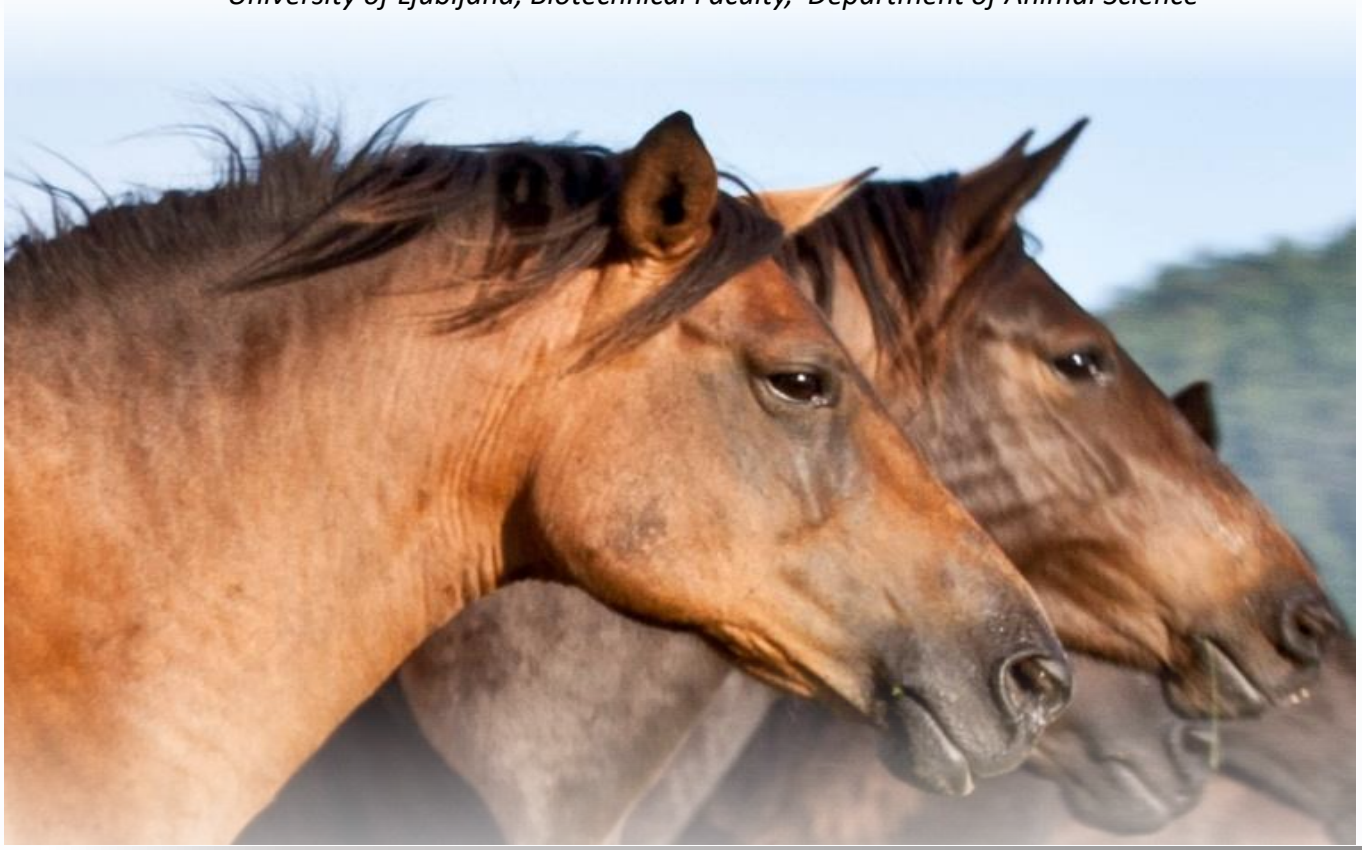
Mitochondrial DNA haplotypes in the population of Bosnian mountain horse

Matjaz Mesaric[1], Anton Dolinsek[2], Marko Cotman[1], Tine Pokorn[3], Minja Zorc[3], Jernej Ogorevc[3], Peter Dovc[3]

[1]University of Ljubljana, Veterinary Faculty, Institute for breeding and health care of horses, [2]Stud Planido, Podkum, [3]University of Ljubljana, Biotechnical Faculty, Department of Animal Science



Twenty years ago…

ANIMAL GENETICS
Immunogenetics, Molecular Genetics and Functional Genomics

Animal Genetics, 1999, **30**, 423–430

Mitochondrial D-loop sequence variation among the 16 maternal lines of the Lipizzan horse breed

T Kavar, F Habe, G Brem, P Dovč

Haplotype \ Position	15494	15495	15496	15510	15534	15538	15542	15585	15596	15597	15602	15603	15604	15615	15616	15617	15635	15649	15650	15659	15666	15667	15703	15709	15720	15770	15771	15775	15776	15777	15806	15807	15809	15810	15826	15827	16361	16371	16407	16439	16476	16540	16543	16546	16556	16559	16563A	16605	16629
X79547	T	T	A	T	C	A	C	G	A	A	C	T	G	A	A	T	C	A	A	T	G	A	T	C	G	C	C	C	T	A	C	C	A	A	A	A	A	T	C	C	C	C	T	T	T	C	-	A	A
Batosta	.	C	.	.	.	.	A	.	.	T	.	.	.	.	.	.	.	G	.	.	.	.	A	.	.	.	.	.	.	.	.	.	.	.	G	.	.	C	.	.	.	.	.	.	.	.	.	C	.	.
Capriola	.	C	.	.	.	.	A	.	.	.	.	.	.	.	.	.	.	G	.	A	.	.	A	.	.	.	.	.	.	.	.	.	.	G	G	.	.	C	.	.	.	.	.	.	.	.	.	.	.	.
Slavina	.	C	.	.	.	T	A	.	.	T	.	.	.	.	.	.	T	.	G	.	A	.	C	.	A	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	.	.	.	.	.	.	.	.	.
Dubovina	.	C	.	.	.	T	.	.	G	T	.	.	.	.	.	.	T	.	G	.	A	.	C	.	A	.	.	.	.	.	.	.	.	.	.	.	.	C	.	.	.	.	.	.	.	.	.	.	.	.
Trompeta	.	C	.	.	G	.	.	G	.	T	.	.	.	.	.	.	.	G	.	.	.	.	T	A	.	T	.	.	.	.	.	.	.	.	G	.	.	C	.	T	.	.	.	.	.	.	.	.	.	.	.
Gaetana	.	C	.	.	.	.	.	.	G	T	.	A	.	.	.	.	.	.	.	.	G	C	.	A	.	T	.	.	G	.	.	G	.	.	.	.	C	.	.	.	.	A	.	.	.	C	.	G	
Gratiosa	.	C	.	C	.	.	.	.	.	T	.	.	.	.	C	.	.	.	.	.	.	A	.	T	.	.	.	T	.	.	.	.	G	.	C	.	.	.	.	A	C	.	T	.	G	G	
Strana	.	C	.	.	.	.	A	.	.	T	.	.	.	.	C	.	.	C	.	.	.	A	.	T	T	.	.	T	.	.	.	.	G	.	C	.	.	.	.	A	C	.	T	.	.	G	
Thais	.	C	.	.	.	.	.	.	.	T	.	.	G	G	.	.	.	C	.	.	C	.	A	T	.	T	C	.	T	.	.	.	G	.	C	.	.	.	T	T	A	.	.	.	.	.	G	
Allegra	C	C	G	.	T	.	.	.	.	T	C	.	.	.	.	.	G	.	.	.	.	.	A	.	T	.	.	.	.	.	.	.	.	.	C	-	.	.	.	.	.	.	.	.	C	.	G	
Wera	C	C	G	.	T	.	.	A	.	.	C	.	.	.	.	.	G	.	.	.	.	.	A	.	T	.	.	.	.	.	.	T	.	.	C	-	.	.	.	.	.	.	.	.	C	.	G	
Monteaura	C	C	G	.	T	.	.	A	.	.	T	C	.	.	.	.	G	.	.	.	.	.	A	.	T	.	.	.	.	.	.	.	.	.	G	C	-	.	.	.	.	.	C	.	C	.	G	
Betalka	C	C	G	.	T	.	T	A	.	.	T	C	.	.	.	.	G	.	.	.	.	.	A	.	T	.	.	.	.	.	.	.	.	.	G	C	-	.	.	.	.	.	C	.	C	.	G	

Fig. 1. Polymorphic sites within the upstream (nt 15457–15834) and downstream (nt 16351–16660) region of the equine D-loop sequence.

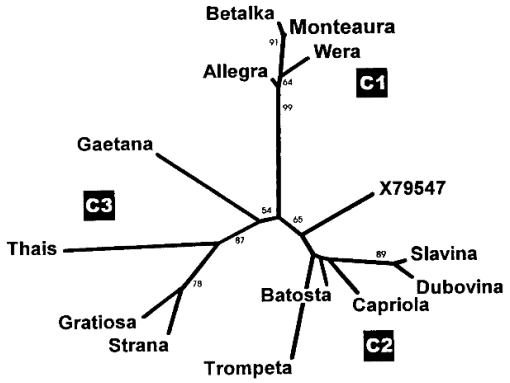
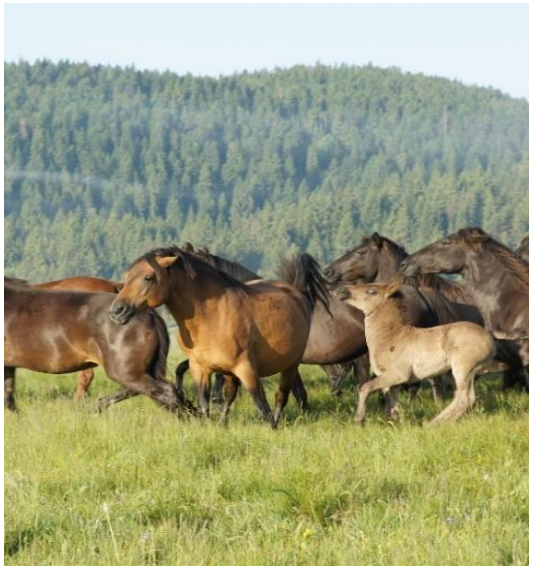


Fig. 2. Unrooted tree representing relations among 13 Lipizzan mtDNA haplotypes and the reference sequence (GenBank X79547).

Bosnian Mountain Horse

- The Bosnian Mountain Horse (BMH) is authentic indigenous breed which represents the most typical small horse of the Balkans.
- The horses were bred as pure breed only at state-owned studs.
- The Bosnian Mountain horse is a typical example of a breed, created by the selection efforts, long-standing isolation and adaptation to a specific environment.
- The basic characteristics of BMH breeding in the Borike and Han Pijesak studs was closed population based on two stallion lines: Miško and Barut.
- Since 1948 breeding was continued based only on the existing maternal lines and two stallion lines.

Breeding stock of BMH



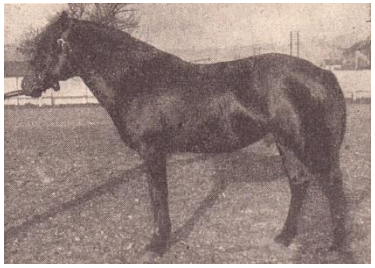
- Established mare lines
  (34 authentic bloodlines)

- Stallion lines

MIŠKO

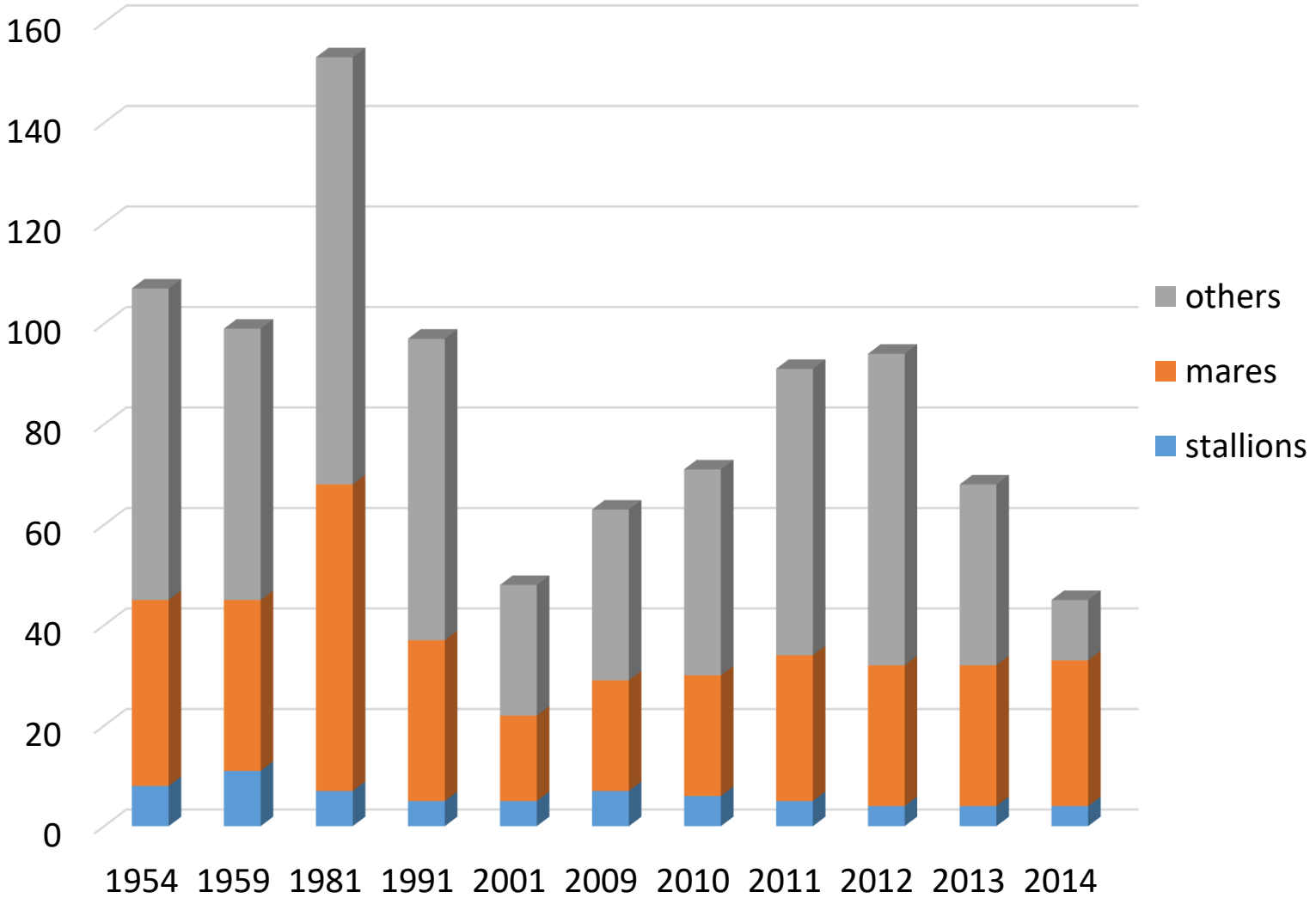


BARUT



746 ISKRA XL, 1998, Borike, f: 55 MIŠKO XXII, m: 689 ISKRA XXVI.

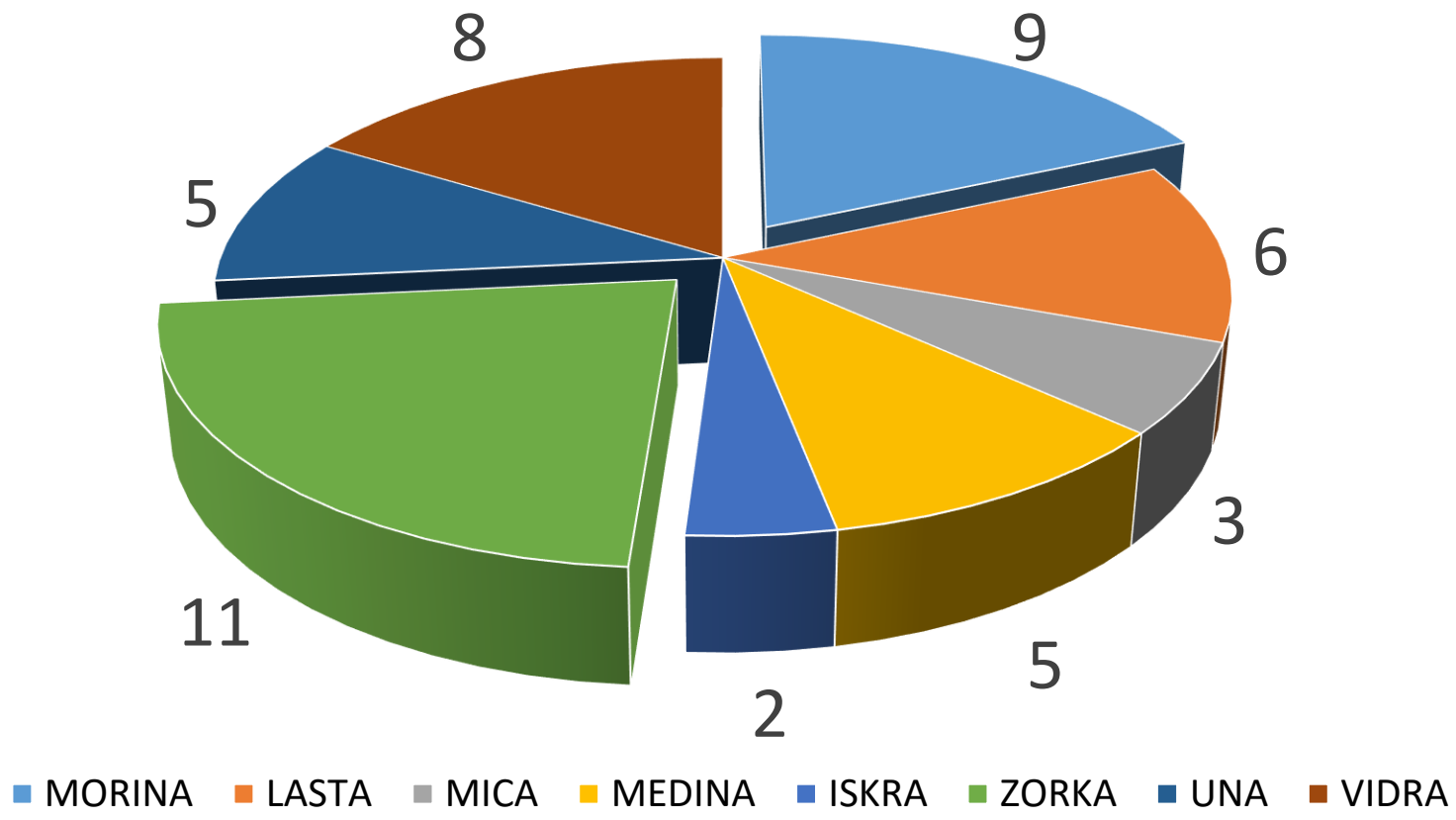
Population dynamics at Borike (last 60 years)



Goals of the BMH breeding programme

- preservation of the breed,
- preservation of original phenotypic traits,
- maintenance of various possibilities of use,
- maintenance of genetic variability.

Most prominent autochthonous mare lines in the BMH population



Mare blood lines in BMH

Traditional	Recently established
Zorka	Mrkuša
Morina	Una-P
Lasta	Dinara
Medina	Zora
Una	Sena
Vidra	Đula
Mica	Gara
Iskra	Bosna

Some traditional BMH mare lines

MORINA

UNA

MICA

BMH country breeding (new maternal lines)

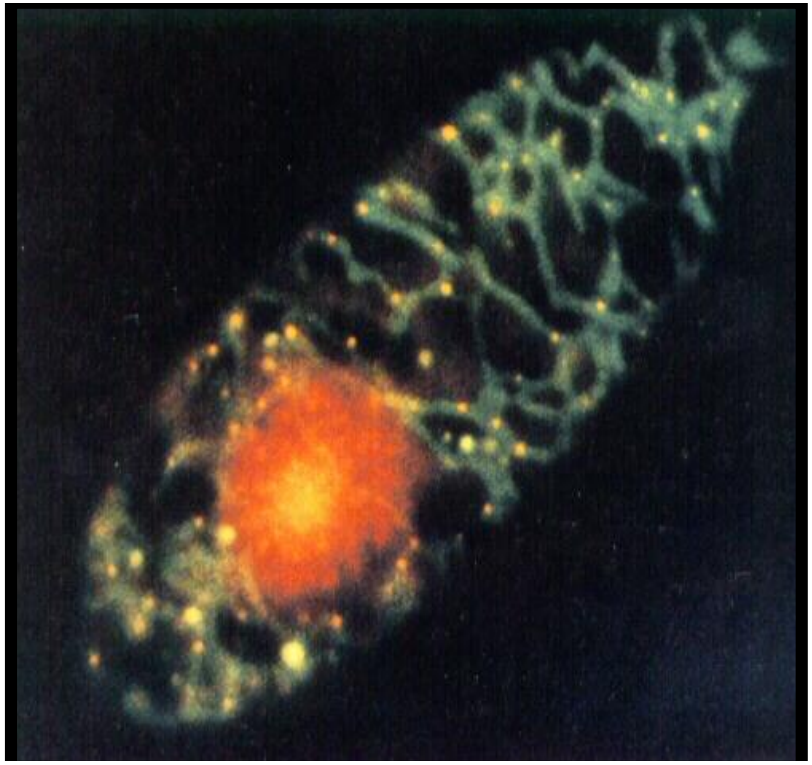
MRKUŠA
DINARA
BOSNA
SENA
GARA
ĐULA
UNA P
ZORA

9 UNA I, 2004

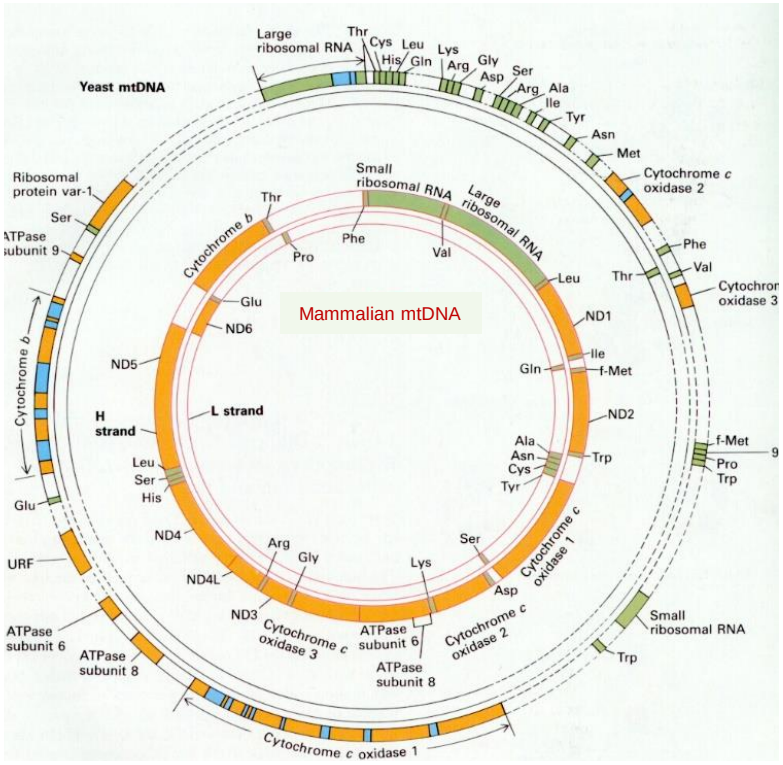
10 BOSNA I, 2010

These mares are considered as being in the BMH type and can be entered into the supplementary section of the stud book.

mtDNA



Small, beautiful, essential



Cluster C1 is typical for North European ponies,

and cluster D1 is well represented in Iberian and North African breeds.

Clusters of the mtDNA in BMH

Nomenclature according to Achilli *et al.*, 2012

	15494	15495	15496	15526	15530	15534	15540	15542	15577	15585	15597	15598	15600	15602	15603	15604	15615	15617	15635	15649	15650	15659	15666	15703	15718	15720	15740	15770
X79547	T	T	A	T	C	C	A	C	C	G	A	T	G	C	T	G	A	T	C	A	A	T	G	T	C	G	A	C
d	.	C	.	.	.	.	.	.	.			.	.	.	.	.	.	.	.	.	.	.	.	.	.	A	.	
A	.	C	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ba	.	C	.	.	.	.	.	.	.	A	.	.	.	.	.	.	.	.	.	.	G	.	A	.	.	A	.	T
Bb	.	C	.	.	.	.	.	.	.	A	.	.	.	.	.	.	.	.	.	.	G	.	A	.	.	A	.	.
Bc	.	C	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	G	.	A	.	.	A	.	.
Ga	.	C	.	.	.	.	.	T	.	A	.	.	.	T	.	.	.	.	T	.	G	.	A	C	.	A	.	.
Gb	.	C	.	.	.	.	.	T	.	A	G	.	.	T	.	.	G	.	T	.	G	.	A	C	.	A	.	.
Gc	.	C	.	.	.	.	.	T	.	.	.	.	.	T	.	.	.	.	T	.	G	.	A	C	.	A	.	.
a	.	C	.	.	.	.	.	.	.			.	.	T	.	.	.	.	.	.	.	.	.	.	.	A	.	.
H	.	C	.	C	.	.	G	.	.	A	.	.	.	T	.	.	.	.	.	G	.	.	.	.	T	A	.	.
J	.	C	.	.	-	.	.	.	.	A	.	.	.	T	.	.	.	.	.	.	.	.	.	.	.	A	.	.
La	C	C	G	.	-	T	.	.	.	A	.	.	.	T	C	A	.	.	.	G	.	.	.	.	.	A	.	.
Lb	C	C	G	.	.	T	.	.	.	A	.	.	.	T	C	A	.	.	.	G	.	.	.	.	.	A	.	.
Lc	C	C	G	.	.	T	.	.	.	A	.	.	.	T	C	.	.	.	.	G	.	.	.	.	.	A	.	.
b	.	C	.	.	.	.	.	.	.			.	.	T	.	.	.	C	.	.	.	.	.	.	.	A	.	.
b1	.	C	.	.	.	.	.	.	.			.	.	T	.	.	.	C	.	.	.	C	.	.	.	A	.	.
M	.	C	.	.	.	.	.	.	.	.	.	.	.	T	.	.	.	C	.	.	.	C	.	.	.	A	.	.
k	.	C	.	.	.	.	.	.	.			.	.	T	.	.	.	.	.	.	.	.	.	C	.	A	G	.
Qa	.	C	.	.	.	.	.	.	.	.	.	.	A	T	.	.	.	.	.	.	.	.	.	C	.	A	G	.
Qb	.	C	.	.	.	.	.	.	.	.	.	.	.	T	.	A	.	.	.	.	.	.	.	C	.	A	G	.

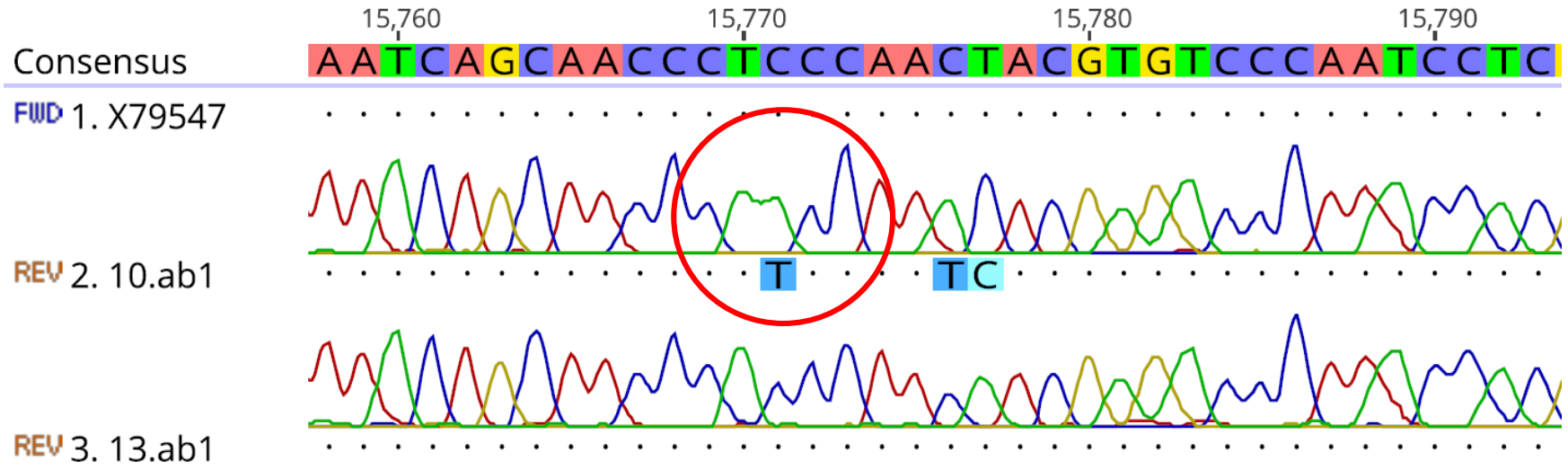
mtDNA clusters in BMH

Haplotype	Mare line	Year
H	ZORKA	1928
La	LASTA	1923
	MORINA	1997
Lb	BOSNA	2010
Lc	DINARA	1997
J	MRKUŠA	1998
M	MICA	1945
	DRINA	2000
Qa	ISKRA	1929
Qb	ZORA	1996
A	MORINA	1964
Ba	VIDRA	1999
Bb	UNA I	2004
	UNA II	2009
Bc	LENKO	2008
Ga	MEDINA	1924
Gb	UNA	1937
Gc	SENA	2000

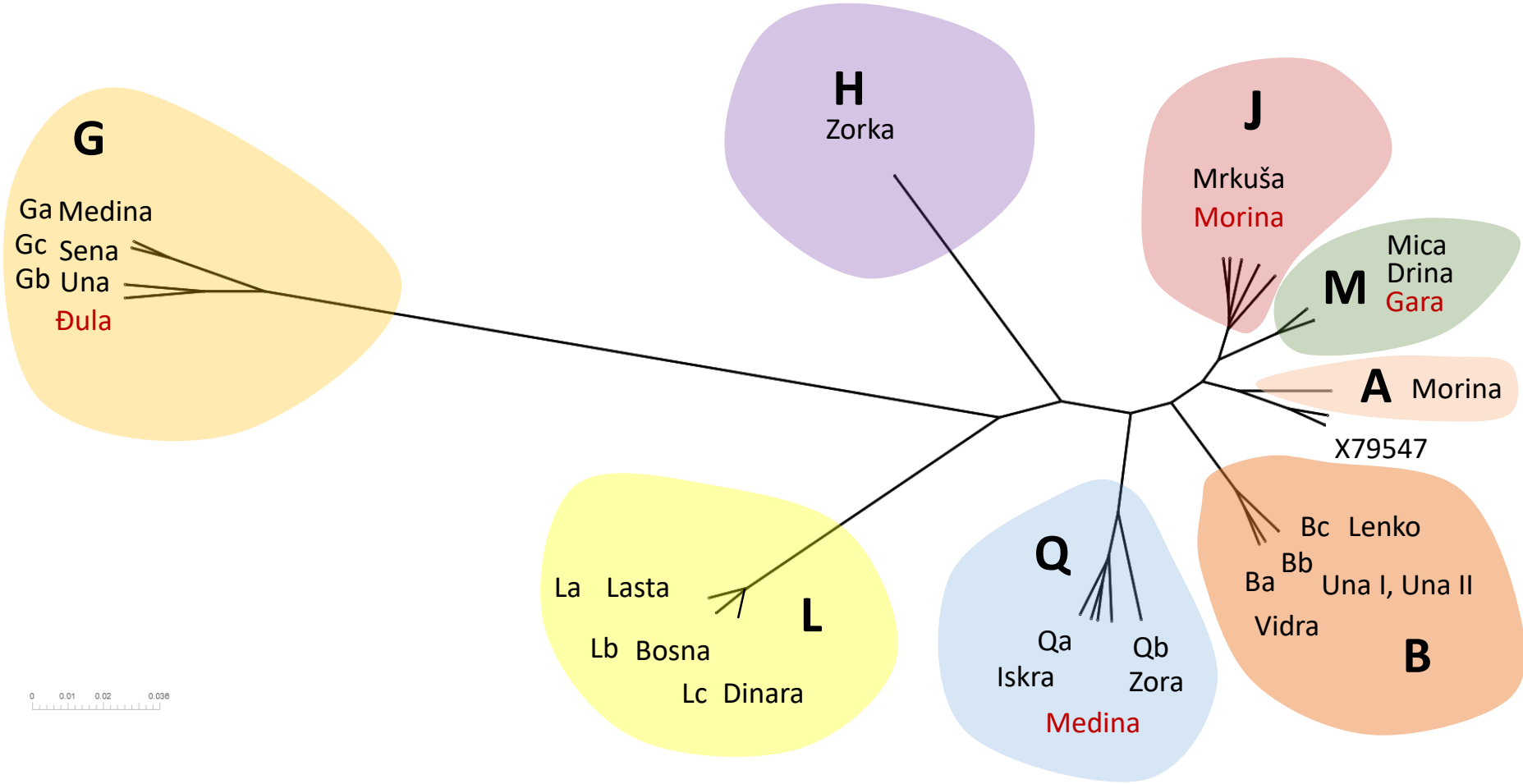
Overview of polymorphic sites in the D-loop region of the mtDNA in BMH

	494	495	496	526	530	534	540	542	585	600	602	603	604	615	617	635	649	650	659	666	703	718	720	740	770
X79547	T	T	A	T	C	C	A	C	G	G	C	T	G	A	T	C	A	A	T	G	T	C	G	A	C
A	.	C	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ba	.	C	.	.	.	.	.	.	A	.	.	.	.	.	.	.	.	G	.	A	.	.	A	.	T
Bb	.	C	.	.	.	.	.	.	A	.	.	.	.	.	.	.	.	G	.	A	.	.	A	.	.
Bc	.	C	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	G	.	A	.	.	A	.	.
Ga	.	C	.	.	.	.	.	T	A	.	T	.	.	.	.	T	.	G	.	A	C	.	A	.	.
Gb	.	C	.	.	.	.	.	T	A	.	T	.	.	G	.	T	.	G	.	A	C	.	A	.	.
Gc	.	C	.	.	.	.	.	T	.	.	T	.	.	.	.	T	.	G	.	A	C	.	A	.	.
H	.	C	.	C	.	.	G	.	A	.	T	.	.	.	.	.	G	.	.	.	.	T	A	.	.
J	.	C	.	.	.	.	.	.	A	.	T	.	.	.	.	.	.	.	.	.	.	.	A	.	.
La	C	C	G	.	-	T	.	.	A	.	T	C	A	.	.	.	G	.	.	.	.	.	A	.	.
Lb	C	C	G	.	.	T	.	.	A	.	T	C	A	.	.	.	G	.	.	.	.	.	A	.	.
Lc	C	C	G	.	.	T	.	.	A	.	T	C	.	.	.	.	G	.	.	.	.	.	A	.	.
M	.	C	.	.	.	.	.	.	.	.	T	.	.	.	C	.	.	.	C	.	.	.	A	.	.
Qa	.	C	.	.	.	.	.	.	.	A	T	.	.	.	.	.	.	.	.	.	C	.	A	G	.
Qb	.	C	.	.	.	.	.	.	.	.	T	.	A	.	.	.	.	.	.	.	C	.	A	G	.

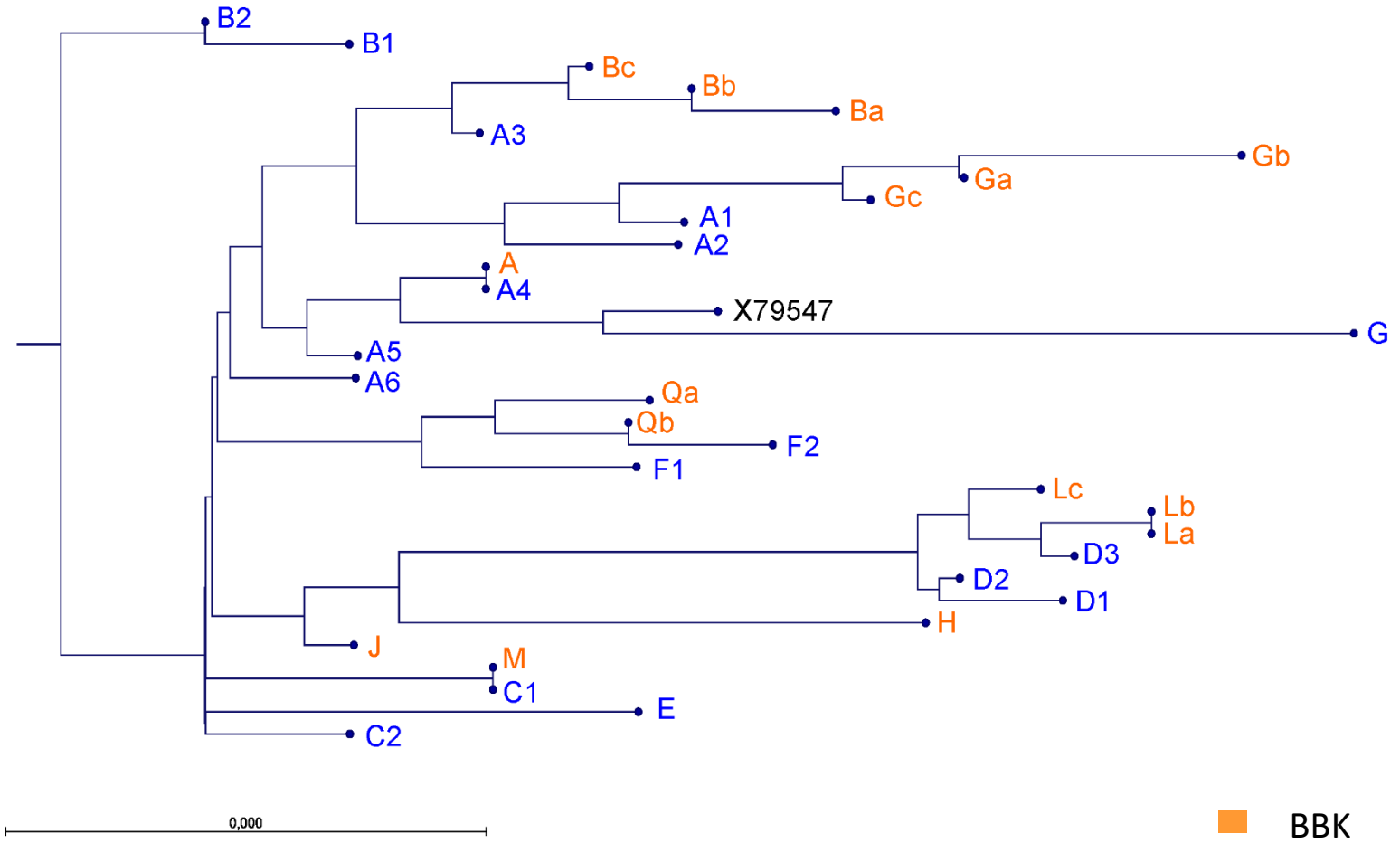
Example of the novel haplotype Ba found in the BMH



mtDNA clusters in BMH – including new maternal lines



Relationship between BBK and mtDNA haplotypes according to Jansen *et al*., 2002



Acknowledgements

- Minja Zorc
- Matjaz Mesaric
- Tine Pokorn
- Slovenian Research Agency
  - Research prgramme: Comparative genomics and genomic biodiversity (P4-0220)