Research Institute of
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Fiber characteristics of cashmere goat in Mongolia

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Cashmere goats in Mongolia

- **Mongolia produces up to 40 percent of world raw cashmere annually**
- ~ 27 million (5-fold increase since 1990)
- Mongolian herders largely depend on cashmere goats for their livelihoods
- Escalated growth in goat population poses environmental challenges
- Evaluate current production and biological resources to improve efficiency
- 11 registered breeds and lines
- **Study aims to define fiber characteristics of cashmere goats in Mongolia**

Aims of this study

- Analyze phenotypic diversity of 14 populations:

Body weight and cashmere traits

- Perform GWAS on body weight, cashmere quality traits

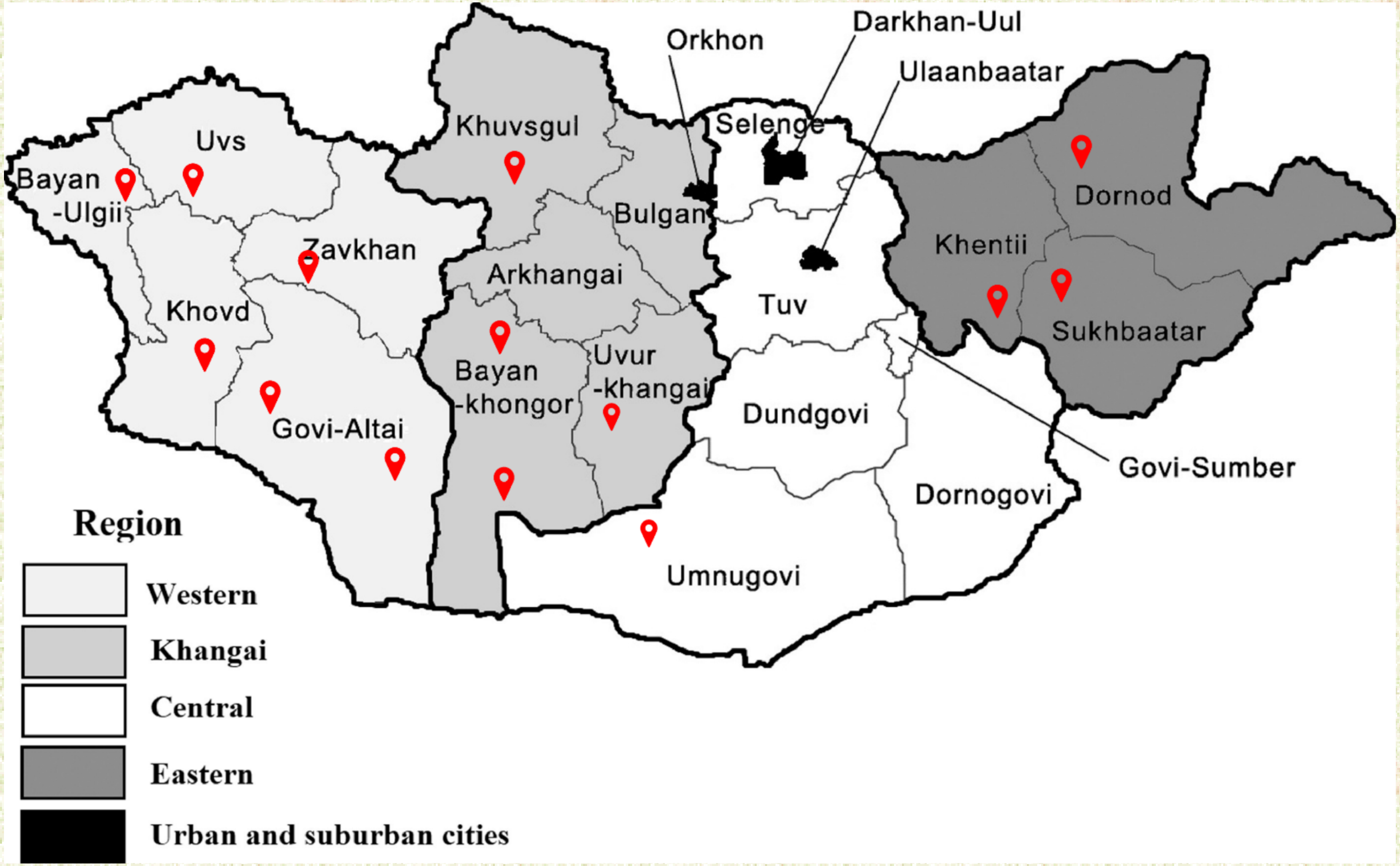
and coat color

- In the framework of IAEA Project MON5025

“Improving breed characterization of cashmere goats to

facilitate the establishment of the strategic breeding program’

Locations of sample populations



Materials

	Population name	Population abbrevation	Region	N_P	N_G	N_M
1	Alai Ulaan	ATU	West	190	98	25
2	Khuvchiin Ulaan	KHU	West	122	99	54
3	Mungun Sort Khar	MSK	West	90	78	-
4	Ulgiin Ulaan	ULU	West	167	97	39
5	Zavkhan Buural	ZBL	West	108	98	60
6	Bumbugur Ulaan	BUU	Khangai	172	96	41
7	Erchim Khar	ERK	Khangai	153	95	14
8	Teeliin Ulaan	TEU	Khangai	164	70	42
9	Zalaa Jinst Edren	ZJE	Khangai	193	83	66
10	Bayandelger Ulaan	BDU	East	176	73	56
11	Galshar Ulaan	GLU	East	289	99	47
12	Tsagaan Ovoo Khar	TSK	East	157	93	72
13	Govi Gurvan Saikhan	GGS	Outliers	145	98	21
14	Uuliin Bor	UBR	Outliers	130	79	-
	Overall			**2256**	**1256**	**537**

Methods

- Phenotypic diversity

- Genetic structure, diversity & differentiation

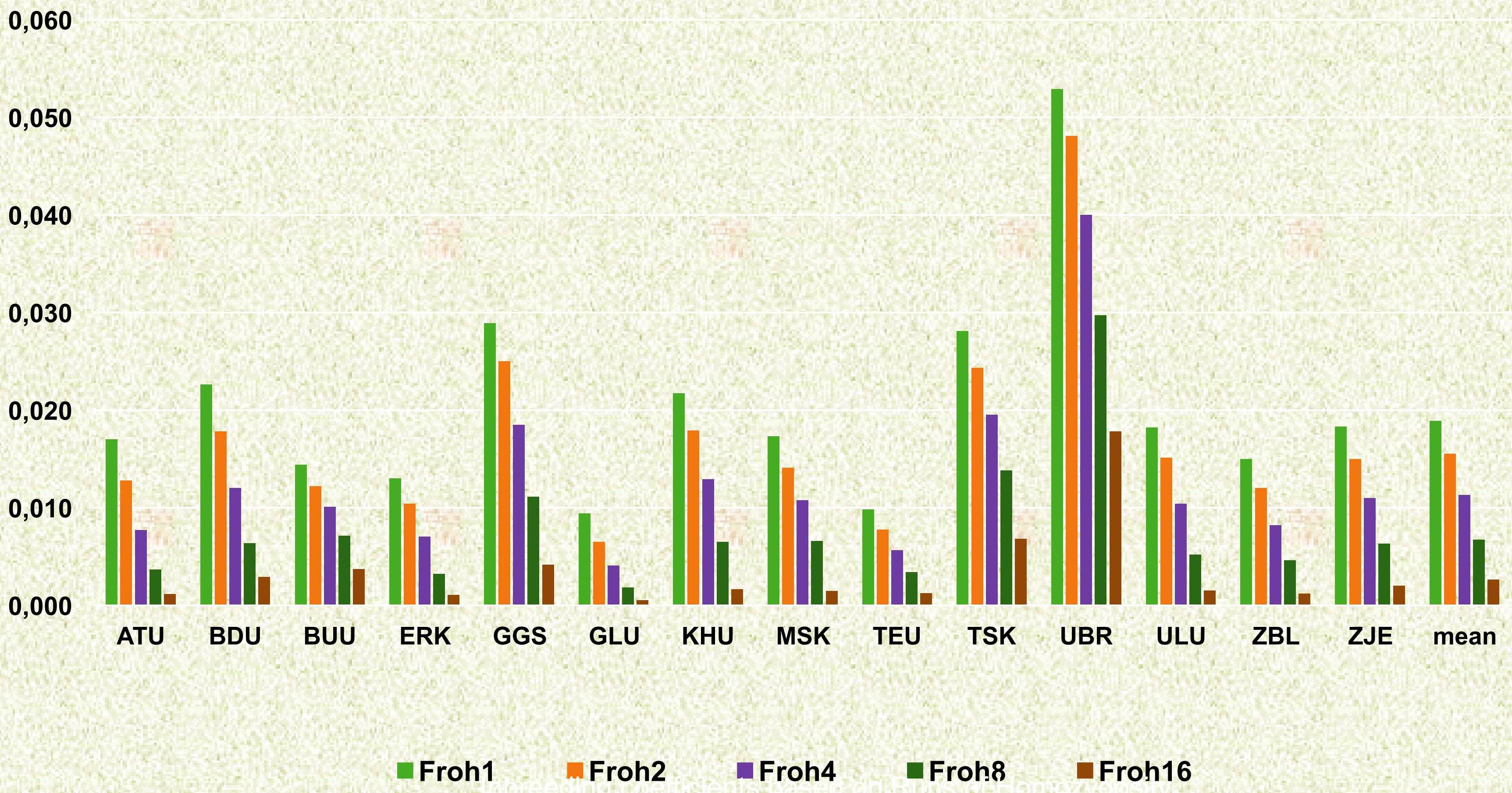
  plink1.9

- GWAS

  GCTA

  a tool for Genome-wide Complex Trait Analysis

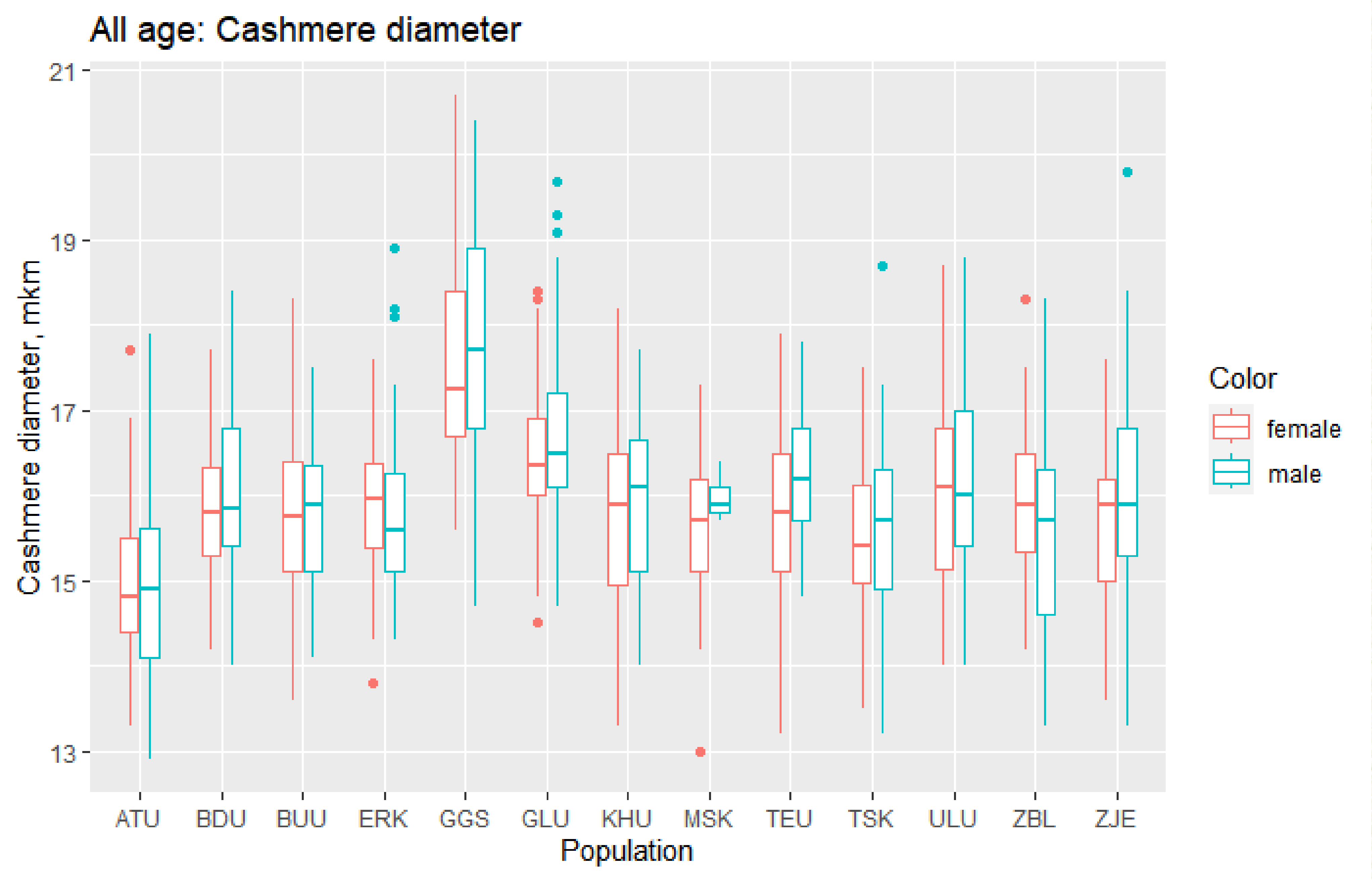
Runs of Homozygosity & F_{ROH}

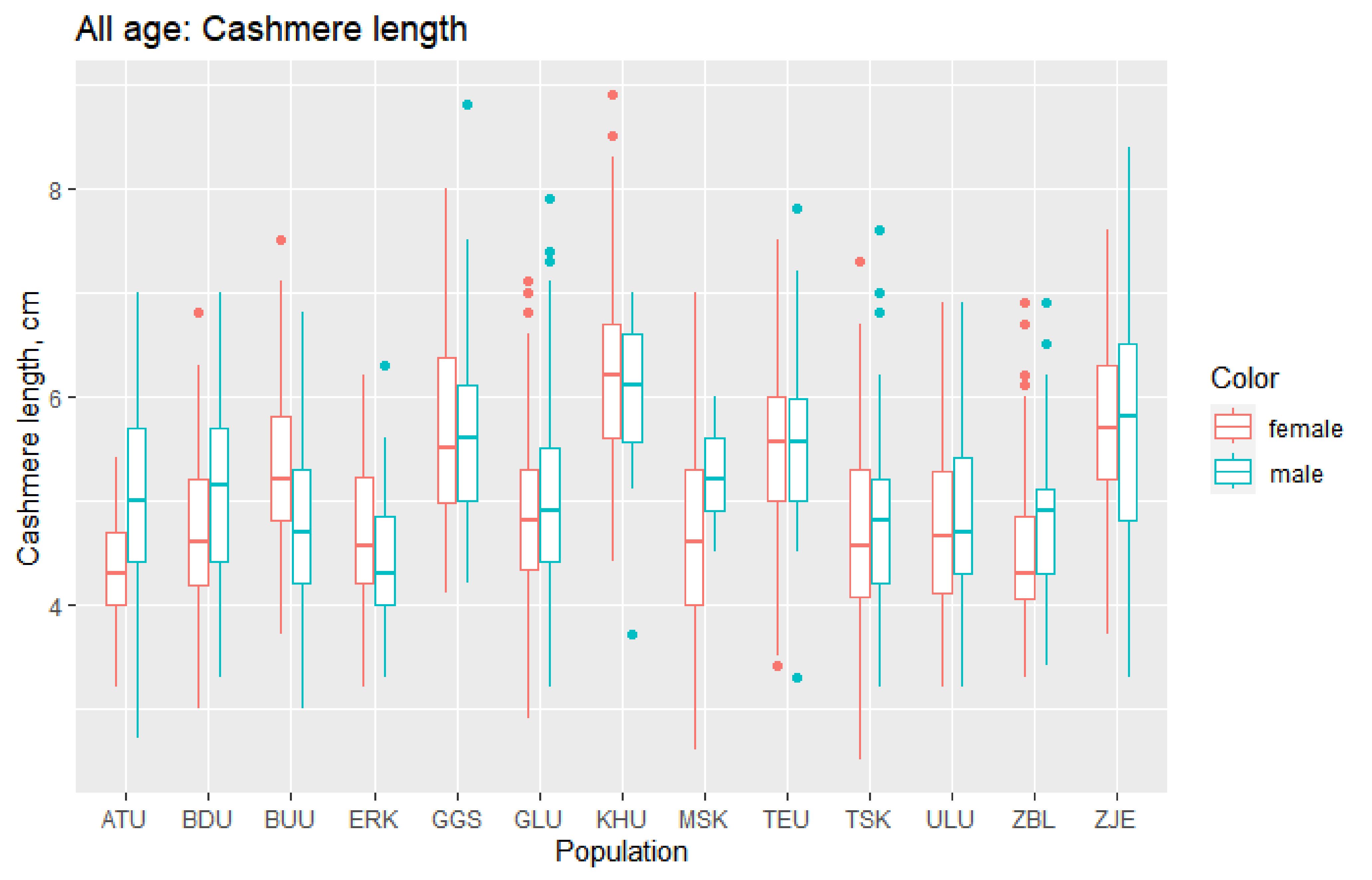


Genetic distances: Pairwise *Fst*

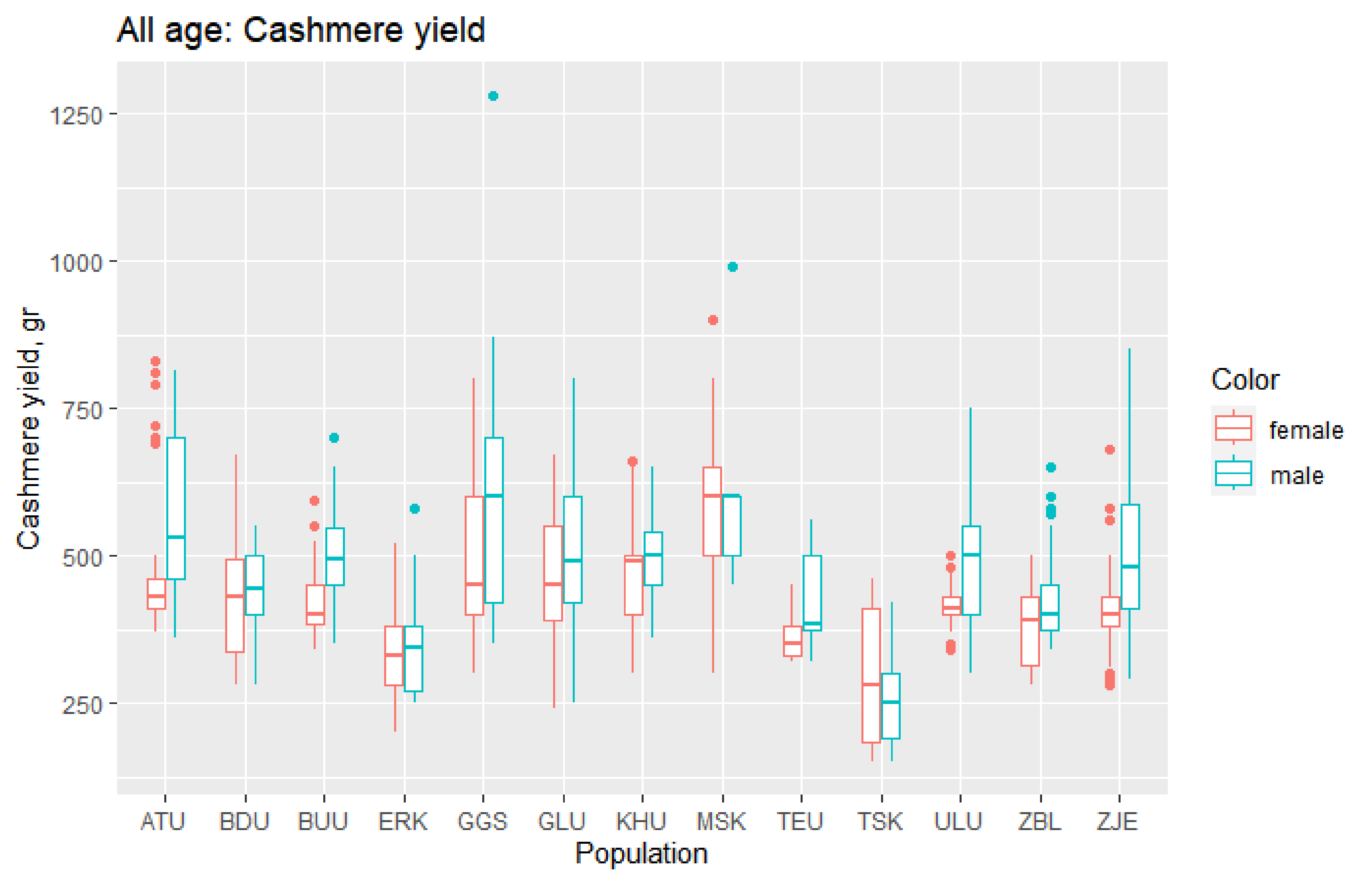
Overall *Fst* – 0.017

	ATU	BDU	BUU	ERK	GGS	GLU	KHU	MSK	TEU	TSK	UBR	ULU	ZBL	ZJE
ATU	-													
BDU	0.018	-												
BUU	0.013	0.014	-											
ERK	0.015	0.016	0.011	-										
GGS	0.025	0.026	0.018	0.020	-									
GLU	0.013	0.009	0.009	0.011	0.022	-								
KHU	0.019	0.022	0.016	0.018	0.025	0.017	-							
MSK	0.017	0.018	0.012	0.014	0.023	0.013	0.019	-						
TEU	0.012	0.013	**0.007**	0.010	0.015	0.01	0.015	0.011	-					
TSK	0.018	0.017	0.015	0.016	0.027	0.013	0.022	0.019	0.014	-				
UBR	0.042	0.043	0.036	0.034	0.037	0.039	0.043	0.040	0.034	**0.044**	-			
ULU	0.015	0.017	0.009	0.012	0.024	0.011	0.019	0.015	0.012	0.017	0.039	-		
ZBL	0.015	0.016	0.011	0.013	0.024	0.012	0.019	0.015	0.011	0.017	0.040	0.013	-	
ZJE	0.017	0.018	0.012	0.014	0.019	0.013	0.019	0.015	0.011	0.019	0.038	0.016	0.015	-


All age: Cashmere diameter
Cashmere diameter, mkm
21
19
17
15
13
ATU
BDU
BUU
ERK
GGS
GLU
KHU
MSK
TEU
TSK
ULU
ZBL
ZJE
Population
Color
female
male

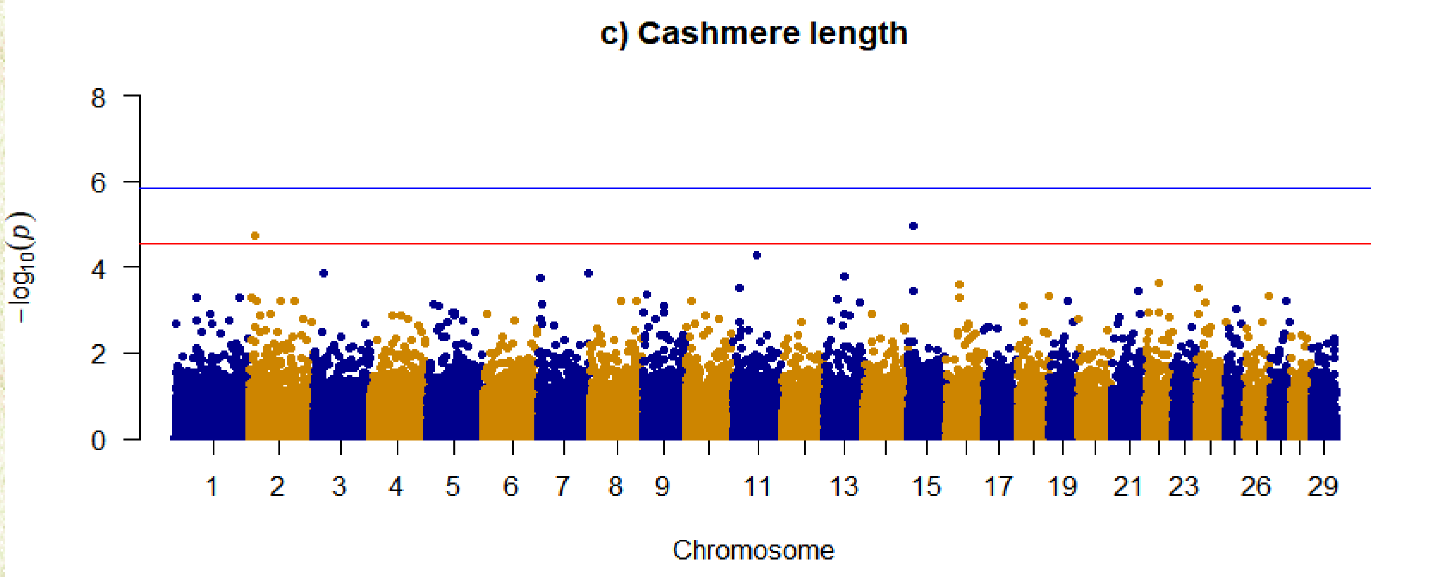


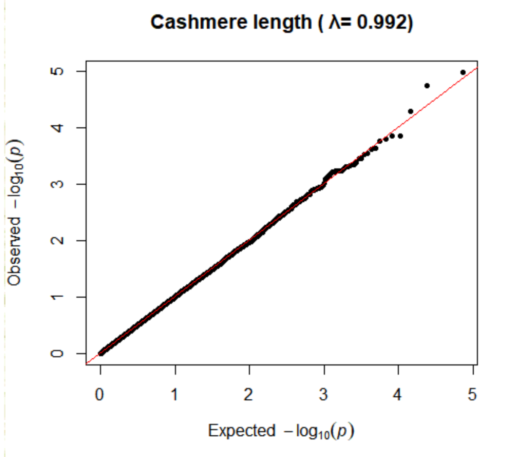
All age: Cashmere length
Cashmere length, cm
8
6
4
ATU
BDU
BUU
ERK
GGS
GLU
KHU
MSK
TEU
TSK
ULU
ZBL
ZJE
Population
Color
female
male

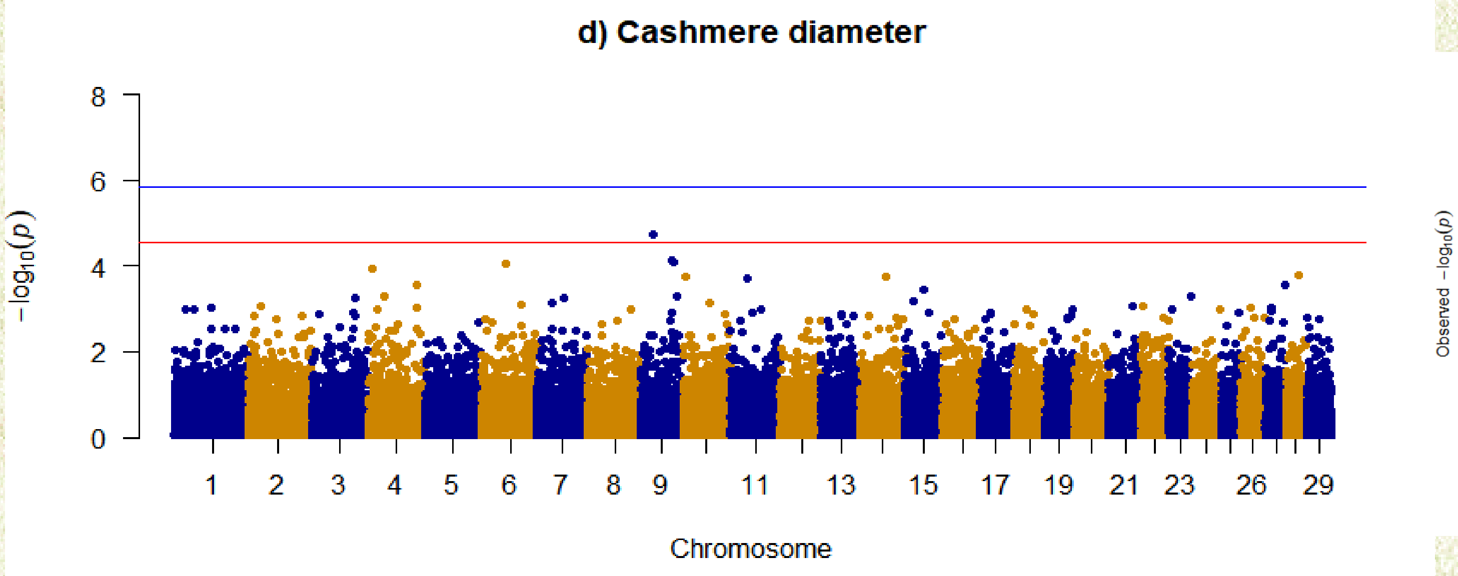


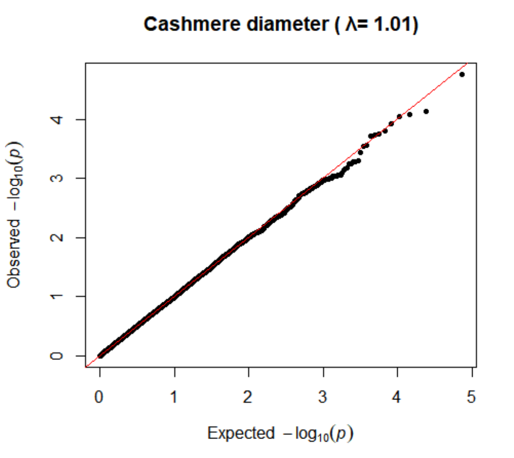
All age: Cashmere yield
Cashmere yield, gr
1250
1000
750
500
250
ATU
BDU
BUU
ERK
GGS
GLU
KHU
MSK
TEU
TSK
ULU
ZBL
ZJE
Population
Color
female
male

GWAS – Cashmere traits

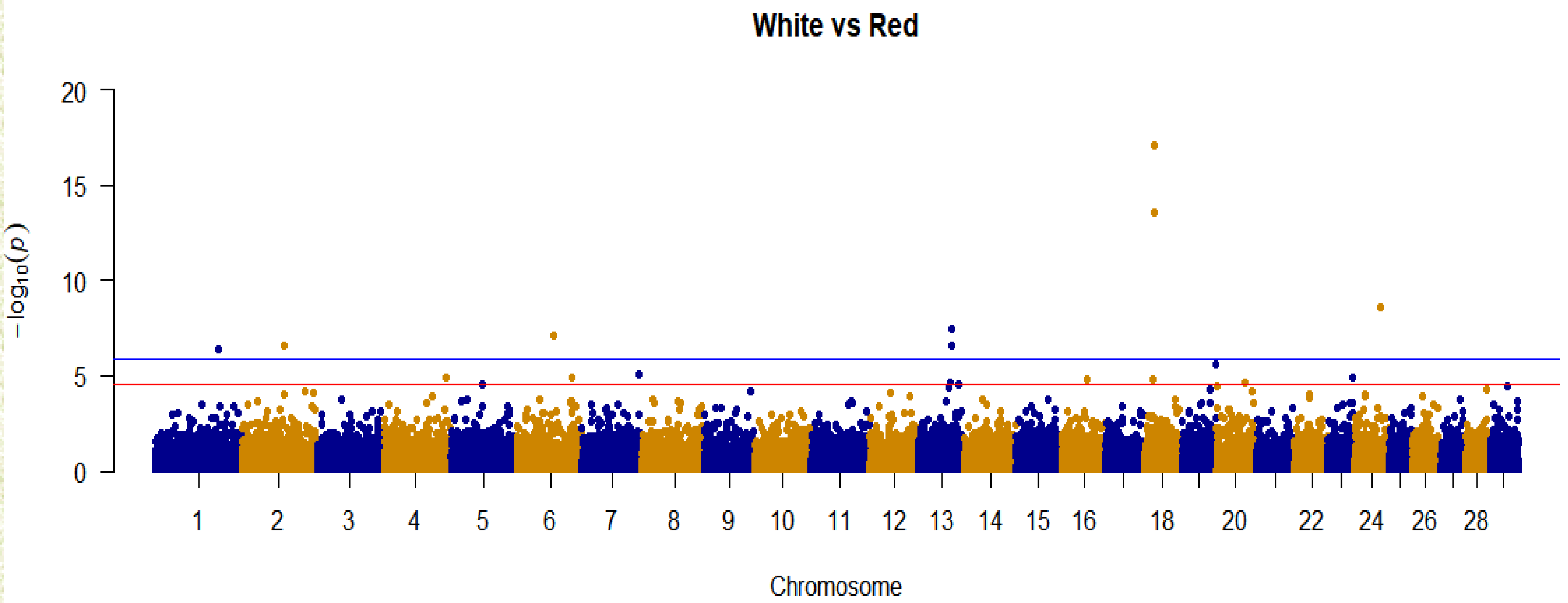


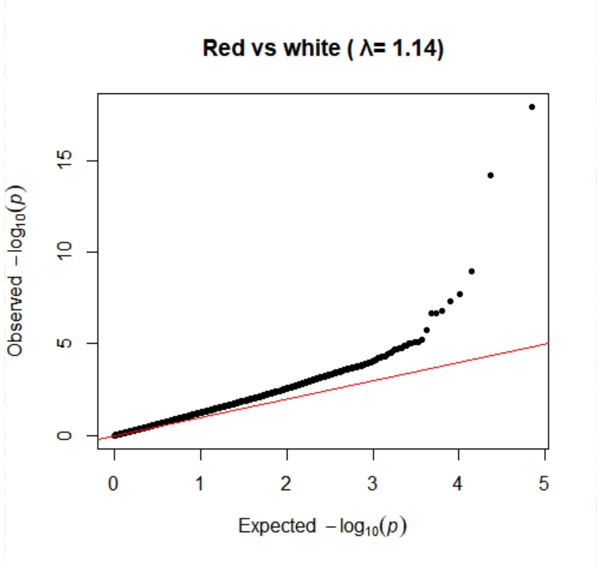






GWAS coat color





Loci of signal SNPs for coat color

SNP name	Chromo some	Locus, Mb	Genes harboring the locus	Coat color candidate genes in the proximity
AX-123303762	1	114.54	*Intergenic region*	*GMPS, HPS3*
AX-123266901	2	76.53	*THSD7B*	*UBXN4, ZEB2*
AX-519549237	6	66.86	*CORIN*	*CORIN, KIT*
AX-123307776	13	60.57	*BCL2L1*	*TFAP2C, POFUT1, ASIP*
AX-123254476	13	61.53	*MAPRE1*	*TFAP2C, POFUT1, ASIP*
AX-123294167	18	16.15	*LOC102181419*	*FANCA, SPIRE2, MC1R*
AX-123312274	18	16.19	*GAS8*	*FANCA, SPIRE2, MC1R*
AX-123262623	24	48.11	*ZBTB7C*	*MC2R, MC4R, IER3IP1*

Conclusions

- Large numbers of cashmere goats sampled in all regions of Mongolia with substantial populations
- Great insight into phenotypic diversity
- Genetic differentiation across regions is small -> lots of trade
- GWAS for fiber quality traits did not reveal significant genes -> small sample size
- GWAS for coat color worked well: usual suspects

Future prospects

- ✓ Development of strategic plans based on phenotypic and genetic evaluations of goat breeds and strains.

- ✓ Comparison of genetic diversity of Mongolian goats with goat breeds of the world

Thank you everyone!