

Origin of native Danish cattle breeds

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Maintain animal genetic resources

- Characterize native Danish cattle breeds using molecular data
- Basis for future sustainable breed management

Native Danish cattle breeds

- Red Danish Dairy cattle (cRDM),
anno 1970
- Jutland cattle (JYS)
- Black-and-White Danish Dairy cattle (SDM),
anno 1965
- Danish Shorthorn (SHO)
- Agersø cattle



Red Danish Dairy Cattle

- Traditional Danish
- Origin in 19th century
- Native Danish cattle crossed with Schleswig cattle
 - Angler
 - Ballum (extinct)
 - North Schleswig cattle (extinct)
- Traditionally dual-purpose
- 1950 ~1 million animals

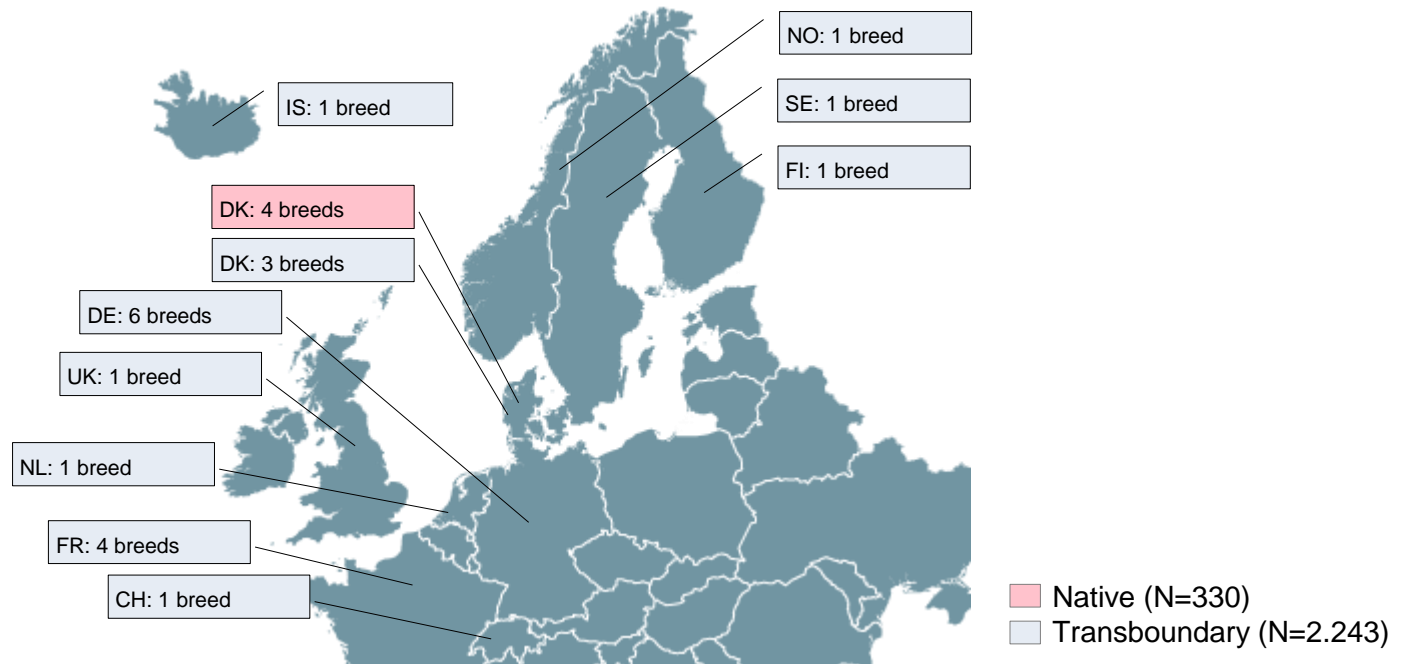


Red Danish Conservation Breed

- Since 1970, increased focus on milk production
- Crossbreeding with Brown Swiss, Holstein, and recently Nordic Red led to modern Danish RDC (RDCDNK)
- Tiny remnant population of pure bred cRDM70
~250 animals

Data

- Genotype data (50k)
- Native Danish breeds (tRDM, cRDM70, JYS, SDM, SHO)
- Northern European Reference population (21 breeds)

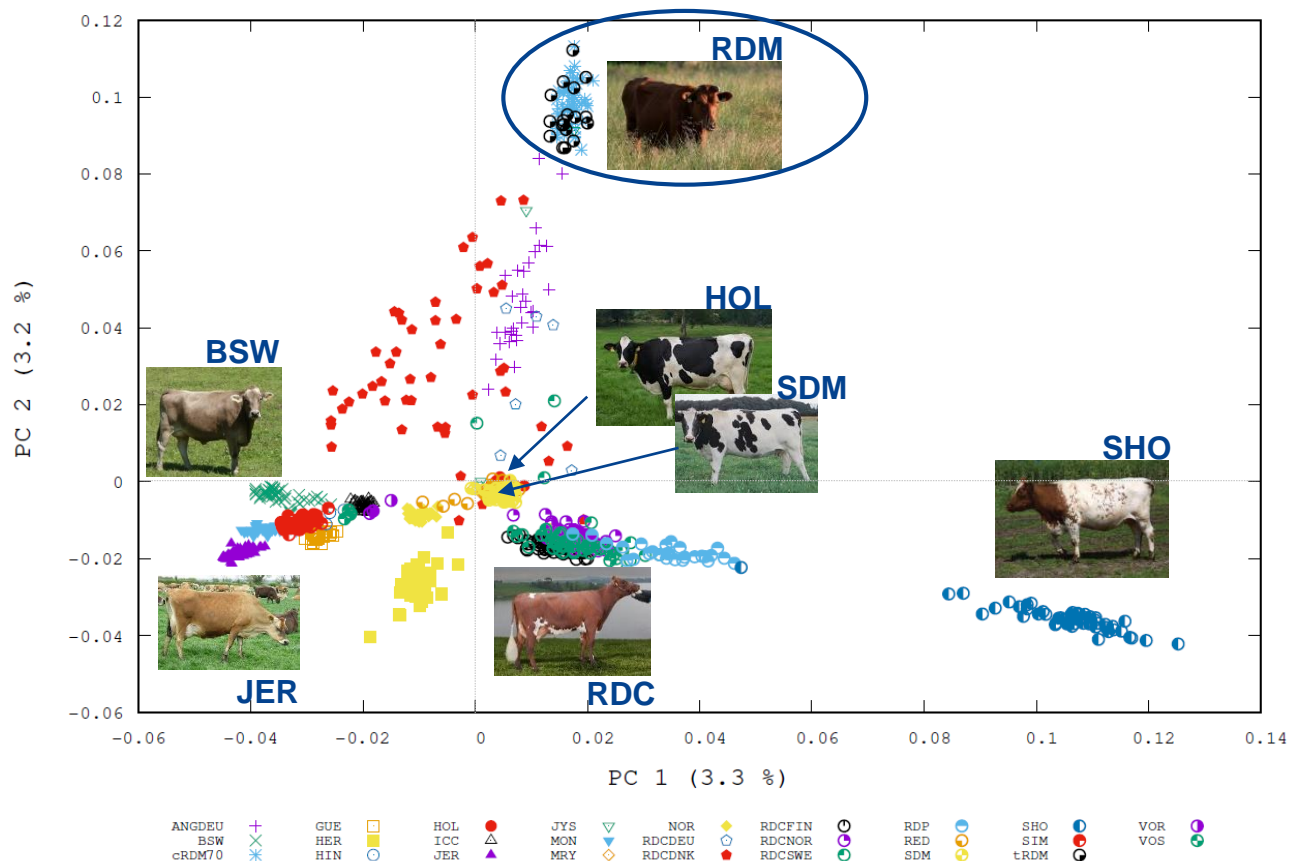


Genomic characterization

- Breed differentiation and admixture
 - PCA
 - ADMIXTURE
- Introgression by TreeMix
- Genomic inbreeding using ROH

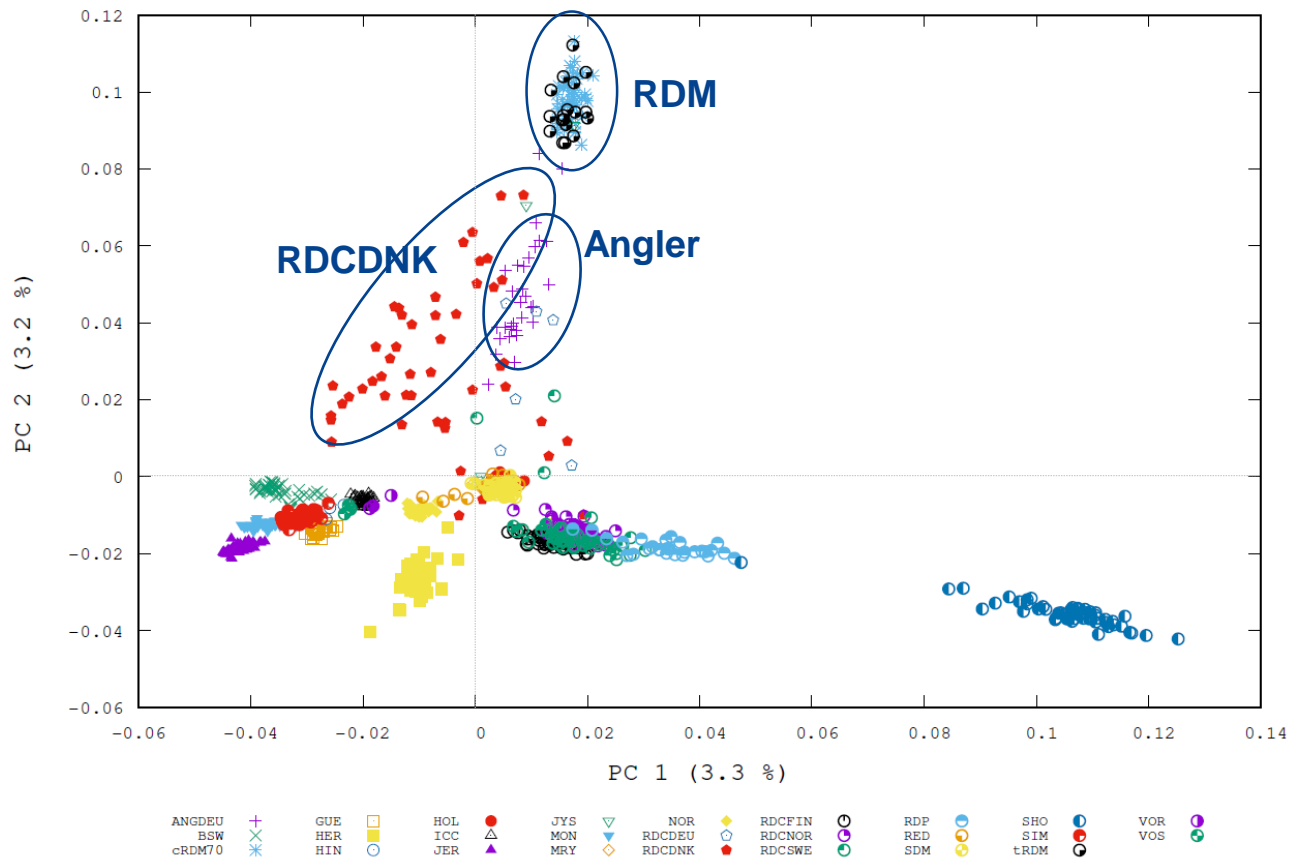
Population structure & breed relationships

Old and consevation Danish Red form a distinct cluster



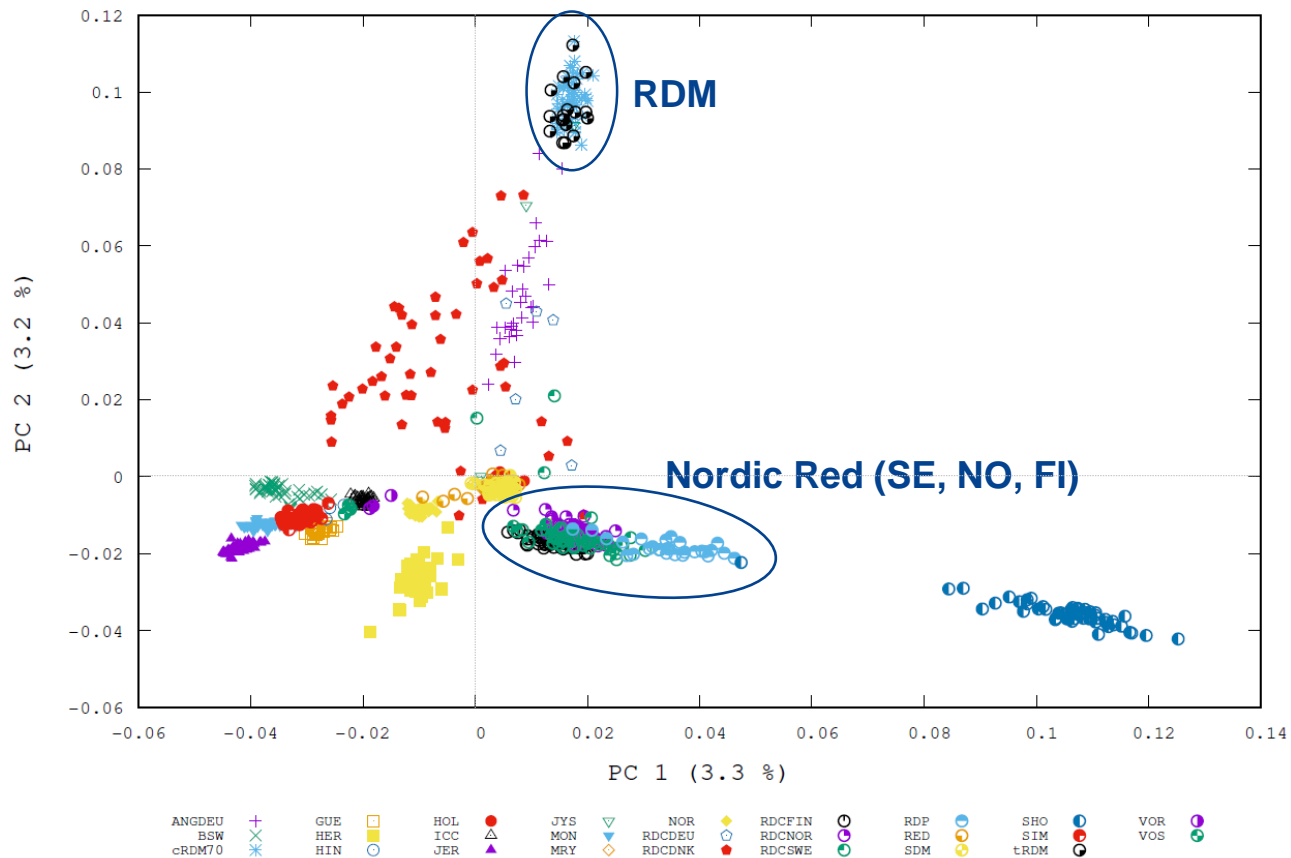
Population structure & breed relationships

Old and conservation Danish Red close to Angler and RDCDNK



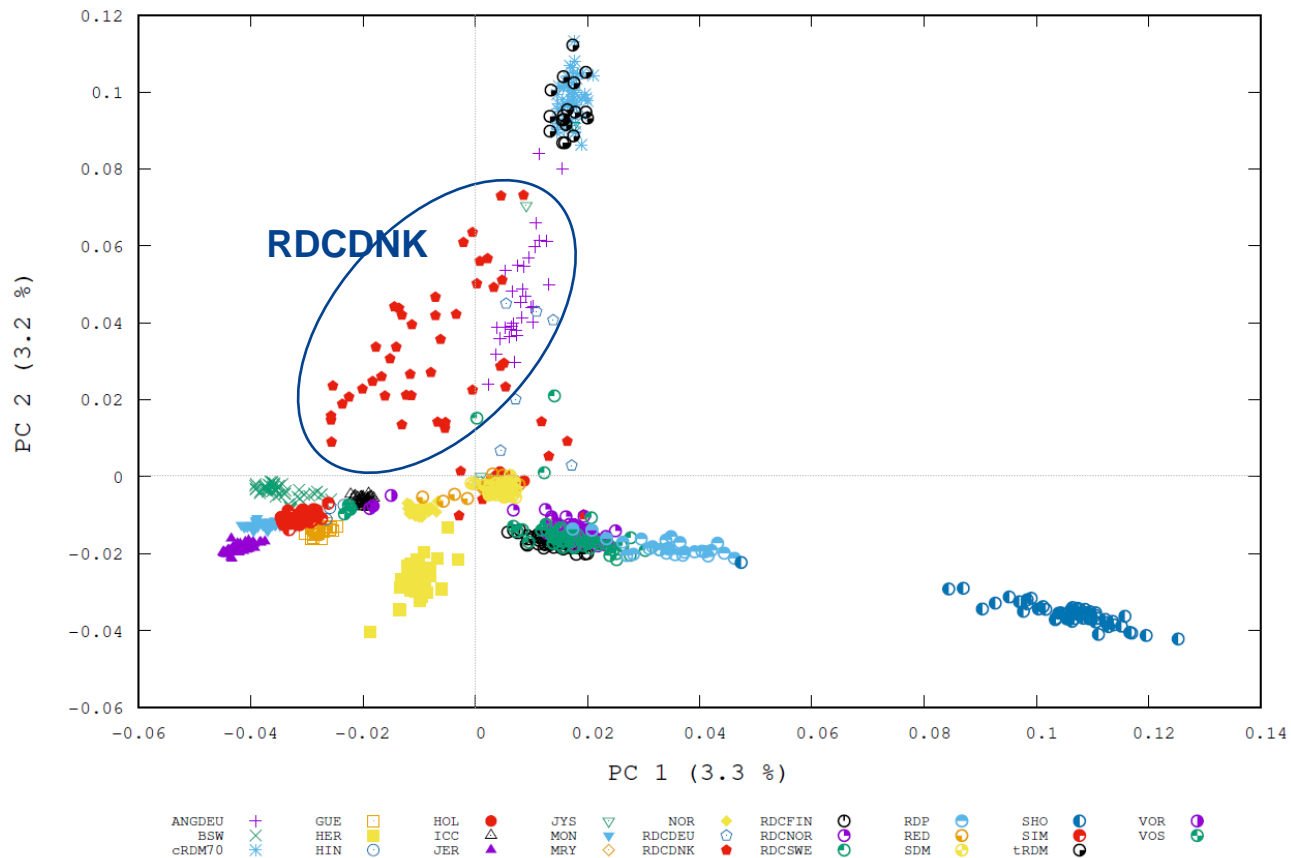
Population structure & breed relationships

Old and conservation differ from modern RDC (SE, NO, FI)

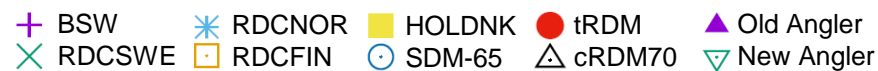
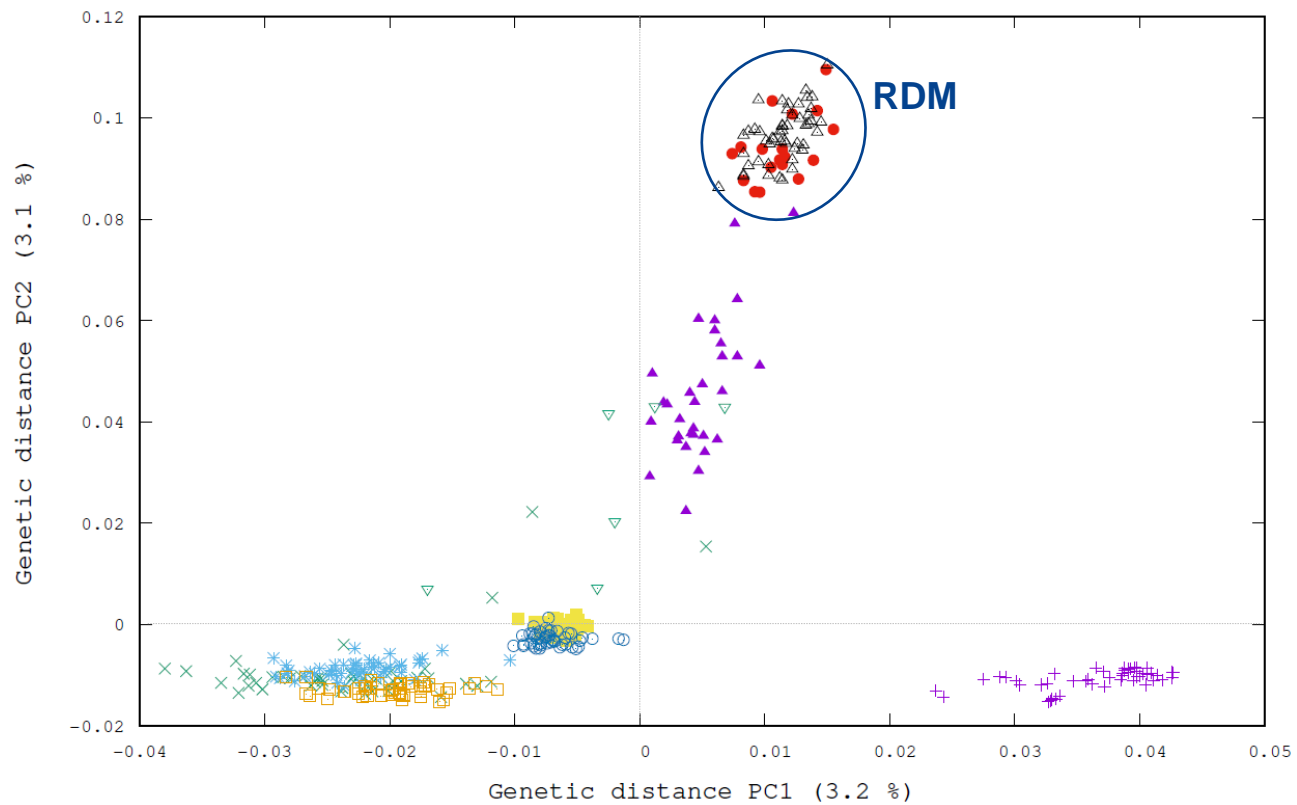


Population structure & breed relationships

Modern Danish Red very diverse

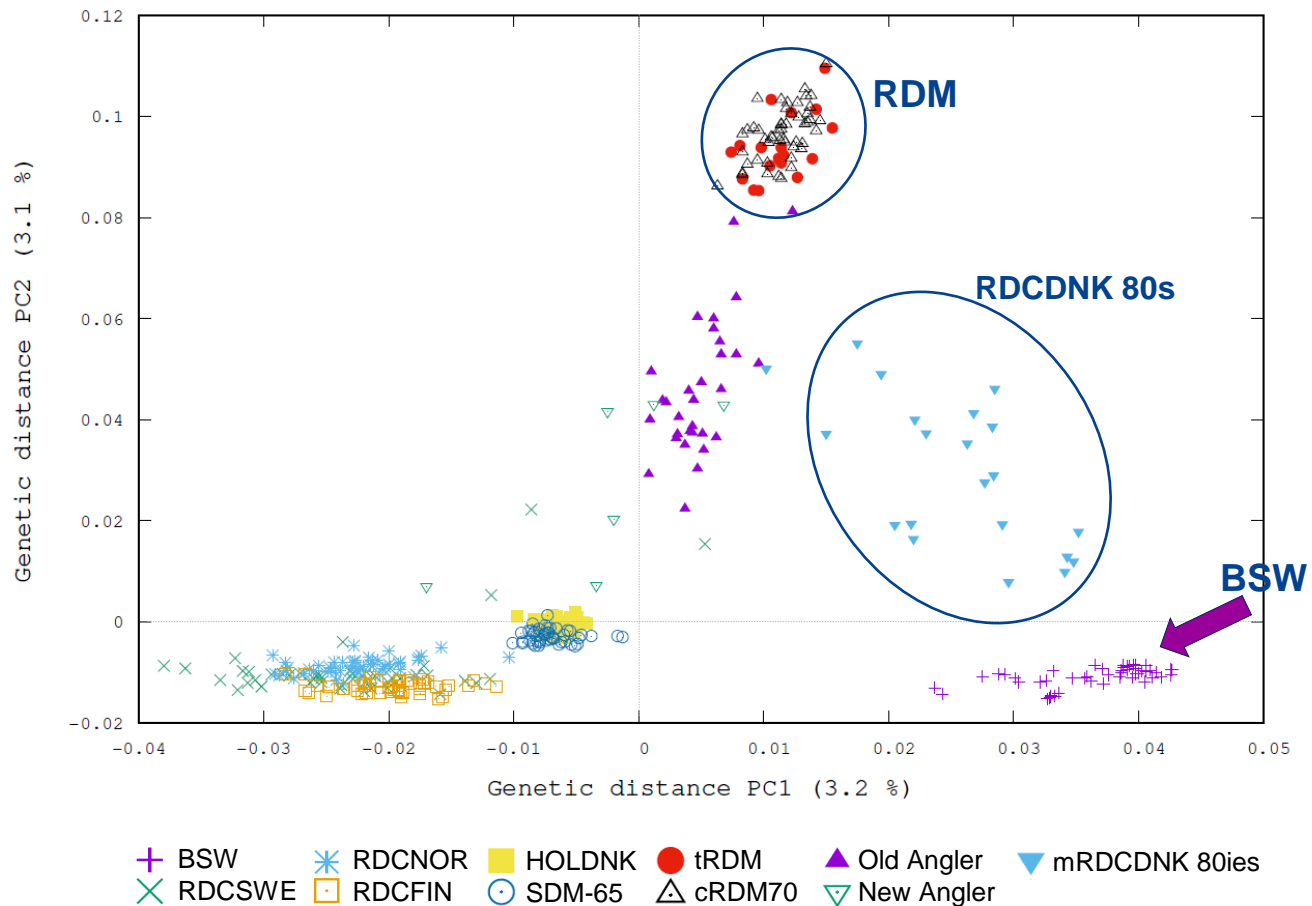


Danish Red prior to 1970



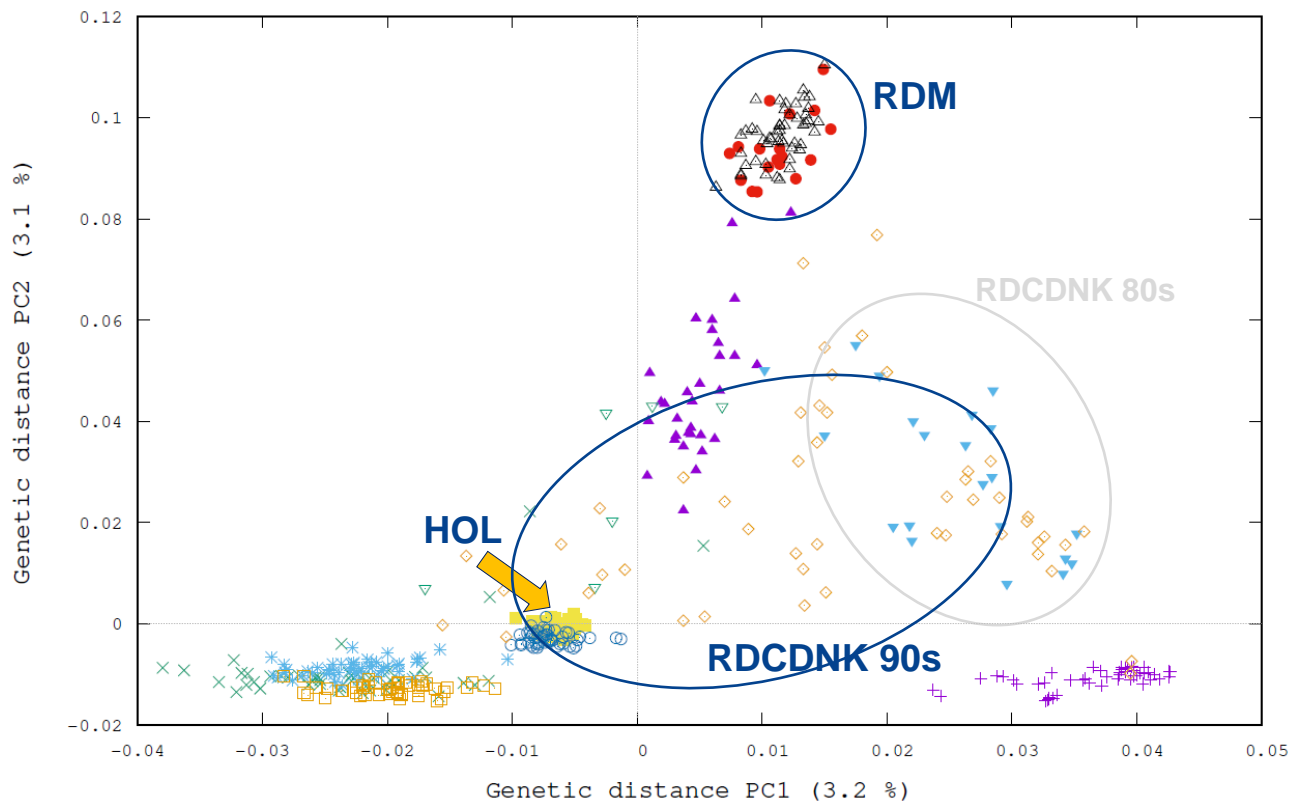
Formation of RDCDNK in the 1980s

Extensive crossing with Brown Swiss



RDCDNK in the 1990s

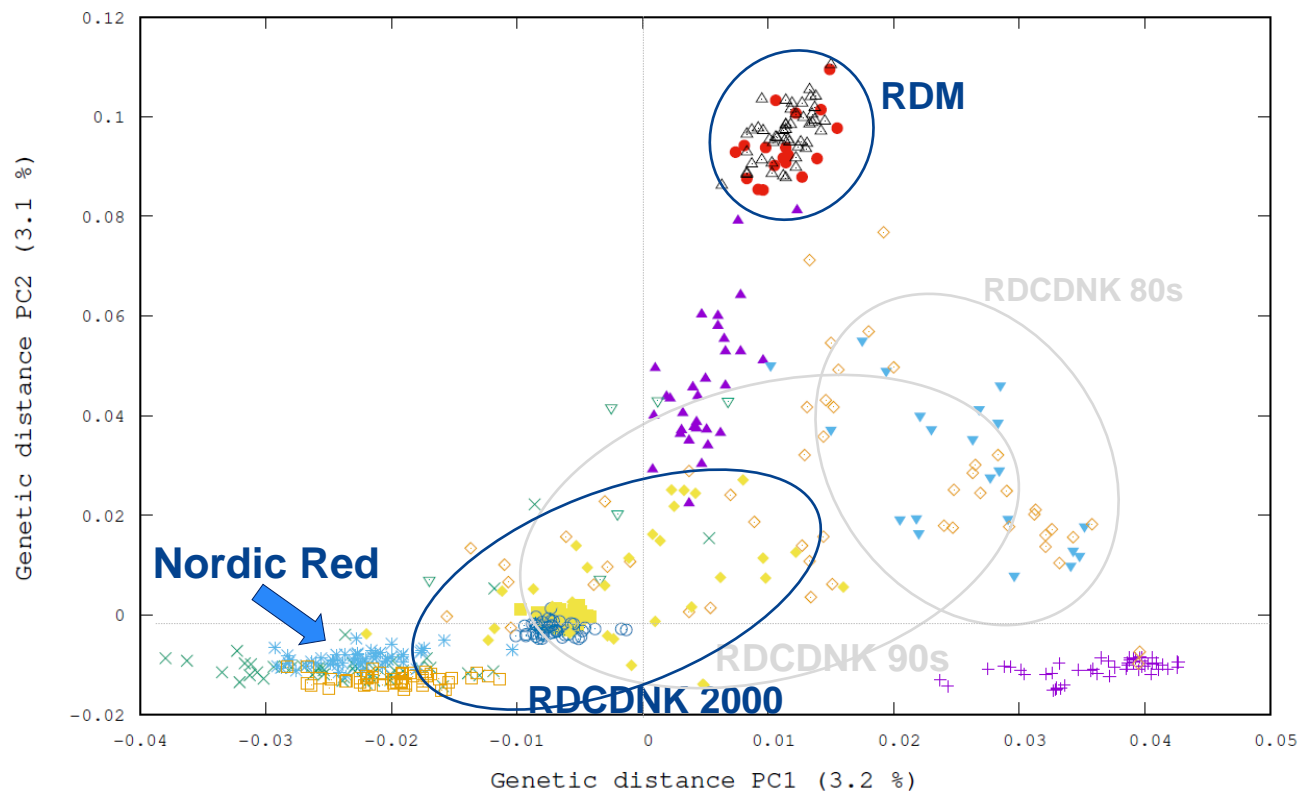
Extensive crossing with Holstein



- + BSW
 * RDCNOR
 HOLDNK
 ● tRDM
 ▲ Old Angler
 ▼ mRDCDNK 80ies
- × RDCSWE
 RDCFIN
 SDM-65
 △ cRDM70
 ▽ New Angler
 mRDCDNK 90ies

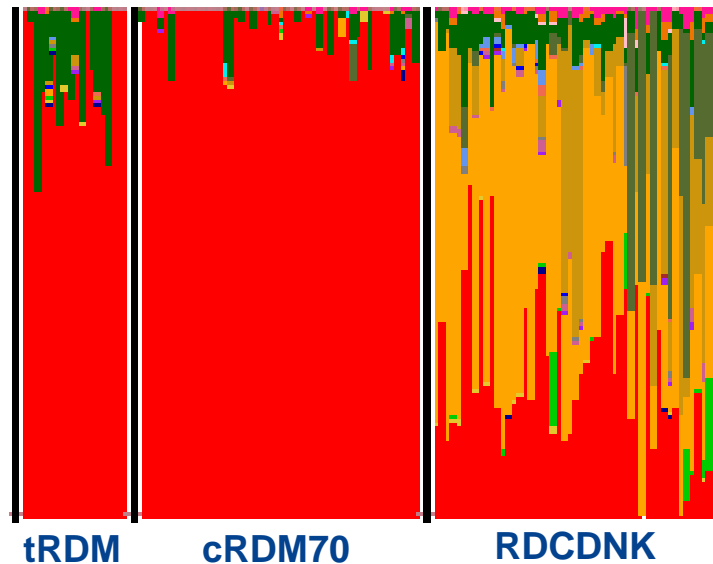
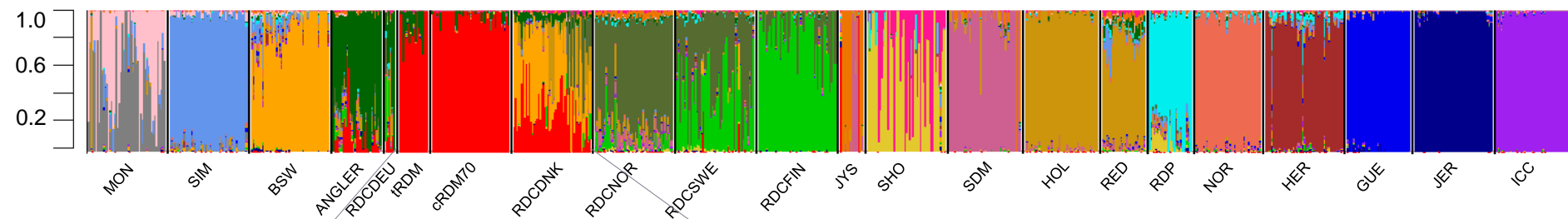
RDCDNK after 2000

Crossing with Swedish and Finnish Red



- + BSW
 * RDCNOR
 ■ HOLDNK
 ● tRDM
 ▲ Old Angler
 ▼ mRDCDNK 80ies
 ◆ mRDCDNK after 2000
- × RDCSWE
 □ RDCFIN
 ○ SDM-65
 △ cRDM70
 ▽ New Angler
 ◇ mRDCDNK 90ies

Patterns of breed admixture



- Heterogeneous breed
- No distinct breed component
- Synthetic breed made up of BSW, RDM, HOL, RDCNOR, RDCFIN

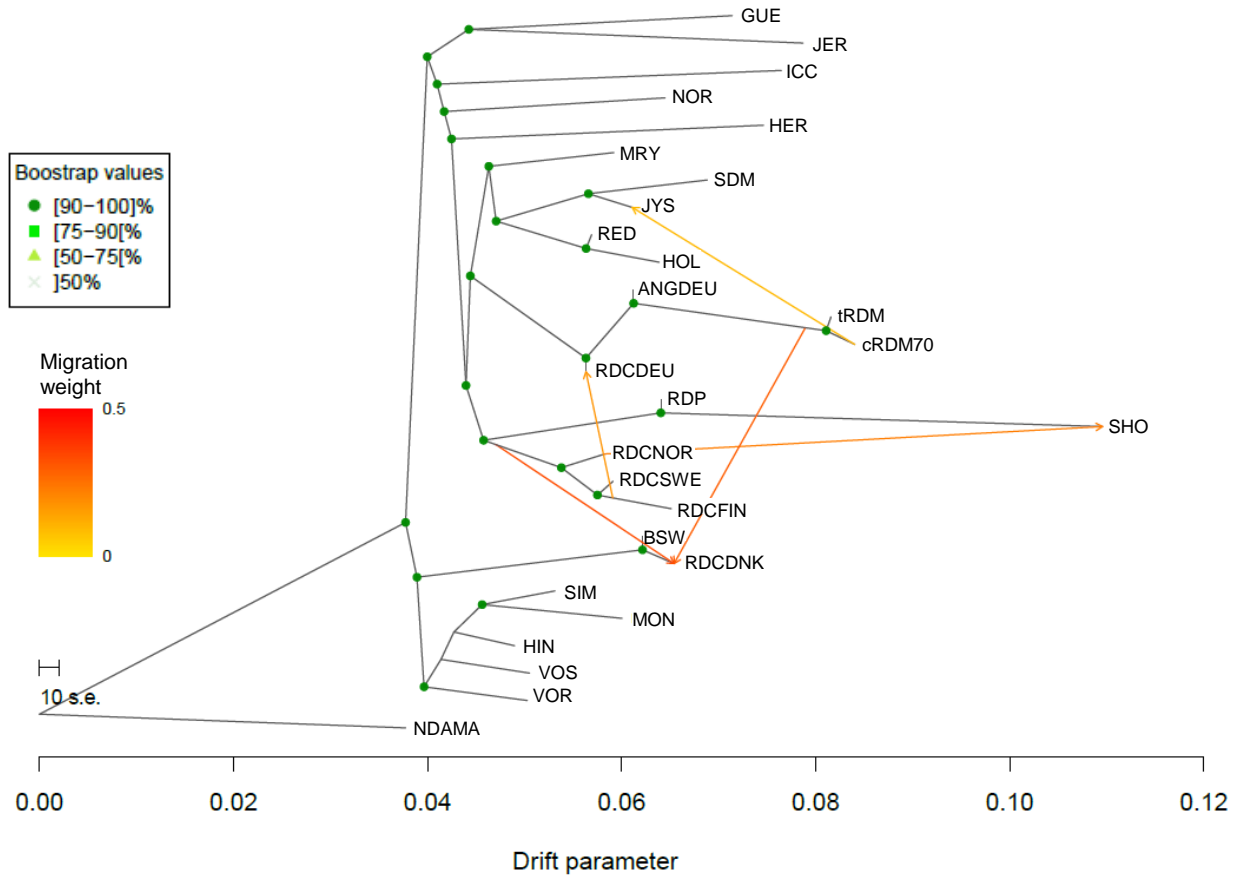
Introgression

- Introgression by TreeMix from allele frequencies
- Reconstructs relationships between populations
- Infers introgression among diverged populations
- Root: N'Dama (*Afr. taurine*)

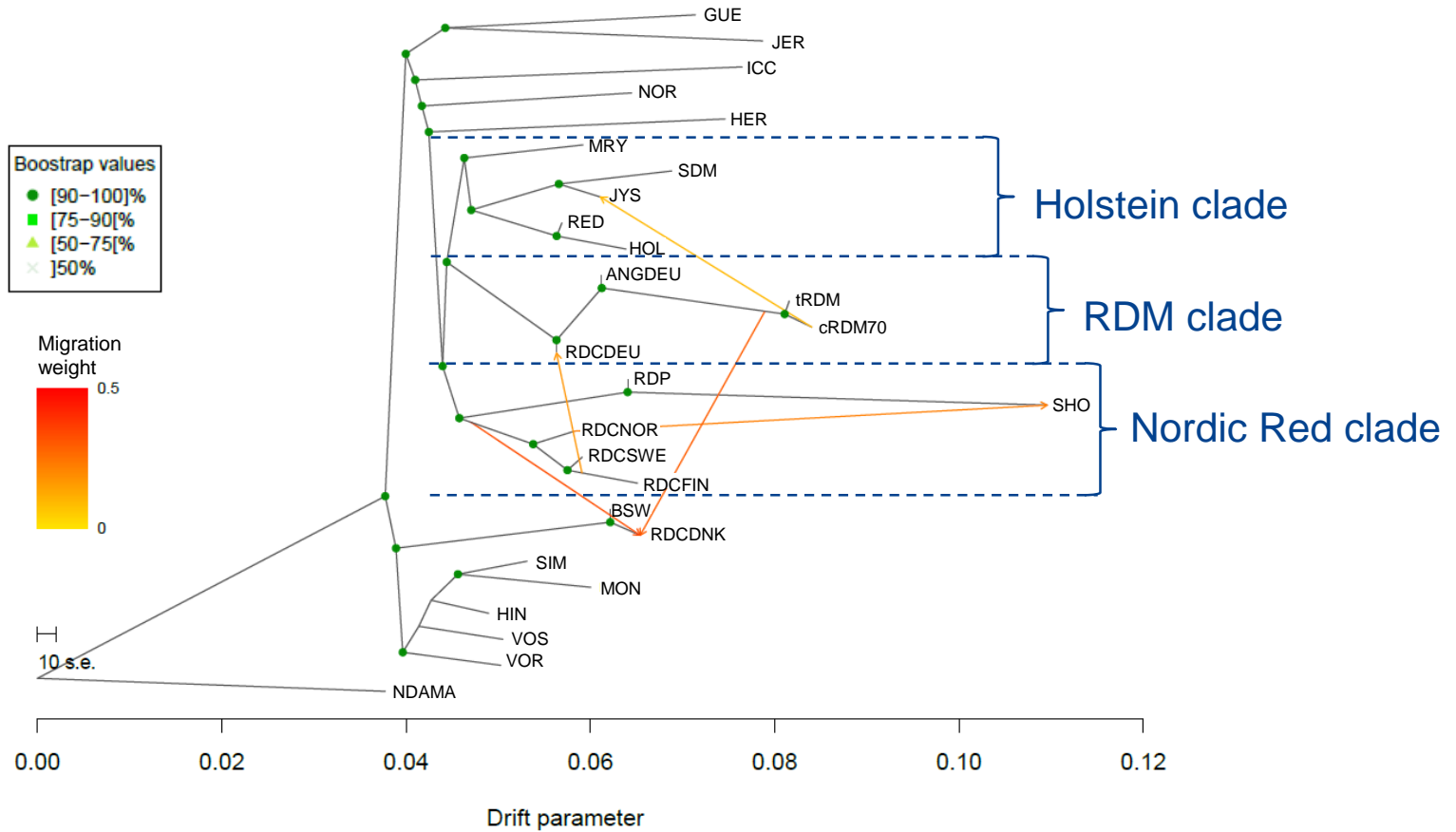


N'Dama: West African *taurine* breed

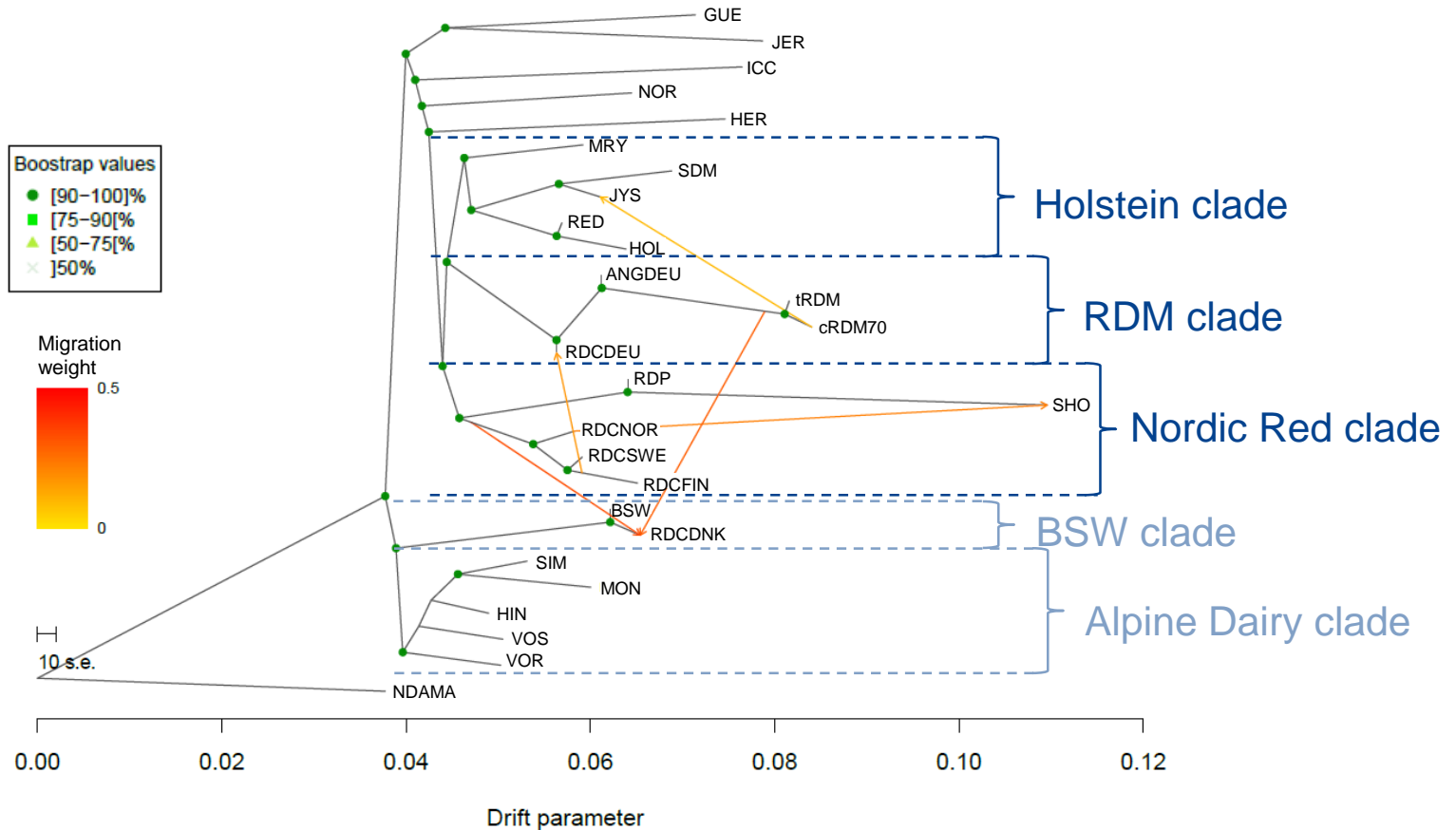
Introgression in Northern European cattle



Introgression in Northern European cattle

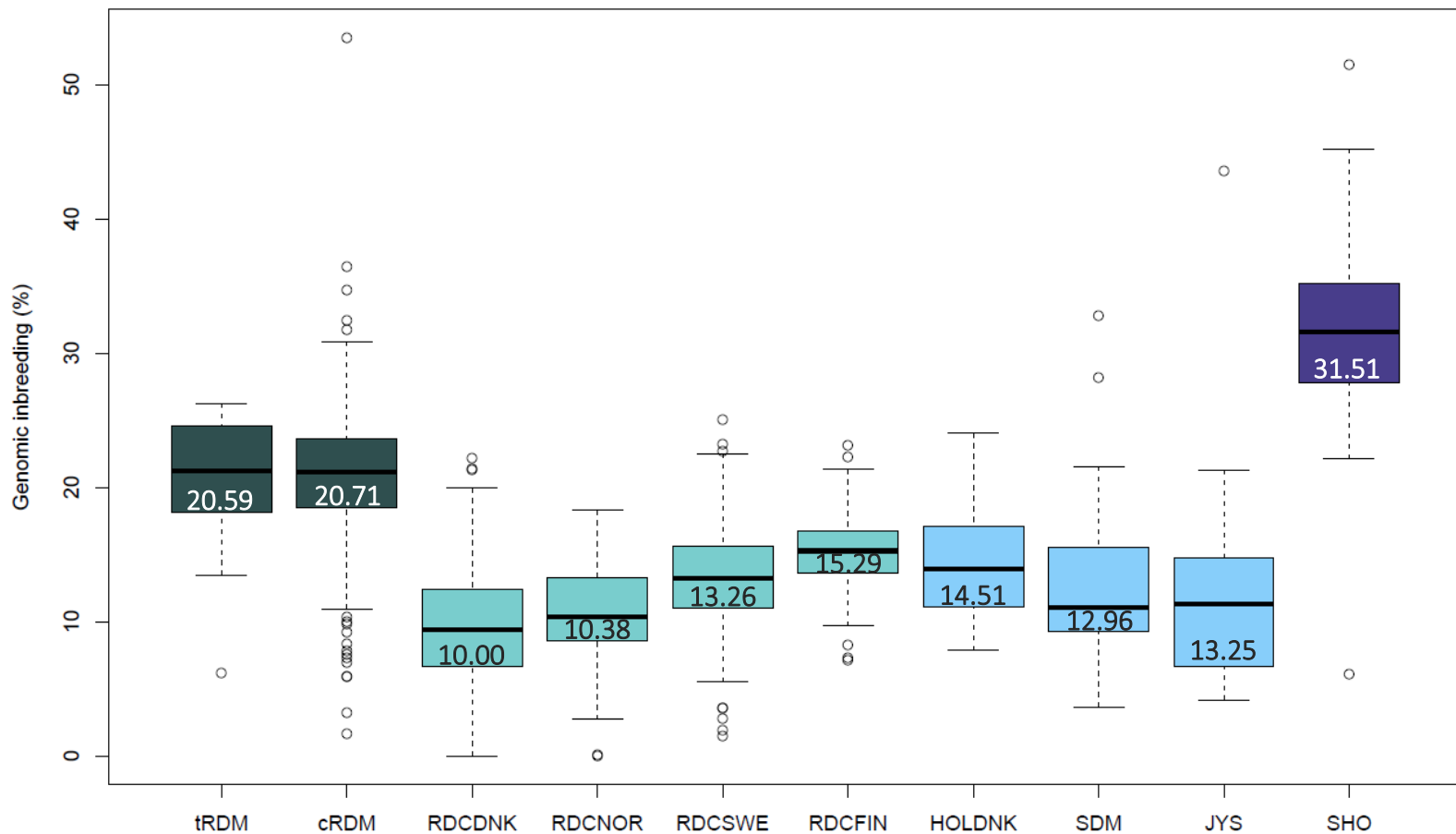


Introgression in Northern European cattle



Complex introgression among Scandinavian breeds

Genomic inbreeding (F_{ROH})



High inbreeding levels in old and consevation Danish Red

Conclusions

- Genebank and living old Danish Red are close
- Old Danish Red related to Angler
- Old Danish Red very different from modern SWE, NOR, FIN Red cattle
- Modern Danish Red is a synthetic breed, admixed with Brown Swiss, Holstein, and Norther Red

Conclusions

- Northern and Central European cattle group into 5 clades plus island breeds
 - Alpine, Brown Swiss, Holstein, Nordic Red, and Danish Red
- Old Danish Red only pure bred representative of its clade but somewhat inbred