

# Preparation Unit 1

## Basics of Domestic Animal Biology

### 1 – Evolution, Domestication, Breeding



## Estimated number of animal species in different groups and number of livestock species recruited from those

<i>Species Group</i>	<i>total</i>	<i>domestic</i>
Mammals	4 500	35
Birds	10 000	8
Amphibians & Reptiles	12 000	-
Fish	22 000	(2)
Insects	960 000	2
Others	400 000	2



# Livestock or domestic livestock: Definitions

- Animals kept or dealt in for use or profit (The Concise Oxford English Dictionary)
- Cattle, horses, poultry, and similar animals kept for domestic use but not as pets, especially on a farm or ranch (Collins English Dictionary – Complete and Unabridged © Harper Collins)
- Domestic animals, such as cattle or horses, raised for home use or for profit, especially on a farm (The American Heritage Dictionary of the English Language)
- Farm animals, with the exception of poultry. In Western countries the category encompasses primarily cattle, sheep, pigs, goats, horses, donkeys, and mules; other animals (e.g., buffalo, oxen, or camels) may predominate in other areas. (Merriam-Webster Concise Encyclopaedia)
- In the insurance sector a difference is made between **livestock** and **bloodstock**. Bloodstock are horses. Livestock are the rest. In accountancy a difference is made between **livestock** and **deadstock**. Deadstock are tractors and machinery and seed and other inputs - i.e. stock that is dead at the end of the year or at least not alive. Livestock are things that are alive and are valued as stock at the end of the year. (Philip Colfox, 2012)



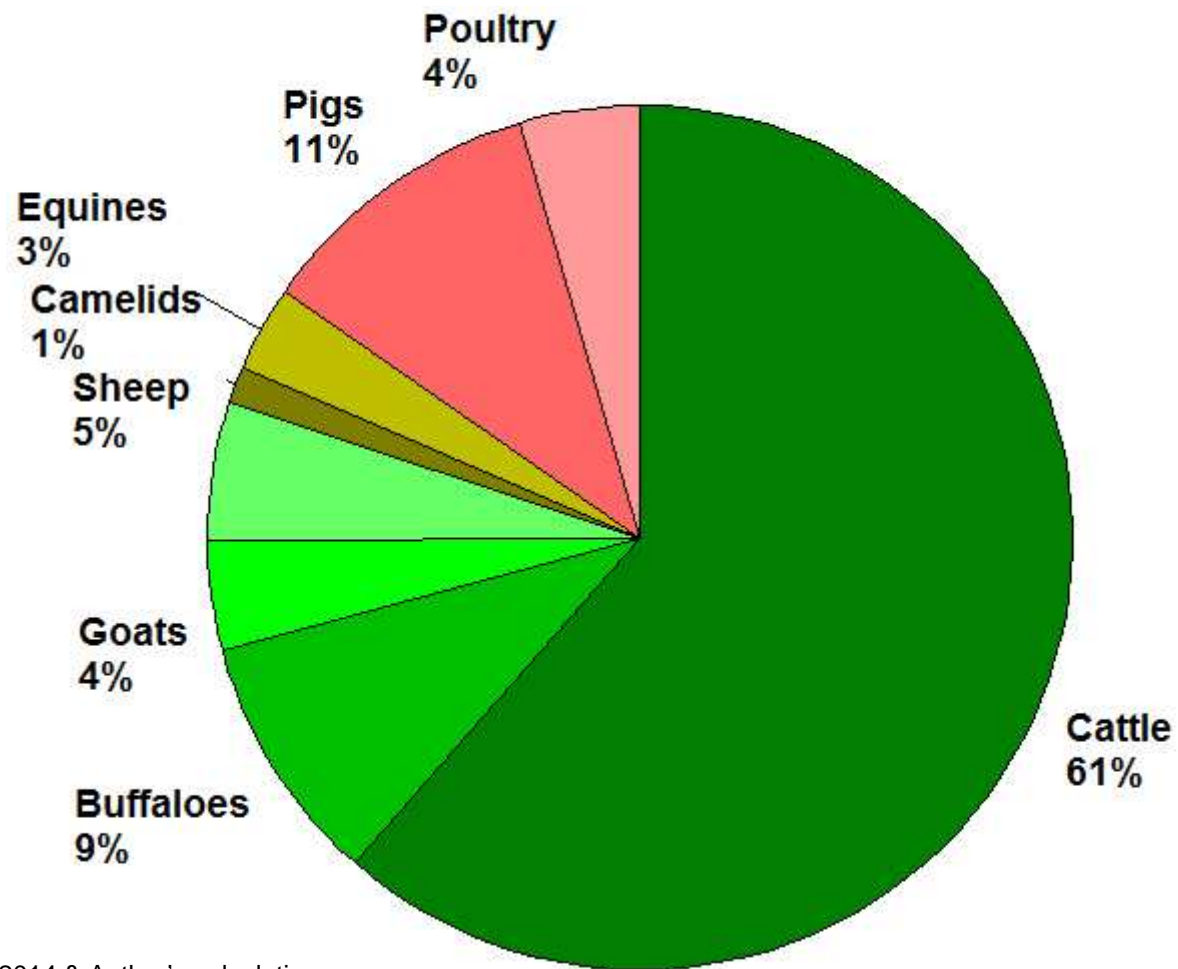
# Numbers and biomass of domestic animals and humans

Source: FAO Stat 2013 and author's calculations

<i>Species</i>	<i>Numbers (million)</i>	<i>Average live weight (kg)</i>	<i>Biomass (million t)</i>
Cattle	1 485	350	520
Buffalo	198	400	79
Sheep	1 169	38	44
Goats	996	35	35
Camelids	27 + 9	380 / 90	11
Equines	59 + 44 + 10	300 / 140 / 280	27
Pigs	966	95	92
Poultry	24 075	1.6	38
<b>Total</b>			<b>846</b>
<b>Humans</b>	<b>6 800</b>	<b>55</b>	<b>374</b>



# Global Biomass [%] of different livestock species



Data Source: FAO 2014 & Author's calculations



# The process of Evolution

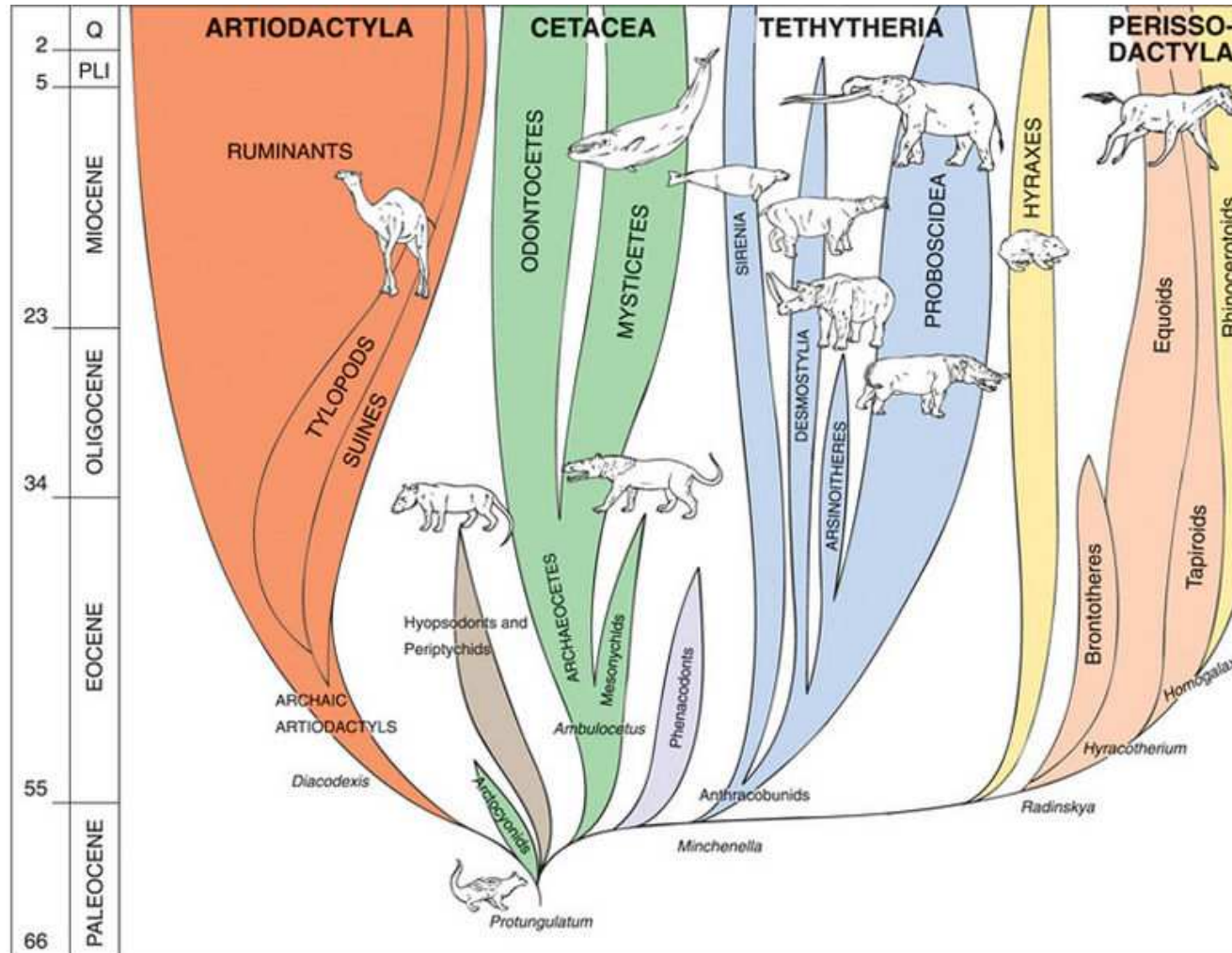
**Evolution** is change in the heritable traits of biological populations over successive generations. Evolutionary processes give rise to diversity at every level of biological organisation, including the levels of species, individual organisms, and molecules.

All of life on earth shares a common ancestor known as the last universal ancestor, which lived approximately 3.5–3.8 billion years ago. Repeated formation of new species (speciation), change within species (anagenesis), and loss of species (extinction) throughout the evolutionary history of life on Earth are demonstrated by shared sets of morphological and biochemical traits, including shared DNA sequences. These shared traits are more similar among species that share a more recent common ancestor, and can be used to reconstruct a biological "tree of life" based on evolutionary relationships (phylogenetics), using both existing species and fossils. The fossil record includes a progression from early biogenic graphite, to microbial mat fossils, to fossilized multicellular organisms. Existing patterns of biodiversity have been shaped both by speciation and by extinction. More than 99 percent of all species that ever lived on Earth are estimated to be extinct. Estimates of Earth's current species range from 10 to 14 million, of which about 1.2 million have been documented.

Source: <https://en.wikipedia.org/wiki/Evolution>

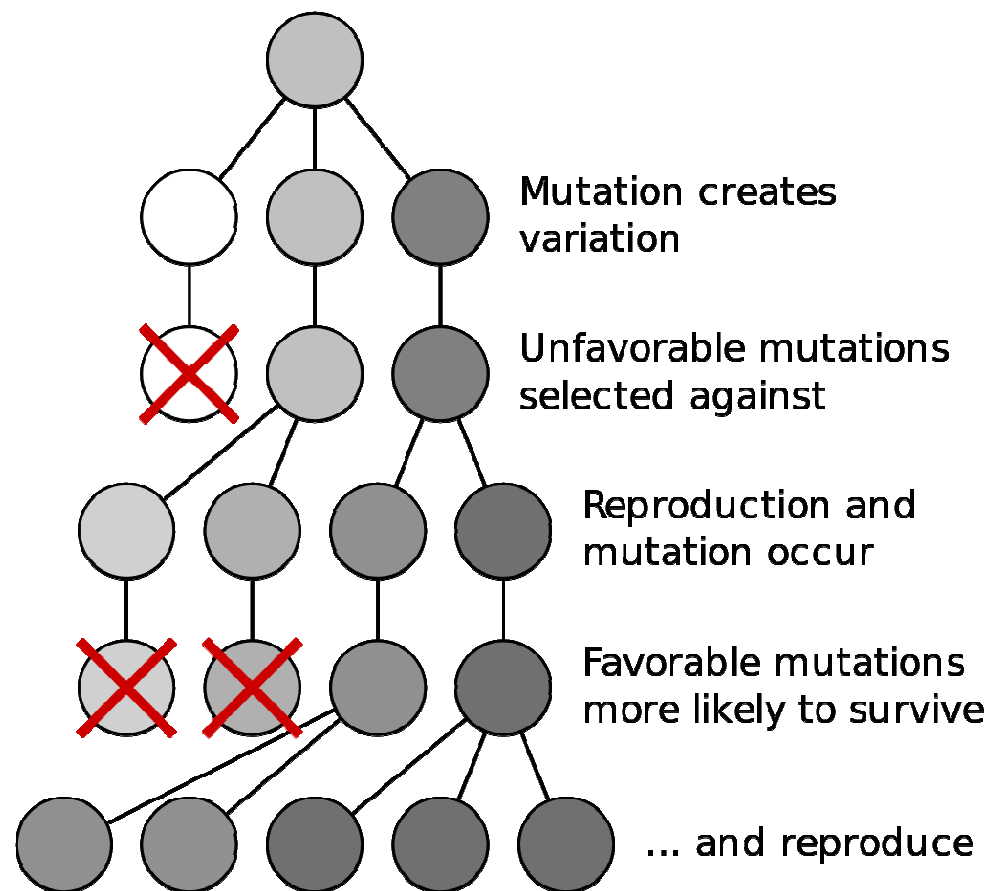


# The evolution of Ungulates



# Mutation and natural selection driving evolution

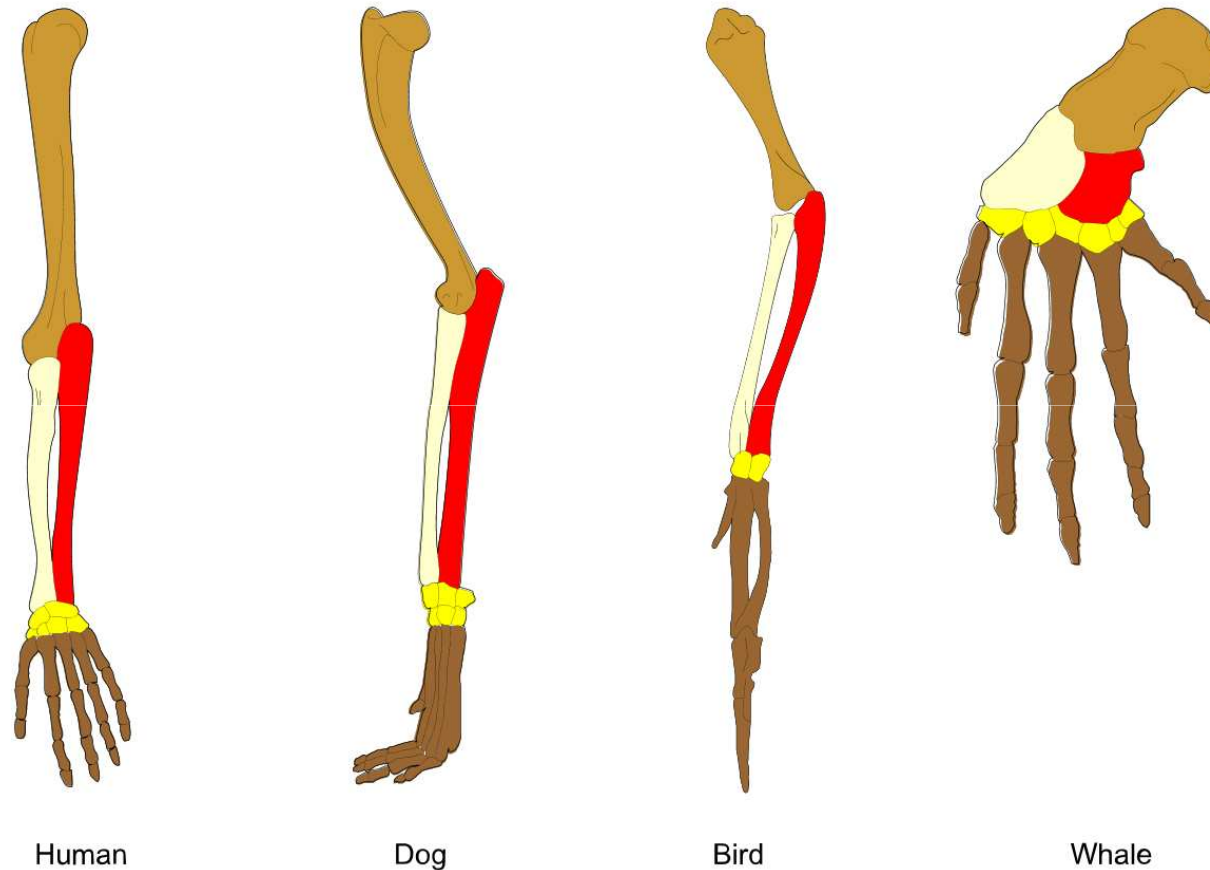
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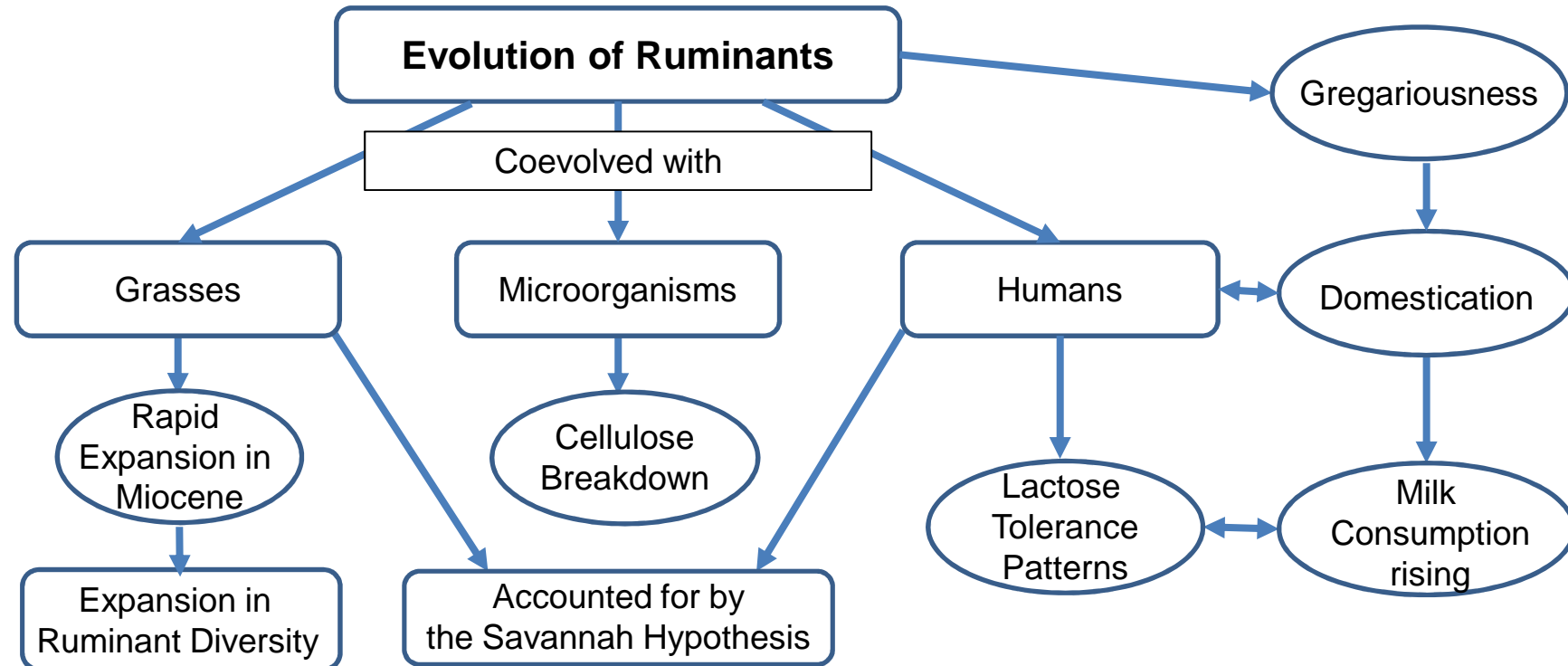


# Homologous bones in the limbs of tetrapods

Source: <https://en.wikipedia.org/wiki/Evolution>



# The Evolution of Domestic Grazing Systems



# The Savannah Hypothesis



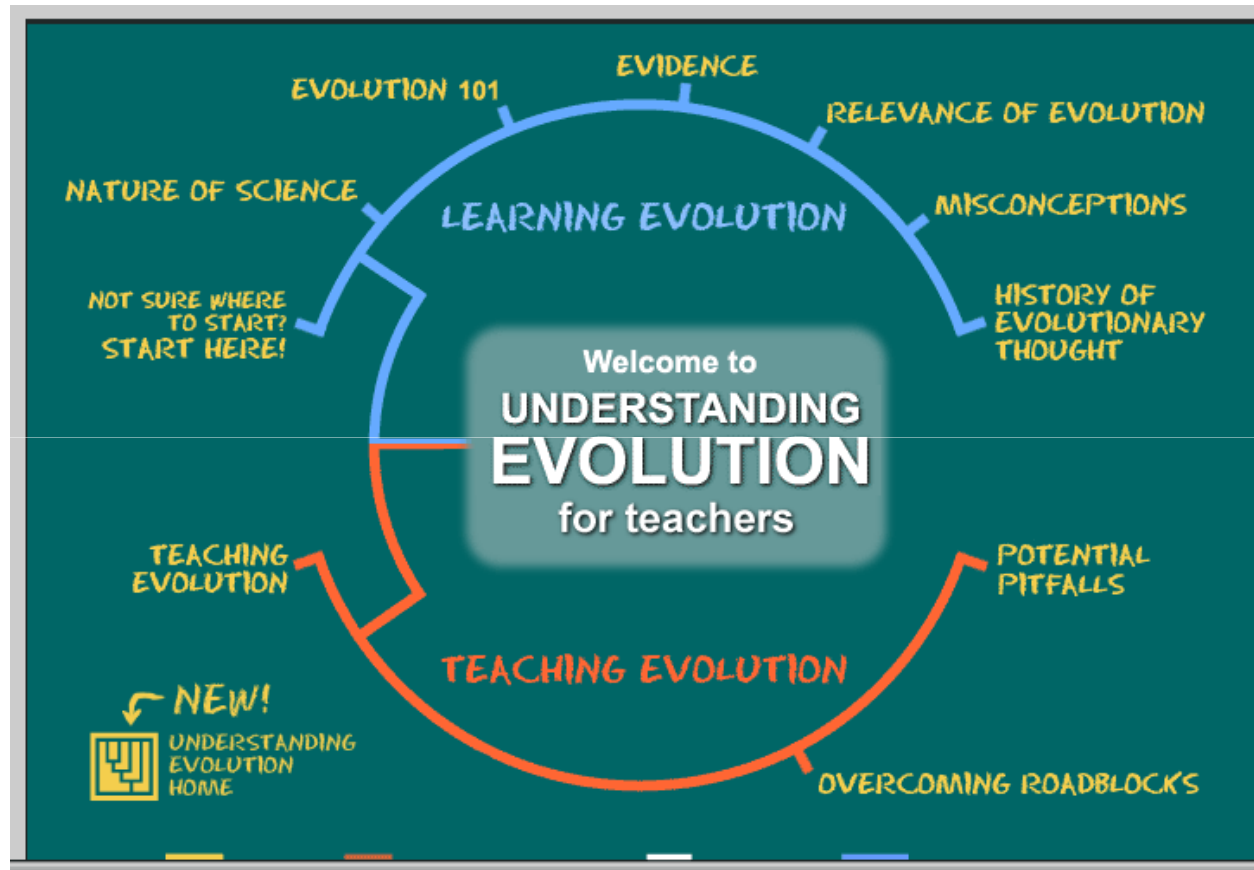
Renato Bender, Phillip V. Tobias, Nicole Bender (2012)  
The Savannah Hypotheses: Origin, Reception and Impact on Paleoanthropology.  
Hist. Phil. Life Sci., 34 (2012), 147-184.

<http://hornshire.com/AAH/2012%20Savannah%20Hypotheses%20-%20Bender%20et%20Tobias.pdf>



If you want to learn more about evolution, check this website

<http://evolution.berkeley.edu/eosite/evohome.html>



# What is a species?

**Species:** The lowest taxonomic rank, and the most basic unit or category of biological classification; it is the major taxonomic subdivision of a genus or subgenus. Species as the basic category of biological classification are composed of related individuals that resemble one another closely and are able to interbreed and produce fertile offspring.

**Subspecies:** A uniform, genetically distinct population within a species, often geographically isolated from the main body of the species. A species can contain several subspecies.



# Phylogenetics of domestic ungulates

**Phylogenetics** is the study of **phylogenesis**, or the evolutionary history, development and relationships among groups of organisms (e.g. species, or populations). These are discovered mainly through molecular data matrices, based on nucleic acids sequences and protein structures. Thus, the result of phylogenetic studies are hypotheses about the evolutionary history of taxonomic groups or their phylogeny.

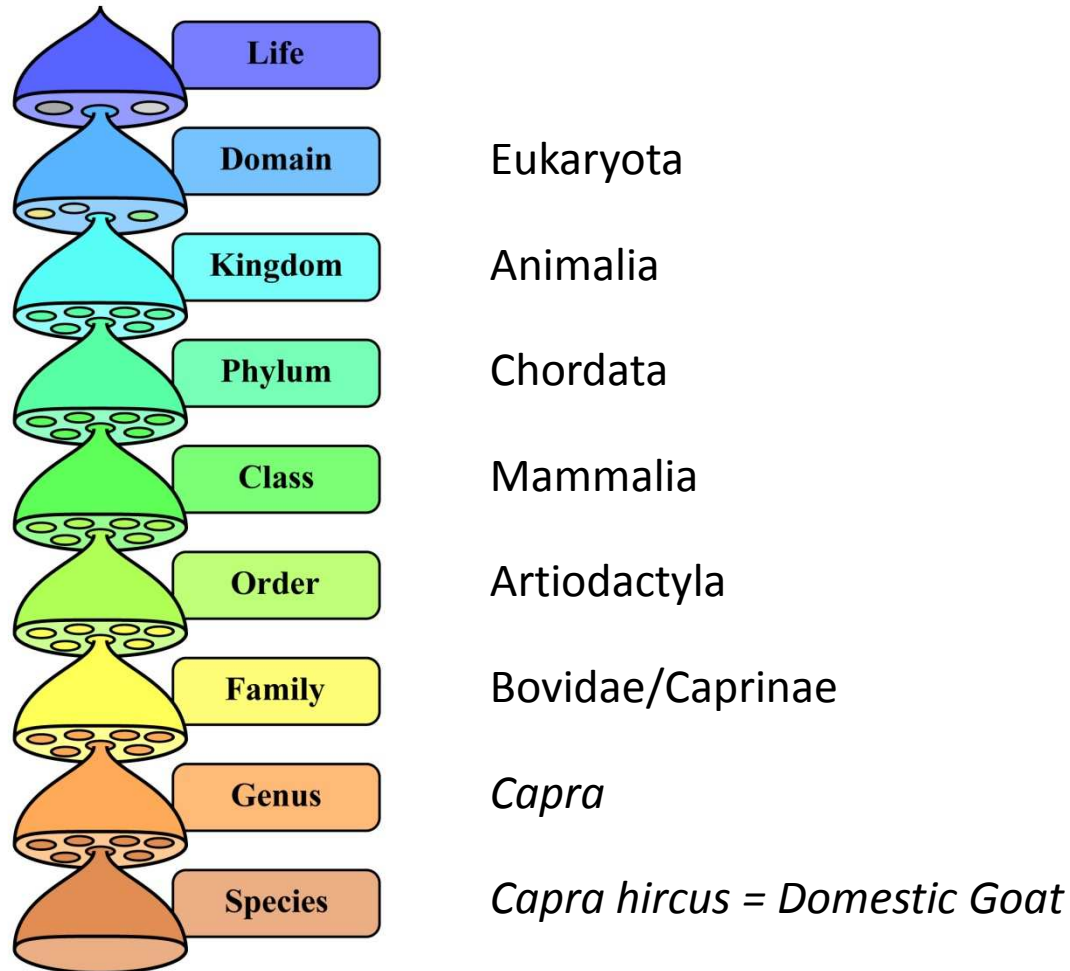
The evolutionary branching process may be depicted as a phylogenetic tree, and the place of each of the various organisms on the tree is based on a hypothesis about the sequence in which evolutionary branching events occurred.

Taxonomy is the classification, identification and naming of organisms. It is usually richly informed by phylogenetics, but remains a methodologically and logically distinct discipline. The degree to which taxonomies depend on phylogenies (or classification depends on evolutionary development) differs depending on the school of taxonomy: phenetics ignores phylogeny altogether, trying to represent the similarity between organisms instead; cladistics (phylogenetic systematics) tries to reproduce phylogeny in its classification without loss of information; evolutionary taxonomy tries to find a compromise between them in order to represent stages of evolution

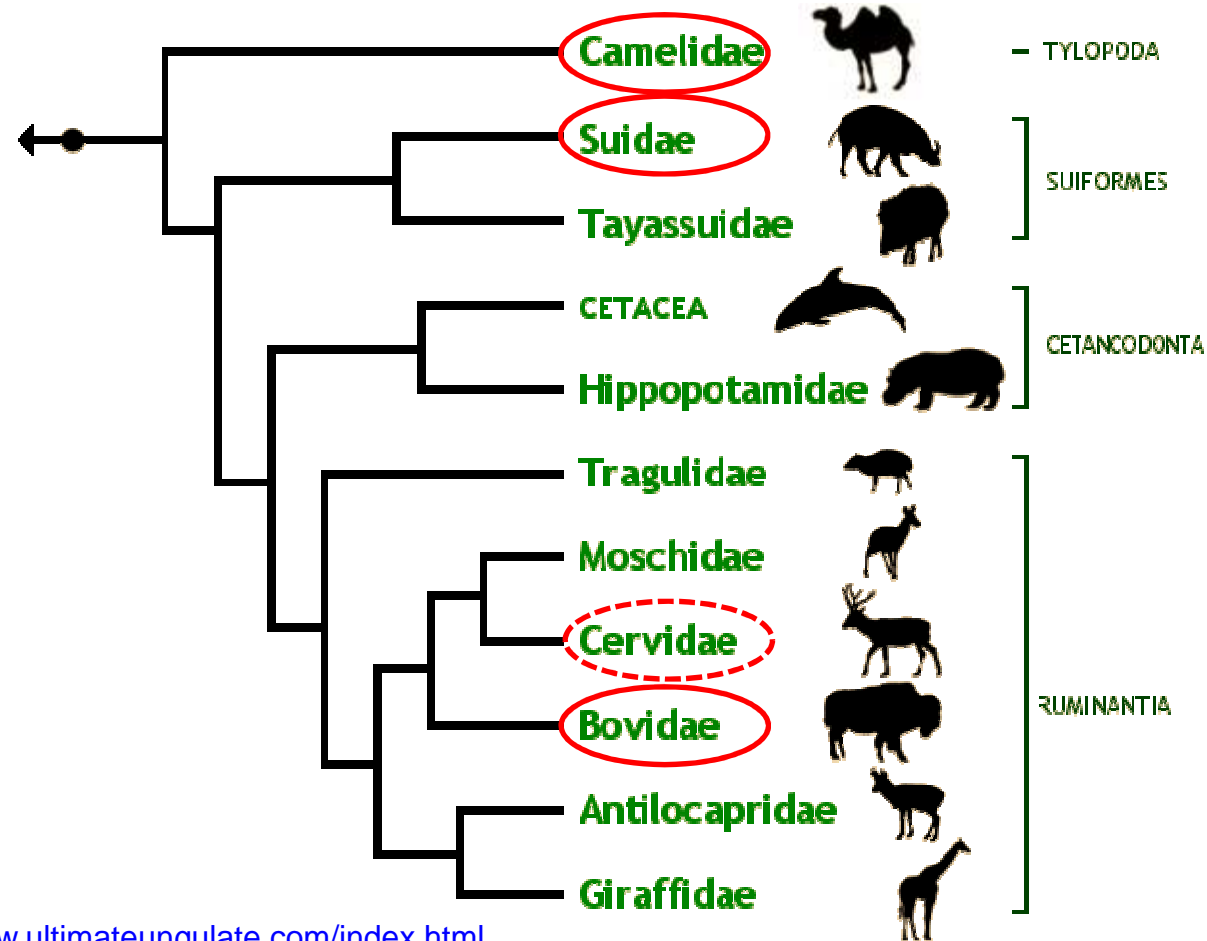
Source: <https://en.wikipedia.org/wiki/Phylogenetics>



# Example: Taxonomy of the domestic goat



# The Artiodactyla Family Tree (even-toed ungulates)

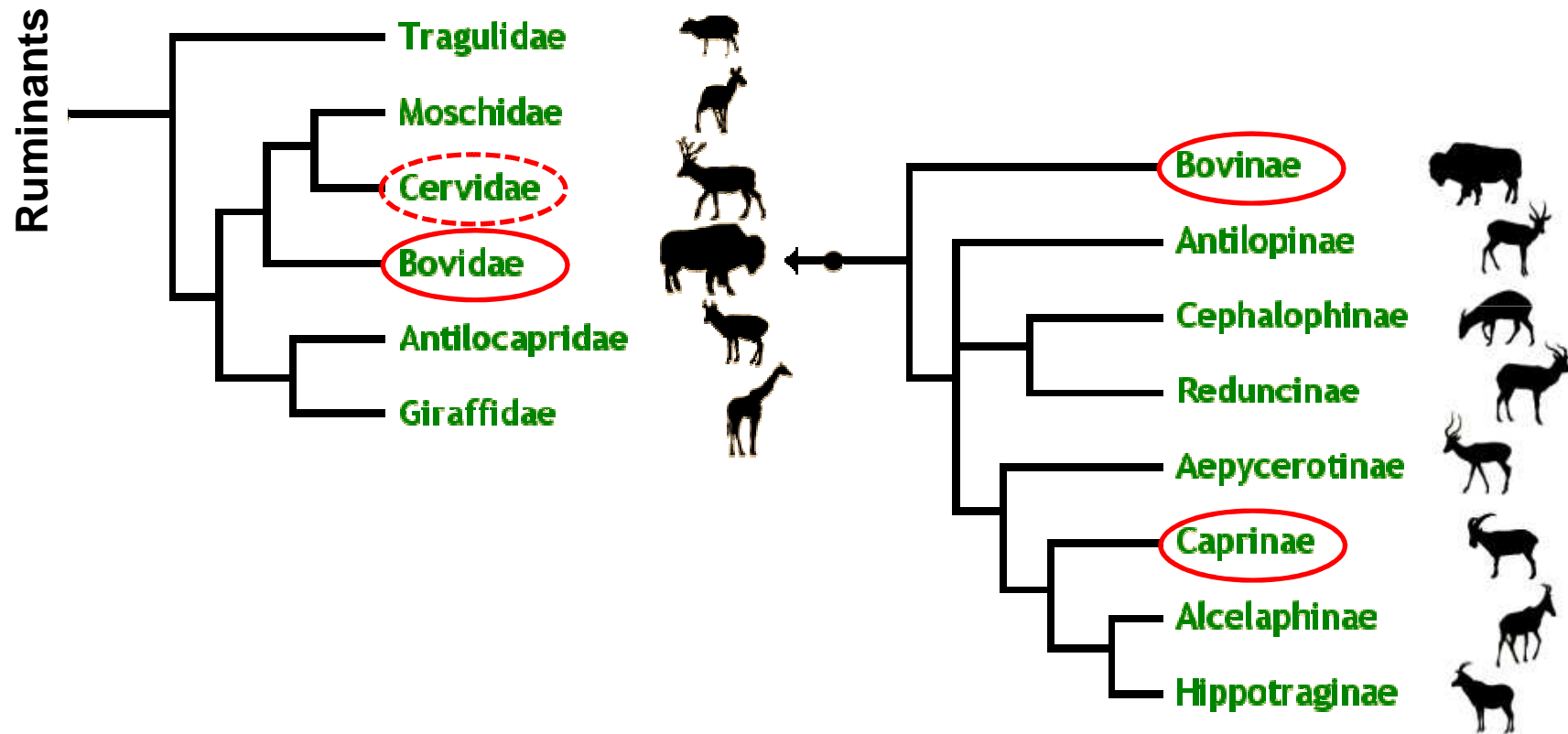


Source: <http://www.ultimateungulate.com/index.html>

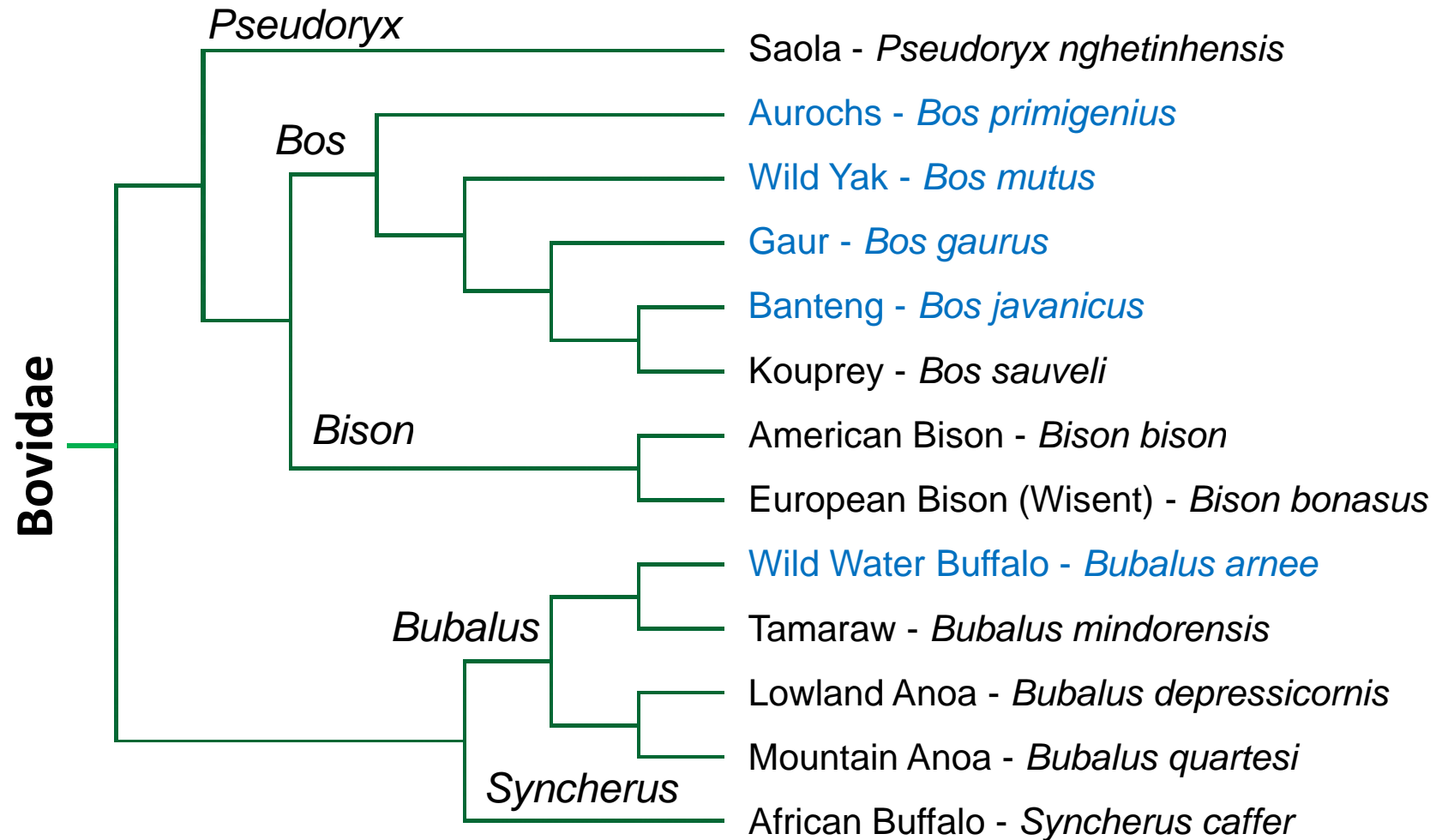




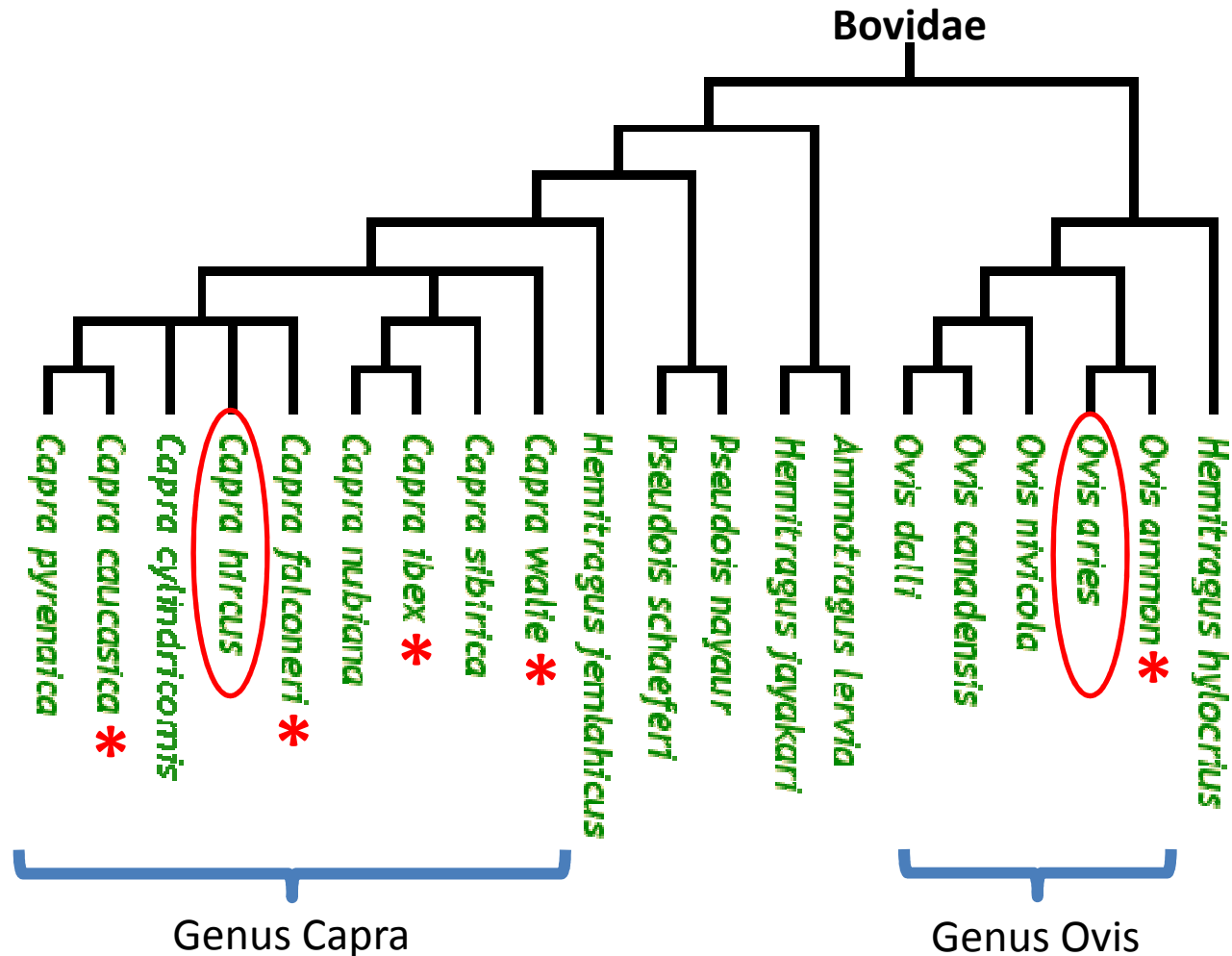
# The Position of *Bovini* and *Caprini* in the Ruminant Family Tree



# The *Bovini* subfamily tree

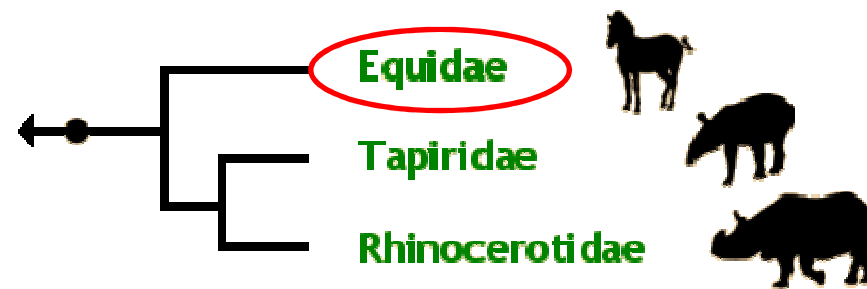


# The *Caprini* subfamily tree

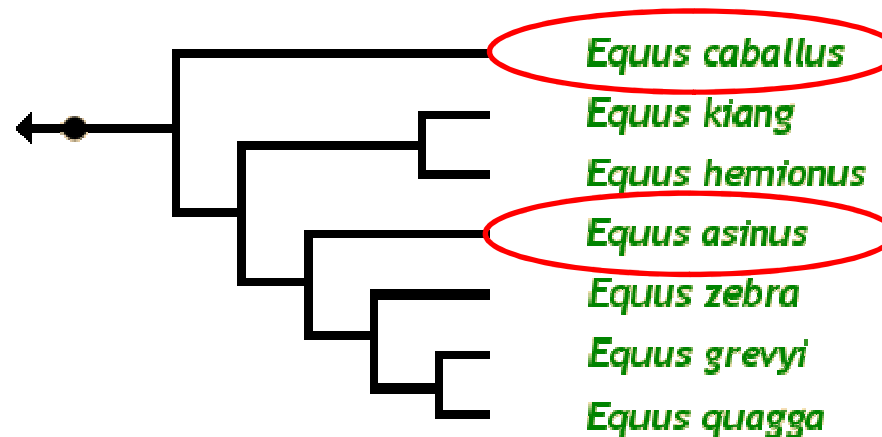


# The Perissodactyla Family Tree (odd-toed ungulates)

<http://www.ultimateungulate.com/index.html>



## The Equid Genus Tree



# The Family Suidae

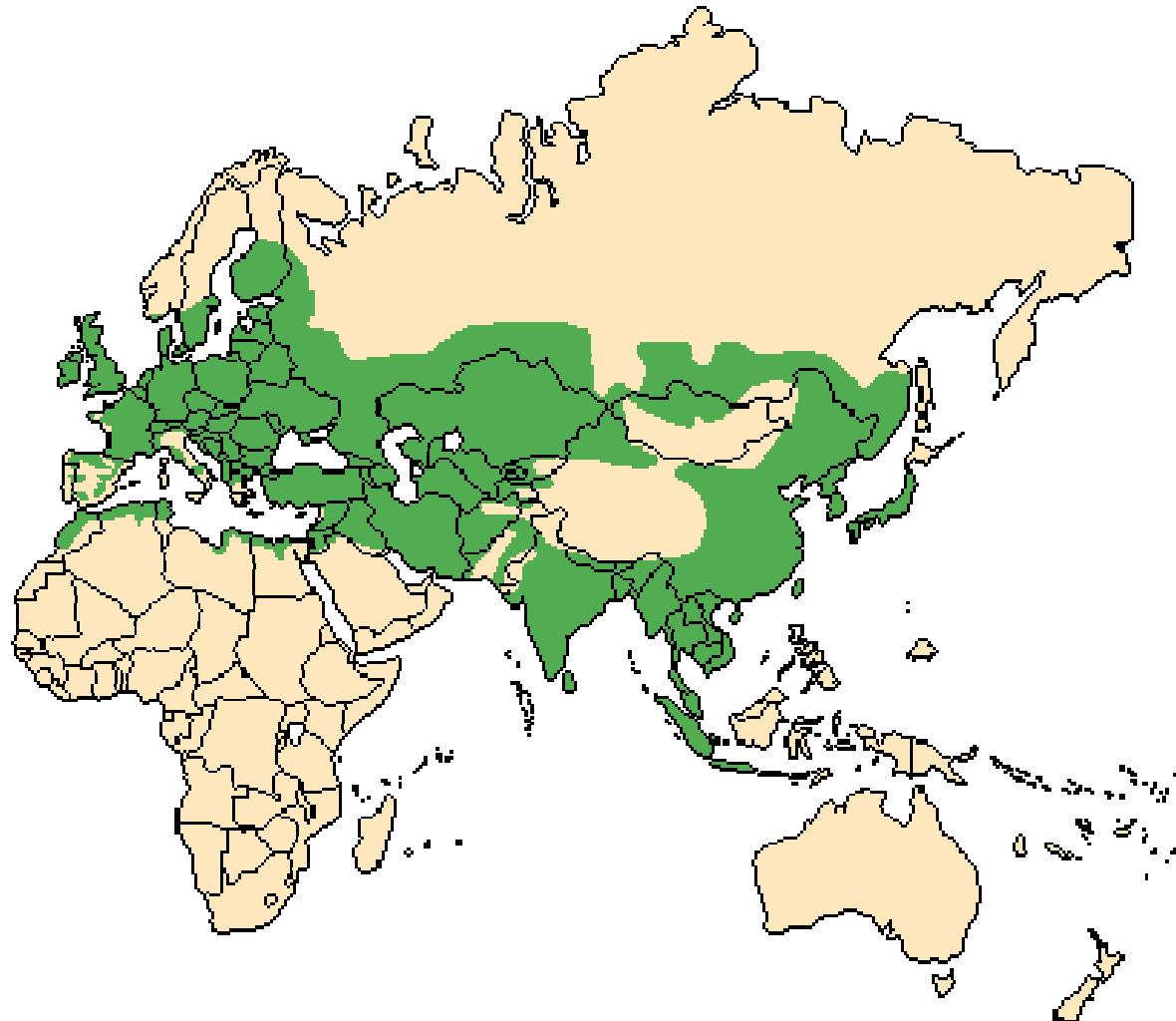
Genus	Babyrousa	Babirusa	(3 species)
	Hylochoerus	Forest Hog	(1 species)
	Phacochoerus	Warthogs	(2 species)
	Porcula	Pygmy Hog	(1 species)
	Potamochoerus	Bush Pigs	(2 species)
	Sus	True Pigs	(9 species)

## *Sus scrofa* Eurasian wild pig

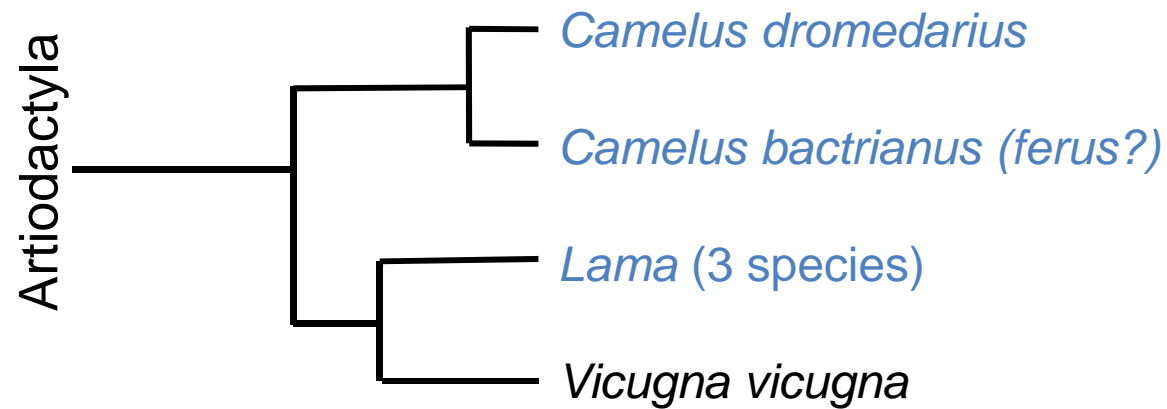
(wild form of the domestic pig, *Sus domesticus*)



# Range Map of *Sus scrofa*



# The Camelid (*Tylopodae*) Family Tree



# The process of domestication

- Loose contacts between man and animal, taming of individuals, with free breeding
- Confinement to human environment; with breeding in captivity
- Selective breeding organised by man to obtain certain characteristics; occasional crossing with wild forms
- Economic considerations of man leading to planned “development” of breeds with desirable properties
- Wild ancestors persecuted or exterminated



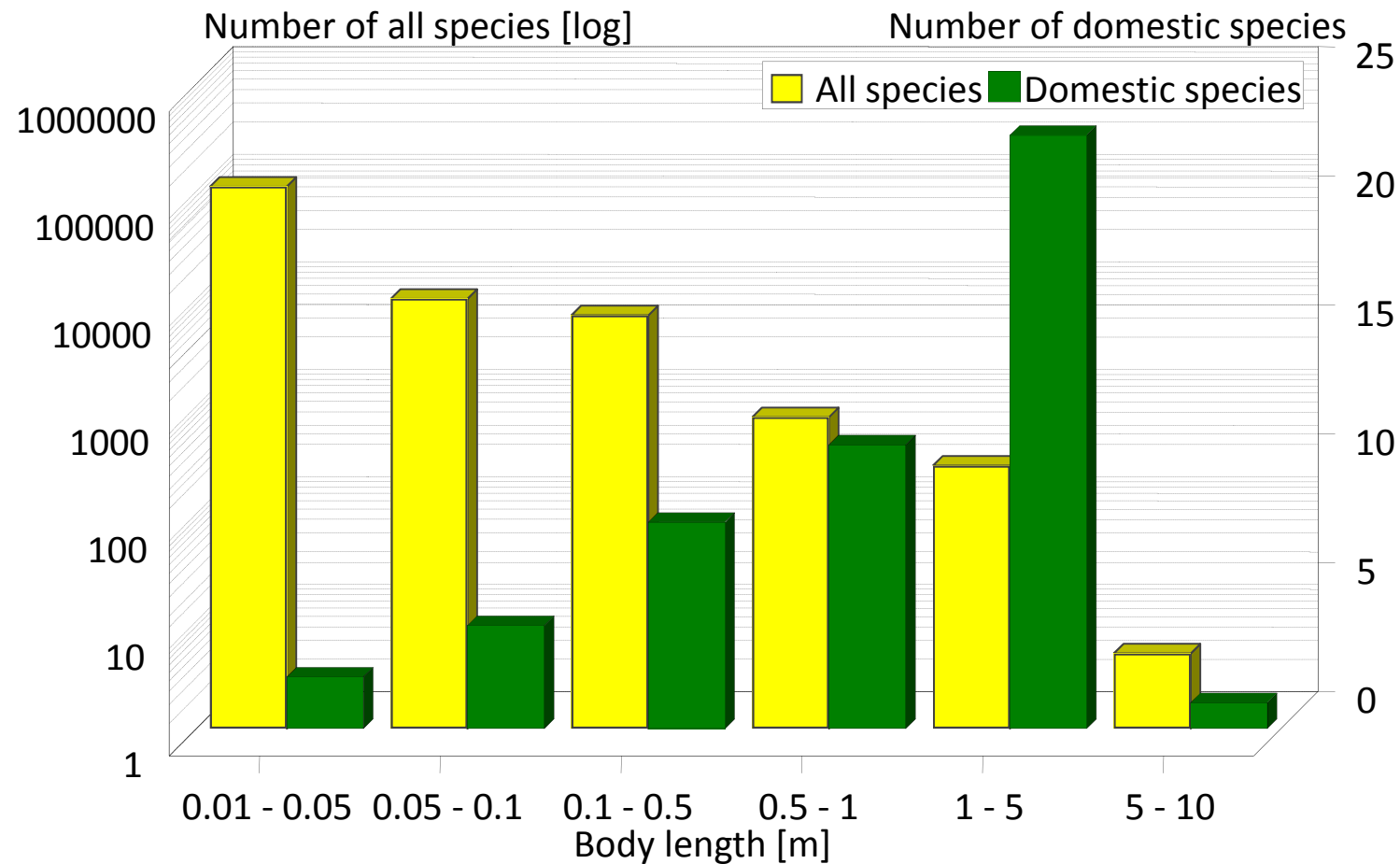


# Temporal sequence of species in domestication

- Mammals domesticated in the pre-agricultural phase: Dog, Reindeer, Sheep, Goat
- Mammals domesticated in the early agricultural phase (crop-robbers): Cattle, Buffalo, Gaur, Banteng, Yak, Pig
- Mammals domesticated for transport: Horse, Bactrian Camel, Dromedary, Donkey, (Elephant)
- Mammals domesticated for pest control: Cat, Mongoose, Ferret
- Latecomers: Rabbit, various recent domesticants
- Without temporal classification: Birds, Insects, Fishes, Molluscs



# Number of domestic species in different body size classes compared to the number of all known animal species

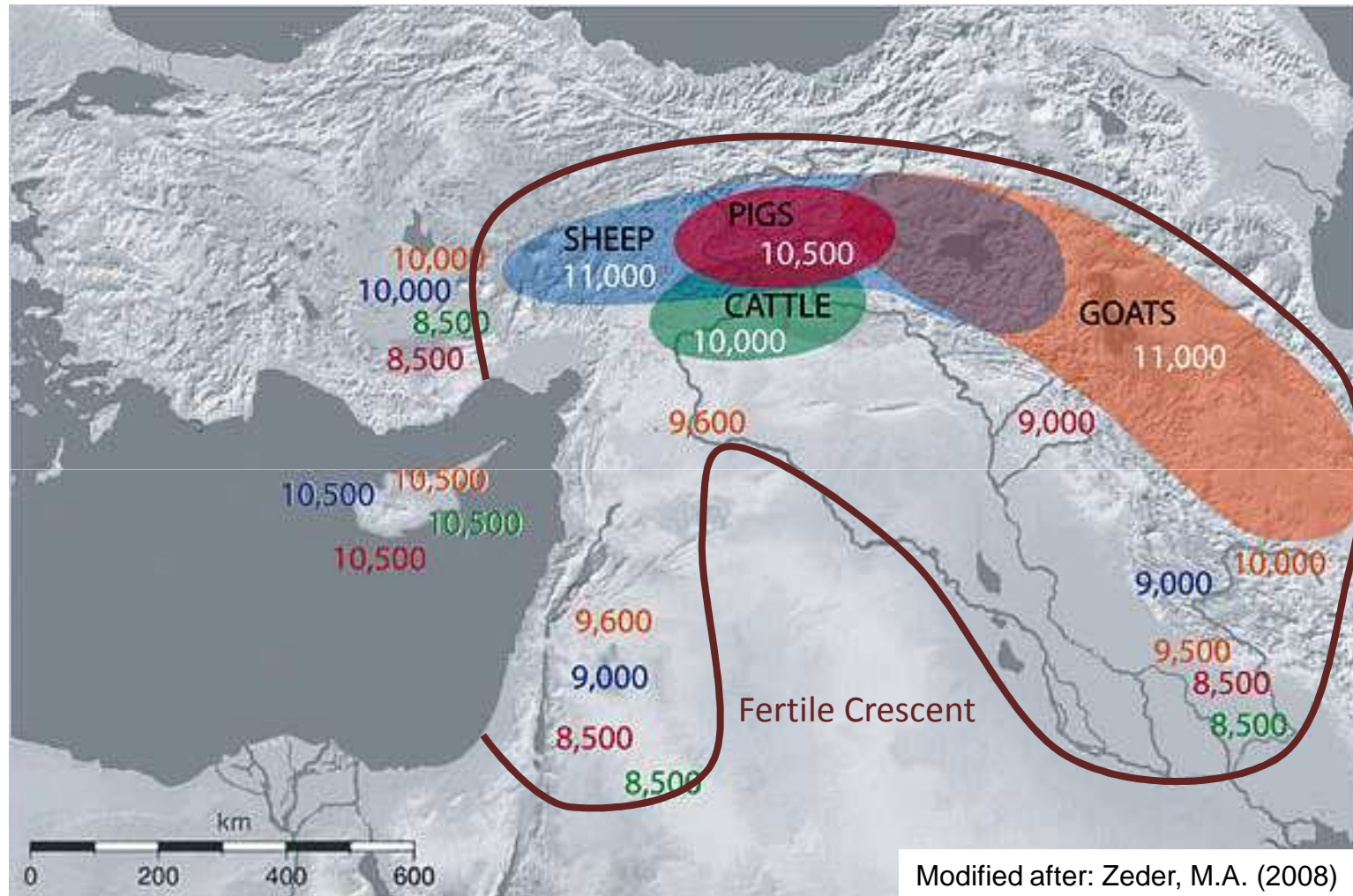


# Behavioural pre-adaptations to domestication

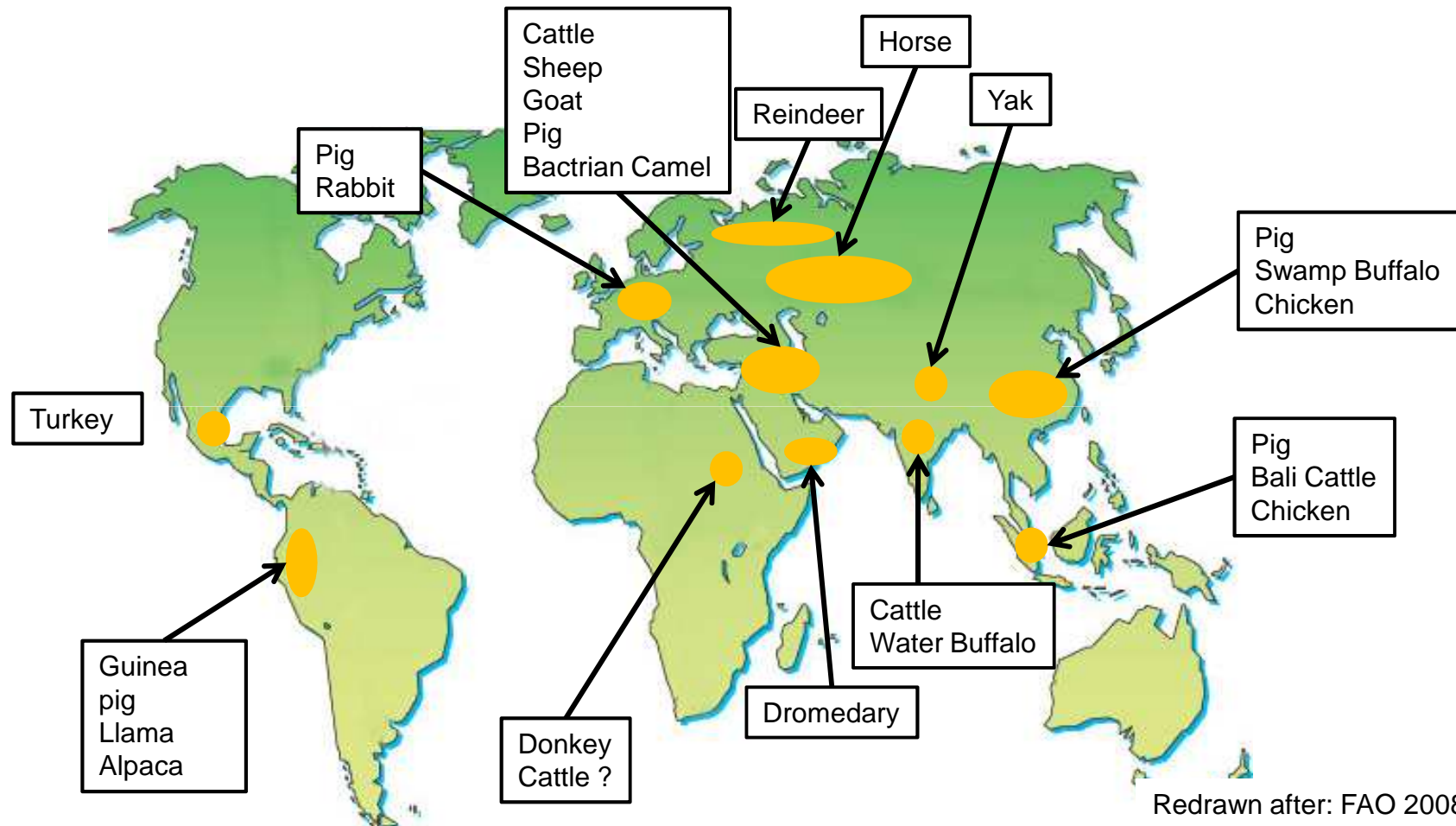
	Favourable	Unfavourable
Social Structure	Dominance hierarchy Large gregarious groups Male social group affiliation Persistent groups	Territoriality Family groups or solitary Males in separate groups Open memberships
Food Preferences	Generalist herbivores or omnivores	Dietary specialist or carnivore
Captive Breeding	Polygamous/Promiscuous mating Males dominant over females Males initiate Precocial young	Pair bonding prior to mating Females dominant Females initiate Altricial young
Aggressiveness ( within or between species)	Non-aggressive Tameable/readily habituated Readily controlled Solicits attention	Naturally aggressive Difficult to tame Difficult to control Avoids contact/attention
Captive Temperament	Limited agility Small home range Wide environmental tolerance Non-shelter seeking Implosive herd reaction to threat	Highly agile/difficult to contain Large home range Narrow environmental tolerance Shelter seeking Explosive herd reaction to threat



# Domestication of Ungulates in the Fertile Crescent



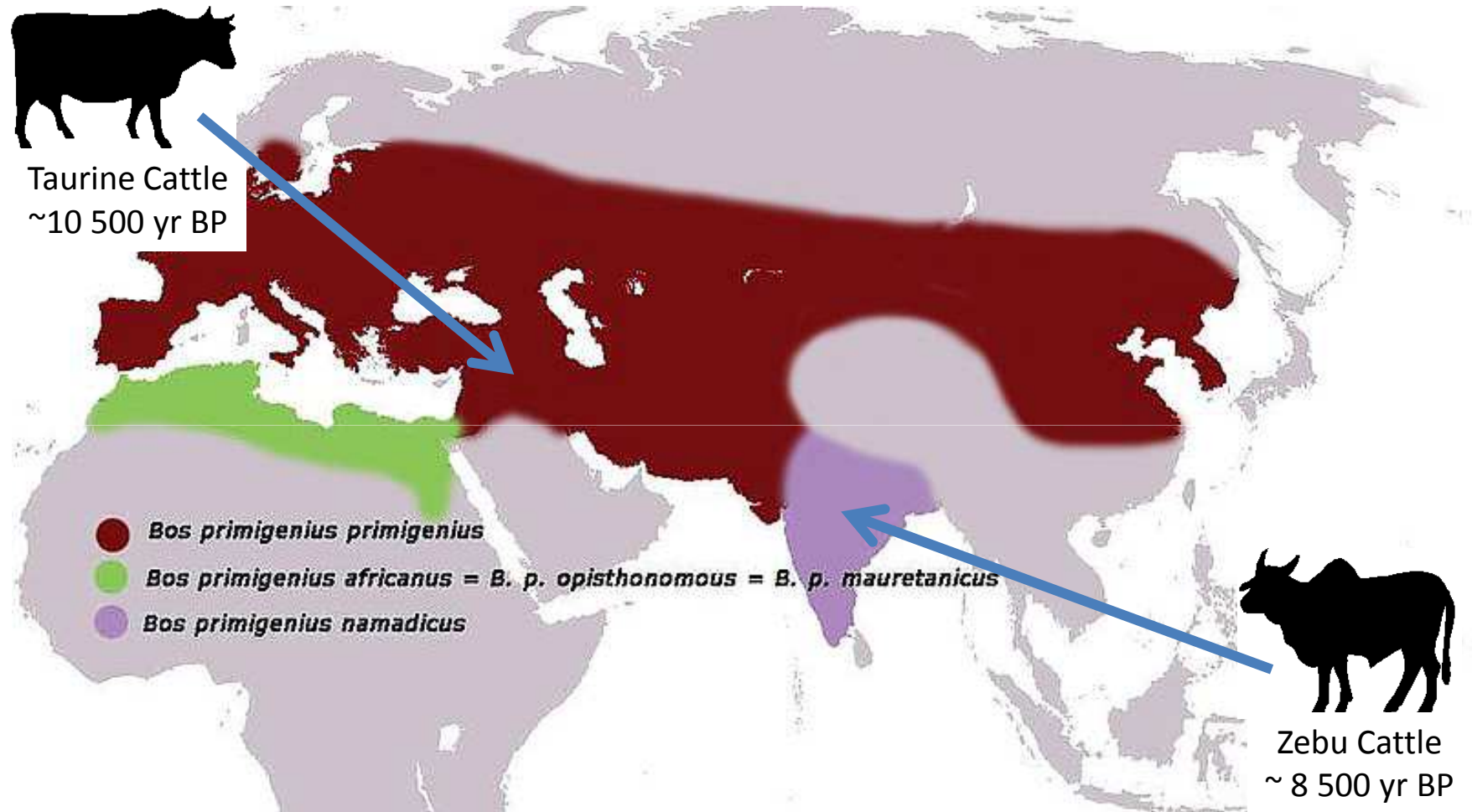
# Centres of domestication based on archaeological and molecular genetics information



# The Range of *Bos primigenius* subspecies



Taurine Cattle  
~10 500 yr BP



Zebu Cattle  
~ 8 500 yr BP



# Genetic diversity through breeding

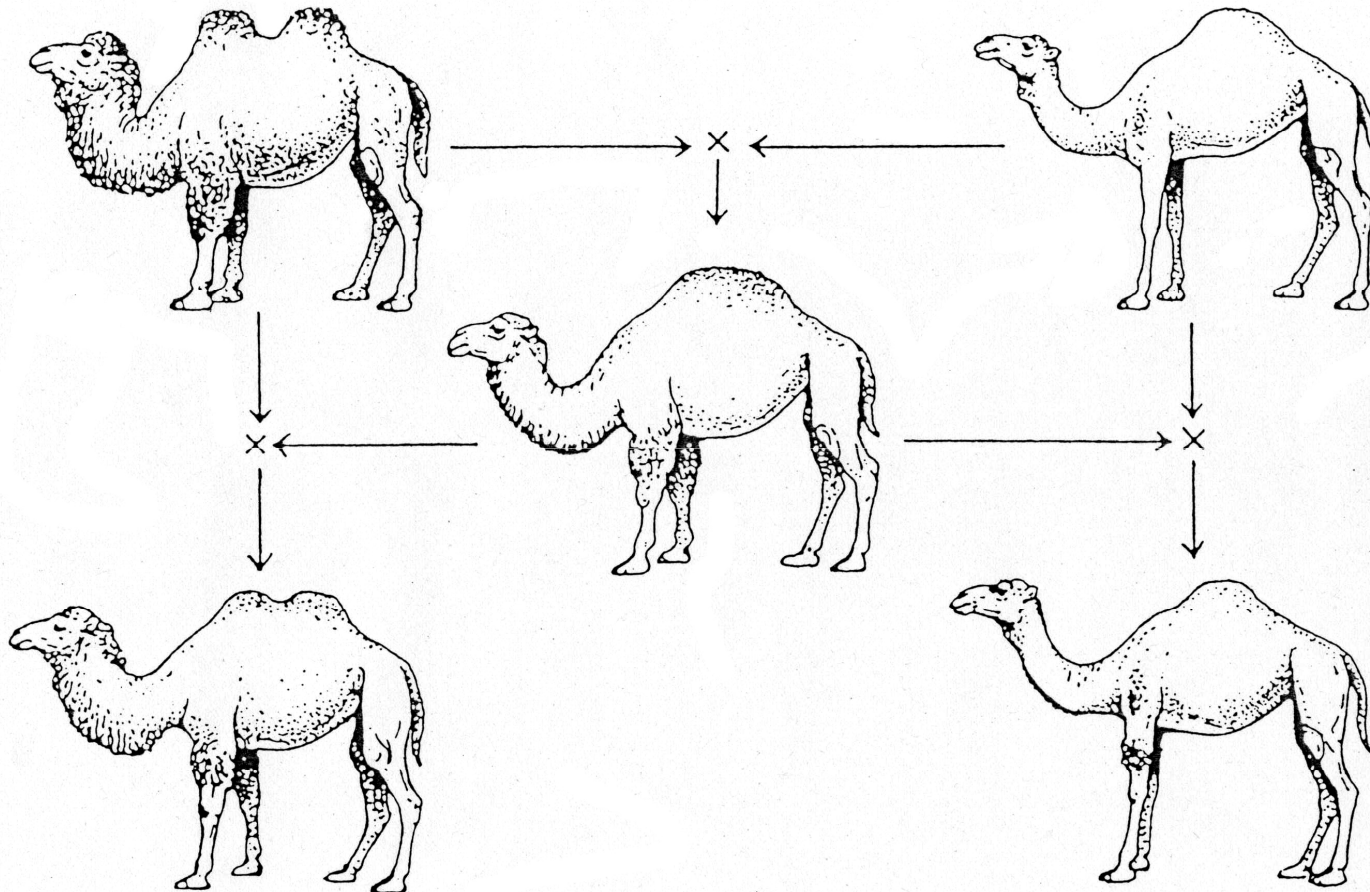
A **breed** is a specific group of domestic animals or plants having homogeneous appearance, homogeneous behaviour, or other characteristics that distinguish it from other animals or plants of the same species and that were arrived at through selective breeding. Despite the centrality of the idea of "breeds" to animal husbandry, no scientifically accepted definition of the term exists. A breed is therefore not an objective or biologically verifiable classification but is instead a term of art amongst groups of breeders who share a consensus around what qualities make some members of a given species members of a nameable subset. The term is distinguished from *landrace*, which refers to a regional variety of domestic (and sometimes feral) animal through relatively uncontrolled breeding.

When bred together, animals of the same breed pass on these predictable traits to their offspring, and this ability - known as "breeding true" - is a requirement for a breed. Plant breeds are more commonly known as cultivars. The offspring produced as a result of breeding animals of one breed with other animals of another breed are known as crossbreeds or mixed breeds. Crosses between animal or plant variants above the level of breed/cultivar (species, subspecies, botanical *variety*, even different genera) are referred to as *hybrids*.

<http://en.wikipedia.org/wiki/Breed>



# Dromedary and Bactrian Camel – Different Species or just Breeds?

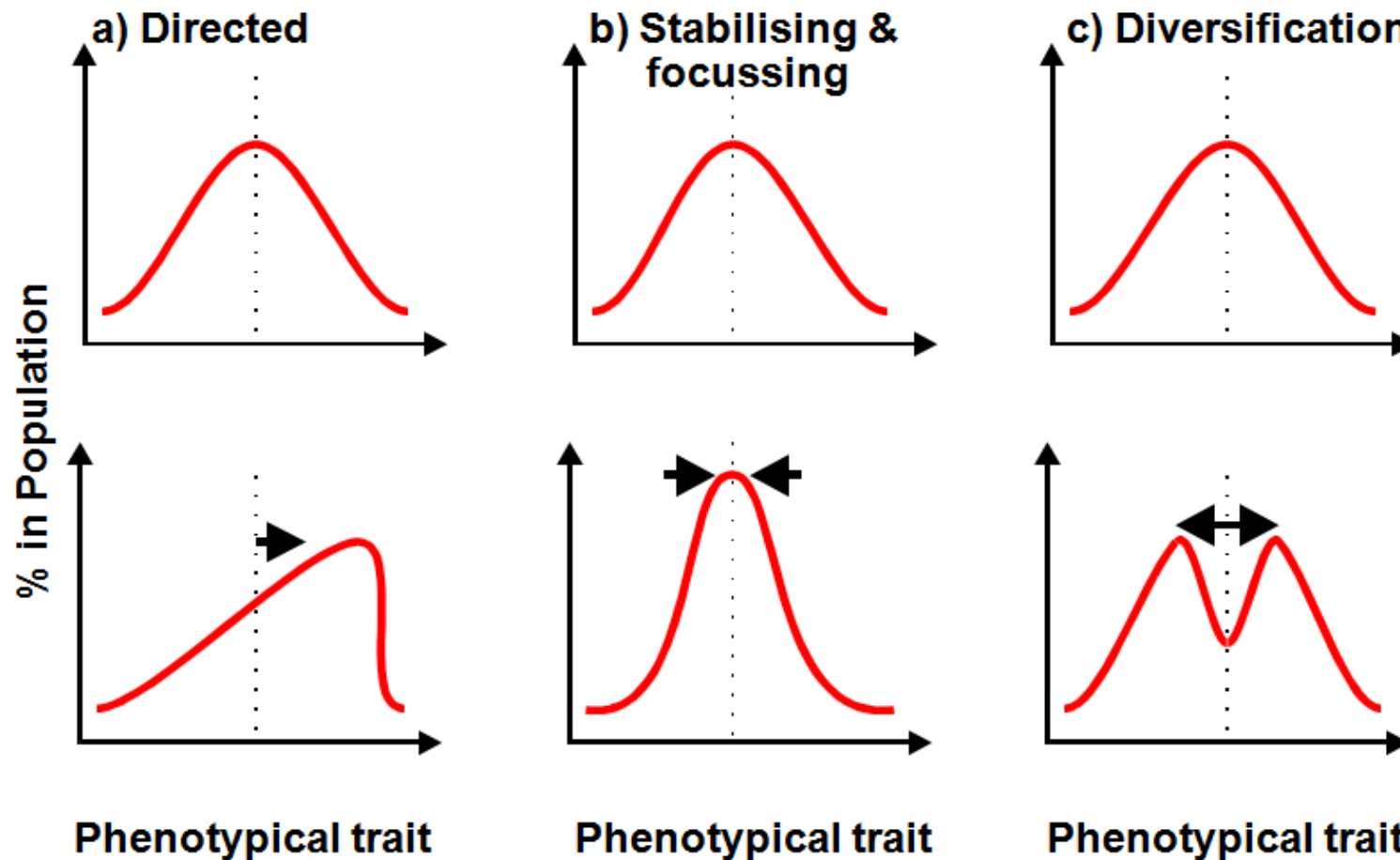


Source: S. Legel (1990) Nutztiere der Tropen und Subtropen

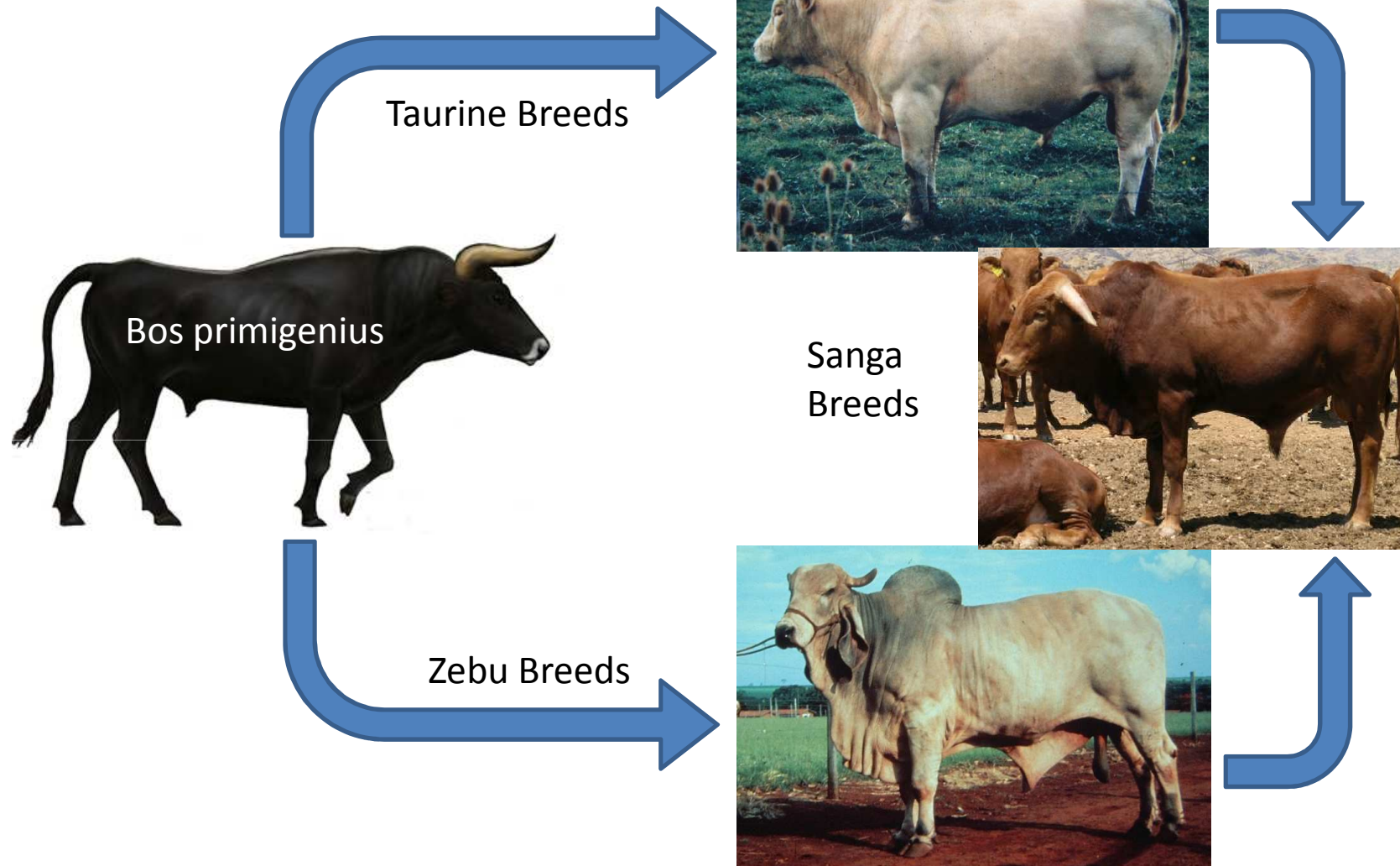




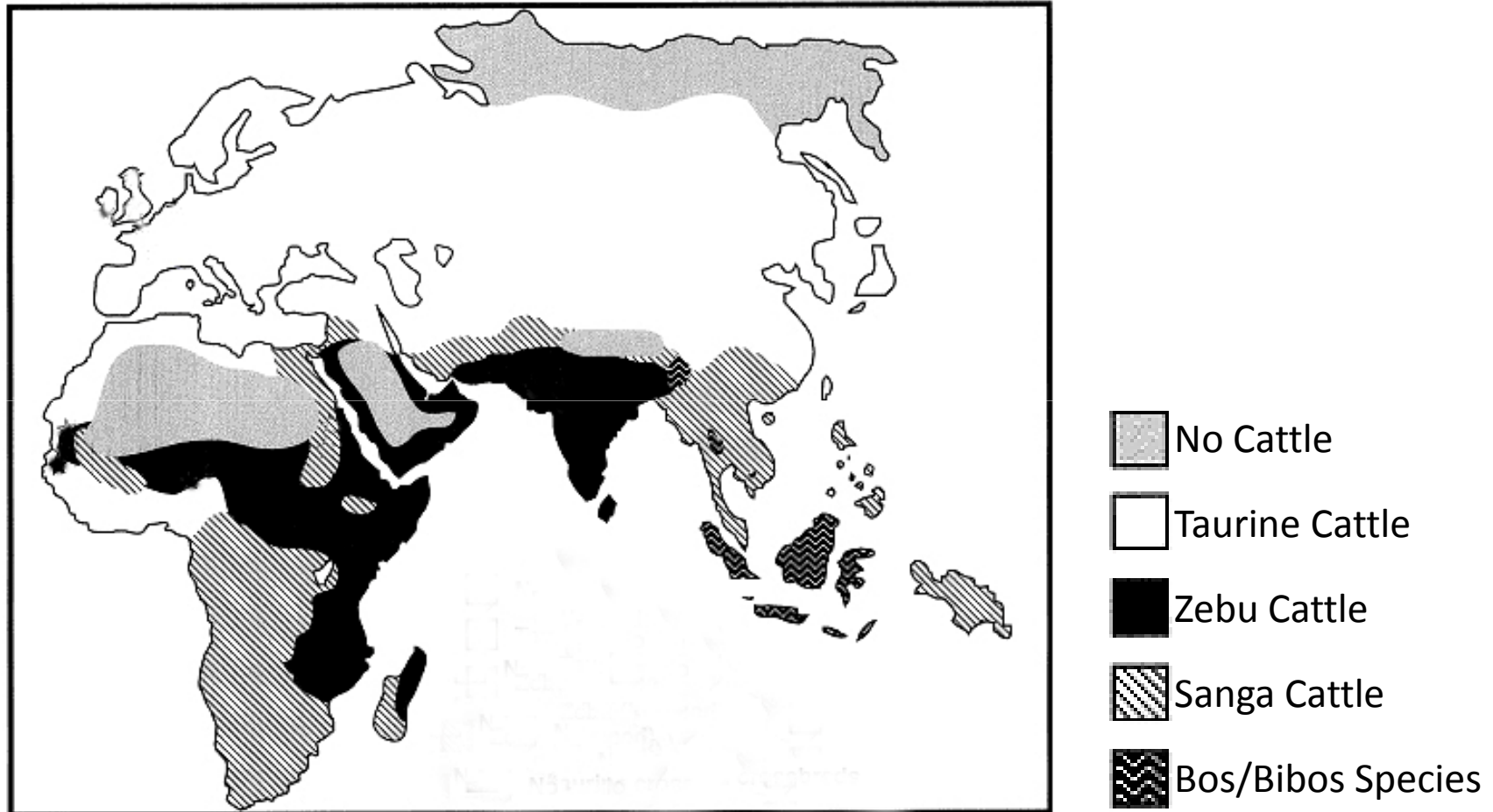
# Three patterns in which natural or man's selection may lead to differentiation into breeds



# Main cattle breed groups



# Distribution of cattle breed groups





**Taurine**



**Zebu**



**Bos (Bibos)**



**Sanga**



# Genetic diversity in domestic livestock shown by approximate number of breeds world wide

Species	No of breeds
Buffalo	17 (+)
Camels Dromedaries	97
Bactrian	16
Cattle	850 (+/-)
Chicken	600 (+)
Sheep	380 (+/-)
Goats	110 (+)
Horse	1400
Pig	200 (+/-)



# Bos primigenius – extinct since 1627 AD



# Breeding back the Aurochs - An example for the creation of a breed

**Heck cattle** are a hardy breed of domestic cattle. These cattle are the result of an attempt to breed back the extinct aurochs from modern aurochs-derived cattle in the 1920s and 1930s. Controversy revolves around methodology and success of the program. There are considerable differences between Heck cattle and the aurochs. Furthermore, there are other cattle breeds which resemble their wild ancestors at least as much as Heck cattle.

**Taurus cattle** are an advanced form of Heck cattle, an attempt of breeding back the aurochs, the wild ancestor of domestic cattle. They are the result of crossbreeding traditional Heck cattle with aurochs-like cattle mostly from Southern Europe to achieve a greater resemblance to the aurochs and larger body size. Taurus cattle herds are located in Germany, Denmark, Hungary and Latvia and are used in conservation of natural landscapes and biodiversity. Taurus cattle is a breed that is still being crossbred and selected.



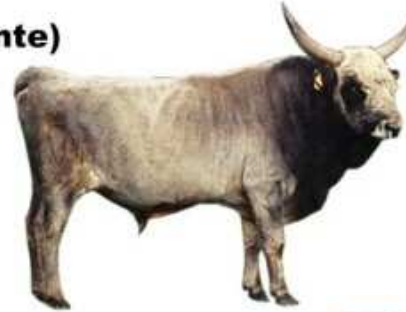
# Breeds used for phenotypical reconstruction of *B. primigenius*



**Old Frisian (Schwarzbunte)**



**Highland**



**Hungarian Gray**



**Murnau-Werdenfelser**



**Corsicana**



**Braunvieh**



**Angeln cattle**

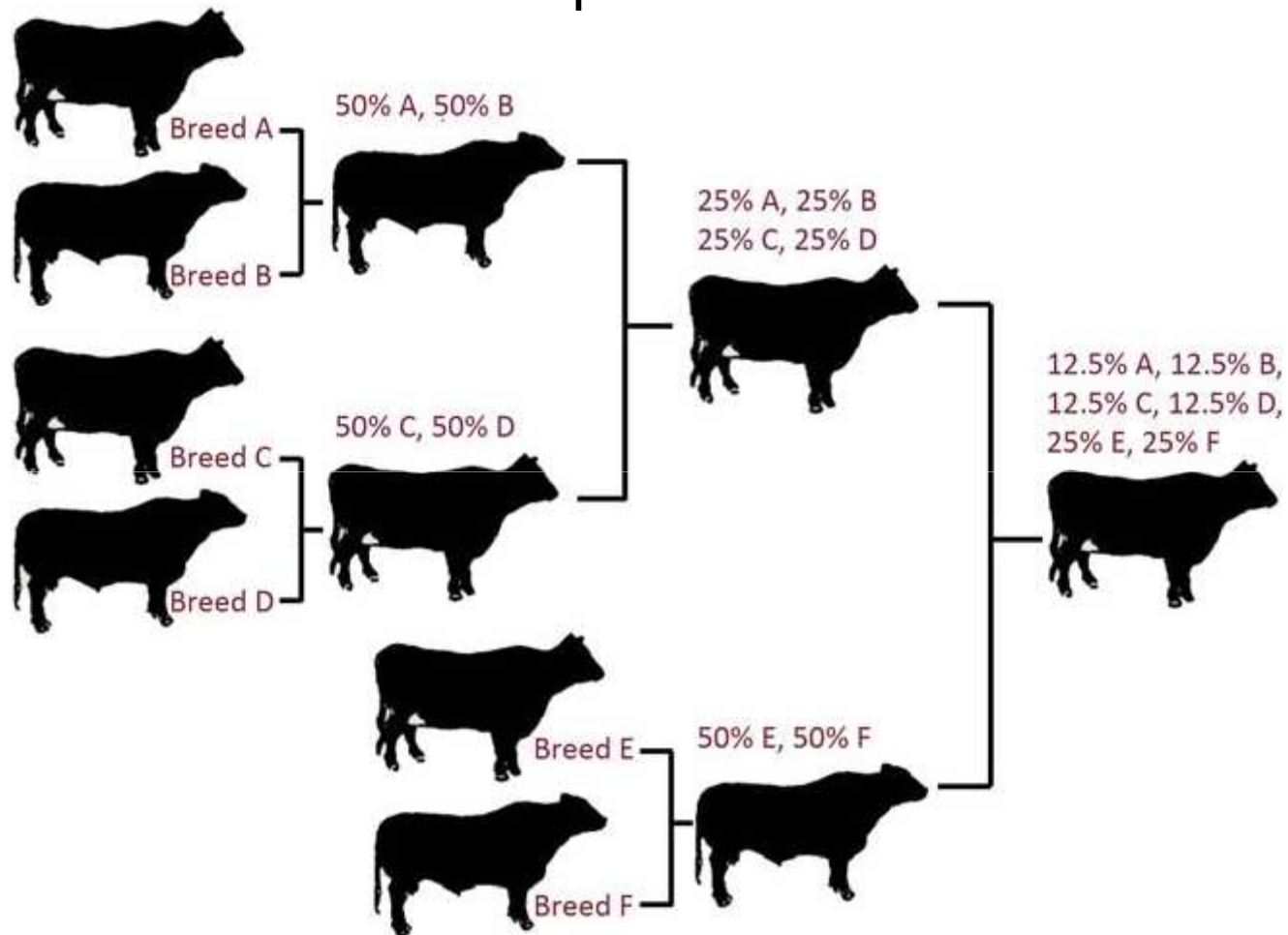


**Watussi**





# Schematic representation of the establishment of a composite breed



# Back bred Aurochs – Heck Cattle



# Taurus cattle displaying aurochs-like colour dimorphism



Source: Wikimedia Commons



# Literature

Cis van Vuure: History, Morphology and Ecology of the Aurochs (*Bos primigenius*). 2002  
< <http://members.chello.nl/~t.vanvuure/oeros/uk/lutra.pdf> >

Maas, P.H.J. (2014). Aurochs - *Bos primigenius*. In: TSEW (2015). The Sixth Extinction Website. <<http://www.petermaas.nl/extinct>>.

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Renato Bender, Phillip V. Tobias, Nicole Bender (2012). The Savannah Hypotheses: Origin, Reception and Impact on Paleoanthropology. Hist. Phil. Life Sci., 34 (2012).  
<http://hornshire.com/AAH/2012%20Savannah%20Hypotheses%20-%20Bender%20et%20Tobias.pdf>

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DOI 10.1007/s12052-008-0114-z

