertolenga.

IV Podolian cattle

Steppe cattle, presumed to originate from the Podolia region. Contains also Ukranian Grey, Turkish Grey and Chianina.

V South-Eastern European and SouthWest-Asian taurine

Authentic taurine cattle smaller and less developed than most European breeds: Busha, Anatolian and Caucasian cattle.

Lexicon of Latin Designations

The term *Bos primigenius* was in 1973 proposed for both aurochs and domestic cattle [58]. However, the International Commission on Zoological Nomenclature published a Code list with names for mammals [59] in which the name *Bos primigenius* [60] was converted into *Bos taurus*, the name given by Linnaeus [61] in order to consequently apply the first Latin name given to a species. Van Vuure [62] suggested to use *Bos taurus primigenius* for the European aurochs and *Bos taurus domesticus* for (European) domestic cattle [63].

However, it is more common, although formally incorrect, to use separate Latin designations for domestic animals. This was defended by Clutton-Brock [64]: "I believe that animals bred under domestication evolve into new species, as a result of reproductive isolation from their wild progenitors combined with natural and artificial selection in association with human societies." Gentry et al. [65] also pleaded for differentiation in names for wild and domestic cattle and proposed to accept *Bos primigenius* for all aurochs.

Today the Latin names *Bos primigenius* and *Bos namadicus* are commonly accepted for the two main aurochs species. The names *Bos taurus* (non-humped) and *Bos indicus* (true zebus) are then used for the domestic descendants of respectively *Bos primigenius* and *Bos namadicus*. *Bos taurindicus* indicates the several taurine and indicine intermediates [66]. One step further, and certainly incorrect, is the latinizing of breed names, such as *Bos taurus taurus ankole*, *B.t.t. ayrshire*, etc. This is, for instance, done on the website Mammals' Planet (www.planet-mammiferes.org/drupal/en/node/20) and may suggest prehistoric mutants or stem forms that never have existed as such. Many Latin terms were already introduced by Fitzinger [67], Werner [2], Sanson [6] and Keller [3,68] and were used in 1930 in a review of the descent of cattle [69].

Since several of these keep turning up in the scientific literature, we have compiled a list. Several terms are even on the International Commission on Zoological Nomenclature Code list [59]. Latin designations commonly used are underlined. For literature references that are part of the species designation in the Linnaean format (e.g., *Bos taurus* Linnaeus, 1758) bibliographic details are not always available.

Bos abyssinicus Oken 1838 [69] earliest name *B. domesticus t. abyssinicus*, later as *B. t. abyssinicus* (q.v.).

Bos acutifrons (Lydekker, 1877) [70] for an early *Pliocene* form, after a two million years old cranium with extreme long horns excavated in the Siwalik Hills in northern India. This so-called Siwalik Ox is presumed to be the ancestor of all species of the group *Bovina* (common cattle, bibovine cattle, yak and bison). Lydekker thought it not improbable that a skull from the same deposits described by him as *Bos planifrons* indicated the female of the same species.

Bos africanus Kerr, 1792 for the Sanga, as in *Brehms Tierleben* [71].

Bos akeratos Arenander, 1898 [72] for remains of a polled cranium excavated in Scandinavia, supposed to represent the original European aurochs and to be the ancestor horned cattle [72].

Bos alpinus Sanson, 1878 [73] for Alpine cattle, renamed *B. taurus alpinus* [74].

Bos alpium Fitzinger, 1860 [67] for Alpine [*Braunvieh*] type cattle comprising 18 breeds found in Switzerland, Tyrol, Styria and Bohemia, renamed *B.taurus alpium*.

Bos aquitanicus Sanson, 1878 [6] presumed a local aurochs and forefather for blond cattle from

southern France and northern Iberian Peninsula. Later regarded as domestic form: *B. taurus aquitanicus*.

Bos asiaticus Sanson, 1878, renamed *B. taurus asiaticus* [74].

Bos avernensis Sanson, 1878, renamed *B. taurus avernensis* [74].

Bos balticus Stegmann von Pritzwald, 1924, renamed *B.t. balticus* [75], small aurochs-type crania from Danzig, Königsberg and Copenhagen [76,77] [Hilzheimer 1925] and identified as the skull of an aurochs cow [78].

Bos bojanus Gérard, 1871 [69] other name for *B. p. Bojanus*.

Bos bombifrons Nesti [79] after a Pliocene cranium, by Falconer named *Bos (Amphibos) etruscus*, which was later shortened to *Bos etruscus*.

Bos brachycerooides Pohling, 1911 [80] after a skull fragment with short horns excavated in Asti, Italy, dated early Pliocene or the oldest Pleistocene layer, considered a miniature aurochs. One year later the name was changed into *Bos mastodontis* by Pohlig and later denoted as *B.t. brachycerooides*.

Bos brachyceros Owen, 1830 [81,82] holotype named after its short horns, first described in a catalogue of the museum of the College of Surgeons in 1830. In 1846 he replaced the name by *Bos longifrons* (long-head cattle). Rüttimeyer [79,82] retained the first name for this type of prehistoric cattle, which had been first excavated at Neolithic sites in the Swiss Lake district. He considered this *Torfrind* (village cattle) as being introduced from Asia, and an older, more important type than *primigenius* type domestic cattle. For a long time *Bos brachyceros* was (incorrectly) presumed to be the source of modern shorthorned cattle and is still used to indicate shorthorned cattle of all kinds. Hilzheimer [83] correctly assumed that these cattle had evolved by domestication.

Bos brachyceros arnei Amschler, 1939 [82,84] for a skull fragment excavated at Shah Tepé, North Iran and incorrectly regarded as wild ancestral species of all shorthorn cattle of Asia, Africa and Europe, as well as the orthoceros cattle of the Kalmyks and Mongols. Renamed *B.t. arnei*.

Bos brachyceros europaeus Adametz, 1898 [85]. Initially Adametz did not accept the *brachyceros* as an introduced Asian form, but as a separate European wild form next to the *B.primigenius* Bojanus, and incorrectly presumed to be the ancestor of many European cattle breeds.

Bos brachyceros ibericus Sanson, 1878 [73] replacing the designations *B. ibericus* and *B. curvidens*, for wild forms, found in Algeria and Tunisia [86].

Bos brachycerosus Cividini & Kume, 2008 [87] a putative small wild progenitor of all shorthorned Busha type cattle of the Balkans, a rendered out of date theory.

Bos brachycerosus palustris according to Kume *et al.* (2008) [88] the designation of Rüttimeyer for the remains of Neolithic village cattle excavated from the Swiss lake sites.

Bos braquiceros Aparicio, 1960 [89] for *brachyceros*, in other Spanish literature also written as *brachyceros* and sometimes with the extension *Europeo* or *Africano*.

Bos braquiceros africanus Sanchez Belda, 1984 [14] considered to trace to the *B.t. ibericus* and putative predecessor of the Sayaguesa.

Bos caesaris Keferstein, 1834 [70] a classic name for the aurochs because of the description of the aurochs by Julius Caesar in *De Bello Gallico*.

Bos curvidens Pomel, 1893 [90], for remains from Algerian palaeolithic sites for a smaller than *Bos primigenius* and considered identical to *B. opisthonomus* and *B. p. mauritanicus* [69].

Bos Dante Link, 1793 for cranium excavated by Link [70,91]. Rüttimeyer [79] stated that the skull had belonged to a polled zebu, named it *B. indicus* var. *Dante*, also found as *B.taurus dante*. Dürst [92] considered it a *macroceros* type.

Bos desertorum hispanico Aparicio, 1960 [89] after Fitzinger's *B.t. desertorum*, presumed to descend from the African *B.p. Hahni* and *B.t. mauritanicus*, a hypothetical Iberian aurochs variant, characterized by 'high-lyred' horns and a light coat and connected with breeds as Barrosá, Cachena, Blanca Cácerena, and Cárdena Andaluza breed.

Bos domesticus Johnston, 1651 [93]. The *Bos* species are distinguished as a subclass of horned ruminants for the first time in Johnston's systematic. He mentioned domestic cattle: *Bos domesticus* besides the wild cattle forms: *Urus*, *Bison*, *Bonassus*, *Buffelus* and *Strepsiceros*.

Bos ecornis Wagner, 1837 [94] probably for polled cattle after the French *écorner*.

Bos elatus Pomel, 1853 [70,90] fossilized skull fragment from Tertiary deposits of Val d'Arno, Italy, typified as small, possible female form of *Bos etruscus* (on display in the *Museum National d'Histoire Naturelle*, Paris).

Bos etruscus Falconer, 1868 [95] from ***Bos (Amphibos) etruscus*** [79], the Etruscan Ox for an entire fossilised Late-Pliocene skull excavated in Val d'Arno, a bovid type considered to have been distributed over Italy and southern France. Alternative names are *Bos elatus* (Pomel) and *Bos stenometopon* (Sismonda). Rüttimeyer [79] considered it akin to *Bos*

- namadicus* and the predecessor of gaur, banteng, yak and zebu, and used the name *Bos (Bibos) etruscus* [79]. However, Lydekker [70] classified it in the *Leptobovine* group as subgenus *Leptobos* [79], a form which became extinct during Early Pleistocene without descendants.
- Bos europaeus (brachyceros)*** Adametz, 1927 [96] for European shorthorned cattle, after Kerr's *Bos europaeus*.
- Bos falconeri*** Lydekker, 1898 [70] Falconer's Ox, remains from the Siwalik region, India, akin to the Siwalik Ox, but also to the Etruscan Ox, earlier named *Leptobos falconeri* [79] and the Pliocene *Bos fraseri* from the Narbada valley, which was presumed to be closer to the banteng.
- Bos ferus sylvestris*** Castello, 1721 [69] for aurochs.
- Bos fossilis*** Keferstein, 1834 [69,70,97] for aurochs remains also named *B. t. fossilis (q.v.)*.
- Bos frontosus*** Nilsson, 1849 [70,98] denoting a broad-headed cranium excavated in Scandinavia, considered as separate aurochs variant that was the founder of the small, often polled cattle of Norway. In 1868 it was identified as the remains of a domestic specimen, and thus renamed *Bos taurus frontosus* [99]. [Rütimeyer 1861]
- Bos Galla*** Salt, 1814 [91,92], turned out to be a sanga cranium from Abyssinia (Ethiopia), re-named *B. taurus galla* and by Dürst [92] identified as a *macroceros* type.
- Bos giganteus*** Croizet, 1828 [70,86] also ***Bos giganteus*** [70] for a Pliocene aurochs.
- Bos hybridus*** Fitzinger 1860 [67] for crossbred cattle.
- Bos ibericus*** Sanson, 1878 [73] a so-called 'nature type', without specifying it as being wild or tame cattle, renamed *B.taurus ibericus* by Sanson (1893) [74], by Von Leithner [78] identified as identical to *Bos opistonomus* and not differing from *Bos primigenius*.
- Bos ibéricus*** Pomel, 1893 [90] considered an aurochs in Portuguese and Spanish literature often mentioned as ancestor of Iberian breeds.
- Bos indicus*** Linnæus, 1758 [59,61,70] the taxon including all domestic zebu or indicine cattle.
- Bos indicus var. Dante*** Rütimeyer, 1867 [79] for the *Bos dante* cranium identified as from a domestic polled zebu skull.
- Bos indicus Galla*** Salt, 1814 [59,100] former *Bos Galla*, also as *B. taurus galla*, for the N.W. Ethiopian Raya-Azebó breed, in the past named *Galla* breed.
- Bos indicus namadicus*** Falconer, 1859 [70,79,95] Falconer's term for domestic zebu, initially indicated as *B. namadicus*.
- Bos indicus nanus*** [100] dwarf zebu, also *B.t. indicus minor*.
- Bos indicus planus*** Sasaki, 1934 [101] the Formosa zebu, a subtype of South-Korean cattle considered a strain descending the Indian zebu.
- Bos indicus var. Pusio*** Rütimeyer, 1867 [79] for the *Bos Pusio* cranium identified as from a domestic longhorned zebu.
- Bos intermedius*** Serres, 1829 [69] for a fossil excavated in Lunel-Viel [probably Lunéville in Meurthe-et-Moselle]. In the table *Palaeontologische Reihe* as well as *Morphologische Reihe* Rütimeyer [79] placed *Bos intermedius* next to the diluvial *Bos primigenius* with a cautionary note.
- Bos italiae*** Pohlig, 1911 [69,80] also *B.p. Italiae*, skull excavated in Lombardia [80] belonging to a diluvial aurochs [78]; term used occasionally for indicating a local aurochs as presumed ancestor of white Italian cattle.
- Bos Larteti*** Indre, 1866 [86] after a skull fragment from Monte Sacro, Rome (Museum, Paris) considered a small aurochs (*B.p. minutis*) [70], but by Duerst [86] identified as a female aurochs.
- Bos latifrons*** Fischer, 1830 [70] for the late *Pliocene* aurochs from northern India's Shivalik Hills, possibly a later form of the *Bos acutifrons / Bos planifrons*.
- Bos leucopymnus*** Wagner, 1837 [94] Rütimeyer presumed it to be a hybrid form between banteng and European cattle.
- Bos longifrons*** Owen, 1846 [70,81] After the term *brachyceros* had been for the wild *Bubalus brachyceros* [82], Owen [81] changed *Bos brachyceros* into *B. longifrons*, meaning long-headed, which fitted the type as well [82,86]. Although Rütimeyer [99] did not agree, this name became used by several authors. Rütimeyer [99] and Owen [70,81] agreed that this small Neolithic type or Celtic shorthorn was domestic, thus should be named *Bos taurus*, var *longifrons*. Rütimeyer [99] postulated an Asian origin [82], but Hilzheimer [83] showed that it was not a single, basic domestic type, let alone an aurochs form, so a *Bos longifrons* never existed as such.
- Bos macroceros*** Dürst, 1899 [92] presented this African type together with *B. akeratos* and *B. brachyceros* as one of the three basic modified types of domestic cattle, later indicated as *B.p. macroceros / B.t. macroceros*.
- Bos mastodontis*** Pohlig, 1911 [80] replacing after one year the term *Bos brachyceroides* for a

small type of aurochs, after small aurochs skulls, later turned out to have belonged to female aurochs.

Bos namadicus Falconer, 1859 [70] according to the current view representing the Asian aurochs as a separate species, from which the *Bos indicus* is the domestic form. Remains of the *namadicus* are very scant and its taxonomy has been disputed for decades. Rüttimeyer [79] incorrectly presumed this to be the ancestor of *Bos primigenius*. Lydekker [102] referred to it as the Nabada Ox and supposed that this form was probably related to the 'banting' (banteng) or a close allied species, that was the ancestor of the zebu as well as ancient Egyptian cattle and modern Hungarian longhorned cattle. Adametz [96] stated that his student Liebscher observed a considerable variation in these skulls, some resembling the *Bos primigenius* Bojanus, others Bibovine type cattle.

Bos (Urus) namadicus Falconer, 1865 [70] synonym for *Bos namadicus*.

Bos opisthonomus Pomel, 1893 [90] for a North-African 'Wild Race' identical to *B. primigenius mauritanicus* and *B. curvidens* [69] and also not differing from the Spanish *Bos ibericus* or the *Bos primigenius* [78].

Bos opisthnotus, according to [86] miswriting of *opisthonomus* by Troussart.

Bos palaeogarus Rüttimeyer, 1867 [79] for a skull that according to Lydekker [102] belonged to a banting [banteng].

Bos planifrons Lydekker, 1898 [70] Pliocene fossil that may have belonged to a female *Bos acutifrons* found in the same deposit of the Siwalik Hills in northern India.

Bos primigenius Bojanus, 1827 [60] Bojanus introduced this name for a skeleton in the museum of Jena, considering it as a prehistoric (*antediluvialis*) species, not aware that it in fact was the historic aurochs, by Linnaeus designated as *Bos taurus*.

Bos primigenius estrepicerus Fernández, 1998 [33] postulated aurochs variant, with *B.p. ibericus* and *B.p. hahni* the supposed ancestors of a cluster of NorthWest-Iberian breeds (see also [103,104]).

Bos primigenius ferus Pira, 1926 [105] regarded as predecessor of *brachyceros* type cattle of which skeletal remains were excavated from a Stone Age site on the island of Stora Karlsö, of the southwest coast of Gotland, Sweden.

Bos primigenius f.d., proposed for domestic humpless European cattle of Europe (*f.d.*: *forma domesticata*)

Bos primigenius f.d. indicus Zeuner, 1963 [106] for domestic zebu.

Bos primigenius frontosus Keller, 1905 [3] after Rüttimeyer's morphological type *B.primigenius* var. *frontosus* [79] for cattle typified by heavy horns, flattened at the root, growing downward, and then turning sideways and finally upward, including Frieberg and Simmental strains as well as the English Longhorn. Keller presumed these breeds traced to a mixture of *primigenius* type and *frontosus* type domestic cattle.

Bos primigenius hahni Hilzheimer, 1917 [107] a diluvial cranial fragment excavated in 1910 in Fajum (Egypt), by Hilzheimer identified as an important aurochs subtype, named *Bos primigenius Hahni nova subspecies*. By Adametz [108] used for Egyptian aurochs, but in 1926 shortened to *Bos primigenius* var *Hahni* Hilzheimer. According to Von Leithner [78] identical to *Bos trochoceros*.

Bos primigenius hollandicus Keller, 1905 [3] for the heavy lowland breeds of Holland, Schleswig-Holstein and Oldenburg, considered a *primigenius* form.

Bos primigenius Italiae Pohlig, 1911 [80], also *Bos Italiae* (*q.v.*), Italian aurochs postulated on the basis of a cursory description of a skull fragment [78].

Bos primigenius macroceros Duerst, 1903 [109,110] earlier described as *Bos macroceros*, also as *B. macróceros*.

Bos primigenius maureticanus Pomel for an early aurochs fossil found in Algeria (probably miswriting of *mauritanicus*) [78].

Bos primigenius mauritanicus Thomas, 1881 [70,111] for the North-African 'Wild Race' or aurochs and identical to *B. opisthonomus* and *B. curvidens* [69].

Bos primigenius minutus Von Malsburg, 1911 [86,112,113] for two skull fragments from the Märkischen Museum (Danzig) and two crania excavated in West Prussia, identified as the first domestic cattle [77] but identified in 1927 as female aurochs [70].

Bos primigenius namadicus Falconer, 1859 by Epstein and Mason [114] accepted as designation for the Asian aurochs as subspecies of *Bos primigenius*.

Bos primigenius opisthonomus Epstein and Mason, 1984 [114] name for the African type of aurochs as subspecies, after Pomel's *Bos opisthonomus*.

Bos primigenius podolicus Wagner, 1837 [94] for Grey Steppe cattle of south-eastern Europe, southern Siberia, and also found in Italy and considered to show pure aurochs morphology.

Bos primigenius primigenius distinguishing European aurochs from two other possible aurochs varieties: *B.p. opisthonomus* from North Africa and *B.p. orthoceros* from Central Asia.

- Bos primigeniu primigeniu*** possibly a miswriting of *B.p. primigenius* [115].
- Bos primigenius (recentiorum)*** Storer, 1877 [116] presumably indicating the Holocene aurochs to be distinguished from the Pleistocene type aurochs.
- Bos primigenius Siciliae*** Pohlig, 1911 [80], also *Bos Siciliae* [69] postulated on the basis of cursory description of a skull fragment from Sicily [78].
- Bos primigenius var. trochoceros*** Rüttimeyer, 1861 [79,99], initially considered an early wild form *Bos trochoceros*, [99] later identified as a domestic type: *B.taurus* var. *Trochoceros* [79].
- Bos priscus*** Bojanus, 1827 [60] also named *Urus priscus*, before its identification as *Bison priscus*.
- Bos pusio*** Swainson, 1835 [70,117] after a longhorned zebu cranium, by Rüttimeyer [79] identified as a domestic form *B. indicus* var. *Pusio*.
- Bos scoticus*** Swainson, 1835 [70,117] for Chillingham and other white park cattle, als *B.t. scoticus* or *Urus scoticus*.
- Bos scythicus*** Johnston, 1661 by Zimmerman (1780) [118] mentioned as a type of humped cattle (*Bückelochse*), illustrated in the form of a bull with a dromedary-like hump.
- Bos scythicus gibbosus*** Charleton, 1668 [70] presumably for polled humped cattle; cattle of the Scythians were considered to be polled and *gibbus* means hump.
- Bos siciliae*** Pohlig, 1911 [69,80] also as *B. p. Siciliae (q.v.)*.
- Bos silvestris*** Charleton, 1668 [93] for wild bovids as opposed to *Bos domesticus* for domestic cattle.
- Bos sondaicus*** Blyth, 1842 [70] for Bali cattle, domestic form of the Java banteng (*Bos javanicus*). Keller [68] used this name for the banteng, which he incorrectly assumed to be the ancestor of all Asian cattle. Therefore he used *sondaicus* as prefix for a number of presumed stem forms.
- Bos sondaicus africanus*** Keller, 1905 [3] name for the sanga (by then known from Abyssinia, towards the upper Nile and Lake Chad). The name is possibly taken from *Bos taurus brachyceros Africanicus* [2]. Keller did not believe in an African aurochs and was convinced that all cattle were imported into that continent.
- Bos sondaicus akeratos*** Keller, 1905 [3] for hornless cattle found in several places in Europe, Asia and Africa. The taxon refers to the domestic *Bos akeratos* of Arenander [72], although Keller stated the type was of Asian origin, developed separate from small-horned cattle in several places.
- Bos sondaicus brachyceros*** Keller, 1905 [3] According to Keller more appropriate for *Bos brachyceros*, as he postulated the origin of the wild form was found in the Asian zebu, which in turn was assumed to descend from the banteng as already proposed by Rüttimeyer [79]. According to Keller this type of cattle, present in East Asia, West Asia and North Africa was already known in the time of the pharaohs in the Nile Valley and included the prehistoric *Torfrind*, Braunvieh, Albanian cattle, Polish Red and the Jersey.
- Bos sondaicus brachycephalus*** Keller, 1905 [3] Keller was convinced this domestic form had developed by selection on European soil. It was typified by a short head, very broad forehead and strong rounded horns and included the breeds Eringer (Hérens), Duxer (Tuxer), Pustertaler, Egerlander, Voigtländer, Devon, Sussex and Hereford.
- Bos sondaicus indicus*** Keller, 1905 [3] for the Indian zebu and German colonial East-African zebu.
- Bos sondaicus longicornis*** Keller, 1905 [3] for an ancient form of Sanga, depicted in earliest Egyptian cultures and receded to central African Lake district, where it is known as Watusi cattle. Keller believed this form had entered Africa from Asia, as he did not believe in an African aurochs.
- Bos stenometopon*** Sismonda, 1861 [79] for a Pliocene skull excavated near Asti, Italy, by Rüttimeyer [79] identified as *Bos (Amphibos) etruscus* [95].
- Bos synophrys*** Fischer, 1829 [70] no description given.
- Bos sylvestris*** Bonaparte, 1845 [59] wild white cattle in Great Britain. According to John Leslie, Bishop of Ross (1598) [119] *Bos sylvestris* roamed the woods of Scotland in large numbers, especially in the Sylva Caledonia, while the chronicler Fritz-Stephen around 1174 refers to *tauri sylvestres (Uri sylvestres)* in the forest near London [102]. The *B. sylvestris* of Belonius mentioned in 1780 by Shaw [120] might also indicate wild cattle [119].
- Bos taurus*** Linnaeus, 1758 [61] for European domestic cattle as well as their wild predecessor, the *urus* as described by Caesar. Currently the most common zoological name for domestic, humpless or taurine cattle. Linnaeus seemed uncertain about the extinction of the wild form in Poland.
- Bos Taurus***, by Fitzinger 1860 applied for the *Thallandrind* [67], meaning valley type cattle as found in the lower parts and hills of Switzerland, Germany, Austria, France, England and Spain.
- Bos taurus abyssinicus*** Gmelin, 1788 [69] for *B. t. domesticus abyssinicus (q.v.)* and identical

to *B. macroceros* Dürst.

Bos taurus aceratos Hilzheimer, 1926 [59,83] possibly *B.t. akeratos*

Bos taurus adelensis Boddaert, 1785 [59,121] might indicate white cattle.

Bos taurus aegyptiacus Lydekker, 1904 [59,102] after Fitzinger's *Bos aegyptiorum*.

Bos taurus akeratos Arenander, 1898^{IC} by only two authors [72] considered as aurochs. Keller [3] accepted the polled *Bos sondaicus akeratos* as a separate domestic type.

Bos taurus albus Sundevall, 1848 [93], with *Urus*, gaur, gayal and banteng subspecies of *Boves proprii* (proper cattle).

Bos taurus alpestris Wagner, 1837 [59,94] possibly the same as Sanson's *B.t. alpinus*.

Bos taurus alpinus Sanson, 1878 [59,73] name for cattle of the presumed ethnic Alpine *Dolichocephale* type: Swiss, Tarentaise and Gasconne. In 1893 Sanson added *taurus* to most of his names for taurine cattle.

Bos taurus alpium Fitzinger, 1860 [59,67,100] former *B. alpium*

Bos taurus akeratos Arenander, 1898 [59,72,100] former *B. akeratos*

Bos taurus aquitanicus Sanson, 1878 [59,73,100] former *B. aquitanicus*, also as *B.t. aquitanus*, indicated as cattle of the presumed ethnic Aquitaine *Dolichocephale* type: Blonde d'Aquitaine, Limousin and Lourdaise.

Bos taurus arnei Amschler, 1939 [59,100,122] former *B. brachyceros arnei*.

Bos taurus arvernensis Sanson, 1878 [59,73] for the *Brachycephale* type breeds Salers and Ferrandaise.

Bos taurus asiaticus Sanson, 1878 [59,73] former *Bos asiaticus*, for cattle of the presumed ethnic Asiatic *Brachycephale* type, and fantasized origin of the cattle of the Camargue.

Bos taurus atlanticus Sanson, 1878 [73] one of the twelve presumed basic *truncos* (strains or types, [115]).

Bos taurus balticus Stegmann von Pritzwald, 1924 [59,75] former *B. balticus*.

Bos taurus batavicus Sanson, 1878 [59,73] for the presumed ethnic Lowland *Dolichocephale* type, Dutch and Flemish cattle.

Bos taurus brachyceros Brehm, 1864 [59,123] misspelling of *B. brachyceros*.

Bos taurus brachycephalus Wilckens, 1876 [1,59] also found as *B.t. brachicephalus* for short-headed type cattle, a cranial type excavated in Italian soil, dating back to the Roman period, and presumed the foundation for several short-headed breeds of Alpine cattle. Keller changed the name to *Bos sondaicus brachycephalus*.

Bos taurus brachycephalus africanicus Werner, 1912 [2] for North-African Algerian Brown Atlas cattle.

Bos taurus brachycephalus alverniensis Fitzinger, 1860 [67] after Sanson's *B. arvernensis* for Salers and related breeds from Auvergne.

Bos taurus brachycephalus aquitanicus Werner, 1912 [2] after Sanson's *B. aquitanicus* for Limousin and former Garonne and related Southwest-French blond breeds, which in 1961 were amalgamated into the Blonde d'Aquitaine.

Bos taurus brachycephalus britannicus Werner, 1912 [2] after Sanson's *B. britannicus* for West-English breeds (Devon, Sussex, Hereford).

Bos taurus brachycephalus celticus Werner, 1912 [2] for breeds of French Brittany (Bretonne Pie-Noir and related breeds), Ireland (Kerry), and Wales (Welsh Black and former related strains).

Bos taurus brachycephalus ibericus Werner, 1912 [2] after Sanson's *B. ibericus* for unspecified Iberian breeds.

Bos taurus brachycephalus isolanus Werner, 1912 [2] for cattle from Sicily, Corsica and the Camargue.

Bos taurus brachycephalus italicus Werner, 1912 [2] for North-Italian Grey Alpine and former varieties.

Bos taurus brachycephalus licestriensis Fitzinger, 1860 [67] for the Longhorn (former Leicester).

Bos taurus brachycephalus pyreneus Werner, 1912 [2] for the many Pyrenean strains of cattle.

Bos taurus brachycephalus salisburgensis Werner, 1912 [2] for Pinzgauer, Pustertal, Ennstal Spotted and former related strains.

Bos taurus brachycephalus tauricus Werner, 1912 [2] for breeds of the Vosges Mountains, Wallis and Tyrol.

Bos taurus brachycephalus teutonicus Werner, 1912 [2] for a number of (now mainly extinct) South- and Southwestern-German red-brown, red white-headed, red white-backed and red-pied breeds.

Bos taurus brachyceroides Pohlig, 1911 [59,80] former *B. brachyceroides*

Bos taurus brachyceros Owen, 1843 [59,81] former *B. brachyceros*, short-horned domestic cattle of which remains from 6750 yr ago were unearthed in North Africa and from 6000 years ago in Iran, Asia and Europe (Neolithic Shorthorn or Celtic Shorthorn) Ad-

- ametz [124] noted similarities with modern, small shorthorned Balkan cattle, for which he introduced the term Illyrian and is most probably is the nearest in type to the early shorthorned domestic stock. Keller [68] assumed that these shorthorned cattle were introduced from Asia (*Bos sundaicus brachyceros*) and in 1997 Payne [125] still refers to ideas of a separate shorthorned domestication for this type. It is now accepted that short-horned cattle were the result of degeneration due to the domestication of *Bos primigenius*, already put forward by Dawkins [126] and Nehring [127].
- Bos taurus brachyceros africanicus*** Werner, 1912 [2] after *B. africanus*, for Sanga cattle and considered a separate type that had not changed over thousands of years. By Morse [128] and Newbold [129] used to designate ancient Egyptian cattle, regarded as a local race of the *primigenius* type.
- Bos taurus brachyceros palustris*** Cardas, 1936 [59] *palustris* for 'living in the marshes' as the former Polesian cattle from the Pripet Marshes of Byelorussia and Ukraine.
- Bos taurus brachyceros polonicus*** Cardas, 1936 [59] after Adametz' *B. t. longifrons (brachyceros) polonicus*.
- Bos taurus britannicus*** Sanson, 1878 [59,73] also found as *B. britanicus* for breeds from Great Britain, indicated as cattle of the presumed British *Dolichocephale* type.
- Bos taurus bunelli*** Frick, 1937 [59] no description given.
- Bos taurus burdeyalensis*** [100] for Bordelaise cattle.
- Bos taurus caledoniensis*** Sanson, 1878 [59,73] for cattle of the presumed ethnic Scottish *Brachycephale* type.
- Bos taurus chinensis*** Swinhoe, 1870 [100,130,131] as *B.t. indicus chinensis*.
- Bos taurus collicerus*** Rostafinski, 1933 [59] no description given.
- Bos taurus communis*** S.D.W., 1836 [59] probably indicates common cattle (taurine and zebu).
- Bos taurus curvidens*** Pomel, 1893 [59,90,100] domestic form of the *B. curvidens*.
- Bos taurus dante*** Link, 1794 [59,100] and as *B.t. indicus dante*, former *Bos Dante (q.v.)*, identified as a polled zebu skull by Rütimeyer [79].
- Bos taurus desertorum*** Fitzinger, 1860 [59,67] for Steppe cattle found from Mongolia to Eastern Europe and southern Italy.
- Bos taurus ditophus*** Fischer, 1829, 1914 [59,70,100] no description given.
- Bos taurus domesticus*** Erleben, 1777 [59,63] for domestic cattle.
- Bos taurus domesticus abyssinicus*** Pennant, 1771, later *Bos taurus abyssinicus* Gmelin 1788 and *Bos abyssinicus* Oken 1838 [69], *brachyceros* type skull with gigantic long horns [107] and identical to *Bos macroceros Dürst* [69].
- Bos taurus dunelmensis*** Fitzinger, 1860 [59,67] for the Durham (Shorthorn) breed.
- Bos taurus ecornis*** Wagner, 1837 [59,94] former *Bos ecornis*.
- Bos taurus europaeus*** Kerr, 1792 [59] presumed wild European ancestor of domestic cattle.
- Bos taurus ferus*** for wild cattle from Chillingham park [99], also named *Bos urus scoticus* [94] and White Urus [70,132].
- Bos taurus forma domesticata*** Zeuner & Mourant, 1963 [133] proposed for domestic cattle.
- Bos taurus fossilis*** Baer [69] *Bos fossilis (q.v.)*.
- Bos taurus friburgensis*** Fitzinger, 1860 [67,100] for the extinct Fribourg (*Freiburger*) breed.
- Bos taurus frisius*** Wagner, 1837 [59,94] for straightbacked Friesian-type cattle.
- Bos taurus frisius*** Wagner, 1837 [59,86,94].
- Bos taurus frontosus*** Nilsson, 1849 [59,98] Initially considered a separate Scandinavian aurochs (*Bos frontosus*) and the ancestor of small, often polled Norwegian cattle. By Rütimeyer (1867) [79] considered a domestic form: *Bos taurus* var. *frontosus*, in 1892 definitive identified as remains of a domestic specimen.
- Bos taurus frontosus burgundicus*** Werner, 1912 [2] for Swiss Fleckvieh (Fribourg and Simmental) and related breeds of central Europe and France (Montbéliarde).
- Bos taurus frontosus franconicus*** Fitzinger, 1860 [67] for Franconian and other German yellow breeds and the French Charolais.
- Bos taurus frontosus goticus*** Werner, 1912 [2] for the Småland-Gotland breed.
- Bos taurus frontosus noricus*** Werner, 1912 [2] for Austrian Blond breeds.
- Bos taurus frontosus piemontanus*** Werner, 1912 [2] for Piemontese and related strains.
- Bos taurus galla*** Salt, 1814 [100] former *Bos Galla*, also as *B. indicus Galla*.
- Bos taurus garumnensis*** [100] French Garonnaise breed.
- Bos taurus germanicus*** Sanson, 1878 [73,74] former *B. germanicus*, indicating cattle of the presumed ethnic *Dolichocephale* cattle of Normandy.
- Bos taurus giganteus*** Owen, 1846 [70,81,102] description of huge skulls from Ilford, kept in the British Museum .
- Bos taurus grandifrons*** Kaltenecker, 1904 [8] large-head cattle, alternative of *frontosus* (broad-headed) for several Austrian breeds such as the Pinzgauer.

- Bos taurus hamiticus*** Adametz, 1920 [108] for domestic longhorned cattle of North-African (Egyptian) descent.
- Bos taurus hibernicus*** Sanson, 1878 [59,73] for cattle presumed to descent (Cornish) Irish *Dolichocephale* type cattle, the Channel Island breeds, Bretonne, Froment du Léon, and Jersey.
- Bos taurus hollandicus*** Fitzinger, 1860 [59,67] for Dutch-Friesian cattle.
- Bos taurus hungaricus*** Gray, 1846 [91] for Hungarian Steppe cattle [86,134].
- Bos taurus hypselurus*** Wagner, 1937 [59,94,100] synonymous for *B.t. taurus* for with their back sloping up from withers to hindquarters, contrary to the straight backed type *Taurus Frisius* [93].
- Bos taurus ibericus*** Sanson, 1878 [59,73] former *B. ibericus*, according to Sanson ancestor of *Brachycéphale* breeds: Corse, Basque and Béarnais; in Spanish-Portuguese literature as *B.t. ibéricus*, predecessor of brown and black, elegant cattle in central and south Spain and adjoining Portugal.
- Bos taurus indicus***^c [59,100] disputed name for *Bos indicus*, just as *B.T indicus* var. *major* (large zebu) and *B.t. indicus minor* (small zebu).
- Bos taurus indicus abessinicus*** Kerr, 1792 [59] also found as:
- Bos taurus indicus abessynicus*** Fischer, 1829 [59,86] presumably for Ethiopian cattle.
- Bos taurus indicus aegyptiorum*** Fitzinger, 1860 [59,67] presumably for Egyptian cattle.
- Bos taurus indicus aethiopicus*** Fitzinger, 1860 [59,67] originally as *B. Zebu africanus aethiopicus*.
- Bos taurus indicus africanus*** Kerr, 1792 [59] for African cattle.
- Bos taurus indicus brookii*** Smith, 1827 [59] no description given.
- Bos taurus indicus chinensis*** Swinhoe, 1870 [59,130] also as *Bos taurus chinensis*, for Chinese cattle.
- Bos taurus indicus dante*** Link, 1794 [59] originally named *Bos Dante* (*q.v.*).
- Bos taurus indicus galla*** Salt, 1814 [59] originally as *Bos Galla* (*q.v.*).
- Bos taurus indicus gibbosus*** Blyth, 1860 [135] [59] originally as *Zebu gibbosus*, no description given.
- Bos taurus indicus harveyi*** de Rochebrune, 1882 [59] no description given.
- Bos taurus indicus hottentottus*** Fitzinger, 1860 [59,67] former *Bos Zebu africanus hottentottus*, cattle of the South-African Khoi herders ('Hottentot').
- Bos taurus indicus hybridus*** Fitzinger, 1860 [59,67] presumably for zebu × taurine crossbred cattle.
- Bos taurus indicus madagascariensis*** Kerr, 1792 [59] for Madagascar zebu.
- Bos taurus indicus major*** Fitzinger, 1860 [59,67] presumably for large Indian zebu type.
- Bos taurus indicus medius*** Fitzinger, 1860 [59,67] presumably for medium large Indian zebu type.
- Bos taurus indicus pusio*** Swainson, 1835 [59,117] originally as *Bos pusio* (*q.v.*).
- Bos taurus indicus sanga*** Fitzinger, 1860 [59,67] presumably for sanga.
- Bos taurus indicus tricerus*** Rochebrune, 1882 [59] no description given.
- Bos taurus indicus zebu*** Boddaert, 1785 [59,121] for domestic zebu.
- Bos taurus inermis*** Boddaert, 1785 [59,121] possibly indicates hornless cattle (*inermis* = unarmed)
- Bos taurus jurassicus*** Sanson, 1878 [59,73] former *B. jurassicus*, for the *Brachycéphale* type breeds, identical to the *B. frontosus*: Pie-rouge de l'est, Montbéliarde, Abondance and Charolais
- Bos taurus latifrons*** Kalternegger, 1904 [8] for several Austrian cattle breeds of the shorth-headed type, by Wilckens [1] named *brachycephalus*. Kaltenecker, however, used the name broad-headed in stead of shorth-headed. However, Fischer (1830) [70] already had used the term *Bos latifrons* for Pliocene *Bos* remains excavated in the Siwalik range of India.
- Bos taurus ligeriensis*** Sanson, 1878 [59,73] former *B. ligeriensis*, for the *Brachycéphale* type breeds: Parthenaise and Aubrac.
- Bos taurus longifrons*** [81] [59] for *Bos longifrons*, indicating domestic cattle rather than an aurochs species.
- Bos taurus* var. *longifrons*** Lydekker, 1885 [70] synonym for *B.t. longifrons*.
- Bos taurus longifrons alpestris*** Wagner, 1837 [94] with the proposed varieties *B.t.l.* var. *brunneus* (Swiss, German, Austrian Brown, etc.), *B.t.l.* var. *griseus* (Tyrol Grey, Grey Alpine, etc.) and *B.t.l.* var. *flavus* (German and Austrian Yellow).
- Bos taurus longifrons illyricus*** Adametz, 1895 [124] for Illyrian Shorthorn cattle (Busha) of the Balkans.
- Bos taurus longifrons isolanus*** Werner, 1912 [2] for Channel Island cattle (Jersey, Guernsey,

- former Alderney).
- Bos taurus longifrons ligeriensis*** Werner, 1912 [2] after Sanson's *B.t. ligeriensis* for breeds and strains of the Vendée (Parthenaise, Nantaise, Maraîchine).
- Bos taurus longifrons polonicus*** Adametz, 1895 [124] for extinct Polish Brown, Busha-like cattle from the West Carpathians.
- Bos taurus longifrons vasconiensis*** Werner, 1912 [2] for the Gasconne, Bazadaise and related grey lowland and highland breeds.
- Bos taurus macroceros*** Dürst, 1899 [59,92] collective name for the 'zoological' types *Bos Galla*, *Bos Dante* and *Bos triceros*, which represented several East- and West-African cattle.
- Bos taurus major*** Fitzinger, 1860 [67,100] presumably *B.t. indicus major*
- Bos taurus mastodontis*** Pohlig, 1911^{IC} [80] former *Bos mastodontis* (*q.v.*).
- Bos taurus mauritanicus*** Thomas, 1881 [70] after *B.p. mauritanicus* for domestic cattle of African descent.
- Bos taurus minor*** Owen, 1846 [59,81] for a hypothetic small type of aurochs.
- Bos taurus minutis*** Von der [113]Malsburg, 1911 [59,70,113] for a hypothetic small type of aurochs, which turned out to be female aurochs remains.
- Bos taurus orthoceros*** Stegmann von Pritzwald, 1906; 1912 [59,136,137] for Kalmuk-Kirgiz (Turano-Mongolian type) cattle from central and eastern Asia, typified by peculiar upright direction of the horns that influences the cranial conformation as well as a ridge along the forehead from the poll downwards. Initially Stegmann von Pritzwald [136] assumed a descent from Bali cattle. In 1912 he as well as Kuleschow *et al.* [137] considered it as a taurine x zebu crossbred, but Adametz [96] postulated a separate wild form.
- Bos taurus planifrons*** Kaltenegger, 1904 [8] synonym for the 'flat forehead' *primigenius* type breeds of Austria. However, Lydekker [70] already had use the designation *Bos planifrons* for a Pliocene skull from the Siwalik range of northern India.
- Bos taurus podolicus*** Wagner, 1837 [59,94] renamed *B. primigenius podolicus* for Steppe cattle after the region Podolia in Southwest Ukraine.
- Bos taurus primigenius*** Lydekker, 1885 [70] used for both aurochs and longhorned domestic cattle, presumed to trace 'directly' to the aurochs (as all cattle).
- Bos Taurus var. Primigenius*** Rüttimeyer, 1868 [79], for domestic cattle tracing to the *Bos primigenius*.
- Bos taurus primigenius dacicus*** Fitzinger, 1860 [67] for steppe cattle from the lower Danube.
- Bos taurus primigenius ferus*** Werner, 1912 [2] for feral British White Park cattle.
- Bos taurus primigenius germanicus*** Werner, 1912 [2] after Sanson's *B.t. germanicus* for pied and unicolored red lowland breeds from the Netherlands (*B.t.germanicus var. frisiusus*); N.W. Germany (*B.t.g. var. saxonicus*), Belgium (*B.t.g. var. flandricus*), Normandy (*B.t.g. var. normanus*) and Britain (*B.t.g. var. anglosaxonius*).
- Bos taurus primigenius hungaricus*** Werner, 1912 [2] for Austrian-Hungarian Steppe type cattle.
- Bos taurus primigenius montanus*** Werner, 1912 [2].for intermediate steppe-shorthorn cattle from the Balkan Mountains.
- Bos taurus primigenius nomas*** Werner, 1912 [2] for Kalmyk and Kirgiz cattle.
- Bos taurus primigenius norvegicus*** Fitzinger, 1860 [67] for Norwegian Mountain (Blacksided Trondheim).
- Bos taurus primigenius podolicus*** Werner, 1912 [2] earlier *B.p. podolicus* for Podolian Steppe cattle.
- Bos taurus primigenius romanicus*** Werner, 1912 [2] for Italian Romagnola and related breeds.
- Bos taurus primigenius sarmaticus*** Werner, 1912 [2] for North-Russian horned breeds.
- Bos taurus primigenius scoticus*** Werner, 1912 [2] after earlier *Urus scoticus*, *B. urus scoticus*, *B. scoticus*, *B. t. scoticus*, or *B.t. var. scoticus*. for Scottish Highland cattle, by also used for both the tame Scottish Highland and feral English park cattle [67]
- Bos taurus primigenius suecicus*** Fitzinger, 1860 [67] for *Fjell* (Swedish Mountain) breed.
- Bos taurus priscus***(Keferstein, 1834 [70] after *Urus priscus* [60] for supposed aurochs remains that later were identified as originating from the steppe wisent *Bison priscus*.
- Bos taurus scythicus*** for Russian polled cattle, presumably after Charleton's *Bos scythicus*., Several scholars maintained that polled cattle of North Russia, Scandinavia and Iceland were descended from the hornless cattle owned by the ancient Scythians described by Herodotus.
- Bos taurus scoticus*** Smith, 1827 [59,100] after *Urus scoticus* by Smith (1827) [70,132], also as *Bos scoticus*.
- Bos taurus var. scoticus*** Bell and Alston, 1847 [70,138] after *Urus scoticus* [70,132] or Swainson's *Bos scoticus* [117] for Chillingham and other feral park cattle.
- Bos taurus silvestris*** Fischer, 1829 [Szalay] for *Bos silvestris* Charleton, 1668 or *B. primigenius*.
- Bos taurus tinianus*** Boddaert, 1785 [59] possibly designating the same as:

Bos taurus tinianensis Fischer, 1829 [59,86], white cattle with black ears from the Pacific Tinian island (Northern Mariana Islands, VS).

Bos taurus var. Trochoceros Rüttimeyer, 1861 [99] domestic form of the wild *B. p.* var. *trochoceros* and one of the races ('*Trochoceros Race*') of the current *Frontosus-Rind* [79].

Bos taurus turdetanus Sánchez Belda, 1981 [13] postulated ancestor of blond and red, rounded French, Iberian, German, Austrian and British breeds.

Bos taurus typicus Lydekker, 1898 [70] for the Swedish domestic cattle, considered a typical representative of *Bos taurus* [102].

Bos (Taurus) Urus Smith, 1827 [70] aurochs.

Bos taurus vulgaris Wagner, 1837 [59,94] no description given

Bos tricerus Rochebrune, 1880 [92] identified as a Senegalian type (*B.t. macrocerus*) [92].

Bos trochoceros Meyer, 1835 [79,110,139] a diluvial (Pleistocene) form excavated in Arezzo. According to Rüttimeyer [79] Meyer based the existence of the *trochoceros* species on one female skull that was a *primigenius* variant (*B. primigenius* var. *trochoceros*) and was found in Swiss and German Stone Age cattle as well as in Wild White cattle from Lyme park. Early domestic cattle with similar skulls was denoted by *B.taurus* var. *Trochoceros* [79]. Leithner (1927) [78] identified *Bos trochoceros* as being identical to *Bos primigenius hahni*.

Bos trochoceros hahni Leithner, 1927 [78] combination of *B. trochoceros* and *B. primigenius hahni* and indicating the same type.

Bos turano-mongolicus Kolesnik, 1936 [140] a presumed basic type as ancestor of several breeds of central Asia: Kalmuck, Mongolian, Yakut and Kirgiz cattle.

Bos turano-mongolian Chen 1990 [160]

Bos urus Boddaert 1785 [59,121] for aurochs [126,132,141]. *Urus* is the name Caesar gave to wild cattle living in Germanic woods. Cuvier [142] used this name for a cranium, which later turned out to be from a wisent [119]. A drawing from 1827 of an wild ox entitled *Bos urus* was copied from a painting on a panel from the 16th century, which showed the word *Thur* (aurochs) in golden German characters in one of the corners [132]. Reynolds [143] used 'urus' as the common name for *B. primigenius*.

Bos urus (antiquorum) Storer, 1877 [116] presumably indicating the Pleistocene aurochs.

Bos urus Gesneri, also for *Bos primigenius* [119] after the print of an aurochs by Gessner in a text of Jonston (1660).

Bos urus minutus von der Malsburg, 1911 [77,83,86,113,144] for a skull in the Antwerp Museum, excavated in superficial formations of the Lower Rhine region, supposed to belong a juvenile aurochs, just as skulls from musea in Bruxelles and Danzig ([112,145], see *B.p. minutus*), but identified as female aurochs crania [78].

Bos urus primigenius Melnyk, 1927 [146] for the ancestor of East-European domestic cattle of *primigenius* type with a large and proposed to have been influenced by *Bos namadicus* or banteng.

Bos urus priscus Schlotheim, 1820 [69] for *B. primigenius*.

Bos urus scoticus Wagner, 1837 [94] after *Urus scoticus* for Chillingham cattle.

Bos velanus Robert, 1930 [86] [69] for a supposed diluvial aurochs subspecies.

Bos vulgaris Wagner, 1937 [94] no description given.

Bos zebu Boddaert, 1785 [59,121] early name for humped cattle, also used by Blandford [70,147].

Bos Zebu africanus Fitzinger, 1860 [67] for East- and West-African zebu.

Bos Zebu africanus aethiopicus Fitzinger, 1860 [67] for Ethiopian zebu.

Bos Zebu africanus hottentottus Fitzinger, 1860 [67] for cattle owned by the South-African Khoi herders ("Hottentots").

Bos Zebu africanus Sanga Fitzinger, 1860 [67] for the Raya-Azebó breed, formerly named Galla breed, synonym of *Bos sondaicus africanus* and *Bos sondaicus longicornis*.

Bos Zebu Indicus major Fitzinger, 1860 [67] for large Indian zebu.

Bos Zebu indicus medicus Fitzinger, 1860 [67] for medium sized Indian zebu.

Bos Zebu indicus minor Fitzinger, 1860 [67] for miniature zebu.

Uri sylvestres *Bos sylvestres* (q.v.).

Uro ibérico, postulated subtype of the *B.p. primigeniu* [115] as ancestor of the Maronesa breed.

Urus Smith, 182 [70] for aurochs, already mentioned by Johnston (1651) [93].

Urus colossus Keferstein, 1834 [70] also for aurochs remains.

Urus fossilis Keferstein, 1834 [70] also for aurochs remains.

Urus nostras Bojanus, 1827 [60] or **Uro nostrate** for an assumed cattle species from the 'pre world', having thrived in the same period as the *Elephas primigenius* and *Rhinoceros antiq-uitatis*, and not having influenced modern *taurina* (cattle).

Urus priscus Bojanus, 1827 [60] as *Bos taurus priscus* [70] identified later as the extinct steppe wisent.

Urus scoticus Smith, 1827 [59,70,132,138] for 'White urus', British white park cattle supposed to

be “the probable remains of the genuine urus” .However, Lydekker [70] already recognized that the feral park cattle descended from domestic cattle.

Zebu, *Zebu gibbosus* Blyth, 1860 [70,135] for zebu as a separate *genus*, besides the *genus Bos*. First mentioned as Zebus by Blyth, who supposed the zebu had its origins in Africa and came to Asia as domestic cattle, but was still found as a wild species in India, Ceylon and Africa.

Authors of Texts on Breed Classification

Adametz, L. (1895) [124] Teacher at the Austrian *Hochschule für Bodenkultur* in Vienna. He stated that early shorthorned cattle (*Torfrind*) as described by Rüttimeyer represented a genuine European wild form and gave it the name *Bos europaeus (brachyceros)*. He also accepted the polled *Akeratos* type of Arenander as a separate type and emphasized the strict separation of European and Asian types of the *Taurina*. In 1920 [108] he compared crania of Egyptian Apis bulls with those of modern cattle and applied the term *Bos primigenius* var. *Hahni* Hilzeheimer for this type, which he believed to have entered Africa as domestic cattle from Asia and to be the ancestor not only of North, East- and South-African domestic cattle, but also of several European breeds from Spain, France, Great Britain, Switzerland and Austria.

Alderson, L. (1977, 1992) Prominent in the rare breeds movement, Technical Advisor to the Rare Breeds Survival Trust and author of several books on the subject. He designed a chart with three branches (Iberian, Scandinavian and Germanic) to clarify a putative origin of British and related breeds, related to pre-historic and historic immigrations of peoples and their cattle ([148]; cf. [149]). In 1992 he categorized European breeds into four main groups: Podolic, Northern European, Central European and Western European [36].

Amschler, J. (1956) classified on the basis of the hypothesis of two main stem forms (*B.t. primigenius* and *B.t. brachyceros / B.t. longifrons*), with mutual influence of the descendants of both types [122].

Antonius, O. (1922) [110] Teacher at the same high school as Adametz. He stated that systematic morphological comparison of domestic animals species reveals the groups in which one has to look for the wild progenitor. He recognized two branches of taurine cattle, and as Rüttimeyer believed that the aurochs formed the basis of only part of the domestic cattle classified as *B.t. primigenius*, while *B.t. brachyceros* was the oldest type of domestic cattle in Europe. He observed that zebu occurs over a wide area and with various degrees of crossbreeding with taurine cattle. For him zebu is not the same as “*Buckelrind*” [humped cattle] but denotes all cattle with a zebu type skull with or without a hump.

Aparicio, G. (1960) designed a phylogenetic tree of Spanish breeds in which each cluster of breeds is supposed to originate from hypothetical aurochs variant, such as *B.t. ibericus*, *B.t. desertorum hispanico*, *B.braquiceros Europeo* and *B.braquiceros Africano* [89].

Aristotle (350 BC) distinguished species by habitat and means of reproduction and divided animals into higher and lower classes [150].

Baker, C.M.A. & Manwell, G. (1980) published two seminal papers on a biochemical classification of 196 breeds [30,31].

Baron, R. (1928) Professor in zootechnics at the *École d'Alfort* in France. He applied three criteria: form, color, production type . He designed a diagram according to profile of body, head and type of horns as tool for classification [9]. The *Coordonnées baroniennes* [Baron's arrangement] were followed in the *Larousse Agricole* [11].

Bojanus, L. (1827), supposed that only one wild form of cattle had lived in Europe, the wisent and that by the name *urus* Linnaeus had meant the wisent [60]. After an unidentified skeleton in the museum of Jena, Germany, mentioned by Goethe in 1822, Bojanus thought to describe a ‘new’ prehistoric (*antediluvialis*) species which he named *Bos primigenius*, not aware this was the historic aurochs, classified as *Bos taurus* by Linnaeus.

Buffon, G.-L. Leclerc, Comte de (1749) French naturalist, mathematician, cosmologist and encyclopedic author. Buffon made the suggestion that species may have been both ‘improved’ and ‘degenerated’ after dispersing from a centre of creation. In volume 14 he argues that all quadrupeds had evolved from an original set of just thirty-eight quadrupeds, qualifying as preDarwinina ‘transformist’ [151]. He described the *Urus* and *Bison* as two different species.

Cheng, P (1986) designed a classification for Chinese cattle breeds according to regions and climatic zones [152].

Curson and Thornton (1936) introduced the term sanga for African cattle characterized by a cervico-thoracic placed hump and long, lyre-shaped horns [153].

Cuvier, G.L.C.F.D. (1823) Founder of paleontology, a student of Lamarck and in 1795 his successor as professor of comparative anatomy at the Jardin des Plantes. He used anatomy to clas-

sify animal species by skeletal structures. Cuvier observed little difference between fossilized skulls of the 'pre-world' *Bos primigenius* and those of modern cattle and stated that all domestic cattle are descending one *Urus* (aurochs) [142]. However he confused the European bison (wisent) with the aurochs.

- Darwin, C.R. (1859)** Founder of the evolution theory [154]. On the authority of Blyth, Darwin believed that zebu descended from a different source than European cattle. Blyth, who observed the different habits, voice, constitution and structure of humped Indian cattle, later classified the zebu in a separate genus besides genus *Bos*: *Zebus gibbonus*.
- Dechambre, P. (1913)**, professor at the same agronomic school at Grignon as Sanson and at *L'École vétérinaire d'Alfort*. He followed the classification developed by his colleague veterinarian Raoul Baron (*q.v.*). As second criterion for classification Dechambre used coat color [10].
- Diffloth, P. (1914)** Ingénieur agronome and *professeur spécial d'Agriculture* at the veterinary school in Brussels. He adopted Sanson's *brachycéphale / dolichocéphale* typing, recognizing twelve European cattle populations strictly according to geographic region [7].
- Doutresoulle, G. (1947)** Veterinarian and *Chef du Service de l'Élevage du Sudan*. [director breeding services in French Sudan]. Doutresoulle described and classified the cattle breeds of colonial French West Africa according to region and climate zones and classed cattle in two main groups: the taurine breeds and short-horned, long-horned and sanga-type zebus (intermixed with taurine cattle) [23].
- Dürst, J.U. (1899)** examined a large number of ancient and modern crania from Europe, Egypt and Mesopotamia. In his *Inaugural-Dissertation* [92] he recognized two additional basic forms which were thought to have been evolved by modification from the 'earliest cattle of the world': the polled *Bos taurus akeratos* as introduced by Arenander [72], and longhorned *B.t. macrôceros* for African and Iberian cattle which he believed to be related. He agreed with Dawkins [126] and Nehrling [127] that *brachyceros* cattle represented an impoverished form of the large aurochs and advocated the monophyletic domestic cattle descent theory. He proposed that the burden of the horn weight determines the shape of the skull and presented five different outlines of basic types. Furthermore he recognized three Pleistocene aurochs varieties: *B. namadicus*, *B. opisthonomus* and *B. primigenius*.
- Epstein, H.** initiated in 1933 the classification of African cattle, worked out further by Curson and Epstein (1934) [153]. With Mason [155] he did in 1984 not recognize the *namadicus* as a separate species and emphasized the geographical range is the basis of the classification. They followed Duerst (1931) in distinguishing three aurochs subspecies according to continental origin: *B. p. primigenius* for the European Aurochs; *B. p. opisthonomus* for the North-African aurochs and *B. p. namadicus* for the Asian aurochs [155].
- European Cattle Genetic Diversity Consortium (from 2002)**. Participants and collaborators of the EU project *Towards a strategy for the conservation of the genetic diversity of European cattle* (1999–2002), coordinated by J.A. Lenstra, Faculty of Veterinary Medicine, Utrecht University. This consortium is listed as coauthor of several publications on the genetic diversity of cattle [40,41,55,156,157].
- Falconer, H. (1868)** In the *Catalogue of the Fossil Remains of Vertebrata in the Museum of the Asiatic Society of Bengal, Calcutta*, the name *Bos namadicus* Falconer appears first. Falconer published in *Palaeontological Memoirs* (1868) on fossils excavated in the Siwalik Hills of northern India, where the oldest remains of *B. namadicus* were found [95].
- Fernández, A. et al. (1998)** analyzed 11 blood proteins of 10 different breeds from Galicia and northern Portugal [33]. Some of the breeds were also include in Vallejo's survey, but with different outcomes. Like Vallejo [32] the breed clusters according to the molecular markers were linked to prehistoric forms denoted by Latin names.
- Fitzinger, L.J. (1860)** Naturalist who proposed that domestic cattle consisted of at least seven geographic based forms [67].
- Felius, M. (1995)** based the classification of cattle breeds from all over the world according to geographical, historical and morphological data by combining the information by early authors as well as later prominent authors on classifying cattle breeds, by personal communications and by travelling [38]. After classifying first 470 breeds into 16 groups [158] the 1995 classification emphasizes more the continental and geographic location. The coverage was extended to 700 breeds and supported by pictures.
- Hansen, J. (1927)** described breeds according to region, per region into external type as well as after purpose: high productive dairy, beef and dual-purpose; lowland or highland; or low productive triple-purpose land cattle type [21]. This led to a classification into 14 main groups, the first of which consisting of German, Dutch, Danish and Swiss cattle.
- Hengeveld, G.J. (1865)** Veterinarian who was the first to described Dutch cattle in detail, stating that the cattle of the Netherlands belong to one breed only [119]. He classified the various locally adapted varieties of the Dutch breed according to type of soil on which they were found:

rich, medium or poor soil, after which he described the local types per province.

- Hilzheimer, M. (1909, 1917, 1926)** Division director of the Marker Museum in Berlin. Considered the *Bos primigenius* as 'the one and only' aurochs, though consisting of several subspecies, such as the *B.p. Hahni* (Hilzheimer, 1917) [83,107,159].
- Hodges, J. & Payne, W.J.A. (1997)** classified breeds according to the continent of their recent origin, within continents on a regional basis and within regions on a breed type basis. They differentiated humpless (*Bos taurus*), humped (*Bos indicus*) breeds, taurindicine crossbred and Southeast-Asian *bibos* breeds. The crossbred breeds have been further subdivided into three groups, stabilized, intermediate and recent crossbreds, respectively [160]. Another subdivision is according to type of horn, purpose or region.
- Holecek Holleschowitz, C. (1939)** recognized two main stem forms from which domestic cattle originated, the genuine Ur (*Bos primigenius*) and the smaller, shorthorned species (*Bos europaeus brachyceros*). However, he recognizes three basic types of European cattle: a western European variety, a northern subtype and the genuine aurochs [4]. He then also presented four groups of breeds, tracing to the aurochs, shorthorned cattle, short-headed cattle and polled cattle, respectively.
- Joshi, N.R. & Phillips, R.W. (1953)** adopted the classification of cattle of India and Pakistan of Olver [161] and recognized six morphological/regional groups [27]. **Joshi, N.R., Phillips, R. & McLaughlin, E.A.M. (1957)** arranged African cattle geographically and then morphologically [25].
- Keller, C. (1902, 1905)** Professor in zoology in Zürich. He recognized a number of basic domestic cattle forms according to cranium and type of horns, but also considered coat coloration and geographic origin [3,68]. He developed breed groups and classified according to their supposed origin: *Primigeniustype* cattle descending from European aurochs and shorthorned cattle of Oriental (Asian) origin. He was of the opinion that the *brachyceros* type traced to the Asian zebu (which in turn descended from the banteng or Bali cattle) but had lost its hump, and therefore named it *Bos sondaicus brachyceros*.
- Linnaeus, C. (1735, 1758)** Swedish naturalist, catalogued eighteen thousand species and classified individual species, which he then arranged according to their similarities [61,162]. He introduced the binary nomenclature (genus name plus species name) and a definitive concept of species in biology. Linnaeus introduced the name ***Bos taurus*** for humpless cattle (aurochs and domestic) and ***Bos indicus*** for the zebu. Linnaeus also used the name *Urus*.
- Lydekker, R. (1898)**, British naturalist, dismissed the common believe that the half-wild Chillingham and other British park cattle are authentic wild animals. He proposed the name *Bos taurus* var. *longifrons* for domestic taurine cattle. Lydekker believed that the *namadicus* is closely allied to the European wild ox, initially presuming it to be the ancestor of the bibovine group. He noted that nothing was known about the ancestry or original habitat of humped cattle [70]. In 1912 he described the history of the extermination of the aurochs [102].
- Mason, I.L.** classified in 1951 the breeds of West Africa according to Doutresoulle, but in a more specified way as he divided the taurine cattle into longhorned Chad cattle and small (N'Dama) cattle; and humped cattle into short-horned, medium-horned, lyre-horned and long-lyre-horned zebus [24]. Original author of the standard work *Mason's world dictionary of livestock breeds, types and varieties*, which lists names and synonyms of farm animals [163]. With Maule he refined in 1960 their classification of West-African and East- and South-African humped cattle, respectively, recognizing the form and place of the hump and the form and length of the horns and arriving at 14 Sanga, 9 zebu and 5 intermediate breed types [164].
- Maule, J.P. (1990)** classified tropical cattle into five groups: zebu, sanga, humpless, humped × humpless and Bibovine cattle, further subdivided according to locality (region, continent or country) or to breed and regional type [29].
- McKenny Hughes, T. (1896)** proposed in an extensive theory on the origin of several British breeds. He considered Kerry cattle as the most typical Celtic short-horn of the British Isles, the Chillingham as the most close to the cattle introduced by the Romans, Highland and Welsh cattle as a mixture of the Roman breed with the Celtic shorthorns and the longhorns as offspring from the breeds imported from Holstein and the Low Countries in the late Middle Ages [149].
- Miranda Do Vale, M.J. (1907/1949)** adhered to the twelve basic ethnic types *troncos* of Sanson (1893), such as *Bos taurus aquitanius*, *Bos taurus ibericus* and *B.t. atlanticus* [115].
- Müller, W. (1957)** divided Austria into three different historical zones: Rheatian, Norik and Pannonica [12]. To each zone an ethnic group was considered endemic, each owning a specific type of cattle: Western unicolored, Central pied group and Eastern unicolored breeds.
- Olver, A. (1938)** Animal husbandry expert of the Imperial Council of Agricultural Research in British India. Olver related the different types of zebus on the Indian subcontinent to migrations of peoples into India, in pre-historic times, as along the various migration routes characteristic

zebu types are to be found, some of which must have been in existence prior to these invasions [161].

- Ramm, E. (1901)** Teacher at the Agricultural Academy in Bonn am Rhein. He applied a more practical inventory than a rigorous zoological classification, a geographical classification according to both country or region and level (highland vs lowland) [19].
- Rütimeyer, L. (1861, 1868)** Professor of zoology in Basel and considered as the founder of domestic animal archaeozoology. He founded a classification within the *Bovini* tribe according to basic types of fossil as well as modern crania [79]. By examining extensive material from a Neolithic Swiss settlements he stated that shorthorned Neolithic domestic cattle, *Bos taurus brachyceros* represented the oldest form of cattle from which all other forms had evolved. He believed that *B.t. brachyceros* descended from an Asian ancestor and was the progenitor of most European domestic cattle. In 1868 he recognized in the European *Bos primigenius* both the wild animal as its domestic (longhorned) taurine progeny, while in the Indian *Bos namadicus* (Falconer, 1859) [95] he recognized all forms of humped cattle. He was not sure on the predecessor of the domestic zebu (*Bos indicus*) and suggested a close relationship to banteng and yak. He further proposed that *Bos namadicus* was the predecessor of *Bos primigenius*.
- Sánchez Belda, A. (1981, 1984)** combined skull, coat color and region of Spanish cattle and recognized three branches of Iberian cattle and a fourth group, directly related to North-African Atlas cattle [13,14].
- Sanson, A. (1878, 1893)** Prof. in zoology and zootechnics at the National Agricultural School, Grignon and the National Agronomic Institute, Paris. Sanson introduced a 'scientific' method for animal ethnology founded on the skull measurement theories of the anthropologists Retizius and Broca. He classified cattle according to their cranium, the form of the poll and horn implant, and the length and form of the horns [6,73,74]. He linked these types to those of human migrants: *Dolichocéphale* (longheaded) and *Brachycéphale* (short-headed) people. In 1878 Sanson introduced many Latin *Bos* names for basic types, to which in 1893 the term, *taurus* was added in order to indicate their domestic status (e.g., *Bos aquitanicus* became *Bos taurus aquitanicus*).
- Simon, D.L. & Buchenauer, D. (1993)** classified cattle breeds in 10 main groups, based mainly on coat color, but with subgroups according to color patterns, geographical origin and genetic relationship [17].
- Vallejo, M. et al. (1990)** applied a biochemical approach to Iberian cattle, linking breed clusters of breeds to presumed origin and supposed prehistoric forms ([32] cf. [13,14,89]).
- Van Leithner, O. (1927)** compared and measured a large number of aurochs crania. He recognized large (pre-world) diluvial aurochs (*Bos trochoceros*) and smaller alluvial aurochs (*Bos primigenius*), each containing of several subtypes [78]. He also concluded that African aurochs crania (such as *B.p. mauritanicus* [111], *B. opisthonomus* (Pomel, 1893) *B.p. Hahni* [107] were not to be distinguished from the crania of the European *Bos primigenius*. He delivered convincing evidence of the pronounced sexual dimorphism in the aurochs, which excluded the idea of a small type of aurochs as proposed by Pohlig [80].
- Werner, H. (1912)** Teacher at the Agricultural Highschool in Berlin. In his Practical Handbook he elaborated upon the classification of Wilckens by a detailed regional subdivision in *Rasse* (Types) and *Unterrasse* (Subtypes) [2].
- Wilckens, M. (1876)** Teacher at the Highschool for Soil Science in Vienna. He rejected the idea that *Bos primigenius* was the ancestor of domestic cattle [165]. He proposed the first classification of domestic cattle breeds, based on measurements of crania: *B. primigenius*, *B.t. brachyceros*, *B.t. frontosus* and *B. t. brachycephalus*.
- Wilson, J. (1909)** Professor at the Royal College of Science Dublin. He followed McKenny Hughes [149] with even stronger, though equally unfounded ideas on the relation between different ethnics which entered the British Isles in course of time and the color of the cattle they introduced: Black Celtic, White Roman, Red Anglo-Saxon, Dun (polled) Scandinavian and flecked Dutch. [131].
- Youatt, W. (1834)** Veterinarian, the first to describe British breeds in detail. Classified the British breeds on basis of their horns while disregarding the rest of the cranium [166].
- Zeuner, F.E. (1963)** believed that the so called *Torfrind* (*Bos longifrons*) descended from the *Bos primigenius* and believed that in several modern breeds the *primigenius* or *longifrons* type was relatively well kept, although most current breeds are of mixed origin [106,133].

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CHAPTER 5

World Atlas of Cattle

World atlas of cattle

There is no livestock species that has so many roles under such extremely diverse environmental conditions as domestic cattle. Accompanying the spread of agriculture, this livestock species migrated to all inhabited continents, providing dairy products, beef, leather and traction. Starting in the 18th century, adaptation to different environments and breeding regimes has been accentuated by the formation of more than 1000 different breeds: local subpopulations, separately managed and together constituting the genetic resources of a domestic species. Effective management of these resources is essential for optimizing agricultural production, minimizing the environmental burden and anticipating climate changes (Hayes et al., 2013). This requires a comprehensive description of the global breed repertoire. Several sources of information on cattle breeds are available already, such as a breed encyclopedia ordered via an integrative classification (Felius 1995; Felius et al., 2011), several databases (Groeneveld et al., 2010), a categorization according to breed origin and a breed dictionary with separate lists per country with indication of breed origin (Felius et al., 2015). Here we add a historical and cartographic description of the global cattle genetic resources (Lenstra, Felius, 2014).

On the maps, breeds are indicated by abbreviations. Coloring of letters indicates the groups and subgroups as defined in our breed classification. This reveals on several maps important links between diversity and geography as the result of historic as well as recent patterns of gene flow. Moreover, a graphical display of the historic and recent exports shows the intercontinental dispersal of several breeds and local types. This spreads their risk of extinction and thus is also relevant for their conservation. Most people who are interested in cattle - breeders, farmers, agricultural and rare-breed experts, government officials, scientists - are well familiar with their own national or regional breeds, but much less with the diversity of cattle elsewhere. With this geographic exhibition of the world-wide diversity of cattle, we intend to contribute to a well-informed discussion on breed conservation.

Breed letter codes

- XXX** First letter indicates the group and the second and third letter the sub group. Color keys are indicated per region in the lists of codes accompanying the maps.
- XXX** A black third letter indicates Asian and African zebu breeds or American Criollo breeds created by crossbreeding to European breeds imported during the 19th century (e.g., Frieswal, Bonsmara, Criollo altiplanico, Pampa).
- XXX** A light blue third letter indicates Asian breeds created by crossing taurine and / or bibovine cattle to Indo-Pakistani zebu bulls (e.g., Local Indian Dairy, Javanese Zebu), modern African zebu breeds crossed recently [19th and 20th century] to Indo-Pakistani zebus (e.g., Mauritius Zebu, Wakwa) or American and Australian taurindicine breeds (e.g., Canchim, Santa Gertrudis).
- XXX** Black second and third letters indicate global taurine breeds that are important in Asia or Africa (e.g., Israeli Holstein, Kenya Friesian).
- XXX** Light blue second and third letters indicate global zebu breeds (e.g., Kenya Sahiwal).

Breed codes indicate the origin of the breed, but not their countrywide or transboundary dispersal. Global breeds imported after the 1960s in European countries (e.g., Belgian Blonde d'Aquitaine, British Limousin) are only indicated as indigenous breeds if such a population has been selected into a different phenotype than the original one (e.g., British Blue, descending from Belgian White-Blue). Varieties, breed lines, F1 crossbreds etc. bred in the same region as the parental breed are not all indicated. A colon following a breed name precedes names of varieties, which also may be listed below the name of the parental breed. Common alternate names are placed between brackets. Transboundary African breeds may have various names in different countries, indicated by one or more backslashes following or below the original or English name.

Breed groups

The classification of breeds used has been described previously and for European breeds largely agrees with a genetic classification (Felius, 1995; Felius et al., 1995). To give an overview:

- Group 1 Polled and 'Celtic' breeds from North and Northwest Europe
- Group 2 Lowland breeds from West, North and Eastern Europe
- Group 3 Short-headed and broad-headed Highland breeds from West and Central Europe
- Group 4 Grey and blond to brown breeds from France, North Italy, the Alps and the Balkans
- Group 5 The breeds from Southwest Europe
- Group 6 Podolian breeds from Italy and East Europe
- Group 7 Shorthorned breeds from the Caucasus, Anatolia, the Levant and Egypt
- Group 8 Indo-Pakistani type zebu breeds
- Group 9 Turano-Mongolian breeds from Central and Northeast Asia, yak and yak-cattle hybrids
- Group 10 Breeds from Central and South China, Southeast Asia; Bibovine cattle and their hybrids
- Group 11 North and West African taurine breeds
- Group 12 West African Zebu breeds
- Group 13 East African zebu breeds
- Group 14 African sanga and zenga breeds
- Group 15 American breeds of Iberian descent
- Group 16 Modern breeds from America, Australia and New Zealand and bovine hybrids

Symbols indicating breed category or subcategory (Felius et al., 2014)

1. National or regional local breeds and their derivatives, with or without influence from imported cattle

- * **Landrace**, non-improved, locally adapted or feral cattle
- ** **Authentic breed**, original, selectively bred since the 18th or 19th century with or without herd book, with limited or no influence of imported sires; originating from older land races or (as in the case of American authentic breeds) historic imports; in some cases recognized outside their country of origin as imported global breed (e.g., Limousin); in other cases carrying the same name as an Americanized derivative
- * **Authentic variety**, original variety of a breed (color type, breed line, polled, etc.)
- † **Reconstructed breed or variety**, completely or almost lost breed rebred from animals with another origin
- ≡ **Local derivative**, local breed derived in the 19th to early 20th century from females of local landraces or authentic breeds by incrossing of exotic sires
- :: **Local multiple composite breed**, modern breed from the 19th century bred by using sires from several different breeds
- ✳ **Local crossbred populations**, diffuse breeds with continuous influx of neighbouring populations
- + **Local crossbreed**, crossbred breed of related and/or geographic close breeds, and upgraded landrace
- { **Local amalgamate**, recent breed emerged since mid-20th century by amalgamating local varieties and breeds from the 19th century or breeds created by crossbreeding of cattle from different regions

2. Cattle that emerged later from crossbreeding with cattle from other regions

- Π **Local population of international breed**, modern breed developed by crossing local females to sires of international breeds, morphologically close to the imported ancestor and maintained as purebred population; local transboundary breed; mostly dating from the 19th century.
- α **Composite breed**, synthetic breeds developed by planned crossbreeding of two or three non-related breeds, and still being developed by using both own sires and sires from parental breeds
- § **Multiple composite breed**, breed of multiple origin
- ψ **Bovine composites**, breeds that emerged from crossbreeding with other species than taurine and zebu cattle.

supplemental codes:

- † breeds which became recently extinct or existence unknown
- ◇ recent import of a vulnerable breed restoring a closely related or comparable lost breed
- i breed recognized as indigenous, in spite of an origin outside the country and not restricted to a certain region.
- u breed of which the region or state of origin is not known or not defined
- c was or is being developed in various regions or states
- ? genetic origin of composite breed uncertain

3. Highly productive imported cattle with continuing international exchange of breeding material

- ⊖ **Global or international purebred breeds**, originating from a local breed; elsewhere introduced by import or by upgrading local populations that have become at least 15/16 identical to imported; kept within continents (Africa, Asia, Europe) or on most inhabited continents with international exchange of breeding material
- Δ **Americanized local breed**, breed reformed by using American stock tracing directly to the original breed
- ∇ **American-European composite**, European breed from first category reformed by strong infusion of unrelated American breed and developing towards the American breed
- ⊖ **International multiple composite breed**, breed of multiple origin kept on most continents and/or populations maintained by crossbreeding

4. Populations maintained by crossbreeding

- ∞ **Continuous cross**, mix of several breeds with continuous input of parental and other breeds
- ƒ **Terminal F1 cross**, crosses with high performance by first-generation heterosis but not used for breeding
- Ω **Bovine hybrid**, terminal crosses of taurine or zebu cattle with gayal, banteng, yak or bison

1 • Overview:

Regions of origin of the major transboundary cattle breeds worldwide

the numerically most important breeds are indicated by *

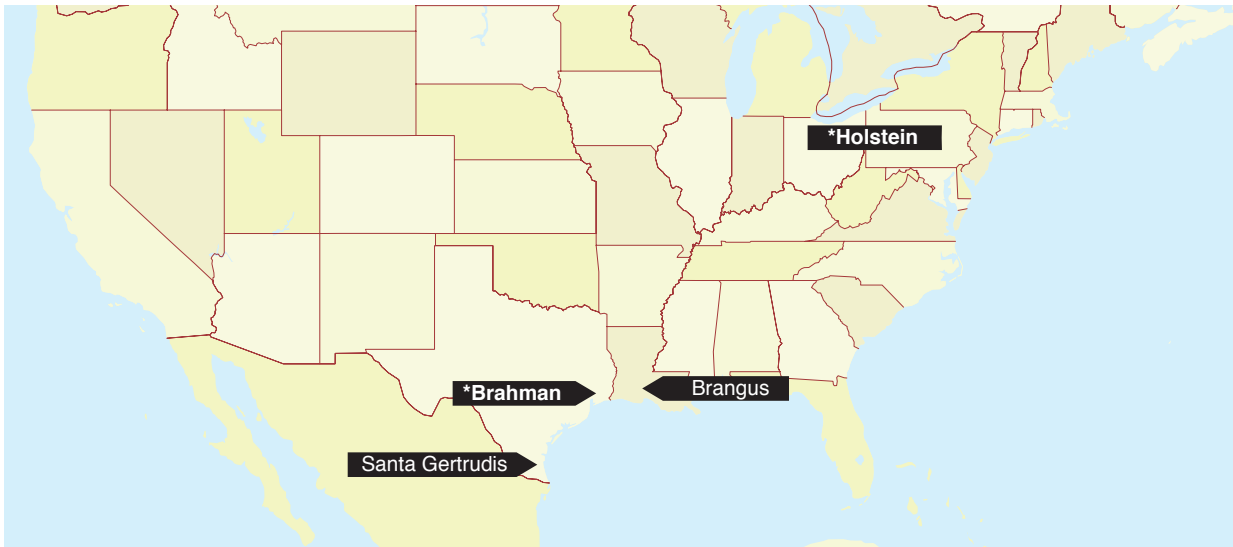


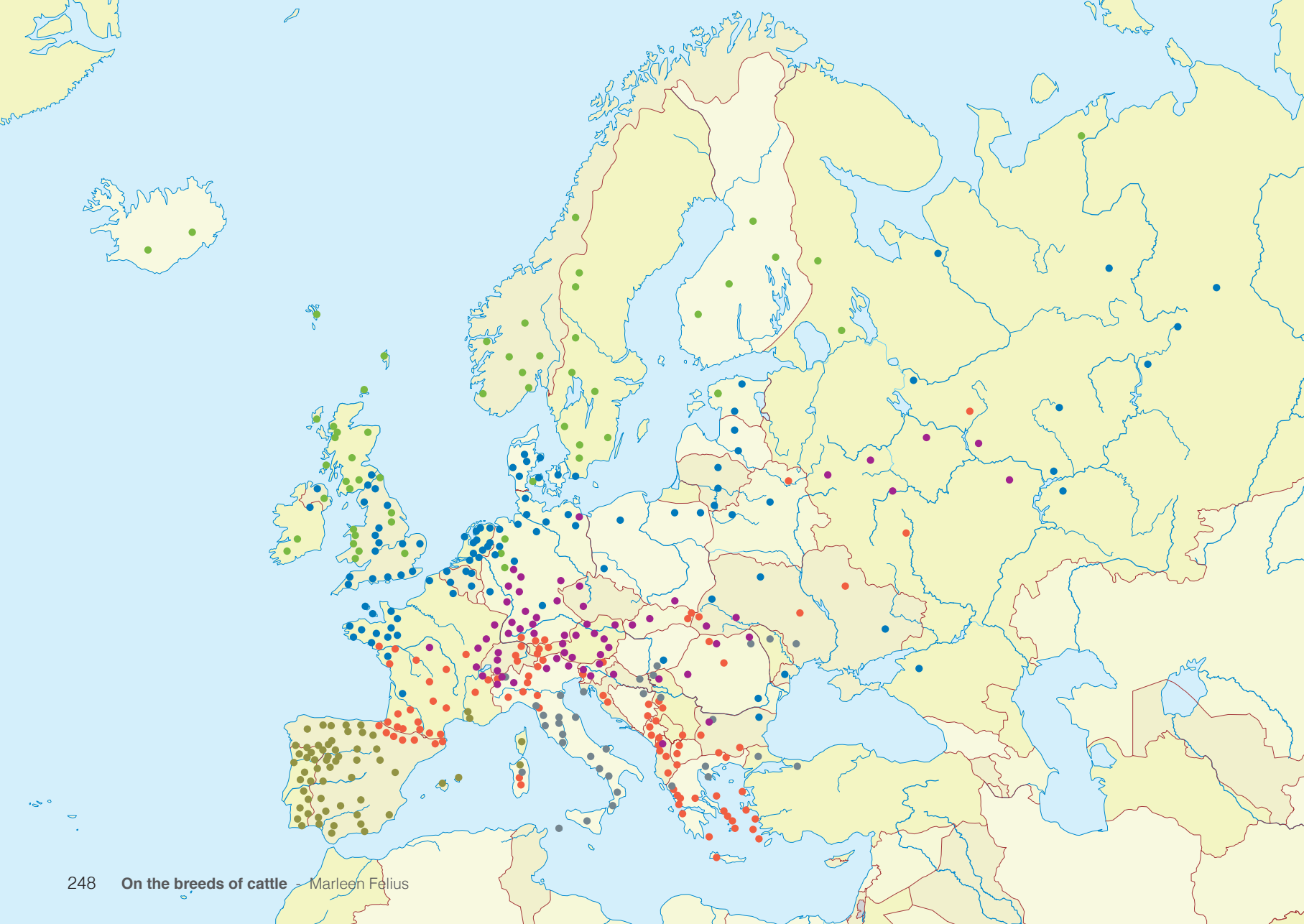


1. Overview: Regions of origin of the major transboundary cattle breeds worldwide

the numerically most important breeds are indicated by *







2. Overview of European breed groups

- Group 1** Polled and 'Celtic' breeds from North and Northwest Europe
- Group 2** Lowland breeds from West, North and Eastern Europe
- Group 3** Short-headed and broad-headed Highland breeds from West and Central Europe
- Group 4** Grey and blond to brown breeds from France, North Italy, the Alps and the Balkans
- Group 5** The breeds from Southwest Europe
- Group 6** Podolian breeds from Italy and East Europe

note the contrast of the black-pied, red pied and red dairy cattle from **Group 2** in the northwestern part of the continent with the central-European cattle that is dual-purpose spotted cattle (Fleckvieh) from **Group 3** and the brown mountain cattle from **Group 4** are found in central Europe. The last group also comprised the South-French beef breeds and the primitive small Balkan cattle. The British-Nordic **Group 1** and the British cattle from **Group 2** contain breeds with a considerable morphological variety.

Subgroup 1A

Polled dairy breeds from, Iceland, Scandinavia and the Baltics

**	ICL	Icelandic Dairy
**	WRP	Westland Red Polled
**	ORP	Red Polled Eastland
‡	JAR	Jarlsberg
**	SRP	Swedish Red Polled
**	BST	Blacksided Trondheim and Nordland
**	SFR	Swedish Mountain (Fjällras)
*	FJA	Fjällnära
*	BOH	Bohus Polled
{	SPO	Swedish Polled
**	NFC	Northern Finncattle
**	EFC	Eastern Finncattle
**	WFC	Western Finncattle
**†	RPK	Red Pied Kareliyan
≡	ESN	Estonian Native

Subgroup 1B

Horned dairy breeds from Scotland and Scandinavia and derivatives

**	AYR	Ayrshire see also map 4
††	AYRs	Swedish Ayrshire
≡	AYRf	Finnish Ayrshire
≡	AYRr	Russian Ayrshire
**	TMK	Telemark
**	DOL	Doela
**	WFJ	Western Fjord
∞C	NVR	Norwegian Red
‡	FAR	Faeroes Allmoge
*	RIN	-Ringmala
*	VAN	-Vane
∞C	SRW	Swedish Red-and-White
**	AGE	Agersoe

Subgroup 1C Scottish derivatives

ø	IGA	Icelandic Galloway
ø	GGA	German Galloway
††	GRA	German Angus

Subgroup 1D

German composite

≡	WIR	Wilseder Red
---	-----	--------------

Subgroup 2A see also map 5

Lowland red breeds from Denmark, North Germany and derivatives in the Baltics and Eastern Europe

**	DAR	Red Danish Dairy 1970
**	ANG	Angeln (original)
≡	ESR	Estonian Red
≡	LBR	Latvian Brown
∞:	LIR	Lithuanian Red
≡	BER	Belarus Red
≡	POR	Polish Red Lowland

Subgroup 2B

Lowland pied dairy breeds from the Baltics and derivatives

**	LBL	Latvian Blue
**	LLG	Lithuanian Ash-Grey
**	LWB	Lithuanian White-Back
**	POW	Polish Whitebacked
≡	ESB	Estonian Black Pied
≡	PBW	Polish Black-and-White Lowland

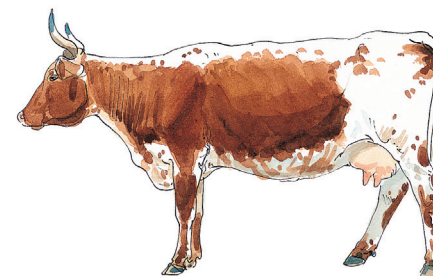
Subgroup 2G see also map 5

Scandinavian composite

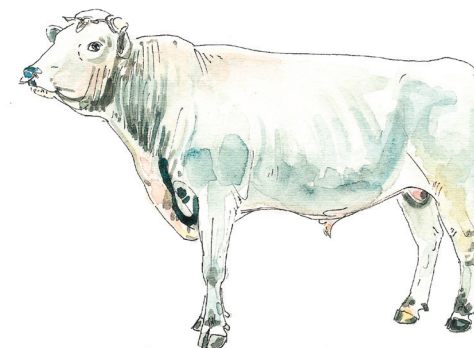
≡C	VIR	Viking Red
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JAR Jarlsberg



VAN Vane



LLG Lithuanian Ash-grey



4. United Kingdom and Ireland

Group 1 Polled and 'Celtic' breeds from North and Northwest Europe

Group 2 Lowland breeds from West, North and Eastern Europe

Group 4 French-British variety

1 Scotland

2 England

3 Northern Ireland

4 Ireland



SWO Swona



ACL Ancient cattle of Wales



HER British Polled Hereford

Subgroup 1B

Horned dairy breed from Scotland

- ** **AYR** Ayrshire see also map 3

Subgroup 1C

Polled breeds from Ireland, Scotland and England

- ** **IRM** Irish Moiled
- ** **GAL** Galloway
 - * -Dun Galloway
 - * -Red Galloway
 - * -White Galloway
 - * -Rigget Galloway
- ** **BGA** Belted Galloway / Red Belted Galloway
- ** **ABA** Aberdeen-Angus (original population)
 - * -Tyrone Black
 - * -Aberdeen-Angus
 - * -Red Angus
- +* **SWO** Swona
- ** **BRW** British White
- ** **REP** Red Poll

Subgroup 1D

Horned 'Celtic' breeds from Ireland, Scotland and England

- ≡ **SHE** Shetland
- ** **SHI** Highland (West Highland)
- f **HLR** Herelard
- f **BLG** Bluegrass
- ≡ **LUI** Luinig
- f **WHP** White Park:
- * **DYN** -Dynevor
- ** **VAY** Vaynol
- ** **CHL** Chillingham
- ** **KER** Kerry
- * **DRM** Drimmon
- ** **DEX** Dexter (Irish) / i English
- ** **WBL** Welsh Black
 - ≡ -Polled Welsh Black
 - ** Ancient Cattle of Wales
 - * -Belted Welsh

Subgroup 2B

Lowland pied dairy breeds in the United Kingdom and Ireland

- **i **IRF** Irish Friesian
- **i **BRF** British Friesian
 - * -Polled Friesian
 - * -Red-and-White Friesian

Subgroup 2C

Blue-pied breed in the United Kingdom

- *i **BRB** British Blue

Subgroup 2D

The British Shorthorn breeds

- ** **SHNb** Beef Shorthorn
- Δ **Δ** Poll Beef Shorthorn
- * **WHS** Whitebred Shorthorn
- f **BGR** Blue Grey
- ≡ **NDS** Northern Dairy Shorthorn
- ** **SHNd** Original Population Dairy Shorthorn
 - Δ Blended Red-and-White
 - ‡ **BLA** Blue Albion
 - ** **LIR** Lincoln Red
 - ≡ Polled Lincoln Red

Subgroup 2E

Breeds from Central-West and South England

- ** **LHN** Longhorn
- ** **HER** Hereford Traditional
 - ≡ British Polled Hereford
 - Δ Hereford
 - f Black Hereford
- ** **GLO** Gloucester
- ** **RDE** Devon
- ** **SDE** South Devon
- ** **SUS** Sussex
 - ≡ Polled Sussex
 - ≡ Sussex new type

Subgroup 2F

see also map 5

Channel Islands breeds

- e **JER** Jersey [Island]
- Δi [English] Jersey
- e **GUE** Guernsey [Island]
- Δi [English] Guernsey

Subgroup 2G British composite

- ∞ Stabiliser

Subgroup 4A

- *u **BBL** British Black Limousin



5. Western Europe

Group 2 Lowland breeds from West, North and Eastern Europe

1 Sweden
2 Denmark

3 Germany
4 Poland

5 Netherlands
6 Belgium

7 France
8 Channel Islands

The lowland red breeds (**Subgroup 2A**) from the Baltic coasts are genetically distinct from the red Flemish cattle in the same subgroup. The lowland black-pied dairy cattle from **Subgroup 2B** are the progenitors of the cosmopolitan Holstein-Friesian. The Red-pied cattle from **Subgroup 2C** are closely related to the black-pieds but are bred rather as dual-purpose cattle. Most Belgian and northwestern French cattle have been influenced by English Shorthorn in the 19th century and the Maine-Anjou is now closely related to this breed. The island breeds Jersey and Guernsey have been kept isolated since the end of the 18th century.

Subgroup 2A

Lowland red breeds

**	DAR	Red Danish Dairy 1970 -Danish Red Dairy
**	ANG	Angeln original (Old Red Angeln) -Angeln-German Red
**	DOR	Donnersberg Red
**	BRE	West Flemish Red (Belgian Red) -Red Beef Type
**†	FLA	Flamande originelle -Flamande type laitier -Flamande type mixte

Subgroup 2B

Lowland pied dairy breeds

**c	DUB	Witrik (Dutch Whiteback)
**c	GWH	Lakenvelder (Dutch Belted)
**	RFR	Groningen Whiteheaded
**	DFR	Red Pied Friesian
**	DFR	Dutch-Friesian
**	BPW	German Black Pied (Western reserve)
**	BPE	German Black Pied (Eastern reserve)
\$ †	GBD	German Black Pied Dairy
**	JUT	Jutland -Oregaard -Kortegaard -Westergaard
*◇	HEA	Heather cattle

Subgroup 2C

Red pied and blue pied dual-purpose and beef breeds

**	MRY	Meuse-Rhine-Yssel (MRY) -Burnt red (Deep red)
*	IRP	Improved Red Pied
▣	RBE	Red Beggar
∇	RH1	Dutch Red Pied H
∇	RH2	Red Holstein DP
**	GRP	German Red Pied DN
∇	DRP	Danish Red Pied
∏	PRW	Polish Red-and-White Lowland
∇	PRP	Pie Rouge des Plaines
‡	CAR	Campine Red Pied
∇	BRP	Belgian Red Pied H
≡	BWR	Belgian White-and-Red
≡	BWB	Belgian White-Blue
≡	BWB	Belgian White-Blue dual-purpose
≡	BNO	Bleue du Nord [rameaux mixte]

Subgroup 2D

Derived Shorthorn breeds

e	MSH	Milk Shorthorn
∏	DAS	Danish Shorthorn
∏	GSH	German Shorthorn
Δ	GBS	German Beef Shorthorn
f	SBR	Shorbrack
f	STB	Steibu

Subgroup 2F

Breeds from the Channel Islands and Northwest France

**	JER	Jersey [Island]
**i	JERd	Danish Jersey
**i	JERS	Swedish Jersey
**i	JERf	Jersiaise
*	GUE	Guernsey [Island]
**i	GUF	Guernsiase
**	FRL	Froment du Léon
**◇	CAN	Canadienne
≡	ARM	Armoricaïne
≡	MAN	Rouge des prés (Maine-Anjou)
†	BAZ	Bazougers
∴	SAO	Saônoise
**	BPN	Bretonne Pie Noir
**	NOR	Normande
‡	BOR	Bordelaise (nouvelle)

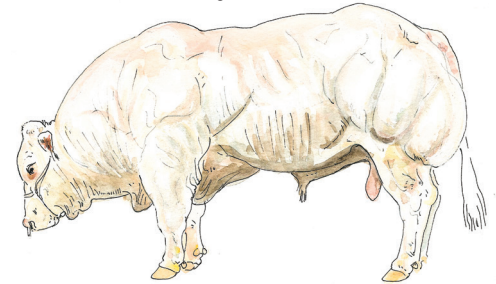
Subgroup 2G

Northwest European composite breeds

\$	DAF	Danish Forest
\$u	VIR	Viking Red
\$	MBA	Munich-Berlin Aurochs
*	HEC	Heck cattle
∞	ECO	Ecolander
∞	TAU	Taurus
∞	TAO	Tauros



JUT Jutland - Kortegaard



BWB Belgian White-Blue



VIR Viking Red

6. Europe

Subgroup 2B

Derived Holstein-Friesian populations of Europe

The transboundary Holstein-Friesians are now in most countries the dominant dairy cattle. Although top breeding stock is internationally exchanged, differences between national populations persist; for example in the Netherlands Holsteins are preferred not to be as tall as in America and in Italy, the first European country to import American Holsteins.

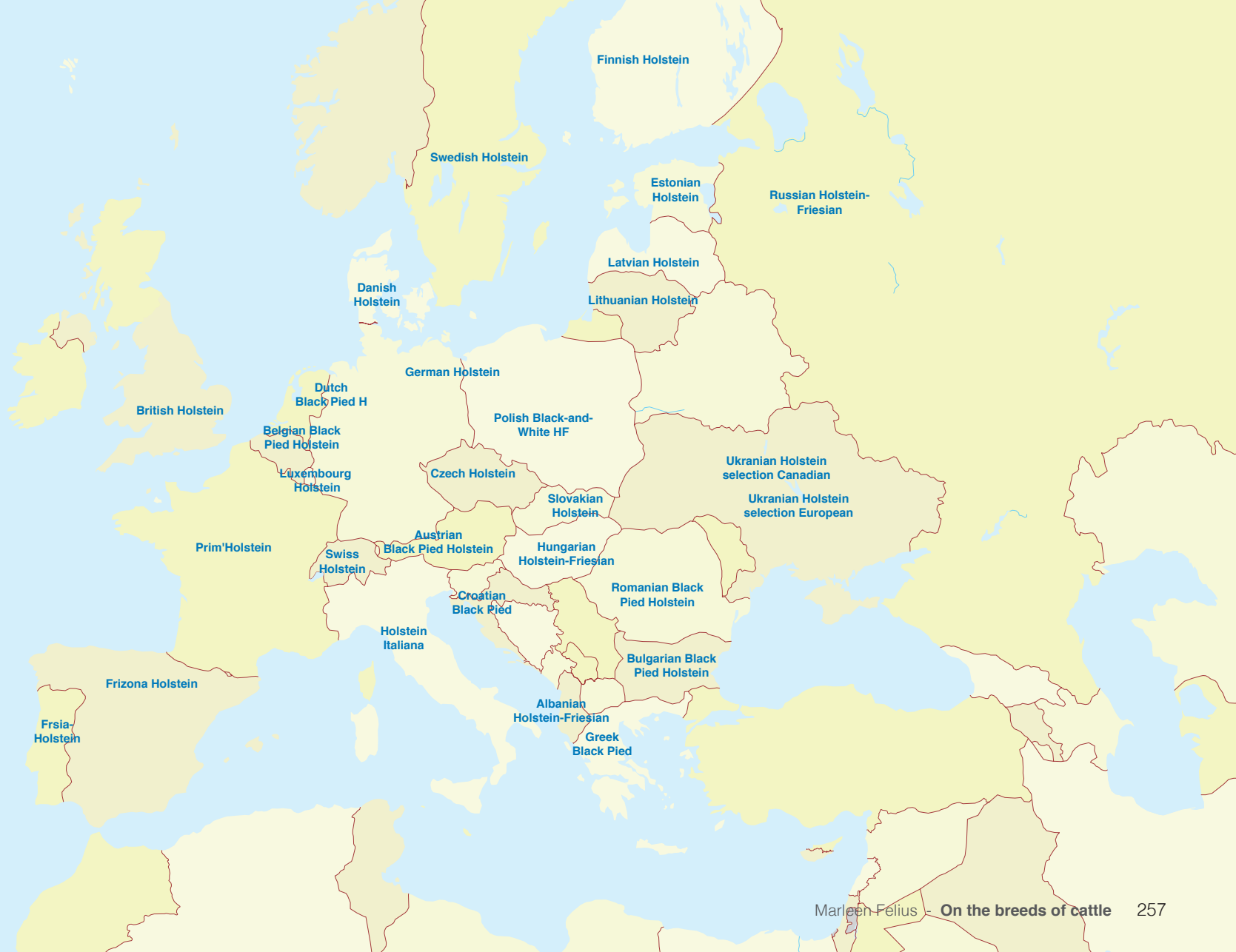
- Δ [European] Holstein-Friesian (Northwest Europe):
 - Dutch Black Pied H
 - German Holstein
 - Danish Holstein
 - British Holstein
 - Swedish Holstein
 - Finnish Holstein-Friesian
 - Belgian Black Pied-Holstein
 - Luxembourg Holstein
 - Prim'Holstein
 - Friziona Holstein
 - Frisia-Holstein
 - Holstein Italiana
 - Swiss Holstein
 - Austrian Black Pied Holstein



- ∇ [European] Red Holstein (Northwest and Eastern Europe)

- Δ [European] Holstein-Friesian (Eastern Europe):
 - Estonian Holstein
 - Latvian Holstein
 - Lithuanian Holstein
 - Polish Black-and-White HF
 - Czech Holstein
 - Slovakian Holstein
 - Hungarian Holstein-Friesian
 - Romanian Black Pied Holstein
 - Black Lemming
 - Bulgarian Black Pied Holstein
 - Ukraine Holstein selection Canadian
 - Ukraine Holstein selection European
 - Russian Holstein-Friesian
 - Croatian Black Pied
 - Albanian Holstein-Friesian
 - Greek Black Pied





Subgroup 3A

Vosges and Black Forest breeds

**	VOS	Vosgienne
**	VOR	Vorderwäld
**	HIN	Hinterwäld

Subgroup 3B Central European red Highland breeds

‡	GRH	German Red Highland:
*	WFR	-Westphalian Red
‡	WBL	-Witgenstein Blazed rebred
*	HER	-Hesse Red
*	VBE	-Vogelsberg
*	HAR	-Harz Red
‡	VLA	-Vogtland Red
**	BOR	Czech Red (Bohemian Red)
**	POD	Podgórska

Subgroup 3C

Alpine short-headed breeds and derivatives in Eastern Europe

**	ABO	Abondance
**	VALc	Valdostana nero-castani
*		Valdostana pezzata nera
∴	VALr	Valdostana pezzata rossa
**	ERI	Hérens (Eringer)
**	EVO	Evolèner
‡	TXZ	Tux-Zillertal
≡	BUR	Burlina
‡	PUS	Pustertaler
+		Bara
‡	ENB	Ennstal Spotted Mountain (Bergscheck)
**	PIG	Pinzgauer
*	JOC	Jochberger Hummel
Π	PIGg	German Pinzgauer
Π	PIGi	Pinzgau
Π	PIN	Pinzgavac
≡	CIK	Cika
≡	SPI	Slovakian Pinzgau
≡	TRP	Transylvanian Pinzgau
*	DOR	Dorna

Subgroup 3D

Central European blond and yellow Highland breeds

‡	GLA	Glan
‡	LAH	Lahn
‡	LMP	Limpurger

∴	GYE	Yellow Franconian
*		-Gelbvieh beef
**	WBL	Waldviertel Blond
**	MBO	Murboden
∴	CBL	Carinthian Blond
{	AUY	Austrian Yellow

Subgroup 3E

West and Central European broad-headed red spotted mountain breeds

**	MBE	Montbéliarde
**	SIM	Edelweiss-Simmental
∇	SRP	Swiss Red Pied
Π	SIMf	Simmental Français
Π	PRI	Pezzata rossa Italiana
Π	PRO	Pezzata rossa d'Oropa
Π	SIMg	German Fleckvieh
*		-Fleckvieh beef
‡	ATR	Ansbach-Triesdorf
Π	AUF	Austrian Fleckvieh
∇		-Austrian Dairy Simmental

Derivatives in Eastern Europe:

∇	CZF	Czech Fleckvieh
eu		-Czech Pied Dairy
Π		Masny Simmental
eu	SLP	Slovakian Pied
Π		Masovy Simmental
∇u	HUP	Hungarian Pied
Π		Bavarian Simmental
Π	SIP	Slovenian Pied
Π	CRS	Croatian Simmental
Π	SDS	Serbian Domestic Spotted
Π	ALS	Albanian Simmental
Π	ROS	Romanian Spotted
Π	BUS	Bulgarian Simmental
§	UKS	Ukrainian Simmental
		-Ukrainian Red-and-White

Subgroup 3F

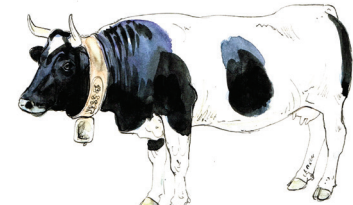
Charolais and derivatives

**	CHA	Charolais
∞u		INRA 95
∞	UCK	Uckermärker
f		-Genotyp 67

Group 4A.B.C., see map 8



GRH German Red Highland



VALc Valdostana pezzata nera



CHA Charolais



8. West-Central Europe

Group 4 Grey and blond to brown breeds from France, North Italy, the Alps and the Balkans with their neighbours from **Group 3** and **Group 5**

1 France

2 Spain

3 Switzerland

4 Germany

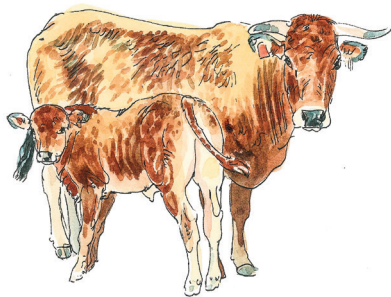
5 Italy

6 Austria

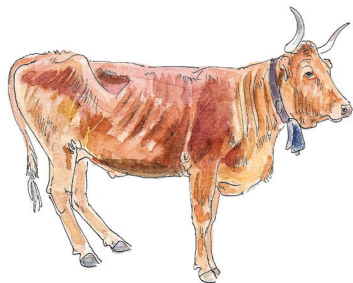
7 Slovenia

8 Croatia

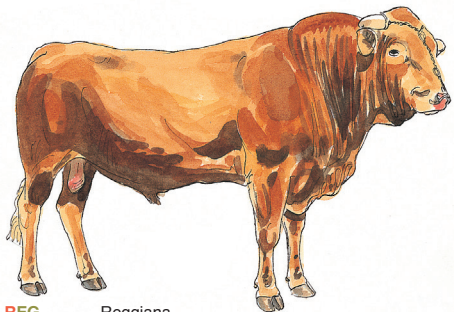
Original Swiss Brown (**Subgroup 4D**) has influenced surrounding Alpine cattle, Pyrenean cattle and cattle from the Balkans. Swiss Brown was further developed in America under the name Brown Swiss. These cattle returned to Europe and transformed the original Swiss Brown dual-purpose type into a dairy type.



PAR Parthenaise



BET Betisouak (Betizú)



REG Reggiana

Subgroup 4A

Breeds from Central France

**	NAN	Nantaise
**	PAR	Parthenaise
**	MAR	Maraichine
**	LIM	Limousine
**	SAL	Salers
*		-Salers Latier
**	FER	Ferrandaise
**	AUB	Aubrac
**	VIL	Villard-de-Lans
**	TAR	Tarentaise
¶	SAV	Savoiarde

Subgroup 4B

Grey and blond breeds from

Southwest France and the Pyrenees

**	BAZ	Bazadaise
{	BDA	Blonde d'Aquitaine
**	MIR	Mirandaise
*	MRI	Marine
*	BET	Betisouak (Betizú)
**	BEA	Béarnaise
**	LOU	Lourdaise
**	PAL	Pallaresa
**	PIR	Pirenaica
**	GAS	Gasconne
**	CAS	Casta
✳	MAS	Massanaise
*		Alberes:
*	ALB	-Albera Negra
*	FAG	-Fagina

Subgroup 4C

North Italian fawn-brown breeds

**	CAB	Cabannina
{	MON	Montana rossa
**	REG	Reggiana
**	PON	Pontremoles

Subgroup 4D

see also map 9

Alpine Grey and Brown Mountain breeds, derivatives and Americanised breeds

‡	RGR	Rhaetian Grey
**	TGV	Tyrol Grey
**	GRA	Grigria Alpina
**	REN	Rendena
**	SWB	Original Swiss Brown
*		-Belted Swiss Brown
*		-Whitebacked Swiss Brown
Δ	SBR	Swiss Brown
**	MWE	Murnau-Werdenfels
¶	BRO	German Original Brown
Δ	GRB	Geman Brown
¶	AUB	Austrian Original Brown
Δ	ABR	Austrian Brown
¶	BRU	Bruno Italiana Vecchio Ceppo
Δ	BRA	Bruna Alpina
¶	SBR	Sardo Bruna
‡	FRA	Frati
¶	SLB	Slovenian Brown
≤	SGR	Savinja Grey
Δ	BRN	Brune
¶	BPI	Bruna de los Pirineos
Δ	PMO	Parda de Montaña

for subgroup 4E see map11

Subgroup 5A

Isolated breeds from the Camargue, Corsica and Sardinia

**	CAM	Raço di Biòu (Camargue)
*	COR	Corse
*	SAR	Sarda / Pettiazza

Subgroup 5E

•i	RCO	Race de Combat see also map 10
----	------------	--------------------------------

Group 3 breeds, see map 7



9. Southwestern Europe

Group 5 The breeds from Southwest Europe

1 France
2 Spain

3 Portugal
4 Azores

5 Madera
6 Canary Islands

7 Corsica
8 Sardinia

9 Balearic Islands

- Subgroup 4D** see also map 8
Brown Mountain derivatives
 ¶ **SBR** Sardo Bruna
 ‡ **FRA** Frati

- Subgroup 5A**
Isolated breeds from the Camargue, Corsica and Sardinia
 ** **CAM** Raço di Biòu (Camargue)
 * **COR** Corse
 * **SAR** Sarda / Pettiazza

- Subgroup 5B**
Cantabrian breeds
 * **MON** Monchina
 ** **TER** Terraña:
 * -Terraña gorbeana
 * -Terraña de la Sierra
 ** **PAS** Pasiega
 ** **TUD** Tudanca
 ** **ASV** Asturiana de los Valles
 ** **ASM** Asturiana de la Montaña (Casina)

- Subgroup 5C**
Galician, Balearic and Canarian blond breeds
 ** **RGA** Rubia Gallega
 ≡ **MIN** Galega / Minhota
 ** **MAL** Mallorquina
 ** **MEN** Menorquina
 ** **PAL** Palmera
 ** **CAN** Canaria

- Subgroup 5D**
Northwest Iberian chestnut breeds
 ** **CAL** Caldelá
 { **MNO** Morenas del Noroeste:
 ** **LIM** -Limiana
 ** **VIA** -Vianesa
 ** **FRI** Frieresa
 { **ALS** Alistana-Sanabresa
 ** **SAY** Sayaguesa
 * **CCH** Cachena
 ** **BAR** Barrosã
 ** **ARQ** Arouquesa
 ** **MAR** Maronesa
 ** **MIR** Mirandesa
 ** **BER** Berciana
 * **BRA** Bragança
 * **BEI** Beiroa
 *

- ** **MAH** Marinhoa
 § **RAG** Ramo Grande
 ∞ **MMX** Madeira Mixed

- Subgroup 5E**
Iberian Black breeds and fighting cattle
 ** **STE** Serrana de Teruel
 ** **SES** Serrana de Soria
 * -Pinariega
 * **SNE** Serrana Negra
 { **AVI** Avileña-Negra Ibérica
 ** **MOR** Morucha
 * **MRN** Morucha Variedad Negra
 ** **NAN** Negra andaluza
 ** **PRT** Preta
 ** **CAR** Cárdena andaluza
 ** **BER** Berrenda en Negro andaluza
 ** **ARA** Aracena
 * **MOS** Marismaña (Mostrenca)
 ** **TDL** Ganado Bravo (Toro de Lide)
 ** **CNA** Casta Navarre
 ** **BRL** Brava de Lide
 ** **RCO** Race de Combat
 * **BR** Brava dos Açores

- Subgroup 5F**
Central and South Iberian red breeds
 ** **MET** Mertolenga:
 * **BRS** -Bragado do Sorroia
 * **MBG** -Malhado do baixo Guadiana
 ** **ALE** Alentejana
 ** **GAR** Garvonesa
 ** **ALG** Algarvia
 ** **BLC** Blanca Cácerena
 ** **RET** Retinta andaluza
 ** **BER** Berrenda en Colorado

- Subgroup 5G**
Southeast Iberian breeds
 ** **MUL** Murciana-Levantina
 * -Huertana
 ** **PAJ** Pajuna
 * **AXA** -Axarquía

- Subgroup 6B** see also map 10
Podolian derivative
 ≡ **SAM** Sardo-Modicana



TUD Tudanca



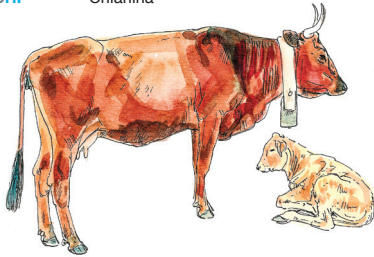
CCH Cachena



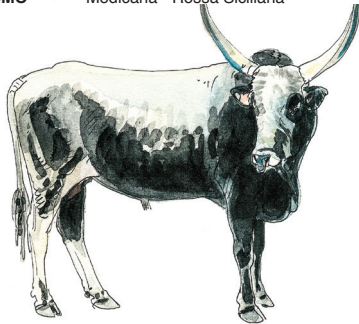
MRN Morucha Variedad Negra



CHI Chianina



SMO Modicana - Rossa Siciliana



SPO Slavonian Podolian

Subgroup 5A

Isolated breeds from Corsica and Sardinia

- * **COR** Corse
- * **SAR** Sarda
- * **PET** -Pettiazza

Subgroup 6A

Italian large white breeds

- :: **PIM** Piemontese
- ** **ROM** Romagnola
- ** **MOD** Modenese
- ** **CAV** Calvana
- ** **CHI** Chianina
- ≤ **PIS** Pisana
- ** **MCG** Marchigiana

Subgroup 6B

Podolian breeds from South Italy and Istria

- ** **GAR** Garfagnina
- + **PAS** Pasturina
- ** **MMA** Maremmana
- * -Maremmana primitivo
- ** **PDI** Podlica Italiana:
- * **PUG** -Pugliese
- * **CAM** -Campanina
- * **LUC** -Lucana
- * **CAL** -Calabrese
- :: **AGR** Agerolese
- ** **IST** Boskarin (Istrian)
- ** **CIN** Cinisara
- ** **MOD** Modicana:
- * -Rossa Siciliana
- * -Montanina
- * -Olivestra Modicana
- ≤ **SMO** Sardo-Modicana
- :: **PNT** Pantelleria

Subgroup 6C

Podolian Grey Steppe breeds from Eastern Europe

- ** **HGY** Hungarian Grey
- ** **SPO** Slavonian Podolian
- ** **POD** Srem Podolian
- ** **RGR** Romanian Grey
- ** **MLD** Moldavian Steppe
- ** **UGR** Ukrainian Grey

Subgroup 6D

Podolian-Illyrian breeds from the Balkans and Anatolia

- * **SPR** Spreca
- * **KOL** Kolubara
- ** **ISK** Iskar
- * **MRE** Metsovo Red
- * **KAT** Katerini
- * **SYK** Sykia
- * **THR** Thrace
- * **TGY** Anatolian Grey (Turkish Grey)

Subgroup 7B

- ‡ **MAL** Maltese Ox
see also maps 14 and 24

Group 4 breeds, see maps 8 and 11



11. The Balkan and Greece

Group 4 Grey and blond to brown breeds from France, North Italy, the Alps and the Balkans with their neighbours from Group 6

- | | | | | | | |
|---------------|------------|------------|-------------|-----------------------|---------------|-------------|
| 1 Switzerland | 4 Italy | 7 Slovakia | 10 Hungary | 13 Bosnia-Herzegovina | 15 Kosovo | 18 Bulgaria |
| 2 Germany | 5 Sardinia | 8 Ukraine | 11 Slovenia | 14 Serbia | 16 Montenegro | 19 Albania |
| 3 Austria | 6 Poland | 9 Romania | 12 Croatia | 17 Macedonia | 20 Greece | |

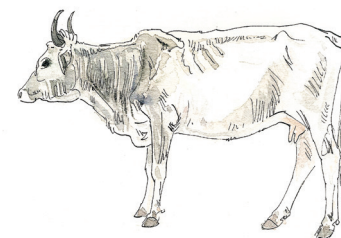
The Illyrian Shorthorn or Busha cattle are small, extremely hardy and suitable for extensive management in marginal areas.

Subgroup 4E

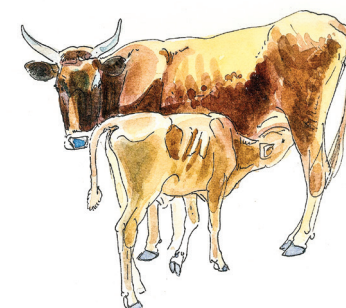
Illyrian Shorthorn breeds from the Balkan and Greece

*†	VAD	Valachian Dwarf
**	MOC	Mocanitsa
**	CRB	Croatian Busha
*		-Croatian Red
*	POB	Polim Busha
**	SRB	Serbian Busha
*	SHB	Sharri Busha
**	RMB	Red Metohijan Busha
**	MNB	Montenegro Busha
**	MKB	Macedonian Busha
**	LKB	Lekbian Busha
*	DBB	Dibra Busha
*	SKB	Shkodra Busha
**	MAB	Middle Albanian Busha
**	GUB	Gurgucka Busha
*	PRE	Prespa Dwarf
**	RHS	Rodope Shorthorn
∞	POR	Pomak Red
*	AGR	Agrinio dark
*	AGR	Agrinio white ivory
**	ACH	Acheloos
**	PES	Perdikaki shorthorn
**	MAN	Mani
*	DER	Dervenhoria
	Greek Aegean Island Shorthorns: see also map 14	
*†	AND	Ándros
**	KEA	Kea
*†	LES	Lesvos
*†	SAM	Samos dwarf
*	DOD	Dodekánisos shorthorn
*†	RHO	Rodos dwarf see map 14
*	FOL	Folégandros see map 14
*	CRE	Cretan mountain see map 14
	Illyrian and Greek Shorthorn upgraded derivatives:	
∞	SBR	Slovakian-Carpathian Brown
∞	UBR	Ukrainian-Carpathian Brown
∞	RBR	Romanian Brown
∞	DAG	Dalmatian Grey
∞	GGB	Gacko
∞	SEB	Serbian Brown
∞	DGB	Dukagjini Busha
∞	MBB	Macedonian black Busha
∞	IRO	Improved Rodope
∞	BBR	Bulgarian Brown
∞	BLE	Black Etolokarnania

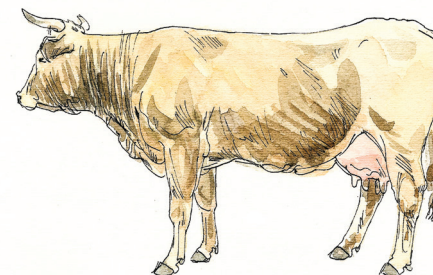
* **TZA** Kea / Tzia
 * **SVI** Svitsika
 for subgroups **4C** and **4D** see map 8 **Group 6**
 breeds, see map 10



MOC Mocanitsa



ILG Illyrian Dwarf cattle Gurgucka



SBR Slovakian-Carpathian Brown



12. Eastern Europe

Group 1 Polled and 'Celtic' breeds from North and Northwest Europe

Group 2 Lowland breeds from West, North and Eastern Europe

Group 3 Short-headed and broad-headed Highland breeds from West and Central Europe

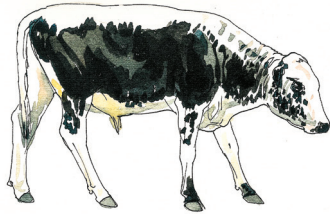
Group 4 Grey and blond to brown breeds from France, North Italy, the Alps and the Balkans

Group 6 Podolian breeds from Italy and East Europe

Group 9 Turano-Mongolian breeds

1 Russia	3 Poland	5 Slovakia	7 Moldova	8 Romania
2 Belarus	4 Ukraine	6 Hungary	Republic	9 Bulgaria

With the exception of the Petsjora, Kholmogory, Mocanitsa, Grey Steppe and Kalmyk, East European breeds are the result of crossing local cattle with imported West European breeds.



PET Petsjora



UKW Ukrainian Whiteheaded



ROS Romanian Spotted

Subgroup 1A

Polled breeds from Northern Russia

- **† PET Petsjora
- **† RKA Red Pied Kareliyan
- Subgroup 1B see also map 3

Horned dairy derivatives from Northern Russia

- ≡ AYRr Russian Ayrshire
- Subgroup 2A

Lowland red derivatives

- ≡ BER Belarus Red
- ≡ UPR Ukrainian-Polish Red
- ≡ RUK Red Ukrainian:
 - * -Donetsk
 - * -Crimean Red
 - * -Zaporiz
- ∩u Ukrainian Dairy Red
- ∩ New Red Dairy

- ≡ MER Moldovian-Estonian Red
- ≡ ROR Romanian Red
- ≡ BUR Bulgarian Red
- ≡ RRS Russian Red Steppe
- ≡ SUK Suksun

Subgroup 2B

East European Lowland pied dairy breeds and derivatives

- ≡ UKW Ukrainian Whiteheaded
- ** KHO Kholmogory
- ** YAR Yaroslavl
- ∩ BBB Belarus Black Pied
- ∩ UKB Ukrainian Black Pied
- ∩ CBP Central Russian Black Pied
- ∩ URB Ural Black Pied
- ** IST Istoben
- ** TAG Tagil:
 - * -Starotagil
 - * -Tagil-standard
 - * -Tagil-Dutch

Subgroup 2D

Shorthorn derivatives

- ** BES Bestuzhev
- ∩ SCR Scentes Red

Subgroup 3C see also map 7

Alpine shorthorned derivatives

- ∩ GOR Gorbatov Red
- ∩ YUR Yurino
- ∩ TAM Tambov Red
- ∩ PNS Pinsgow
- ≡ TRP Transylvanian Pinzgau

Subgroup 3E

see also map 7

Fleckvieh derivatives

- ∩ SYC Sychevka
- ∩ STS Steppe Simmental
- ∩ UKS Ukrainian Simmental
- ∩ \$u Ukrainian Red-and-White
- ∩ ROS Romanian Spotted
- ∩ BUS Bulgarian Simmental

Subgroup 4D

Brown Mountain derivatives

- ** KOS Kostroma
- ∩ RSW Russian Swiss
- ∩ LEB Lebedin

Subgroup 4E see also map 11

Illyrian Shorthorn breeds and upgraded derivatives

- **† VAD Valachian Dwarf
- ** MOC Mocanita
- ≡ SBR Slovakian-Carpathian Brown
- ≡ UBR Ukrainian-Carpathian Brown
- ≡ RBR Romanian Brown

Subgroup 4F

East European composites

- \$ BLS Belarus Synthetic
- \$ UBE: Ukrainian Beef:
 - * -Polesian
 - * -Volynsk
 - * -Znamensk
 - * -Southern Ukrainian

Subgroup 6C see also map 10

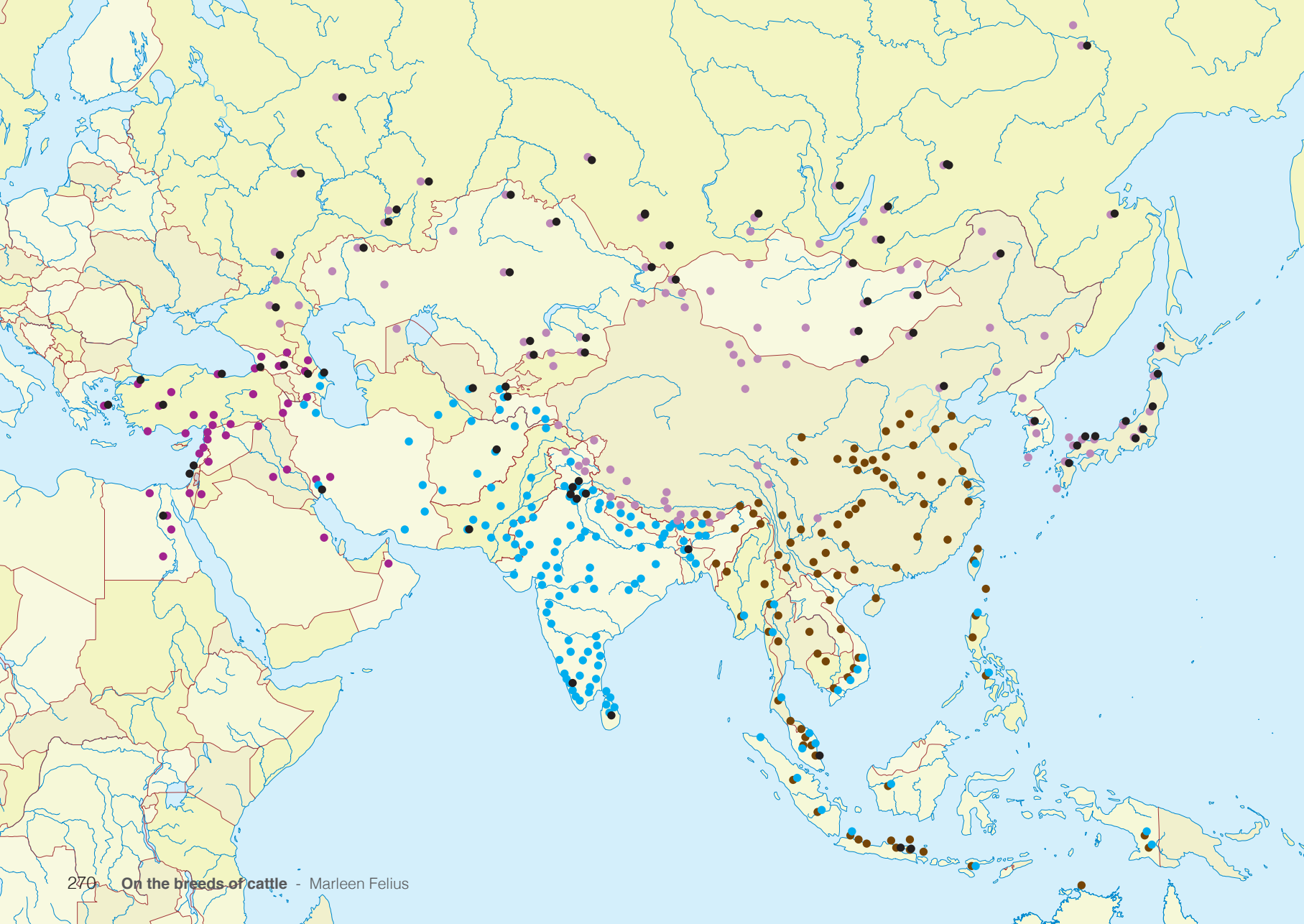
Grey Steppe breeds

- ** MLS Moldavian Steppe
- ** RGR Romanian Grey
- ** UGR Ukrainian Grey

Subgroups 9A see also map 18

Central Asian Turano-Mongolian breeds

- ** KAL [Russian] Kalmyk:
 - * -Lower Volga
 - * -North Caucasian
- * VSI Volga Simmental
- ∩ USI Ural Simmental
- \$ KUR Kurgan
- ∩ NNC New North Caucasian
- ∩ BYE Byelagolova (Kazakh Whiteheaded)



13. Overview of the Asian breed groups

- **Group 7** Shorthorned breeds from the Caucasus, Anatolia, the Levant and Egypt
- **Group 8** Indo-Pakistani type zebu breeds
- **Group 9** Turano-Mongolian breeds from Central and Northeast Asia, yak and yak-cattle hybrids
- **Group 10** Breeds from Central and South China, Southeast Asia; Bibovine cattle and their hybrids

Recent imports and crossbreds

- European / American taurine
- Asian taurine x European / American taurine
- Asian taurine x Indo-Pakistani zebu
- Indo-Pakistani zebu x European / American taurine
- Bibovine cattle x zebu
- Bibovine cattle x taurine

Asia harbors cattle with a diverse species origin. Cattle from **Group 7** are taurine with some zebu influence. **Group 8** contains the most pure zebu. **Group 9** comprises Asian taurine cattle, the Tibetan yak and their hybrids. Many humped cattle from **Group 10** are of mixed zebu/taurine origin with strong taurine introgression in central China; populations from South China, Indochina, Indonesia also have bibovine (gayal, banteng) ancestry. **Group 10** also contains the pure bibovine cattle

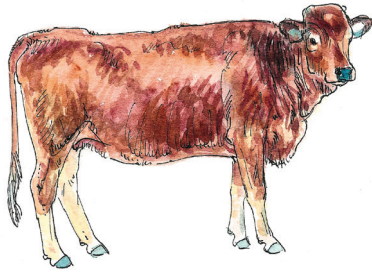


14. Southwest Asia, the Arabian Peninsula and Egypt

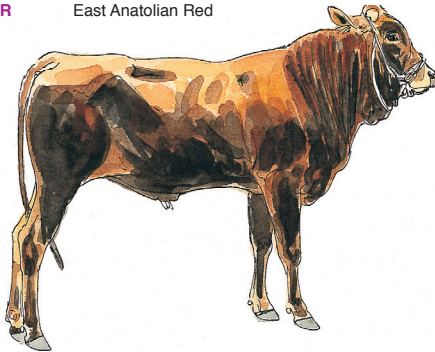
Group 7 Shorthorned breeds from the Caucasus, Anatolia, the Levant and Egypt with Greek Island Aegean cattle from **Group 4E**

- | | | | | | | | |
|------------|--------------|----------|-----------|----------|-----------|-----------------|---------|
| 1 Dagestan | 3 Azerbaijan | 5 Turkey | 7 Syria | 9 Israel | 11 Jordan | 13 Iran | 15 Oman |
| 2 Georgia | 4 Armenia | 6 Cyprus | 8 Lebanon | 10 Egypt | 12 Iraq | 14 Saudi Arabia | |

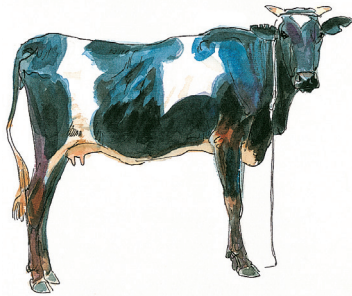
All Southwest Asian cattle are under pressure due to crossing with West European and American dairy breeds. The Israeli Holstein has been developed into a heat resistant, highly productive variety of the Holstein-Friesian.



EAR East Anatolian Red



DAM Damascus



KHA Khalit

Subgroup 7A

Humpless breeds from the Caucasus and Southwest Asia and derivatives with exotic influence

††	TBR	Turkish Brown
*		-Eskisehir Brown
*	NBL	Native Black
∞	ABP	Anatolian Black Pied
*	EAR	East Anatolian Red
☐	YPI	Yellow Pied
☐	ZAV	Zavot
**	MIR	Mingrelian Red
**	GMO	Georgian Mountain
*		-Khevsurian
☐	DMA	Dagestan Mountain
☐	CBR	Caucasian Brown
☐	ABR	Azerbaijan Brown
*	KUR	Kurdi
*	SHA	Sharabi
*	GOL	Golpayegani
✳	NEJ	Nejdi
*	BED	Bedu
*	ANA	-Anatolian
*	KLE	-Kleit
*U		-Chesi
*	JAU	Jaulan
*	LBA	Lebanese Baladi
*	OKS	Oksh
*	ARA	Arab
††	SAT	Saudi Taurine

Subgroup 4E see also map 11

Greek Aegean Island Shorthorns:

††	AND	Ándros
*	KEA	Kea
*	FOL	Folégandros
*	CRE	Cretan mountain
††	LES	Lesvos
††	SAM	Samos dwarf
*	DOD	Dodekánisos shorthorn
††	RHO	Rodos dwarf

Subgroup 7B

Damascus-type breeds from the Mediterranean islands, West Asia and Egypt and derivatives with exotic influence

**†	CYP	Cyprus
‡	MAL	Maltese Ox see maps 10 and 24
*	KAS	Kastellorizo
*	NSY	Native Southern Yellow
*	SAY	South Anatolian Yellow-Red
*		-Halep
*		-Kilis
**	DAM	Damascus
**	LEB	Lebanese
**	SAR	Sarabi
*	DIS	Dishti
*	JEN	Jenubi
☐	RUS	Rustaqi
*	HAS	Hassawi
*	OBA	Oman Baladi
		Egyptian:
*	DAI	Damietta
*	BAL	Baladi
*	MEN	Menufi
∞c	KHA	Khalit

European/American derivatives:

∞c	ISH	Israeli Holstein
∞u	ISR	Israeli Red



15. Central-West Asia

Group 8 Indo-Pakistani type zebu breeds

1 Azerbaijan 3 Turkmenistan 5 Tajikistan 7 Pakistan
 2 Iran 4 Uzbekistan 6 Afghanistan

The Azerbaijan Zebu is the most northwestern true zebu breed.

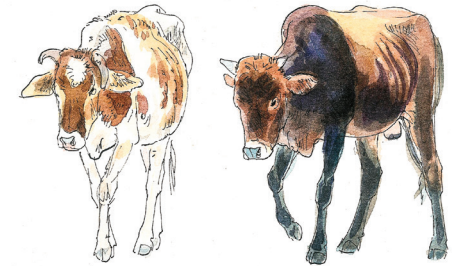
Subgroup 8A see also map 16

**Zebu and zeboid breeds from
Central-West Asia and
derivatives with exotic influence**

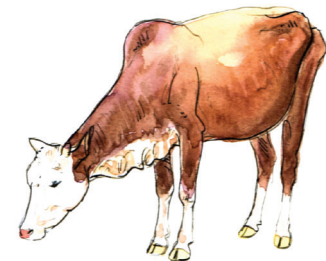
**	AZZ	Azerbaijan Zebu
▣	AZA	Azangus
**	TAL	Talishi
*	MAZ	Mazanderani
§	BUS	Bushuev
▣	SCZ	Schwyz-Zeboid
▣	TSH	TSSH-1
*	TUZ	Turkestan Zebu
*	KHU	Khurasani
*	KHZ	Khorsan Zebu
*	BAM	Bami
*	SHA	Shakhansurri
*	DAS	Dashtiani
*	SIS	Sistani
*	TAZ	Tadzhik Zeboid
*	VAT	Vatani
*	PAM	Pamir
*	ACH	Achai
**	DHA	Dhanni
*	KON	Konari
∞†	AFS	Afghan Subtropical
*	KAN	Kandahari
**	LOH	Lohani
**	ROJ	Rojhan



AZZ Azerbaijan Zebu



VAT Vatani



ACH Achai



Subgroup 8A see also map 15

Zebu breeds from Central-West Asia

**	LOH	Lohani
**	ROJ	Rojhan

Subgroup 8B

Zebu breeds with convex forehead and derivatives with taurine influence

**	SAW	Sahiwal
+	CHO	Cholistani
**†	LBE	Las Bela
**	RES	Red Sindhi
§	RAI	Rathi
▣	FRW	Frieswal
▣	JES	Jersind
▣	KSW	Karan Swiss
§	KAM	Kamaduk
**	GIR	Gir
▣	PTR	Phule Triveni
+	NIM	Nimari
*	KHA	Khamala
**	DAG	Dangi:
*		-Kalakhari
*		-Sonkheri
**	RKA	Red Kandahari
**	DEO	Deoni
*		-Deogir

Subgroup 8C

Shorthorned grey-white zebu breeds and derivative with taurine influence

**	BHA	Bhagnari
▣	NMA	Nari Master
≤	DAJ	Dajjal
**	HAR	Hariana
**	NAG	Nagori
§	RAT	Rath
+	MEW	Mewati
**	GAN	Gangatiri
+	SHH	Shahabadi
+	BAC	Bachaur
+	BIN	Binjharpuri

**	GAO	Gaolao
**	ONG	Ongole
*	DEV	Deverakota

Subgroup 8D

Zebu breeds with lyre-shaped horns and derivative with taurine influence

**	KAN	Kankrej
+	SAN	Sanchori
**	THR	Thari
**	THA	Tharparkar
§	NAR	Nari
*	HIS	Hissar / Hissari
▣	CUT	Cutchi
**	KFR	Karan Fries
**	MAL	Malvi:
*		-Saugar
**		-Umatwara
**	KHE	Kherigarh
‡	KEN	Kenkatha
	WHS	White Sindhi

Subgroup 8E

Mysore Zebu breeds from South India and Sri Lanka

**	KHI	Khillari
*	THI	Thillari
*		-Nakali Khillari
∴	DVN	Devni
*	MHA	Mhaswad
*	ATM	Atpadi Mahal
*	KVA	Krishna Valley
**	AMM	Amritmahal
**	HAL	Hallikar
**	ALA	Alambadi
**	MLM	Malaimadu
*	PUN	Punganoor
*	NAT	Naattukuttai
*	KRI	Krishnagiri
**	BAR	Bargur
+	UMB	Umbalachery
**	KGA	Kangayam

•U		-Manapari
**	PUL	Pulikulam
‡	KIN	Klnniya

Subgroup 8F

Small zebu breeds from Bangladesh, India, Sri Lanka and derivatives with taurine influence

**	SOV	Son Valley
**	RAM	Ramgarhi
‡	TAY	Taylor
**	NBE	North Bengal Grey
**	BHG	Bhagalpore
**	KHS	Khasi
**	NBG	North Bangladesh Grey
∞	PNA	Pabna
**	MDA	Madaripur
‡	RCH	Red Chittagong
**	GOO	Goomsur
*	KHA	Khariar
**	MOT	Motu
**	MGI	Malnad Gidda
**	KAD	Kasargod Dwarf
**	KUT	Kuttanbula
**	VAT	Vattakari
§	SUN	Sunandini
**	KAP	Kapila
**	VEC	Vechur
**	IDU	Iduki
‡	TAM	Tamankaduwa
**	SIN	Sinhala
‡	HAT	Hatton

Subgroup 8G see also map 17

Himalaya hill zebu breeds

**	LAD	Ladakhi
**	KUM	Kumauni
**	PON	Ponwar
**	PUR	Purnea
**	SIR	Siri



17. Himalaya region and Tibetan Highland

Group 8 Indo-Pakistani type zebu breeds

Group 9 Turano-Mongolian breeds from Central and Northeast Asia, yak and yak-cattle hybrids

Group 10 Breeds from Central and South China, Southeast Asia; Bibovine cattle and their hybrids

1 India 2 Nepal 3 Bhutan 4 Burma 5 China

Note the contrast between zebu cattle at normal altitude south of the Himalayan ridge (**Subgroup 8G**), Asian taurine cattle in Nepal and North India (**Subgroup 9A**) and yaks or yak-taurine hybrids at high altitudes (**Subgroup 9C**). The bibovine Mithun and its varieties (**Subgroup 10D**) are only found in the far northeast of India and adjoining regions of China, Bangladesh and Burma.

Subgroup 8G see also map 16

Himalaya hill zebu breeds

**	LAD	Ladakhi
**	KUM	Kumauni
**	PON	Ponwar
**	ACH	Achham
*	NHZ	Nepalese Zebu: -Nepalese Hill Zebu
*	KVZ	-Kathmandu Valley Zebu
**	MOR	Morang
**	PUR	Purnea
**	SIR	Siri
**	TRB	Trahbun
ψ		-jatsum / jatsa
ψ		-yankum / yanka
ψ		-doebum / doeb
ψ		-doethram / doethra
ψ		-datum / data
≡	KSI	Kachcha Siri
8	ASL	Assam local
::	TRA	Tarai
::	JAB	Jaba

Subgroup 9A see also map 20

Central Asian

Turano-Mongolian breeds

**	LAH	Ladakh Hill
**	LUL	Lulu
**	KIR	Kirko
**	TID	Tibetan Dwarf
**	LEP	Lepcha
**	GLE	Goleng
**	BAJ	Bajo
**	DIQ	Diqin see map 20

Subgroup 9C see also map 20

Yak and yak-cattle hybrids

**	LAY	Ladakh yak: -Feral yak -Mountain type -Plateau type
**	HIY	Himachal yak
**	NEY	Nepalese yak
**	ALY	Alpine yak
**	SIY	Sikkim yak: -Bho yak -Aho yak
*	BUY	Bhutanese yak: -haapa -herakpa
**	ARY	Arunachal yak: -Bareback type -Bisonian type -Common type -Hairy forehead type
*	TIY	Tianzhu White yak
**	QPY	Qinghai Plateau yak
**	JIY	Jiulong
**	MAY	Maiwa
Ω	YKO	yakow (mdzo / bhotey)

Subgroup 10D see also map 20 and 21

Bibovine cattle

**	MIT	Mithun (Gayal):
*	BAM	-Bami
*	ARU	-Arunachali
*	NAG	-Nagami
*	MAN	-Manipuri
*	MIZ	-Mizorami
*	DUL	-Dulong



TID Tibetan Dwarf



MAY Maiwa



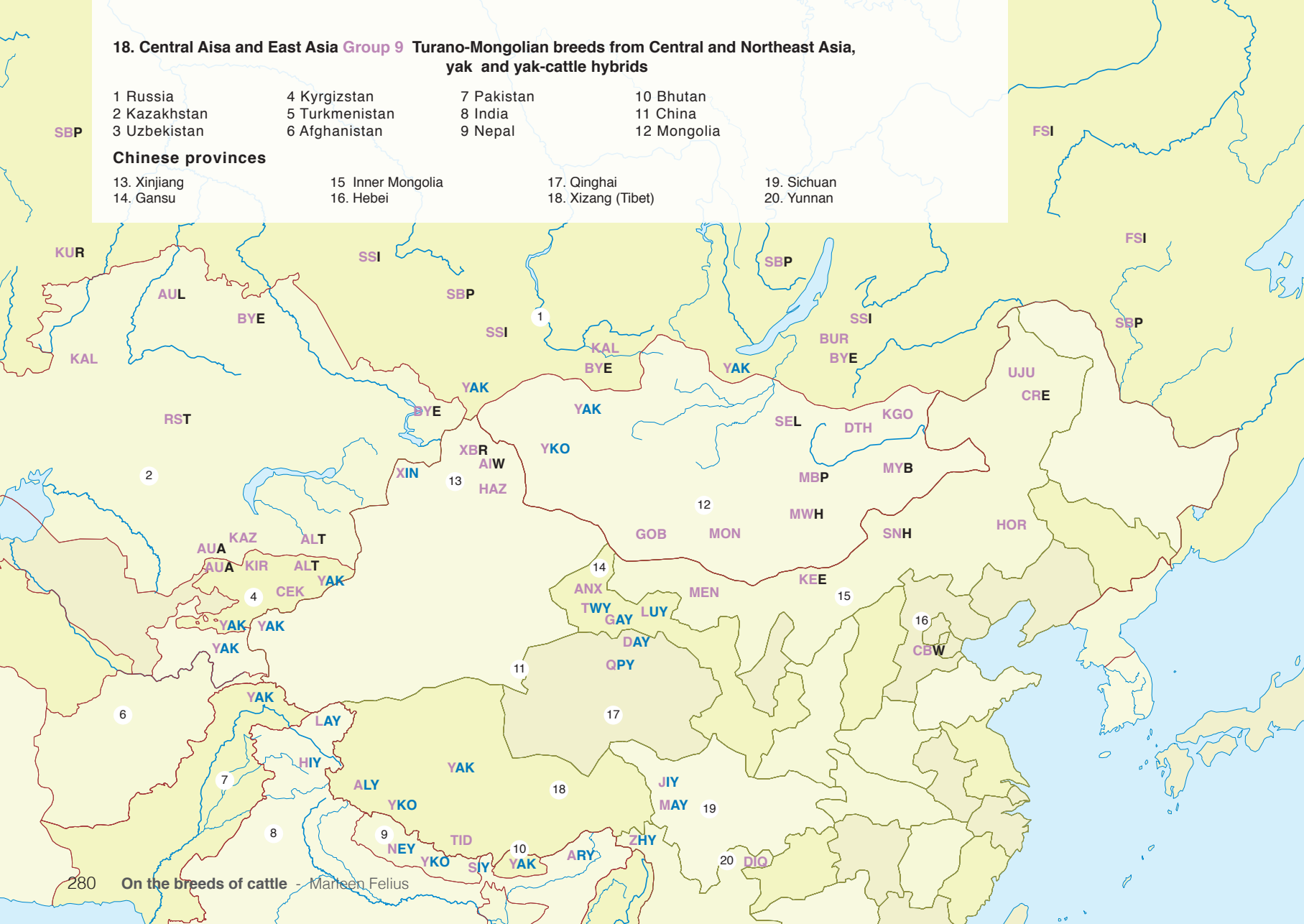
MIT Mithun

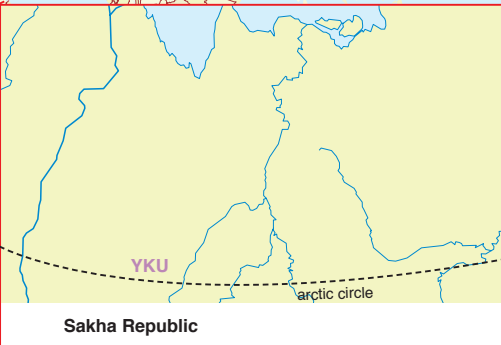
18. Central Asia and East Asia Group 9 Turano-Mongolian breeds from Central and Northeast Asia, yak and yak-cattle hybrids

- | | | | |
|--------------|----------------|------------|-------------|
| 1 Russia | 4 Kyrgyzstan | 7 Pakistan | 10 Bhutan |
| 2 Kazakhstan | 5 Turkmenistan | 8 India | 11 China |
| 3 Uzbekistan | 6 Afghanistan | 9 Nepal | 12 Mongolia |

Chinese provinces

- | | | | |
|--------------|--------------------|--------------------|-------------|
| 13. Xinjiang | 15. Inner Mongolia | 17. Qinghai | 19. Sichuan |
| 14. Gansu | 16. Hebei | 18. Xizang (Tibet) | 20. Yunnan |





Sakha Republic

Subgroup 9A see also maps 12 and 17

Central Asian Turano-Mongolian breeds

- * * YKU Yakut
- * * KAL [Russian] Kalmyk:
- * LOW -Lower Wolga
- * * * * *
- * * NOC -North Caucasus
- * * KAL Kalmyk
- * * KAR Karakalpak
- * * KAZ South Kazakh
- * * KIR North Kirgiz
- * * CEK Central Kirgiz
- * * HAZ Hazake
- * * MEN Menggu
- * * UJU -Ujumqin
- * * HOR -Horqing
- * * * * *
- * * ANX -Anxi
- * * MON Mongolian
- * * GOB -Gobi Steppe
- * * KGO -Khalkhun Golun
- * * † DTH -Dornod talyn Hevshil
- * * BUR Buryat
- * * Ψ TID Tibetan Dwarf (Lhasa)
- * * DIQ Diqin

Central Asian Turano-Mongolian upgraded derivatives with European influence from Angeln

- ⊠ RST Red Steppe
- from Black Pied:
- ∞ SBP Siberian Black Pied
- ∞ AUA Aulie-Ata
- ∞ MBP Mongolian Black Pied
- ∞ CBW Chinese Black-and-White
- ∞ KEE Keerqin
- from Shorthorn:
- \$ KUR Kurgan
- ⊠ CRE Caoyuan Red
- from Hereford:
- ⊠ BYE Byelagolova (Kazakh Whiteheaded)
- ⊠ AUL Aulieakol
- ⊠ ALW Altay Whiteheaded
- ⊠ MWH Mongolian Whiteheaded
- ⊠ SEL Selenge

from Simmental:

- ⊠ VSI Volga Simmental
- ⊠ USI Ural Simmental
- ⊠ SSI Siberian Simmental
- ⊠ FSI Far Eastern Simmental
- \$ SNH Sanhe

from Swiss-Brown:

- ∞ ALT Ala-Tau
- ⊠ XBR Xinjiang Brown
- ⊠ MYB Mongolian Yellow-Brown

from Angus and Charolais:

- ⊠ NNC New North Caucasian

Subgroup 9C see also map 17

Yak and yak-cattle hybrids

- * * YAK yak / nak
- * * XIN Xinjiang yak
- * * LAY Ladakh yak
- * * HIY Himachal yak
- * * NEY Nepalese yak
- * * ALY Alpine yak
- * * SIY Sikkim yak
- * * ARY Arunachal yak
- * * JIY Jiulong
- * * MAY Maiwa
- * * QPY Qinghai Plateau yak
- * * DAY Daton yak
- * * TWY Tianzhu White yak
- * * GAY Gannan
- * * LUY Luqu
- * * ZHY Zhongdian
- Ω YKO yakow (pien niu / hainag)





19. East Asian coast and Japan

Group 9 Turano-Mongolian breeds from Northeast Asia

1 China 2 North Korea 3 South Korea 4 Japan

Japanese islands

5. Hokkaido 6. Honshu 7. Shikoku 8. Kyushu

In Japan all breeds except the Mishima have been developed by incrossing local working cattle with imported European and American dairy and beef breeds.

Subgroup 9B

Breeds from Northeast China, Korea and Japan and derivatives with European influence

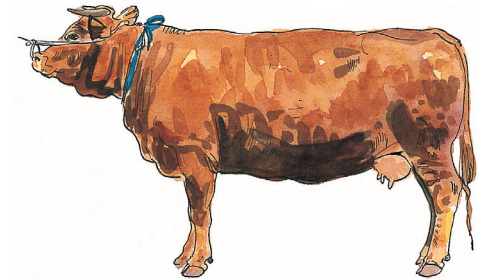
- ** **YAN** Yanbian
- ** **FUZ** Fuzhou
- ** **KNA** Korean Native
- ** **KHA** Korean Hanwoo:
 - Brown Hanwoo
 - Brindle Hanwoo (Chikso)
 - Black Hanwoo
- ** **JBL** -Jeju Black (Heugu)
- ** Japanese Brown:
 - Kochi
- ≡ **KOC** -Kumamoto
- ▣ **KUM** -Kumamoto
- ** **MIS** Mishima
- fu **Kenran**
- * **KUC** Kuchinoshima
- §c **Japanese Black:**
 - * **TAJ** -Tajima
 - * **TOT** -Tottori
 - * **SHI** -Shimane
- ∞ **JPO** Japanese Poll
- § **JSH** Japanese Shorthorn

Global breeds:

- e **SKH** [South Korean] Holstein
- e **JAH** [Japanese] Holstein-Friesian
- e **JER** [Japanese] Jersey



KNA Korean Native



KUM Japanese Brown -Kumamoto



TAJ Japanese Black -Tajima



20. Southeast Asia

Group 9 Turano-Mongolian breeds from Northeast Asia

Group 10 Breeds from Central and South China; Bibovine cattle and their hybrids

1 Bhutan 2 India 3 Birma 4 China 5 Taiwan

Chinese provinces

6. Xizang (Tibet)	9. Ganus	12. Hebei	15. Anhui	18. Zhejiang	21. Jiangxi	24. Guangdong
7. Yunnan	10. Shaanxi	13. Shandong	16. Jiangsu	19. Guizhou	22. Fujian	
8. Sichuan	11. Shanxi	14. Henan	17. Hubei	20. Hunan	23. Guangxi	

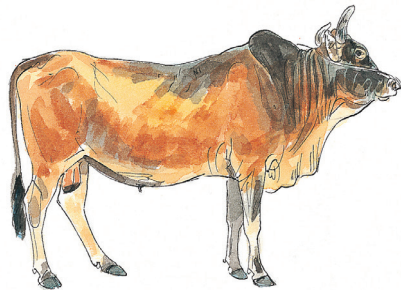
'Yellow cattle' indicates in China all cattle, which are mainly taurine in the north (**Subgroup 9A**), zebu in the south (**Subgroup 10B**) and intermediate in between (**Subgroup 10A**).



BBL Bohai Black



LON Longlin



MIN Minnan

Subgroup 9A see also maps
17 and 18

Central Asian

Turano-Mongolian breeds

- * **GLE** Goleng
- * **BAJ** Bajo
- ψ **DIQ** Diqin

Subgroup 10A

Central Chinese yellow breeds

- *† **ZAO** Zaosheng
- * **QIN** Qinchuan
- * **JYE** Jinnan Yellow
- * **PMT** Pinglu Mountain
- * **JIN** Jinan
- * **LUX** Luxi
- * **BBL** Bohai Black
- * **SZA** -Szyang
- * **TAN** -Tanyang
- * **JRE** Jiaxian Red
- * **NAN** Nanyang

Subgroup 10B

Subtropical Chinese yellow and Indo-Chinese humped breeds

- * **SAN** Sanjiang
- * **BAQ** Bashan: -Qinba
- * **BAP** -Pingli
- * **BAZ** -Xizhen
- * **BAX** -Xuanhan
- * **BAC** -Chiya
- * **BAL** -Lingnan
- * **BAM** -Miaoya
- * **ZAB** Zaobei
- * **WUE** Wuling: -Enshi
- * **WUX** -Xiangxi

- { **DAB** Dabieshan: -Dabie Mountain
- * -Huangpi
- * **WAN** Wannan
- * **GUA** Guangfeng
- * **ZHU** Zhoushan
- * **WHU** Wenling Humped
- * **ESP** Ebian Spotted
- * **DEN** Dengchuan
- * **ZHA** Zhaotong
- * **PAN** Panjiang
- * **GUL** Guanling
- * **LIP** Liping
- * **SIN** Sinan
- * **LON** Longlin
- * **WEN** Wenshan
- * **JIA** Ji'an
- * **MIN** Minnan
- * **TBL** Taiwan Black
- * **TZE** Taiwan Zebu
- * **BBL** Batanes Black see map 21
- * **HKZ** Hong Kong Zebu

Subgroup 10D see also maps 17 and 21

Bibovine cattle

- * **MIT** Mithun (Gayal):
- * **BAM** -Bami
- * **ARU** -Arunachali
- * **NAG** -Nagami
- * **MAN** -Manipuri
- * **MIZ** -Mizorami
- * **DUL** -Dulong



21. Indo-China and the Philippines

Group 10 Breeds from Southeast Asia; Bibovine cattle and their hybrids

- | | | | | |
|----------|---------|------------|------------|---------------|
| 1 China | 3 India | 5 Thailand | 7 Cambodia | 9 Philippines |
| 2 Taiwan | 4 Burma | 6 Laos | 8 Vietnam | |

In Indochina and the Philippines the swamp buffaloes outnumber cattle. Mithun (Gayal) is the domestic form of the gaur and belong together with the banteng to the Bibovine cattle (**Subgroup 10D**) found in the western part of the Indochina.

Subgroup 10B see also map 20

Subtropical Chinese yellow and Indo-Chinese humped breeds

**	MIN	Minnan
**	JIA	Ji'an
*	TBL	Taiwan Black
*	TZE	Taiwan Zebu
*	BBL	Batanas Black
**	HKZ	Hong Kong Zebu

Subgroup 10C

Tropical Indo-Chinese zebu

**	YUN	Yunnan Zebu
*	XIS	-Xishuangbanna
*	DEH	-Dehong
*		-Dali
*	HMO	Hmong
**		Leiqiong
*	LEI	Leizhou
*	HHU	Hainan Humped
ψ	BAT	Batangas
*	BUR	Burmese:
*		-Burmese Racing
*	SHA	-Shan
ψ	THI	Thai Highland
ψ	TLO	Thai Lowland
*	LAO	Laotian:
*		-Laos Yellow
*		-Ngoua
*	CAM	Cambodian:
*		-Highland Khmer
*		-Lowland Khmer
*		-Moi
*	NYE	North Vietnamese Yellow
*	CAB	-Cao Bang
*	URI	-U Riu

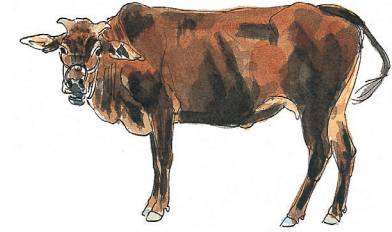
Tropical Indo-Chinese derivatives with exotic (zebu) influence

*	SYE	South Vietnamese Yellow
*	THO	-Tuy-Hoa
*	BRI	-Ba Ria
+u		-Phu Yen
*	CHB	Chaubauk:
*	KAD	-Kadonta
+u		-Pyar Sein
+u		-Pyar Phy
+u		-Kyank Phu
+u		-Shwe Ni Gyi
*	WLU	White Lumpoon
*	TFI	Thailand Fighting
*	TOZ	Tonkin Zebu
π	LAI	Laisind
ψ§	LIL	Ilocos:
*		-Large Ilocos
*		-Small Ilocos
ψ§	ILO	Iloilo

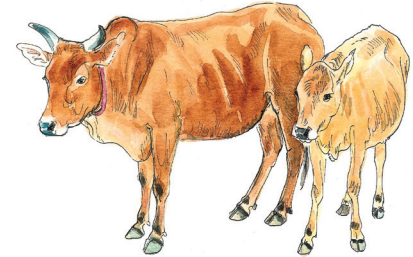
Subgroup 10D see also maps 17 and 20

Bibovine cattle and their hybrids

**	MIT	Mithun (Gayal):
*	BAM	-Bami
*	ARU	-Arunachali
*	NAG	-Nagami
*	MAN	-Manipuri
*	MIZ	-Mizorami
*	DUL	-Dulong
‡	MBA	Malay banteng
Ω	CBA	Cambodian x banteng:
+u		-Lowland Khmer x banteng
+u		-Highland Khmer x banteng



HKZ Hong Kong Zebu



URI U Riu



ILO Iloilo



22. Maritime Southeast Asia

Group10 Breeds from Southeast Asia; Bibovine cattle and their hybrids

1 Malaysia

2 Indonesia

Indonesian islands

3. Sumatra

6. Java

9. Sumba

11. Cobourg Peninsula
(Australia)

4. Kalimantan

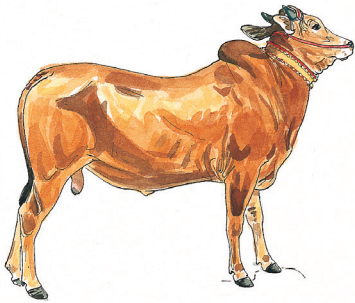
7. Madura

10. Irian Jaya

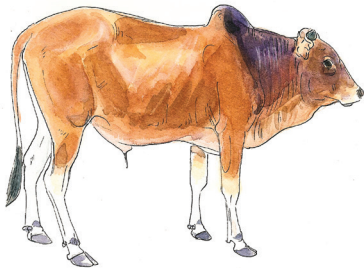
5. Sulawesi

8. Bali

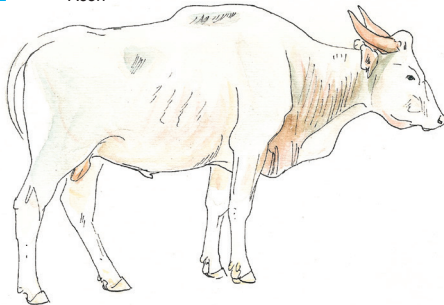
Authentic Malaysian and Indonesian breeds descend from a mixture of taurine, zebu and Bibovine cattle (**Subgroup 10C**). Since the late 19th century Indian zebus, especially the Ongole were imported and used to develop several Indonesian zebu breeds, which were initially used as draught cattle. Western taurine dairy and beef breeds are in Malaysia and Indonesia of increasing importance, both as purebred cattle and for crossbreeding. Bali cattle are domestic banteng (**Subgroup 10D**).



MAD Madurese



ACE Aceh



BAL White Bali cattle

Subgroup 10C

Malaysian and Indonesian breeds

- ** **KKE** Kedah-Kelantan
- ψ **MAD** Madurese
- ψ* -Madura karapan
- ψ* -Madura sonok
- ψ **JAV** Javanese
- ψ* **BRE** Brebes
- ψ* **GAL** Galekan
- ψ* **RAB** Rambon Banyuwangi
- ψ* Jawi Pandaan

derivatives with exotic influence from Indo-Pakistani zebu:

- ∞ **LID** Local Indian Dairy
- π **BRK** Brakmas
- e **SON** Sumba Ongole
- ψ **ACE** Aceh
- ψ **PES** Pesisir
- ψ **FON** Filial Ongole
- ψ **BZE** Borneo Zebu
- ψ **JON** Javanese Ongole
- * **JZE** Javanese Zebu
- * **MER** Merauke
- ∞ **MAF** Mafriwal
- π **CRO** Charoke

from continental European and Holstein:

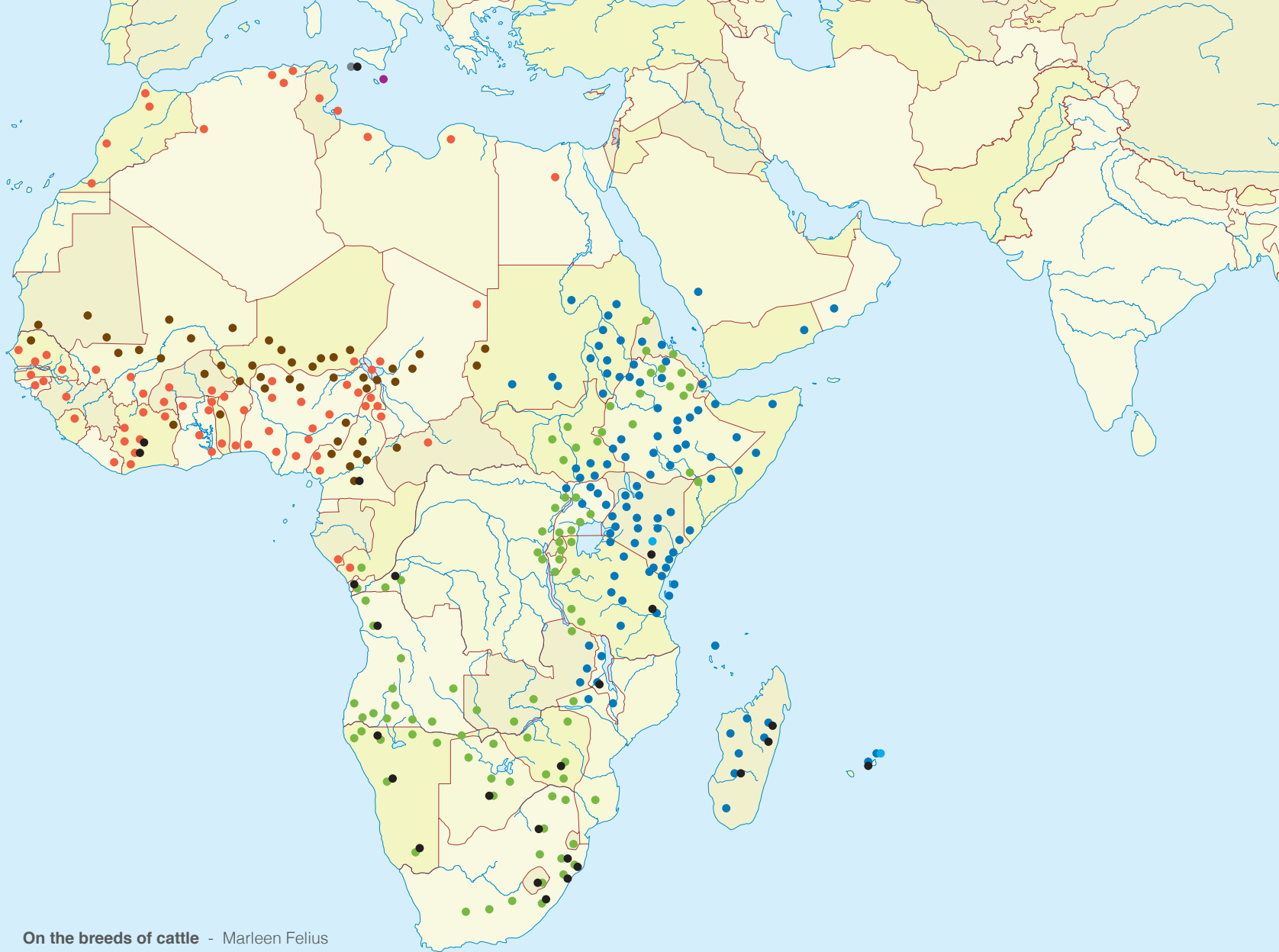
- ∞ **GRA** Grati
- e **FHR** FH red pied
- * FH red pied dual-purpose
- ∞ **MDR** Madrasin

Subgroup 10D

Bibovine cattle and their hybrids

- ** **BAL** Bali cattle
- * -White Bali cattle
- Ωu Rambon Bali
- Ωu Rambon Madura
- Ω **SEL** Selembu
- e* **CPE** banteng (Cobourg Peninsula)

see also map 38



23. Overview of the African breed groups

- **Group 11** North and West African taurine breeds
- **Group 12** West African Zebu breeds
- **Group 13** East African zebu breeds
- **Group 14** African sanga and zenga breeds

Recent imports and crossbreds

- European / American taurine
- African zebus x European / American taurine
- Indo-Pakistani zebus
- African zebus x Indo-Pakistani zebus

Note the distribution of the West African and East African zebus from **Group 12** and **Group 13**, which became dominant after the epidemic rinderpest- to which zebus are resistant - at the end of the 19th century. African zebus emerged by incrossing of zebu sires in African taurine populations and still have partial taurine ancestry. Sangas from **Group 14** are taurindicine cattle that are mainly of taurine ancestry. Until the rinderpest epidemic they were the dominant cattle in East Africa. Zebu does not occur near the West-African coasts, where the tsetse fly transmits trypanosomiasis. The authentic African taurine cattle from **Group 11** are resistant to this disease.



24. North Africa

Group 6 Podolian breed

Group 7 Shorthorned breeds from the Caucasus, Anatolia, the Levant and Egypt

Group 11 North and West African taurine breeds

1 Morocco

3 Tunisia

5 Egypt

2 Algeria

4 Libya

6 Malta (Europe)

Except the Maryuti, most Egyptian cattle (**Subgroup 7B**) are similar to the Damascus type breeds of the Levant (Southwest Asia). The cattle of the Atlas Mountains (**Subgroup 11A**) are taurines and are under pressure due to incrossing with imported dairy cattle.

∴ **Subgroup 6B**
PNT Pantelleria see also map 10

✳✳ **Subgroup 7B**
MAL Maltese Ox see also maps 10 and 14
Egyptian:
* **DAI** Damietta
* **BAL** Baladi
* **MEN** Menufi
∞c **KHA** Khaliit

Subgroup 11A

**North African Shorthorned breeds
and derivatives with exotic influence**

Moroccan Brown Atlas:

* **TID** Tidili
* **BRA** Brune de l'Atlas
✳✳ **BLO** Blonde d' Oulmès- et des Zaërs
* **NPM** Noir-Pie de Meknès

Algerian Brown Atlas:

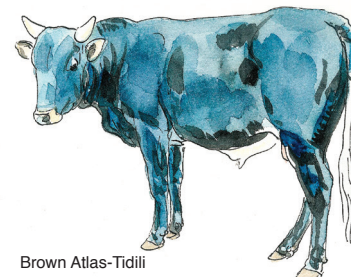
* **CHA** Chaouia
✳✳ **GUE** Guelma
* **KAB** Kabyle
* **CHE** Cheurfa

Tunisian Guelma:

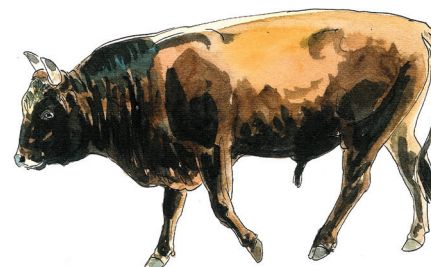
* **MOG** Mogod
* **BCB** Blonde-du Cap Bon
∞ **THI** Thibar
✳ **LIB** Libyan Shorthorn
* **MAR** Maryuti



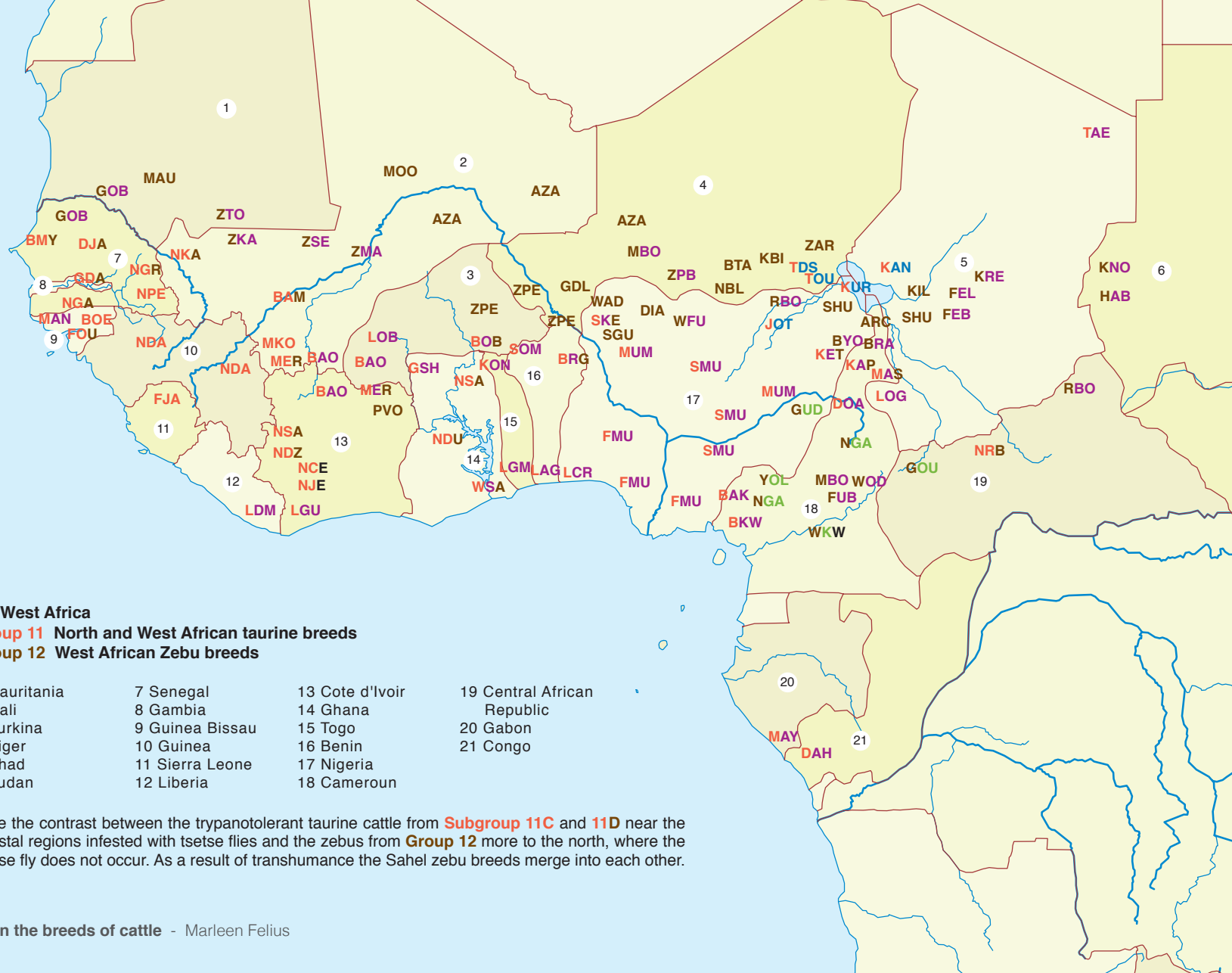
MAL Maltese Ox



TID Brown Atlas-Tidili



CHA Brown Atlas -Chaouia



25. West Africa

Group 11 North and West African taurine breeds

Group 12 West African Zebu breeds

- | | | | |
|--------------|-----------------|------------------|-----------------------------|
| 1 Mauritania | 7 Senegal | 13 Cote d'Ivoire | 19 Central African Republic |
| 2 Mali | 8 Gambia | 14 Ghana | 20 Gabon |
| 3 Burkina | 9 Guinea Bissau | 15 Togo | 21 Congo |
| 4 Niger | 10 Guinea | 16 Benin | |
| 5 Chad | 11 Sierra Leone | 17 Nigeria | |
| 6 Sudan | 12 Liberia | 18 Cameroun | |

Note the contrast between the trypanotolerant taurine cattle from **Subgroup 11C** and **11D** near the coastal regions infested with tsetse flies and the zebus from **Group 12** more to the north, where the tsetse fly does not occur. As a result of transhumance the Sahel zebu breeds merge into each other.

Subgroup 11B

Lake Chad breed and taurindicine crossbreeds

**	KUR	Kouri / Kuri
*	TDS	Taurin de Sayam
✳	JOT	Jotko
✳	TOU	Toubou
✳	KAN	Kanem

Subgroup 11C

N'Dama, taurindicine derivatives and derivatives with exotic influence

**	NDA	N'Dama
*	MKO	/ Méré Kourouni
*	NPE	/ N'Dama Petite
*	BOE	/ Boenca
*	FJA	/ Fouta Jallon
+	NGR	N'Dama Grande
*	NKA	/ N'Dama de Kaarta
*	GDA	/ Gambian N'Dama
✳	DJA	Djakoré
✳	BMY	Bambey
∞	NGA	N'Gabú / N'Gabou
✳	FOU	Foula
✳	BAM	Bambara
✳	MER	Méré Ouloosso
✳	NDZ	N'Damaza
✳	NCE	N'Damance
✳	NJE	N'Dama-Jersey
✳	NDU	Ndagu
✳	NSA	N'Dama-Sanga
✳	NRB	N'Dama-M'Bororo

Subgroup 11D

West African Shorthorn and taurine derivatives Savannah Shorthorn:

*	BAO	Baoulé
*	LOB	Lobi
*	GSH	Ghana Shorthorn
*	SOM	Somba
*	KON	/ Konkomba
*	MUM	Montane Muturu
*	SMU	Savannah Muturu
*	LOG	Logone
✳	DOA	Doayo (Namchi)
*	TAE	Taurin de l'Est

Lagune / Forest Dwarf Shorthorn:

*	MAN	Manjaca
*	LDM	Liberian Dwarf Muturu
*	LGU	Lagune
*	LAG	Lagunaire / Nigerian Dwarf Muturu
*	FMU	Forest Muturu
*	BAK	Bakosi
*	BKW	Bakweri
✳	LGM	Lagunaire grande modele
✳	LCR	Lagos Cross
††	MAY	Mayombe (Mayumbe)
††	DAH	Dahomey
	taurindicine derivatives:	
+	MER	Méré
✳	BOB	Bobori
+	WSA	White Sanga
+	BRG	Borgou / Borgu
✳	SKE	Sokoto Keteku
✳	KET	Keteku
+	KAP	Kapsiki
✳	MAS	Massa

Subgroup 12A

Shorthorned Sahel Zebu breeds

**	MAU	Maure
**	MOO	/ Moor
**	AZA	Azaouak / Adar / Touareg
**	ZAR	Zébu Arabe:
*	NBL	-Noble
*	BTA	-Batarde
*	KBI	-Kabi
*	WAD	-Wadara
*	SHU	/ Shuwa Arabe / Shuwa Arab
*	KIL	-Kilara
*	ARC	/ Arabe Choua
**	GDL	Goudali
**	SGU	/ Sokoto Gudali
**	DIA	Diali
*	ZPE	/ Zébu Peul nigérien
*	PVO	/ Zébu Peul Voltaïque

Subgroup 12B

Adamawa zebu breeds and derivative with exotic influence

**	GUD	Admawa Gudali
**	NGA	/ N'Gaoundéré Goudali
+	YOL	Yola
✳	WKW	Wakwa

Subgroup 12C

Fulani zebu breeds with long, lyre-shaped horns

**	GOB	Gobra:
*		-Gobra de Djoloff
*		-Gobra de Baol
*		-Dagana
*		Zébu Peul Sudanaïis:
*	ZTO	-Zébu Toronké
*	ZKA	-Zébu de Kaarta
*	ZSE	-Zébu Peul de Ségou
*	ZMA	-Zébu Peul de Macina
**	WFO	White Fulani
*	ZPB	/ Zébu Peul blanc
*	FEB	/ Fellata blanc
*	FUB	/ Foulbé blanc
**	RBO	Red Bororo
*	MBO	/ M'Bororo
*	KRE	/ Kréda
*	BRA	/ Brahaza
+	WOD	Wodaabe
+	BYO	Banyo Gudali
+	FEL	Fellata
+	KNO	Kanouri
**	HAB	Habbani

Subgroup 13A

Zebu breeds

from Northeast Africa

**	BAG	Baggara
*	WNB	-White Nile Baggara
*	NYB	-Nyalawi Baggara
*	HAB	-Hawazma Baggara
✱	NMZ	Nuba Mountain Zebu
*	SAI	Saidi
**	BUT	Butana:
*	DON	-Dongola
*	SHE	-Shendi
*	BAM	-Bambawa
*	HAD	-Hadendawa / El Gash
**		Kenana:
*	FKE	-Fung Kenana
*	GEZ	-Gezira
+	WNK	-White Nile Kenana
+	ING	-Ingessana
**	BAR	Barca
*	BEG	/ Begait
*	DOH	Dohin

Subgroup 13B

Small Zebus

from the Arabian Peninsula and the Horn of Africa

*	ZUF	Zufari
*	YZE	Yemeni Zebu
*	SAZ	South Arabian Zebu (Janobi)
*		Somali Shorthorned zebu:
*	BAH	Baherie
*	ADZ	Aden Zebu
*	WNZ	/ Western North Somali Zebu
*	ENZ	Eastern North Somali Zebu
*	GAS	Gasara
*	GAR	Garre
✱	MAG	Magal

Subgroup 13C see also map 27

East African

Shorthorn Zebu breeds

*	MUR	Murle
*	TOP	Toposa
*	TUR	Turkana
**	KAR	Karamajong
*		-Jie
*	OZE	Ogaden Zebu
**	AWA	Awai
**	BOR	Boran
*	HZE	Hammer Zebu
*	OBO	Orma Boran
**	KBO	Kenya Boran
✱	MZE	Masai Zebu

Subgroup 13D

Small East African Zebu breeds

Abyssinian Shorthorn Zebu:

*	ADW	Adwa
**	WOL	Wollo Highland
**	SMA	Smada
**	AMB	Ambo
*	JIJ	Jijiga Zebu
**	HRA	Harar
**	GUR	Guraghe
**	GOJ	Gojjam Highland
*	ARS	Arsi
*	BAL	Bale
*	JEM	Jem Jem Zebu
*	GOF	Gamo-Goffa:

-Gamo highland
-Gamo lowland

✱ **SHE** Sheko / Goda
* **MRS** Mursi

South Sudan Zebu:

*	BAR	Bari
*	MON	Mongalla
+	DID	Didinga
+	LAT	Latuka
*	NKE	Nkedi
*	LUG	Lugware

Teso Zebu:

✱	KYO	Kyoga
✱	USU	Usuk / Suk
✱	KIP	Kipsiki

Continued on map 27

Subgroup 14A

Northeast African sanga and zenga breeds

+	ARS	Arashie /
	BEJ	Beja
+	MED	Medenes
		Abyssinian sanga:
**	ARA	Aradó
+	IRO	Irob
+	ABE	Abergelle
**	DAN	Danakil
	AFI	/ Afar Sanga
**	RAZ	Raya-Azebó
+	FOG	Fogera
+	HOR	Horro
+	GID	Giddu
	JID	/ Jiddu

Nilotic sanga:

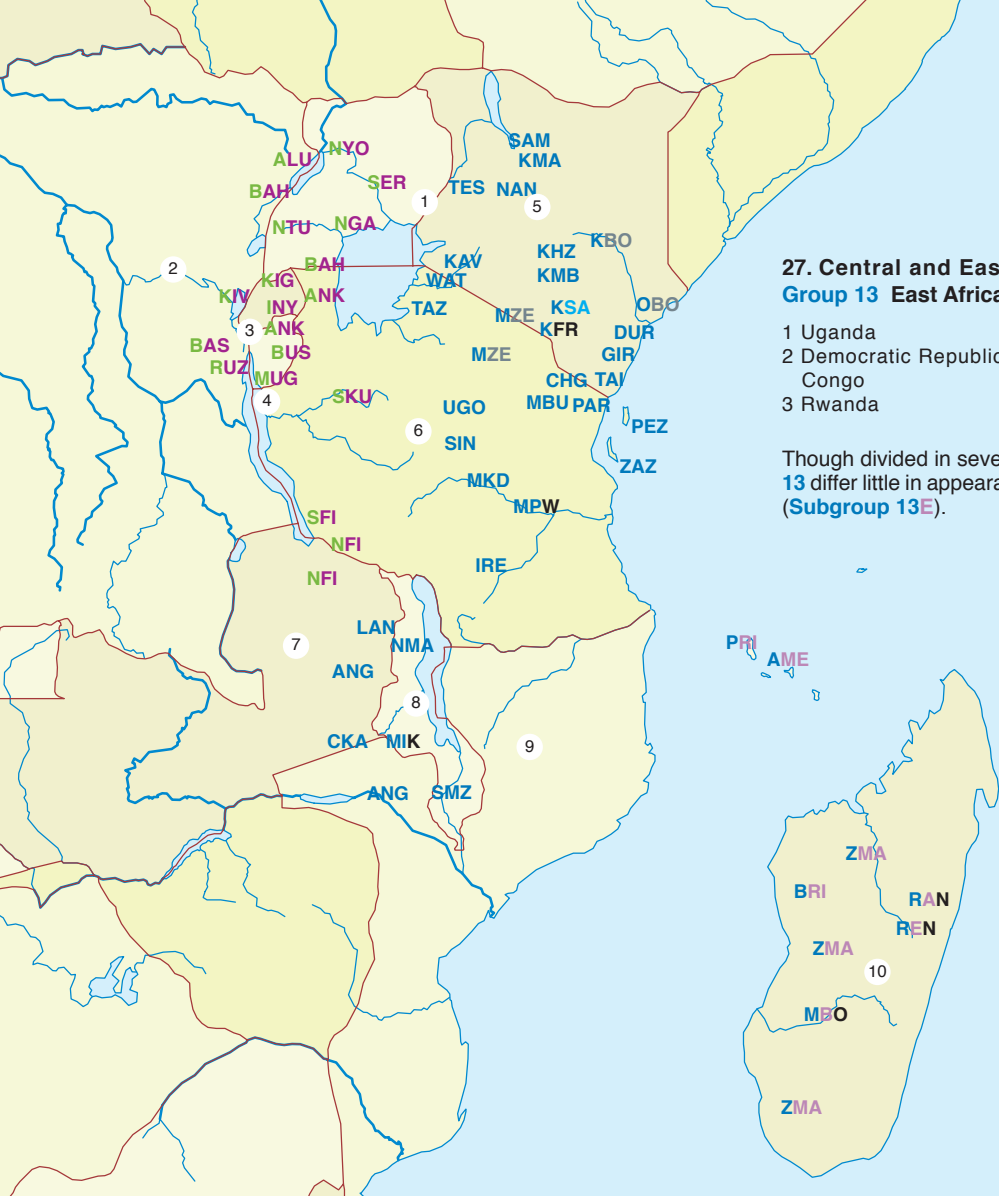
*	NUE	Nuer
+	ABI	Abigar
+	ENU	Eastern Nuer
*	SHI	Shilluk
+	AWD	Aweil Dinka
**	ADI	Aliab Dinka

Subgroup 14B

Ankole sanga and zenga breeds from Central Africa

+	ALU	Alur
+	NYO	Nyoro
+	SER	Serere
**	BAH	Bahima Ankole
*	NTU	Ntuuku
*	NGA	Nganda
**	ANK	Ankole
*	KIG	Kigezi
*	KIV	Kivu sanga
*	INY	Inyambo
*		-Ibigarama
*		-Inkuku
*	BUS	Busoni
+u		Inyaruguru
*	MUG	Mugamba
*	RUZ	Ruzizi
*	BAS	Bashi
+	SKU	Sukuma

see also map 27



27. Central and East Africa

Group 13 East African zebu breeds **Group 14** African sanga and zenga breeds

- | | | |
|--------------------------------|------------|---------------|
| 1 Uganda | 4 Burundi | 8 Malawi |
| 2 Democratic Republic of Congo | 5 Kenya | 9 Mozambique |
| 3 Rwanda | 6 Tanzania | 10 Madagascar |
| | 7 Zambia | 11 Mauritius |

Though divided in several regional groups, the Kenyan and Tanzanian zebus from **Group 13** differ little in appearance and production. The Madagascar zebus form a separate group (**Subgroup 13E**).

Subgroup 13D Continued

Small East African Zebus

Western Province Zebu:

- * **SAM** Samburu
- * **KMA** Kamasia
- * **NAN** Nandi
- * **KAV** South Kavirondo / Winam
- * **TES** Teso Zebus see also map 26
- * **WAT** Watende
- + **TAZ** Tarime Zebu

Central Kenyan Zebu:

- * **KHZ** Kikuyu Highland Zebu
- * **KMB** Kamba

Coastal Zebu:

- * **DUR** Durama
- * **GIR** Giriama
- * **TAI** Taita-Taveta

Kilimanjaro Hill Zebu:

- * **CHG** Chagga
- * **PAR** Pare
- * **MBU** Mbulu

Tanganyika Shorthorn Zebu:

- * **UGO** Ugogo
- * **SIN** Singida
- * **MKD** Mkalama Dun
- ** **IRE** Iringa Red
- * **PEZ** Pemba Zebu
- * **ZAZ** Zanzibar Zebu

Angoni Zebu:

- ** **ANG** Angoni
- * **LAN** Lundazi Angoni
- * **CKA** Chipata-Katete
- * **ANG** Angonia
- ** **ANG** Malawi Angoni:
- * **NMA** -North Malawi Angoni
- * **SMZ** -South Malawi Zebu

Global breeds and derivatives:

- ∞ **KSA** Kenya Sahiwal
- ∞ **KSA** Kenyawal
- ∞ **KFR** Kenya Friesian
- ∞ **KFR** [Kenya] Jersey
- ∞ **KFR** [Kenya] Guernsey
- ∞ **KFR** [Kenya] Ayrshire
- § **MPW** Mpwapwa
- ∞ **MIK** Mikolongwe

Subgroup 13C see also map 26

East African Shorthorn Zebu breeds

- ** **OBO** Orma Boran
- ** **KBO** Kenya Boran
- * **MZE** Masai Zebu

Subgroup 13E

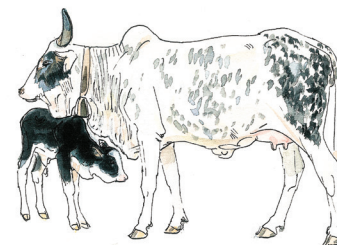
Zebu breeds from Madagascar, Mauritius and Ocean Islands and derivatives with exotic influence

- * **PRI** Primitif
- ∞ **AME** Amélioré
- ** **ZMA** Zébu Malgache
- * **BRI** Baria
- ∞ **RAN** Rana
- ∞ **REN** Renitelo
- ** **MBO** Manjan 'i Boina
- ** **MZE** Zébu de Maurice
- ** **MCR** Créole de Maurice (Ile d'Amsterdam) (Félicité)

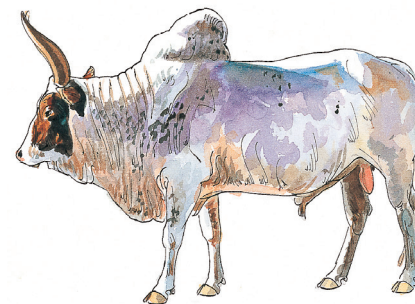
Subgroup 14B see also map 26

Ankole sanga and zenga breeds from Central Africa

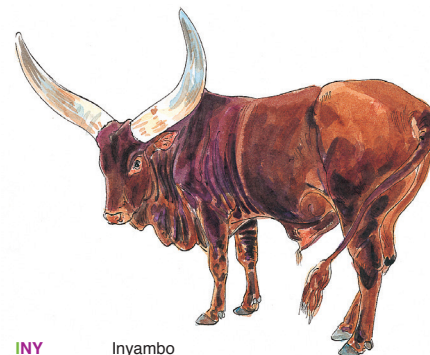
- + **ALU** Alur
- + **NYO** Nyoro
- + **SER** Serere
- ** **BAH** Bahima Ankole
- * **NTO** Ntuuku
- * **NGA** Nganda
- ** **ANK** Ankole
- * **KIG** Kigezi
- * **KIV** Kivu sanga
- ** **INY** Inyambo
- * **INY** -Ibigarama
- * **INY** -Inkuku
- * **BUS** Busoni
- * **BUS** Inyaruguru
- + **MUG** Mugamba
- * **BAS** Bashi
- * **RUZ** Ruzizi
- + **SKU** Sukuma
- + **SKU** Fipa:
- * **SFI** -Sumbawanga Fipa
- * **NFI** -Nkasi Fipa



UGO Ugogo



ZMA Zébu Malgache



INY Inyambo

Subgroup 14D

European, American and Australian international breeds in South Africa

- ⊖ Red Pied Schleswig-Holstein
- ⊖ SA Ayrshire
- ⊖ SA Dairy / Milking Shorthorn
- ⊖ SA Dairy Swiss
- ⊖ SA Dexter
- ⊖ SA Guernsey
- ⊖ SA Holstein
- ⊖ SA Jersey
- ⊖ SA Kerry
- ⊖ SA Red

taurine beef:

- ⊖ SA Aberdeen Angus
- ⊖ SA Beef Shorthorn
- ⊖ SA Braunvieh
- ⊖ SA Charolais
- ⊖ SA Chianina
- ⊖ SA Galloway
- ⊖ SA Gelbvieh
- ⊖ SA German Red
- ⊖ SA Hereford
- ⊖ SA Highland
- ⊖ SA Limousin
- ⊖ SA Marchigiana
- ⊖ SA North Devon
- ⊖ SA Pinzgauer
- ⊖ SA Red Poll
- ⊖ SA Romagnola
- ⊖ SA Salers
- ⊖ SA Senepol
- ⊖ SA Simmentaler
- ⊖ SA South Devon
- ⊖ SA Sussex
- ⊖ SA Wagyu
- ⊖ SA Weebollabolla

taurindicine beef:

- ⊖ SA Beefmaster
- ⊖ SA Brangus
- ⊖ SA Charbray
- ⊖ SA Gelbray
- ⊖ SA Santa Gertrudis
- ⊖ SA Simbrah

zebu beef:

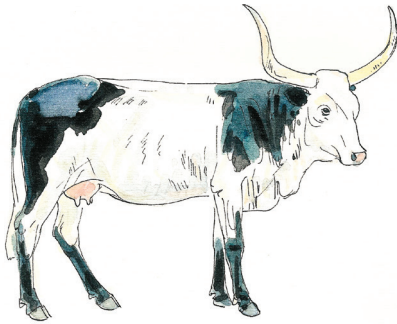
- ⊖ SA Boran
- ⊖ SA Brahman
- ⊖ SA Gir
- ⊖ Gir-Brahman

28. Southern Africa Group 14 African sanga and zenga breeds

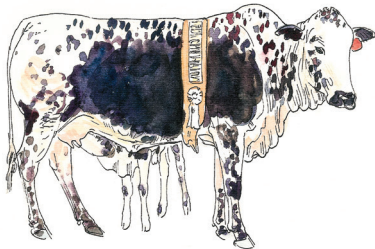
- 1 Congo
- 2 Democratic Republic of Congo
- 3 Angola
- 4 Zambia
- 5 Zimbabwe
- 6 Mozambique
- 7 Botswana
- 8 Namibia
- 9 Swasiland
- 10 Lesotho
- 11 South Africa

The cattle of southern Africa consist of sanga and zenga (=sanga-zebu intermediates) breeds (Subgroup 14C). The Afrikaner is the first to have been selectively bred into a prime beef breed. Many exotic breeds (Subgroup 14D) have been imported in South Africa, which are bred pure and are also used for crossbreeding with African breeds. Several exotic breeds are also popular in Zimbabwe, Botswana and Namibia.

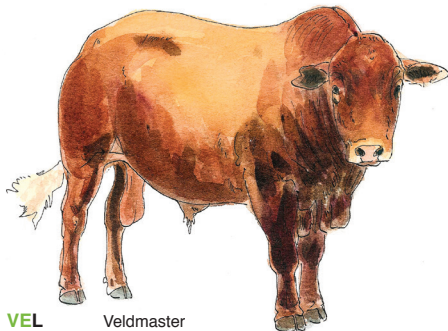




BAT Tswana -Batawana



SAN Sanganer



VEL Veldmaster

Subgroup 14C

Sanga and zenga breeds from southern Africa Angolan/Namib group:

- ** **ANG** Angolan
- * **POA** / Porto Amboim
- ** **MDM** Mocho do Malanje
- ** **MDQ** Mocho do Quitengues
- ** **CAT** Cateta
- ** **MUC** Mucubai
- ** **HUM** Humbe
- ** **MUM** Mumulla
- ** **DAM** Damara
- * **OVA** Ovambo
- * **OKA** Okavango
- * **KAO** Kaokoveld
- ** **KWA** Kwaniama
- ** **NHA** Nhaneca
- * **CAP** Caprivi sanga
- * **KAS** Kashibi

Setswana group:

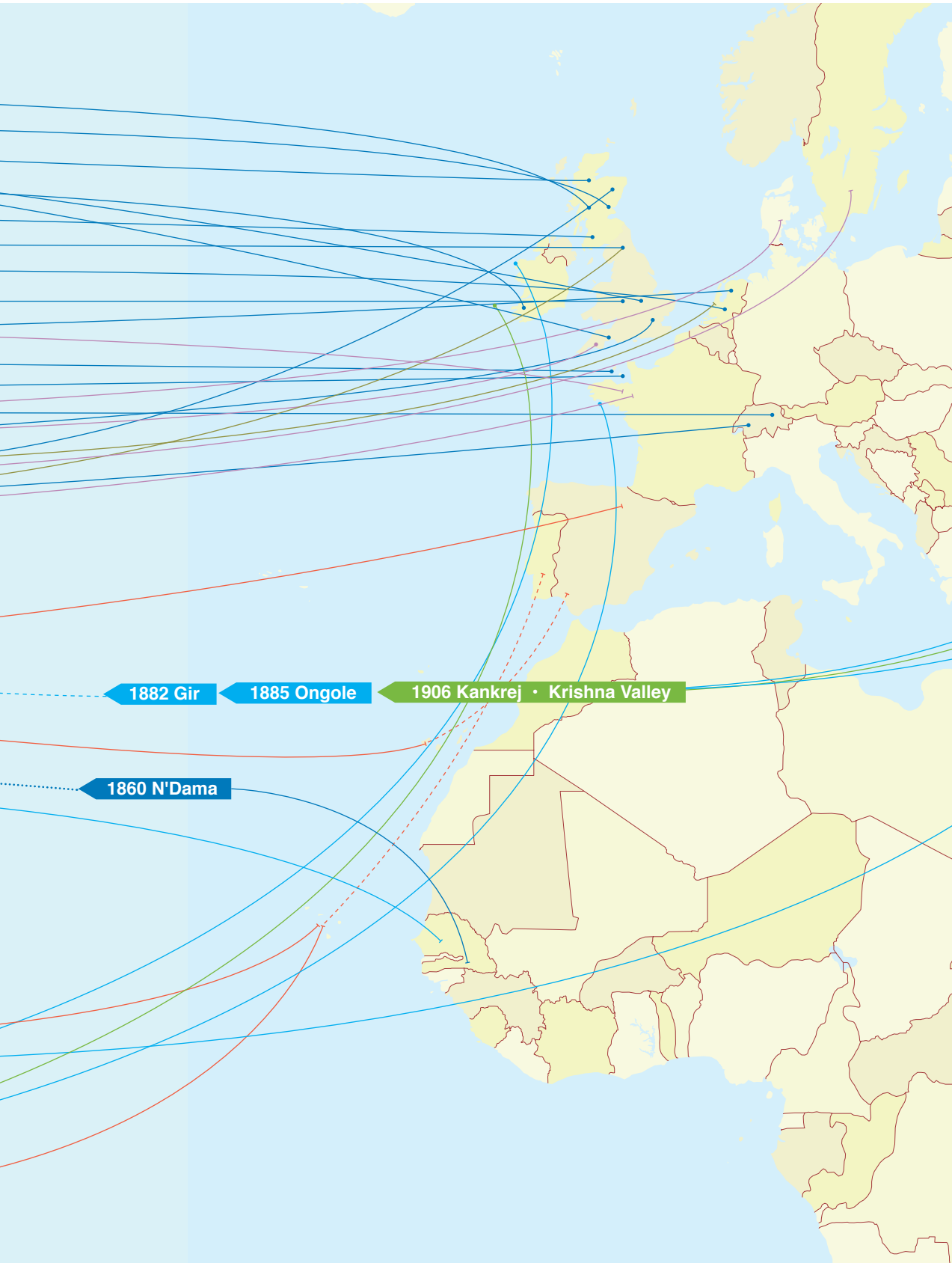
- ** **BAR** Barotse
- * **BAI** Baila
- * **TON** Tonga
- + **MAS** Mashona
- ** **NKO** Nkone
- ** **TUL** Tuli
- **OKU** Okuma
- { **Tswana (West Sana):**
- * **BAT** -Batawana
- * **SEN** -Sengologa
- * **SES** -Seshaga

East Coast cattle:

- + **BOT** Bovines da Tete
- ** **LAN** Landim
- { **NGU** Nguni
- * **BAP** -Bapedi
- * **BAP** -Shangan
- * **BAP** -Xosa
- * **RZU** -Royal Zulu herd
- **BOR** Borguni
- **SAN** Sanganer
- ** **AFR** Afrikander / Afrikaner
- * **AFR** -Yellow Afrikander
- * **AFR** -Poll Afrikander
- ** **AFR** SA Kashibi

Sanga and zenga from southern Africa, with exotic (European) influence

- \$ **MAT** Mateba
- \$ **KIS** Kisantu
- ¤ **BAC** Barra do Cuanzo
- ¤ **PIT** Pitangera
- ∞ **VEL** Veldmaster
- ¤ **HOL** Holmonger
- ¤ **NUR** Nuras
- * **NAM** Nama
- \$ **MUS** Musi
- ∞ **BOV** Bovelder
- ≡ **DRA** Drakensberger
- ∞ **BAS** Basuto
- ¤ **TAU** Tauricus
- ∞? **SYM** Symons cattle
- ¤ **BON** Bonsmara
- * **Wesselsvlei**
- * **Roodenbos**
- * **Vaalhaiz**
- * **Supertaler**
- ¤ **Huguenot**
- ¤ **Afrigus**
- ¤ **Afrisim**
- ¤ **Tulim**



- British breeds**
- South Devon 1936
 - Belted Galloway 1939
 - White Park 1940s
 - British White 1941
 - Sussex 1947
 - Welsh Black 1966
 - Lincoln Red 1966
 - Irish Friesian 1971
 - Luining 1975

- Continental European**
- Charolais 1930
 - Limousin 1968
 - Maine-Anjou 1969
 - Montbéliarde 1969
 - Blonde d'Aquitaine 1971
 - Gelbvieh 1971
 - Chianina 1971
 - Romagnola 1971
 - Salers 1972
 - Tarentaise 1972
 - Pinzgauer 1972
 - Marchigiana 1972
 - Norwegian Red 1973
 - Normande 1973
 - Piemontese 1980
 - Hérens 1980
 - Belgian White-Blue 1980
 - Abondance 1990s
 - Parthenaise 1992
 - MRY 2004

- Asian breeds**
- Red Sindhi 1946
 - Wagyu 1976

- African breeds**
- Afrikander 1931
 - Ankole-Watusi 1960
 - Tuli 1990s

- Australian breeds**
- Murray Grey 1969
 - Australian Shorthorn 1990s
 - Weebollabolla 1990s

Introduced:	AU	NZ
Shorthorn	1825	1825
Hereford	1826	18XX
Angus	1840s	1863
Ayrshire	1848	1884
Red Poll	1850s	1898
Devon	1873	1838
Dutch-Friesian	1886	1884
Holstein	1890	20th
South Devon	1890s	-
Jersey	19/20th	1862
Guernsey	19/20th	19/20th
Lincoln Red	19/20th	19/20th

- Dutch-Friesian → Holstein 1968
- Lakenvelder → Dutch Belted 1970s
- Aberdeen-Angus → Angus 1971
- Hereford 1970s
- Ayrshire 1970s
- Shorthorn → Milking Shorthorn 1975
- Swiss Brown → Brown Swiss 1976
- Guernsey 1990s
- Jersey 2008



30. Overview of the breed groups in North and South America and the Caribbea

- **Group 15** American breeds of Iberian descent
- **Group 16** Modern breeds from America, Australia and New Zealand and bovine hybrids

Imported cattle and their derivatives

- Spanish-Portuguese (late 15h to mid. 17th century)
- Northwest European (early to mid 17th century)
- Criollo / Crioulo x European / American breeds
- taurindicine: Criollo / Crioulo x Indo-Pakistani zebus
- Indo-Pakistani zebus and derivative zebu breeds
- European dairy breeds and derivatives
- taurindicine [European] dairy breeds
- British beef breeds and derivatives
- taurindicine [British] beef breeds
- Continental European beef breeds
- taurindicine [Continental European] beef breeds
- bison hybrids

Except for the North-American bison, no bovine species were endemic in the New World. Cattle imported from Europe, Africa and Asia (see Overview II) founded the breeds in the Western Hemisphere.





31. South America

Group 15 American breeds of Iberian descent

- | | | | | | | |
|-------------|-----------|-----------------|-----------|-----------|-------------|--------------|
| 1 Colombia | 3 Guiana | 5 French Guiana | 6 Brazil | 8 Peru | 10 Paraguay | 12 Uruguay |
| 2 Venezuela | 4 Surinam | | 7 Ecuador | 9 Bolivia | 11 Chili | 13 Argentina |

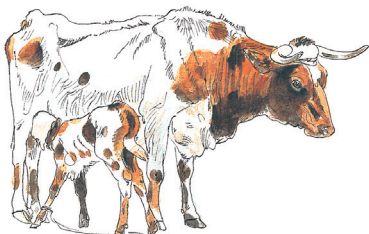
Brazilian states

- | | | | | | |
|-------------|----------------|-----------------|------------------|--------------------|-----------------------|
| 14. Piauí | 16. Pernambuco | 18. Brasilia | 20. Goiás | 22. São Paulo | 24. Rio Grande do Sul |
| 15. Paraíba | 17. Bahia | 19. Mato Grosso | 21. Minas Gerais | 23. Santa Catarina | |

Only relatively small populations of the South American Criollos, which descend from 15th and 16th century Iberian cattle, have remained pure after the 19th century imports of zebu and European cattle. In several regions Criollos are currently reevaluated for their adaptive qualities to harsh local circumstances.



BLO Blanco Orejinegro



CCO Criollo Colorado



CAC Caracú

- **u **TDL** Toro de Lidia
- .u **SCO** -Santa Coloma

Subgroup 15D
Criollo breeds of the north of South America and derivatives with exotic influence

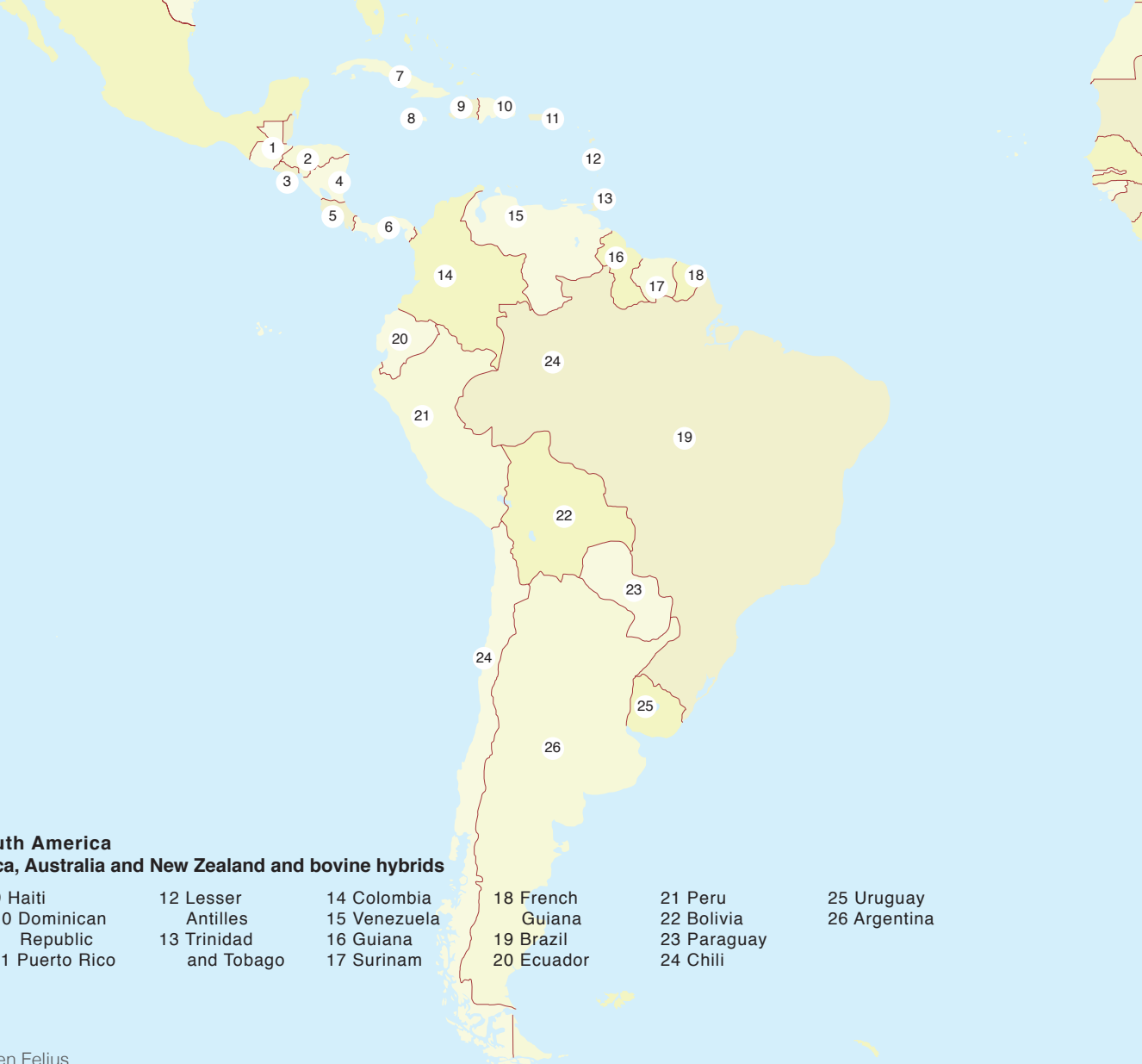
- ** **CRN** Caroreña
- ∞ **MPE** Mestizo perijanero
- ** **CCU** Costeño con Cuernos
- ** **RSI** Romosinuano
- ∞ **LVE** La Velásquez
- ** **CSA** Chino Santandereano
- ** **BLO** Blanco Orejinegro
-Blanco Orejimonó
- * **CLL** Criollo lechero Limonero
- ** **LLA** Llanero
- ** **CAS** Casanareño
- ** **SMA** San Martinero
- ** **HAR** Hartón
- ** **LUC** Lucerna
- ** **CAQ** Caqueteño
- ∞ **CGU** Créole [de Guyana]
- * **SUC** Surinam Créole
- ∞ **SMC** Surinam Mixed Criollo
- ∞ **RUP** Rupununi Criollo

Subgroup 15E
Sierra Criollo breeds from the High Andes and taurine derivatives

- * Criollo equatoriano:
- * -Criollo del Páramo
- * **CNL** -Criollo Negro Lojano
- * **CEN** -Criollo Encerado
- * **CCO** -Criollo Colorado
- * **CPI** -Criollo Pintado
- + **CHO** -Criollo de las Hoyas
- ** **CPE** Criollo peruano
- ∞ **CAL** Criollo altiplánico
- * **NAT** Ñata
- * **SER** Serrano
- ** **CRO** Criollo Costeno
- ∞ **CCH** Criollo chileno

Subgroup 15F
South American Criollo breeds of Spanish-Portuguese descent and derivatives with exotic influence

- ** **CUR** Curraleiro
- ∞ **CST** Casteado
- + **PAT** Patuá
- ‡ **MNA** Mocho Nacional
- ** **CAC** Caracú
- ∞ **CZE** Carazebú
- ** **CLD** Caldeano
- +† **JUN** Junqueiro
- ‡ **CLA** Crioulo Lageano
- ** **CMP** Crioulo Mocho Pereira Camargo
- ∞ **AQU** Aquitânica
- * **PAN** Pantaneiro
- ** **YAC** Yacumeño
- ∞ **SAA** Saavedreño
- * **VAG** Valle Grande
- **u **CCD** Criollo Cral.Díaz
- ** **CAE** Criollo Arroyos-e-Esteros
- ** **CNE** Criollo Neembucú
- ** **CHQ** Chaqueño
- ** **FRO** Fronterizo
- ** **CUR** Criollo [de Uruguay]
- ∞ **PAQ** Pampa chaqueño
- ∞ **PAM** Pampa
- * **CAP** Criollo argentino patagónico



32. The Caribbean, Central and South America

Group 16 Modern breeds from America, Australia and New Zealand and bovine hybrids

1 Guatamala	5 Costa Rica	9 Haiti	12 Lesser	14 Colombia	18 French	21 Peru	25 Uruguay
2 Honduras	6 Panama	10 Dominican	Antilles	15 Venezuela	Guiana	22 Bolivia	26 Argentina
3 El Salvador	7 Cuba	Republic	13 Trinidad	16 Guiana	19 Brazil	23 Paraguay	
4 Nigaragua	8 Jamaica	11 Puerto Rico	and Tobago	17 Surinam	20 Ecuador	24 Chili	

Most important global and international breeds in Central and South America and in the Caribbean, imported and local derivative

Taurine dairy and dual-purpose:

Ayrshire
Danish Red
Frisona / Overo negro europeo / Holandês
Guernsey
Holstein-Friesian
Holandês Variedad Mosa Rhino-e-Issel
Jersey
Montbéliarde
Normande / Normando
-Normando mocho
Overo Colorado
-Clavel de Carne
Suizo Americano / Pardo Suíço
(Brown Swiss)
Red Holstein

Taurindicine dairy:

Australian Milking Zebu
Girolando / Gyrholando
Mestizo-Holstein
New Zealand Taurindicus

British origin beef:

Aberdeen Angus colorado
Angus
Devon
Galloway
Hereford
Lincoln Red
Luining
Red Poll
Shorthorn
South Devon
Sussex

Continental origin beef:

Blonde d'Aquitaine / Rubio de aquitania
Charolês
-Charolês mocho
Chianina
Fleckvieh
Gelbvieh
Limousin
Marchigiana
Suizo Europeo / Pardo Suíço Corte
Piemontês
Pinzgauer
Salers
Simmental / Simental
Tarentaise

Taurindicine beef:

Beefmaster
Braford / Herebu
Brangus / Brangus-Ibagé
-Red Brangus / Brangus vermelho
Droughtmaster
Santa Gertrudis

Zebu dairy and beef:

Brahman
Gir
Gyr lechero
Guzerá
Indubrasil
Nelore
Red Sindhi / Sindi
Sahiwal



33. East and South Brazil, Bolivia and Northern Argentina

Group 16 Modern breeds from America, Australia and New Zealand and bovine hybrids

1 Brazil 2 Bolivia 3 Argentina

Brazilian states

4. Paraíba 6. Rodônia 8. Goiás 10. São Paulo
 5. Bahia 7. Mato Grosso 9. Minas Gerais 11. Rio Grande do Sul

Though many zebu and taurindicine breeds are being developed in Brazil, the Nelore is by far the most important beef zebu and the Gir the most important dairy zebu, whereas Girolando's crossbreeds are the prime dairy cattle of the subtropical zone.

Subgroup 16-1B

Taurindicine dairy and dual-purpose breeds
British-French breeds x zebu:

▣	PIL	Pitalanda
▣	PIT	Pitanqueiras
fu		Jerdi
fu		Normanzu
Holstein x zebu:		
▣	GRO	Girolando
∞C	GRO	Girolando
f	SRO	Sinderolando
▣	RIP	Riopardense
fu		Nelorando
▣u		Guzolando
▣	GZO	Guzerolando
▣	XIN	Xingu
▣u		Santa Mariana
∞	MHO	Mestizo-Holstein
∞	MLB	Mestiço leiteiro brasileiro
Alpine breeds x zebu:		
▣	ITA	Itapetinga
▣	LAV	Lavinia
fu		Subu
fu		Gipardo
∞u		Jaguanês

Subgroup 16-2Ab

Taurindicine beef breeds mainly descending
from British breeds

▣	HBU	Herebu
▣	PBR	Pampiano-Braford
§	SCL	Santa Clara
▣	BRI	Brangus-Ibagé
▣u		Bravon (brasileiro)
§	RNO	Red Norte
▣u		Natura

Subgroup 16-2B

Taurine beef breed descending from
Continental European breeds

▣	LIA	Limangus
---	------------	----------

Subgroup 16-2Bb

Taurindicine beef breeds mainly descending from
Continental European breeds French breeds x zebu:

▣	CNC	Canchim
*		-Canchim mocho
fu		Charonel
▣u		Charbray (brasileiro)
▣	INS	Indusin
▣u		Branor
Alpine breeds x zebu:		
▣u		Simbrasil
▣	SBC	Simbrasil-Cariri
Italian breeds x zebu:		
▣u		Caiuá
fu		Chianel
▣	SUI	Suiá
▣	PIE	Piemonel
European breeds x zebu:		
§u		Bos certus
∞u		Montana

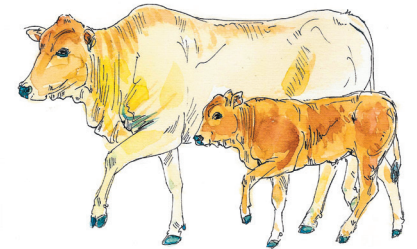
Subgroup 16-2C

Brazilian zebu breeds and derivatives

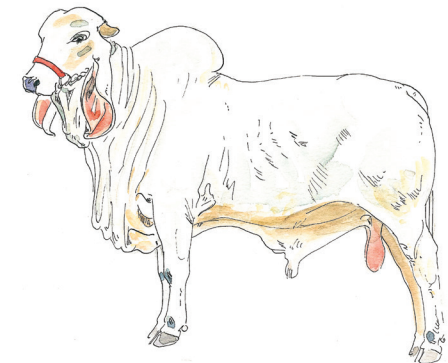
**	GUZ	Guzerá
*		-Guzerá leiteiro
*		-Guzerá mocho
f	GUN	Guzonel
**	NEL	Nelore
*		-Nelore mocho leiteiro
*		-Nelore vermelho
*		-Nelore pintado em preto
*		-Nelore em branco
▣	TAB	Tabapuá
▣	TNL	Tabanel
**	GIR	Gir brasileiro
*		-Gir leiteiro
*		-Gir leiteiro mocho
*	ZLU	Zebú leiteiro de Uberaba
fu		Gironel / Nelogir
fu		Girindu
fu		Indunel
▣	IND	Indubrasil
*		-Rojo Indubrasil
∞		Brahman (American Brahman)
e		Kangayam brasileiro
e		Sindi



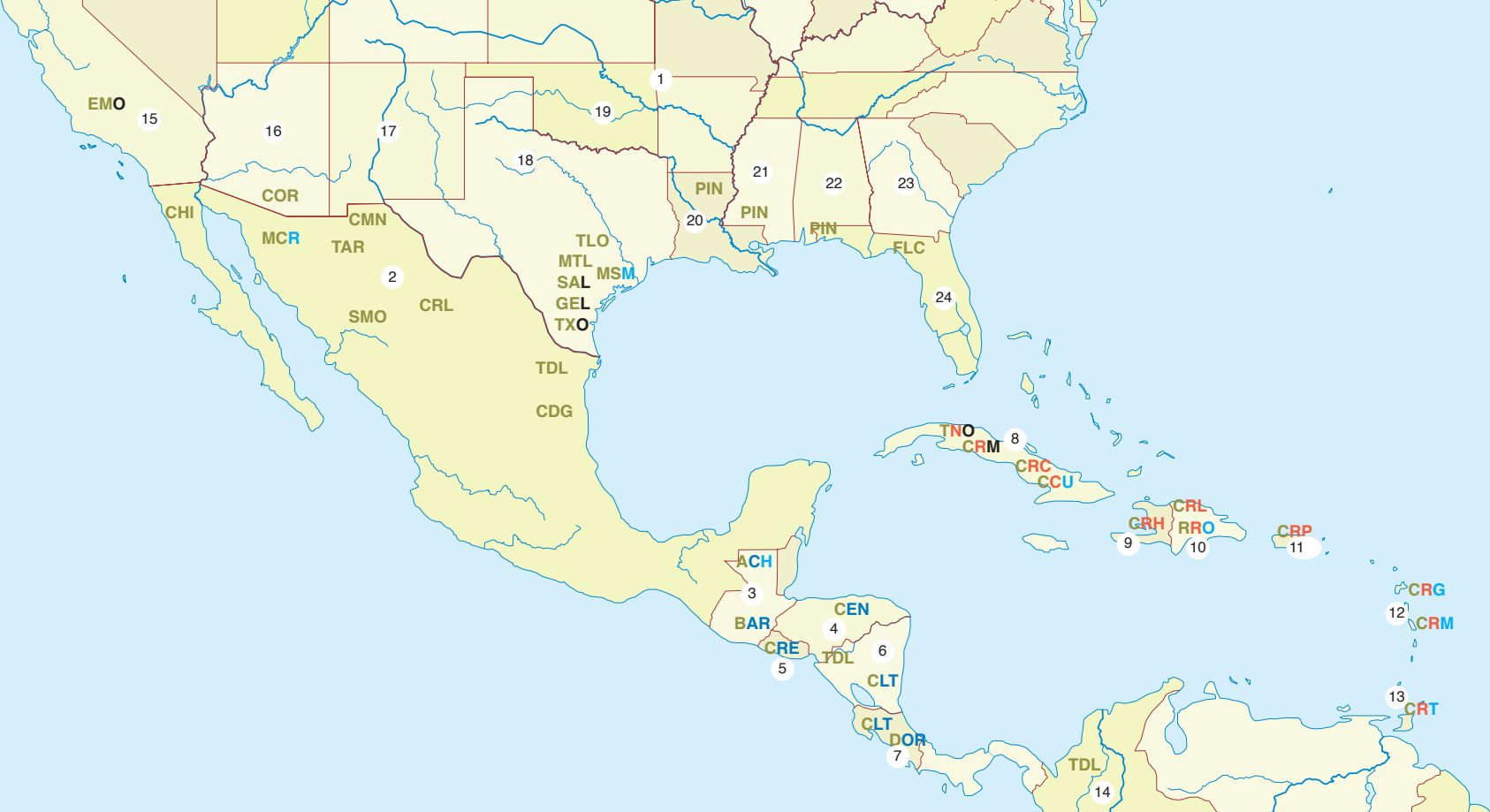
GRO Girolando



PIE Piemonel



IND Indubrasil



34. Southern States of N. America, Central America, the Caribbean and N.W. South America

Group 15 American breeds of Iberian descent Breed codes are placed in the state where the breed was developed

- | | | | | |
|----------------------------|---------------|--------------|-----------------------|------------------------|
| 1 United States of America | 4 Honduras | 7 Costa Rica | 10 Dominican Republic | 13 Trinidad and Tobago |
| 2 Mexico | 5 El Salvador | 8 Cuba | 11 Puerto Rico | 14 Colombia |
| 3 Guatemala | 6 Nicaragua | 9 Haiti | 12 Lesser Antilles | |

American States

- | | | | | |
|----------------|----------------|---------------|-----------------|-------------|
| 15. California | 17. New Mexico | 19. Oklahoma | 21. Mississippi | 23. Georgia |
| 16. Arizona | 18. Texas | 20. Louisiana | 22. Alabama | 24. Florida |

Following a rapid decline since the late 19th century, the Texas Longhorn was revived after the mid-20th century, as were Gulf Coast cattle of which many varieties have been inventoried (**Subgroup 15A**). Criollo cattle in the Caribbean (**Subgroup 15B**) and Central America (**Subgroup 15C**) are declining.

Subgroup 15A

Texas Longhorn, Gulf Coast cattle, Mexican Criollos and derivatives

**	TLO	Texas Longhorn (Longhorn)
*	MTL	-Miniature Texas Longhorn
*	MSM	Miniature Spanish Las Manchas
□	SAL	Salorn
□	GEL	Geltex
□	TXO	Texon
□?	EMO	El Monterey
**	PIN	Pineywoods
*		-Ladnier herd
*		-Ladner herd
*		-Baylis herd
*		-Palmer Dunn herd
*		-Diamond herd
*		-Agricola herd
*		-Vice herd
**†	FLC	Florida Cracker
*		-Ezell herd
*		-Neal herd
*		-Guinea dwarf
§	COR	Corriente
**	CHI	Chinampo (Criollo del desierto de Baja California)
*	CMN	Criollo de las montañas del Norte
*	TAR	Tarahuma
*	SMO	Criollo de la Sierra Madre Occidental
*	CDG	Criollo del Golfo
∩	CRL	Criollo Lechero
∞	MCR	Criollo mexicano (Hawaiian wild)
∞		(Hawaiian wild)
**u	TDL	Toro de Lidia
*		-Santa Coloma

Subgroup 15B

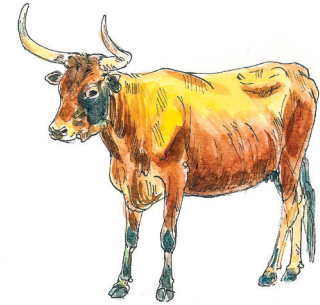
Caribbean Criollo breeds, and derivatives with exotic influence

**	CRC	Criollo Cubano
*		-Tinema
∞	CCU	Cebú Cubano
□	TNO	Taino de Cuba
□	CRM	Crimousin
*	CRH	Créole [de Haití]
**	CRL	Criollo Lechero
∩	RRO	Romano Rojo
†	CRP	Créole [de Puerto Rico]
∩	CRG	Créole de Guadeloupe
∩	CRM	Créole de la Martinique
∩	CRT	Trinidad Criollo

Subgroup 15C

Central American Criollo breeds and derivatives with exotic influence

∩	ACH	Achiote
**	BAR	Barroso
**	CEN	Criollo encastado (Chino)
**	CRE	Criollo [de El Salvador]
{	CLT	Criollo lechero tropical
∩	DOR	Doran



FLC Florida Cracker



CRG Créole de Guadeloupe



CLT Criollo Lechero Tropical



35. North America and the Caribbean: Group 16

Modern breeds from America, Australia and New Zealand and bovine hybrids

Breed codes are placed in the state where the breed has been developed

1 Canada:

2. Britisch
Columbia

3. Alberta

4. Saskatchewan

5. Ontario

6. Quibec

7 USA:

8. Washington

9. California

10. Montana

11. Wyoming

12. Colorado

13. Arizona

14. New Mexico

15. North Dakota

16. South Dakota

17. Nebraska

18. Oklahoma

19. Texas

20. Iowa

21. Vermont

22. Main

23. Florida

24. St Croix

25. Cuba

26. Jamaica

Subgroup 16-1A
Authentic American breeds
 ** **GI** Graham Island
 ** **CAN** Canadienne
 ** **RLI** Randall Lineback
 ∞c Lineback:
 * -American G
 * -Colorsided
 ** **MDE** Milking Devon

Subgroup 16-1B
Dairy and dual-purpose breeds
of European descent British origin:
 ** Milking Shorthorn
 * -Polled Milking Shorthorn
 ** [American] Ayrshire
 ** [American] Guernsey
 ** [American] Jersey
 * -Polled Jersey
 * -Guinea Jersey
 e [American] Kerry

Dutch origin:
 ** Dutch Belted
 ** Holstein
 * -Polled Holstein
 * -Red Holstein
 e MRY

Continental European origin:
 ** Brown Swiss
 ** Suizo Pardo
 e [American] Normande
 e [American] Norwegian Red
 □ **DSY** Dairy Synthetic

Subgroup 16-1Bb
Taurindicine dairy breeds
Jersey / Guernsey x zebu:
 □ **JHO** Jamaica Hope
Holstein x zebu:
 □ **SBO** Siboney
 □ **MAM** Mambi de Cuba
 □ **CAR** Caribe de Cuba
 f **BRS** Brahmanstein
Red Poll x zebu:
 ?u **RJA** Rojo Jamaicaano
TRO Troleche

Subgroup 16-2A
Beef breeds descending
from British breeds
 ** Beef Devon
 * -Poll Devon
 ** [Americ.] Beef Shorthorn
 * -Mini Durham
 * / Mini Shorthorn
 * -Polled Shorthorn
 ** [American] Hereford
 * -Line One Hereford
 * -Miniature Hereford
 ** Polled Hereford
 * -American Black Hereford
 ** Angus
 * -Mini Angus
 * -Red Angus
 ** [American] Red Poll
 ** [American] Galloway
 * -American White Galloway
 * -Miniature Galloway
 e [American] Belted Galloway
 ** [American] Highland
 * -Mini Highland
 ** [American] Sussex
 e [American] Luig
 e Ancient White Park
 e Mini Dexter
 e [American] Kerry
 e [American] South Devon
 e [American] Welsh Black
 e Beef Friesian

British beef breed derivatives:
 □ (Makaweli) [Hawai]
 □ **HCO** Hays Converter
 □ **BID** Better Idea
 □ **REG** Regus
 □ **AME** Amerifax
 □ **RX3** RX3
 □ **SPC** Speckled Park
 □ **SEN** Senepol
 □u American White Park
 □ **MBE** Mini Belfair / Mini Belmont
 § **BMA** Beef Machine
 § **PWE** Pee Wee
 § **BUL** BueLingo
 § **HCR** Hash Cross
 ∞ **AMB** Mini American Beltie

∞ **MHM** Happy Mountain
 ∞? **MAG** Magnum
 f Black Baldie
 f Mini Black Baldie
 f **HOG** Holgus
 f **OKI** Okie
 f **SEA** Senagus

Subgroup 16-2B
Beef breeds descending from
Continental European
or Asian taurine breeds
French origin:
 e [American] Charolais
 * -Polled Charolais
 * -Black Charolais
 * -Red Charolais
 e [American] Limousin
 * -Black-Polled Limousin
 * [American] Maine-Anjou
 e [Americ.] Blonde d'Aquitaine
 e [American] Salers
 * -Black-Polled Salers
 e [American] Tarentaise
 e [American] Parthenaise
 e [American] Bazadaise

Alpine origin:
 e Simmental
 * -Black-Polled Simmental
 e [American] Herens
 e [American] Braunvieh
 e Beef Brown Swiss
 e [American] Gelbvieh
 e -Black-Polled Gelbvieh
 * [American] Pinzgauer
 e

Italian origin:
 * [American] Chianina
 * -Black-Polled Chianina
 e [American] Romagnola
 e Marky
 e [American] Piedmontese

Belgian origin:
 e [American] Belgian Blue

Japanese origin:
 e [American] Wagyu
 f Wangus

European and Asian taurine
beef breed derivatives:
French origin:
 □ **CSW** Char-Swiss
 □ **BRW** Burwash
 □ **FCR** Fort Cross
 □u M4 (Heyster)
 □ **KIN** Kinsella
 □ **BLM** Black Maine-Anjou
 □u MainTainer
 § **MAI** MARC I
 § **BSY** Beef Synthetic
 § **CUH** Cuprem Hybrid
 § **CAH** Cash
 f **RFI** Range Fire
 f **CHW** Charwiss
 fu Lim-Flex
 fu Salerford

Alpine origin:
 ∞ **MAI** MARC II-III
 ∞ **BAL** Balancer
 fu Pinzbrau

Italian origin:
 □ **CIA** Chiangus
 □u Chimaine
 □u Chiford
 □ **RMK** Romark
 □u RomAngus

Mixed:
 □ **BEE** Beefbooster:
 □ -M2
 □ -M3
 □ -M4
 □ -TX
 § **SHA** Shaver
 § **RMA** Range Maker
 §? **BMX** Black Maximizer

Subgroup 16-3A
Bovine hybrids
 ψ **CAT** Cattalo
 ψ **BFL** Beefalo
 ψ **SML** Simmalo
 ψ **ABR** American Breed
 ψ **HYM** Hybridmaster
 Ωu Yakmac



36. North America, the Caribbean and N.W. South America
Group 16: Modern breeds from America, Australia, New Zealand and bovine hybrid
 (Breed codes are placed in the state where the breed has been developed)

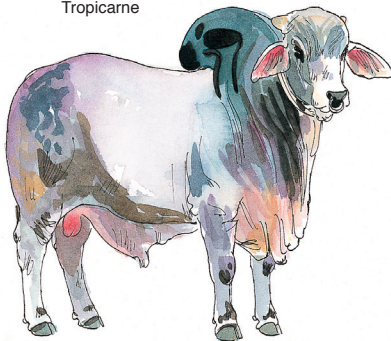
- | | | | |
|---------------|---------------|------------|--------------|
| 1 USA: | 7. Texas | | |
| 2. California | 8. Oklahoma | | |
| 3. Arizona | 9. Missouri | | |
| 4. Colorado | 10. Louisiana | | |
| 5. Wyoming | 11. Alabama | | |
| 6. Nebraska | 12. Florida | | |
| 13 Mexico | 14 Cuba | 15 Jamaica | 16 Venezuela |



RBR Angus/Brangus Plus



TRC Tropicarne



BRA Brahman

Subgroup 16-2Ab
American taurindicine beef breeds
mainly descending from British breeds

- ▣ **SGE** Santa Gertrudis
- * -Polled Santa Gertrudis
- f **BRH** Brahorn
- ▣ **SCR** Santa Cruz
- ▣ **BEE** Beefmaster
- * -Poll Beefmaster
- * **BRF** Braford
- ▣ **VIC** Victoria
- f **NFO** Nelorford
- ▣ **BRN** Brangus
- * -Mini Brangus
- ▣ **JBL** Jamaice Black
- ▣ **RBR** Red Brangus
- * -Angus/Brangus Plus
- ▣ **AFR** Africangus
- ▣ **SAB** Sabre
- ▣ **BRV** Bravon
- ▣ South Bravon
- § **BAR** Barzona
- § **SPO** South Poll
- § **HOT** Hotlander
- Ranger:
- § **RHE** -Ritchie herd
- § **WHE** -Watson herd

Subgroup 16-2Bb
American taurindicine beef breeds mainly
descending from Continental European
breeds

French breeds x zebu:

- ▣ **CBR** Charbray
- ▣ **CCU** Chacuba
- ▣ **CFO** Charford
- ▣ Brah-Maine
- ▣ Brahmousin
- ▣ **BRO** Bravado
- ▣ **BRL** Bralers
- ▣ **BNO** Branor
- § **BFM** Beefmaker
- § **TRC** Tropicarne

Alpine breeds x zebu:

- ▣ **Simbrah**
- ▣ **SBF** Simbrangerford
- ▣ Gelbray /
- ▣ **GBR** Gelbra
- ▣ **NLI** Noble Line
- ▣ **BRS** Bra-Swiss /
- ▣ **SBU** Suiz-Bu

Mixed:

- ∞ **Rodeo bucking stock**
- ∞ **Little Rowdy**
- ∞ **Sundog**

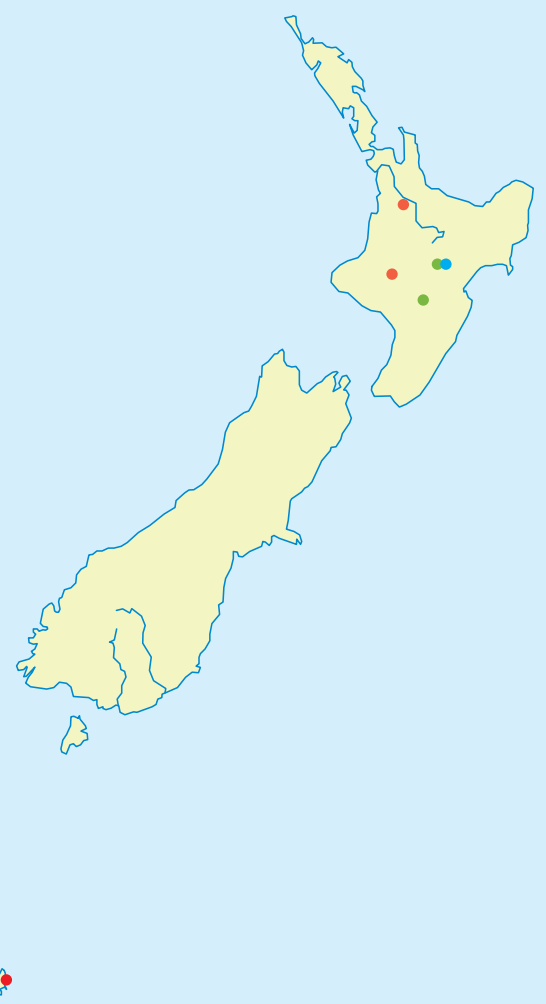
Subgroup 16-2C

American zebu and sanga breeds
zebu:

- e [American] Red Sindhi
- ▣ **CBL** Cebú lechero
- ▣ **CVE** Cebú Venezolano
- § **BRJ** Brahman Jamaicano
- § **BRA** Brahman
- * -Grey Brahman
- * -Red Brahman
- * **BZE** Bonsai Zebu
- ∞ **MZE** Miniature Zebu
- ∞ **BIM** Bos indicus miniature

sanga:

- eu **Ankole-Watusi**

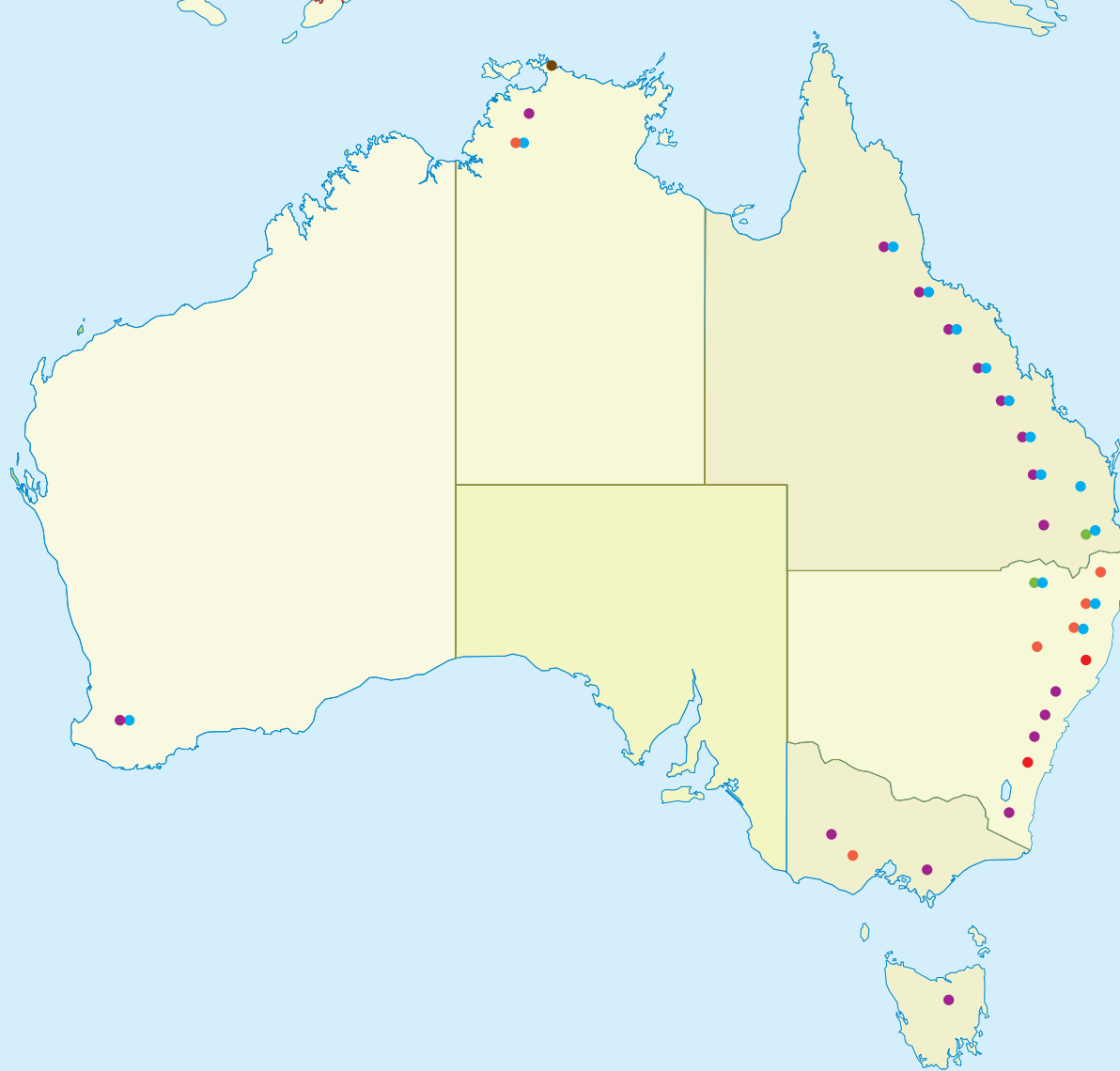


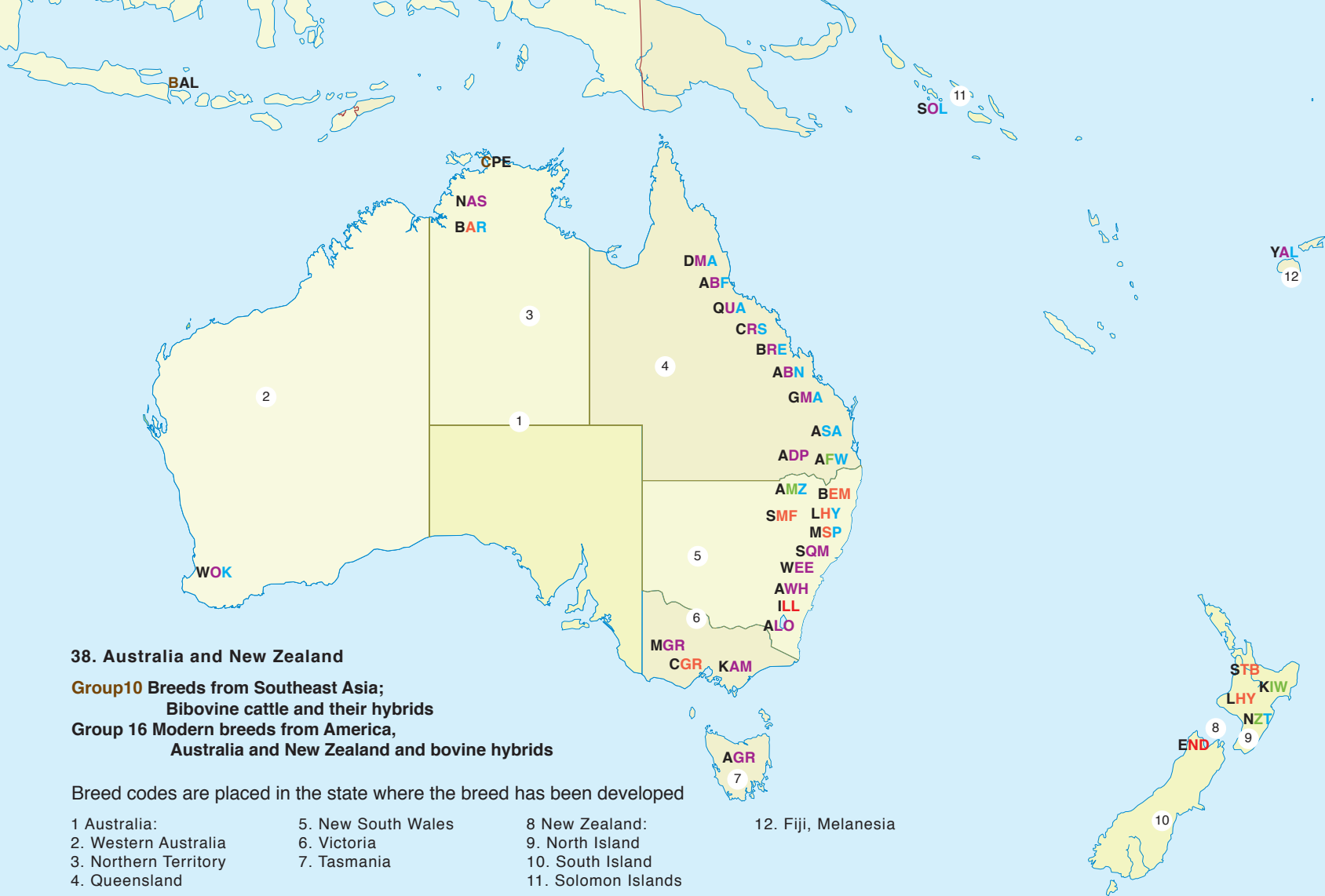
37. Overview of the breed groups in Australia and New Zealand

- **Group 16 Modern breeds from America, Australia and New Zealand and bovine hybrids**

Imported cattle and derived breeds

- European cattle, 19th-early 20th century import
- European dairy breed derivatives
- taurindicine (European) dairy
- British beef breeds and derivatives
- taurindicine (British) beef
- Continental European beef breeds and derivatives
- taurindicine (European Continental) beef
- Indo-Pakistani zebu breed
- feral bibovine cattle





Subgroup 16-1A
Authentic Australian and New Zealand breeds

* ILL Illawarra
 *† END Enderby Island cattle
 *‡ END Enderby Island

Subgroup 16-1B
Dairy and dual-purpose breeds of European descent

⊖ [Australian] Jersey
 ⊖ New Zealand Jersey
 ⊖ [Australian] Guernsey
 ⊖ [Australian] Holstein-Friesian
 ** New Zealand Friesian
 ⊖ Dutch Shorthorn (MRY)
 ⊖ [N.Z.] Hinterwald
 ∞u Australian Commercial Dairy Cow
 ∞u Australian Red Dairy
 fc **KIW** Kiwi

Taurindicine dairy breeds:

⊖ **AMZ** Australian Milking Zebu
 ⊖ **AFW** Australian Frieswal
 ∞ **NZT** New Zealand Taurindicus

Subgroup 16-2A
Australian beef breeds descending from British breeds and derivatives

** **NAS** Australian Shorthorn:
 -North Australian Shorthorn
 * -Australian Beef Shorthorn
 * -Australian Poll Shorthorn
 * **WEE** -Weebollabolla
 * [Australian] Devon
 ** [Australian] Hereford
 ** [Australian] Lincoln Red
 ** [Australian] Angus
 ⊖ **ALO** -Australian Lowline
 * -Aussie Black
 * -[Australian] Red Angus
 * -Red Line
 * **MGR** Murray Grey
 ⊖ -Paymaster
 * **SQM** Square Meaters
 * **AGR** Australian Grey
 ⊖ -Aussie Miniature Grey
 * **KAM** Khyrhet Australian Miniature Cattle
 ∞ **ADP** Adapteur
 ue [Australian] Polled Hereford

⊖ [Australian] Galloway
 ⊖ -Miniature Galloway
 * [Australian] White Galloway
 ⊖ **AWH** Australian White
 ⊖ [Australian] Belted Galloway
 ⊖ [Australian] Luining
 ⊖ [Australian] South Devon
 ⊖ [Australian] Welsh Black
 ⊖ [Australian] Sussex
 ⊖ Mini Dexter

New Zealand beef breeds descending from British breeds and derivatives

[N.Z.] Beef Shorthorn
 [N.Z.] Hereford
 [N.Z.] Red Poll
 [N.Z.] Lincoln Red
 [N.Z.] Aberdeen-Angus
 [N.Z.] Angus
 [N.Z.] Galloway
 [N.Z.] White Galloway
 [N.Z.] Highland
 * -Mini Highland
 [N.Z.] Devon
 * -Poll Devon
 ⊖ [N.Z.] Welsh Black

Subgroup 16-2B
Australian and New Zealand beef breeds descending from Continental European or Asian breeds and derivatives

French origin:

⊖ [Australian] Charolais
 ⊖ **CGR** Chargrey
 ⊖ [Australian] Limousin
 * -Australian Polled Limousin
 ⊖ [Australian] Maine-Anjou
 ⊖ [Australian] Blonde d'Aquitaine

Alpine origin:

⊖ [Australian] Gelbvieh
 ⊖ [Australian] Simmental
 ⊖ Beefmaker [Australian]
 ⊖ **SMF** Simford

Italian origin:

⊖ [Australian] Chianina
 ⊖ [Australian] Romagnola
 ⊖ [Australian] Marchigiana

Japanese origin:
 ** [Australian] Black and Red Wagyu

Mixed origin:
 ∞ **LHY** Leachman Hybrids
 ∞ **STB** Stabilizer

Subgroup 16-2Ab
Australian taurindicine beef breeds mainly descending from British breeds

⊖ **QUA** Quasah
 * **CRS** Charsar
 ⊖ **GMA** Greyman
 ⊖ **ABF** Australian Braford
 ⊖ **BRF** Belmont Red
 ⊖ **ABN** Australian Brangus
 Bramalow
 § **DMA** Droughtmaster
 § **WOK** Wokalup
 fu Sahford

Pacific Ocean island breeds:

⊖ **YAL** Yalavou
 § **SOL** Solomon Red

Subgroup 16-2Bb
Australian taurindicine beef breeds mainly descending from Continental breeds

⊖ [Australian] Charbray
 ⊖ **BAR** Barkly
 § **MSP** Mandalong Special
 ∞u **LHY** Leachman Hybrids Z
 ∞u Sundogs

Subgroup 16-2C
Australian zebu and sangha breeds

⊖ [Australian] Red Sindhi
 ⊖ **ASA** Australian Sahiwal
 ⊖ [Australian] Africander
 ⊖ [Australian] Boran
 ⊖ [Australian] Tuli
 ⊖ Australian Brahman
 ∞ Australian Nadudana

Subgroup 10D see also map 22
Bibovine cattle
 ** **BAL** Bali cattle (Indonesia)
 †i **CPE** banteng (feral Bali cattle)

Chapter 5 References and literature on cattle breed geography

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Chapter 6

On the Conservation of Cattle Genetic Resources - the Role of Breeds

Felius, M., Theunissen, B. & Lenstra, J.A. (2015) J. Agricult. Sci., 153, 152-162, adapted

On the conservation of cattle genetic resources - the role of breeds

Abstract

Focusing on cattle (*Bos taurus*, *Bos indicus*), the breed concept is discussed in the context of the dynamic history of livestock domestication. A breed categorization is proposed on the basis of how the breeds came into existence. The online Appendix presents a survey of the cattle breeds of the world consisting of (1) a list of breeds per country and then subdivided according to the proposed categories; (2) a list of breed names, including synonyms and translations, ordered according to a comprehensive breed classification; and (3) an alphabetical list of these names. The commonly accepted perceptions of breeds and how these are influenced by the nomenclature are analyzed. Considering the history of breeds, it is argued that conservation of genetic diversity does not necessarily imply conservation of breeds. However, breeds are instrumental for the conservation of genetic diversity as independent genetic management units. These considerations may very well be extrapolated to other domestic species.

Introduction

Cattle are kept for various purposes on all inhabited continents and in a large variety of environments (Epstein and Mason, 1984; Rath, 1998). This has created more subpopulations than in any other livestock species (Feliuss, 1995; Buchanan and Dolozal, 1999). These are commonly - and also in this paper - referred to as 'breeds', a term that in its broadest sense indicates populations in which reproductive matings were or are completely or partially under human control. Most breeds are bred separately from animals of the same species and share typical characteristics. Depending on the degree of organization, animals are evaluated according to standardized breeding objectives and herd books are maintained.

Breeds are generally assumed to represent unique contributions to the diversity of livestock. Monitoring diversity, the EAAP, FAO and other organizations record the breed 'unit of conservation' (Hall, 1994; FAO, 2007). Extinction of any breed is considered as an irreversible loss of genetic resources (Oldenbroek, 2007; Hiemstra et al., 2010). However, how realistic are these perceptions? Does the conservation of the diversity of cattle require the maintenance of all breeds as distinct components of the diversity of the species? The term breed needs to be clarified and at the same time put into perspective. Here the breed concept is considered in the light of the history of livestock species. Focusing on cattle, for which breed differentiation is more pronounced than for any other livestock species, the molecular-genetic studies of breed diversity are discussed and the breed categorization used by the FAO is refined. The breed is described as a social concept, including the urban legends on the origin of breeds and the role of nomenclature. We conclude that breeds do not always represent unique genetic resources. It is suggested that the breed concept can be instrumental for conservation purposes if considered as genetic management units.

Never the same

Breeds of cattle are the result of a most dynamic history from the earliest domestication to modern times (Zeuner, 1963; Ajmone-Marsan et al., 2010). After the development of agriculture about 10,000 BP in Mesopotamia and the Indus valley, domestic cattle spread over Eurasia and Africa together with sheep, goats, pigs and various crop species (Zeder et al., 2006; Groeneveld et al., 2010). In the Neolithic period this led to the establishment of sedentary pastoral societies and then to a progressive cultural development. For cattle this initiated a series of evolutionary, genetic and demographic events (Ajmone-Marsan et al., 2010), which are relevant to understand the genetic constitution of the current breeds:

- Accompanying human civilization on all inhabited continents, cattle adapted to extreme climates and agricultural environments.
- Preferential use of sires conferring favorable characteristics led to changes that diffused to surrounding cattle populations. For instance, as early as prehistoric times heat-tolerant zebu replaced taurine cattle in subtropical and tropical zones. Specialized dairy cattle developed in different European regions and spread to other regions long before the development of breeds since the 18th century (Edwards et al., 2011).
- In most regions cattle decreased in size from the Neolithic until the Middle Ages (Zeuner, 1963; Benecke, 1994) and grew again after the 15th century by the improvement of fodder crops and farming practices (Felius, 1995; Markham, 1614; Fussel, 1972; Russel, 1986)
- Local livestock populations often suffered from epidemics, famines or wars and were replaced by imports from neighboring regions (Haring et al., 1961; Armitage, 1982).
- Taurine cattle accompanied the colonization of America and Australia (Rouse, 1977). They were followed by zebu, after which new breeds emerged by mixing and further development of the imports.
- Breed formation in cattle by systematic selective breeding started in Europe in the 18th century in Great Britain with the pioneering development of the Longhorn by Robert Bakewell and of the Shorthorn by the Colling brothers (Felius, 1995; Haring et al., 1961; Armitage, 1982; Russell, 1986). Many of the present breeds originate from the 19th century. Major changes as compared to earlier breeding practices were the use of controlled inbreeding ("breeding in-and-in") and crossbreeding, the introduction of explicitly formulated breeding objectives and the documentation of pedigrees in herd books. However, this did not at all fix the genetic constitutions of breeds.
- The continuing selection of top sires, facilitated by artificial insemination since the mid-20th century, has increased productivity by the introduction of traits such as the dairy conformation of the Holstein-Friesians and the muscular hypertrophy in several beef breeds.
- Breeding objectives shift over time. For instance, mechanization of agriculture ended the selection for draught power. Dairy cattle are now selected for milk with less fat, while a new fashion prescribes a black coat color in several American beef breeds.
- From the 18th century onward, popular breeds more and more spread outside their region of origin. In the 19th century an 'anglomania' (Béranger and Vissac, 1994) led to the widespread use in Northwestern continental Europe of sires of the

British Shorthorn, the first breed for which a herd book was established. This was followed by the export of Black- and Red-Pied, Baltic Red, Ayrshire, Brown-Mountain and spotted triple-purpose cattle, several English beef breeds and in the 20th century also French beef breeds. Much more consequential was the spread in the late 20th century of the Holstein-Friesian, now the most numerous cattle breed worldwide. Such exports led to either the development of regional varieties with their own names or the establishment of cosmopolitan breeds with international exchange of breeding material.

- The cattle breeds inspired Wright (1969) to develop the seminal theory of population subdivision and inbreeding. However, genetic isolation of breeds is rarely absolute. Crossbreeding is reported in the history of most breeds, ranging from sporadic introgression of surrounding cattle to intentional upgrading with more productive breeds (Feliuss, 1995). Even most local breeds, often considered to be authentic and rustic, have multiple roots, such as the Dutch Lakenvelder breed, which was influenced by the Belted Galloway and Gurtenvieh, and the Portuguese Minhota, which is now almost identical to German Yellow cattle (Groeneveld et al., 2010).
- In spite of an intense gene flow within and across national borders, a genetic contrast still separates North- and South-European cattle (Edwards et al., 2011).
- Several European breeds were crossed with their American offspring, which by selection for productivity had acquired a modified appearance ('allopatric development', Feliuss et al., 2011) and thus differ markedly from their European ancestors. American top sires brought about profound changes in European breeds such as the Black-Pied Dutch-Friesian, Aberdeen-Angus, Hereford, Guernsey and Swiss Brown (Feliuss, 1995).
- Several successful breeds have absorbed minor neighboring local populations or a number of minor breeds were merged. For instance, the reputed French beef breed Blonde d'Aquitaine emerged as an amalgamate of several South-French local breeds (Amigues et al., 2011).
- Conversely, breeds were split into populations that are managed separately in different countries or regions. Within several breeds (e.g. Simmental) different lines were selected for different purposes (milk, beef, dual). The Dutch Burnt Red cattle have only recently been selected from MRY cattle for their dark color and are now kept as a new breed (Hiemstra et al., 2010).
- New 'synthetic' or 'composite' breeds were formed by crossbreeding of breeds of different origins. Examples are the several American and taurindicine breeds, the Heck cattle, heralded as a revival of the wild aurochs, and the modern Viking Red, that emerged from a cross of Finnish Ayrshire, Swedish Red-and-White and Danish Red.
- Several efforts to revive old breeds such as the Belgian Campine and the German Highland Red have led to 'counterfeits': cattle with reconstructed phenotypes but with only spurious links to the original population with the same name.
- Although less severely than in horses and dogs, inbreeding has narrowed the genetic basis of isolated populations. Examples are an isolated Betizu population, the Mallorquina, Menorquina (Martin-Burriel et al., 2007) and Jersey islands breeds (although less extreme, Chikhi et al., 2004), the various subpopulations of fighting cattle (Canon et al., 2008), and the genetically almost homogeneous Chillingham (Visscher et al., 2001).

In general, breeding is less advanced in the developing world where breed phenotypes are often less strictly defined and pedigrees are generally not recorded in writing. Differences between breeds are more gradual and intermediate breed types are generated by tribal migrations and nomadic movements (Joshi et al., 1957). Moreover, changes are less dynamic while a long standing adaptation to local conditions and extensive management is preserved.

Similar processes also influenced breeds of other livestock species (Groeneveld et al., 2010). Because of the demand for high-quality wool, sheep have been crossbred even more intensively than cattle with a major influence of several English breeds and the Spanish sheep all around the world (Wood and Orel, 2001; Kijas et al., 2012). In contrast, microsatellite genotyping indicates that goats have maintained a strong phylogeography (Canon et al., 2006; Nomura et al., 2012) with possibly a more complex domestication history than previously assumed (Nomura et al., 2013).

Breed differentiation in river buffalo is weak and even absent in swamp buffalo, but in the latter species a low gene flow between regions has maintained genetic differences between regions (Zhang et al., 2011; Yindee et al., 2010). Asian as well as European pigs derived from local wild boars (Larson et al., 2010). European pig breeds have been influenced by introgression of Asian domestic sows (Clop et al., 2004; Amaral et al., 2011), while production animals are often bred by crossing of parents from divergent lines (Wiseman, 1986). Several horse breeds exchange breeding sires, but there is a differentiation according to breed type and geographical origin (Van de Goor et al., 2011; Petersen et al., 2013). Breed differentiation is strongest in fancy dog breeds with typical and often unhealthy morphologies and extreme inbreeding.

What's in a breed

We consider as a breed any domestic population that is bred under some form of human reproductive management irrespective of the degree of reproductive isolation and the sharing of typical features (see the Introduction). Thus our definition does not comply with the criterion of “purebred pedigree provenance” (Alderson, 2010, http://www.globaldiv.eu/Livestock_Biodiversity_Workshop/index.html). Formal definitions are discussed by Buchanan and Dolozal (1999), Hall (2004), Woolliams and Toro (2007), FAO (2007) and Sponenberg (2011). More informal definitions such as “A breed is a breed if enough people say it is” (K. Hammond, cited in Woolliams and Toro (2007)) and “A breed is a breed if its breeders get along” (after K. Oldenbroek, personal communication) illustrate the volatility of the breed concept (see also Sponenberg, 2011).

Our survey of the history of cattle supports the notion that breeds have never been static entities. And breeds continue to change. Both highly productive and local breeds are not what they were fifty years ago; further changes are to be expected in the near future and their rate may even increase as a result of genomic selection.

Results of molecular studies are consistent with a young history of the breeds and their incomplete genetic isolation. In spite of clear differences in appearance, animals from different breeds differ only marginally more than animals belonging to the same breed (Giovambattista et al., 2001; McKay et al., 2008; Martinez et al., 2012). Within continents

there is little segregation of mitochondrial DNA haplotypes between breeds (Groeneveld et al., 2010). Breeds differ in frequencies of alleles of autosomal markers, but are certainly not an “identifiable package of specific genes” (Sponenberg, 2011).

Genetic distances between breeds indicate regional clusters of breeds, which reflect former or present gene flow between neighboring populations (Felius et al., 2011; Decker et al., 2009). These clusters either combine breeds with similar appearance (Lowland Pied dairy, Baltic-Highland Red, Central Spotted, Central Brown and Podolian cattle) or breeds with a different appearance but a common local ancestry (British, Nordic, South-French or Iberian cattle). The effects of crossbreeding and local ancestry are illustrated by the Baltic Red cluster, which contains the Eastern-European derivatives but not the Flemish Red (Felius et al., 2011).

Decrease of genetic diversity is predicted for subpopulations in which no new gene variants emerge (Wright, 1969), a trend that is supposed to be exacerbated by modern breeding methods (Taberlet et al., 2008). However, according to the theory of selection-induced genetic variation (SIGV, Eitan and Soller, 2004; Carlborg et al., 2006), adaptation to selective breeding and feeding regimes continuously changes the spectrum of alleles with new variants emerging or the frequency of rare alleles increasing. Thus, while the repertoire of gene variants keeps shifting, overall diversity and response to selection are maintained. As mentioned above, crossbreeding, often promoted by migrations (Ajmone Marsan et al., 2010) may also counteract the decrease of diversity by genetic isolation.

On the basis of data and considerations mentioned before, breeds are suggested preferably to be seen as primary units for the genetic management of livestock. The FAO DAD-IS data base (Groeneveld et al., 2010) lists 951 breed names in 47 European or West-Asian countries, including several imported populations. A distinction is made between truly ‘local’ breeds that appear in one country only, ‘regional transboundary’ breeds found in different countries, and the more widespread ‘international transboundary’ breeds (FAO, 2007). As indicated above, local breeds are not always authentic and may have multiple origins. In practice, cattle derived from imports before 1960 are often perceived as being local. In accordance with a definition originally formulated by the British Rare Breed Survival Trust (www.rbst.org.uk/watchlist-criteria.pdf), in 2011 an FAO working-group defined a breed as endemic if it had been present in a country for more than 40 years plus six generations (K. Oldenbroek, personal communication). Table 1 presents a more refined categorization of breeds on the basis of their recent history.

Table 1. Breed categories and subcategories on the basis of recent history

(Sub)category	Description	Examples
1. National or regional local breeds and their derivatives, with or without influence from imported cattle		
Landrace	Non-improved, locally adapted or feral cattle of local origin	Betisoak Prespa Dwarf Tibetan Dwarf Muturu
Authentic breed	Original, selectively bred since the 18 th or 19 th century with or without herd book, with limited or no influence of imported sires; originating from older landraces or (as in the case of American authentic breeds) historic imports; in some cases recognized outside their country of origin as imported global breed (e.g., Limousin); in other cases carrying the same name as an Americanized derivative	Hereford Jersey Limousin Telemark Ongole Hallikar Gobra
Authentic variety	Original variety of a breed (color type, breed line, polled, etc.)	Dun Galloway Fleckvieh beef Polled Limousin Gurtenvieh Witrik
Reconstructed breed or variety	Completely or almost lost breed rebred from animals with another origin	Blue Albion Bordelaise nouvelle Glan Maltese
Local derivative	Local breed derived in the 19 th century from females of local landraces or authentic breeds by incrossing exotic sires	East Flemish White-and-Red Dalmatian Grey Cika
Local crossbreds	Breeds emerged in the 19 th or 20 th century by crossbreeding of local breeds: <ul style="list-style-type: none"> • unplanned regional crossbreds • multiple composite modern breed from the 19th century, bred by using sires from several different breeds • diffuse breeds with continuous influx of neighbouring populations • breed emerged by amalgamating older local varieties and breeds 	Swona N'Dama Grande Fellata Piemontese Aosta Red Pied Yellow Franconian Massanaise Marismeña Macedonian Busha Kea Tarai Mestizo perijanero Rupununi Criollo Lineback Blonde d'Aquitaine Austrian Yellow Nguni

2. Breeds emerged by crossbreeding of cattle from different regions

Local population of international breed	Modern breed developed by crossing local females to sires of international breeds, morphologically close to the imported ancestor and maintained as purebred population; local transboundary breed; mostly dating from the 19th century.	Several Black-Pied Friesian, Fleckvieh, Brown Mountain, Shorthorn populations Pinzgavac Minhota
Composite breed	Synthetic breeds developed by planned crossbreeding of two or three non-related breeds	Uckermärker Girolando Santa Gertrudis Renitelo Bonsmara
Multiple composite breed	Breed still being developed by using both own sires and sires from parental breed Breed of multiple origin	Viking Red Borguni Piemonei Heck cattle Shaver Droughtmaster Mandalong Special Indonesian zebu breeds
Bovine composites	Breeds that emerged from crossbreeding with other species than taurine and zebu cattle	Madura Beefalo

3. Breeds and varieties that since the 20th century were imported and are bred pure with continuing genetic influx from the parental breed; established as or developing into international transboundary breeds

Global or international purebred breeds	Originating from local breed; elsewhere imported or upgraded to being at least 15/16 identical to imported; kept within continents (African, Asian, European) or on the majority inhabited continents with international exchange of breeding material	Holstein-Friesian Simmental Angus Brown Swiss Charolais Limousin British Blue American Gelbvieh Sahiwal
Americanized local breed	Breed from the first category reformed by using American stock tracing directly to the original breed	Ayrshire Dutch Black-Pied Friesian Swiss Brown Guernsey
American-European composite	European breed from first category reformed by strong infusion of an unrelated American breed and developing towards the American breed	Danish Red Pied Pie Rouge des Plaines Czech Pied Dairy Ukrainian Dairy Red
International multiple composite breed	Breed of multiple origin kept on most continents	Brahman

4. Populations maintained by crossbreeding

Continuous cross	Mix of several breeds with continuous input of parental and other breeds	Norwegian Red Montana
Terminal F1 cross	Crosses with high performance by first-generation heterosis but not used for breeding	Little Rowdy Stabilizer Bluegrass Black Baldie Nelorford
Bovine hybrid	Terminal crosses of taurine or zebu cattle with gayal, banteng, yak or bison	Selembu Yakow

This categorization is independent of the integrated and genetic classifications of cattle breeds on the basis of breed relationships (Felius et al., 2011; Buchanan and Lenstra, 2013). Four categories of breeds may be defined, which differ gradually and can each be divided in subcategories:

1. Local cattle, which originate from cattle present in the region in the 18th century or earlier and may have been influenced by cattle from other regions.
2. Cattle that emerged later by crossbreeding with cattle from other regions. Even though their genetic roots derive mainly from outside the region, there are many examples of crossbreds from the 19th century that are commonly perceived as belonging to the local heritage (Felius, 1995).
3. Highly productive imported cattle with continuing international exchange of breeding material.
4. Cattle that are still maintained by crossbreeding with breeds of other origin or with other bovine species.

For all four categories, 'modern' indicates a breed origin after the 18th century but before World War II, and 'recent' an origin after 1945. A comprehensive overview per country of the breeds from the different (sub)categories, ranging from well-known cosmopolitan breeds to local breeds not known outside their region of origin, is given in the first part of the Appendix.

Club icons

Management of a breed depends on the combined effort of cattle owners and the breeding associations. Understandably, breeders often are proud of their animals and breeding plays an important role in their social life. This makes a breed a genetic as well as a social concept: a group of animals that via the breed name confers an identity to the breeders, who share the appreciation of the breed. The perceived value of a breed is derived from its performance, but also from its role in the local tradition and from ideas about its (supposed) origin: the breed may function as an integral part of the breeders' cultural heritage. In the Dutch province of Friesland, for instance, the Black Pied Friesian breed was believed to be more than a thousand years old. The sturdy, well-rounded and reliable dual-purpose Friesian cow of the mid-20th century was referred to as 'our mother', not only because she was the source of prosperity, but also because her

characteristics reflected the farmers' view of their Friesian identity. When the dual-purpose Friesian came under attack in the 1960s for their decreasing productivity, many Friesian breeders took this as an attack on its ideology of farming and way of life (Theunissen, 2008; 2012). Hall (2004) described cultural aspects for several African and European breeds and Hiemstra et al. (2010) for European local breeds.

In particular breeders of traditional breeds tend to project the origin of their breeds into the remote past (Trow-Smith, 1959). Yet the history of breeds before the 18th century has been documented only partially or not at all. This has created room for ideas on an ancient origin, which often have been amplified into urban legends and are now perpetuated via the new web-based sources of information. To give a few examples of 'mythical breeds':

- Long-horned and long-haired Scottish Highland cattle, which are closely related to other British cattle (Edwards et al., 2011; Decker et al., 2009) are promoted to be akin to aurochs, fitting their use for 'natural' landscape management.
- Similarly, the long-horned French Salers is supposed to be derived from the aurochs depicted 17,500 BP in the Lascaux caves (Rath, 1998). This is contradicted by the arrival of domestic cattle 10,000 years later and a close genetic relationship of the present Salers to other South French breeds (Edwards et al., 2011; Decker et al., 2009; Felius et al., 2011).
- The feral Spanish Mostrenca/Marismeña from Doñana National Park is claimed to descend from primigenius cattle (Rodriguez, 2010). Yet it is known to have descended from local cattle (Sanchez Belda, 1984).
- For White Park cattle, 19th-century ideas persist on descending from animals brought by the Romans and having survived as feral cattle (Wilson, 1909; Ludwig et al., 2013). In fact, the current white herds did not exist until the 17th century (Cheese, 1979) and White Park is related to other British breeds (Decker et al., 2009).
- Similar conjectures (www.lincolnredcattlesociety.co.uk) link the Lincoln Red to cattle imported by Viking invaders, ignoring the late 18th-century development of this red cattle (Skehel, 1995).
- Speculations on an Asian (Tubbs, 1947) or African (Bangham and Blumberg, 1958) origin of Channel Island cattle have been refuted by mtDNA, microsatellite and SNP analysis (Edwards et al., 2011; Decker et al., 2009; Troy et al., 2001).
- A recent compilation of French breeds (Dervillé et al., 2009) still mentions a medieval Spanish-Arabian origin of the 19th-century amalgamate Bazadaise, Roman roots of the Tarentaise and a primigenius origin of the Camargue. In fact Bazadaise is closely related to other South-French breeds (Felius et al., 2011; Decker et al., 2009).

All these stories lack support of reliable historical documentation, but fortify the perception of the breed as a genetic resource of old origin.

On the names of cattle

Most breed names refer to a region of origin, coat color, color pattern or horn size. However, a name is not just a convenient denotation for a local kind of cattle; as indicated it evokes the inherent perceptions and feelings that its breeders associate with it.

Several breeds are essentially identical and even exchange breeding sires but carry different names. This is the case if a breed is kept by people speaking different languages such as national breeds in bilingual countries (e.g., Hérens and Eringer in Switzerland), local transboundary breeds in neighbouring countries (e.g., Spanish Berciana and Portuguese Mirandesa) or imported breeds with translated names (e.g., La Brune, Bruna Alpina and Parda de Montañá for Swiss Brown). Nevertheless, these breeds are often perceived as being different and listed separately in the FAO surveys. New names may be coined for existing breeds because of a marketing strategy ('branding': Rouge des prés in 2003 for Maine-Anjou, formerly Durham-Mancell; Istrian for the Croatian Buje since 1954) or for new amalgams (Blonde d'Aquitaine in France). Varieties that are being developed also derive their status from a new name, such as the Dutch Burnt Red (Brandrood, also Deep Red) variety of the MRY red-pied breed. Names of recent 'synthetic' breeds as Beef Machine, Beefmaker and Tropicarne leave no doubt for what purpose they have been developed.

The second part of the Appendix presents a survey of 5574 names of cattle breeds and their varieties in the local languages and in English, including the many synonyms. These names are arranged according to the integrative geographic, morphological and historic classification (Feliuss, 1995; 2011); the third part gives an alphabetical list with references.

To conserve or not

It is well recognized that the continuing replacement of traditional local cattle by highly productive international breeds may lead to a loss of the original genetic resources (Groeneveld et al., 2010). This has initiated several initiatives to compile and analyze the current state of livestock diversity. Methods developed for a rational prioritization of breeds for conservation on the basis of a set of selectively neutral genetic markers (reviewed by Boettger, 2010) did not reach the stage of practical applications (European Cattle Genetic Diversity Consortium, 2006). However, for several breeds DNA studies with neutral markers do indicate a high conservation priority (FAO, 2011):

- Breeds with a high diversity in the neutral markers are likely to have also retained adaptive variation. For instance, cattle originating from the first domestication site may have retained the diversity of the wild ancestor.
- Several Asian breeds have a unique species composition with input from banteng, gayal or yak.
- Breeds for which the molecular phylogeny (Feliuss et al., 2011) indicates a long separation from other breeds are likely to have developed unique features. For instance, Jersey from the Isle of Jersey has not been crossbred since 1789 and has a special milk composition; Siberian Yakut developed an adaptation to the cold (Granberg et al., 2009), and African N'Dama survived in West-Africa by its trypanotolerance (Joshi et al., 1957). A special case is the Chillingham cattle in which centuries of complete isolation in a small group have created an extreme degree of homozygosity, a most unique feature of considerable scientific interest (Visscher et al., 2001).

Since selectively neutral genetic markers are generally not informative about adaptation (Hall et al., 2012), an adaptive index is considered as a criterion for conservation. (Bonin et al., 2007). Unique and valuable morphological breed-specific traits are still the most

obvious arguments for conservation, even if the breeding for phenotypic distinctiveness and strict genetic isolation decrease their contribution to the molecular diversity.

However, considerations of this kind do not guide decisions about conservation for all breeds. Given the short history of many breeds and their intensive contacts, it cannot be taken for granted that each breed has retained valuable features not present in other breeds. A more detailed insight in the uniqueness of breeds is to be expected from a molecular characterization of the adaptive variation, which is being catalyzed by affordable genomic sequencing.

Breeds as management units

In the current view, breeds are units of conservation that each contribute independently to the diversity of the species. Since a considerable part of the diversity is not unique for a single breed but is dispersed over several others, a different role of the breeds and breeding organizations is proposed, which also conforms to practical reality. Instead of units of conservation, breeds may be considered as what they really are: units of management. In line with the historical and molecular evidence, a breed is not a unique reservoir of diversity, but may be considered as a 'genetic reserve', managed separately from other breeds and containing a portion of the livestock variation that is either specific for the breed or shared by others.

Effective genetic management is being achieved by maintaining herdbooks, which by recording of pedigrees and documenting admixture allows for an estimation of the level of inbreeding, and keeps track of the phenotype by monitoring relevant traits. This allows for an identification of authentic breeding lines that need to be conserved, but also facilitates the discovery of spontaneous new variants to be evaluated as new additions to the genetic repertoire. Breed standards are to be maintained, but preferably in the context of a broad genetic basis.

Keeping populations purebred according to herdbook records appeals to our sense of order, but inbreeding leads to a decrease of biodiversity and also invites a higher prevalence of genetic diseases, a lower fertility and a decrease of disease resistance. Moreover 'genetic purity' in a diploid species eludes a clear definition in molecular terms. Controlled cross-breeding has been practiced for centuries and is not always and in itself undesirable. In practice it has never diminished the role of a breed in the local tradition and its place in the cultural heritage as long as the typical breed features were conserved.

Last but not least, breed societies should interact with scientists for applying the state-of-the-art technology of molecular monitoring and for a scientifically rewarding characterization of their genetic resources.

References Chapter 6

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Chapter 6 Appendix

Index of breed names

Cattle breeds per country

See Table 1 for an explanation of the breed categories. Local-international refers to the subcategory Local populations of international breeds and Global/International to the subcategory Global or International purebred imported. For non-European breeds a zeboid (taurindicine) or bovine species origin, early or later import of exotics and local development (Local Euro-Asian or Local Euro-African derivatives and Exotic-local composites, respectively) are indicated. Asterisks indicate according to the available information rare and vulnerable breeds and double asterisks endangered breeds. *Italics* indicate names in the local language for which no English name exists. Indentations indicate breed varieties.

EUROPE

Scandinavia and Finland

Denmark

Extinct

Black Pied Danish Dairy
1965

Danish Red-and White Shorthorn
Land cattle

Landrace

Agersoe**

Authentic

Jutland*

herds:

*Kortegaard***

*Oregaard***

*Westergaard***

*Vesterboelle***

Black Pied

Jutland Dairy**

Red Danish Dairy 1970**

Local derivative

Black Pied Danish Dairy 1970**

Local-international

Danish Shorthorn**

Continious cross

Danish Forest

Viking Red

Americanized local

Danish Holstein

American-European

Danish Red Dairy

Danish Red Pied

Global / International

Aberdeen-Angus

American Beef Shorthorn

Belgian White-Blue

Blonde d'Aquitaine

Brown Swiss

Charolais

Danish Jersey

Dexter

Galloway

Gelbvieh

Hereford

Highland

Limousin

Milk Shorthorn**

Piemontese

Salers

Simmental

Swiss Brown

Tyrol Grey

Witrik

Finland

Authentic

Eastern Finncattle**

Northern Finncattle**

Western Finncattle*

Local derivative

Finnish Ayrshire

Composite

Viking Red

Global

Aberdeen-Angus

Blonde d'Aquitaine

Charolais

Finnish Holstein-Friesian

Hereford

Highland

Limousin

Piemontese

Simmental

Iceland

Authentic

Icelandic Dairy

Global / International

Aberdeen-Angus

Icelandic Galloway

Limousin

Norway

Extinct

Blacksided Trondheim

Coastal land cattle

Gudbrandsdal

Hallingdal

Hedmark

Hordaland

Horned Lowland

Lyngdal

Malselv

Northland

Norwegian Red-and-White

Osterdal

Red Trondheim

Roros

South and Westland

Trönder

Valdres

Authentic

Blacksided Trondheim
and Nordland*

Doela**

Red Polled Eastland**

*Jarlsberg***

Telemark**

Western Fjord**

Westland Grey Möre**

Westland Red Polled**

Reconstructed

Faeroes**

Continuious cross

Norwegian Red

Global / International

Aberdeen-Angus

Ayrshire

Charolais

Galloway

Hereford

Jersey

Sweden

Extinct

Amasa

Frövidal

Gotland

Herjeadals

Herrgard

Jonstrop

Oland

Red Pied Swedish

Rorbottenland

Sabyland

Scanian

Smaland

Waldholm

Swedish Ayrshire
Authentic
 Allmoge:
 Ringmala**
 Vane**
 Swedish Polled
 Swedish Mountain*
 Bohus Polled**
 Fjallnara**
 Swedish Red Polled**
 Ringamala**
Continuous cross
 Swedish Red-and-White
 Viking Red
Global / International
 Aberdeen-Angus
 Blonde d'Aquitaine
 Charolais
 Galloway
 Hereford
 Highland
 Limousin
 Simmental
 Swedish Holstein
 Swedish Jersey
 Swedish Lowland**

Northeastern Europe

Estonia

Extinct
 Estonian land cattle
Authentic
 Estonian Native*
Local derivative
 Estonian Red
Local-international
 Estonian Black Pied
Global
 Aberdeen-Angus
 Blonde d'Aquitaine
 Charolais
 Estonian Holstein
 Hereford
 Highland
 Limousin
 Piemontese

Latvia

Extinct
 Latvian Red Pied
 Latvian Light red
 Latvian Dairy
 Latvian Black Pied
Authentic
 Latvian Blue**
Local-derivative
 Latvian Brown
Global / International
 Aberdeen-Angus
 Angeln
 Ayrshire
 Aubrac

Belgian White-Blue
 Blonde d'Aquitaine
 Brown Swiss
 Charolais
 Danish Red
 Dexter
 Estonian Red
 Galloway
 German Red
 Grey Steppe
 Heck cattle
 Hereford
 Highland
 Jersey
 Latvian Holstein
 Latvian Red Holstein
 Limousin
 Lithuanian Red
 Montbéliard
 Norwegian Red
 Piemontese
 Salers
 Simmental
 Swedish Red-and-White
 Swiss Brown
 Tyrol Grey
 Ukrainian Grey
Continuous cross
 Cross Breed Dairy
 Cross Breed Beef

Lithuania

Extinct
 Polled Lithuanian land cattle
 Lithuanian Dairy
Landrace
 Lithuanian Ash Grey**
 Lithuanian White-Back**
Local-international
 Lithuanian Black Pied
Local multiple composite
 Lithuanian Red
Global / International
 Angeln
 Aubrac
 Ayrshire
 British Friesian
 Brown Swiss
 Charolais
 Danish Red
 German Red Pied DP
 Hereford
 Limousin
 Lithuanian Holstein
 Hereford
 Simmental
 Swedish Black Pied
 Swedish Red-and-White

Poland

Extinct
 Bukowina Mountain
Dolinowa

East Prussian
 Black Pied
 Goralen Mountain
Klodzka
 Kreuzberg
 Mandans
 Polish Brown
Rawicka
 Sandeck
 Silesian Red
 Silesian Whiteback
 Valachian Dwarf
Wilna
 Zulawka
Landrace
 Polish Whitebacked**
Authentic
*Podgórska***
Local derivative
 Polish Red*
Local-international
 Polish Black-and-White Lowland
 Mazury**
 Polish Red-and-White Lowland
Global
 Aberdeen-Angus
 Charolais
 Hereford
 Jersey
 Piemontese
 Polish Black-and-White HF
 Polish Simmental
 Salers

Bovine composite
Zubroń

British Isles

England, Scotland, Wales and Channel Islands

Extinct
 Aberdeenshire
 Alderney
 Anglesey
 Angus Doddie
 Beevilde
 Black Beevilde
 Brae-Glen
 Buchan Humlie
 Cadzow
 Castlemartin
 Chartley
 Cheshire
 Derbyshire
 Dewsland
 Dishley
 Dorsetshire
 Durham
 Earsham Polled
 Fifeshire
 Forfarshire
 Glamorgan
 Holderness

Lancashire
 Lincoln Red (Original)
 Lord Caernarvon's breed
 Montgomeryshire
 Norfolk Horned
 New Yorkshire
 North Wales Black
 Old Marlborough Red
 Orkney
 Pembroke
 Sheeted Somerset
 Shropshire
 Staffordshire
 Suffolk Dun
 Teeswater
 Warwickshire
 Woburn
Authentic
 Aberdeen-Angus (original population)**
 Tyrone Black
 Red Angus
 Ancient Cattle of Wales**
 color types:
 Belted Welsh**
 White Welsh**
 Ayrshire*
 Beef Shorthorn*
 Belted Galloway*
 Red Belted Galloway**
 British White*
 Devon*
 Dexter
 Galloway*
 color types:
 Dun Galloway**
 Red Galloway**
 Rigget Galloway**
 White Galloway**
 Gloucester*
 Guernsey [Island]
 Hereford Traditional*
 Highland*
 Jersey [Island]
 Lincoln Red**
 Longhorn
 Northern Dairy Shorthorn**
 Original Population
 Dairy Shorthorn**
 Red Poll*
 South Devon
 Sussex *
 Welsh Black*
 Whitebred Shorthorn**
 White Park*
 Chillingham**
 Dynevor**
 Vaynol**
Local deriv./cross
 Shetland*
 Swona**
reconstructed
 Blue Albion**

Composite
 British Polled Hereford*
 Luing*
 Polled Sussex
 Polled Welsh Black**
 Sussex new type
Multiple composite
 Blended Red-and-White
 Polled Lincoln Red
Americanized local
 Aberdeen-Angus
 Ayrshire
 British Holstein
 Dairy Shorthorn*
 Guernsey
 Hereford
 Jersey
 Poll Shorthorn*
Global / International
 Aubrac
 Australian Dairy Shorthorn
 Bazadaise
 British Blonde
 British Blue
 British Charolais
 British Friesian
 Poll Friesian*
 Red-and-White Friesian*
 British Limousin
 British Black Limousin
 British Simmental
 Brown Swiss
 Chianina
 Gasconne
 Gelbvieh
 Heck cattle
 Illawarra
 Maine-Anjou
 Marchigiana
 Meuse-Rhine-Issel
 Montbéliarde
 Murray Grey
 Normande
 Parthenais
 Piemontese
 Salers
 Swedish Red-and-White
 Viking Red
Continuous cross
 Stabiliser
Terminal F1 cross
 Black Hereford
 Bluegrass
 Blue Grey
 Hereland
 Jersian
 Sim-Luing
 WBS/Highland X

Ireland, N.Ireland
Extinct
 Donegal Reds
 Irish Dun

Irish Longhorn
 Polled Irish
Authentic
 Dexter
 Drimmon**
 Irish Moiled**
 Kerry**
Local-international
 Irish Shorthorn
Americanized local
 Holstein-Friesian
Global / International
 Angus
 Aubrac
 Ayrshire
 British Blue
 Blonde d'Aquitaine
 Charolais
 Dutch Belted
 Hereford
 Jersey
 Limousin
 Meuse-Rhine-Issel
 Montbéliard
 Normande
 Parthenais
 Piedmont
 Salers
 Simmental
 Wagyu

Western continental Europe

Belgium

Extinct
 Ardennes landrace
 Belgian Black Pied
 Belgian Red Pied
 Campine land cattle
Cassel
 Central and Upper Belgian
 Condroz
 Eastern Red-pied Ardennes
 Eastern Red-pied Belgian
 Famenne
 Hervé Black Pied
 Limon Blue
 Polders Black Pied
Veurne-Ambacht
 Red-pied Eastern Belgian
Authentic
 West Flemish Red**
 Red Beef Type*
 Local derivative
 Belgian White-Blue
 Belgian White-Blue dual- purpose
 East Flemish White- and-Red**
Reconstructed
 Campine Red Pied**
Americanized local
 Belgian Black Pied- Holstein
American-European
 Belgian Red Pied-

Holstein
Global / International
 Bazadaise
 Blonde d'Aquitaine
 Brown Swiss
 Charolais
 Dutch Belted
 Fleckvieh
 Heck cattle
 Highland
 Irish Friesian
 Jersey
 Lakenvelder
 Limousin
 Maine-Anjou
 Marchigiana
 Montbéliarde
 Normande
 Parthenaise
 Salers
 Simmental
 Wagyu

France

Extinct
 Aganaise
 Albanaise
 Albigeoise
 ALPHA 16
 Angavine
 Anglès
 Angoumoise
 Ardennaise
 Artésienne
 Aspe
 Augeronne
 Aure
 Auvergnate
 Bailleuloise
 Barétous
 Barousse
 Bas-Adour
 Basco-Béarnaise
 Bas-Rhin
 Basquaise
 Bazougers
 Béarnaise
 Beauceronne
 Beaufort
 Bédous
 Berguenarde
 Berrichonne-Brennouse
 Bessarde
 Bessine
 Bleue du Limon
 Blonde des Pyrénées
 Bordelaise
 Boucquemon
 Boulonnaise
 Bourbonnaise
 Bournaisienne
 Brayonne
 Bressane

Bresse
 Bretonne de Saint Brieux
 Bretonne Rouge et Pie Rouge
 Brune de Guingamp
 Carhaisienne
 Carolaise
 Casseloise
 Cauchoise
 Causse
 Cévennes
 Comtoise
 COPELSO 93
 Cornouailles
 Cotentine
 Dauphinoise
 Dombes
 Durcet
 Durham-Bretonne
 Durham-Mancelle
 Eifel
 Fémeline
 Flamande originelle
 Forézienne
 Française Frisonne Pie-Noire
 Garonnaise
 Garonnaise de côteau
 Garonnaise de plaine
 Gasconne à muqueuses noires
 Gasconne de Lauraguais
 Gâtinaise-Choletaise
 Gâtine
 Gesienne
 Gévaudan
 Guisarde
 Haut Bugey
 INRA 9
 Isigny
 Laguiole
 Landaise
 Léonnaise
 Limagne
 Maine-Anjou latiere
 Mancelle
 Marchoise
 Marine
 Marmandaise
 Maroillaise
 Mayennaise
 Merlerault
 Meymac
 Meyssac
 Mézenc
 Micahaille
 Montagne Noire
 Montalbanaise
 Mont Dor
 Morvandelle
 Münster
 Namponnaise
 Néracaise
 Nivernaise
 OMEGA 47
 Ossau

Pays Sault
 Percheronne
 Péricourdins
 Picarde
 Pie Rouge de Carhaix
 Pie Noire Morbihannaise
 Poitevine
 Provençale
 Quercy
 Rennaise
 Rouerge
 Rouge de l'Ouest
 Roussillon
 Saint Girons
 Saintongeoise
 Saint Poloise
 Salvagnac
 Sarlabot
 Ségala
 Simmental d'Alsace
 Solognote
 Solzerienne
 Soule
 Tachetée de l'Est
 Tarasconne
 Tourache
 Treignac
 Urt
 Valognaise
 Vendéenne
 Vendonnaise
 Vivardaise
 Landrace
 Albera:
 Albera Hêtre**
 Albera Noire**
 Betizú**
 Corse*
 Marine**
 Authentic
 Abondance
 Alpine Hérens*
 Evolène**
 Aubrac
 Bazadaise*
 Béarnaise**
 Bretonne Pie Noir*
 Casta**
 Charolaise
 Ferrandaise**
 Froment du Léon**
 Gasconne
 Jersiaise
 Limousine
 breed lines:
 type tardif
 type mixte
 type viande
 Lourdaise**
 Maraichine**
 Mirandaise**
 Montbéliarde
 Nantaise**

<i>Normande</i>	Bramstedt	Bavarian land cattle
<i>Parthenaise</i>	Branntager	Volmau
<i>Raço di Biòu</i>	Breitenburg	Waldeck
<i>Salers</i>	Cleve	Weida
<i>Salers Latier**</i>	Chamau	Wesermarsh
<i>Salers vergeade**</i>	Dachau Moor	Westwäld
<i>Tarentaise</i>	Ditmarsh	Wilstermarsh
<i>Villard-de-Lans**</i>	East Friesian	Wittgenstein Blazed
<i>Vosgienne*</i>	East German Black Pied	Württemberg Brown
<u>Local derivative</u>	Eiderstedt	Württemberg Spotted
<i>Armoricaïne**</i>	Ellingen-Weissenburg	<u>Authentic</u>
<i>Bleue du Nord (rameau mixte)*</i>	Franconian	German Black Pied Lowland*
<i>Flamande laitier*</i>	German Black Pied Dairy	Hinterwald**
<i>Flamande mixte*</i>	Glan-Donnersberg	Murnau-Werdenfels**
<i>Rouge des prés</i>	Hassberg	Vorderwäld*
<u>Reconstructed</u>	Hesse-Westphalian Red	<u>Reconstructed</u>
<i>Bordelaise (nouvelle)**</i>	Itsgründ	Angeln (original)**
<u>Local-international</u>	Itz and Baunach	Ansbach-Triesdorf**
<i>Simmental Française</i>	Jeverländ	Donnersberg Red*
<u>Local multiple composite</u>	Kellheim	German Red Highland:
<i>Saôneise**</i>	Krempermarsh	Harz Red**
color types:	Lower Swabian	Hesse Red**
<i>Augeronne**</i>	Mainland	Vogelsberg**
<i>Caille-Blond**</i>	Messkircher	Vogtland Red**
<i>Durham**</i>	Miesbach	Westphalian Red*
<i>Manceau**</i>	Münster runts	Glan**
<i>Percheronne**</i>	Neckar-Heilbron	Lahn **
<u>Local amalgamate</u>	New Miesbach	<i>Limpurger**</i>
<i>Blonde d'Aquitaine</i>	Obermain valley	<u>Local-international</u>
<u>Americanized local</u>	Ochsenfüt	German Angus
<i>Brune</i>	Odenwäld	German Fleckvieh
<i>Prim'Holstein</i>	Oldenburg Geest	Fleckvieh beef
<u>American-European</u>	Oldenburg-Wesermarsh	German Original Brown**
<i>Pie Rouge des Plaines**</i>	Old Franconian	Belted Swiss Brown**
<u>Global / International</u>	Red East Friesian	German Pinzgauer*
<i>Aurochs reconstrué</i>	Red North Schleswig Dairy	Pinzgau beef*
<i>Blanc Bleue Belge</i>	Red Pied East Friesian	German Red Pied DP*
<i>Canadienne</i>	Red Pied Lower Rhineland	<i>Land Shorthorn**</i>
Galloway	Red Pied Schleswig-Holstein	<u>Composite</u>
<i>Guernsaise**</i>	Red Pied South Oldenburg	<i>Uckermärker**</i>
Hereford	Red Pied Westphalian	<i>Genotyp 67*</i>
Highland	Red and Yellow Moor	Wilseder Red*
<i>Race de Combat</i>	Rhineland	<u>Local multiple composite</u>
<u>Continuous cross</u>	Röhn	Angeln-German Red
Corsican crossbred	Röhn-Spessart	Yellow Franconian
<i>INRA 95*</i>	Rottal	Gelbvieh beef
<i>Massanaise**</i>	Sauerland	<u>Multiple composite</u>
<u>Terminal F1 cross</u>	Scheinfeld	<i>Auerox*</i>
<i>Charollandais</i>	Schönwäld	Heck cattle*
	Schwalm	<i>Taurus**</i>
	Schweinfürt	<u>Americanized local</u>
	Sechssämt	German Holstein
	Siegerland	German Brown
	Spessart	<u>Global / International</u>
	Swabian-Hall	Aubrac
	Swabian-Hall Brown blazed	Belgian White-Blue
	Taunus	Belted Galloway
	<i>Teck</i>	Blonde d'Aquitaine
	<i>Tiger</i>	Cachena
	Tondern	Charolais
	Unicoloured Red-brown	Chianina
	East Friesian	Dahomey
	Upper and Lower	Dexter

German Beef Shorthorn
 German Galloway
 German Red Holstein
 Hereford
 Highland
 Holstein
 Hungarian Grey
 Jersey
 Limousin
 Lincoln Red
 Luïng
 Maine-Anjou
 Piemontese
 Pustertal
 Salers
 Swedish Mountain
 Swedish Red-and-White
 Texas Longhorn
 Tux-Zillertal
 Welsh Black
 Vosgienne
 Wagyu
 Watasi
 Welsh Black
 Dwarf Zebu
Terminal F1 cross
Shorbrack
Steibu

Luxembourg

Extinct
Ardennaise ou
Meusienne
Global
 Belgian White-Blue
 Charolais
 Limousin
 Luxembourg Holstein
 Luxembourg Red Pied

Netherlands

Extinct
 Friesian
Bovian
 Groningen white head
 North Holland
 Red Pied Dual Purpose
 Sand and heather cattle
 South Holland Islands
Authentic
*Baggerbont***
 Black Pied Dutch-Friesian*
 Groningen Whiteheaded*
*Lakenvelder**
 Meuse-Rhine-Yssel*
 Burnt red*
 Red Pied Friesian**
*Witrik**
Composite
*Ecolander***
 Improved Red Pied
 Red Beggar**
Multiple composite

*Tauros***
Americanized local
 Dutch Black Pied H
American-European
 Dutch Red Pied H
Global / International
 Angus
 Bazadaise
 Belgian White-Blue
 Belted Galloway
 Blonde d'Aquitaine
 Brown Swiss
 Charolais
 Chianina
 Dahomey
 Dexter
 Fleckvieh
 Galloway
 Gasconne
 Glan
 Heather cattle
 Heck cattle
Oostvaarders-
*plassen Heckrund**

Hereford
 Highland
 Holstein
 Hungarian Grey
 Jersey
 Limousin
 Longhorn
 Maine-Anjou
 Maraichine
 Marchigiana
 Maremmana primitivo
 Montbéliarde
 Parthenaise
 Piemontese
 Polled Hereford
 Salers
 Sayaguesa
 Simmentaler
 Swedish Red-and-White
 Texas Longhorn
 Tudanca
 Vosgienne
 Watasi
 Wagyu

Central Europe

Austria

Extinct
 Albulah
 Allgäu
 Bernese Spotted
 Brenner
 Bregenz Grey-yellow Wood
 Brixental
 Brown Helmet
 Carinthian Blazed
 Danube Fleckvieh
 Durtal

East Styrian Fleckvieh
 Feldsberg
 Gföhl-Zwetteln
 Helmer Blazed
 Immendorf
 Inntal Spotted
 Innviertel Fleckvieh
 Jochberg
 Kampete
 Kematen
 Kitzbühl
 Klostertal
 Landl
 Lavanttal
 Lechtal
 Light Helmet
 Lungau
 Maltein
 Mariahof
 Mariahof-Lavanttal
 Mölltal
 Montafon
 Murboden-Mürztal
 Mürztal
 Paznaun
 Pongau
 Pustertal
 Raabs
 Rauris
 See
 Selrain
 South Styrian
 Carinthian land cattle
 Spotted Mountain
 Sterzing
 Stubai
 Styrian Brown
 Stockeraur
 Thandberg
 Tux
 Tyrol Grey-brown
 Mountain
 Tyrolese
 Tyrolese Brown
 Tyrolese Fleckvieh
 Tyrolese Pinzgauer
 Vorarlberg Brown
 Vorarlberg Grey-brown Mountain
 Walsertal
 Wels Spotted
 Wipptal
 Zillertal
Landrace
 Bündner Grey*
Authentic
 Ennstal Spotted Mountain**
 color types:
 Helmet**
 Kampete**
*Jochberger Hummel***
 Murboden**
Pinzgauer
*Pustertaler***

Tux-Zillertal**
 Tyrol Grey*
 Waldviertel Blond**
Local-international
 Austrian Fleckvieh
 Austrian Original Brown*
Local multiple composite
 Carinthian Blond**
Local amalgamate
 Austrian Yellow*
Americanized local
 Austrian Brown
American-European
 Austrian Dairy Simmental
Global / International
 Angus
 Austrian Black
 Pied Holstein
 Blonde d'Aquitaine
 Charolais
 Chianina
 Dahomey
 Heck cattle
 Highland
 Hungarian Grey
 Limousin

Czech Republic
 Extinct
 Berno-Hana
 Bohemian-Berne
 Bohemian Wood
 Budweiser
 Cheb
 Czech Black Pied
 Czech Red Pied
 Czechoslovakian Red Pied
 Hrbinecky
 Kladsko-Sudeten Red
 Kravarsky
 Lisna Red
 Manhartsberg
 Mariadvur
 Moravian Red
 Moravian Red Pied
 Opatchno
Plava akvitsanske
 Stitary
 Sudeten Red
 Sumava
Authentic
 Czech Red**
Local-international
 Czech Fleckvieh
American-European
 Czech Pied Dairy
Global / International
 Aberdeen-Angus
 Ayrshire
 Belgian White-Blue
 Blonde d'Aquitaine
 Brown Swiss
 Charolais

Czech Holstein
 Galloway
 Gasconne
 Hereford
 Highland
 Jersey
 Limousin
 Masny Simmental
 Montbéliard
 Piemontese
 Salers
 Swiss Brown

Hungary

Extinct
Bonyhádi
 Bonyhádi-Simmental Landrace
 Carpathian Mountain
 Dairy Hungarian Brown
 Dairy Hungarian Pied
 Hungarian Brown
 Hungarofries
 Karst
 Red Pied Landrace of Allföld
Authentic
 Hungarian Grey*
Local-international
 Hungarian Pied
Composite
 Scentes Red*
American-European
 Bavarian Simmentall
Global / International
 Aberdeen-Angus
 Ayrshire
 Belgian White-Blue
 Blonde d'Aquitaine
 Charolais
 Danish Jersey
 Gelbvieh
 Heck cattle
 Hereford
 Hungarian Holstein-Friesian
 Jersey
 Limousin
 Lincoln Red

Slovakia

Extinct
 Bukowina Mountain
 Carpathian Mountain
 Mandans
 Podhalaner
 Slovakian Black Pied
 Slovakian Red
 Valachian Dwarf
 West Galizian-Carpathian
Local derivative
 Slovakian-Carpathian Brown
Local-international
 Slovakian Pied
 Slovakian Pinzgau
Americanized local

Slovakian Brown
Global
 Aberdeen-Angus
 Blonde d'Aquitaine
 Charolais
 Hereford
 Limousin
 Masovy Simmental
 Piemontese
 Slovakian Holstein
 Swiss Red Pied

Switzerland

Extinct
 Appenzel
 Bernese
 Bryenz
 Bündner Mountain
Feldis
 Fribourg
 Frütig-Adelboden
Glarus
 Goms
 Graubünden-Oberland
 Illiez
Interlaken
 Jura
 Livin
 Lötsch
Oberhasli
Oberwalden
 Schwyz
 Simmental-Saanen
 Toggenburg
Uri
Authentic
 Edelweiss- Simmental*
*Evolèner**
Hérens
 Original Swiss Brown
 *Gurtenvieh***
 Whitebacked**
 Simmental
Americanized local
 Swiss Brown
American-European
 Swiss Red Pied
 Swiss Holstein
Global / International
 Angus
 Aubrac
 Blonde d'Aquitaine
 Dexter
 Galloway
 Grey Mountain
 Hereford
 Highland
 Hinterwäld
 Limousin
 Jersey
 Rhaetian Grey

Southwestern Europe

Italy

Extinct

Abruzzese
Bardigiana
Bellunese
Berciana
Bergamo
Bionda Tortonese
Bolognese
Brina
Cabellota
Camandona
Campanina
Canavese
Carmagnola
Carnia
Carniella
Carpigiana
Collina delle Marche
Cornigliese
Demonte
Drautal
Friulana
Friulana pezzata rossa
Grigia di Val d'Adige
Grigia di Val di Fiemme
Grigia di Val d'Ultimo
Grossetana
Lucana
Marchigiana gentile
Meraner
Modenese di pianura
Modicana primitivo
Mölltal
Murgese
Ossolane
Ottonese
Passeier
Perugiana
Pezzata Rossa Norica
Piemontese ordinaria
Pinerlo
Pugliese del basso
Racconigi
Romagnola gentile
Romagnola di montagna
Siciliana Grande
Siciliana Picolo
Susa
Ultimo
Valdarno
Val di Chiana
Vaitarese
Valtellina
Varzese
Veneto
Vintschauer
Welschtirol
Landrace
Garfagnina**
Authentic

Burlina**
Cabannina**
Calvana**
Chianina
Cinisara
Grigia Alpina
Marchigiana
Maremmiana
Maremmiana primitivo**
Modenese*
Modicana:
Montanina
Olivestra Modicana
Rossa Siciliana
Montana rossa**
Podolica Italiana:
Podolica Calabrese
Podolica Campanina
Podolica Pugliese
Pontremolese**
Pusteria**
Barà
Reggiana**
Rendena
Romagnola
Sarda*
Pettiazza**
Valdostana pezzata
nera-castana:
Valdostana castana**
Valdostana pezzata nera**
Valdostana pezzata rossa
Local derivative
Pasturina**
Pezzata rossa d'Oropa**
Pisana**
Sardo-Modicana
Local-international
Bruno Italiana Vecchio Ceppo*
Pezzata rossa Italiana
Pinzgau*
Sarda Bruna
Savoiarde**
Local multiple composite
Agerolese**
Pantelleria**
Piemontese
Americanized local
Bruna Alpina
Global
Charolais
Holstein Italiana
Jersey
Limousin
Terminal F1 cross
Fрати

Malta

Reconstructed
Maltese Ox**
Global
Chianina

Portugal

Extinct

Jarmelista
Mirandez estremenho
Turino
Authentic
Alentejana
Algarvia**
Aracena**
Arouquesa
Barrosã
Brava de Lide
Cachena*
Garvonesa**
Marinhoa
Maronesa
Mirandesa
Beiroa
Braganseça
Campo
Preta*
Local derivative
Mertolenga:
Bragado do Sorroia
Malhado do baixo Guadiana
Local multiple composite
Ramo Grande**
Local-international
Galega/Minhota
Global / International
Brava dos Açores
Charolais
Frisia-Holstein
Gelbvieh
Hereford
Limousin
Salers
Continuous cross
Madeira Mixed
Terminal F1 cross
Chamusco

Spain

Extinct

Agrupación Eo
Agrupaciones-Serrañas
Alistana
Almanzoreña
Atigrado de Salamanca
Avileña-Negra
Calasparreña
Campurriana
Castiliana
Casta Cabrera
Casta Carriquirris
Casta Castellana
Casta de la Tierra
Casta de los Gallardo
Casta Espinosa y Zapata
Casta Jijona
Colorada extremeña
Frizoria
Llanuras

Lebaniega
 Leonesa
 Lorquina
 Marinera
 Negra Ibérica
 Rubia andaluza
 Sanabresa
 Verinesa
Landrace
 Monchina*
Authentic
 Albera:*
 Albera Negra*
 Fagina*
 Almanzoreña
 Asturiana de la Montaña
 Asturiana de los Valles
 Asturiana muscúlosa
 Blanca Cácerena**
 Berciana
 Berrenda en Colorado**
 Berrenda en Negro andaluza**
 Betisoak**
 Bruna de los Pirineos
 Cachena*
 Caldela
 Canaria*
 Cárdena andaluza**
 Frieiresa**
 Gallega
 Ganado Bravo
 herds:
 Casta Arann*
 Casta Domec*
 Casta Miura*
 Casta Pablo Romero*
 Casta Ramirez*
 Casta Uргуino*
 Casta Vazquez*
 Casta Vega-Villar*
 Casta Veragua*
 Casta Vistahermosa*
 Lidia Casta Navarre*
 Limiá**
 Mallorquina**
 Menorquina**
 Morucha
 Morucha Variedad Negra
 Murciana-Levantina**
 Huertana**
 Negra andaluza*
 Pajuna**
 Axarquía**
 Pallaresa**
 Palmera**
 Pasiega**
 Pirenaica
 Retinta andaluza
 Salinera
 Sayaguesa**
 Serrana Negra**
 Pinariega**
 Serrana de Soria****

Serrana de Teruel**
 Terraña**
 Terraña gorbeana**
 Terraña de la Sierra
 Tudanca
 Vianesa*
Local crossbred
 Marismería**
Local amalgamate
 Alistana-Sanabresa*
 Avileña-Negra Ibérica
 Bociblanca**
Local-international
 Parda de Montaña
Global / International
 Brown Swiss
 Charolais
 Gelbvieh
 Frisoña-Holstein
 Hereford
 Limousin
 Salers
 Simmental

Southeastern Europe, Balkan

Albania
 Extinct
 Mursi
Landrace
 Albanian Busha:
 Dibra Busha**
 Lekbian Busha**
 Gurgucka Busha**
 Middle Albanian Busha**
 Prespa Dwarf**
 Shkodra Busha
Local-international
 Albanian Simmental**
Global / International
 Albanian Holstein-Friesian
 Belgian White-Blue
 Charolais
 Estonian Red
 German Black Pied Lowland
 Guernsey
 Jersey
 Limousin
 Maremmna
 Marchigiana
 Montbéliard
 Norwegian Red
 Oberinntal Grey
 Piemontese
 Simmental
 Tarentaise

Bosnia-Herzegovina

Extinct
 Imljani black
 Neretva
 Posavina

Wocheind
 Tolmeind
Landrace
 Gacko**
 Polim Busha**
 Spreca**
Global / International
 Brown Swiss
 Holstein-Friesian
 Simmental
 Tyrol Grey

Bulgaria

Extinct
 Red Sadovo
 Sofia Brown
 Stara Planina
Landrace
 Rodope Shorthorn**
 Madjarovo feral*
Authentic
 Iskar**
Local derivative
 Bulgarian Brown
Multiple composite
 Bulgarian Red**
Local-international
 Bulgarian Simmental*
Continuous cross
 Improved Rodope**
Global / International
 Aberdeen-Angus
 Angeln
 Ayrshire
 Blonde d'Aquitaine
 Bulgarian Black Pied Holstein
 Charolais
 Danish Red
 Jersey
 Latvian Brown
 Limousin
 Polled Hereford
 Salers
 Simmental
 Swiss Brown
 Tyrol Grey

Croatia

Extinct
 Croatian Pinzgau
 Imljani black
 Istar-Karst
 Kranjsko
 Labin
 Lika
 Neretva
Landrace
 Croatian Busha**
 Croatian Red**
Authentic
 Boskarin**
 Slavonian Podolian**
Local derivative

Dalmatian Grey
Local-international
Croatian Brown
Croatian Simmental
Global
Croatian Black Pied
Swiss Brown

Cyprus

Extinct
Messaoria
Paphos
Authentic
Cyprus
Global / International
Dairy Shorthorn
Holstein-Friesian
Jersey

Greece

Extinct
Alonissos
Amorgos dwarf
Arki
Asguru
Corinthian
Cretan lowland
Elis/Elia
Epiros
Gávdos
Giura
Greek Steppe
Kos
Kerkyra/Corfu
Kyra Panagia
Kythnos
Naxos
Nisyros dwarf
Paros
Piperi dwarf
Pleira
Prespa Dwarf
Samos dwarf
Sifnos
Skópelos
Skýros
Thessaly
Tilos dwarf
Tinos
Landrace
Greek Shorthorn:
Achelooos**
Agrinio dark**
Agrinio white ivory**
Ándros**
Cretan mountain**
Dervenhoria**
Dodekánisos shorthorn**
Folégandros**
Kea**
Lesvos**
Mani**
Perdikaki shorthorn**

Rodope shorthorn
Rodos dwarf**
Kastellorizo**
Katerini**
Sykia**
Local crossbred
Black Etolokarnania**
Folégandros**
Kea/Tzia
Metsovo Red**
Peloponnese**
Pomak Red**
Svitsika
Thrace**
Global
Blonde d'Aquitaine
Charolais
Greek Friesian Black Pied
Limousin
Swiss Brown
Simmental

Kosovo

Landrace
Dukagjini Busha**
Red Metohian Busha**
Sharri Busha**

Macedonia / FYROM

Extinct
Prespa Dwarf
Landrace
Macedonian Busha**
Local crossbred
Macedonian black Busha**
Global / International
Hereford
Holstein
Simmental
Tyrol Grey

Moldova Republic

Extinct
Bessarabian Grey
Bessarabian Red
Moldavian Red Steppe
Local derivative
Moldavian-Estonian Red**
Global / International
Aberdeen-Angus
Angus
Estonian Red
Limousin
Moldavian Black-and-White
Piemontese
Red Steppe
Simmental
Continuous cross
Black Lemming

Montenegro

Extinct
Pester Busha

Landrace
Montenegrian Busha**
Global
Brown Swiss
Holstein-Friesian
Limousin
Simmental

Romania

Extinct
Bucsan
Danube miniature
Dobrogea Red
Dobrudja
German Rosie
Ialomita
Maramures Brown
Romanian Grey
Obstesc
Risca
Red German
Romanian Mountain
Transylvanian Grey
Landrace
Mocanita**
Moldavian**
Local derivative
Dorna**
Romanian Brown
Romanian Red
Local-international
Romanian Spotted
Transylvanian Pinzgau**
Global / International
Danish Red
Jersey
Red Poll
Romanian Black Pied Holstein
Santa Gertrudis
Shorthorn

Serbia

Extinct
Podolian Simmental
Landrace
Dukagjini Busha**
Kolubara**
Metohija Red**
Pester Busha**
Serbian Busha**
Sharri Busha**
Srem Podolian**
Local derivative
Serbian Brown
Local-international
Serbian Domestic Spotted
Siva**
Global / International
Charolais
Hereford
Limousin
Simmental
Tyrol Grey

Slovenia

Extinct
 Bohinj Cika
 Goricka
 Koruska Blond
 Pomurska
 Slovenian Busha
 Slovenian White
 Tolmin Cika
Local derivative
 Cika*
Local-international
 Pinzgavac*
 Slovenian Brown
 Savinja Grey
 Slovenian Pied
 Slovenian Red Pied
Global
 Belgian White-Blue
 Charolais
 Galloway
 Highland
 Limousin
 Montbéliard
 Red Angus
 Red Holstein

Eastern Europe**Belarus**

Extinct
 Goralen Mountain
 Goryn
 Majdaner
 Menno-Fries
 Polesian Marsh
Local-international
 Belarus Black Pied
 Belarus Red*
Multiple composite
 Belarus Synthetic*
Global / International
 Aberdeen-Angus
 Brown Swiss
 Charolais
 Hereford
 Kostroma
 Limousin
 Swiss Brown
 Simmental

Russia (European Part)

Extinct
 Babaev
 Bjelsk
 Bryansk Forest
 Chuwash-Mari
 Don
 Dwina
 Gorbatov
 Goryn
 Great Russian land cattle
 Ilmen

Kalmuck
 Kargopolian
 Komi
 Lenfa
 Mezen
 Miskov
 Murmansk
 North Russian Polled
 Oka
 Oka Black Pied
 Olonets
 Pashkov
 Perm
 Petsjora branch of
 the Kholmogory
 Red Pied Kareliyan
 Rokschenga
 Simbirsk
 Schenkursk
 Syrjänen
 Ssuchona
 Tscherdian
 Vladimir
 Vychegado-Vym
 Waldais
 Wijtegras
 Zarizyner
Landrace
 Petsjora**
Authentic
 Kalmyk:
 Lower Volga
 North Caucasian
 Kholmogory
 Yaroslavl
Local derivative
 Russian Ayrshire
 Russian Red Steppe
 Suksun*
Local multiple composite
 Bestuzhev
 Gorbatov Red**
 Istoben
 New North Caucasian
 Tagil:
 Tagil-Dutch
 Tagil-standard
 Starotagil
 Tambov Red**
 Yurino**
Local-international
 Russian Black Pied:
 Central Russian Black Pied
 Ural Black Pied
 Russian Simmental:
 Sychevka
 Ural Simmental
 Volga Simmental
 Russian Swiss
Composite
 Bestuzhev
 Gorbatov Red**
 Istoben

New North Caucasian
 Tambov Red**
 Yurino**
Multiple composite
 Kostroma
 American-European
 Kholmogory Hybrid
Global / International
 Aberdeen-Angus
 Angeln
 Aubrac
 Ayrshire
 Blonde d'Aquitaine
 Brown Swiss
 Charolais
 Chianina
 Danish Red
 Danish Jersey
 Dutch-Friesian
 Galloway
 German Black Pied
 Hereford
 Jersey
 Limousin
 Russian Holstein
 Salers
 Simmental
 Swedish Red-and-White
 Swiss Brown

Ukraine

Extinct
 Cherkassy
 Chernigov
 Crimean
 Cuban Red
 Dnieper
 Donetsk
 Kuban-Black Sea
 Kuban Red
 Kuban Steppe
 Odessa
 Podolian
 Podolian Black Pied
 Polesian Marsh
 Red Colonist
 Taurien
 Tschernomeridian
 Ukrainian Whitebacked
 Werschowen
Authentic
 Hutzul**
 Ukrainian Grey*
Local derivative
 Red Ukrainian:
 Donetsk
 Crimean Red
 Zaporiz
 Ukrainian-Carpathian Brown
 Ukrainian Whiteheaded
Local-international
 Ukrainian Black Pied
 Ukrainian Pinzgau

Ukrainian Simmental
Multiple composite
 Askian Meat*
 New Red Dairy*
 Ukrainian Beef*
 breed lines:
 Polessian*
 Southern Ukrainian*
 Volynsk*
 Znamensk*
 Ukrainian Red-and-White
 American-European
 Ukrainian Dairy Red**
 Global / International
 Angus
 Aberdeen-Angus
 Ayrshire
 Brown Swiss
 Blonde d'Aquitaine
 Charolais
 Chianina
 Cuban Zebu
 Hereford
 Piemontese
 Simmental
 Swiss Brown
 Ukraine Holstein
 selection Canadian
 Ukraine Holstein
 selection European
 Continuous cross
 Ukrainian-Polish Red

ASIA

Southwest Asia

Armenia

Extinct
 Armenian landrace
 Lorii
 Exotic-local composite
 Caucasian Brown
 Unidentified
 Grey Caucasian

Azerbaijan

Extinct
 Azerbaijan Red
 Authentic
 Azerbaijan Zebu
 Exotic-local zeboid composite
 Azangus
 Azerbaijan Brown
 Global / International
 Cuban Zebu
 Holstein-Friesian
 Kostroma
 Polled Hereford
 Latvian Red
 unidentified
 Holloway

Dagestan

Extinct
 Dagestan Brown
 Landrace
 Dagestan Mountain
 North Caucasian
 Exotic-local composite
 Caucasian Brown

Georgia

Landrace
 Greater Caucasus:
 Georgian Mountain
 Khevsurian**
 Lesser Caucasus:
 Mingrelian Red*
 Exotic-local composite
 Caucasian Brown

Iran

Extinct
 Khuzestan landrace
 Landrace
 Bami
 Dashtiari
 Golpayegani
 Khorsan Zebu
 Kurdi
 Mazanderani
 Sistani
 Talishi
 Authentic
 Sarabi
 Local crossbred
 Nejd
 Global / International
 Ayrshire
 Charolais
 Danish Red
 Holstein-Friesian
 Jersey
 Montbéliard
 Red Sindhi
 Swiss Brown

Iraq

Landrace
 Dishti
 Jenubi
 Kurdi
 Authentic
 Sharabi
 Exotic-local composite
 Rustaqi
 Global / International
 Ayrshire
 Danish Red
 Holstein-Friesian
 Jersey
 Red Sindhi
 Swiss Brown

Israel / Gaza Strip

Landrace
 Oksh**
 Exotic composite
 Israeli Red
 Global / International
 American Brahman
 Charolais
 Hereford
 Hinterwäld
 Israeli Holstein
 Santa Gertrudis
 Simford
 Simmental
 Swiss Brown
 Tyrol Grey

Jordan

Landrace
 Arab**
 Global / International
 Aberdeen-Angus
 American Brahman
 Dutch-Friesian
 Hereford
 Holstein
 Jersey
 Santa Gertrudis
 Simmental

Lebanon

Extinct
 Beirut
 Landrace
 Baladi*
 Authentic
 Lebanese
 Global / International
 Damascus
 Danish Red
 Holstein-Friesian
 Jersey
 Swiss Brown

Syria

Landrace
 Bedu
 Jaulan
 Authentic
 Lebanese*
 Damascus*
 Chesi
 Global / International
 Angeln
 Danish Red
 Holstein-Friesian
 Jersey
 Swiss Brown

Turkey

Extinct
 Çukurova
 Diyarbakir

Dörtyol
 Eleskirt
 Halep
 Kalmuk
 Karacadag
 Karaısalı
 Kibris
 Kirim
 Kultak
 Malakan
 Seferihisar
 Siverek
 Siyah
 Urga Sigiri
 Urla
Landrace
 Anatolian Grey
 East Anatolian Red
 Çıldır**
 Göle**
 Kurdi
 Native Black
 Native Southern Yellow*
 South Anatolian Yellow Red*
 Kilis*
 Maras*
Exotic-local composite
 Anatolian Black Pied
 Turkish Brown
 Eskisehir Brown
 Yellow Pied
 Zavot**
 Unidentified
 Güney sarısı
 Global
 Aberdeen-Angus
 Anatolian Black Pied
 Angeln
 Brown Swiss
 Hereford
 Holstein
 Jersey
 Limousin
 Simmental
 Swiss Brown

Arabian peninsula

Bahrain

Global / International
 Holstein-Friesian
 Jersey
 Meuse-Rhine-Yssel

Kuwait

Global / International
 Guernsey
 Holstein-Friesian

Oman

Landrace
 Oman Baladi
 Zufari

Global
 Holstein-Friesian

Qatar

Global
 Holstein-Friesian
 Jersey

Saudi Arabia

Landrace
 Saudi Taurine**
 Hassawi*
 South Arabian Zebu
Global / International
 Devon
 Holstein-Friesian
 Jersey
 Limousin
 Meuse-Rhine-Yssel

United Arab Emirates

Global
 Holstein-Friesian

Yemen

Extinct
 Socotra
Landrace
 Yemeni Zebu

Central Asia

Kazakhstan

Landrace
 Kalmyk**
 Kazakh**
 Local Euro-Asian derivative
 Aulie-Ata
 Red Steppe
Exotic-local composite
 Byelagolova
Exotic-local multiple composite
 Ala-Tau
 Auliekol
Global / International
 Angus
 Brown Swiss
 Charolais
 Dutch-Friesian
 Hereford
 Simmental
 Swiss Brown
 Tyrol Grey

Kyrgyzstan

Landrace
 Central Kirgiz**
 North Kirgiz**
 Exotic-local composite
 Aulie-Ata
Exotic-local multiple composite
 Ala-Tau
Global

Dutch-Friesian
 Simmental
 Swiss Brown
 Yak
 Kyrgyz yak

Tadzhikistan

Landrace
 Tadzhik Zeboid
 Pamir
Exotic-local zeboid composite
 Schwyz-Zeboid
 TSSH-1
Global / International
 Holstein-Friesian
 Kholmogory
 Russian Swiss
 Swiss Brown

Turkmenistan

Landrace
 Khurasani
 Turkestan Zebu*
Global
 Holstein-Friesian
 Swiss Brown

Uzbekistan

Extinct
 Kuramin
 Fergana
Landrace
 Central Asian Zebu
 Karakalpak
Exotic-local zeboid composite
 Bushuev
Global / International
 Angus
 Dutch-Friesian
 Estonian Red
 Hereford
 Holstein-Friesian
 Latvian Brown
 Lithuanian Red
 Russian Red Steppe
 Santa Gertrudis
 Simmental
 Swiss Brown

Central-south Asia

Afghanistan

Landrace
 Afghan
 Kandahari
 Konari
 Shakhansurri
 Vatani
Global / International
 Brown Swiss
 Dutch-Friesian
 Holstein-Friesian
 Jersey

Red Sindhi
Sahiwal
Tharparkar
Zeboid continuous cross
Afghan Subtropical

Bangladesh

Extinct
Dacca-Faridpur
Kamdhino
Landrace
Bengali
Munshiganj**
North Bangladesh Grey*
Madaripur
North Bangladesh Grey
Red Chittagong
Global / International
Australian Friesian-Sahiwal
Hariana
Jersey
Red Sindhi
Sahiwal
Zeboid continuous cross
Pabna
Bibovine
Mithun

Bhutan

Landrace
Bajo
Goleng
Jaba
Trahum
Unidentified
Langu
Nagamee
Global
Jersey
Swiss Brown
Bibovine
Bami
Bibovine composite
datsa
datum
doeb
doebum
doethra
doethram
jatsa
jatsum
thrapa
thrabum
yanka
yankum
Yak
Bhutanese yak
Bovine hybrid
Mithun-Siri
haapa
merakpa

India

Extinct
Agar
Ajjumpur
Bagondha
Benne Chavadi
Bagondha
Bettadapur
Bhur
Brownsind
Chitaldrug
Deccan
Dhaurahra
Geonti
Goranea
Gujamavu
Gujerat
Hagalvadi
Hissar-Hansi
Kangam
Khariar
Konkan
Lingadahalli
Madras Red
Malabar
Malnad Gidda
Mandsur
Manjra Singhai
Masti dana
Midighesi
Molvally
Nagar
Nundi dana
Patha
Parehar
Pavagada
Shahabadi
Swanta Gosu
Vadhya
Vadhiyar
Landrace (desi)
Assam local
Bhagalpore
Gaini
Goonsur
Iduki*
Kapila
Kasargod Dwarf**
Khariar**
Khasi
Krishnagiri
Kumauni
Kuttanbula kullan
Ladakhi
Ladakh Hill**
Madhya Pradesh dwarf zebu*
Mampati*
Ramgarhi*
Son Valley*
Malnad Gidda**
Motu
*Naattukutta***
North Bengal Grey

Punganoor*
Purnea
Vattakari*
Vechur**
Authentic
Alambadi*
Amritmahal
Bargur
Dangi:
Kalakheri
Sonkheri
Deoni
Deogir
Gangatiri**
Gaolao
Gir
Hallikar
Hariana
Hissar
Kangayam
Manapari
Kankrej
Sanchori
Kenkatha
Kherigarh
Killari
Atpadi Mahal
Devni
Mhaswad
Nakali Khillari
Thillari
Malaimadu
Malvi
Saugar
Umatwara
Nagori
Nari
Ongole*
Deverakota
Ponwar
Pulikulam
Red Kandahari*
Red Sindhi
Sahiwal
Siri
Swanta Gosu
Tarai
Tharparkar
Cutchi
Local crossbreed
Bachaur
Binjharपुरi
Nimari
Khamala
Mewati
Shahabadi
Umbalachery**
Attukari Madu
Ganapathiyen Madu
Mariapillai Madu
Sooriyankattu Madu
Venna Madu
Local multiple composite

Krishna Valley**

Rath

Rathi*

Unidentified

Anaj

Tho Tho

Zosial

Bibovine

Mithun / Gayal

Arunachali:

adi

aki

nishi

Manipuri

Mizorami

Nagami

Zeboid local derivative

Taylor*

Zeboid composite

Frieswal*

Jersind**

Karan Fries

Karan Swiss

Sunandini

Phule Triveni

Zeboid multiple

composite

Kamaduk

Global / International

Australian Milking Zebu

Ayrshire

Danish Red

Dutch-Friesian

Holstein

Jersey

New Zealand Taurindicus

Swiss Brown

Zeboid continuous cross

Holstein x desi

Jersey x desi

Yak

Arunachal yak:

Bareback type

Bisonian type

Common type

Hairy forehead type

Chou-gau yak

Himachal yak

Ladakh yak:

Feral yak

Mountain type

Plateau type

Sikkim yak:

Aho yak

Bho yak

Nepal

Landrace

Achham*

Khaila

Kirko

Lulu

Morang

Pahadi

Nepalese Zebu:

Nepalese Hill Zebu

Kathmandu Valley Zebu

Authentic

Ponwar

Siri

Local derivative

Kachcha Siri

Local crossbred

Terai

Global / International

Ayrshire

Bachaur

Brown Swiss

Hariana

Holstein-Friesian

Jersey

Kherigarh

Sahiwal

Yak

Nepalese yak

Bovine hybrid

yakow

Pakistan

Landrace

Achai

Las Bela

Authentic

Bhagnari

Dhanni

Kankarej

Lohani

Red Sindh

Rojhan

Sahiwal

Local crossbreed

Cholistani

Cutchi

Dajjal

Thari

Local multiple composite

Hissari

Zeboid composite

Nari Master

Global / International

Ayrshire

Australian Frieswal

Australian Milking Zebu

Brown Swiss

Chinese Black-and-White

Droughtmaster

Dutch-Friesian

Holstein-Friesian

Illawarra

Jersey

New Zealand Taurindicus

Swedish Red-and-White

Zeboid continuous cross

Friesian x desi

Sri Lanka

Landrace

Sinhala

Local derivative

Tamankaduwa

Zeboid local derivative

Hatton**

Global / International

Australian Friesian-Sahiwal

Australian Milking Zebu

Ayrshire

Dutch-Friesian

Finnish Ayrshire

Gujarati

Holstein

Jersey

Killari

Kinniya

Meuse-Rhine-Yssel

Ongole

Red Sindh

Sahiwal

White Sindh

East Asia

China

Extinct

Bainiu

Changning

Danjiao

Dashanqian

Erlitou

Gaotai

Meiniu

Pingchuan

Pinzhou

Shanghai

Tangjiao

Taosi

Wanniu

Xiaohu

Yangba

Landrace

Hazake

Menggu

Anxi

Horqing

Ujumqin

Sanjiang

Tibetan Dwarf

Authentic

Bashan:

Chiya

Miaoya

Pingli

Qinba

Xizhen

Xuanhan

Bohai Black

Dabieshan:

Dabie Mountain

Huangpi

Dengchuan
 Zhaotong
 Diqin
 Ebian Spotted
 Fuzhou
 Guanfeng
 Hainan Humped
 Hmong
 Jiaxian Red
 Ji'an
 Jinan
 Jinnan Yellow
 Keerqin
 Leiqiong
 Leizhou
 Lepcha
 Lingnan
 Luxi:
 Szyang
 Tanyang
 Minnan
 Nanyang
 Panjiang
 Guanling
 Liping
 Longlin
 Sinan
 Wenshan
 Pinglu Mountain
 Qinchuan
 Zaosheng
 Wannan
 Wenling Humped
 Wuling:
 Enshi
 Xiangxi
 Yanbian
 Yunnan Zebu:
 Dali
 Dehong
 Xishuangbanna
 Zaobei
 Zhoushan
Bibovine
 Dulong
Local Euro-Asian derivative
 Sanhe
Exotic-local composite
 Altay Whiteheaded
 Caoyuan Red
 Xinjiang Brown
Unidentified
 Apeijaza
 Caidamu
 Chunnan Mountain
 Ganzhizang
 Jinjang
 Liangsan
 Menyshan
 Nandan
 Pinguru
 Rikaze Humped

Taihang
 Weining
 Weizhou
 Wuchuan Black
 Xuzhou
 Zhangmu
Global / International
 Aberdeen-Angus
 Australian Braford
 Charolais
 Dairy Shorthorn
 Danish Red
 Droughtmaster
 German Gelbvieh
 Hereford
 Holstein
 Jersey
 Limousin
 Murray Grey
 Piemontese
 Red Sindhi
 Red Poll
 Simmental
 South Devon
Continuous cross with exotics
 Chinese Black-and-White
 Beijing Black Pied
 Yak
 Henduan Alpine yak:
 Alpine yak
 Bazhou
 Huanhu
 Jiulong
 Yardong
 Qinghai-Tibet Plateau yak:
 Daton yak
 Gannan
 Luqu
 Maiwa
 Qinghai Plateau yak:
 Tianzhu White yak
 Zhogdian
 Xinjang
Unidentified yak
 Muli
 Niangya
 Pali
 Sibiu
Bovine hybrid
 yakow:
 false pien niu
 improved pien niu
 local pien niu

Japan
Extinct
Atsuta Tsuru
Fuki Tsuru
Kaiyo-washu
Kenrangyu
Mishima ushi
Nambu

Shusuku Tsuru
Tonkaku Washu
Wagyu
Yoshi Tsuru
Landrace
*Kuchinoshima***
Authentic
 Mishima*
Local Euro-Asian derivative
 Japanese Black
 Shimane
 Tajima
 Tottori
Exotic-local composite
 Japanese Brown:
 Kochi
 Kumamoto
 Japanese Shorthorn
Global / International
 Angus
 Ayrshire
 Beef Shorthorn
 Blonde d'Aquitaine
 Charolais
 Devon
 Gasconne
 Hereford
 Japanese Holstein
 Jersey
 Limousin
 Maine-Anjou
 Montbéliard
 Murray Grey
 Normande
 Salers
 Simmental
 South Devon
 Swiss Brown
 Tarentaise
Continuous cross with exotics
 Japanese Poll*

Mongolia
authentic
 Mongolian:
 Dornod talyn
 Hevshil
 Gobi Steppe
 Khalkhun Golun
Exotic-local composite
 Mongolian Whiteheaded
 Mongolian Yellow-Brown
 Selenge
unidentified
 Kalimag
Global / International
 Ala-Tau
 Swiss Brown
 Holstein-Friesian
Continuous cross with exotics
 Mongolian Black Pied
Yak
 Mongolian yak:

Common yak
Bareback yak
Bovine hybrid
khainag
sarlag

North Korea

Landrace
Korean Native

Russia (Asian part)

Extinct
Altay
Buryat
Kemerovo
Oka
Russo-Siberian
Siberian White*
Transbaikalian
West Siberian
Authentic
Kalmyk
Yakut
Exotic-local composite
Russian Simmental:
Far Eastern Simmental
Siberian Simmental
Siberian Black Pied
Exotic-local multiple composite
Kurgan*
Global / International
Ayrshire
Brown Swiss
Charolais
Jersey
Hereford
Holstein-Friesian
Kholmogory
Milking Shorthorn
Swiss Brown
Yaroslavl

South Korea

Authentic
Hanwoo
Black Hanwoo
Brindle Hanwoo**
Brown Hanwoo
Jeju Black
Global
South Korean Holstein
Akaushi

Southeast Asia

Cambodia

Landrace
Cambodian:
Highland Khmer
Lowland Khmer
Moi
Bovine hybrid
Lowland Khmer x banteng

Highland Khmer x banteng
International
Hariana

Hong Kong

Authentic or extinct
Hong Kong Zebu
Global
Ayrshire
Holstein
Jersey

Indonesia

Extinct
Blateran Java
Mirrit
Sumatra cattle
Local derivative of
bibovine composite:
Javanese
Galekan
Rambon Banyuwangi
Jawi Pandaan
Brebes
Madura
Madura karapan
Madura sonok
Local derivative of
bibovine composite
Borneo Zebu
Kabota
Kaningan
Javanese Ongole
Javanese Zebu
Merauke
Sumatra Ongole
Pesisir
Aceh
Bibovine
Bali cattle
White Bali cattle
Rambon Bali
Rambon Madura
Exotic local composite
Madrasin
Global / International
American Brahman
Australian Frieswal
Australian Milking Zebu
Droughtmaster
Dutch-Friesian
Gir
Hissari
Holstein
Kankrej
Limousin
Montgomery
Mysore
Santa Gertrudis
Simmental
Sumba Ongole
New Zealand Taurindicus
Continuous cross with exotics
Grati

FH red pied
FH red pied dual-purpose

Laos

Landrace
Laotian:
Laos Yellow
Ngoua
Bibovine
gayal
International
Sahiwal

Malaysia

Extinct
Malay banteng
Authentic
Kedah-Kelantan
Bibovine
gayal
Exotic-local composite
Brakmas
Charoke
Global / International
American Brahman
Angus
Australian Frieswal
Australian Milking Zebu
Bali cattle
Braford
Charolais
Droughtmaster
Hallikar
Hereford
Holstein-Friesian
Kangayam
New Zealand Taurindicus
Ongole
Red Sindhi
Sahiwal
Continuous cross with exotics
Local Indian Dairy
Mafriwal
Bovine hybrid
Selembu
Seladang x Holstein-Friesian

Myanmar (Burma)

Landrace
Burmese:
Burmese Racing
Shan
Local crossbred
Chaubauk
Kadonta
Kyank Phu
Pyar Phu
Pyar Zein
Shwe Ni Gyi
Bibovine
Mithun
Global / International
Finnish Ayrshire

Holstein-Friesian
Jersey
Red Sindhi
Sahiwal
Tharparkar

Philippines

Extinct
Philamin
Landrace
Batanes Black
Authentic bibovine composite
Batangas
Bibovine multiple composite
Ilocos:
 Large Ilocos
 Small Ilocos
Iloilo
Global / International
Afrikander
American Brahman
Australian Brahman
Australian Frieswal
Ayrshire
Brown Swiss
Charolais
Danish Red
Hallikar
Hereford
Holstein
Illawarra
Indo-Brazilian
Jersey
Ongole
Red Sindhi
Sahiwal
Santa Gertrudis
Simbrah
Tharparkar

Taiwan

Extinct
Taiwan Yellow
Landrace
Taiwan Black
Exotic-local composite
Taiwan Zebu
Global / International
Charolais
Droughtmaster
Holstein
Red Sindhi
Sahiwal
Santa Gertrudis
Tharparkar

Thailand

Authentic bibovine composite
Thai:
 Thai Fighting
 Thai Highland
 Thai Lowland

Bibovine
gayal
Global / International
American Brahman
Charolais
Danish Red
German Brown
Hereford
Holstein-Friesian
Jersey
Limousin
New Zealand Taurindicus
Red Angus
Red Sindhi
Sahiwal
Swiss Brown
Local crossbred or continuous cross
White Lumpoon
Kho Peun Nyang Thai E San

Vietnam

Landrace
Hmong
North Vietnamese Yellow
 Cao Bang
Uriu
Bibovine
gayal
Local crossbred
South Vietnamese Yellow:
 Baria
 Phu Yen
 Tuy-Hoa
 Thanh-Hoa
Tonkin Zebu
Exotic-local composite
Laisind
Global / International
American Brahman
Belmont Red
Charolais
Droughtmaster
Hereford
Holstein-Friesian
Jersey
Limousin
Ongole
Red Brahman
Red Brangus
Red Sindhi
Sahiwal
Santa Gertrudis
Simmental

AFRICA

North Africa

Algeria

Extinct
Aïn-Beïra
Biskra

Beni Sliman
Chélif
Oran
Tiaret
Authentic
Brune de l'Atlas:
 Chaouia
 Guelma**
 *Cheurfa***
 *Kabyle***
Global / International
Aubrac
Charolais
Holstein-Friesian
Montbéliarde
Normande
Piemontese
Simmental
Tarentaise
unidentified
Mehalli

Egypt

Authentic
Egyptian:
 Damietta
 Egyptian Baladi
 Menufi
 Maryuti
 Hassawi
 Saïdi
Global
Brown Swiss
Hereford
Holstein-Friesian
Jersey
Shorthorn
Continuous cross with exotics
Khalit
Unidentified
asri

Libya

Authentic
Libyan Shorthorn
Global / International
Brown Swiss
Holstein-Friesian
Jersey
Montbéliarde
Tarentaise

Morocco

Extinct
Beni-Ashene
Blond Zaërs
Branes
Demnat
Fez-Meknès
Oulmès Blond
Zemour
Authentic
Brune de l'Atlas:

Blonde d'Oulmès et des Zaërs
Noire Pie de Meknès

Tidili

Global / International

Aubrac

Brown Swiss

Charolais

Holstein-Friesian

Montbéliarde

Santa Gertrudis

Tarentaise

Tunisia

Extinct

Béja

Djerba

Ichkeul

Mateur

Kef

Authentic

Mogod**

*Blonde-du Cap Bon***

Exotic-local multiple composite

Thibar

Global / International

Aubrac

Charolais

Finnish Ayrshire

Holstein-Friesian

Limousin

Modicana

Montbéliarde

Normande

Ongole

Red Sindhi

Sahiwal

Tarentaise

West Africa

Benin

Extinct

Pabli

Authentic

West African Shorthorn:

*Lagunaire**

Somba

Zébu Peul

Local crossbred

Borgou

Borgou-zébu

Global / International

N'Dama

Burkina

Authentic

Azaouak

M'Bororo

Savannah Shorthorn:

Baoulé

Baoulé de Ghana

Lobi

Somba

Zébu Peul

Local crossbreed

Bobori

Méré

Global / International

Brown Swiss

Holstein-Friesian

Jersey

Limousin

Montbéliarde

N'Dama

Tarentaise

Chad

Authentic

Kouri

Kréda

Savannah Shorthorn:

Logone

Taurin de l'Est

Shuwa Arabe

Kilara

Local crossbreed

Fellata

Local crossbred

Kanem

Toubou

Global / International

N'Dama

Cote d'Ivoire

Extinct

Oudalan

Authentic

West African Shorthorn:

Baoulé

Lobi

*Lagune***

Peuhl Voltaïque

Local crossbreed

Méré

Local composite

N'Damaza

Exotic-local composite

N'Dama-Jersey

N'Damance

Global / International

Abondance

Jersey

N'Dama

Simmental

Zébu Peul soudanais

Gambia

Extinct

Gambian Dwarf

Local crossbreed

Gambian N'Dama

International

Gobra

Ghana

Extinct

Ghana Dwarf Muturu

Authentic

Savannah Shorthorn:

Ghana Shorthorn

Diali

Local derivative

White Sanga

Composite

Ndagu

N'Dama-Sanga

Global / International

Adamawa

Azaouak

Boran

Brahman

Braford

Droughtmaster

Hereford

Holstein-Friesian

Jersey

N'Dama

Ongole

Red Poll

Sahiwal

Santa Gertrudis

Sokoto Gudali

Swiss Brown

White Fulani

Guinea

Authentic

N'Dama

Local crossbreed

Méré

Global / International

Ayrshire

Holstein-Friesian

Jersey

Red Steppe

Guinea-Bissau

Landrace

Manjaca

Authentic

Boenca

Local derivative

N'Gabú

Local continuous cross

Foula

Global / International

Gir

Nelore

Unidentified

Thomton

Liberia

Authentic

Dwarf Shorthorn:

Liberian Dwarf Muturu

Global / International

Angus

Baoulé
Brahman
Brown Swiss
Fouta Longhorn
Hereford
Santa Gertrudis

Mali

Authentic
Azaouak
Baoulé
Moor
Zébu Peul soudanais:
 Zébu de Kaarta
Zébu Peul de Macina
Zébu Peul Sambourou
 Zébu Peul de Ségou
 Zébu Toronké
Méré Ouolosso
local crossbreed
Bambara
N'Dama de Kaarta
Méré Kourouni
Global / International
Charolais
Jersey
Montbéliarde
Red Sindhi
Sahiwal
Tarentaise

Mauritania

Authentic
Maure
Gobra
Zébu Peul soudanais
 Zébu Toronké
Global
Holstein-Friesian

Niger

Authentic
Azaouak
Gobra
Goudali
Kouri
 Taurien de Sayam
M'Bororo
 Abrankeji
 Na' i iririji
 Poulpulli
Yakanaji
Zébu Arabe
 Batarde
 Kabi
 Noble
Zébu Peul nigérien
Local crossbred
Toubou
Global
Charolais
Tarentaise

Nigeria

Extinct
Biu
Yola Gudali**
Authentic
Adamawa Gudali
Azaouak
Diali
Kuri
Nigerian Shorthorn:
 Bakosi*
Muturu:
 Dwarf Muturu
 Montane Muturu
 Forest Muturu
 Savannah Muturu
Red Bororo
Shuwa Arab
 Wadara
Sokoto Gudali
White Fulani
Local crossbreed
Banyo
Borgu
Kapsiki*
Local crossbred
Jotko
Keteku
Lagos Cross
Sokoto Keteku
Global / International
American Brahman
Brown Swiss
Butana
Droughtmaster
Holstein
Jersey
N'Dama
Sahiwal
Santa Gertrudis
South Devon

Senegal

Extinct
Manjaca
Senegambian Shorthorn
Authentic
Gobra:
 Dagana
 Gobra de Baol
 Gobra de Djoloff
Foula
N'Dama Petite
Local derivative
Djakoré
N'Gabou
Local composite
Bambey
N'Damazza
Global / International
Holstein-Friesian
Kankrej
Nelore

Red Sindhi
Sahiwal

Sierra Leone

Authentic
N'Dama
International
Sahiwal
Kenya Friesian

Togo

Extinct
Avétonou
Authentic
West African Shorthorn:
 Konkomba
 Lagune
Local crossbred
Lagunaire grande modele
Global / International
American Brahman
Brown Swiss
Fulani
Gelbvieh
Gir
Kankrej
N'Dama
Shuwa-Aral
Simmental
Wakwa

North-Central Africa

Cameroon

Extinct
Bamiléké
Préwakwa
Authentic
Arabe Choua
M'Bororo
Foulbé blanc
N'Gaoundéré
West African Shorthorn:
 Bakosi**
 Bakweri**
Local crossbreed
Goudali de Banyo
Kapsiki
*Yola***
Local crossbred
*Doayo***
Massa
Pul-M'Bor
Wodaabe
Exotic-local composite
*Wakwa***
Global / International
Brahman
Baoulé
Charolais
Holstein-Friesian
Jersey
Limousin

Montbéliarde
N'Dama
Normande
Pinzgauer
Salers
Tarentaise

Centrafrique

Authentic
Goudali
M'Bororo
Composite
N'Dama-M'Bororo
Global / International
Baoulé
Montbéliarde
N'Dama
White Fulani

Congo

International
Baoulé
Kenya Boran
Lagune
N'Dama
N'Gaoundéré

Gabon

Composite
Okuma
International
Baoulé
Dahomey
N'Dama
Nguni
Tuli

Northeast Africa

Djibouti

Authentic
Aden
Afar

Eritrea

Extinct
Bileri
Authentic
Abyssinian sanga:
 Aradó
 Danakil
South Arabian Zebu:
 Baherie
 Beja
North Sudan Zebu:
 Barca
Global
Holstein-Friesian
Kenya Friesian

Ethiopia

Extinct
Arusi-Galla

Gimira
Authentic
Abyssinian sanga:
 Afar
 Aradó
 Raya-Azebó
 Fogera
 Horro

Abyssinian
Shorthorn Zebu:
 Adwa
 Ambo
 Arsi
 Bale
 Gamo-Goffa:
 Gamo highland
 Gamo lowland
 Gojjam Highland
 Guraghe
 Harar
 Jem Jem Zebu
 Jijjiga Zebu
 Mursi
 Smada
 Sheko
 Wollo Highland
 Qocherie

Boran Zebu:
 Orma Boran
 Ogaden Zebu
 Hammer Zebu
Karamajong Zebu:
 Murle

Nilotic sanga:
 Abigar
North Sudan Zebu:
 Begait
 Dohin

Local crossbreed

Abergelle
Giddu
Goda
Dembia
Irob
Medenes
Global
Ayrshire
Holstein-Friesian
Jersey
Kenya Friesian

Somalia

Extinct
Bimal
Singhi
Authentic
Awai
 Jiddu
North Somali Zebu:
 Eastern North Somali Zebu
 Western North Somali Zebu
Garre
 Magal

Gasara

Sudan

Extinct
Nuba Shorthorn
Authentic
Arashie
North Sudan Zebu:
 Baggara:
 White Nile Baggara
 Nyalawi Baggara
 Hawazma Baggara
 Butana:
 Bambawa
 Dongola
 Shendi
 Kenana:
 Fung Kenana
 Gezira
 Ingessana
 White Nile Kenana
Habbani
Red Bororo
Local crossbreed
Fellata
Kanouri
Nuba Mountain Zebu
Global / International
Ayrshire
Brown Swiss
Holstein-Friesian
Normande
Sahiwal

South Sudan

Authentic
Karamajong Zebu
 Murle
 Toposa
Nilotic sanga:
 Abigar
 Aliab Dinka
 Aweil Dinka
 Nuer
 Eastern Nuer
 Shilluk
Mongalla:
 Bari
 Didinga
 Latuka

East Africa

Kenya

Authentic
Boran Zebu:
 Kenya Boran
 Orma Boran
Coastal Zebu:
 Durama
 Giriama
 Kamba
 Taita

Karamajong Zebu:
Turkana*

Kilimanjaro Hill Zebu:
Chagga**

Kikuyu Highland Zebu

Masai Zebu

Teso Zebu

Suk*

Kipsiki

Western Province Zebu:

Kamasia

Karapokot

Nandi

Samburu

South Kavirondo

Teso

Watende

Winam

Exotic-local composite

Boran x Holstein

Kenyawal

Global / International

Afrikander

Ayrshire

Brown Swiss

Charolais

Devon

Finnish Ayrshire

Guernsey

Hereford

Jersey

Kenya Friesian

Kenya Sahiwal

N'Dama

Red Poll

Simmental

Tarentaise

Tanzania

Extinct

Masai Grey

Taurindicus

Ugoi

Unguja Shorthorn

Authentic

Ankole:

Enyambu

Iringa Red

Kilimanjaro Hill Zebu:

Chagga**

Mbulu**

Pare**

Masai Zebu

Mkalama Dun

Pemba Zebu

Sango

Singida

Tanganyika Shorthorn Zebu

Ugogo

Zanzibar Zebu

Local crossbreed

Nkasi Fipa

Sukuma

Sumbawanga Fipa

Tarime

Exotic-local multiple composite

Mpwapwa*

Global / International

Afrikander

Australian Milking Zebu

Ayrshire

Holstein-Friesian

Jersey

Kenya Boran

Jiddu-Tuni

Red Sindhi

Sahiwal

South-Central Africa

Burundi

Authentic

Ankolé:

Busoni

Inyambu

Inyaruguru

Mugamba

*Ruzizi***

International

Sahiwal

Democratic Republic of Congo

Extinct

Bantu cattle

Wadai Dinka

Authentic

Angolan

Bahima

Kivu sanga*

Bashi*

Lugware

Ruzizi**

Local crossbreed

Alur

Kigezi

Exotic-local multiple composite

Kisantu

Mateba

Global / International

Afrikander

American Brahman

Angus

Barotse

Brown Swiss

Charolais

Devon

Guernsey

Hereford

Holstein-Friesian

Jersey

Lagune

Limousin

Mayombe

N'Dama

Red Sindhi

Sahiwal

Shorthorn

Simmental

Tharparkar

Tonga

Unidentified

Dhani

Rwanda

Authentic

Ankole:**

*Ibigarama***

*Inkuku***

*Inyambo**

Global / International

Bonsmara

Boran

Holstein-Friesian

Jersey

Kenya Friesian

Sahiwal

Simmental

Uganda

Extinct

Sesse Shorthorn

Karagwe Shorthorn

Kigezi Shorthorn

Authentic

Ankole:

Bahima Ankole*

Kigezi

Nganda

Nkiga

Nsongora

Ntuuku

Karamajong

Jie

Lugware

Nkedi

Local crossbreed

Nyoro

Serere

Teso Zebu:

Kyoga

Usuk

Global / International

Boran

Hinterwäld

Holstein-Friesian

Red Poll

Welsh Black

Indian Ocean Islands

Comoros

Landrace

Primitif

Continuous cross

Amélioré

International

Zébu Malgache

Madagascar

Authentic

*Baria***

Zébu Malgache

Exotic-local composite

*Manjan 'i Boina***

*Renitelo**

Continuous cross with exotics

Rana

Global / International

Afrikander

American Brahman

Brown Swiss

Holstein

Limousin

Normande

Norwegian Red

Sahiwal

Mauritius

Authentic

*Créole de Maurice***

Zébu de Maurice

International

Kankrej

Sahiwal

Zébu Malgache

Amsterdam Island

Feral crossbred

*Ile d'Amsterdam***

Seychelles

Feral

*Felicité***

Southern Africa

Angola

Authentic

Barotse

Cateta

Humbe

Kombe

Kwaniama

Mocho do Malange

Mocho do Quitengues

Mucubai

Mumuila

Ngombe

Nhaneca

Porto Amboim

Local crossbred

Damara

Ovambo

Exotic-local composite

Barra do Cuanzo

Pitangueira

Global / International

Afrikander

American Brahman

Bonsmara

Brown Swiss

Charolais

Daomé

Holstein-Friesian

Jersey

N'Dama

Nelore

Nguni

Santa Gertrudis

Simbrah

Simmental

Botswana

Extinct

Damara-Herero

Mangwato

Ngami

Ngwato

Southern Tswana

Sekgatla

Local crossbred

Damara

Local amalgamate

Tswana:

Batawana

Sengologa

Seshaga

Exotic-local multiple composite

Musi

Global / International

Afrikander

Bonsmara

Brahman

Charolais

Chianina

Dairy Shorthorn

Hereford

Holstein-Friesian

Pinzgauer

Santa Gertrudis

Simbrah

Simmental

South Devon

Sussex

Tuli

Malawi

Authentic

Malawi Angoni:

North Malawi Angoni

South Malawi Zebu

Exotic-local composite

Mikolongwe

Global / International

Afrikander

American Brahman

Holstein-Friesian

Jersey

Unidentified

Nkole

Mozambique

Authentic

Angonia

*Landim**

Local crossbreed

Bovines da Tete

Mashona

Global / International

Afrikander

Aberdeen-Angus

American Brahman

Chianina

Hereford

Holstein-Friesian

Pinzgauer

Santa Gertrudis

Simmental

Namibia

Extinct

Herero

Authentic

Caprivi sanga

Kaokoveld

Kashibi

Okavango

Local crossbred

Damara

Ovambo

Exotic-local crossbred

Nama

Exotic-local composite

Holmonger

Nuras

Global / International

Aberdeen-Angus

Afrikander

Belgian White-Blue

Brown Swiss

Charolais

Hereford

Hinterwäld

Holstein-Friesian

Pinzgauer

Red Poll

Shorthorn

Simbrah

Simmental

Sussex

South Africa, Lesotho,

Swasiland

Extinct

Ama-Xosa

Basuto (original)

Bavenda

Bolowana

Cup-Shape-Horn

Kemp

Long-Twisted-Horn

Namaqua

Notch-Neck

Ondongolo

Pondo

Tintern Black

Uysbees

Vaderlanders
 Zwazi
 Zulu
Authentic
 Afrikander
 Yellow Afrikander
 Poll Afrikander
Reconstructed
 Royal Zulu herd
Local amalgamate
 Nguni:
 Bapedi
 Shangan
 Xosa
 West Sanga
Local composite
 Borguni
 Okouma
 Sanganer
Local Euro-African derivative
 Drakensberger
Exotic-local composite
 Afrigus
 Bonsmara
 Roodenbos
 Vaalhaiz
 Wesselsvlei
 Huguenot
 Supertaler
 Symons cattle
 Tauricus
 Tulim
Global / International
 Australian Red
 Kashibi
 Red Pied Schleswig- Holstein
 Gir-Brahman
 SA Aberdeen Angus
 SA Ayrshire
 SA Beefmaster
 SA Beef Shorthorn
 SA Boran
 SA Brahman
 SA Braunvieh
 SA Brangus
 SA Charbray
 SA Charolais
 SA Chianina
 SA Dairy Shorthorn
 SA Dairy Swiss
 SA Dexter
 Dexter-Kerry
 SA Gelbray
 SA Gelbvieh
 SA German Red
 SA Gir
 SA Guernsey
 SA Hereford
 SA Highland
 SA Holstein
 SA Jersey
 SA Kerry
 SA Limousin

SA Marchigiana
 SA North Devon
 SA Pinzgauer
 SA Red
 SA Red Poll
 SA Romagnola
 SA Salers
 SA Santa Gertrudis
 SA Senepol
 SA Simbrah
 SA Simmentaler
 SA South Devon
 SA Sussex
 SA Tuli
 SA Wagyu
 SA Weebollabolla
 Veldmaster
Continuous cross
 Basuto
 Bovelder
 SA Red

Zambia

Extinct
 Govuvu
Authentic
 Angoni
 Chipata-Katete
 Lundazi
 Barotse
 Baila
 Tonga
Local crossbreed
 Fipa
Global / International
 Afrikander
 German Gelbvieh
 Hereford
 Holstein-Friesian
 Jersey
 Kenya Boran
 Sahiwal
 Simmental
 Sussex

Zimbabwe

Extinct
 Amabowe
 Binga
 Govuvu
 Makalanga
 Manguni
 Ngwato
 Pecanite
Authentic
 Barotse
 Tonga
 Tuli
Reconstructed
 Mashona
Local derivative
 Nkone**
Global / International

Afrikander
 Aberdeen-Angus
 American Brahman
 Angoni
 Ayrshire
 Charolais
 Guernsey
 Hereford
 Holstein-Friesian
 Jersey
 Kenya Boran
 Pinzgauer
 Red Poll
 Shorthorn
 Simmental
 Sussex
Continuous cross
 Veldmaster

AMERICA

Mexico and Central America

Costa Rica

Extinct
Criollo
Mysol
Authentic
Criollo lechero tropical **
Local derivative
*Doran***
Global / International
 Angus
 American Brahman
 Beefmaster
Indubrasil
Pardo Suizo
 Charbray
Charolés
 Guernsey
 Guzerat
 Holstein
 Jersey
 Nelore

El Salvador

Landrace
*Criollo**
Global / International
 American Brahman
 Angus
 Ayrshire
Charolés
 Guzerat
 Holstein
Indubrasil
 Jersey
 Nelore
Pardo Suizo
 Santa Gertrudis

Guatemala

Extinct
Criollo
Authentic
*Barroso***
Local taurindicine derivative
Achiote
Global / International
 American Brahman
 Angus
Charolés
Gyr lechero
 Holstein
Indubrasil
 Jersey
 Nelore
 Santa Gertrudis
Toro de Lidia

Honduras

Landrace
Criollo encastado
Global / International
 American Brahman
 Bralers
Criollo lechero tropical
 Guernsey
 Guzerat
 Holstein
Indubrasil
 Jersey
 Nelore
Pardo Suizo
 Red Poll
 Sahiwal
 Santa Gertrudis
Unidentified
 Red Shine

Mexico

Landrace
*Criollo de las montañas del Norte**
*Tarahuma**
*Chinampo**
*Frijolillo**
*Criollo de la Sierra Madre Occidental**
*Criollo del Golfo**
Local deivative
Corriente
Taurindicine crossbred
Criollo mexicano
Taurindicine composite
Suiz-Bu
Tropicarne
Troleche
Gobal / International
 American Brahman
 Angus
 Aubrac
 Boran
Charolés

Criollo lechero tropical
Gelbra
 Gir
 Guzerat
 Hereford
Holstein Mexicano
Indubrasil
Bonsai Zebu
 Jersey
 Limousin
 Nelore
 New Zealand Taurindicus
 Red Sindhi
 Romosinuano
 Salers
 Santa Gertrudis
Suizo Americano
Suizo Europeo
Toro de Lidia
 Tuli

Nicaragua

Extinct
Criollo
Authentic
*Criollo lechero tropical ***
Global / International
 American Brahman
 Angus
Charolés
 Guernsey
 Jersey
 Holstein
 Indubrasil
 Nelore
Pardo Suizo

Panama

Extinct
Criollo
Global / International
 American Brahman
 Australian Milking Zebu
 Brangus
Charolés
Criollo lechero tropical
 Guernsey
 Holstein
Indubrasil
 Jersey
 Nelore
Pardo Suizo
 Red Poll
 Santa Gertrudis

The Caribbean**Cuba**

Authentic
Criollo Cubano
 Miniature Criollo
Tinima
Composite

Crimousin
Taino de Cuba
Taurindicine composite
Caribe de Cuba
Chacuba
Siboney de Cuba
Mambi de Cuba
Global / International
 American Brahman
 Angus
 Ayrshire
Charolés
 Devon
 Gir
 Guernsey
 Guzerat
 Hereford
 Holstein
 Illawarra
Indubrasil
 Jersey
 Limousin
 Milking Shorthorn
 Nelore
Pardo Suizo
 Red Poll
 Sahiwal
 Santa Gertrudis
 Shorthorn
 South Devon
Continuous zebu cross
Cebú Cubano
Cebú lechero

Dominican Republic

Authentic
*Criollo Lechero ***
Taurindicine composite
*Romana Rojo**
Global / International
 American Brahman
 Angus
 Brangus
 Charbray
Charolés
 Holstein
 Nelore
Pardo Suizo
Rojo Jamaicano
 Santa Gertrudis

Haiti

Landrace
Créole
Global / International
 American Brahman
 Brown Swiss
 Jersey
 Holstein

Jamaica

Extinct
Creole Jamaicano

Taurindicine composite

*Jamaica Hope***
*Negro Jamaicano***
*Rojo Jamaicano**
Multiple zebu composite
Brahman Jamaicano
Global / International
American Brahman
Angus
Ayrshire
Charolés
Devon
Guernsey
Hereford
Holstein
Jersey
Pardo Suizo
Sahiwal
Santa Gertrudis
Shorthorn
South Devon
Welsh Black

Lesser Antilles

Local taurindicine derivative
Créole de la Martinique
Créole de Guadeloupe
Composite
Senepol
Global / International
American Brahman
Brown Swiss
Charolais
Guernsey
Holstein
Jersey
N'Dama
Red Poll
Santa Gertrudis

Puerto Rico

Landrace
*Créole***
Global / International
American Brahman
Ayrshire
Charolés
Holstein
Jersey
Pardo Suizo

Trinidad and Tobago

Local taurindicine derivative
Criollo de Trinidad
Créole
Global / International
American Brahman
Australian Milking Zebu
Charbray
Charolés
Guernsey
Holstein
Rojo Jamaicano

South America

Argentina

Extinct
Sierra Criollo
Suisbú
Tarquinos
Tropical
Tropicana
Landrace
*Chaqueño***
Fronterizo
*Ñata***
*Serrano**
Feral crossbred
*Criollo argentino Patagónico***
Composite
Limangus
Taurindicine composite

Herebu
Indusin
Global / International
American Brahman
Angus
Argentine Shorthorn
Beefmaster
Blonde d'Aquitaine
Braford
Brangus
Charbray
Charolés
Chianina
Danish Red
Devon
Gelbvieh
Guernsey
Hereford
Highland
Holando-Argentino

Jersey
Limousin
Lincoln Red
Nelore
Normande
Pardo Suizo
Piemontese
Polled Hereford
Red Poll
Retinta
Romagnola
Santa Gertrudis
Simmental
South Devon
Sussex
Swedish Red-and-White
Tuli
Continuous cross
Pampa

Bolivia

Extinct
Beni Criollo
Authentic

*Chaqueño***
*Valle Grande Criollo**
*Yacumeño**
Composite
*Saavedreño***
Local crossbred
Criollo altiplanico
Mestizo-Holstein
Global / International
American Brahman
Brangus
Charolés
Gir
Holstein
Nelore
Normande
Pardo Suizo
Santa Gertrudis

Brazil

Extinct
Angola
China
Crioulo leiteiro de Irecé
Dinamarquês
Flamenga
Franqueiro
Frisoña vermelho e branca
Guadamar
Guzerando
Igarapé
Indo-europeu leiteiro
Junqueiro
Legítimo
Malabar
Mineiro
Pedreiro
Quinhentão
Santa Gabriele
Suisbú
Landrace
*Curraleiro Pé-Duro**
*Pantaneiro***
Authentic
*Caldeano**
Caracú
Reconstructed
*Crioulo Lageano***
*Mocho Nacional***
*Patuá***
Local derivative
Crioulo Mocho Pereira
*Camargo***
Taurine composite
Aquitânica
Taurindicine composite
Bos certus
Braford brasileiro
Brangus-Ibagé
Branor
Bravon
Caiuá:
Caiuá 1

Caiuá 2
 Caiuá 3
 Canchim
 Canchim mocho
 Casteado**
 Carazebú**
 Charbray
 Girolando
 Girsey
 Guzerolando
 Guzolando
 Itapetinga
 Jaguanês
 Jerdi
 Lavínia*
 Natura
 Nelorando
 Pampiano-Braford
 Patuá
 Piemonel
 Pitalanda
 Pitangueiras
 Red Norte
 Riopardense
 Santa Clara
 Santa Mariana
 Simbrasil
 Simbrasil-Cariri
 Suiá
 Xingu
Zebu composite
 Indubrasil*
 Rojo Indubrasil*
 Tabanel*
 Tabapuá
 Zebú leiteiro de Uberaba
Global / International
 Aberdeen Angus colorado
 Aberdeen
 Ayrshire
 Beefalo
 Beefmaster
 Belted Galloway
 Blonde d'Aquitaine
 Charolês
 Charolês mocho
 Chianina
 Devon
 Droughtmaster
 Galloway
 Gelbvieh
 Guernsey
 Hereford
 Holandês
 Holandês Variedad Mosa,
 Rhino-e-Issel
 Jersey
 Limousin
 Lincoln Red
 Maine-Anjou
 Marchigiana
 Montbéliarde
 Normando

Normando mocho
 Pardo Suíço
 Pardo Suíço Corte
 Piemontês
 Pinzgauer
 Red Poll
 Rubia Gallega
 Salers
 Santa Gertrudis
 Shorthorn
 Simental
 Sussex
 Tarentaise
 Valdostana
International zebu
 Brahman
 Gir brasileiro
 Gir leiteiro
 Gir mocho
 Guzerá
 Guzerá leiteiro
 Guzerá mocho
 Kangayam brasileiro*
 Nelore
 Nelore mocho
 Nelore pintado em branco
 Nelore pintado em preto
 Nelore vermelho
 Sindhi*
Continuous taurindicine cross
 Mestiço leiteiro brasileiro
 Montana
Terminal F1 cross
 Charonel
 Chianel
 Gipardo
 Gironel
 Girindu
 Guzonel
 Indunel
 Nelogir
 Normanzu
 Sinderolando
 Subu

Chile
Authentic
 Criollo costino**
 Nata**
Local crossbred
 Criollo chileno
Global / International
 Galloway
 Charbray
 Charolês
 Hereford
 Jersey
 Lincoln Red
 Montbéliarde
 Negro japonês
 Normande
 Overo Colorado
 Clavel de Carne*

Overo negro europeo
 Rubia de aquitania
 Simmental

Colombia

Landrace
 Casanareño**
Authentic
 Blanco Orejinegro
 Blanco Orejimonono
 Caqueteño
 Chino Santandereano**
 Costeño con Cuernos**
 Hartón
 Romosinuano**
 San Martinero**
 Santa Coloma
Composite
 La Velásquez
 Lucerna*
 Simhol
Global / International
 American Brahman
 Ayrshire
 Charbray
 Charolês
 Gyrholando
 Holstein
 Jersey
 Normande
 Pardo Suizo
 Red Poll
 Santa Gertrudis
 Simmental
 South Devon
 Toro de Lidia
Continuous cross
 Cebú comercial

Equador

Extinct
 Costa Criollo
 Criollo de El Oro
 Criollo de Esmeraldas
Landrace
 Criollo equatoriano**
 Criollo de las Hoyas**
 Criollo del Páramo**
 Colorado**
 Encerado**
 Negro Lojano**
 Pintado**
Global / International
 American Brahman
 Hereford
 Holstein-Friesian
 Gir
 Jersey
 Pardo Suizo
 Santa Gertrudis
 Shorthorn
 Simmental
 Toro de Lidia

Falkland Islands

International
Highland
Shetland

French Guiana

Global
Simmental
Continuous taurindicine cross
Créole

Guiana

Taurindicine crossbred
Rupununi Criollo
Global / International
American Brahman
Charolais
Holstein
Jamaica Hope
Romana Red
Santa Gertrudis

Paraguay

Extinct
Pantaneiro
Landrace
*Chaqueño***
*Criollo Arroyos-e-Esteros**
Criollo Cral.Díaz
*Criollo Neembucú**
Composite breed
Pampa chaqueño
Global / International
American Brahman
Canchin
Charolés
Chianina
Hereford
Holstein
Hotlander
Indubrasil
Jersey
Limousin
Montana
Nelore
Nelore mocho
Normande
Roughmaker
Santa Gertrudis
Salers
Simmental
Stabilizer
Tabapuã

Peru

Landrace
Criollo peruano
Global / International
American Brahman
American Scottish
Charolés
Galloway
Gir

Holstein-Friesian
Indubrasil
Nelore
Normande
Pardo Suizo
Polled Simmental
Sahiwal
Santa Gertrudis
Simmental
Toro de Lidia

Surinam

Extinct
Criollo
Global / International
American Brahman
Australian Milking Zebu
Charolais
Dutch-Friesian
Hereford
Holstein
Indubrasil
Jersey
Meuse-Rhine-Yssel
Nelore
Red Sindhi
Santa Gertrudis
Continuous taurindicine cross
Surinam Mixed Criollo

Uruguay

Extinct
Colônia
*Nata***
Crossbred population
*Criollo***
Global / International
Angus
Blonde d'Aquitaine
Charolés
Chianina
Frisona
Hereford
Jersey
Limousin
Luig
Normande
Polled Hereford
Shorthorn
Simmental
Continuous cross
Pampa

Venezuela

Extinct
Ocampo
Perijanero
Landrace
*Llanero***
Authentic
Criollo lechero Limonero
Taurindicine crossbred
Mestizo perijanero

Composite

*Caroreña**
Composite zebu
Cebú Venezolano
Global / International
American Brahman
Charbray
Charolés
Danish Red
Gir
Holstein
Indubrasil
Limousin
Nelore
New Zealand Taurindicus
Pardo Suizo
Santa Gertrudis
Simmental
Toro de Lidia

North America**Canada**

Feral crossbred
Graham Island**
Authentic, European origin
*Canadienne***
European origin, dairy
American Ayrshire
Brown Swiss
Dutch Belted**
Canadian Holstein
Red Holstein
American Guernsey
American Jersey
Milking Shorthorn**
British origin, beef
Angus
Ancient White Park**
Beef Devon*
American Beef Shorthorn
Polled Shorthorn
American Belted Galloway**
American Galloway
American Hereford
American Luig
Mini Dexter*
Polled HerefordS
Red Angus
American Red Poll*
American South Devon*
American Welsh Black*
Scottish Highland
European-continental origin, beef
Abundance
Aubrac
Belgian Blue
Blonde d'Aquitaine
Braunvieh
Charolais
Chianina
Gasconne
Gelbvieh

Herens
 Limousin
 Maine-Anjou
 Marchigiana
 Montbéliard
 MRY
 Normande
 Parthenais
 Piedmontese
 Pinzgauer
 Romagnola
 Salers
 Simmental
 Tarentaise
American/Australian origin, beef
 American Brahman Murray Grey
 Santa Gertrudis
Yak
 American yak
Composite dairy
 Dairy Synthetic
Composite beef
 Beef Synthetic
 Burwash
 Fort Cross
 Hays Converter**
 Kinsella
 Romark
 Speckled Park
Multiple composite
 Pee Wee
 Shaver Beefblend
 Beefbooster
Terminal F1 cross
 RomAngus
Bovine hybrid
 Cattalo
 Yakmac

USA

Extinct
 Californian cattle
 Columbian
 Cream Pot
 Flemish
 Griffin
 Holderness
 Marks
 Native cattle
 Philips
 Poppel
 Polled Albion
 Polled Durham
 Red Dane
 Robinson
 Single Standard Polled Hereford
 Single Standard Polled Shorthorn
 Tornhill
 Woods
 Wright
 Yellow Dane
Feral crossbred
 Chirikof Island**

Hawaiian wild**
Authentic French and/or Iberian origin
 Florida Cracker**
 lines:
 Guinea dwarf**
 Grews brothers **
 Wassie Fish**
 herds:
 Ezell**
 Neal**
 Pineywoods*
 lines:
 Barnes**
 Broadus**
 Carter**
 Conway**
 Dedeaux**
 Hickman**
 Holt**
 herds
 Agricola**
 Baylis**
 Diamond**
 Ladner**
 Ladnier**
 Palmer-Dunn**
 Vice**
 Texas Longhorn*
 lines:
 Buttler
 Yates
 herds:
 Peeler
 Wichita Wildlife Refuge
Crossbreed
 Corriente
Authentic, European origin
 Randall Lineback**
European origin, dairy and dual-purpose
 American Ayrshire
 American Guernsey
 American Jersey
 Polled Jersey
 American Kerry**
 American Normande
 American Norwegian Red**
 Brown Swiss
 Dutch Belted**
 Holstein
 Polled Holstein
 Red Holstein
 Lineback:
 American G
 Colorsided
 Milking Devon**
 MRY**
 Milking Shorthorn*
 Poll Milking Shorthorn
British origin, beef
 American Beef Shorthorn
 Polled Shorthorn

American Belted Galloway*
 American Galloway*
 American Hereford
 American Black Hereford
 Line One Hereford
 American Luining
 Red Angus
 American Red Poll*
 American South Devon*
 American Sussex*
 American Welsh Black*
 American White Galloway**
 Ancient White Park**
 Angus
 Beef Devon**
 Poll Devon
 Beef Friesian
 Polled Hereford
 Scottish Highland
European-continental origin, beef
 American Maine-Anjou
 American Belgian Blue
 American Blonde d'Aquitaine
 American Braunvieh
 American Charolais
 Polled Charolais
 Black Charolais
 Red Charolais
 American Chianina
 Black Chianina
 Polled Chianina
 Black-Polled Chianina
 American Gelbvieh
 Black Gelbvieh
 Polled Gelbvieh
 Black-Polled Gelbvieh
 American Herens**
 American Limousin
 Black Limousin
 Polled Limousin
 Black-Polled Limousin
 American Marchigiana
 American Piedmontese
 American Pinzgauer
 American Romagnola
 American Salers
 Black Salers
 Polled Salers
 Black-Polled Salers
 American Simmental
 Black Simmental
 Polled Simmental
 Black-Polled Simmental
 American Tarentaise
 Beef Brown Swiss
Canadian/Australian origin, beef
 Hays Converter**
 Mandalong Special
Asian origin
 American Wagyu*
 American yak
Asian/African origin
 zebu and sanga

Africander*
 Ankole-Watusi
 Gir*
 Guzerat*
 Indo-Brazilian*
 Nellore*
 Red Sindhi*
Composite taurine, beef
 American White Park*
 Amerifax
 Balancer
 Better Idea**
 Black Maine-Anjou
 Char-Swiss
 Chiangus
 Chiford
 Chimaine
 Geltex
 MainTainer
 Makaweli
 M4 (Heyster)
 Regus
 RX3
 Salorn
 Senepol*
 Texon
 Wangus
Multiple composite taurine, beef
 Beef Machine
 Black Maximizer
 BueLingo*
 Cash
 Magnum
 Range Maker
Composite taurindicine, beef
 Angus/Brangus Plus
 Africangus
 Beefmaker
 Beefmaster
 Poll Beefmaster
 Braford
 Victoria
 Brah-Maine
 Brahmousin
 Brah-Swiss
 Bralers
 Brangus
 Branor
 Bravado
 Bravon
 Bucking Stock
 Charbray
 Charford
 Cuprem Hybrid
 El Monterey
 Gelbray
 Hash Cross
 Holgus
 Hotlander
 Kenesaw
 Noble Line
 Red Brangus
 Ritchie

Sabre
 Salerford
 Santa Cruz
 Santa Gertrudis
 Polled Santa Gertrudis
 Simbrah
 Simbrangerford
 Simbrahvieh
 South Bravon
 Watson
Multiple composite taurindicine, beef
 Barzona
 Ranger
 South Poll
Multiple composite zebu, beef
 American Brahman
 Grey Brahman
 Red Brahman
Miniature
 Bos indicus miniature
 Covingtonshire
 Grad-Wohl Miniature
Miniature Crossbreds and F1:
 Auburnshire
 Barbee
 Belted Irish Jersey
 Belted Lessor Jersey
 Belted Kingshire
 Belted Milking Devon
 Burienshire
 Covingtonshire
 Five Breed Grad-Wohl
 Four Breed Grad-Wohl
 Happy Mountain
 Justinshire
 Kentshire
 Red Kentshire
 Kingshire
 Panda
 Red Panda
 Mini Dextford
 Guinea Jersey
 Little Rowdy
 Lowline Angus
 Mini American Beltie
 Mini Belmont
 Mini Belfair
 Mini Brangus
 Mini Dexter*
 Mini Durham/Shorthorn
 Miniature Black Baldie
 Miniature Galloway
 Miniature Hereford
 Miniature Highland
 Miniature Holstein
 Miniature Spanish Las Manchas
 Miniature Texas Longhorn
 Miniature Zebu
 Sundog
Bovine composite
 American Breed
 Beefalo

Cattalo
 Hybridmaster
 Simmalo
Continuous cross
 Balancer
 Beefbooster
 lines:
 M1
 M2
 M3
 M4
 TX
 MARC
 lines:
 MARC I
 MARC II
 MARC III
Terminal F1 cross
 Black Baldie
 Brahmanstein
 Brahorn
 Charwiss
 Holgus
 Nelorford
 Okie
 Pinzbrau
 Range Fire
 Sahford
 Salerford
 Senagus

AUSTRALASIA, OCEANIA

Australia
Extinct
 Australian Milking Shorthorn
 Belmont Adapteur
 Darbalara
 Tasmanian Grey
Authentic, European origin
 Illawarra*
European/American origin, dairy
 Angeln
 Ayrshire
 Australian Holstein-Friesian
 Brown Swiss
 Dairy Shorthorn
 Danish Red
 Guernsey
 Jersey
 Red Holstein
 Swedish Red-and-White
British origin, beef
 Australian Angus
 Australian Lowline
 Aussie Black
 Red Line
 Australian Shorthorn:
 Australian Beef Shorthorn
 Australian Polled Shorthorn
 North Australian Shorthorn
 Weebollabolla
 Belted Galloway

British White
 Devon
 Dexter
 Galloway
 Australian Hereford
 Polled Hereford
 Lincoln Red
 Luing
 Red Angus
 Red Poll
 South Devon
 Sussex
 Welsh Black
European-continental origin, beef
 Australian Braunvieh
 Belgian Blue
 Blonde d'Aquitaine
 Charolais
 Chianina
 Gelbvieh
 German Brown
 Limousin
 Australian Polled Limousin
 Maine-Anjou
 Marchigiana
 Piemontese
 Romagnola
 Salers
 Simmental
Asian beef
 Black Wagyu
 Red Wagyu
Asian/African/ American origin
zebu and sanga
 Australian Africander*
 Australian Tuli*
 Australian Nadudana**
 Australian Brahman
 Australian Sahiwal*
 Australian Boran*
 Queensland Miniature Boran
 American Brahman
 Ongole
 Red Sindhi*
Bibovine
 banteng
Composite taurindicine, dairy
 Australian Frieswal
 Australian Milking Zebu
 Composite taurine, beef
 Adapteur
 Belmont BX
 Australian Grey
 Aussie Miniature Grey**
 Australian White
 Australian Beefmaker
 Chargrey
 Leachman Hybrids
 Murray Grey
 Paymaster
 Square Meaters
 Simford
Composite taurindicine, beef

Australian Braford
 Australian Brangus
 Australian Charbray
 Belmont Red*
 Bramalow**
 Chiangus
 Greyman
 Quasah
 Sahford
 Santa Gertrudis
Multiple composite taurindicine,
beef
 Droughtmaster
 Mandalong Special
 Wokalup*
Continuous cross taurine
 Australian Red Dairy
 Australian Commercial Dairy Cow
 Kyrhet Australian Miniature
 Cattle**
Terminal F1 cross
 Charsar
Unidentified
 Cape Cattle

New Zealand

Extinct
 Campbell Island
Reconstructed
 Enderby Island**
European/American origin, dairy
 Ayrshire
 Brown Swiss*
 Danish Red*
 Dutch Shorthorn**
 Guernsey*
 Kiwi
 Milking Shorthorn**
 New Zealand Friesian
 New Zealand Jersey
 Swedish Red-and-White
European/American/ Australian
origin, beef
 Aberdeen-Angus
 Beef Shorthorn
 Belted Galloway
 Braford
 British Black Limousin
 Charolais
 Chianina
 Devon
 Dutch Belted
 Galloway
 Hereford
 Hinterwald
 Limousin
 Maine-Anjou
 Mini Angus
 Murray Grey
 Red Poll
 Simmental
 South Devon
 Sussex

Welsh Black
Asian origin, zebu
 Sahiwal*
Continuous cross
 Leachman Hybrids
 New Zealand Taurindicus
 Stabilizer
Terminal F1 cross
 Kiwi

Papua New Guinea

Global / International
 Angus
 Australian Brahman
 Australian Braford
 Australian Milking Zebu
 Ayrshire
 Bali cattle
 Beef Shorthorn
 Droughtmaster
 Guernsey
 Hereford
 Holstein-Friesian
 Illawarra
 Java Ongole
 Jersey
 Madura
 Red Poll
 Red Sindhi
 Sahiwal
 Santa Gertrudis

Fiji (Melanesia)

Composite
 Yalavou
Continuous cross
 Charolais
 Jersey
 Ongole

Micronesia

Authentic, Iberian
 Marianas

Samoa

Global / International
 Australian Brahman
 Australian Braford
 Australian Frieswal
 Australian Holstein-Friesian
 Droughtmaster
 Jersey
 Piemontese
 Santa Gertrudis
Unidentified
 Samoa bovine

Solomon Islands

Composite
 Solomon Red

Breed names in local languages and English

Breeds are ordered according to the integrative classification (Felius et al., 2011). All parts of the entries are optional. Non-English names are in *italics*. Names after the indent refer to varieties or strains. Entries in **pale yellow color** are extinct or indicate closely related extinct or assimilated breeds or varieties.

Key:

Original local name(s) if not English / Non-English name in other country / Non-English synonyms (e.g., local name for imported breed) / former non-English names / English name / [country]

English name in other country / English synonyms / former English names and synonyms

Variety, strain if not in English / Non-English synonyms / extinct varieties if not in English

Variety, strain in English / English synonyms / extinct varieties in English

Original local name(s), if not English, of extinct breed / (further as for existing breeds, **pale yellow color**)

GROUP 1 Polled and 'Celtic' breeds from North and Northwest Europe Subgroup 1A Polled dairy breeds from Iceland, Scandinavia, the Baltics, and Northern Russia

*Islandska Mjólkurkyrinn / Islenskir Nautgripir, Islanenska kyrin / Icelandic Dairy / Icelandic
Vestlandsk Raudkolle / Westland Red Polled / Vestland Red Polled, West Coast Red Polled,
Western Red Polled, Westland Polled*

Lyngdal

Sør og vestlandsvfe / South and Westland

*Raukollie Østlandsfe / Østlandsk raudkollie, Ostlandsk rødkollie, Rautt kollet Østlandsfe, Rødkollie /
Red Polled Eastland / Eastern Red Polled, Eastland, Norwegian Red Polled,
Red Polled Ostland*

Jarlsberg

*Svensk Rødkulla / Röd Kullig Boskap, Röd Kullig Lantras, Svensk Kullig, Svensk rødkolla, Svensk
Kullig / Swedish Red Poll / Red Polled Landrace, Swedish Polled, North Swedish*

*Sidet Trønderfe og Nordlandsfe / STN / Black-sided Trondheim and Nordland / Coloursided
Trondheim and Nordland*

Sidet Trønderfe / Black-sided Trondheim / Black Trondheim

Nordlandsfe / Northland

Røros / Roros

*Fjällras / Fjällko, Jämtland, Svensk Kullig / Swedish Mountain / Fjell, Jamtland Mountain,
Swedish Highland, Swedish White Polled*

Herjeådals / Herjeådals

Rorbottenlän / Rorbottenland

Bohuskulla / Bohus Polled

Fjällnära ko / Fjall

Svensk Kullig / SKB / Swedish Polled

*Pohjoissuomenkarja / PSK / Pohjois-Suomalainen Karja, Pohjoissuomenkarja
/ Northern Finncattle / North Finnish, Lapland*

*Länsisuomenkarja / LSK / Länsi-Suomalainen Karja, Länsisuomenkarja / Western Finncattle
/ Brown Finnish, Red Finnish, West Finnish*

*Itäsuomenkarja / ISK / Itä-Suomalainen Karja, Itäsuomenkarja kyyttö / Eastern Finncattle
/ East Finnish, Red-and-White Finnish, Red Pied Karelian*

Eesti Maakari / Eesti Maatõug, Mestnaya èstonskaya / Estonian Native

Estonian land cattle

Polled Lithuanian land cattle

Red Pied Kareliyan / Red Pied Karelian

Severnyi Komolyyi skot / North Russian Polled

Murmansk

Olonets

Wijtegras

Vychegodsko Vymskaya / Vychegado-Vym / Vycheгда-Vym

Waldais

Lenfa
Zyryanka / Syrjänen
Ssuchona
Rokschenga
Perm / Komoloja
Tscherdian

Pechorskiï / Petsjora / Pechora
Mezen / Mesen
Komi

Subgroup 1B Horned dairy breeds from Scandinavia and Scotland and derivatives

Ayrshire / Cunningham, Carrick, Dunlop
Suomen Ayrshire / *Suomalainen Ayrshirekarja* / **Finnish Ayrshire**
Ayrskjerskaja / Russian Ayrshire
Telemarkfe / Telemark / Norwegian Mountain

Valdres
Hallingdal

Dølefe / Doela / Döle

Gudbrandsdal
Østerdal / Osterdal

Vestlandsk Fjordfe / Western Fjord / Vestland Fjord, West Coast Fjord, Westland Fjord,
Westland Horned

Hordaland
Westland Grey Möre

Kyst Kvaeg / Coastal land cattle

Norsk Rødt Fe / NRF / Norwegian Red

Rødt Trønderfe / Red Trondheim
Trønderfe / Trönder
Måselvfe / Malselv
Hornet Slettefe / Horned Lowland
Hedmark

Norsk Rødt og hvitt fe / Norwegian Red-and-White

Rótføroyskar Kýr / Færøerne, Færøesk / Faeroes / Faeroe Island

Allmoge ko / Allmogekor / Allmoge / Peasantry cow

Svensk Röd och Vit / SRB / Swedish Red-and-White
/ Swedish Red, Swedish Red Spotted

Småland / Smaland
Gotland

Olånd / Oland

Herrgård / Herrgard

Rödbrokig Svensk Boskap / RSB / Red Pied Swedish

Skåne / Shonen / Scanian

Sabyland

Waldholm

Frövidal

Amasa

Jonstrop

Svensk Ayrshire / SAB / Swedish Ayrshire

Agersø kvaeg / Agersøe / Danish Island

Subgroup 1C Polled breeds from Ireland, Scotland and England and derivatives

Maol / Irish Moiled / Irish Polled

Polled Irish

Irish Dun

Donegal Reds

Galloway / Southern Scotch Polled

Dun Galloway

Red Galloway

White Galloway

Rigget Galloway

Belted Galloway / Beltie, Sheeted Galloway, White-middled Galloway

Red Belted Galloway

Íslandska Galloway / Icelandic Galloway

Aberdeen-Angus (original population) / Polled Angus, Black Angus / Northern Scotch Polled

Brae-Glen

Aberdeenshire
Forfarshire
Buchan Humlie
Angus Doddie / Polled Aberdeenshire
Tyrone Black
Red Angus

Deutsche Angus / Deutsches-Angus-Fleischrind / German Angus

Swona

British White / White Polled

Lord Caernarvon's breed / Galway

Red Poll / Norfolk Polled, Norfolk and Suffolk Red Polled, Red Polled

Suffolk Dun / Suffolk Golden Dun, Suffolk Polled

Norfolk Horned / Norfolk Red / Old Norfolk

Earsham Polled

**Subgroup 1D Horned 'Celtic' breeds form Ireland, Scotland, England
and German derivatives**

Shetland / Zetland

Orkney

Highland / Black Cattle, Kiloe, Kyle, Norlander, Scotch Highland, Scottish Highlander, Skibo,
West Highlander

Fifeshire / Fife Horned, Falkland

WBS/Highland X

Hereland

Bluegrass

Luing

Sim-Luing

Wilseder Rote / Wilseder Red

White Park / English Park, White Forest, White Horned, Wild White

Dynevor

Cadzow / Hamilton

Chartley

Woburn

Vaynol / Faenol

Chillingham

Kerry

Dexter

Droimeann / Bó droimeann, DroimFiann / Drimmon

Welsh Black / Black Welsh / **Da Duon Cymru / Gwartheg Duon Cymreig**

North Wales Black

Anglesey / Anglesea

Pembroke / South Wales Black

Castlemartin / Castle Martin

Dewsland

Montgomeryshire

Polled Welsh Black

Ancient Cattle of Wales / **Gwartheg Hynafol Cymru / Coloured Welsh**

White Welsh

Belted Welsh / **Bolian Gwynion / Blanket cattle**

GROUP 2 Lowland breeds from West, North and Eastern Europe

**Subgroup 2A West and Northeast European Lowland red breeds
and East-European derivatives**

Rødt Dansk Malke race 1970 / RDM 70 / Rødt Dansk Malkekvæg, RDM-1970, Fynsk
/ Red Danish Dairy 1970 / Danish Red (old type), Fünen

Ballum / Schlesvig Marsh

økvaeg / Land cattle

Rødt Dansk Malke race / RDM / Rødt Dansk Malkekvæg / Danish Red Dairy / Red Dane,
Red Danish / British Dane

Angler-Deutsches Rotvieh / Angeln-German Red

Angler (alte Zuchtrichtung) / Angler Rotvieh, Rotvieh alter Angler Zuchtrichtung,

Angler Rind alter Zuchtrichtung / Angeln (original) / Old Red Angeln / Angeln Red

Roter Nordschleswigscher Milchviehschlag / Red North Schleswig Dairy

/ North Schlesvig Red

Einfarbige Rotbraune Ostfries / Unicoloured Red-brown East Friesian

Donnersberger Rotvieh / Donnersberg Red

Lietuvos Zalieji Gulvijai / LZG / Krasnaya litovskaya / Lithuanian Red

Lithuanian land cattle

Latvijas brūnā / LB / Buraya latviškaya / Latvian Brown / Latvian Red, Latvian Red-brown

Eesti Punane Kai / EPK / Krasnaya èstonskaya / Estonian Red / Estonian Brown,

Estonian Red-Brown

Polska Czerwona / Polska czerwona / Polish Red / Polish Red Lowland

Śląska czerwona / Śląska czerwona / Schlesisches Rotvieh – Tieflandschlag

/ Silesian Red

Rawicka / Rawicz

Wilna

Dolinowa / Lowland

Krasnaya belorusskaya / Krasnobelorusskaya / Belarus Red / Byelorussian Red,

Red White-Russian, White-Russian Red

Gorynskaya / Goryn

Krasnaya Polska / Krasnaya pol'skaya / Ukrainian-Polish Red

Krasnaya stepnaya / Russian Red Steppe

Krasnaya ukrainskaya / Red Ukrainian / Red Steppe

Krasnaya kolonistskaya / Red Colonist / Molotschnaer

Odessa

Taurien

Crimean

Kuban Red

Donetsk

Crimean Red / Red Crimean

Zaparozhye / Zaporiz

Ukrainska Krasnaya / Ukrainian Dairy Red

New Red Dairy

Roşie / Romanian Red

Krasnaya nemetskaya / Red German

Roşie Dobrogeană / Dobrogea Red / Dobruja Red

Rosie Estona / Moldovian-Estonian Red

Bessarabian Red

Moldavian Red Steppe

B"lgarsko cherveno govedo / Bulgarian Red / Red Sadovo, Bulgarian Red Sadovo

Chervena sadovska / Red Sadova

Suksunskaya / Suksun

Rood ras van West Vlaanderen / Vlaams Rood, Vlaams Roodvee, West-Vlaams, West-Vlaams

Rood / Belgisch Roodvee, Rood ras van België / **Rouge Flamande / Rouge de Belgique**

/ Rouge de la Flandre occidentale / **West Flemish Red / Red Flemish / Belgian Red**

Rood Vleestype / Rouge Type Viande / Red Beef Type

Veurne-Ambacht

Cassel / Cassels ras, Yper

Flamande / Flandrine, Rouge Flamande, Rouge du Nord / Red Flemish / Flamand

Berguenarde

Picarde / Picardy

Guisarde

Casseloise / Cassel

Artésienne

Namponnaise

Saint Poloise

Bailleuloise

Boulonnaise

Bournaisienne

Maroillaise / Ardennais-Flamande / Maroilles

Solzerienne

Flamande originelle / Flemish original

Flamande laitier / Flemish dairy

Flamande mixte / Flemish dual-purpose

**Subgroup 2B West and Northeast European Lowland pied dairy breeds
and European derivatives**

**Witrik / Aalstreep, Griemel, Ruggel, Ruggelde, Ruggeling, Spikkel, Streeprug, Witrug, Witruggel,
Wytrêch / Dutch Whiteback**

Baggerbont / Modderbont
Lakenvelder / L / Dutch Belted
Groninger Blaarkop / B / Blaarkop, roodblaar, zwartblaar / Groningen Whiteheaded
 / Groningen White Headed, Groningen Blazed
Groninger witkop / Zwartwitkop / Groningen white head
Roodbont Fries Vee / RFV / Fries Roodbont, Roodbonte Fries / Fryske Readbûnte
 / Red Pied Friesian / Friesian Red Pied, Red-and-White Friesian
Zwartbont Fries-Hollands / FH / Frysk-Hollânske Swartbûnte / Black Pied Dutch-Friesian
 / Dutch-Friesian Black Pied / Black-and-White Holland, Netherlands Black Pied
Friesch type / Friesian
Noord Hollands type / North Holland
type der Zuidhollandsche eilanden / South Holland Islands
Zand- en heidevee / Sand and heather cattle

British Friesian
 Red-and-White Friesian
 Poll Friesian

Irish Friesian
Deutsches Schwarzbuntes Niederungsring / Deutsche Schwarzbunte alte Zuchtrichtung,
Alte Deutsche Schwarzbunte, Deutsches Schwarzbuntes Rind
 / German Black Pied Lowland / Original German Black Pied

German Black Pied (Western reserve)
Ostfries / East Friesian
Bunte Ostfries / Pied East Friesian
Jeverländer / Jeverländ
Wesermarsch / Wesermarsh
Oldenburger Geest / Oldenburg Geest
Oldenburger-Wesermarsch / Oldenburg-Wesermarsh
Schwarzbunte Holsteiner / Black Pied Holsteiner

German Black Pied (Eastern reserve)
Ost-Deutsches Schwarzbuntes Rind / East German Black Pied

Jysk Kvaeg / Jysk Kvieg / Jutland / Grey Jutland / Jutland Grey and Black Pied
Oregaard / Benzon
Kortegaard
Westergaard
Vesterboelle
Heidevee / Heather cattle

Sortbroget Jysk Malkekvaeg / SJM / Sortbroget Jysk Malkerace / Black Pied Jutland Dairy
 / Black-and-White Jutland Milk, Black Spotted Jutland Milk

Sortbroget Dansk Malkerace 1949 / SDM-49 / Black Pied Danish Dairy 1949
 European **Holstein-Friesian** and European **Red Holstein** populations:

Zwartbont HF / Dutch Holstein-Friesian, Dutch Holstein / Dutch Black Pied H
 / Dutch Black Pied Holstein
Roodbont H / Dutch Red Holstein / Dutch Red Pied H / Dutch Red Pied Holstein
Roodbont Dubbeldoel / RDD / Red Pied Dual-Purpose / Dutch Red Pied DP

Holstein farbrichtung Schwarzbunt / Holstein-Sbt / German Holstein
Schwarzbuntes Milchrind / SMR / German Black Pied Dairy

Holstein farbrichtung Rotbunt / Holstein-Rbt / German Red Holstein
Dansk Holstein / Danish Holstein
Sortbroget Dansk Malkerace 1965 / SDM-65 / Black Pied Danish Dairy 1965
 / Danish Black-and-White Milk

British Holstein
Svensk Holstein / Swedish Holstein
 Svensk Laglands / SLB / Swedish Lowland / Swedish Friesian /

Suomen holstein-friisläinen / Finnish Holstein-Friesian
Zwartbont-Holstein ras van België / Belgian Black Pied-Holstein
Zwartbont ras van België / Belgian Black Pied
Zwartbont ras van de Polders / Pie-noire des Polders
 / Polders Black Pied
Zwartbont ras van het land van Hervé / Zwartbont ras van Oost België
 / Pie-noire du Pays de Hervé / Pie-noire de l'Est de la Belgique
 / Hervé Black Pied / Eastern Red Pied

Roodbont-Holstein ras van België / Belgian Red Pied-Holstein
Roodbont ras van België / Pie-rouge de Belgique / Red Pied Belgian,
 Belgian Red Pied

Holstein de Luxembourg / Luxembourg Holstein
Pie Noire de Luxembourg / Luxembourg Black Pied
Prim'Holstein / French Holstein
Française Frisonne Pie-Noire / FFPN / Hollandaise Pie Noire / French Friesian
Raza Frizoña-Holstein / Spanish Holstein-Friesian
Raza Frizoña / Spanish Dutch-Friesian
Frisia-Holstein / Portuguese Holstein-Friesian
Turino / Holandese, Luse-Holandese / Portuguese Friesian
Holstein Italiana / Pezzata nera Italiana / Italian Holstein
Schweizerische Holstein / Schwarzfleckvieh, Tachetée noire / Swiss Holstein
/ Swiss Black Pied
Schwarzbunte Holstein / Austrian Black Pied Holstein
Lietuvos Holstein / Lithuanian Holstein
Holšteinas (melnraibā) / HM / Latvian Holstein
LM, Latviškaya chernopestraya / Latvian Black Pied
Holšteinas (sarkanā) / HS / Latvian Red Holstein
Eesti Holstein / Estonian Holstein
Czarno-biała odmiana hf / Polish Black-and-White HF
České Holstynský / Holštajnsko-frizský / Czech Holstein
Nížinné černostrakatý / Czech Black Pied
Slovenské Holštajnské / Slovakian Holstein
Ciernostrakatý / Slovakian Black Pied
Holstein-Friz / Hungarian Holstein-Friesian
Hungarofriz / Hungarofries
Băltată cu negru românească / Romanian Black Pied Holstein
Moldovian Black Lemming
Moldavian Black-and-White
Bulgarian Black Pied Holstein
Crno-belo / Croatian Black Pied
Holstein-Frisonne / Albanian Holstein-Friesian
Frisiki genea / Greek Friesian Black Pied
Ukraine Holstein selection Canadian
Ukraine Holstein selection European
Ukraine Red Pied Holstein
Russian Holstein
Lietuvos Baltnugariai Galvajoi / Lithuanian White-Back / Lithuanian Whiteback
Lietuvos Šemigalvijai / LS / Lietuvos šemieji / Lithuanian Ash Grey / Lithuanian Light Grey
Litovskii skot / Lithuanian Dairy
Latvijas zilā / LZ / Latvian Blue
Latvian Red Pied / Latvian Brown-and-White
Latvian Light red
Latvian Dairy
Białogrzbietka / Polish Whitebacked
Żulawka / Żulawski, Zulawisches Rind / Żulawka / Polish Marsh
Lietuvos Juodmargiai / LJ / Lietuvos baltnugariai / Chernopestraya litovskaya
/ Lithuanian Black Pied
Lithuanian land cattle
Eesti muatõug / Eesti mustakirju, Éstonskaya chernopestraya / Estonian Black Pied
/ Estonian Black Spotted, Estonian Dutch-Friesian
Polska Czarno-biała / Nizinne czarno-białe bydło polskie / Polish Black-and-White Lowland
/ Polish Friesian, Polish Lowland
Mazurska / Mazurenland, Ostpreuzisches Schwarzbuntes Vieh, Danziger-Bucht Vieh,
Danziger Niederungsschlag, Ostpreuzische Holländer / Mazury
/ East Prussian Black Pied, Masurian
Belorusskaya Chernopestraya / Belarus Black Pied / Byelorussian Black Pied
Menno-Fries
Ukrainska cherno-ryaba / Ukrainskaya chernopestraya / Ukrainian Black Pied
Chernopestraya podol'skaya / Podolian Black Pied / Black Pied Podolian,
Ukrainian-Podolian Black Pied, Ukrainian Oldenburg
Ukrainska Belogolovaya / Belogolovaya ukrainskaya / Belogolovokolonistkaya
/ Ukrainian Whiteheaded / Whiteheaded Colonist
Kholmogorskaya / Kholmogory
Khargopolian

Ilmen

Dwina / Werschnedwina

Schenkursk

Pechorskii tip Kholmogorskogokota / Petsjora branch of the Kholmogory

Kholmogory Hybrid

Yaroslavskaya / Domshinskaya / Yaroslavl / Yaroslav, Vladimir

Chernopestraya / Russian Black Pied / Russian Friesian

Srednerusskaya chernopestraya / Tsentralnaya chernopestraya

/ Central Russian Black Pied

Weliko russkaja poroda / Great Russian land cattle

Priokskaya chernopestraya / Oka Black Pied

Ural'skaya chernopestraya / Ural Black Pied

Istobenskaya / Istoben

Tagil'skaya / Tagil

Starotagil

Tagil-standard

Tagil-Dutch / Tagil-Fries

**Subgroup 2C West European red-and blue-pied dual-purposed and beef breeds
and East European derivatives**

**Maas-Rijn-IJsselvee / MRIJ / Roodbont Maas-Rijn-IJsselvee / Meuse-Rhine-Yssel / MRY/ Meuse-
Rhine-Issel / MRI / Dutch Red-and-White, Red-and-White Meuse-Rhine-Yssel, Red Pied Dutch**

Brandrode Rund / Brandrood, Brandrood IJsselvee / Burnt red / Deep red

Rode Geus / Red Beggar

Verbeterd Roodbont / VR / Verbeterd Roodbont Vleesras / VRV / Improved Red Pied

Rotbunte Doppelnutzung / Deutsche Rotbunte DN, Doppelnutzung Rotbunt

/ Rotbuntes Niederungsvieh / German Red Pied DP / German Red Pied Lowland

/ German Red-and-White Lowland

Rotbunte Schleswig-Holsteiner / Holstein Marsch / Red Pied Schleswig-Holstein

/ Holstein Red Pied, Holstein Marsh, Red Pied Holstein

Eiderstedter / Eiderstedt

Dithmarscher / Ditmarsh

Wilstermarscher / Elb-und Willstermarch / Wilstermarsh

Krempermarscher / Krempermarsh

Breitenburger / Breitenburg

Tondersche / Tondern

Bramstedter / Bramstedt

Rotbunte Südoldenburgische / Red Pied South Oldenburg

Münstervieh / Münster runts

Rotbunte Westfälische / Red Pied Westphalian

Clevisches Vieh / Cleve

Rotbunte Niederrheiner / Red Pied Lower Rhineland

Rotbunte Ostfries / Red Pied East Friesian

**Kempens Roodbont / Kempen roodbont, Kempens runderras, Roodbont Kempisch,
Roodbont Kempen / Rouge-pie Campinoise / Pie-rouge de la Campine / Campine Red Pied
/ Red Pied Campine, Red-and-White Campine**

Kempisch / Campinoise / Campine land cattle

Oostelijk Roodbont / Pie-rouge Ardennes-Liège / Eastern Red-pied-Ardennes

**Roodbont van Oost België / Pie-rouge de l'Est de la Belgique / Red-pied Eastern
Belgian**

Pie Rouge de Luxembourg / Luxembourg Red Pied

Wit-rood ras van Oost Vlaanderen / Oost-Vlaams Wit-Rood, Oost-Vlaams, Wit-Rood Oost-Vlaams

/ Roodbont ras van Oost Vlaanderen, Belgisch Witrood, Witrood ras van België / Blanc-rouge

de la Flandre Orientale / Pie-rouge de la Flandre Orientale / Blanc-rouge de Belgique / East

Flemish White-and-Red / Red-and-White East Flemish / Belgian White-and-Red, Red Pied

East Flemish, Red Pied Belgian

Dender

Pie Rouge des Plaines / Rouge de l'Ouest / French Red Pied Lowland / Western Red

Dansk Rødbroget Kvæg / DRK / Danish Red Pied / Red Pied Danish

Polska czerwono-biała / Nizinne czerwono-białe bydło polskie / Polish Red-and-White Lowland

Schlesischem Rückenschecken / Silesian Whiteback

Kłodzka / Glatzer Gebirgsrind / Kłodzka

Belgisch Witblauw / Witblauw ras van België, Belgisch Witblauw, Belgische Blauwe / Blanc-bleu

Belge / BBB / Blanc Bleue Belge / La Blanc Bleue rameau viandeux / Belgian White-Blue

/ Belgian Blue-White, Belgian Blue, Belgian White-and-Blue pied, Blue Belgian, Meat Belgian Blue Breed

Condroz / Ceney

Famenne

Ras van Midden- en Hoog België / Race de la Moyenne et Haute Belgique

/ *le Franc tournée condruzien / Central and Upper Belgian / White Meuse and Schelde*

British Blue / British Belgian Blue

Belgisch Wit-blauw dubbeldoelras / Belgisch Witblauw Ras-Mixte type

/ *Wit-blauw ras van Henegouwen / Blanc-bleu Belge-type Mixte / DP-BBB / Bleue du Hainaut,*

Bleue de Mons, Bleue de Tirmont, le Grand plat de Ath / Belgian White-Blue dual-purpose

/ *Dual-Purpose Belgian Blue*

Ardenner landras / Ardennaise / Ardennes landrace

Bleue du Limon / Limon Blue

Bleue du Nord (rameau mixte) / Blanc Bleue mixte, Bleue du Hainaut, Bleue de Bavi,

Mixte Bleue du Nord, Maubeugeoise, Montoise, Normandes des régions froides, Mons,

Solemoise / Northern Blue (dual-purpose)

Ardennaise / Alsacienne, Bourguignonne, Champenoise, Lorraine / French Ardennes

Ardennaise ou Meusienne / Ardennes-Meuse

Eifel

Subgroup 2D British Shorthorn breeds and derivatives

Dairy Shorthorn / Improved Shorthorn

Holderness / Yorkshire

New Yorkshire

Teeswater

Durham / Improved Teeswater

Original Population Dairy Shorthorn

Blended Red-and-White / BWRS / Blended Red-and-White Shorthorn

Milk Shorthorn / Old Shorthorn / Malkekorthorn

Dansk Redbroget Korthorn / Danish Red-and-White Shorthorn

Land Shorthorn / Eiderstedter Shorthorn

Northern Dairy Shorthorn / Dales Shorthorn

Whitebred Shorthorn / Cumberland White

Blue Grey

Beef Shorthorn / Irish Shorthorn / Scotch Shorthorn / Scottish Shortorn / Aberdeenshire Shorthorn

Poll Shorthorn

Dansk Korthorn / Danish Shorthorn

Deutsches Shorthorn / German Beef Shorthorn

Shorbrack

Steibu / Steinburger Bunte

Blue Albion / Blue English, Derbyshire Blue

Bestuzhevskaya / Bestuzhev

Simbirsk

Lincoln Red new type

Lincoln Red (Original) / Turnell Reds, Lincoln Red Shorthorn

Polled Lincoln Red / Lincolnshire Beef Poll

Beevbilde

Black Beevbilde

Scentesi Vörös / Pankotai vörös értéke / Scentes Red / Pankota Red

Subgroup 2E Breeds from Central-West and South England

Longhorn / English Longhorn

Lancashire / Craven long-horns

Staffordshire

Warwickshire / Canley breed

Dishley / New Leicester, Improved Longhorn

Cheshire

Derbyshire

Shropshire

Dorsetshire

Irish Longhorn

Hereford Traditional / Hereford (Original), Traditional Hereford

British Polled Hereford / Poll Hereford

Black Hereford

Hereford

Gloucester / Gloucestershire, Old Gloucester

Glamorgan

Devon / North Devon, Red Devon, Red Ruby

Sheeted Somerset / Broadlands, Somerset, Somersetshire Sheeted,
White Sheeted Somerset

South Devon / Hammer, South Hams

Sussex

Sussex new type

Polled Sussex

Subgroup 2F Breeds from the Channel Islands and Northwest France

Jersey / Island Jersey / **Jersiaise** / *Jersiaise Française* / **French Jersey**

Jersian

Dansk Jerseyavlen / Danish Jersey

Svensk Jersey/SJB / Swedish Jersey

Guernsey / **Guernsiaisie**

Alderney

Froment du Léon / Bretonne froment

Léonnaise / *Léonarde, Bretonne du Nord-Finestère et des Côtes-du-Nord, Brette,*
Froment / **Léonnais**

Brune de Guingamp / Guingamp Brown

Bretonne de Saint Brieux

Pie Rouge de Carhaix / *Carhaisienne* / Carhaix Red Pied

Bretonne Rouge et Pie Rouge / Breton Red and Red Pied

Canadienne / French Canadian

Bretonne Pie Noir / *Bretonne* / **Breton Black Pied** / Brittany Black-and-White, Black Pied Breton

Cornouailles

Rennaise / Rennes

Pie Noire Morbihannaise / Morbihan Black Pied

Armoricaine / *Durham-Bretonne* / Armorican

Rouge des prés / *Maine-Anjou* / **Maine-Anjou**

Durham-Mancelle / *Durham-Manceau, Manceau anglais*

Maine-Anjou latiere / Dairy Maine-Anjou

Bazougers / *Bleue de Bazougers* / **Bazougers Blue**

Saônoise / *Saônaisie, Saosnoise* / **Saônois**

Mancelle / *Le Mans, Maine, Manceaux, Manselle, Mansotte*

Percheronne / Percheron

Caille-Blond

Manceau

Durham

Percheronne

Augeronne

Normande / Norman, Normandy

Augeronne / Auge

Cotentine / Cotentin

Valognaise

Bessine / Bessin

Cauchoise / Caux

Brayonne

Merlerault

Mayennaise / Mayenne

Beauceronne

Isigny

Sarlabet / *Dutrône*

Durcet / *Cotentin-Schwitz*

Bordelaise (nouvelle) / **Bordelais (new type)**

Bordelaise / *Maraine* / **Bordelais**

Subgroup 2G North and West European composite breeds

Viking Red

Skovrace / Danish Forest

Stabiliser / Stabilizer

Auerox / *München-Berlin Auerochs* / **Munich-Berlin Aurochs** / **Aurochs reconstrué**

/ Aurochs de Heck / **Heckrund** / **Hekes** / **Heck cattle** / Munich cattle, Munich-Berlin cattle,
bred-back aurochs, Reconstructed Aurochs

Oostvaardersplassen Heckrund
Ecolander
Taurus

Tauros

**GROUP 3 Short-headed and broad-headed Highland breeds
from West and Central Europe**

Subgroup 3A Vosges and Black Forest breeds

Vosgienne / Vogesen / Vogesenrind / Vosges

Münster

Bas-Rhin / Lower Rhine

Vorderwälder / Wäldervieh / Vorderwäld

Hinterwälder / Wäldervieh / Hinterwäld

Schönwälder / Baarvieh / Schönwäld / Baar

Subgroup 3B Central-European Red Highland breeds

Rotes Höhenvieh / RHV / Rotvieh Zuchttrichtung Höhenvieh, Mitteldeutsches Rotvieh

/ Mitteldeutsches Gebirgsvieh, Roten Höhenvieh / German Red Highland

/ Middle German Red, Middle German Hill, Red Hill, Red Mountain

Siegerländer / Siegerland

Westerwälder / Wäller / Westwäld

Wittgensteiner Blässvieh / Wittgenstein Blazed

Röhnvieh / Röhn

Spessartvieh / Spessart

Bayerisches Rotvieh / Bavarian Red

Sechsämter / Sechsämt

Weidaer / Weida

Chamauer / Wäldervieh / Chamau

Kellheimer / Kellheim

Hessisches Rotvieh / Hesse Red

Odenwälder / Odenwäld

Waldecker / Waldeck

Westfälisches Rotvieh / Witgensteiner / Westphalian Red / Red Wittgenstein

Sauerländer / Sauerland

Hessisch-Westfälisches Rotvieh / Hesse-Westphalian Red

Vogelsberger / Vogelsberg / Vogelsberg Red

Taunusvieh / Taunus

Harzer Rotvieh / Harz Red

Branntager

Vogtländer Rotvieh / Vogtländisches Rotvieh / Voigtländer / Vogtland Red

České červienký / České červený / Czech Red / Bohemian Red

Chebské červienký / Chebský červienký dobytok / Egerländer / Cheb / Egerländ

Stitáry / Stitáry

Sumavský / Sumava

Budějovický / Budejovice / Budweizer / Budweiser

Českýles dobytok / Böhmerwald Vieh / Bohemian Wood

Lištnánské červienký / Lischnaer / Lisna Red

Sudetský červený / Sudetenvieh / Sudeten Red / Moravian Sudeten

Kladsko sudetský červený / Kladsko-Sudeten Red

Moravský červený / Moravian Red / Moravian Carpathian Red

Slovenský červený / Slovakian Red

Podgórska / Podgorica-polje / Polish Highland

Sandecker / Sandeck

Kreuzberger / Kreuzberg

Subgroup 3C Alpine short-headed breeds and East-European derivatives

Abondance / Chablaisienne, Pie rouge française de Montagne

Valdostana pezzata rossa / Aosta Red Pied / Red Pied Valdostana

Valdostana pezzata nera-castana / Valdostana Pezzata Nera e Castana,

Valdostana pezzati nero-castani / Aosta black pied-chestnut

Valdostana pezzata nera / Aosta black pied / Black Pied Valdostana

Valdostana castana / Aosta chestnut

Hérens / Alpine Hérens, Valais, Valdotaine chatagnée, Chamoniarde / Eringer / Welsche

Evolèner / Evolène / Evolénard, Patcholé, Valdotaine pie-noire, Valdotaine tachetée noire

Tux-Zillertaler / Tux-Zillertal

Tirolese / Tiroler / Tyrolese / Tirolian

Tuxer / Duxer / Tux
Zillertaler / Zillertal
Brixentaler / Brixental
Durtaler / Durtal
Landler / Landl
Burlina / Asiago, Bassanese, Binda, Boccarda, Pezzata degli Altipiani
Krasnaya gorbатовskaya / Krasnogorsbatovskaya / **Gorbatov Red** / Red Gorbatov
Priokskaya / Oka
Gorbatov
Vladimir
Yurinskaya / Nizhegorod / **Yurino**
Chuwash-Mari
Krasnaya tambovskaya / Krasnotambovskaya / **Tambov Red**
Pashkov
Pustertaler Sprinzen / Pusteria / Pustertaler Schecken, Sprinzen/ **Pustertaler** / Pustertal
Barà / Barà-Pustertaler, Barra
Ennstaler Bergschecken / Steierisches Bergschecken / **Ennstal Spotted Mountain**
 / Styrian Mountain spotted
Helmete / Helmet
Kampete
Welser Schecken / Wels Spotted
Inntaler Schecken / Inntal Spotted
Pinzgauer / Pinzger
Rauriser / Rauris
Kitzbühler / Kitzbühl
Tiroler Pinzgauer / Tyrolean Pinzgauer
Mölltaler / Möll-Drautaler, Übertrauer / Mölltal / Mölltal-Pinzgau
Pongauer / Pongau
Lungauer / Lungau
Jochberger Hummel / Jochberger Hummeln
Jochberger / Jochberg
Pinzgau / Italian Pinzgau
Pezzata Rossa Norica / Red Pied Norica / Norica-Pinzgau
Pinzgauer / German Pinzgauer
Bayerisches Landvieh / Bavarian land cattle
Bistumer / Bishopric
Vollmauer / Voltau
Neue Miesbacher / New Miesbach
Berchtergadener / Berchtergaden
Pinzgauer Fleisch / PIN/ Pinzgau beef
Slovenské Pinzgauské / Slovenský pinzgauský / **Slovakian Pinzgau**
Pinzgave / Pintsgow / **Ukrainian Pinzgau**
Croatian Pinzgau
Pinzgavska / Pinzgavac / Slovenian Pinzgau, Yugoslav Pinzgau
Cika / Cikasto govedo
Bohinjska Cika / Bohinj Cika
Tolminska Cika / Tolmin Cika
Pinzgau de Transilvania / Transylvanian Pinzgau / Romanian Pinzgau
Dorna / Black Pinzgau
Subgroup 3D Central European blond and yellow Highland breeds
Glanrind / Glanvieh / Birkenfelder, Meisenheimer, Rheinbayerisches Schlag, Quirbacher / **Glan**
Glan-Donnersberger / Glan-Donnersberg
Lahnvieh / Limburger / **Lahn**
Limpurger / Leintaler
Schwäbisch-Hall / Swabian-Hall
Nieder-Schwäbisch / Lower Swabian
Gelbes Frankenvieh / Gelbvieh / **Gelbes Höhenvieh**, **Mitteldeutsches Einfarbiges Gelbes**
Höhenvieh, **Deutsches Gelbvieh** / **Yellow Franconian** / **Gelbvieh** / German Yellow, German
 Gelbvieh / Middle German Unicoloured Yellow Highland, Yellow Franconian, Yellow Highland
Altfränkische Roter Landschlag / Old Franconian Red landrace
Hassberger / Hassberg
Schweinfürter / Schweinfürt
Itzgründer / Itsgründ

Baunacher / Baunach
Itz- und Baunachgründer / Itz and Baunach
Ochsenfürter / Ochsenfür
Röhn-Spessartvieh / Röhn-Spessart
Frankenvieh / Franconian
 Elling-Weissenburger / Ellingen-Weissenburg
 Altmühltalvieh / Altmuh valley
 Scheinfelder / Scheinfeld
 Obermaintaler / Obermain valley
 Aischgründer / Aischgründ
 Schwalmer / Schwalm
 Mainlander / Mainland

Gelbvieh Fleisch / GVF / Gelbvieh beef
Murbodner / Steirer / Murboden
 Mürztaler / Mürztal
 Murbodner-Mürztaler / Murboden-Mürztal
 Pomurska goveče / Svetlolisata, Pšenična / Pomurska

Waldviertler Blondvieh / Waldviertel Blond
 Raabser / Raabs
 Gföhler-Zwettler / Gföhl-Zwetteln
 Stockeraurer / Wienevrtler, Wienlandschlag / Stockeraur
 Licht Helmeten / Light Helmet
 Braun Helmeten / Brown Helmet
 Helmer Blässen / Helmer Blazed

Kärtner Blondvieh / Steirisches Blondvieh / Carinthian Blond / Styrian Blond
Sudsteirisch Kärntnerisches Landschlag / South Styrian-Carinthian land cattle
 Kärtner Blässen / Carinthian Blazed
 Mariahofer / Lambrechtler / Mariahof
 Lavantaler / Lavanttal
 Mariahofer-Lavantaler / Mariahof-Lavanttal
 Mariodvorský / Mariadvur
 Beloslovensko govedo / Slovenska belo geveče / Slovenian White
 Koruška plava / Koruska Blond

Österreichisches Gelbvieh / Lichtes Alpenvieh, Lichtes Höhenvieh / Österreichisches Blondvieh,
 Norische rasse / Austrian Yellow / Light Alpine, Light Mountain / Austrian Blond, Pale Highland
 Malteiner / Rachtaler Schlag, Kraudeltes Vieh / Maltein

Subgroup 3E West and Central European broad-headed red spotten mountain breeds
and East-European derivatives

Montbéliarde / Alsace / Montbéliard
Simmental Française / Tachetée de l'Est, Pie Rouge de l'Est / French Simmental
 Comtoise / Franc-Comtoise / Comtois
 Tourache
 Haut Bugey
 Bressane
 Bresse
 Dombes
 Fémeline
 Gesienne / Gex / Gessien
 Micahaille
 Simmental d'Alsace / Alsatian Simmental
 Bouquemont
 Dauphinoise / Tachetée Dauphinoise / Dauphin

Simmentaler / SI / Simmentaler Fleckvieh, Tachetée rouge du Simmental / Burgundische rasse,
 Rotfleckvieh / Swiss Simmental / Swiss Simmental Spotted
 Berner Fleckvieh / Berner-Oberländer, Bernois / Bernese / Bernese-Oberland
 Simmental-Saanen
 Frütig-Adelbodner / Frütig-Adelboden
 Jura
 Illiezer / Illiez
 Lötscher / Lötsch
 Freiburger / Fribourgeoise / Fribourg

Edelweiss-Simmentaler / Edelweiss-Simmental
 Schweizer Fleckvieh / SF / Swiss Red Pied / Swiss Red Spotted

Pezzata rossa d'Oropa / Razetta d'Oropa / Oropa

Pezzata rossa Italiana / Italian Red Pied / Italian Simmental

Friulana pezzata rossa / Pezzata rossa Friulana / Red Pied Friuli / Friuli Simmental, Improved Friuli

Friulana / Friauler/ Friuli

Carniella

Deutsches Fleckvieh / Simmentaler / Alpenfleckviehh, Grosses Fleckvieh, Höhenfleckvieh, Scheckvieh / German Fleckvieh / German Simmental, German Spotted / Red Spotted Highland

Rheinisches Vieh / Neckar / Rhineland

Neckar-Heilbronner / Heilbronner / Neckar-Heilbron

Messkircher / Oberbädisches Fleckvieh / Upper Baden Spotted

Württembergischer Fleckvieh / Württemberg Spotted / Upper Swabian Spotted

Alb

Teck

Bayreuther Fleckvieh / Bayreuth Spotted

Miesbacher / Oberbayerisches Alpenfleckvieh / Miesbach / Upper Bavarian Spotted

Rottaler / Rottal

Ober-und Niederbayerisches Landvieh

/ Upper and Lower Bavarian land cattle

Fleckvieh Fleischnützung / FLF / Fleckvieh beef / German Beef Simmental

Ansbach-Triesdorfer / Triesdorfer Tiger / Ansbach-Triesdorf

Schwäbisch-Haller Braunblässen / Swabian-Hall Brown blazed

Rot- und Gelbmohren / Red and Yellow Moor

Tiger

Österreichisches Fleckvieh / Simmentaler / Austrian Fleckvieh / Austrian Simmental

Bergscheck / Bergscheckvieh, Alpenfleckvieh / Spotted Mountain / Mountain Spotted

Innviertler Schecken / Innviertel Spotted

Berner Schecken / Bernese Spotted

Feldsberger / Feldsberg

Immendorfer / Immendorf

Donau Fleckvieh / Danube Fleckvieh / Danube Spotted

Oststeirisches Fleckvieh / East Styrian Fleckvieh

/ East Styrian Spotted

Innviertler Fleckvieh / Innviertel Fleckvieh

/ Innviertel Spotted

Tiroler Fleckvieh / Unterinntaler Fleckvieh

/ Tyrolese Fleckvieh / Tyrol Spotted

Austrian Dairy Simmental

Simentalska / Polish Simmental

Český strakatý / Českestrakate / Czech Fleckvieh / Czech Pied, Czech Red-and-White, Czech Red Spotted, Czech Simmental, Czech Spotted

Bernskohánacký / Hanáckobernský / Berno-Hana / Bernese-Hana, Haná-Berner

Kravařský / Kuhländer / Kravarsky

Hřbínecký / Schönhengster / Šenhengský / Hrbinecky

Bernsko-český / Bohemian-Berne / Bohemian Red Pied / Bohemian Simmental, Bohemian Spotted

Český červenostrakatý / Czech Red Pied / Czech Mountain Spotted

Manhartsberger / Schiltern / Manhartsberg

Moravský červenostrakatý / Moravian Red Pied / Moravian Red Spotted, Spotted Moravian

Československý červenostrakatý / Czechoslovakian Red Pied

/ Czechoslovak Red-and-White, Czechoslovakian Red-and-White

Opočenské červinky / Opotchno

Czech Pied Dairy

Masny Simentálsky / Masny Simmental / Beef Simmental

Slovenské strakaté / Slovenský strakatý / Slovakian Pied / Slovakian Red-and-White, Slovakian Simmental, Slovakian Spotted, Slovakian Yellow Spotted, Slovakish Yellow,

Mäsový Simentálský / Masovy Simmental / Beef Simmental

Magyartarka / Hungarian Pied / Hungarian Red-and-White, Hungarian Red Pied, Hungarian Spotted, Hungarian Simmental

Bonyhádi

Bonyhádi-Simmental Landrace

Red Pied Landrace of Alföld

Tejelő magyar-tarka / Dairy Hungarian Pied / Hungarian Dairy Fleckvieh,
Hungarian Spotted Dairy

Tejelő magyar-barna / Dairy Hungarian Brown / Hungarian Brown Dairy,
New Hungarian Brown

Bavarian Simmental

Slovensko Lisasto govedo / Simentalsko / Slovenian Pied / Slovenian Simmental
Slovenian Red Pied

Hrvatski Simentalac / Kontinentalna Hrvatska / Croatian Simmental / Croatian Pied

Domaće šareno goveče / Serbian Domestic Spotted / Serbian Pied
/ Yugoslav Simmental

Podolic Simentalac / Podolian Simmental

Băltată românească / Romanian Spotted / Romanian Simmental, Romanian Yellow Spotted,
Spotted Romanian

B'lgarska simentalska / Kulska / Bulgarian Simmental / Kula

Lare e Kuge / Albanian Simmental

Symentalsk / Ukrainski Simentalskaya / Ukrainian Simmental

Ukrainska krasnaya-ryaba / Ukrainian Red-and-White / Ukrainian Red Pied

Simentalskaya / Russian Simmental

Stepnoi Simentalska / Steppe Simmental

Sychëvskaya Simentalskaya / Sychevskaya, Syčovskaja / Sychevka / Sychevka Simmental,
Western Simmental

Subgroup 3F Charolais and derivatives

Charolaise / Charollais, Charolais-pure, Charolais-Nivernais / Charolais

Nivernaise / Charolaise améliorée dans la Nièvre, Nivernoise / Nivernais
/ Niveranis-Charolais in the Nièvre

Morvanelle / Morvandiote / Morvan

Bourbonnaise / Bourbon

OMEGA 47

INRA 9

COPELSONO 93

INRA 95 / Culard INRA

Charollandais

Uckermärker

Genotyp 67

Bovian

GROUP 4 Grey and blond to brown breeds from France, North Italy, the Alps and the Balkans

Subgroup 4A Breeds from Central France

Parthenaise / Vendéenne, Vendée-Parthenay / Parthenais / Vendéen

Angavine / Angavin

Gâtine / Gâtinelle / Gâtinçais

Gâtinaise-Choletaise / Gatinais-Choletais

Solognote / Puisaye / Solognot

Poitevine / Poitevin

Marchoise / Marchais / Marchois

Berrichonne-Brennouse / Bernnouse, Berri, Berry-Bourbonnais, Brenne

Nantaise / Nantais

Maraîchine / Vendée maraîchin / Maraîchin / Vendée Marsh

Limousine / Charentaise / Limousin

Treignac

Vendonnoise / Vendonnais

Angoumoise / Angoumois

Saintongeaise / Saintoganaise / Saintongeais

Meymac / Maurine

Meyssac

ALPHA 16

type tardif / type élevage

type mixte

type viande

British Black Limousin

Salers

Salers Latier / Salers dairy

Salers vergeade / Salers whitebacked

Ferrandaise / Ferrande, Ferrandine, Brugeron, Ferrando-forézienne, Latour, Limagne, Marais, Marat, Pierre-sur Haute, Puy-de-Dôme, Rochefort, Saint-Anthème, la Tour d'Auvergne / Ferrandais

Auvergnate / Bouretts, Mottois / **Auvergne**

Bessarde / Besse

Forézienne / Forezien

Mont Dor / Mont d'Or

Limagne

Aubrac

Gévaudan / Gévaudanne, Lozerienne, Lozerote

Cévennes

Anglès

Albigeoise

Montagne Noire

Rouerge

Causse

Ségala

Salvagnac

Laguiole

Villard-de-Lans / Villardaise, la Vilarde

Mézenc / Mézine

Vivardaise / Vivardais

Tarentaise / Savoisiennne, Savoy

Savoiarde / Tarina

Albanaise / Rumillienne, Savoyarde / **Albanais**

Beafort

Subgroup 4B Grey and blond breeds from Southwest France and the Pyrenees

Marine / Marine-Landaise, Landaise-Marine

Bazadaise / Bazadais

Mirandaise / Gasconne aréolée, Gasconne auréolée, Gasconne de l'Armagnac, Gasconne croisée, Gasconne de Gers et Baise, Gasconne de Gers, Gasconne à rondelle, Gasconne des Plaines / **Mirandais** / Gascon aréolé

Gasconne de Lauraguais / bœuf de Cameman, bœuf de Verfeil / **Lauraguais Gascon**

Gasconne / Carolaise, Gasconne à muqueuses noires, Gasconne à muqueuses totalement noires, Gasconne cul-noir, Gasconne da la Save, Gasconne des Montagnes / **Gascon**

Gasconne à muqueuses noires / **Gascon black skinned**

Carolaise / Ariégéoise, Carolaise-Gasconne, Mijanaise, Querigut / **Carolais**

Roussillon

Pays Sault / Sault

Tarasconne / Tarascon

Casta / Castagne, Castillonnaise, Montagnarde, Montagnole, Aure et Saint Girons, St Girons et Aure, Cerdagne, race des Pyrénées centrales / Central Pyrenean

Aure / Auroise

Barousse / Barous

Saint Girons / Saint Gironaise

Massanaise / Massanesa / **Massanais**

Blonde d'Aquitaine / Aquitaine Blond

Garonnaise / Créon, Entre-Deux-Mers / **Garonnais**

Garonnaise de plaine / Plains Garonnais

Marmandaise / Marmandais

Néracaise / Néracais

Quercy / Montaubanais

Garonnaise de côteau / Mountain Garonnais

Aganaise / Aganais

Montalbanaise / Montalbanais

Périgourdins / Périgourd

Blonde des Pyrénées / Pyrenean Blond

Lourdaise / Lavedan / Lavedan et de la Bigorre, Lourdes, Tarbes, Tarbaise, Bigorre, Bigordane / **Lourdais**

Béarnaise / Pyrénéenne du Sud-Ouest, Pyrénées-Atlantiques, Pyrénées-Occidentales, Pyrénées à muqueuses roses / **Béarnais**

Béarnaise / Béarnais

Barétous / Baretonne

Urt
Bas-Adour
Aspe-Bédous
Ossau / Ossolaïse
Soule

Basquaise / Basque
Basco-Béarnaise / Basco-Béarnais
Landaise / Ledonne / Landais

Pirenaïca / Basque / Pyrenean

Pallaresa / Blanca del Pallars

Betizú / Betisoak / abel gorriak, Basabehi, behi auzoa, behi Betizu, Betissoa, etxeko behiak, herri ganadua, kata bizarrak / Betizuak

Albera / Alberas / Albères

Albera Noire / Albera Negra / Alberesa / Black Alberes

Albera Hêtre / Fagine / Fagina / Brown Alberes

Subgroup 4C North Italian fawn-brown breeds

Montana rossa / Varzese o Tortonese o Ottonese / Montana red / Red Mountain, Varzese-Tortonese-Ottonese

Bionda Tortonese / Tortona Blond / Blond Tortona

Cabellota

Ottonese

Varzese

Cabannina

Pontremolese / Bettolèse, Rossa Pontremolese

Bardigiana / Parma, Parmese

Cornigliese / Corniglio

Valtarese / Valle del Taro

Reggiana / Formentina, Rossa Reggiana

Subgroup 4D Alpine Grey and Brown Mountain breeds and East European derivatives

Rätisches Grauvieh / Bündner Grauvieh / Albula / Rhaetian Grey / Bündner Grey

Graubündner-Oberländer / Graubünden-Oberland

Bündner Bergschlag / Ober-Engadiner, Davoser Bergvieh / Bündner Mountain / Ober Engadin, Davos Mountain

Abullah

Seevieh / See

Valtellina

Grigia Alpina / Bigia Alpina / Grey Alpina

Bergamo / Bergamasker

Grigia di Val d'Adige / Etschtaler / Grey Adige

Grigia di Val d'Ultimo / Ultinger / Ultner / Grey Ultimo

Meraner / Meran

Vintschauer / Vintschau

Passeier / Passei

Grigia di Val di Fiemme / Fleimser / Grey Fiemme / Fleims

Welschtirol / Wels Tyrol

Bellunese / Bellune

Carnia

Tiroler Grauvieh / Oberinntaler Grauvieh, Maintaler / Tyrol Grey / Grey Mountain, Tyrolean Grey, Oberinntal Grey

Lechtaler / Lechtal

Wipptaler / Wipptal

Kematen

Sterzinger / Sterzing

Selrainer / Selrain

Stubai / Stubai

Brenner

Siva

Rendena / Brina di Val di Rendena

Schweizer Original Braunvieh / Original Swiss Brown

Schweizer / Rigi / Schwyz

Appenzeller / Appenzel

Toggenburger / Toggenburg

Oberwalden

Glarus
Interlaken
Oberhasli / Haslitaler
Uri
Brijenzer / Bryenz
Feldis
Liviner / Livin
Gomser / Gommerli, *Petite race brune de Comches* / **Goms**
Gurtenvieh / Weissgurten / **Belted Swiss Brown**
Kreuzschecken / Blüten, Rückenblessen, Rückenscheck, Rigi / **Whitebacked**,
 Whitebacked Swiss Brown
Original Braunvieh / *Braunvieh alter Zuchtrichtung*, *Original Allgäuer Braunvieh*
 / *Graubraunes Gebirgsvieh*, *Graubraunes Höhenvieh* / German **Original Brown**
 / German Brown (old type) / Original Allgäu Brown Mountain
Allgäuer / Allgäu
Württembergisches Braunvieh / **Württemberg Brown**
Murnau-Werdenfelser / Murnau-Werdenfels
Original Österreichisches Braunvieh / **Austrian Original Brown** / Austrian Brown (Original)
Montafoner / *Prätigauer* / **Montafon**
Klostertaler / **Klostertal**
Walsertaler / **Walsertal**
Paznauner / **Paznaun**
Thandberger / **Thandberg**
Graugelbes Bregenzerwälder / **Bregenz Grey-yellow Wood**
Vorarlberger Graubraunes Gebirgsrind / **Vorarlberg Grey-brown Mountain**
Vorarlberger Braunvieh / **Vorarlberg Brown**
Steierisches Braunvieh / **Styrian Brown**
Tiroler Braunvieh / **Tyrolese Brown**
Graubraunes Tiroler Gebirgsrind / **Tyrol Grey-brown Mountain**
Bruno Italiana Vecchio Ceppo / **Italian Brown original**
Sarda Bruna / *Bruno Sarda*, *Ozierese*, *Sardo-Schwyz*, *Svitto-Sarda* / **Sardinian Brown**
 / *Sardo-Swiss*
Bruna de los Pirineos / **PA** / *Bruna dels Pyreneus*, *Parda Alpina* / **Pyrenean Brown**
European Brown Swiss populations:
Schweizer Braunvieh / *Schweizerisches Braunvieh* / *Brune Suisse*, *Bruna Svizzera*
 / **Swiss Brown**
Braunvieh / *Deutsches Braunvieh* / **German Brown**
Österreichisches Braunvieh / **Austrian Brown**
Brune / *Brune des Alpes* / **French Brown**
Parda de Montaña / *Parda Suiza*, *Schwyz Española* / **Spanish Brown Mountain**
Bruna Alpina / *Bruna Italiana*, *Svitto*, *Svizzera* / **Italian Brown Alpine**
 / *North Italian Brown*
Frati
Slovenský hnedy / **Slovakian Brown**
Slovenačko Rjavo govedo / *Rjavo govedo* / **Slovenian Brown**
Sivka iz Gorne Savinje / **Savinja Grey**
Smedje govedo / **Croatian Brown**
Shvitskaya / *Svickaya* / **Russian Swiss** / **Russian Brown**
Bryansker Forest
Kostromskaya / *Karavaevo* / **Kostroma**
Great Russian land cattle
Miskov
Babaev
Lebedinskaya / *Lebedin-Schwyz* / **Lebedin**
Subgroup 4E Illyrian shorthorn breeds from the Balkans and Greece
and upgraded derivatives
Dachau Moos / **Dachau Moor**
Hungarian Brown
Gorynskaya / **Goralen Mountain**
Majdaner / *Maydaner*
Polesian Marsh / **Polish Grey**
Ukrainian Whitebacked
Bryansk Forest / **Bryansk Woodland**

Carpathian Mountain

Polish Brown / Galizian Brown

Mandanscher / *Mandans*, Galizian Woodland

West Galizian-Carpathian

Bukowina Mountain

Podhalasnksi / *Podhalaner*

Valašský / *Valachian Dwarf* / Tatra Dwarf

Werschowen

Gutsul'skaya / *Huzullen* / *Hutzul* / *Hutsul*, *Huzul* / Podolian land cattle

Rasa românească de munte / *Romanian Mountain* / Mountain Grey

Obstesc

Roșie Germana / *German Rosie*

Mocanița / *Mocany*, *Mokany* / *Mocanitsa*

/ Transylvanian Mountain, Sheperd's breed,

Risca

Slovenian Busha

Goricka

Romanian Dwarf

Hrvatska Buša / Croatian Busha

Crno-šaro / *Croatian Red*

Kranjsko

Lika

Polimskoj Buša / Domarac, Polimska buša / Polim Busha / Lim

Neretva

Imljani black / *Imlany*

Buša / Serbian Busha

Kosovaran Busha

Sharri Buša / *Sharri Busha*

Crvena methosijska / *Tsrveni metohjski buša* / *Red Metohian Busha*

/ *Metohija Red*

Dukagjini Buša / *Dukagjini Busha*

Buša / Montenegrrian Busha

Pešterska buša / *Pester Busha*

Shkodra / Shkodra Busha / Shkodra Red / Scutari

Illvaska / *Albanian Busha* / *Albanian Illyrian*, *Albanian Dwarf*, *Illyric Dwarf*

Lopa e Lekbibaj / *Lopa e Lekbibajt* / *Lekbian Busha* / *Illyrian Dwarf-Lekbibaj*

Dibra Busha

Middle Albanian Busha

Lopa e Prespes / *Prespa Dwarf* / *West Macedonian*

Lopa e Gurgucka / *Gurgucka Busha* / *Illyrian Dwarf-Gurgucka*

Makedonska buša / *Plava povardaska* / *Macedonian Busha* / *Blue Macedonian*,

East Macedonian, *Macedonian Blue*, *Plava*

Macedonian black Busha

Pomak Red

Rodopska k'soroga / *Rodopska kusoroga*, *Rodopsko kasorogo* / *Rodopi*

/ *Rodope Shorthorn* / *Rodopska*, *Rhodopean Shorthorn*

Improved Rodope

Hnedý Karpatský / Slovakian-Carpathian Brown

Buraya Karpatskaya / *Ukrainian-Carpathian Brown*, *Buro-Carpathian*

Bruna / *Bruna Maramureș* / *Romanian Brown* / *Maramures Brown*

Smedje govedo / *Croatian Brown*

Sivo govedo Dalmacije / *Dalmatian Grey*

Gatačko govece / *Gacko* / *Grey Gacko Busha*

B'Igarska kafyava / *Bulgarska kafyava* / *Sofiiska kafyava* / *Bulgarian Brown* / *Sofia Brown*

Brachykeratiki / *Braqiikersti* / *Greek Shorthorn* / *Brachyceros*

Kerkyra/Corfu

Epiros

Agrinio dark

Agrinio white ivory

Perdikaki shorthorn

Acheloos

Carinthian

Elis/Elia

Mani / Peloponnese

Pieira

Dervenhoria

Skópelos

Skýros

Alonissos, Giura, Kyra Panagia

Kea / Zéa, Keos

Kythnos

Sifnos

Kakoperato / *Papagalaki* / **Samos dwarf** / Parot Pigeon

Arki

Dodekánisos shorthorn

Nisyros dwarf / Nisiros, Nysiros

Rodos dwarf / Rhodos dwarf / Mediterranean-Anatolian primitive

Kríti boodedé / Cretan lowland / Messara

Kríti venó boodedé / Cretan mountain

Gávdos

Lesvos

Kea/Tsia / *Zéa, Keos* / Kea/Tsia crossbreed

Svitsika

Black Etolokarnania

Folégandros

Subgroup 4F East European composite breeds

Belarus Synthetic

Ukrainian Beef / Ukrainian Beef Synthetic, Ukrainian Meat

Chernigovskii tip / Chernigov

Pridneprovskii tip / Dnieper / Prednieper

Polessi / Polessian

Volynskaya / Volynsk/ Volinian

Znamenskaya / Znamensk

Yuzhnoukrainskaya / Southern Ukrainian

Askian Meat

GROUP 5 Breeds from Southwest Europe

Subgroup 5A Isolated breeds from the Camargue, Corsica and Sardinia

Biou / Camargue / Camarguaise / Camargue

Provençale / Saint-Tropez / Provence

Corse / *Córsega* / Corsican

Pettiazza

Corsican crossbred

Sarda / Sardinian

Subgroup 5B Cantabrian breeds / *Tronco (Castaña) Cántabrio*

Monchina

Terreña

Terreña gorbeana / Terraña Gorbea

Terreña de la Sierra / Terraña Mountain

Asturiana de los Valles / RAV / *Asturiana Occidental, Carreñana, Carreña* / Asturian Valley

/ *Variedad musculosa* / *Culona* / Asturian Double muscled

Asturiana de la Montaña / RAM / *Asturiana Oriental, Asturiana de las montañas, Casina*

/ Asturian Mountain / Asturia Montana

Agrupación Eo / Serrano o Montino / Eo / Serrano

Leonesa / Mantequera leonesa

Pasiega

Tudanca

Campurriana / Campó / Campurrian

Lebaniega / *Picos de Europa* / **Lebaniega** hill cattle

Subgroup 5C Galician, Balearic and Canarian blond breeds / *Rojo convexo turdetano*

Rubia Gallega / Gallega / Galician Blond

Galega - Minhota / *Galega/Minhota, Miñota*

Mallorquina / Majorcan

Menorquina / Mahonesa / Minorcan

Marinera

Canaria / *Criolla, Basta, de la Tierra* / Canary Island

Palmera / *Palmeña*

**Subgroup 5D Northwest Iberian chestnut breeds /
Morenas del Noroeste and Castaña concavo**

Caldelá / Caldelana, Castro Caldelas / **Caldelas**

Alistana-Sanabresa

Alistana

Sanabresa

Frieiresa / Mirandesa-Frieiresa

Sayaguesa / Zamoraña

Llanuras

Limíá / Limiana

Verinesa

Vianesa

Barrosã / Maiana, Pisca / **Barrosao** / Barrosa

Cachena / Barrosã ananizado, Cabreira, Carramelha, Carramilhina, Vilarinhos

Arouquesa

Maronesa / Alvanesa, Carreiro, Montanheiro, Penates, Pinhero, Serraña, Vacas Molares

Mirandesa / **Berciana** / Rathina

Braganseça / **Bragança**

Beiroa / Mirandesa beiroa

Campo

Mirandez estremenho / Rathino Serrano / **Mirandez Mountain** / Rathino Mountain

Jarmelista

Marinhoa

Ramo Grande / Açoreana

Madeira Mixed

Subgroup 5E Black breeds / Negra Ibérica / and fighting cattle

Serrana de Teruel

Serrana Negra / **Serrana Black**

Serrana de Soria / Serrana Soriana, Variedad de Soria / Barqueña, Piedrahitense

Pinariega / Piñorras / **Pine wood**

Avileña-Negra Ibérica / Barco-Piedrahita, Barqueña, Guardameña, Piedrahitense, Castellana,

Serrana / **Avilena Black Iberian**

Avileña-Negra / **Carpetana** / **Avila Black** / Black Carpetana

Negra Ibérica / **Black Iberian**

Bociblanca

Preta / Gado da Terra, Charnequeiro do sul do Tejo, Preto

Morucha

Castiliana / **Castilian**

Atigrado de Salamanca / **Salamanca Brindled**

Morucha Variedad Negra / Salmantina / **Morucha Black**

Negra andaluza / Negra campañesa, Negra de las Campañas andaluzas / **Andalusian Black**

Cárdena andaluza / **Andalusian Grey**

Berrenda en Negro andaluza / Burraca / **Arcena** / **Berrenda Black Pied**

/ Berrenda Black-and-White, Berrendo negro, Black Berrendo

Ganado Bravo / Lidia, Toro de Lidia / **Fighting cattle** / Fighting bull

Casta Cabrera

Casta Carriquirris

Casta Castellana

Casta de la Tierra

Casta de los Gallardo

Casta Espinosa y Zapata

Casta Jijona

Casta Arann

Casta Domec

Casta Miura

Casta Pablo Romero

Casta Ramirez

Casta Urquino

Casta Vazquez

Casta Vega-Villar

Casta Veragua

Casta Vistahermosa

Lidia Casta Navarre / Toro de Casta Navarre / **Navarre**

Race de Combat / *Espagnole Brava* / French **Fighting cattle**
Brava de Lide / *Touro de Lide, Brava de Lide, Ribatejana* / Portuguese **Fighting cattle**
Brava dos Açores / **Azores Fighting cattle**
Marismeña / *Agrupación bovina Mostrenca, Doñana, Palurda* / **Mostrenca**
Subgroup 5F Central and South Iberian red breeds / **Andaluza Rojo convexo**
Raza Retinta andaluza / **Retinta** / Andalusian Brown, Andalusian Red, Dark Andalusian
Colorada extremeña / **Extremadura Red**
Rubia andaluza / *Extremeña rubia* / **Andalusian Blond** / Blond Extremadura
Alentejana / *Transtagana*
Garvonesa
Algarvia
Chamusco
Blanca Cácerena / *Blanca guadiana* / **White Cáceres** / Guadiana White
Mertolenga
Bragado do Sorroia / *Charnequeira* / **Sorroia Pied**
Malhado do baixo Guadiana / **Guadiana Spotted**
/ Spotted cattle of the lower Guadiana
Berrenda en Colorado / *Berrenda roja andaluza, Capirote* / **Berrenda Red Pied**
/ Berrendo colorado, Red Berrendo
Salinera
Subgroup 5G Southeast Iberian breeds / **Castaño ultraconvexo**
Murciana-Levantina / *Murciana*
Huertana / *Cristiana*
Almanzoreña
Calasparreña
Lorquina / *Lorca*
Pajuna / *Serraña*
Agrupaciones-Serrañas / **Agrupacion Mountain**
Axerquia / *Axarquena, Castellano Axarqueno*
GROUP 6 Podolian breeds from Italy and East Europe
Subgroup 6A Italian large white breeds
Piemontese / *Turinoise* / **Piedmont** / Piedmontese
Camandona
Ossolane
Susa
Pinerlo / *Luserna*
Canavese
Piemontese ordinaria / **Common Piedmont**
Demonte / *Cuneo*
Racconigi
Carmagnola / *Piemontese della pianura, Salta* / **Plains Piemontese**
/ Lowland Piedmont
Berciana
Chianina / *Bianca di Chiana*
Perugiana
Valdarno
Val di Chiana / **Valley Chianina**
Calvana
Pisana / *Mucca nera pisana* / Black Pisa milch cow
Modenese / *Bianca val padana* / White Po
Carpigiana / **Carpi hill**
Modenese di pianura / **Modenese plains**
Romagnola / *Romana*
Romagnola gentile / **Romagnola lowland**
Romagnola di montagna / **Romagnola mountain**
Bolognese
Marchigiana / *del Cubante*
Collina delle Marche / **Marchigiana hill**
Brina
Pianura delle Marche / *Marchigiana gentile* / **Marchigiana plains**
Subgroup 6B Podolian breeds from South Italy and Istria
Garfagnina / *Grigia Appeninica, Modenese di Monte, Montanara, Nostrana*
Maremmiana

Grossetana
Romana / Roman
Maremmana primitivo
Pasturina / Chianino-Maremmana / Cecinese, Maremmana stabulata
Podolica Italiana / Italian Podolian / Apulian Podolian
Pugliese del basso Veneto / Pugliesi del Veneto, Poggese / Veneto
Abruzzese / Podolica abruzzese di montagna
Murgese
Lucana / Lucanian
Podolica Pugliese / Puglia / Pugliese
Podolica Campanina / Campanian / Campagna
Podolica Calabrese / Crotonese / Calabrian / Crotone
Agerolese
Boškarin / Istarsko goveče, Istarsko govedo, Istarsko Podolaz / Boskarin / Boscarin / Buje, Istar,
 Istrian, Istrian Grey, Istrian Podolaz, Istrian Podolian, Istrian Podolic
Labin / blue cavallo / blue horse
Istar-Kvarner / blue indigeno bianco / Istar-Karst / blue-violet-white
Cinisara
Modicana / Sicilian
Siciliana Picolo / Small Sicilian
Modicana primitivo / Modicana landrace
Siciliana Grande / Large Sicilian
Rossa Siciliana / Mezzalina / Red Sicilian
Montanina / Montanara
Olivestra Modicana
Sardo-Modicana / Modicano-Sarda, Oristanese / Modica-Sardinian
Pantelleria
Subgroup 6C Podolian Grey Steppe breeds from East Europe
Magyar szürke / Cimeres Ökrök, Magyar alföldi, Szürke Szarvasmarhat / Hungarian Grey
 / Grey Hungarian, Hungarian Silver, Hungarian Steppe
Karst / Karstvieh
Slavonsko srijemski podolac / Slavonski Podolac, Slavonski Podolaz, Slavonsko Podolsko,
 Slavonskopolsko / **Slavonian Podolian / Croatian Steppe, Slavonian Grey Steppe,**
 Slavonian-Syrmian Grey, Slavonian Syrmian podolic
Sremsko podolsko goveče / Podolska, Podolsko goveče, Sivo Stepska / Srem Podolian
 / Serbian Grey Steppe, Serbian Podolian / Yugoslav Steppe
Sură de Stepă / Romanian Grey / Romanian Grey Steppe
Moldovenescă / Romanian Moldavian / Moldavain Steppe
Bessarabian Grey
Ialomiteana / Jalomița / Ialomita / Jalomitzaner
Dobrugeana / Dobrudja / Dobrugia, Isker
Danube miniature
Transilvăneană / Siebenburgisch Steppevieh / Transylvanian Grey / Grey Transylvanian
Bușaneșcu / Boksán, Buksana, Bucsán, Busák / Bukschaner / Bucsan
Seraya Ukrainskaya / Seroukrainskaya, Oukrainskii Skot / Ukrainian Grey
 / Ukrainian Grey Steppe
Podolian / Asovian, Bilhorod, Kherson, Poltavian, Tawrii
Kuban Steppe / Cuban, Caucasian
Tschernomorskaya / Tschernomeridian / Black Sea
Kubano Chernomorskaya / Kuban-Black Sea / Krasnodarsk
Tscherkaskaya / Czerkesz / Cherkassy / Dagestan
Subgroup 6D Podolian-Ilyrian breeds from the Balkans and Anatolia
Kolubarsko goveče / Colubarska, Kolubarac, Kolubarska / Kolubara
Sprečko goveče / Spreca-polje, Tuzla / Spreca
Tolmeind
Wocheind
Posavska gulja /Sava / Posavina
Isk”rsko govedo / Iskursko govedo, Sivo mestno govedo / Iskar / Bulgarian Grey,
 Bulgarian Steppe, Grey Iskar, Grey Iskur, Grey Native, Iskar Grey, Vit
Staroplaninska k”soroga / Straplaninska kusoroga / Stara Planina
Lopa e Mursisë / Mursi
Métsovo / Metsovo Red
Chalkidikhi / Katerini / Katerini Steppe

Greek Steppe

Thessaly / Thessaly Steppe

Sikia / Sykia / Sikia Chalkidiki Steppe

Pipéri / Piperi dwarf

Traki / Thrace / Thracian

Boz Irk / Boz Step, Plevne, Plevner, Podolya / **Anatolian Grey** / Anatolian Steppe, Turkish Grey Steppe, Turkish Gray, Native Grey, Pleven, Plevna

Kultak

Malakan / Okranya

Urla

GROUP 7 Shorthorned breeds from the Caucasus, Anatolia, the Levant and Egypt **Subgroup 7A Humpless breeds from the Caucasus, Anatolia, the Levant and Egypt** **and derivatives with exotic influence**

Yerli Kara / Anadolu Yerli Kara / **Native Black** / Anatolian Black / Anatolian Native Black

Diyarbakir

Karacadag

Doğu Anadolu Kirmizisi / Doğu Anadolu Kirmizi, Şarkî Anadolu Kirmizisi / **East Anatolian Red**
/ Eastern Red, Eastern Anatolian Red, Native Anatolian Red

Çildir

Göle

Eleskirt

Kavkazkii / Kafkazkaya / **Caucasian**

Malokavkazskii / Lesser Caucasus

Grusinskiĭ gorniy / Georgian Mountain

Khevsurskaya gruppă / Khevsurian / Chevsurian

Velikokavkazskii / Velikokavkazskaya / **Greater Caucasus**

Krasnyi megrelskii / Mingrelian Red

Kurt / Kurdî / Kurdish

Sharabi

Golpayegani

Nejdi / Arabi

Khuzestan landrace

Bedouin / **Bedu** / Akshi, Anatolian, Djebli, Kleiti

Chesi / Chaissi

Jaulan / Bisre, Khamissi

Baladi / Lebanese **Baladi**

Oksh / Arab, Arabian / **Saudi Taurine**

Arab / Jordanian **Arab**

Karacabey Esmeri / **Turkish Brown** / Çifteler Brown, Karacabey Brown, Karacabey Montafon, Anatolian Brown

Eskişehir / Eskisehir Brown

Zavot

Sari Alaca / **Yellow Pied** / Kazova Yellow Pied

Anadolu Siyah Alacasi / **Anatolian Black Pied**

Kavkazskaya buraya / **Caucasian Brown** / Caucasus Brown / Knar

Armenian landrace

Lorii / Lorii

Dagestanskaya Buraja / Dagestan Brown

Grey Caucasian

Dagestanskiĭ gornii / Dagestan Mountain

Krasnaya Azerbaidzhanskaya / Azerbaijan Brown

Krasnaya Azerbaidzhanskaya / Azerbaijan Red

Subgroup 7B Damascus-type breeds from the mediterranean Islands, West Asia and Egypt **and derivatives with exotic influence**

Il-Baqra Maltija / Maltese Ox

Kypriaki / Kiprus / Cyprus

Messaoria

Paphos

Ándros

Tinos

Kos

Paros

Naxos

Amorgos dwarf

Tilos dwarf

Asguru

Kastellorizo/ Kastellerizon

Yerli Güney Sarisi / Yerli Sari / Native Southern Yellow

Çukurova

Dörtyol

Karaisali

Siverek

Güney Anadolu Kirmizisi / Cenubî Anadolu Sari Kirmizisi, Bahcivan

/ South Anatolian Yellow-Red / Southern Red, South Anatolian Red, Southern Yellow-Red

Kilis

Maras

Halep / Aleppo

Seferihisar

Damascus / Aleppo, Damascene, Halabi, Shami, Shamia

Lebanese / Antakli

Beirut / Beyrouth

Hassawi / Dirbani, Baladi

Oman Baladi

Sarabi / Ardebili

Dishti

Jenubi / Fao, Ma'amir, Zubairi

Rustaqi

Damietta / Dimyatti, Domiatta, Domiatti, Domyati, Dumiat, Dumyati, Manzlawi

Egyptian Baladi / Beheri, Minnfeya

Menufi

Khalit

Anadolu Siyah Alacasi / Anatolian Black Pied

Israeli Holstein / Israeli Friesian

Israeli Red

Group 8 Indo-Pakistani type zebu breeds

Subgroup 8A Zebu and zeboid breeds form Central-West Asia

and derivatives with exotic influence

Gonur Caucasus / Azerbaïdzhanskii Zebu, Talyshinskii / Talishi / Taleshi, Talyshi

/ Azerbaijan Zebu / Azerbaïdzhan Zebu, Azerbaijan Zebu, Caucasian Zebu

Mazanderani / Gilan

Bami

Sistani

Dashtiari

Khorsanskii Zebu / Khorsan Zebu

Khurasani

Sredneaziatiskii Zebu / Central Asian Zebu

Turkestaniskii Zebu / Turkmenskii zebu / Turkestan Zebu / Turkmenistan Zebu, Turkmen

Kuramin

Fergana

Tadzhikskii zebuvidnyï / Tadzhik Zeboid

Pamir

Afghan / Kabuli

Shakhansurri / Chakhansurri

Konari

Kandahari

Vatani / Watani / village cattle

Achai

Lohani / Acchai, Kohi-Suleimani

Rojhan

Dhanni / Awankari, Nukra, Pahari, Pakhari, Pothwari

Azangus

Bushuevskaia / Pritashkentskaia / Bushuev / Tashkent

Shvitsezebuvidnyï / Schwyz-Zeboid / Russian Brown-zebu, Swiss-zebu

TSSH-1

Afghan Subtropical

Subgroup 8B Zebu breeds with convex forehead and derivatives with taurine influence

Sahiwal / Lambi Bar, Lola, Montgomery, Multani, Teli

Las Bela

Cholistani

Rathi / Ratini

Red Sindhi / Malir, Red Karachi, Sindhi / Sind

Gir / Desan, Kathiawari, Soorhi, Surati, Surti / Junágadh / **Gujarati** / **Gujarati**

Vadhyaal, Vadhial

Dangi / Ghauti, Kanada, / Konkan, Konkani

Sonkheri

Deoni / Dongari, Dongarpati, Dongri, Surti

Deogir

Red Kandahari / Lakhbunda

Nimari / Khargaon, Khargoni, Khurgoni

Khamala / Khamla

Frieswal

Friesian x desi

Karan Swiss

Brownsind

Phule Triveni

Jersind

Jersey x desi

Kamaduk

Subgroup 8C Shorthorned grey-white zebu breeds and derivatives with exotic influence

Bhagnari / Kachhi

Dajjal

Nagori / Nagaur

Hariana / Hurrianah

Rath

Shahabadi

Gangatiri

Bachaur / Sitamarhi

Binjharpuri

Mewati / Kosi, Mevatti

Gaolao / Arvi, Gaulgani

Ongole / Nellore

Deverakota

Nari Master

Subgroup 8D Zebu breeds with lyre-shaped horns and derivatives with taurine influence

Kankrej / Bannai / Kankreji / **Kankarej**

Sanchori / Marwari

Gujerat / Talabda

Vadhiyar / Vagadia, Wadhiar, Wadhir, Wadial

Nagar / Wagad

Konkan

Thari / Grey Sindhi

Tharparkar

Cutchi

White Sindhi

Nari

Hissar / **Hissari** / Milking Zebu

Hissar-Hansi / Hansi, Hissar-Hariana

Malvi / Mahadeopuri, Manthani / Malwi

Saugar

Umatwara

Agar

Mandsur / Bhopal

Deccan

Kherigarh / Khari, Kheri

Bhur

Dhaurahra

Manjra Singhai

Parehar / Banjar

Kenkatha / Kenwariya / Kaneverya

Goranea
Bagondha
Patha

Karan Fries

Subgroup 8E Mysore zebu breeds from South India and Sri Lanka

Khillari / Mandeshi, Shikari

Mhaswad

Atpadi Mahal / Haman Khillari

Thillari / Tapi Khillari, Tapti Khillari

Nakali Khillari / Nakli Khillari

Devni

Krishna Valley / Kistna Valley / Kistna River , Krishná River

Geonti

Hallikar

Gujamavu

Bettadapur

Lingadahalli

Hagalvadi/ Hegglewady

Chitaldrug / Chitaldoorg

Ajjumpur

Molvally

Pavagada / Pavgada

Midighesi

Amritmahal / Amrit Mahal, Benne Chavadi

Swanta Gosu

Alambadi / Bestal, Cauvery, Kaveri, Lambadi, Mahadeswarabetta, Salem

Masti dana

Nundi dana

Bargur

Kangayam / Kanganad, Kongu

Manapari / Manapparai

Umbalachery / *Jathi Madu, Molai Madu, Mottai Madu*, Southern Tanjore, *Therkuthi Madu*,
Umbalachery, Umblacherry / Tanjore Polled

Attukari Madu

Ganapathiyam Madu

Mariapillai Madu

Sooriyankattu Madu

Venna Madu

Malaimadu / Nattupasu

Pulikulam / *Kikad, Kilakad, Kilakattu, Palingu Madu, Mani Madu*, Puliakulam, Pullikkulam,
Pullikulun / *Jellicut*

Naattukuttai / Nattumadu / Trichinoplii, Southern Madras

Kangam

Krishnagiri

Punganoor / Punganur

Madras Red

Kinniya

**Subgroup 8F Small zebu breeds from Bangladesh, India and Sri-Lanka
and derivatives with taurine influence**

Gaini

Madhya Pradesh dwarf zebu

Mampati

Ramgarhi

Son Valley

Khasi

North Bengal Grey

Bhagalpore

North Bangladesh Grey

Bengali / Bangladeshi, West Bengal

Dhaka-Faridpur / **Dacca-Faridpur**

Kamdhino

Madaripur

Munshiganj

Austamukhi / Sundari / Red Chittagong / Chittagong Red

Motu

Goomsur / Ghumsur, Ghumsari

Khariar

Kasargod Dwarf

Kuttanbula kullan

Vattakari / Vatakari, Vadakara Dwarf

Malnad Gidda

Iduki

Kapila / Kappiliyan

Vechur / Dwarf cow

Malabar

Sinhala / Lankan, Batu harak / Cinhalese

Tamankaduwa

Shahjadpur / Pabna / Pabna Milking cow, Pabna improved

Taylor

Sunandini / Nava Sunandini

Hatton / Cape, Cappa harak

Subgroup 8G Himalayan hill zebu breeds and hybrids

Ladakhi

Kumauni

Ponwar

Achham / Acchami, Sanogai

Nepalese Zebu / Mahabharat Lekh

Nepalese Hill Zebu / Black Hill Zebu, Nepali Hill Zebu

Kathmandu Valley Zebu

Morang / Purnea

Siri / Trahbum / Bhutanese

jatsum (♀), **jatsa** (♂) F1

yankum (♀), **yanka** (♂) F2

doebum (♀), **doeb** (♂) F3

doethram (♀), **doethra** (♂) F4

datum (♀), **data** (♂) F5

thrabum (♀), **trapa / nublang** (♂) F6

Kachcha Siri

Assam local

Tarai / Terai

Jaba

**GROUP 9 Turano-Mongolian breeds from Central and Northeast Asia;
yak and yak-cattle hybrids**

**Subgroup 9A Central Asian Turano-Mongolian breeds
and derivatives with European influence**

Yakutskii skot / Sakha Ynaga / Yakut / East Siberian

Beliy sibirskiy skot / Siberian White

Russo-Siberian

West Siberian

Altayskaya / Altay / Altai, South Siberian

Buryat

Transbaikalian

Kalmytskaya / Krasno-astrahanskaya / Kalmyk / Kalmykian, Red Astrakhan

Lower Volga

Zarizyner

Don

Kalmuck

North Caucasian / Nagai

Kazakhskaya / Kazakh / Kazach

Kyrgyzkaya / Kirgizskaya, Ordinskaya poroda / Kirgiz

Severnaya Kyrgyzkaya / Severnii Kirgiz / North Kirgiz / Severo-Kirgiz

Loesnaya Kyrgyzkaya / Central Kirgiz / Narym

Karakalpak

Nutgiin Uulderiin Unee / Mongolian

Dornod talyn Hevshil

Halhin Gol / Khalkhingol, skii skot / Khalkhun Golun / Khalkun Golum

Gobi Steppe
Menggu / Inner Mongolian
Ujumqin / Wuzhumqin
Horqing
Anxi
Gaotai
Yangba
Tangjiao
Meiniu

Hazake
Lulu
Kirko / Kirkho
Khaila
Pahadi
Ladakh Hill
Tibetan Dwarf / Glang, Lhasa
Lepcha
Goleng
Bajo
Diqin / Dikin Yellow
Sibirskaya chernopestraya / *Chernopestryi skot Sibiri, Sibirskii Chernopestraya*
/ Siberian Black Pied
Kemerovskaya / Kemerovo
Auliéatinskaya / *Auliatinskaya, Aulyatinski* / **Aulie-Ata**
Char Tarlan / **Mongolian Black Pied**
Chinese Black-and-White / Chinese Black Pied, Chinese Holstein
Beijing Black Pied
Pinzhou / Pinchow, Pin-chou, Pinchou, North Manchurian Dairy
Keerqin
Kurganskaya / Kurgan
Caoyuan Red / Chinese Red Steppe, Grassland Red
Red Steppe / Kazakh Red Steppe
Byelagolova / *Kazakhskaya belogolovaya* / Kazakh Whiteheaded
Aulyakolski / Auliekol / Aulyakol
Tsagaan Tolgoit / Mongolian Whiteheaded
Selenge
Altay Whiteheaded
Sibirskii Simmentalskaya / *Sibirskaya Simmentalskaya* / **Siberian Simmental**
Dashevostochonii Simmentalskaya / **Far Eastern Simmental**
Priuralskii Simmentalskaya / **Ural Simmental**
Privolzhskii Simmentalskaya / **Volga Simmental**
Sanhe / Three river breed
New North Caucasian
Alatauskaya / Ala-Tau / Alatau
Bor Khalium / **Mongolian Yellow-Brown**
Xinjiang Brown
Subgroup 9B Breeds from Northeast China, Korea and Japan
and derivatives with European influence

Yanbian
Fuzhou / Fuzhou Yellow
Korean Native
Han Woo / *Han Uh, Hanu, Han-u* / **Korean Hanwoo** / Korean native, Chosen
Brown Hanwoo / Korean Brown / Korean Yellow
Chickso / *Ho-Ban-Wool* / **Brindle Hanwoo** / Korean Brindle
Black Hanwoo / Korean Black
Jeju Heugu / Jeju Black / Jeju Black Hanwoo, Cheju Black, Jeju native
Wagyu / Japanese native
Mishima ushi
Shusuku Tsuru
Yoshi Tsuru
Fuki Tsuru
Atsuta Tsuru
Kenrangyu / Kenran

Kuchinoshima ushi

Kairyowashu

Japanese Improved / Nipponese Improved

Akage Washu / Japanese Brown / Red Wagyu

Kochi

Kumamoto / Akaushi

Kuroge Washu / Japanese Black, Black Wagyu

Tajima / Hyogo, Kobe beeves, Tajiri,

Shimane / Fujiyoshi

Tottori / Kedako

Mukaku Washu / Japanese Poll / Japanese Polled

Nihon Tankatu Shu / Tonkaku Washu / Japanese Shorthorn / Tonkaku Brown

Nambu

South Korean Holstein / Korean Holstein-Friesian

Japanese Holstein / Japanese Holstein-Friesian

Subgroup 9C Yak and yak-cattle hybrids

yak (domestic) / **Bos grunniens**, *Bos (Poëphagus) grunniens* / **mao-niu** / **topos** / **bree, bri, dhee, dri, nak** (♀); **g'yag** (♂) / **bri-mo, brimo, gnag**, (♀); **nor, yakpo**, (♂)

Henduan Alpine type yak

Alpine yak / Tibetan High Mountain yak

Jiulong / Jiu Long

Bazhou

Huanhu

Yardong

Qinghai-Tibet Plateau type yak

Qinghai Plateau yak / Long-hair-forehead yak

Daton yak

Maiwa

Tianzhu White yak

Zhogdian / Zhongdian

Gannan

Luqu

Mongolian yak

Common yak

Bareback yak

Kyrgyz yak

Nepalese yak

Bhutanese yak

Ladakh yak

Feral yak

Mountain type

Plateau type

Himachal yak

Chou-gau yak

Sikkim yak

Bho yak

Aho yak

Arunachal yak

Bareback type

Bisonian type

Common type

Hairy forehead type

yakow

pian-niu / p'ien niu / **mdzo / khainag** / hainag, hainýk, hainik, khaynyk , **sarlag** / **bhotey** / **bhotea** / **molang, glangmu / jolong** / cholung, **lhang** / lang

local pien niu, false pien niu, improved pien niu

brimdzo, brimo dzhopo

ushu dzomo, mdzo-mo, ushu dzopho, mdzo-po / dzobo

chauri / cāuri, chowri, churi, tsaury / **shamdzo, jommu** / jum, **zhum** / zomo, zum

/ **dzopkhyo** / jhopke, joppa, zebkyo, zhopyo, zopkio / **rongpalang dzopoho**

dridzo, dhimjo / dimdzo, dimjo, dimschu / **saran-hainag**

bamo, galiba, ah gohr / ago

pamu chowri, payok

haapa / herakpa

**GROUP 10 Breeds from Central and South China, Southeast Asia;
bibovine cattle and their hybrids**

Subgroup 10A Central Chinese yellow breeds (Huanghuai Group)

Qinchuan / Ch'inch'uan / Chinchuan

Zaosheng

Wanniu

Jinnan Yellow

Pinglu Mountain

Pingchuan

Jinan

Bohai Black / Wudi Black

Luxi / Kwangtung, Shandong, Shan-tung

Szyang / Syhyang

Tanyang / Danyang

Shanghai

Jiaxian Red / Jiaxian

Nanyang

**Subgroup 10B Subtropical Chinese yellow breeds (Changzhu Group)
and Indo-Chinese humped breeds**

Sanjiang / Szechuan

Bashan

Xuanhan

Qinba

Pingli

Xizhen

Chiya

Lingnan

Miaoya / Yunba

Zaobei / Chowpei, Chou-pei, Dschau-bei

Wuling

Enshi

Xiangxi

Ebian Spotted

Dengchuan

Zhaotong

Panjiang / H'mong

Sinan

Liping

Guanling / Guanling Yellow, Guizhou

Longlin / Guixi

Wenshan / Guangan

Bainiu / Jiniu

Dabieshan

Dabie Mountain

Huangpi / Huang-p'o, Huang-p'ei

Wannan

Guangfeng / Guanfeng

Zhoushan

Wenling Humped

Ji'an

Minnan / Min

Taiwan Black

Batanes Black

Hong Kong Zebu

Taiwan Zebu / Formosa Drought

Taiwan Yellow

**Subgroup 10C Tropical Indo-Chinese zebus, Phillippine and Indonesian breeds
and derivatives with exotic influence**

Yunnan Zebu / South Yunnan Zebu, Yunnan High-hump, Yunnan Humped

Xishuangbanna / Banna

Dehong

Dali

Burmese / Tavoy, Arakan, Myanmar native
Shwe Ni / Burmese Racing
Shan Nwar / Shan

Thai / Siamese
Thai Highland
Thai Lowland
Kho Peun Nyang Thai E San

Laotian / Yellow Asian
Laos Yellow
Ngoua

Cambodgien / Cambodian / Khmer
Lowland Khmer
Highland Khmer
Moi

H'Mong / Hmong
Bo Lai Sin
Bo Vang / North Vietnamese Yellow / Annamese, Vietnam Yellow
Cao Bang
Bo U dau Riu / Uriu, U Riu
Bo Chau-Doc / South Vietnamese Yellow / Vietnam Yellow
Tuy-Hoa
Ba Rial Baria
Phu Yen

Leiqiong
Leizhou / Xuwen Humped
Ji'An
Hainan Humped / Hainan High hump

Batangas
Kedah-Kelantan / KK / Kedah-Thailand, Kelantan, Kelantan-Kedah, Siam-Kedah, Thai-Kedah, Terengganu, Trengganu
Bligon Madura / Madura / Madurese
Madura karapan
Madura sonok
Madrasin
Blateran Java

Bligon Java / Jawi / Javanese / Java cattle
Galekan / Jawi Trenggalek
Rambon Banyuwangi / Jawi Timur
Jawi Pandaan
Brebes

Nwar Pyiase / Chaubauk
Kadonta / Katonta
Pyar Zein / Pya sein
Pyar Phu
Kyank Phu / Kyankphu
Shwe Ni Gyi / Shwe-ni-gyi

Khao Lumpoon / **Kao Lumpoon**, *Kai Lumpoon* / **White Lumpoon** / White Lamphun
Thai Fighting / Thailand Fighting Zebu
Bo Lai Sin / Laisind
Thanh-Hoa / Tonkin Zebu
Local Indian Dairy / LID
Brakmas
Sumba Ongole
Peranakan Ongole / **Javanese Ongole** / Java Ongole, Grade Ongole
Mirrit

Javanese Zebu
Merauke

Borneo Zebu
Kabota
Kaningan

Aceh
Pesisir
Filial Ongole / Sumatra Ongole

Sumatra cattle

Mafriwal

Charoke

Philippine Native

Philamin

Ilocos / Ilocano

Large Ilocos

Small Ilocos

Iloilo

Marianas / Marianas Island, Marianne

Sapi perahan Grati / Grati

FH-hitam-putin / FH red pied

FH-merab / FH red pied dual-purpose

Subgroup 10D Bibovine cattle and their hybrids

sapi Bali / Bali cattle / *Bos javanicus javanicus*, *Bos (Bibos) javanicus* / Balinese

White Bali cattle

sapi utan / Malay banteng / Siamese banteng, feral Bali cattle

Cobourg Peninsula

Rambon Bali

Rambon Madura / Rambon Madurese, Blateran rambon

Madrasin

Lowland Khmer x banteng

Highland Khmer x banteng

Mithun / Gayal / *Bos frontalis*, *Bos (Bibos) frontalis*

Bami / Menscha / Bhutanese Mithun

Mithun-Siri

Indian Mithun:

Arunachali

adi

aki

nishi

Nagami

Manipuri

Mizorami

Dulong

Selembu

Seladang x Holstein-Friesian

GROUP 11 North and West African taurine breeds

Subgroup 11A North African Shorthorn breeds and derivatives with exotic influence

Blonde d'Oulmès et des Zaërs / Blonde des plateaux d'Oulmès et des Zaërs

/ Oulmès-Zaërs Blond / Blond Moroccan, Moroccan Blond, Morocco Blond Atlas

Oulmès Blond / Morocco Olmez

Blond Zaërs

Tidili / Ouzguitia / Morocco Tidili

Brune de l'Atlas / Charb, Donkhala, Maghreb, Meknès / Moroccan **Brown Atlas, Brown Atlas**

Beni-Ashene

Branes

Demnat

Fez-Meknès

Zemour

Noire Pie de Meknès / Pie-Noir de Meknès / Meknès **Black Pied**

Chaouia / Aran, Mahon, Orano-Algiers, Shauria / Algerian **Brown Atlas**

Aïn-Beïra

Chélif

Beni Sliman

Oran

Tiaret

Guelma / Bouefs de Bône / Algerian **Guelma**

Cheurfa

Kabyle

Biskra

Mogod / Tunisian Guelma / Tunisian Blond

Blonde-du Cap Bon / Cape Bon Blond

Djerba
Kef

Libyan Shorthorn / Libyan local
Maryuti / Arabawi, Arabian, Sahrawi
Thibar

Béja
Ichkeul / Bizerta
Mateur

Subgroup 11B Lake Chad breed and taurindicine crossbreeds

Kouri / *Arabe, Baharié, Bare, Borrié, Boudouma, Dongolé, Kuburi* / **Kuri** / Buduma, Chad, White Lake Chad

Taurien de Sayam
Gimira

Jotko / Jotkoram
Toubou
Kanem

Subgroup 11C N'Dama, taurindicine derivatives and derivatives with exotic influence

N'Dama / **N'Dama Petite** / **Boenca** / *Boyença* / **Fouta Longhorn** / Fouta Jallon, Fouta Malinke, Futa, Guinea N'Dama, Malinke, Mandingo / *Outa Malinke*

Gambian N'Dama / **N'Dama Grande** / **N'Dama de Kaarta**

Malinese N'Dama / **Méré Ouolosso** / *Ouolosso*

N'Gabú / **N'Gabou**

Foula / **Fula**

Djakoré / *Sine*

Bambey
N'Damaza

Bambara / *Farabané, Mandé*

Méré Kourouni / *Méré*

N'Dama-Sanga / *pseudo-Sanga, Sang*

N'Dama-M'Bororo / **N'Dama x Red Bororo**

Ndagu

N'Dama-Jersey

N'Damance

Avétonou

Subgroup 11D West African Shorthorn breeds and taurindicine derivatives

Baoulé

Lobi / *Lobi-Gouin*

Oudalan

Baoulé de Ghana / **Ghana Shorthorn** / Gold Coast Shorthorn, WAS

Somba / *Atakora* / **Konkomba** / *Mango*

Pabli

Logone / *Toupouri*

Muturu / *Moutourou*, Nigerian Shorthorn

Dwarf Muturu / Nigerian Lagune

Montane Muturu

Savannah Muturu / *Pagan*

Forest Muturu / *Kirdi*

Bakosi / *Bakuri, Kosi*

Bamiléké

Bakweri

Taurin de l'Est / Eastern Taurine

Manjaca

Liberian Dwarf Muturu

Senegambian Shorthorn

Lagune / *Bayanzi*

Lagunaire / *Race des Lagunes* / **Lagoon**

Ghana Dwarf Muturu / *Ghanese Lagune*

Mayombe / *Mayumbe* / **Dahomey** / *Daomé*

Doayo / *Kirdi, M'Bougi, Namchi, Namshi, Poli*

Lagunaire grande modele

Lagos Cross / *Keteku*

Méré / *Méré-Lobi*

White Sanga

Bobori / Borgou / Borgawa, Borgowa / Borgu

Borgou-zébu / Borgu zebu

Keteku / Kaiama, Keteku de Borgu

Biu

Kapsiki / Kirdi, Mbuuyé, Tla pseke

Massa

GROUP 12 West African Zebu breeds

Subgroup 12A Shorthorned Sahel zebu breeds

Maure / Moor / Arab, Gabaruyé / Mauritanian, Moorish

Azaouak / Azawa, Azawagh, Azawaje, Azaoual, Azaouadji, Azbingaoua / Azbin / Dalleye, Damerghou, Adar, Shanun Adar / Touareg / Tagama, Tarqui, Tourgai

Shuwa Arab / Arab Shuwa, Arab Zebu, Arab Choa / **Shuwa Arabe / Arabe, Aznadji / **Zébu Arabe** / **Arabe Choua** / Tur**

Shuwa-Aral / Aral Shuwa

Kilara

Noble / Barahaja

Batarde / Farfarou

Kabi

Wadara

Sokoto Gudali / Goudali / Bokoloji, Dalergaoua, Godali, Sokoto Goudali, Zébu de Sokoto

Diali / Jali, Jalliji, Jeli, Nigerian Fulani, Sokoto Keteku / **Zébu Peul nigérien / Djelli, Djeli, Jalli,**

Shanun Bayaro / **Zébu Peul / Peuhl Voltaïque**

Subgroup 12B Adamawa zebu breeds and derivatives with exotic influence

Adamawa Gudali / Adamawa Fulani

N'Gaoundéré / Goudali de l'Adamaoua, N'Gaoundéré Goudali, Bamenda / Cameroon Fulani

Yola Gudali / Yola / Foulbé de Yola, Tattabareji, Mayne

Wakwa

Préwakwa

Subgroup 12C Fulani zebu breeds with long lyre-shaped horns

Gobra / Foulfoulé, Toronké Fulani, Zébu Peul sénégalais / Senegal Fulani, Senegal Zebu

Gobra de Djoloff / Djoloff Gobra

Gobra de Baol / Baol Gobra

Dagana

Zébu Peul soudanais / Baouro, Bogoro-Fulani, Fulani-Nam, Misse, Peul-Fulani / Sudanese Fulani / White Umbroora

Zébu Toronké / Toronké Fulani

Zébu de Kaarta / Kaarta Fulani

Zébu Peul de Ségou / Ségou Fulani

Zébu Peul de Macina / Macina Fulani

Zébu Peul Sambourou / Sambourou Fulani

White Fulani / White Bororo, White Fellata, White Kano / **Yakanaji / Akou, Bima, Bimaji, Boradji,**

Bororo Blanc, Bunaji, Fellata, Foulbé blanc, Fulbe, Katsinaoua, Tulus, Umbororo, Yakanape,

Zébu Peul blanc

Fellata / Kanouri / Bororo

Wodabe / Wodaabe

Banyo / Banyo Gudali / Foulbé de Banyo, Goudali de Banyo

Pul-M'Bor

Red Bororo / Red Fulani / Red Longhorn / **M'Bororo / Abori, Bororodji, Bodaado, Mbororo,**

Na'i bodeeji, Rahadji, Rahaji, Rahaza, Zébu Bororo / **Brahaza / Djafoon / **Kréda** / Fellata, Fogha,**

Gabassé, Gadéhé, Hanagamba / Fogha, Zébu du Fogha

Abrankeji

Poulpulli / N'Dowiji

Na' i iririji

Habbani / Tetrone

GROUP 13 East African zebu breeds

Subgroup 13A Zebu breeds from Northeast Africa

Saidi

Baggara / Western Baggara

White Nile Baggara

Nyalawi Baggara

Hawazma Baggara

Nuba Mountain Zebu

Nuba Shorthorn / Delami, Kawalib, Koalib, Nuba Dwarf

Dar el Reih / Butana / Foya, Red Butana, Red Desert

Bambawa / Bambaua

Dongola

Shendi

Rufa'ai El Hoi / Rufa'ai El Sherik / Kenana / Blue Nile, Fung, Northern Riverain cattle, Northern Province cattle

Fung Kenana

Gezira

White Nile Kenana / Kosti Kenana

Ingessana

Barca / Begait

Dohin

Dembia

Qocherie

Subgroup 13B Small zebu from the Arabian Peninsula and the Horn of Africa

South Arabian Zebu / Janobi, Quarra

Zufari / Dhufar Zebu, Dofar Zebu, Oman Baladi, Omani Dhofari, Oman Zebu

Socotra

Yemeni Zebu

Baherie / Aden Zebu, Arab, Bahari, Berbera

Western North Somali Zebu / Aden

Eastern North Somali Zebu

Gasara / Abgal, Aria, *razetta delle dune*

Magal / Correi

Garre / Dawara, Gerra, Gherra

Bimal / Baria

Singhi

Subgroup 13C East African Shorthorn Zebu breeds

Murle

Toposa

Karamajong

Jie

Turkana

Boran / Borana, Ethiopian Boran / **Awai / Somali Boran**

Ogaden Zebu

Hammer Zebu / Hamer

Orma Boran / Tanaland Boran

Kenya Boran / Improved Boran

Boran x Holstein

Masai Zebu / Maasai

Masai Grey / Maasai Grey

Subgroup 13D Small East African Zebu breeds and derivatives with exotic influence

Adwa

Wollo Highland

Smada

Ambo

Jijjiga Zebu

Harar

Guraghe

Gojjam Highland

Arsi / Arusi, Arussi

Bale / Abyssinian Highland Zebu

Jem Jem Zebu / Black Highland Zebu

Gamo-Goffa / Goffa Dwarf

Goffa highland

Goffa lowland

Sheko / Goda, Dello, Dobe, Bombel, Mitzan, Mulge, Semo, Tunibey, Tunt

Mursi

Mongalla / South-eastern Hills Zebu, Southern Sudan Hill Zebu

Latuka

Didinga

Bari

Lugware / Bahu, Kuku, Lugbara, Mangbattu

Nkedi / Bukedi, Eastern Province Zebu, Lango, Teso

Teso Zebu

Usuk / Usuku / **Suk**

Kyoga

Kipsiki

Western Province Zebu

Karapokot

Samburu

Kamasia

Nandi / Nandi Blue

Winam

South Kavirondo / Kavirondo

Watende

Kikuyu Highland Zebu

Coastal Zebu / Lowland Zebu

Kamba / Akamba, Ukamba, Wakamba

Durama

Giriama

Taita / Taveta

Kilimanjaro Zebu

Chagga / Wachagga

Pare

Mbulu

Tanzanian Shorthorned Zebu / TSZ

Tarime / Shashi

Tanganyika Shorthorn Zebu

Mkalama Dun / Mkalama Gold

Singida / Singida White

Ugogo / Ugogo Zebu, Ugogo Grey, Gogo

Sango

Iringa Red

Zanzibar Zebu

Pemba Zebu

Unguja Shorthorn

Angoni / Ngoni, Zambia Angoni

Lundazi

Chipata-Katete

Angonia / Angone, Mozambique Angoni, Mozambique zebu

Malawi Angoni / Malawi Zebu

North Malawi Angoni / Nyasa Angoni, Nyasaland Angoni

South Malawi Zebu / Nyasa Zebu, Nyasaland Zebu

Mpwapwa / Indo-African Zebu

Mikolongwe

Taurindicus

Kenya Sahiwal

Kenyawal

Subgroup 13E Zebu breeds from Madagascar, Mauritius and Ocean Islands and derivatives with exotic influence

Omby Malagasy / **Zébu Malgache** / Madagascar Zebu

Baria

Omby Rana / Rana

Renitelo

Manjan 'i Boina

Primitif / Comoros Primitif

Amélioré / Comoros mixed

Zébu de Maurice / Mauritius Zebu

Créole de Maurice / Mauritius Creole

Ile d'Amsterdam / Amsterdam Island

Félicité

GROUP 14 African sanga and zenga breeds

Subgroup 14A Northeast African sanga and zenga breeds

Beja / Arashie

Medenes / Medenece

Aradó / *Akele-Guzai, Asaortina / Asaorta / Tigray, Tigré*
Bileri / Baria

Irob

Abergelle

Afar / Adal, Adali, Afar Sanga, Keriyu, Raya / **Danakil** / Dancalian

Raya-Azebó / Galla Azebó, Raya Sanga

Arusi-Galla

Fogera

Horro / Shewa, Uollega, Wallega, Wollega

Nilotic sanga

Nuer

Eastern Nuer

Abigar / Anuak

Shilluk

Aweil Dinka

Wadai Dinka

Aliab Dinka / Dinka Aliab

Jiddu / **Tuni** / **Giddu** / Macien, Serenli, Sorco, Sucra, Surco, Surco Sanga, Surgo, Surug

Subgroup 14B Ankole sanga and zenga breeds from Central Africa

Bahima Ankole / Ankole, Ankole Longhorn, Nsagalla, Nsagara / Bahima

Ntuuku / Ntuku / Ntoro, Toro

Nkiga

Nsongora

Nganda / Sese Island

Sesse Shorthorn

Ankole / Rwanda sanga, / Watusi

Inkuku / *Nkuku, vache ordinaire*

Ibigarama

Inyambo / *vache royale*

Ankolé / Burundi sanga

Inyambu

Inyaruguru

Busoni

Mugambu

Kivu sanga

Kigezi

Kigezi Shorthorn

Karagwe Shorthorn

Bashi

Bantu cattle

Ruzizi

Alur / Blukwa, Nioka

Nyoro

Serere

Sukuma / Tinde, Malagarasi Ankole

Ugoi

Fipa

Nkasi Fipa

Sumbawanga Fipa

**Subgroup 14C Sanga and zenga breeds from southern Africa
and derivatives with exotic influence**

Porto Amboim / **Angolan** / Angola

Mocho do Malange

Mocho do Quilengues / *Tshilengue*, Ondango

Humbe / *Humbi*

Mumuila / *Muila*

Nhaneca

Kwaniana / *Kwanama, Kwanhama*

Mucubai

Ngombe

Kombe

Caprivi sanga

Kashibi

Ovambo / Ambo
Okavango / Kavango
Kaokoveld / Kaokoland
Damara / Herero
Damara-Herero
Barotse / Lozi, Rowzi, Rozi
Baila / Ba-Ila, Mashuk, Mashukulumbwe, Mashukulumpo
Tonga
Govuvu / Kavuvu, Kwavuvu
Binga
Nkone / Mangoni, Manguni, Matabele
Tuli / Harvey's cattle
Amabowe
Tulim
Okuma
Tswana / Bechuana, Sechuana, Setswana / **West Sanga**
Batawana / Ndawana, Tawana
Seshaga
Sengologa
Mangwato
Ngami / Bakalahari, Batawana, Ndawana, Tawana, Tswana
Ngwato / Bamangwato
Ngombe dza Vakaranga / **Makalanga** / Makaranga
Dikgomo tsa Borwa / **Southern Tswana**
Sekgatla
Landim / *Sul do Save*
Nguni / Swasi, Zwazi, Zulu
Bapedi / Pedi
Shangan / Shangaan
Royal Zulu herd
Xosa
Ama-Xosa
Bavenda / Sibasa, Venda
Bolowana / Izankaya
Ondongolo
Pondo
Zwazi
Zulu
Borguni
Sanganer
Afrikander / *Afrikaner* / *Africander*
Hottentottenvee / Namaqua
Bakhoornig / Cup-Shape-Horn
Long-Twisted-Horn
Keepnek / Notch-Neck
Yellow Afrikander
Poll Afrikander
Afrigus
Mashona / Amajanja, Chishona, Mombe, *Ngombe dza Maswina*, Njanja, Sindebele, Shona
Bovines da Tete / **Bovines of Tete**
Barra do Cuanzo
Pitangueira
Mateba
Kisantu
Nama
Musi / Botswana beef synthetic
Basuto
Drakensberger / Black Africander
Vaderlanders
Uysbees
Kemp
Tintern Black
Supertaler

Tauricus

Bonsmara

Wesselsvlei

Roodenbos

Vaalhaiz

Holmonger

Nuras

Huguenot / Hugenot

Veldmaster

Bovelder

Symons cattle

Subgroup 14D European, American and Australian purebred populations in South Africa

Red Pied Schleswig-Holstein / *Rotbunte Schleswich-Holsteiner*

SA Holstein / Holstein-Friesland

SA Ayrshire

SA Guernsey

SA Jersey

SA Dairy Swiss

SA Braunvieh / Brown Swiss dual-purpose

SA Dairy Shorthorn / SA Milking Shorthorn

SA German Red / SA *Deutsches Rotvieh*

SA Dexter

SA Kerry

Dexter-Kerry

Pecanite

SA Aberdeen Angus

SA Beef Shorthorn / *Korthoring*

SA Hereford

SA Highland

SA North Devon

SA Red

SA Red Poll / *Rooi Poenskop*

SA South Devon

SA Sussex

SA Weebollabolla

SA Charolais

SA Limousin

SA Salers

SA Simmentaler

SA Gelbvieh

SA Pinzgauer

SA Chianina

SA Marchigiana

SA Romagnola

SA Senepol

SA Wagyu

SA Beefmaster

SA Brangus

SA Charbray

SA Gelbray

SA Santa Gertrudis

SA Simbrah

SA Boran

SA Brahman

SA Gir

Gir-Brahman

GROUP 15 American breeds of Iberian descent

Subgroup 15A Texas Longhorn, Gulf Coast cattle, Mexican Criollos and derivatives

Texas Longhorn / Longhorn / *Cuernos Largos*

Marks line

Phillips herd

Woods line

Wright line

Buttler line
 Peeler herd
 Wichita Wildlife Refuge herd
 Yates line
 Miniature Texas Longhorn
 Miniature Spanish Las Manchas
Florida Cracker / Florida Native, Florida Scrub
 Ezell herd
 Neal herd
 Grews brothers line
 Wassie Fish line
 Guinea dwarf
Pineywoods / Piney Woods, Southern Woods Cattle
 Diamond herd
 Griffin line
 Poppel line
 Robinson cattle
 Tornhill line
 Agricola herd
 Barnes line
 Baylis herd
 Broadus line
 Carter line
 Conway line
 Dedeaux line
 Hickman line
 Holt line
 Ladner herd
 Ladnier herd
 Palmer-Dunn herd
 Vice herd
Corriente / Mexican
Criollo de las montañas del Norte / Northern Mountains Criollo
 Tarahuma
Chinampo / *Criollo del desierto de Baja California*
 Frijolillo
Criollo de la Sierra Madre Occidental / Sierra Madre Criollo
Criollo del Golfo / Mexican Gulf Criollo
Criollo mexicano / Mexican Criollo
 Hawaiian wild
 Californian cattle
Toro de Lidia / Brava / Mexican **Fighting cattle**
Santa Coloma
 Salorn
 Geltex
 Texon
 El Monterey
Subgroup 15B Caribbean Criollo breeds and derivatives with exotic influence
Criollo Cubano / *Criollo de Cuba* / Cuban Criollo
 Tinima
 Miniature Criollo
Créole / Haitian Criollo
Creole Jamaicano / Jamaica Creole
Criollo Lechero / Dominican Criollo / Dominican Dairy Criollo
Créole / Puerto Rican Criollo
Taino de Cuba
Crimousin
Cebú Cubano / Bermejo / Cuban Zebu
Romana Rojo / Romana Red
Criollo de Trinidad / Trinidad Criollo
Créole de Guadeloupe / Guadeloupe Criollo
Créole de la Martinique / Martinique Criollo
Subgroup 15C Central American Criollo breeds and derivatives with exotic influence

Barroso

Guatemalan Criollo

Criollo encastado / *Chino* / **Honduran Criollo**

Criollo / **Salvadoran Criollo**

Criollo lechero tropical / *Criollo lechero, Reyna* / **Tropical Dairy Criollo**

/ *Central American Dairy Criollo, Improved Criollo, Milking Criollo*

Costa Rica Criollo

Nicaragua Criollo

Doran

Achiote

Mysol

Subgroup 15D Criollo breeds from the northern part of South America and derivatives with exotic influence

Criollo lechero Limonero / *Criollo lechero Venezolano* / **Limonero** / *Rio Limón Dairy Criollo*

Costeño con Cuernos / **CCC** / *Andaluz, Cornigero de la costa, Sinuano de cuernos, Sinú con cuernos* / *Coastal Horned*

Romosinuano / *Moruno-sinuano, Romo* / *Coastal Polled, Polled Sinú*

Chino Santandereano / *Santander Hairless*

Blanco Orejinegro / **BON** / *Antioqueño* / *Black-eared White*

Blanco Orejimonó / **BOM** / *Red-eared White*

Casanareño / *Casanare* / **Llanero**

San Martinero / **SM** / *Sanmartiniana* / **San Martin**

Hartón / *Vallecaucana, Valle de Cauca*

Caqueteño

Surinaamse Créole / **Surinam Criollo**

Caroreña / *Tipo carora* / **Carora**

Ocampo

Lucerna

Mestizo perijanero / **Mixed Perijanero**

Perijanero

La Velásquez / **Velásquez**

Créole / **French Guyana Mixed Criollo**

Surinaamse Mixed Créole / **Surinam Mixed Criollo**

Rupununi Criollo

Subgroup 15E Sierra Criollo breeds from the High Andes and taurine derivatives

Criollo equatoriano / *Chusco* / **Ecuador Sierra Criollo** / *Equador Criollo*

Criollo del Páramo / **Paramo Criollo**

Criollo de las Hoyas / **las Hoyas Criollo**

Costa Criollo / **Coastal Criollo**

Criollo de El Oro / **El Oro Criollo**

Criollo de Esmeraldas / **Esmeraldes Criollo**

Colorado

Encerado

Negro Lojano

Pintado / *Cajamarca*

Criollo peruano / *Chusco* / **Peruvian Criollo** / *Peruvian Sierra Criollo*

Serrano / *Tipo eumétrico*

Nata / **Niata**

Criollo altiplánico / *Chusco* / **Bolivian Altiplano Criollo** / *Criollo of the Altiplano*

Criollo costino / *Costeno*

Criollo chileno / **Chilean Criollo**

Subgroup 15F South American Criollo breeds of Spanish-Portuguese descent and derivatives with exotic influence

Curraleiro Pé-Duro / *Corral Crioulo, Goias Sertanejo, Pé duro Crioulo, Crioulo nordestino*
/ *Hard Hoof Criollo, Northern Crioulo*

Crioulo leiteiro de Irecé / **Irecé Dairy Crioulo**

Mocho Nacional / *Caracú variedade mocho* / **Brazilian Polled**

Caldeano

Junqueiro

Caracú / **Caracu**

Legítimo

Mineiro

Igarapé / *Guarapuéva, Nanico*

Pantaneiro / Cuiabano, Tucara, Tucura
Yacumeño / Beni Criollo, Criollo Yacumeño

Beni Criollo

Saavedreño / Santa Cruz

Valle Grande Criollo

Chaqueño / Chaco Criollo

Criollo Arroyos-e-Esteros

Criollo Cral.Díaz

Criollo Neembucú

Fronterizo / Tipo elipométrico

Crioulo Lageano / Crioulo do Santa Catarina / Lages Crioulo

Franqueiro

Pedreiro

Crioulo Mocho Pereira Camargo / Ganado Pereira Gamargo / **Polled Crioulo Pereira Camargo**

Criollo / Uruguayan Criollo

Colônia

Aquitânica / Aquitanian

Pampa chaqueño

Pampa

Criollo argentino patagónico / Patagonian Criollo / Ushuaia Wild

Patuá

Casteado

Angola

Guadamar

Malabar

Carazebú / Carazebu

China

Quinhentão

**GROUP 16 Modern cattle breeds from America, Australia and New Zealand
and bovine hybrids**

**Subgroup 16-1A Authentic American, Australian
and New Zealand populations and breeds**

Canadienne / **Canadian** / Black Canadian, Black Jersey, French Canadian, Quebec Jersey

Randall Lineback / Randall Blue Lineback, Randall Blue, Randall cattle

Native cattle

Cream Pot

Lineback / American Lineback, skunk cow

Holderness

Columbian

American G

Colorsided

Yellow Dane

Polled Albion

Milking Devon / American Milking Devon, Red Devon

Illawarra / Australian Illawarra Shorthorn, South Coast cattle

Australian Milking Shorthorn

Darbalara

Graham Island

Enderby Island

Campbell Island

Chirikof Island / Aleutian Wild

banteng / feral Bali cattle, Cobourg Peninsula

Subgroup 16-1B Dairy and dual-purpose breeds descending from European breeds

Milking Shorthorn / American Milking Shorthorn

Poll Milking Shorthorn

Polled Durham

American **Ayrshire**

American **Guernsey**

American **Jersey**

Polled Jersey

Guinea Jersey / Barnyard Jersey, Island Jersey, Lesser Jersey, Miniature Jersey,

Rabbit Eyed Jersey

New Zealand Jersey

American **Kerry**

Dutch Belted / American Dutch Belted, Belted Dutch

Holstein / American Holstein / **Canadian Holstein** / Holstein-Friesian

Polled Holstein

Miniature Holstein

Holstein Mexicano

Frisona

Overo negro europeo / *Frisona Chileno* / **Chilean Holstein-Friesian**

Holando-Argentino / **Argentine Holstein** / Argentine Friesian, Dutch Argentine

Holandês / **Brazilian Friesian**

Australian Holstein-Friesian

Red Holstein

Frisoña vermelho e branca / *Holandesa vermelho (e branca)* / **Friesian Red Pied**

New Zealand Friesian / New Zealand Holstein-Friesian

MRY / **Dutch Shorthorn** / **Holandês Variedad Mosa Rhino-e-Issel**

Overo Colorado / *Clavel Alemán*

Clavel de Carne

Brown Swiss / American Brown Swiss / **Suizo Americano** / **Pardo Suizo** / **Pardo Suíço**

American **Normande** / **Normando**

Normando mocho / **Polled Normande**

American **Norwegian Red**

Red Dane / **Dinamarquês**

Flamenga / **Flemish**

Simhol

Dairy Synthetic / Dairy-beef synthetic

Australian Commercial Dairy Cow / **ACDC**

Australian Red Dairy / Aussie Red, Australian Red Dairy

Kiwi

Subgroup 16-1Bb Taurindicine dairy and dual-purpose breeds

Jamaica Hope / Jersey-Zebu, Montgomery-Jersey

Australian Milking Zebu / **AMZ**

Girsey

Jerdi

Tropicana

Siboney de Cuba / **Siboney**

Mambi de Cuba

Caribe de Cuba

Troleche

Girolando / *Girolandia, Gyrholando, Gyrolando, Holangir, Mantiqueira, Tribofe*

Sinderolando

Nelorando

Gipardo

Normanzu

Brahmanstein

Tropical

Jaguanês / *Jaguanese*

Javanês

Riopardense

Guzolando

Guzerolando

Guzerando

Xingu

Santa Mariana

Mestizo-Holstein

Australian Frieswal / **AFS** / Australian Friesian-Sahiwal

New Zealand Taurindicus / **NZSHF** / New Zealand Sahiwal x Holstein-Friesian

Itapetinga

Suiz-Bu

Lavinia

Suisbú / *Suizo-zebú*

Subu

Pitangueiras

Pitalanda

Rojo Jamaicano / *El Descornado Rojo Jamaicano* / **Jamaica Red** / Jamaica Red Poll,
Goodhope Red

Mestiço leiteiro brasileiro / **MLB** / **Brazilian milking crossbred** / Brazilian dairy hybrid
Indo-europeu leiteiro / Dairy Indo European
Santa Gabriele

Subgroup 16-2A Beef breeds descending from British breeds and derivatives

Beef Devon / Red Devon, Ruby Reds

Poll Devon

American **Beef Shorthorn**

Mini Durham/Shorthorn

Polled Shorthorn / Double Standard Polled Shorthorn

Single Standard Polled Shorthorn / Polled Derby, Polled Durham

Argentine Shorthorn

Tarquinos

Argentinian **Lincoln Red**

Australian Shorthorn

North Australian Shorthorn / Kimberley Shorthorn, Northern Territory Shorthorn

Australian Beef Shorthorn

Australian Polled Shorthorn

Weebollabolla / Weebollabolla Shorthorn

American **Hereford** / Whiteface / **Australian Hereford**

Line One Hereford

Miniature Hereford

Polled Hereford / Poll Hereford / Double Standard Polled Hereford

Single Standard Polled Hereford

American Black Hereford

Angus / American Angus, Black Angus / **Aberdeen**

Okie

Holgus

Black Baldie

Australian Angus

Australian Lowline / **Lowline Angus** / Mini Angus

Red Line

Aussie Black

Red Angus / **Aberdeen Angus colorado**

American **Red Poll**

American **Galloway**

American **Belted Galloway**

American **White Galloway**

Miniature Galloway

Scottish Highland / American Scottish

Miniature Highland

American **Sussex**

Mini Dexter

Ancient White Park / Horned White Park

American **South Devon**

American **Luig**

American **Welsh Black**

Beef Friesian / American Beef Friesian

Makaweli / Makalwi

Murray Grey

Paymaster

Tasmanian Grey

Australian Grey

Aussie Miniature Grey

Square Meaters

Kyrhet Australian Miniature Cattle

Adapteur

Belmont Adapteur

Belmont BX

Hays Converter

Better Idea

Regus

Amerifax
RX3
Speckled Park
Senepol / Nelthropp
 Senagus
American White Park / American British White Park
Australian White
Beef Machine
Pee Wee
BueLingo
Magnum
Miniature cattle
 Mini American Beltie / Oreo Cookie
 Miniature Black Baldie / Black Miniature Whiteface
 Mini Belmont / Belmont miniature
 Mini Belfair
 Grad-Wohl Miniature
 Auburnshire
 Barbee
 Belted Irish Jersey
 Belted Lessor Jersey
 Belted Kingshire
 Belted Milking Devon
 Burienshire
 Covingtonshire
 Five Breed Grad-Wohl
 Four Breed Grad-Wohl
 Happy Mountain
 Justinshire
 Kentshire
 Red Kentshire
 Kingshire
 Panda
 Red Panda
 Mini Dextford

Subgroup 16-2Ab Taurindicine beef breeds mainly descending from British breeds

Santa Gertrudis
 Polled Santa Gertrudis
 Brahorn
Santa Cruz
Beefmaster
 Poll Beefmaster
Quasah
Charsar
Braford / *Herebu*
 Victoria
Pampiano-Braford / *Braford brasileiro, Natura, Pampiana, Pampiano*
 Nelorford
Santa Clara
Australian Braford
 Sahford
Belmont Red
Brangus
 Mini Brangus
Australian Brangus
Bramalow
Negro Jamaicano / Jamaica Black
Brangus-Ibagé / Ibagé, Nelangus
 Natura
Red Brangus
Angus/Brangus Plus
Africagnus
Sabre

Bravon / Debu

South Bravon

Greyman

Droughtmaster

Wokalup / Wokalup Multi breed

Solomon Red

Yalavou

Barzona

South Poll

Hotlander

Red Norte

Ranger

Hash Cross

Ritchie

Watson

**Subgroup 16-2B Beef breeds descending from Continental Europe
and Asian taurine breeds and derivatives**

American **Charolais / Charolés / Charolês**

Polled Charolais / Charolês mocho

Black Charolais

Red Charolais / red-factor Charolais

American **Limousin**

Polled Limousin

Black Limousin

Black-Polled Limousin

Australian Polled Limousin

Lim-Flex

American **Maine-Anjou**

Black Maine-Anjou

MainTainer / Maine Tainer

American **Blonde d'Aquitaine**

American **Salers**

Polled Salers

Black Salers

Black-Polled Salers

Salerford

American **Tarentaise**

Simental / Fleckvieh

American **Simmental**

Polled Simmental

Black Simmental

Black-Polled Simmental

American **Braunvieh / Beef Brown Swiss / Suizo Europeo / Suizo Pardo / Pardo Suizo Corte**

American **Gelbvieh**

Polled Gelbvieh

Black Gelbvieh

Black-Polled Gelbvieh

American **Pinzgauer**

Pinzbrau

American **Herens**

American **Chianina**

Polled Chianina

Black Chianina

Black-Polled Chianina

American **Romagnola**

American **Marchigiana / Marky**

American **Piedmontese / Piemontês**

American **Belgian Blue / American Belgian White Blue**

American **Wagyu**

Wangus

Char-Swiss

Charwiss

Range Fire / Range Fire Composite, Fire Red

M4 / Heyster
Kinsella
Burwash
Chargrey
Fort Cross
Limangus
Simford
Australian Beefmaker
Black Maximizer
Romark
 RomAngus
Beef Synthetic
Cuprem Hybrid/ Kenesaw
Cash
Range Maker
Shaver Beefblend / Shaver
Leachman Hybrids
Stabilizer
Balancer
MARC

 MARC I
 MARC II
 MARC III

Beefbooster
 M1
 M2
 M3
 M4
 TX

Chi crosses
 Chiangus / CAX / Ankina
 Chimaine / CM
 Chiford / CF

Subgroup 16-2Bb Taurindicine beef breeds
mainly descendint from Continental European breeds

Charbray
Australian Charbray
Chacuba
Canchim
 Canchim mocho / Polled Canchim

Charonel
Charford
Brah-Maine
Brahmousin
Bravado
Indusin
Bralers
Branor
Noble Line
Simbrah/ *Simbra*
Simbrahvieh
Simbrangerford
Simbrasil

Simbrasil-Cariri

Gelbray / *Gelbra*
Brah-Swiss
Caiuá / *Chinelore*, *Nelchiano*
 Caiuá 1
 Caiuá 2
 Caiuá 3
 Chianel
Suiá / *Suiá-Missu*
Piemonel

Beefmaker

Tropicarne

Montana

Bos certus

Mandalong Special

Bucking Stock / Rodeo bucking stock

Little Rowdy

Sundog

Subgroup 16-2C American and Australian zebu and sanga breeds

Guzerá / Azulego / Guzerat

Guzerá mocho / Polled Guzerat

Guzerá leiteiro / Dairy type Guzerat

Guzonel

Nelore / Nellore

Nelore mocho / Polled Nellore

Nelore vermelho / Red Nellore

Nelore pintado em preto / Nellore black pied

Nelore pintado em branco / Nellore red pied

Gir brasileiro / Brazilian Gir

Gir leiteiro / *Gyr lechero* / Dairy Gir

Zebú leiteiro de Uberaba / Brazilian dairy zebu of Uberaba

Gir mocho / Polled Gir

Gironel

Nelogir

Kangayam brasileiro / *Kangayan*, *Cangaian* / Brazilian Kangayam

Sindi / Red Sindhi

Australian Sahiwal

Indubrasil / *Induberaba*, *Indú Brasil*, *Indoanaxa* / **Indo-Brazilian**

Rojo Indubrasil / Red Indo-Brazilian

Indunel

Girindu

Bonsai Zebu / **Bonsai Brahman**

Tabapuã / *Zebú Mochol* / *Tabapuan*

Tabanel

Cebú Venezolano / Venezuelan Zebu

Cebú lechero

Brahman Jamaicano / Jamaica Brahman

Brahman / American Brahman

Grey Brahman

Red Brahman

Australian Brahman

Miniature Zebu / Australian **Nadudana** / Mini Zebu

Bos indicus miniature

Australian **Africander**

Ankole-Watusi

Australian **Tuli**

Australian **Boran**

Queensland Miniature Boran

Subgroup 16-3A Bovine hybrids

Cattalo

Beefalo

Simmalo

American Breed

Hybridmaster

American **yak**

Yakmac

Žubroň

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Chapter 7

Summarizing Discussion and Conclusions

Summarizing discussion and conclusions

Cattle provide a substantial part of our diet and have become our most important domestic animal. They even changed our DNA: by a mutation in the lactase gene many people are able to digest milk after breast-feeding has stopped. Of course, we changed the DNA of cattle much more and designed different specialized breeds all around the world. By combining zoological, archaeological, historical, topographical, agricultural and molecular-genetic data, this thesis analyzes the enormous diversity of cattle. This integration provides context and arguments for the answer to our main question: how do breeds contribute to the genetic resources of cattle?

As detailed in **Chapter 1**, General Introduction, cattle are kept worldwide in various environments, and play many different roles in our society and culture.

In **Chapter 2** we examine the zoological origin of the diversity of cattle: the various domestic bovine species: taurine cattle, zebu, banteng, gayal, yak and the river and swamp types of water buffalo, but not the wild bison, wisent and African buffalo. Taurine and the tropical zebu cattle are the most abundant bovines with a combined population of about 1.5 billion heads. Together with the fully fertile taurindicine hybrids, they enable us to keep cattle almost wherever we live ourselves. The Southeast Asian banteng and gayal are as adapted to the tropical climate as zebu. Their agricultural potential has not been fully realized, probably because hybridization with taurine and zebu cattle is not as spontaneous as crossing taurine with zebu cattle and also gives sterile bulls. At the other end of the global temperature range, yak serves as domestic cattle on the extremely cold and high Himalayan plateau. Yakow, the first-generation offspring of yak and common cattle allow cattle to be kept on the lower Himalayan slopes. We conclude that both the multispecies origin and interspecific hybridization contribute to the phenotypic and genetic repertoire of cattle.

Chapter 3 reviews the dynamic history of the cattle genetic resources with material from several sources that have been neglected in previous accounts. The domestication of taurine and zebu in West Asia and South Asia, respectively, was a major contribution to the development of farming. Domestic cattle soon dispersed to other regions and later also to America, Australia and New Zealand. Eventually hundreds of regional and specialized breeds were developed, many of which became highly productive. Several lines of evidence are coming together to build an account of the diversity of cattle through time.

- Bones of domestic cattle found by archaeologists reveal the date and place of the first domestication, about 10.000 and 8.000 years ago for taurine and zebu cattle, respectively.
- Skeletal remains from subsequent time periods indicate trends in morphology:
 - body size became smaller than in the wild aurochs ancestor, accompanied by a reduction of the size difference between bulls and cows;
 - short horns became predominant soon after domestication;
 - size diminished further from the Neolithic until the late Middle Ages;
 - since 1000 BC large cattle were kept in Greece, in Italy and then in other regions of the Roman empire, but disappeared after the Roman era;

- since the 15th century European cattle increased in size, the cows of many breeds becoming as large as the former female aurochs.
- ¹³C Isotope analysis of organic remains on Southwest-Asian pottery from 9000 BP detects traces of milk fat, indicating that at that time cattle were already milked.
- ¹⁵N/¹⁴N ratios in teeth indicate early weaning of calves about 6000 BP in France, making milk available for human consumption.
- Pictures of cattle are available from various periods and they confirm the trends in size and show the shape of the horns and of the hump in zebu. Paintings also show the now familiar coat colors and color patterns; unicolored cattle prevail on most Medieval paintings but more variable color patterns appear in 17th century paintings, which show herds that are more diverse than the present breeds.
- Various classical texts describe cattle husbandry and different types of cattle in the Roman Empire. In contrast, not much is known about the small medieval European cattle or about the first improvements in cattle husbandry in the 16th and 17th century, although international trading of cattle since the late Middle Ages has been documented.
- Fortunately, many contemporary reports exist about the development of breeds, starting in the 18th century.

All these lines of evidence are now supported by DNA research.

- Sequences of mitochondrial DNA, the haplotypes, are transmitted from cows to their calves (the maternal lineage). Since the cows mostly remain in the herds and are less mobile than the bulls, regional frequencies of mitochondrial haplogroups (groups of related haplotypes) do not change much once cattle have settled in a new region. Thus, mitochondrial DNA often informs us about the earliest migrations, such as the colonization of Europe, Africa and Asia. The haplotype repertoire also allows estimations of the present and past population size: the more variation, the larger the population.
- In contrast, the male Y-chromosome is transmitted from bulls to their male offspring. In human genetics, Y-chromosomal haplotypes are enormously important for the reconstruction of ancient population history. The results with cattle Y-chromosomal variants are most promising. For instance, in Africa and America, zebu haplotypes reveal that many tropical or subtropical taurine populations have been crossed with zebu bulls. On the European continent we see a sharp boundary between two common taurine Y-chromosomal haplotypes, suggesting that there were two different 'arch-bulls'. The boundary separates the typical northern lowland dairy cattle from the Alpine, South-French and Mediterranean beef or mixed-purpose cattle. It also coincides with the traditional differences between North and South Europe: between the Germanic and Roman societies; between northern and southern French or German dialects; between religions and between culinary traditions.
- Autosomal DNA, or the nuclear DNA without the sex chromosomes, contains a wealth of information, which can be retrieved better and better by the progress of DNA technology. Sophisticated data analysis of large DNA datasets reveals a population's history with genetic events such as subdivisions, inbreeding, gene influx from other populations, admixture and upgrading. Genetic distances between

breeds indicate that European cattle consist of several groups of related breeds. Breeds from the same region usually belong to the same group, unless a breed has been influenced by imported bulls.

Progress made in human genetics research tells us what to expect for cattle in the coming years:

- So far most population studies were done with neutral variation, differences between individuals without any consequence for the fitness of the animal. However, this is not the genetic variation that Darwin had in mind when he postulated natural selection and the adaptation of species to their environment. Our knowledge of the adaptive variation is now growing rapidly by the discovery of DNA variation that can be linked to the phenotype: appearance, health, performance, behaviour, etc. Until now, most DNA mutations that change the phenotype have been found within genes that code for protein sequences, but more and more adaptive variation is discovered in regulatory regions outside the genes.
- Whole-genome sequences are now becoming available for more and more breeds. This will allow a systematic investigation of adaptive genetic diversity and answer a few pertinent questions. Has selection in the highly productive breeds reduced adaptive variation or has it induced the emergence of new variants? Conversely, do the more primitive breeds, known to harbor much selectively neutral variation, also contain adaptive variation as untapped reservoirs of genetic resources for future breeding options?
- Advanced analysis of complete genomes will disentangle the mixed origin of breeds, showing segments with different origins and demographic histories. The time period of historic introgression events can also be estimated since the length of the foreign DNA fragments decreases with each generation.
- Analysis of ancient DNA looks directly into the past. Complete genome analysis of Neanderthals and related hominids now causes the textbooks on human evolution to be rewritten. Interestingly, the genome sequencing of the wild ancestor of cattle, the aurochs, has already been announced. This may tell us, for instance, whether European aurochs has influenced domestic cattle after their arrival from Southwest Asia. If so, we will also want to know which breeds and which genes have been influenced.

The tables in the Appendix of Chapter 3 give a detailed overview of the flexibility of the cattle breed repertoire during the last 200 years:

- 214 breeds founded by amalgamation of local varieties and/or former breeds (mainly in the 19th century) or split in different varieties;
- 161 breeds exported in the 19th or 20th century to other countries;
- 253 taurine or taurindicine synthetic breeds created mainly in America and Australia in the 20th century by combining breeds of different origin;
- 207 breeds and varieties that became extinct.

These figures illustrate that breeds, after their emergence in the 18-19th centuries, underwent a most dynamic history with cross-breeding being the rule rather than the exception. This contrasts with the common perception of breeds contributing separately to the cattle genetic resources and belonging to our cultural heritage. Moreover, these developments, including the many new synthetic breeds in the New World, demonstrate that any assessment of cattle genetic diversity represents merely a snapshot of a continuously changing genetic diversity.

In addition, our survey reveals several interesting parallels of human and cattle history in Europe. Cattle in the Iron Age were small animals, which were relatively easy to handle and stood a better chance to survive the winter. In contrast the Roman Empire with its flourishing economy allowed the keeping of larger cattle and their export to many regions of the Roman world. Strikingly, soon after the fall of the Empire and the breakdown of infrastructure and central authority, farmers exclusively bred smaller cattle, which continued to decrease in size during the Middle Ages. Although hardly anything is known about medieval cattle breeding, Y-chromosomal polymorphisms in European cattle show a genetic contrast between the northern and southern parts of the continent, which plausibly is of medieval origin and correlates with traditional north-south differences. After the 14th century, when society endured catastrophic famines and epidemics, Europe had surpassed the Roman Empire in terms of infrastructure, cultural development, technology and effective government: the Renaissance. Cattle did not miss the trend and started to grow again. The next leap forward in human society, the Industrial Revolution, led in cattle and other livestock to the consequential breed formation and a continuing rationalization of the breeding process. Since 1492 the New World became a genetic melting pot of people with very different backgrounds; the same can be said for their cattle. Finally, when in the second half of the 20th century we were confronted with the negative consequence of technological progress, we also started to protect the local but less performing breeds.

To bring order into a chaotic collection of hundreds of breeds, many breed classification schemes have been developed. As examined in **Chapter 4**, these all deliver a systematic description of the diversity of cattle via an explicit typology. Many classifications from the 19th and early 20th century were based on unfounded ideas on the origin of breeds. A liberal use of Latin names pretended a link with the classical classification of Linnaeus. Although these classifications are now forgotten, several Latin terms, listed and explained in the Appendix, are still used occasionally. We have developed a more systematic and comprehensive classification in our *Cattle Breed - an Encyclopedia* from 1995, which was slightly revised in 2011. Our scheme integrates regions of origin, history and morphology and has several advantages over other classifications:

1. With 16 main groups, it covers all breeds worldwide.
2. Assignment of a given breed to one of the groups is almost always unambiguous.
3. The groups and subgroups have been defined via a strict procedure: first defining geographic groups; then within these groups subgroups with a common history; and finally a further subdivision according to morphological criteria.
4. This procedure avoids grouping breeds together on the basis of superficial similarity in appearance, while similar breeds from the same region, which are likely to have been crossbred, are assigned to the same (sub)group.

The integrative classification correlates very well with a biochemical classification from 1980 and a recent DNA-based classification of the European breeds. There are three major exceptions:

- Group 1 of the integrated classification contains the Nordic and several British breeds, while other British breeds belong to Group 2. In contrast in the DNA-based classifications, one genetic cluster contains most British breeds, a second cluster the authentic Nordic breeds and a third the Nordic Ayrshire-like breeds.
- The integrated classification places the Baltic Red cattle in the same subgroup of Group 2 as Flemish Red, in the DNA-based classifications it is genetically more related to Belgian breeds from another subgroup.
- Because of their historic origins, the integrated classification places the German Highland Red in Group 3. Genetically, it is closely related to the Baltic cattle from subgroup 2A because Baltic Red sires have been used widely in the German Highland Red.

The first two discrepancies show that genetic clustering may follow geographic origins even closer than assumed by the integrative classification. Understandably, the close relationship of breeds from the same region decreases if exotic sires with a similar appearance are used instead of the native sires.

Chapter 5, an atlas of cattle breeds, adds a geographic dimension to the diversity of breeds. Thirty-seven maps show, per continent and per breed group, the regions of origin of 1,589 breeds and varieties (505 European, 411 Asian, 279 African, 328 North- and South- American, 66 in Australia and New Zealand). In the Old World, the distribution of cattle of the different groups defined in Chapter 4 reflects correlations of breed type and landscape features as well as the geographic range of cattle breeding traditions. Of special significance for conservation is map 29, which surveys the many exports since the 17th century from Europe, Asia and Africa to America. Since this has enhanced the geographic distribution of many breeds, it has reduced the risk of their extinction. This illustrates the wider relevance of topographical data for breed conservation: a geographic exposition of the worldwide diversity of cattle informs all those involved in the management of the cattle genetic resources of the current diversity at the global rather than at national or continental level.

Chapter 6 integrates all results from Chapters 2-5 and gives answers to our central question: how do individual breeds contribute to the cattle genetic resources; a question that has direct consequences for the role of breeds in conservation. As argued in Chapter 1, these genetic resources are essential for keeping cattle in a wide variety of environments and for maintaining future breeding options. Although many breeds have small effective population sizes, numerous breeds all over the world are not endangered at all and together continue to present a large variety in type, size, color, horns, productivity, adaptation and many other traits (Chapters 3-5). The current diversity originates from different species (Chapter 2). Most diversity has been acquired long after domestication and for a large part even during the last 250 years via the development of breeds. The dynamic history of cattle suggests that the spectrum of variation has been changing forever, shedding old as well as acquiring new variants continuously (selection- induced genetic variation, Chapter 6).

On the other hand, breeds do disappear because of the demands from society, e.g. of productivity. The most obvious threat is the irreversible loss of locally adapted populations by replacement with highly developed breeds that require intensive management. Upgrading of hardy taurine and zebu breeds with exotic sires increases production in the short run at the expense of their being profitable under marginal conditions. This narrows the range of conditions for sustainable cattle husbandry and reduces the long-term agricultural options.

To better define the role of breeds in conservation, we first refine in Chapter 6 the categorization of breeds on the basis of their recent history as it is used by the FAO. We define four categories:

1. Authentic local breeds, the so-called landraces.
2. Breeds developed by crossbreeding of cattle from different regions, mostly during the 19th century. Since this is beyond the reach of memory, many of these are now commonly considered as authentic local breeds.
3. Highly productive cosmopolitan breeds, developed during the 20th century on the basis of 19th century breeds and now exploited in many countries around the world.
4. Populations maintained by crossbreeding.

As discussed in Chapter 6, breeds from the first category have highest relevance for conservation because they are most likely to harbour irreplaceable uniqueness. This applies especially to breeds that have preserved their uniqueness by having been kept in isolation from other populations. For instance, Jersey, Guernsey and Chillingham have been isolated for more than 200 years and are more likely to have retained or developed unique properties. Other indicators of uniqueness are partial ancestry from exotic bovine species (Chapter 2, gayal, banteng, bison, wisent and yak), distinct phenotypes (adaptation, morphology, performance) and a high molecular diversity of breeds originating from regions near the domestication site.

Most breeds in the other categories emerged only 50 to 150 years ago and genetic exchange between breeds is rule rather than exception (Table S1 and S3 of Chapter 3). This explains why molecular studies with neutral DNA markers indicate that breeds have considerable genetic overlap. Many extinct breeds (Table S4 of Chapter 3) existed for only 50 or 100 years before being absorbed into more productive breeds and it is very likely that they shared so much DNA variation with neighboring breeds that they might be rebred by selection of animals from related breeds with the desired characteristics.

Because of this history of intensive gene flow across breeds, we argue that it is not realistic to consider all breeds as units of conservation, i.e., as independent reservoirs of genetic diversity that each contribute independently to the genetic diversity of cattle. It is quite understandable that exaggerated perceptions are often fostered by breed societies. Breeds are their icons and are often supposed to have an old origin that is not supported by any evidence. Breed names (listed in the appendices of Chapter 6 both per classification and in alphabetic order) contribute to the perceived status of breeds. For instance, by endowing a name to a first-generation cross of two non-related breeds or to a young, not yet stabilized subpopulation, a newly invented herd can be advertised as a genuine breed. Further, so-called transboundary breeds are kept in different

countries. These are often known by different names, each with its own breeding society, and are often listed separately in breed surveys. The appendix of Chapter 6 surveys the breed nomenclature, which contains many more breed names than breeds.

We propose that breeds serve the conservation of genetic resources better as, in our terminology, units of management: genetic reserves managed by the respective breed societies separately from other breeds and containing a portion of the genetic resources, either specific for the breed or shared by other breeds. Separate management maintains independent development of breeds and thus contributes to diversity.

Thus we arrive at the following conclusions on the contribution of breeds to the cattle genetic resources:

- The many breeds that are kept worldwide still represent an appreciable diversity of adaptation, morphology and performance.
- The most urgent threat of the cattle genetic resources is the replacement of breeds adapted to local conditions by highly productive breeds requiring intensive management.
- Several breeds have unique traits by genetic input of exotic bovine species, special traits and/or genetic isolation; these breeds obviously contribute to the overall diversity of cattle.
- However, for most breeds this is not the case, especially if their genetic history indicates considerable genetic and phenotypic overlap with other breeds.
- Even if these breeds are not clear units of conservation, they are units of management since all decisions regarding the diversity of cattle are taken by the breed societies.

Conservation of the more unique breeds may be enhanced by branding of local dairy or beef products. Since 2009 this is encouraged by the trendy 'Slow Food' movement (en.wikipedia.org/wiki/Slow_Food). Another fashion is the selection of cows producing the A2 variant of β -casein instead of the A1 variant, which is most common in northern European dairy breeds such as the Holstein. This preference for A2 milk is due to supposed harmful health effects of A1, although this is not as yet supported by scientific evidence (en.wikipedia.org/wiki/A2_milk).

An interesting option for the conservation of primitive cattle breeds is 'rewilding': introducing cattle as wild animals in newly developed or existing nature reserves, exploiting and further developing their natural adaptation. This offers promising perspectives for reconstructing a natural ecosystem and may also deliver interesting research material for investigating genomic aspects of adaptation. For this purpose, a few projects envisage to breed a phenotypic lookalike of the extinct aurochs by combining several primitive breeds and by selecting for aurochs-like traits (www.taurosproject.com; <http://www.truenaturefoundation.org/project/species-restoration/uruz-project>). This is an ongoing challenge, but also presents interesting scientific opportunities if we can identify the DNA changes associated with the aurochs-like traits that were changed by the original domestication.

Samenvatting

Het rund is ons belangrijkste huisdier. Overal ter wereld is de koe een onmisbare bron van voedsel. Ze heeft zelfs ons DNA veranderd: dankzij een mutatie in het gen voor lactase kunnen veel mensen ook als volwassenen melk drinken. Omgekeerd hebben wij het DNA van de koe nog veel meer veranderd door ermee te fokken.

In dit proefschrift beschrijven wij de enorme diversiteit van het rund: de verschillende soorten, hun geschiedenis en de ontwikkeling en mondiale verspreiding van meer dan 1000 rassen. We gaan in op de verschillende manieren waarop deze rassen kunnen worden ingedeeld. Tot slot bespreken wij hoe en waarom we de diversiteit van het huisrund in stand moeten houden.

In het eerste hoofdstuk, de **Algemene Introductie**, gaan we in op de wereldwijde verspreiding van rundvee en zijn aanpassing aan verschillende, soms heel extreme omstandigheden. Ook beschrijven we de belangrijke rol die het rundvee wereldwijd in onze samenleving speelt: in de voedselproductie, bij godsdienstige rituelen en, niet altijd even diervriendelijk, bij verschillende vormen van volksvermaak.

In **Hoofdstuk 2** beschrijven we de verschillende soorten huisrunderen: taurien vee (d.w.z., het ons vertrouwde vee in de gematigde streken), zeboes (tropische runderen met hun typische bult), het Bali-vee, gayal, jak en waterbuffels.

De wilde bizon, wisent en Afrikaanse buffel zijn wel verwant aan deze huiskoeien, maar zijn nooit gehouden als huisdieren. Taurien vee, zeboes en hun onderlinge kruisingen worden vrijwel overal ter wereld gehouden, in totaal gaat het om zo'n 1,5 miljard dieren.

Het Bali-vee stamt af van de wilde banteng en de gayal van de wilde gaur. Zowel zeboes als Bali-vee en gayals zijn uitstekend aangepast aan tropische omstandigheden. Daarentegen voelt de Tibetaanse jak zich juist thuis in de extreme kou op het Himalayaplateau. Omdat, met uitzondering van de buffels, de rundersoorten onderling kruisbaar zijn, komen we hier en daar verschillende tussenvormen tegen.

Er zijn twee ondersoorten van de waterbuffel. De moerasbuffel, ook bekend als de karbouw, trekt de ploeg in de natte rijstvelden van Oost- en Zuidoost-Azië. De rivierbuffel wordt gemolken en heeft zich verspreid van het westen van Indochina tot in Italië. De melk is door zijn hoge vetgehalte bijzonder geliefd als grondstof voor *mithai* (zoetigheden) in India en voor *mozzarella* in de Italiaanse keuken.

In **Hoofdstuk 3** wordt een overzicht gegeven van de bewogen geschiedenis van het huisrund. Deze begon met de domesticatie van oerruunderen, waarbij wilde dieren werden gevangen, die zich na een aantal generaties aanpasten aan het leven bij de mens. Dit gebeurde in twee verschillende gebieden.

Het tauriene vee ontwikkelde zich 10.000 jaar geleden in Mesopotamië en de zeboe ontstond 2000 jaar later in het huidige India en Pakistan. Dit maakt allemaal deel uit van een belangrijke ontwikkeling in onze geschiedenis: aan het begin de Nieuwe

Steentijd veranderde een gemeenschap van groepen jager-verzamelaars in een samenleving met landbouwers en veetelers.

In Mesopotamië en de Indusvallei ontstonden boerderijen, dorpen en steden. Vanaf het begin werden verschillende granen en groentes verbouwd en werden behalve koeien ook schapen, geiten, varkens, honden en katten als huisdieren gehouden. Binnen een paar duizend jaar verspreidde deze maatschappijvorm zich samen met al die huisdieren als een olievlek over heel Azië, Afrika en Europa. In de loop der tijd ontstonden overal regionale types van het rund en landrassen.

Sinds ongeveer 250 jaar wordt het fokken van runderen en andere huisdieren systematisch aangepakt en worden stamboeken nauwkeurig bijgehouden. Daardoor ontstonden voornamelijk in Europa honderden gespecialiseerde runderrassen. Een beperkt aantal rassen is de laatste 50-100 jaar over de hele wereld heel populair geworden vanwege hun hoge productie, zoals het zwartbonte Holstein melkvee.

De bijlagen van hoofdstuk 3 geven een indruk van wat er de afgelopen 200 jaar allemaal is gebeurd.

- We noemen 214 rassen die zijn ontstaan door lokale variëteiten (slagen) of rassen samen te voegen of door een ras juist op te splitsen. Dit gebeurde voor een groot deel in de 19e eeuw toen de rassen nog maar net bestonden.
- Minstens 161 rassen werden in de 19e of 20e eeuw uitgevoerd naar andere landen.
- In de 20e eeuw ontstonden zeker 253 mengrassen door rassen van verschillende afkomst te kruisen. Dit gebeurde voornamelijk in Amerika, Australië en Zuid Afrika, want in Europa is een groot deel van de fokkerij nog heel streekgebonden.
- Minstens 207 rassen en slagen zijn intussen verdwenen.

Met meer dan 1000 rassen raak je natuurlijk snel het overzicht kwijt. Om orde aan te brengen zijn er indelingen (classificaties) ontwikkeld. Dit is het onderwerp van **Hoofdstuk 4**. De eerste indelingen stammen uit de 19^e en begin 20e eeuw en zijn gebaseerd op theorieën die inmiddels zijn achterhaald. In onze *Cattle Breeds, an Encyclopedia* uit 1995 hebben we een systematische classificatie ontwikkeld, die recht doet zowel aan de streek van oorsprong als aan de geschiedenis en de morfologie. Deze indeling komt grotendeels overeen met een classificatie van de Europese rassen op basis van DNA-gegevens.

Hoofdstuk 5 bestaat uit een atlas van runderrassen. Zevenendertig kaarten geven per rasgroep de oorsprong aan van in totaal 1589 rassen en variëteiten: 505 uit Europa, 411 uit Azië, 279 uit Afrika, 328 uit Noord- en Zuid-Amerika en 66 uit Australië en Nieuw-Zeeland. Een speciale kaart geeft een overzicht van wat er allemaal is geëxporteerd naar en vanuit Amerika, inclusief de rassen die daar zijn doorgefokt en vervolgens werden teruggehaald naar Europa.

In **Hoofdstuk 6** proberen we een antwoord te geven op een belangrijke vraag: wat is de rol van rassen voor het behoud van de genetische diversiteit. We beginnen met een indeling van rassen in vier categorieën, niet zoals in hoofdstuk 4 op basis van afkomst, maar om aan te geven hoe een ras is ontstaan.

1. De authentieke lokale rassen, de zogenaamde landrassen, die al in de 18e eeuw of nog eerder in een bepaalde streek rondliepen.
2. De rassen die zijn ontstaan door in een bepaalde streek vee uit een andere streek in te kruisen. Dit gebeurde voor het grootste deel tijdens de 19e eeuw. Dat is voor ons toch al zo lang geleden dat we ook hier spreken van traditionele rassen.
3. De hoogproductieve wereldrassen, ontwikkeld in de 20e eeuw en nu overal ter wereld gehouden.
4. De populaties die in stand gehouden worden door kruising.

Voor het behoud van rassen moeten we vooral letten op de eerste categorie. De rassen van de derde categorie zijn natuurlijk behoorlijk oververtegenwoordigd, maar dat neemt niet weg dat alle rassen samen nog altijd een geweldige diversiteit vertonen met verschillende kleuren, patronen, hoorns, productiekenmerken, aanpassingen aan de omgeving, en nog veel meer. Verreweg de meeste variatie is ontstaan na de domesticatie en voor een belangrijk deel zelfs pas gedurende de afgelopen 250 jaar toen de rassen werden ontwikkeld.

Hiermee willen we niet zeggen dat we ons helemaal geen zorgen hoeven te maken over het verlies van genetische diversiteit. Landrassen die zich gedurende eeuwen hebben aangepast aan lokale omstandigheden - ziektekiemen, klimaat, vegetatie - worden vaak gekruist met rassen die veel meer melk of vlees produceren, maar daarbij wel afhankelijk zijn van intensief management: een dierenarts die vaak langskomt, vaccinaties, krachtvoer en zelfs klimaatbeheersing. Hoewel dit in ontwikkelingslanden lang niet altijd goed uitpakt, worden er toch op grote schaal geïmporteerde hoogproductieve rassen ingezet. Zo verliezen we de unieke eigenschappen van de landrassen, en daarmee ook de mogelijkheid om runderen op een meer natuurlijke manier te houden.

We moeten ons serieus afvragen of het behoud van ál die rassen noodzakelijk is voor het instandhouden van de waardevolle genetische hulpbronnen. Sinds ze 250 geleden zijn “uitgevonden”, zijn er steeds rassen bijgekomen en ook weer verdwenen. De meeste rassen worden nog steeds beïnvloed door omliggende rassen. Dit wordt bevestigd door moleculaire studies die aangeven dat de rassen elkaar genetisch aanzienlijk overlappen en allemaal 85-95% van de totale diversiteit van de soort bevatten. Aan de andere kant zijn er ook rassen, zoals de Jersey en Chillingham, die al 200 jaar lang zonder invloed van buitenaf worden gefokt.

Het is niet realistisch om alle rassen te beschouwen als onafhankelijke reservoirs van genetische diversiteit (*units of conservation*), die los van elkaar zouden bijdragen aan de genetische diversiteit van rundvee. Dit is wel het uitgangspunt van de fokverenigingen die hun eigen ras als uniek beschouwen. Een eigen naam van een ras draagt bij aan deze beeldvorming, zelfs als een ras in een ander land anders heet, maar met dezelfde stieren wordt gefokt. Met andere woorden: er zijn meer rasnamen dan rassen. In de Appendix van hoofdstuk 6 wordt dit per ras uitgewerkt.

Wij stellen voor dat we rassen beter kunnen beschouwen als 'management-eenheden'. Een ras is dan een genetische reservaat dat onafhankelijk van andere rassen wordt beheerd. Ook als de meeste kenmerken van een ras niet uniek zijn, kan het onafhankelijk beheer ervoor zorgen dat die kenmerken niet in alle rassen verloren gaan. Natuurlijk moet altijd de meeste aandacht uitgaan naar die rassen die wel veel unieke en waardevolle eigenschappen hebben ontwikkeld, zoals de landrassen die aan hun omgeving zijn aangepast. We verwachten dat dit binnen afzienbare tijd wordt onderbouwd door wetenschappelijk onderzoek, waarmee wij slechts beter en steeds sneller kunnen achterhalen welke DNA varianten belangrijk zijn voor de waardevolle raskenmerken.



foto: Pieter Vandermeer

Curriculum vitae

Marleen Felius werd geboren op 23 januari 1948 te Rotterdam. Van 1965 tot 1970 volgde zij een opleiding op de Academie van Beeldende Kunsten, Rotterdam.

Van jongs af aan is zij gebiologeerd door landbouwhuisdieren en ze heeft zich gespecialiseerd in het schilderen van runderen. Ze schilderde diverse werken in opdracht en verzorgde illustraties voor vakbladen en boeken. Haar schilderijen werden in binnen- en buitenland tentoongesteld op meer dan 30 individuele exposities en net zo vaak samen met andere kunstenaars. Van 1990 tot 1994 was zij docent op de Academy of Industrial Design in Eindhoven. In 2012 ontwierp zij met Joost Veerkamp een serie postzegels, hetgeen werd gewaardeerd als het 'Mooiste Postzegelontwerp 2012'.

Ze ondernam 13 studiereizen naar verschillende landen in Azië, Afrika, Amerika en Nieuw Zeeland. Dit leidde tot de publicatie van 14 boeken en 9 artikelen over runderen en andere landbouwhuisdieren. Deze zijn geïllustreerd met tekeningen van eigen hand. Ze won de Drempelprijs 1970, de prijs 'Best Verzorgde Boek 1995' voor de encyclopedie '*Rundvee - Rassen van de Wereld*' en samen met Anno Fokkinga de Eureka non-fictie prijs 1999/2000 voor '*Het varken*'. Haar '*Cattle Breeds, an Encyclopedia*' wordt internationaal erkend als het meest gezaghebbende standaardwerk over runderrassen. Ze ontving stipendia van de Ministeries van WVC (1979) en CRM (1990). De afgelopen jaren was ze eerste auteur of coauteur van een aantal wetenschappelijke publicaties.

Marleen Felius is gehuwd met de beeldend kunstenaar John van 't Slot en woont in Rotterdam.

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