

Cattle: more than taurine and zebu

J.A. Lenstra,

Faculty of Veterinary Medicine, Utrecht University, Netherlands

- Ca. 0.7 G taurine cattle
- Ca. 0.8 G zebus
- 350 kg/animal
- ☞ **500 x 10¹² g biomass** for the combined subspecies:
more than any other animal species

followed by the antarctic krill



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1. Southeast-Asian cattle species
2. On the origin of Indonesian and Thai cattle
zebu, banteng
3. On the origin of Chinese cattle
zebu, banteng, gayal
4. On the origin of Cambodian cattle
kouprey
5. Perspectives in science and agriculture



Cattle: more than taurine and zebu

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Zebu (*Bos indicus*)

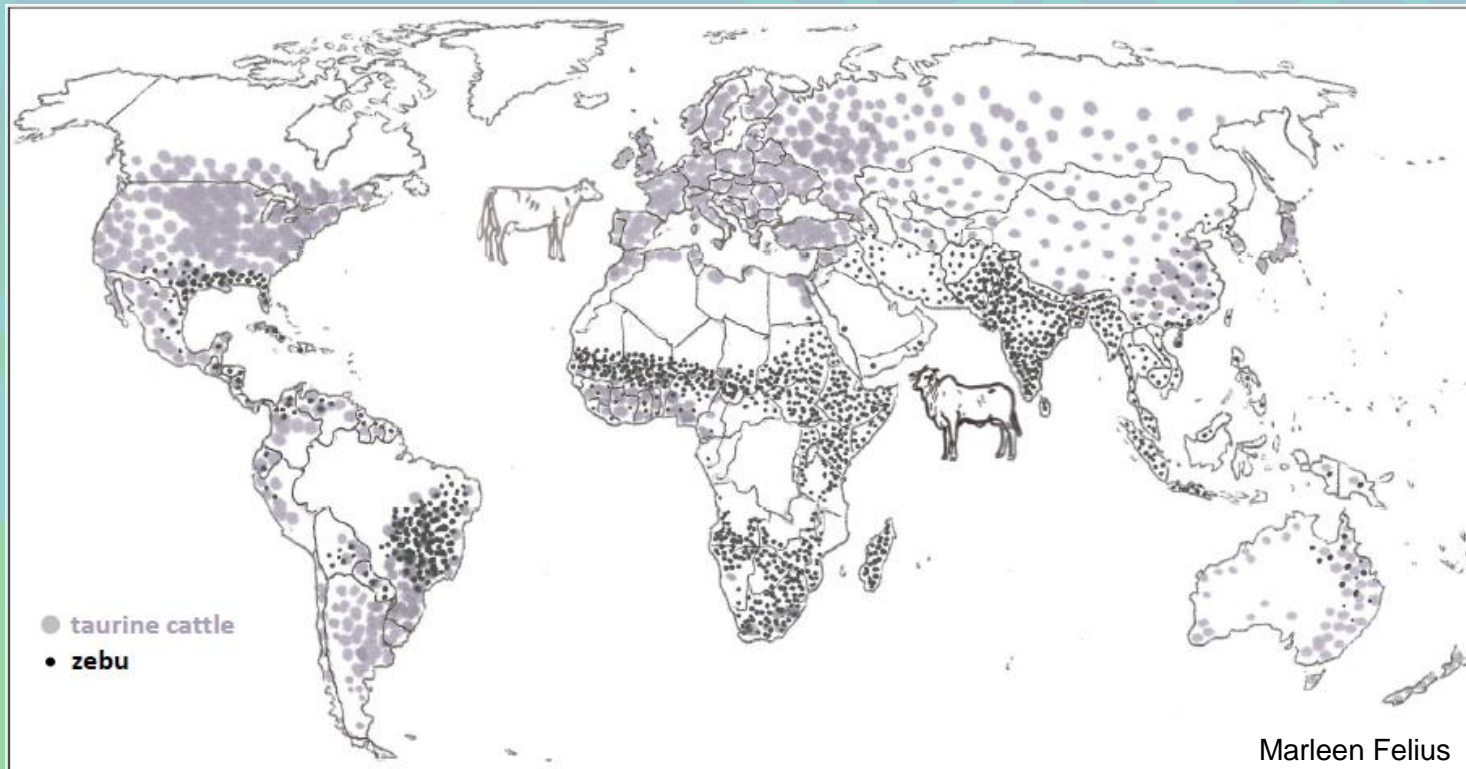
hump, dewlap, slender

loose skin



1. Southeast-Asian cattle species

tropical adaptation



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1. Southeast-Asian cattle species

tropical adaptation

Zebu (*Bos indicus*)

hump, dewlap, slender
loose skin,



Bali cattle

(*Bos javanicus*)

domestic banteng
compact



Gayal/Mithun

(*Bos frontalis*)

domestic gaur
stocky



Kouprey

(*Bos sauveli*)

extinct



Cattle: more than taurine and zebu

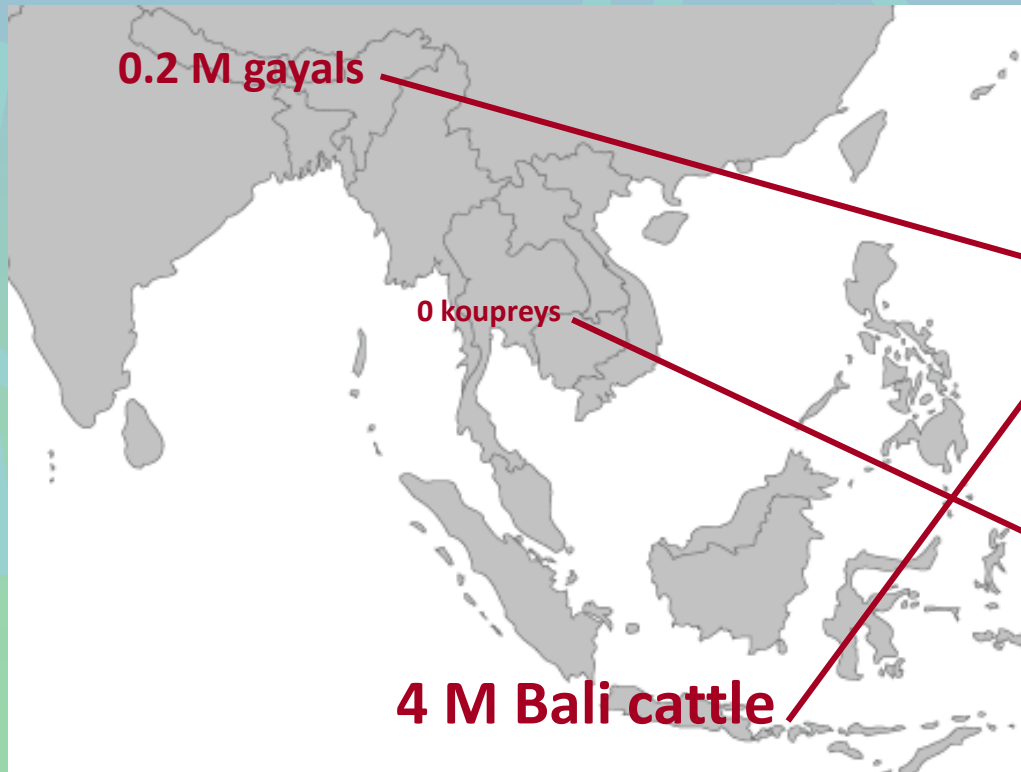
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Zebu



1. Southeast-Asian cattle species tropical adaptation



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Zebu



1. Southeast-Asian cattle species

tropical adaptation

Crossing of *Bos* species:

- Zebu × taurine: fertile taurindicine
- Other crosses:
 - female offspring fertile
 - male offspring sterile
- Spontaneous (anomalous mtDNA phylogeny)
- Terminal cross (gayal × zebu, yak × taurine)
- Hybrid breed

Bali cattle



Gayal



Kouprey



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2. On the origin of Indonesian and Thai cattle



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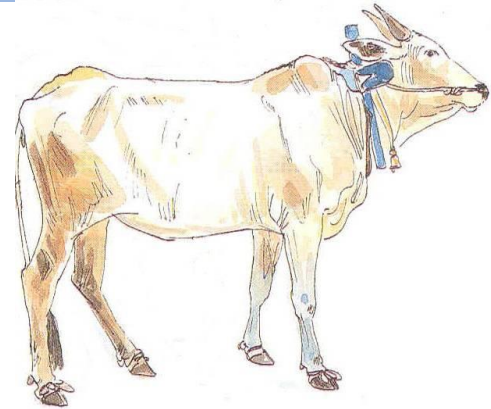
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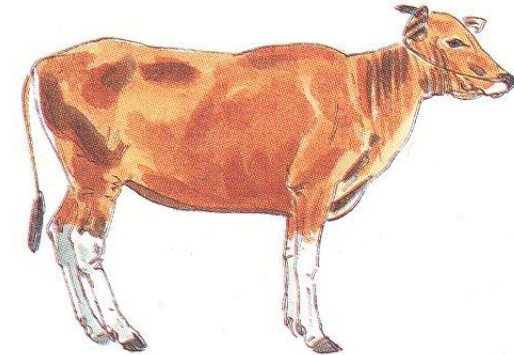
1. Southeast-Asian cattle species
2. On the origin of Indonesian cattle



Indonesian cattle breeds



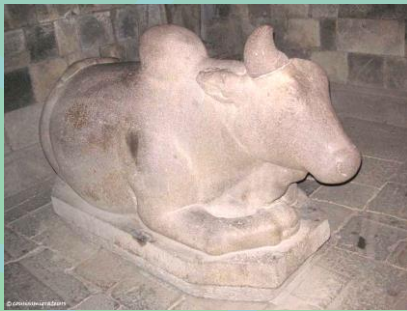
**Indonesian
Ongole zebu**



Bali cattle

Marleen Felius

- Indian zebu brought by Singalese immigrants, 1500 years ago?

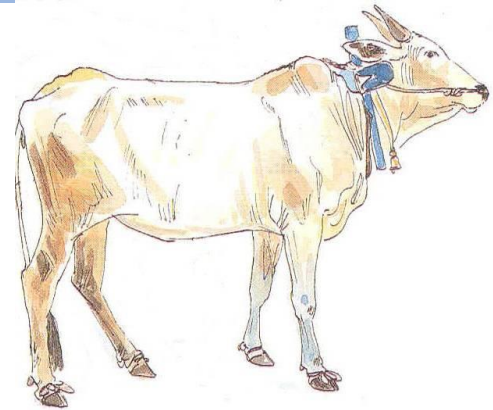


Bull *Nandi*, Prambanan, ~850 A.D.

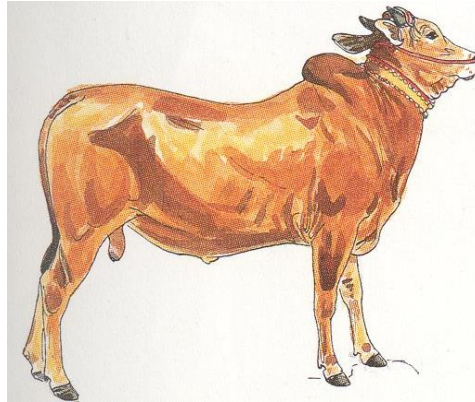
- Ongole imported by Dutch government around 1900

- Domestic banteng
- Earlier than zebu: 3500 BC
- Little difference with wild ancestor; large feral population in North Australia
- Indonesian bulls dark brown, continental bulls as light as females
- Tropical adaptation with normal body size
- Extensive management, highly fertile, deer-like temperament, tender meat

Indonesian cattle breeds



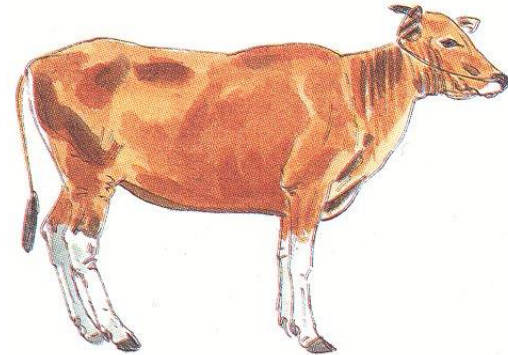
Indonesian
Ongole zebu



Madura zebu
the *Racing Bull*



Galekan, authentic
East-Java cattle



Bali cattle

Marleen Felius

Reputed hybrid breeds

Indonesian cattle breeds



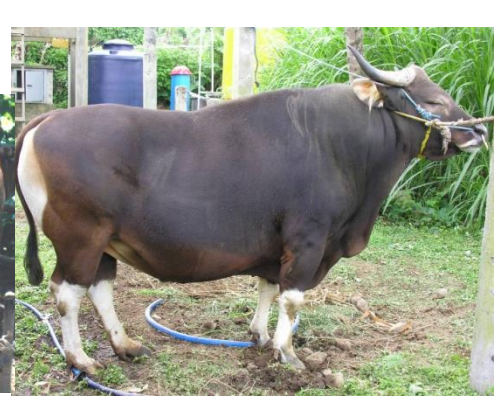
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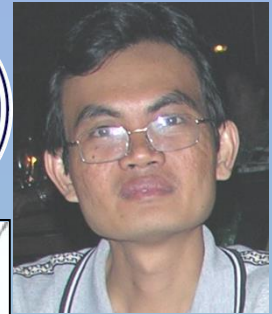
Species composition?

- How pure are the Indonesian zebus?
- How pure is Bali cattle?
- Hybrid breeds?
- species origin: maternal, paternal lineages, autosomes
- unique conservation value?
- agricultural potential?

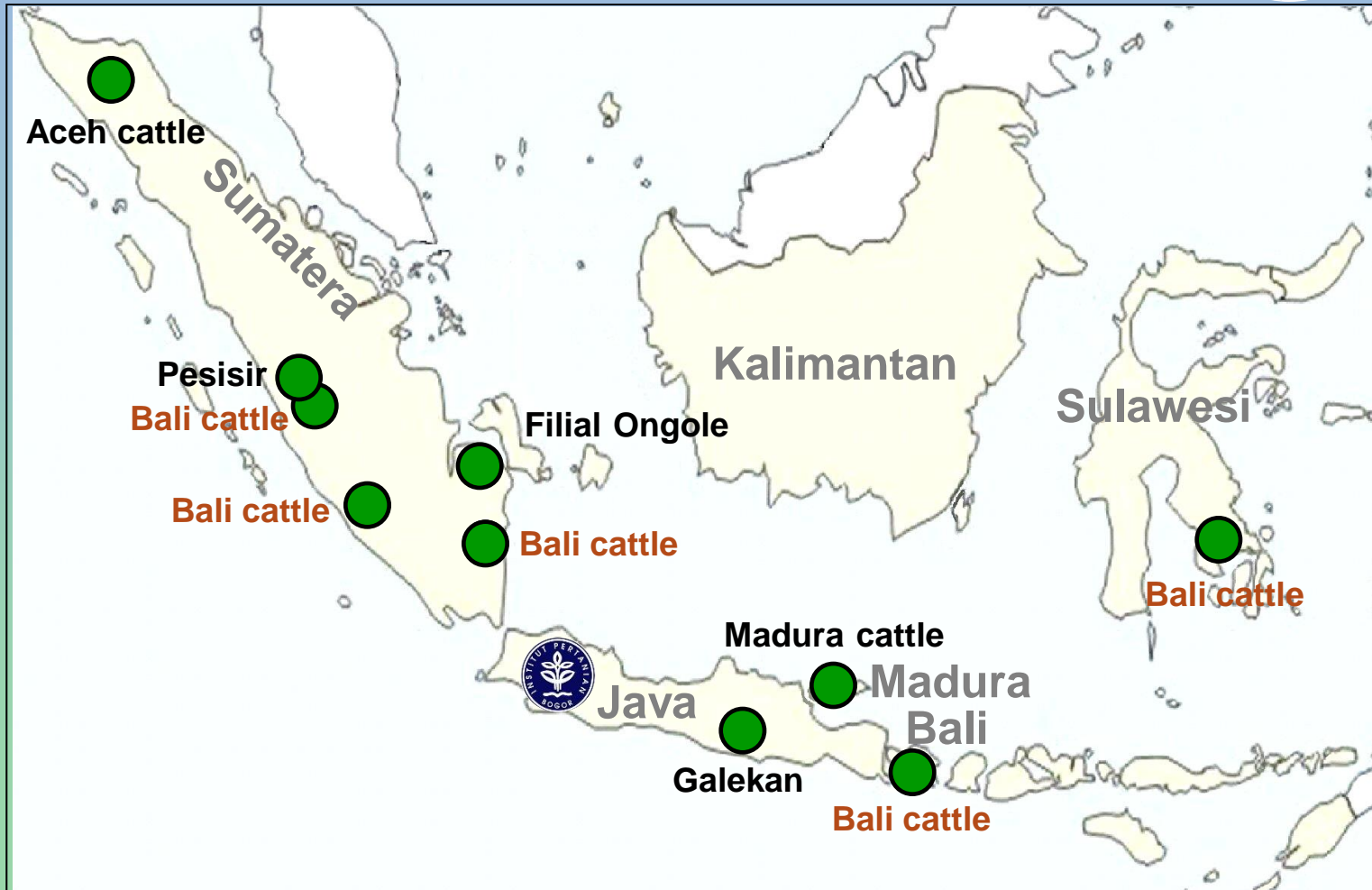
Indonesian cattle breeds: DNA analysis



✓ Sample collection - Bogor



Mohamad
Kusdiantoro



Indonesian cattle breeds: DNA analysis

- ✓ Sample collection - Bogor
- ✓ DNA isolation - Utrecht
- ✓ mtDNA analysis - Utrecht
- ✓ Y-chromosomal analysis- Utrecht
- ✓ microsatellites - Uppsala



Mohamad
Kusdiantoro

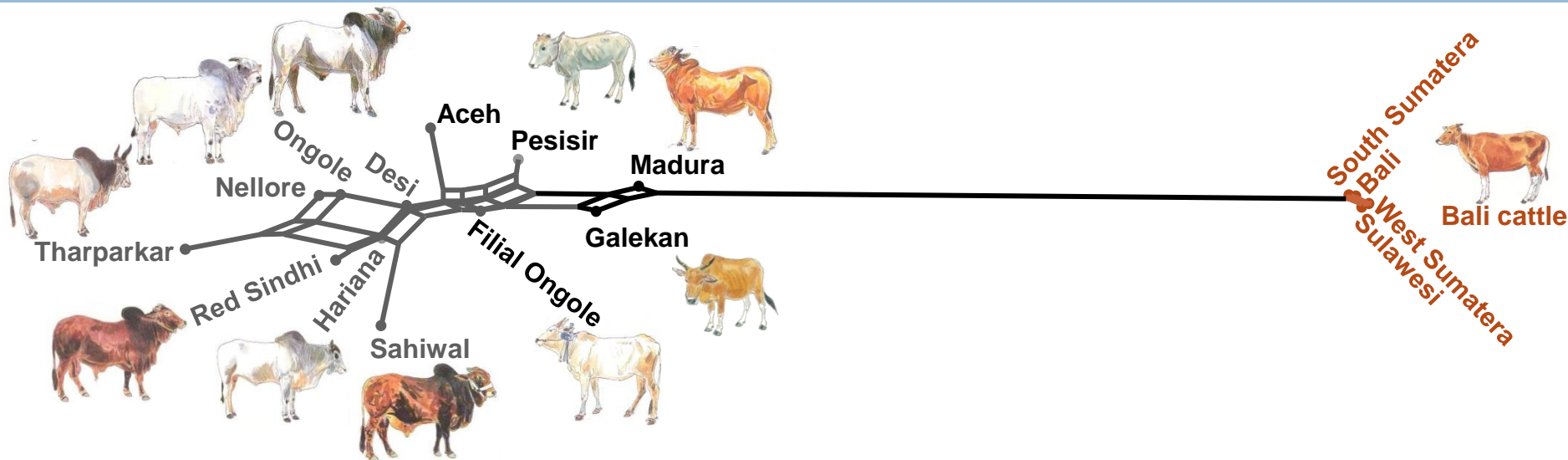


Göran Andersson
Mia Olsson

Indonesian cattle breeds: DNA analysis

microsatellite allele frequencies

» genetic distances of Indonesian breeds » network



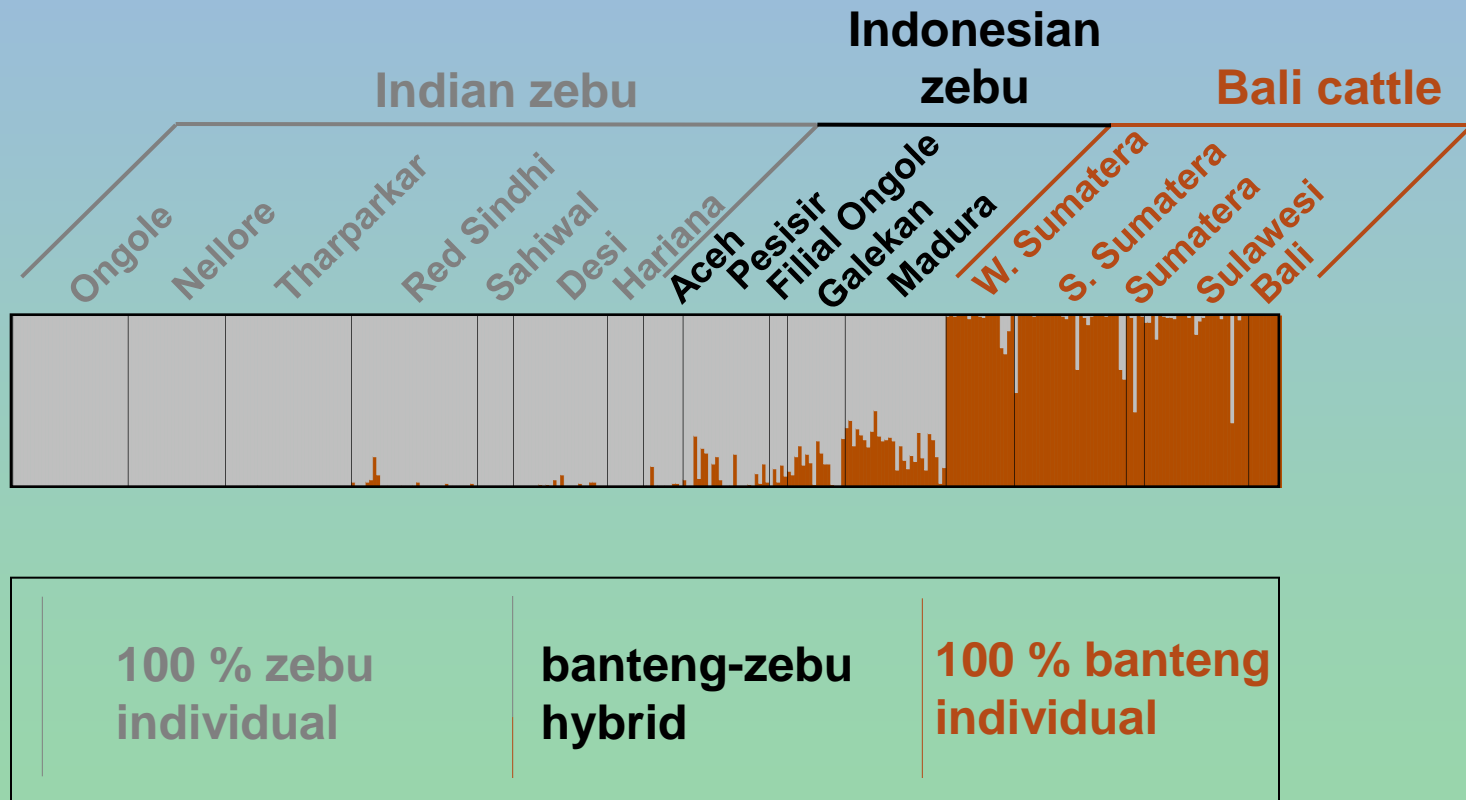
Indian zebu
(data from Dan
Bradley, Dublin)

Indonesian zebu:
intermediate

banteng

Indonesian cattle breeds: DNA analysis

microsatellite data > *Structure* program >
banteng/zebu ratios of individual animals



Indonesian cattle breeds

zebu-banteng ratios



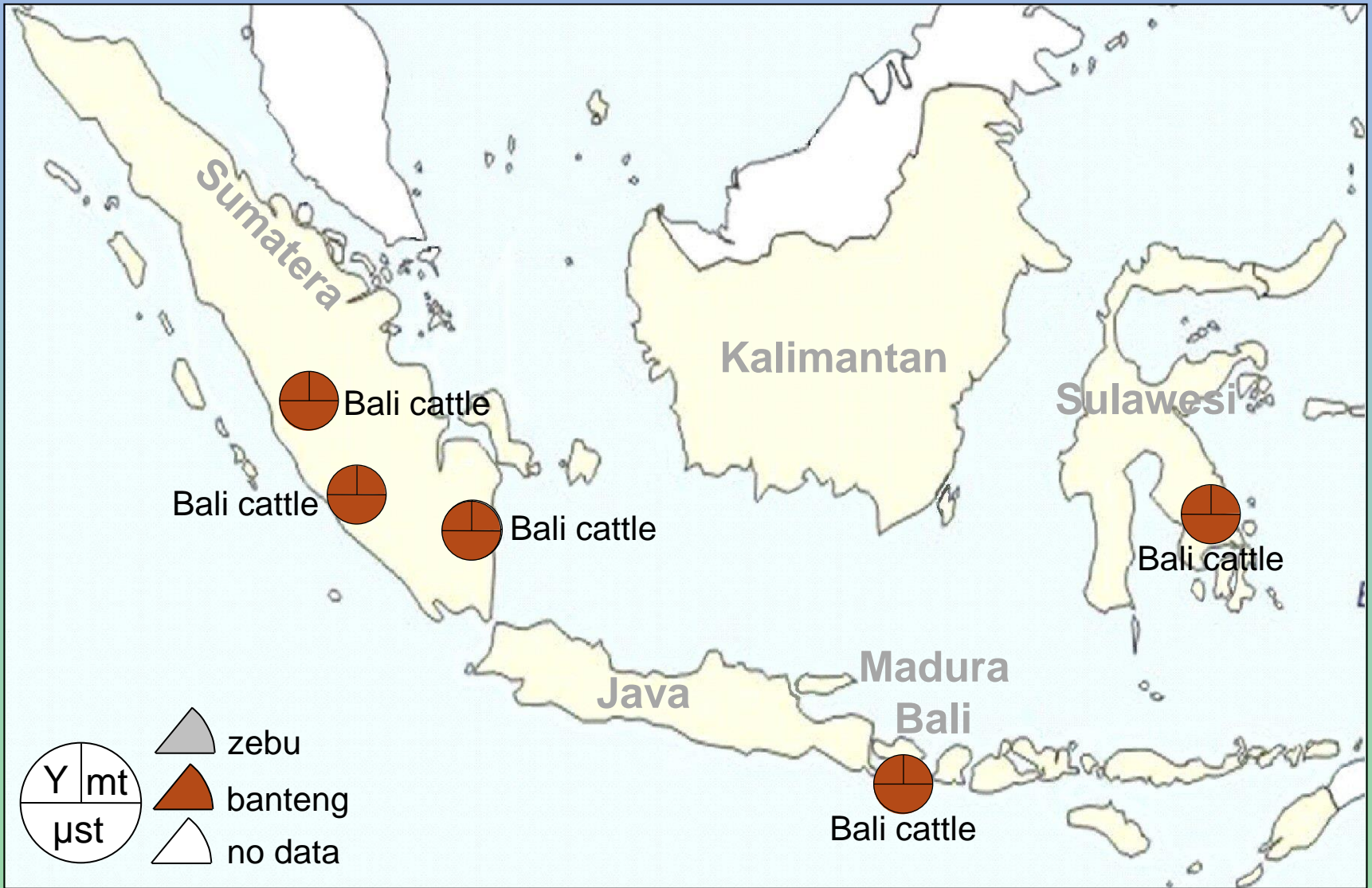
Indonesian cattle breeds

zebu-banteng ratios / mt: maternal origin / Y: paternal origin



Indonesian cattle breeds

zebu-banteng ratios / mt: maternal origin / Y: paternal origin



Indonesian cattle breeds

zebu-banteng ratios / mt: maternal origin / Y: paternal origin



Indonesian cattle breeds

zebu-banteng ratios / mt: maternal origin / Y: paternal origin



Indonesian cattle breeds

zebu-banteng ratios / mt: maternal origin / Y: paternal origin



Indonesian
Ongole zebu

Madura zebu
the *racing bull*

Galekan, authentic
East-Java cattle

Bali cattle
domestic banteng

- **Bali cattle** populations still purely banteng
- **Zebu** bulls descend from Indian zebu bulls; most zebu cows descend from Indian zebu cows, but clear banteng introgression
- **Galekan** and ~half of **Madura** cattle descend from zebu bull × banteng cow crosses: **javindicine hybrid breeds**
- **Valuable genetic uniqueness of Indonesian cattle**

Indonesian cattle breeds

zebu-banteng ratios / mt: maternal origin / Y: paternal origin



Indonesian
Ongole zebu

Madura zebu
the *racing bull*

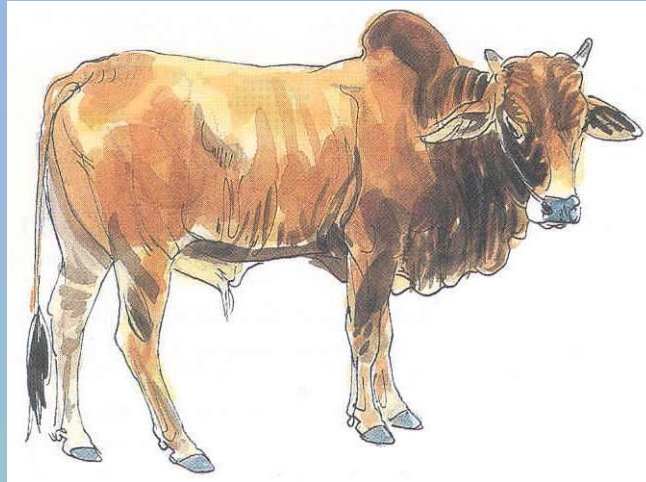
Galekan, authentic
East-Java cattle

Bali cattle
domestic banteng

➤ Banteng component possibly of wider interest

- ✓ sustainable agriculture under **tropical conditions**:
alternative for zebu
- ✓ high **fertility**
- ✓ survives on **low-quality fodder**
- ✓ excellent tender **meat**

Thai cattle: more than taurine and zebu



- **Local breed**
- **Banteng influence supposed**
- **Not yet investigated**
- **Sampling the most difficult part**

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2. On the origin of Indonesian and Thai cattle zebu and/or banteng
3. On the origin of Chinese cattle zebu, gayal, banteng



Chinese cattle: more than taurine and zebu



Gayal (*Bos frontalis*)

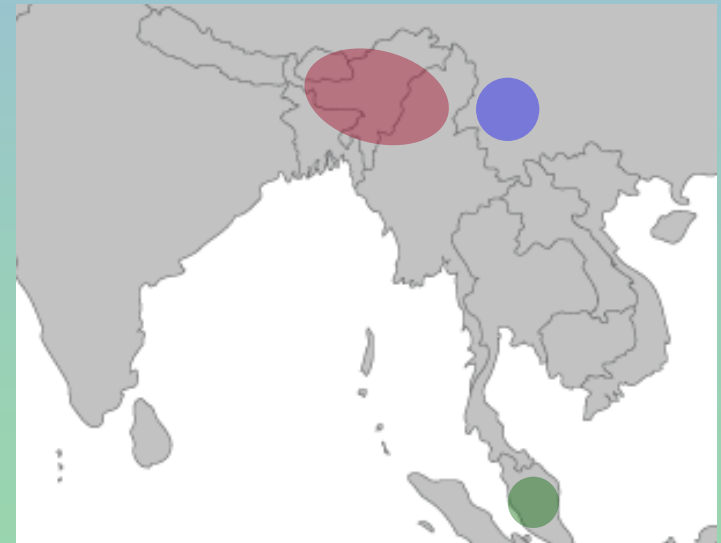


Gaur (*Bos gaurus*)



Selembu (zebu × gayal)

- Domestic form of **gaur**
- In **East India** and **Northern Myanmar**
- Kept for status and ceremonial slaughter
- In **Malaysia**, terminal cross with zebu: highly productive dairy and beef **selembu**
- **Yunnan** gayal in China:
zebu and taurine mtDNA (Gou *et al.*, 2010, JABG 127, 154-160)
» bred by incrossing by gayal bulls: why??

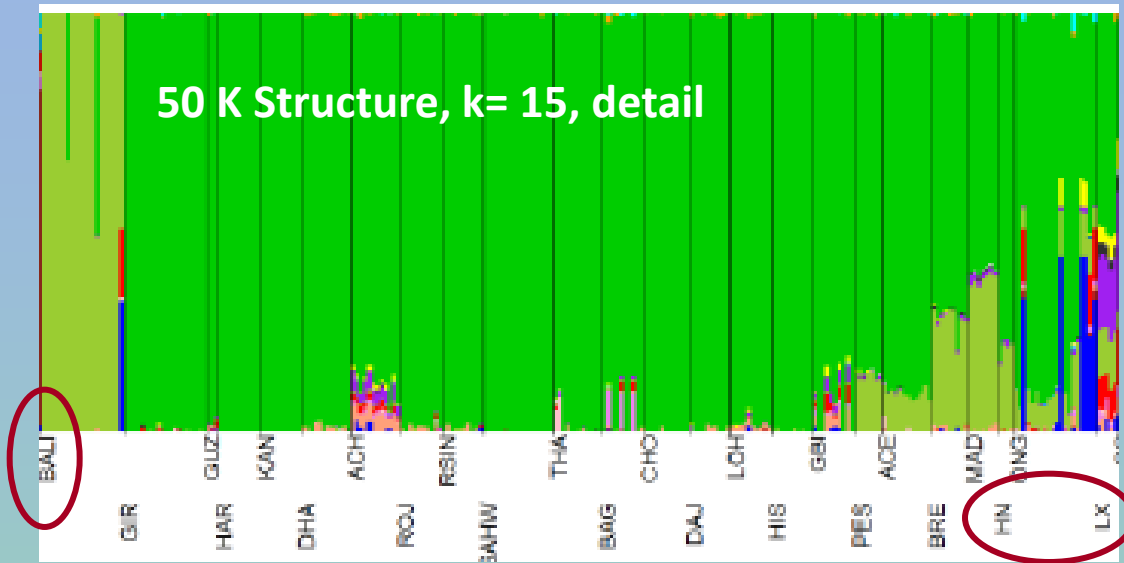


Chinese cattle: more than taurine and zebu

- Yellow cattle = all taurine and zebu cattle
- **North** China: taurine autosomes
mtDNA, Y-chromosomes
- **South** China: zebu autosomes
mtDNA, Y-chromosomes
- North-south **cline** with all possible
intermediate taurindicice combinations
- Decker et al., 2014, PNAS, 50K SNP:
*Indonesian Pesisir and Aceh and the Chinese Hainan and
Luxi breeds also have **Bali ancestry***



Chinese cattle: more than taurine and zebu



- Decker et al., 2014, PLoS Genetics, e1004254, 50K SNP: *Indonesian Pesisir and Aceh and the Chinese Hainan and Luxi breeds also have Bali ancestry [banteng ancestry]*
- **Gayal** instead of banteng not at all yet excluded
- Random introgression of specific genes conferring adaptation?

Cattle: more than taurine and zebu

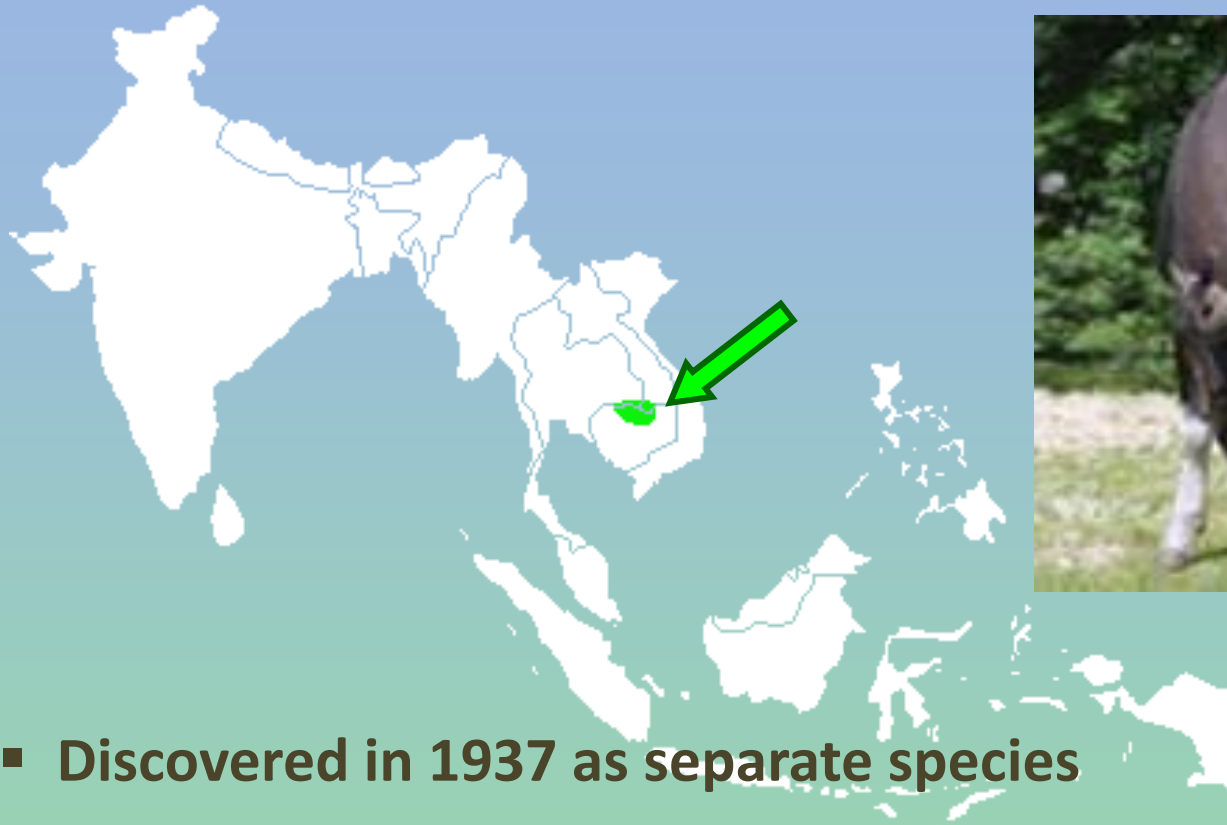
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kouprey



The mysterious Cambodian kouprey



- Discovered in 1937 as separate species
- Not been observed since 1988
- Hunting expeditions without success



Kouprey: species status debated

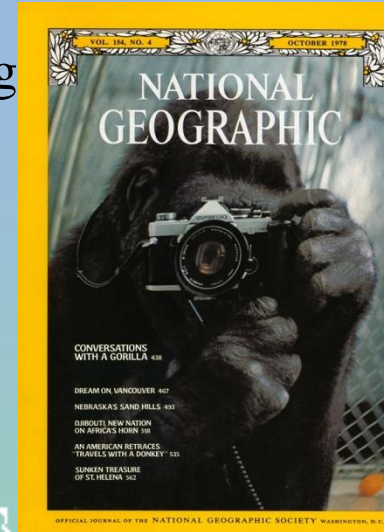
- **Mitochondrial DNA: similar to continental banteng**
» proposed to be a **zebu-banteng hybrid**

Galbreath, Mordacq & Weiler, 2006. Genetically solving a zoological mystery: was the kouprey a feral hybrid?

Implication: do not conserve!

- **Debate in National Geographics**

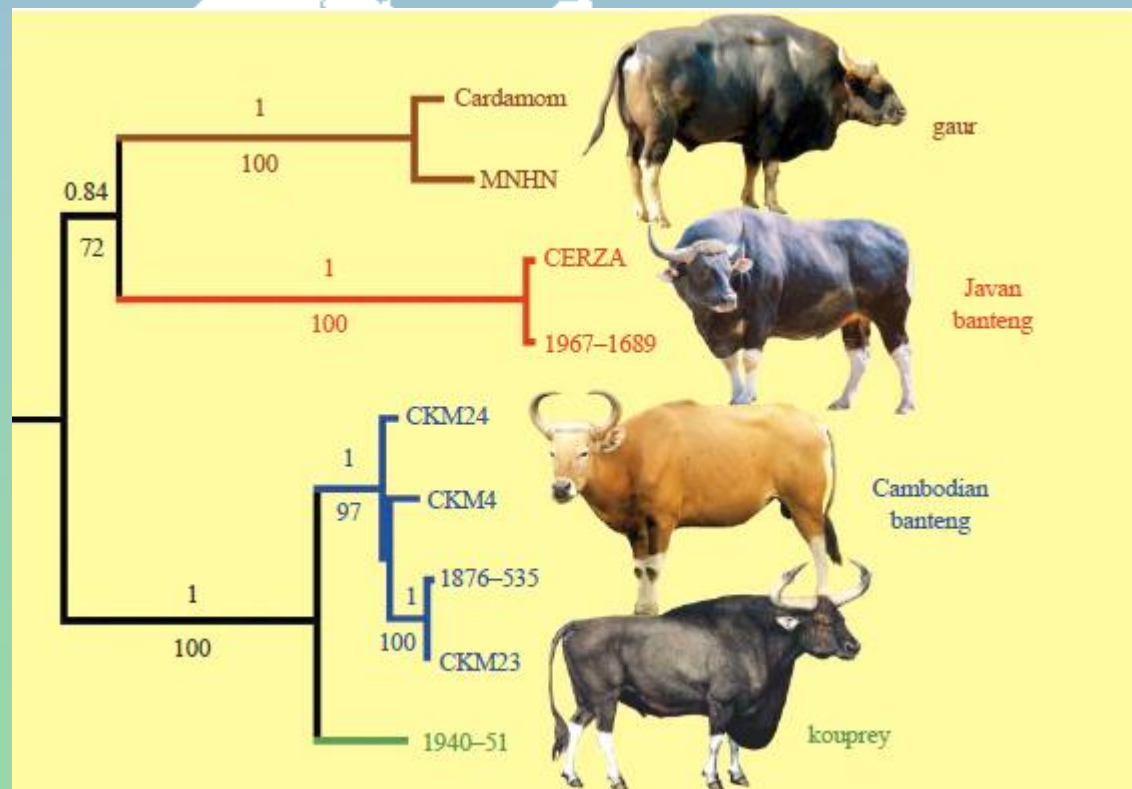
"There are several other scenarios that would explain their finding equally well," said **Hans Lenstra**, associate professor of genetics at **Utrecht University** in the Netherlands. "If the kouprey is of mixed-species origin, hybridization with domestic zebus is just one of the possibilities. Maybe, maybe not." "No genetic mystery has been solved," Lenstra said. "For this, additional research would be required, such as a comparison of paternally transmitted Y-chromosomal sequences of kouprey with those of banteng and zebu."



Kouprey: species status debated

- Distinct nuclear genes and mtDNA; Pleistocene maternal introgression of kouprey -> continental banteng
 - » **kouprey** again a **separate species**

Hassanin & Ropiquet, 2007. Resolving a zoological mystery: the kouprey is a real species



Kouprey: species status debated

- **Museum specimen from 1871 has kouprey DNA, but looks like domestic cattle**

Hassanin, Ropiquet, Cornette, Tranier, Pfeffer, Candegabe & Lemaire (2006) Has the kouprey been domesticated in Cambodia?



Kouprey from Vincennes Zoo, † 1940



Bourges museum, France

- **Reports on the use of semi-feral oxes in rice**
- **Main problem: sampling**
- **If substantial random kouprey introgression: de-extinction by selective breeding for kouprey genes??**

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If useful in Asia, why not elsewhere?

- **extensive management as beef cattle**
- **incrossing and selection**
(*cf.* taurindicine breeds)
- **terminal crossing**
(newest trend in industrial agriculture, heterosis)

