



**Mend
The
Gap**



ORIGIN OF CROATIAN COMMON BEAN (*Phaseolus vulgaris* L.)

Klaudija Carović-Stanko

University of Zagreb, Faculty of Agriculture, Zagreb, Croatia

Centre of Excellence for Biodiversity and Molecular Plant Breeding (CoE CroP-BioDiv),
Zagreb, Croatia

E-mail: kcarovic@agr.hr



Europska unija
Zajedno do fondova EU



Republika Hrvatska

Cambridge, 2018

PLAN



1)

Introduction:
Common
bean origin
and
domestication



2)

Materials
and
Methods



3)

Origin and
genetic
diversity



4)

Further
research

PLAN



1)

Introduction:
Common
bean origin
and
domestication



2)

Materials
and
Methods



3)

Origin and
genetic
diversity



4)

Further
research



(100 – 700 AD)



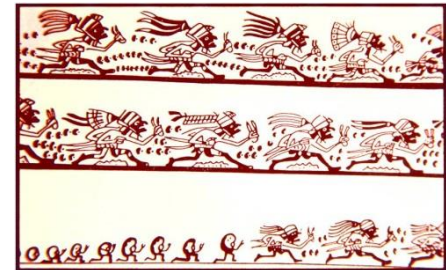
Phaseolus lunatus L.
Lima bean



Señor de Sipán



Bird Runners and Moche Beans



Moche pottery with ceremonial
Bean Runners

ORIGIN / DIVERGENCE



- Origin of wild common bean:
Mesoamerica
- Divergence: Andean wild bean
diverged from Mesoamerican
prior to domestication

DOMESTICATION



- Domestication: Independently domesticated in Mesoamerica and the Andes
- Mesoamerican centre: indeterminate (maize-bean-squash multicrop system)
 - Andean centre: determinate types (no suitable crop: root crops, quinoa)



DIVERSIFICATION

Domestication:

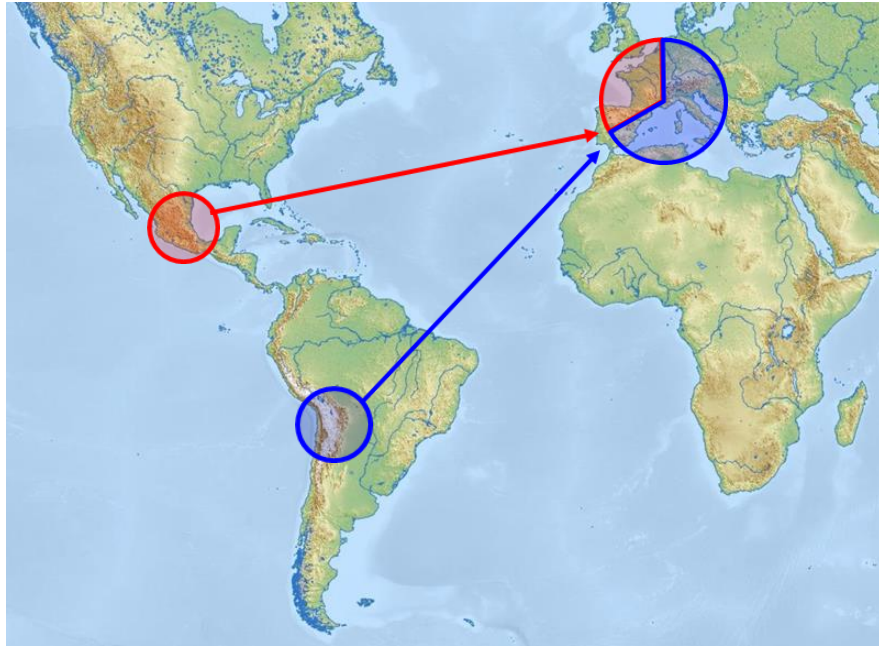
- Mesoamerican centre: indeterminate
- Andean centre: determinate

Diversification: Adaptation to new environments and local preferences

- Andean centre: indeterminate (after maize introduction)
- Mesoamerican centre: determinate (determinacy has been selected independently in both centres)



INTRODUCTION TO EUROPE



→ Introduction to Europe:
16th century
Portugal and Spain
several introductions

⌚ Origin (phaseoline type):
Mesoamerican 33%
Andean 67%
Hybrids:
up to 33%

Our neighborhood:

- (A) The proportion of landraces of the Mesoamerican origin tends to increase in eastern and south-eastern Europe (Albania, Bulgaria, Macedonia, Greece)
- (B) The proportions found in accessions from Bosnia and Herzegovina, Croatia, Serbia and Slovenia were very similar to those found in the Iberian Peninsula and Italy indicating that common bean was introduced mainly from the Mediterranean Basin

PLAN



1)

Introduction:
Common
bean origin
and
domestication



2)

Materials
and
Methods



3)

Origin and
genetic
diversity



4)

Further
research

MATERIALS: LANDRACES IN CROATIA

- the majority of the common bean production is based on local landraces
 - grown by small-scale farmers in low input production systems
 - no plant breeding programme
 - landraces
 - known by their traditional names
 - different seed coat patterns and colours
 - also found in neighbouring countries
(central Europe, western Balkans)
- 174 accessions >> 10 morphotypes
- aim: origin and genetic diversity
 - goal: association mapping study



'Kukuruzar'



'Tetovac'



'Biser'



'Trešnjevac'



'Puter'



'Dan i noć'



'Zelenčec'

METHODS: MOLECULAR ANALYSES

(1) Phaseoline type analysis

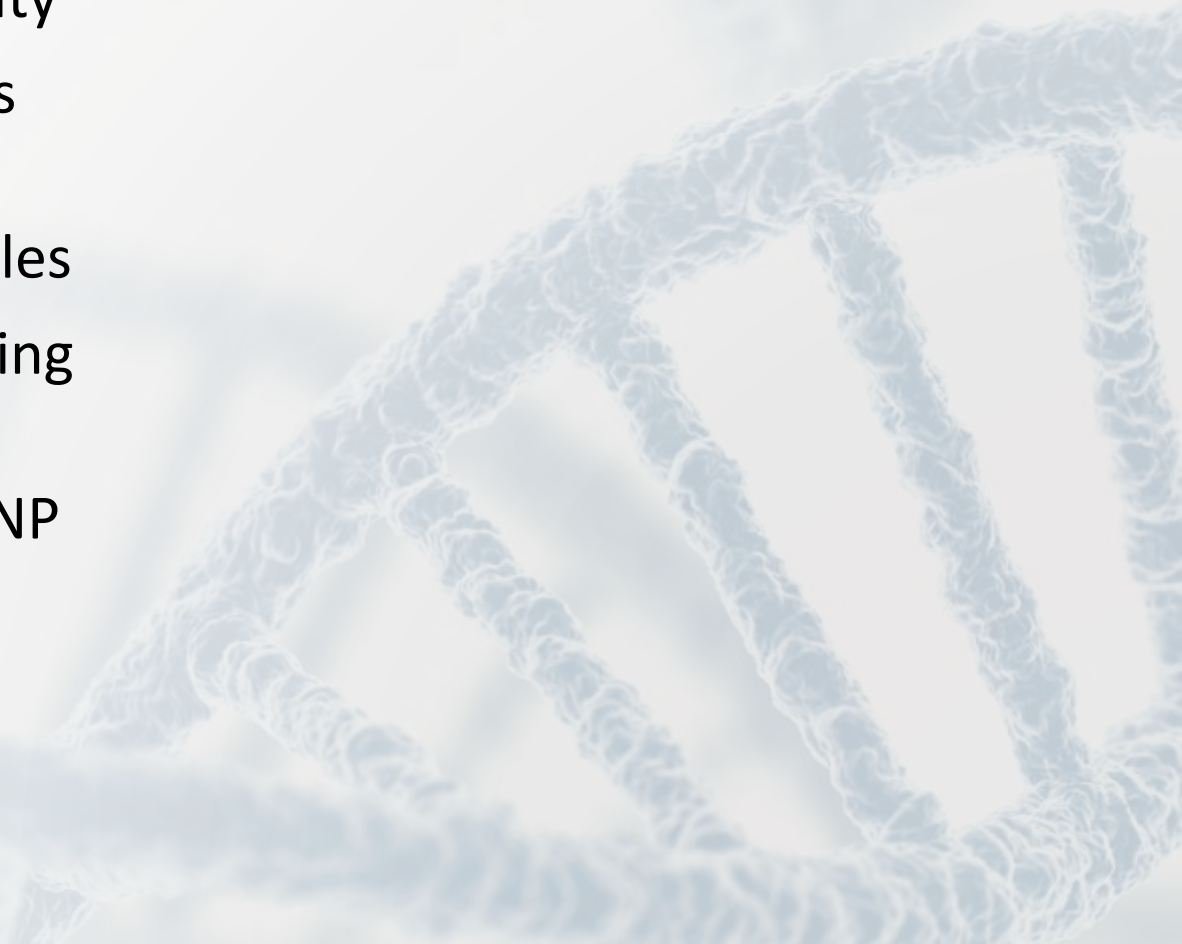
- a DNA marker for phaseolin-type diversity

(2) Microsatellite markers (SSRs)

- 26 markers / 135 alleles

(3) DArTseq SNP genotyping (SNPs)

- 6,599 polymorphic SNP markers



PLAN



1)

Introduction:
Common
bean origin
and
domestication



2)

Materials
and
Methods



3)

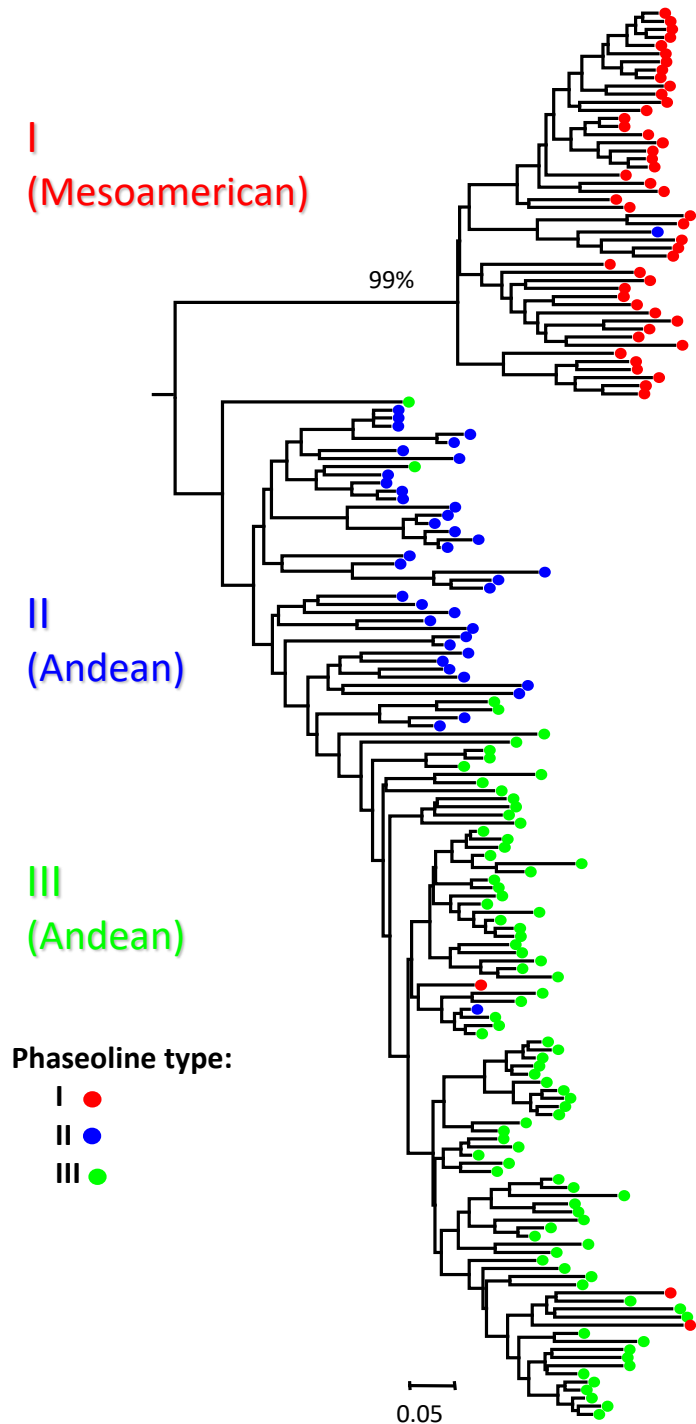
Origin and
genetic
diversity



4)

Further
research

PHASEOLIN TYPE ANALYSIS



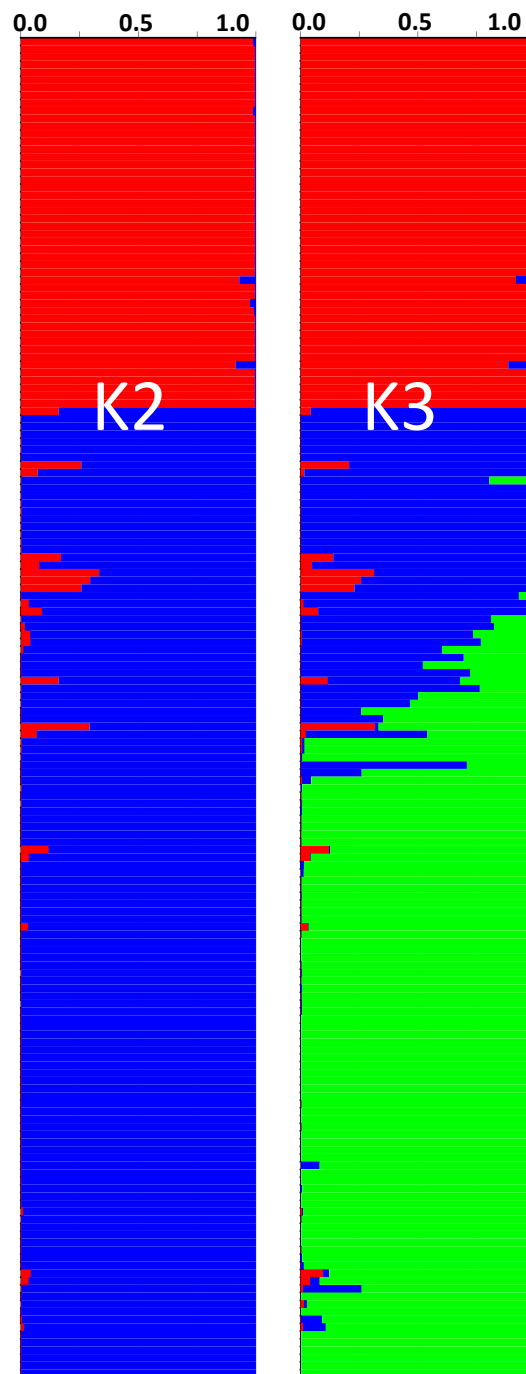
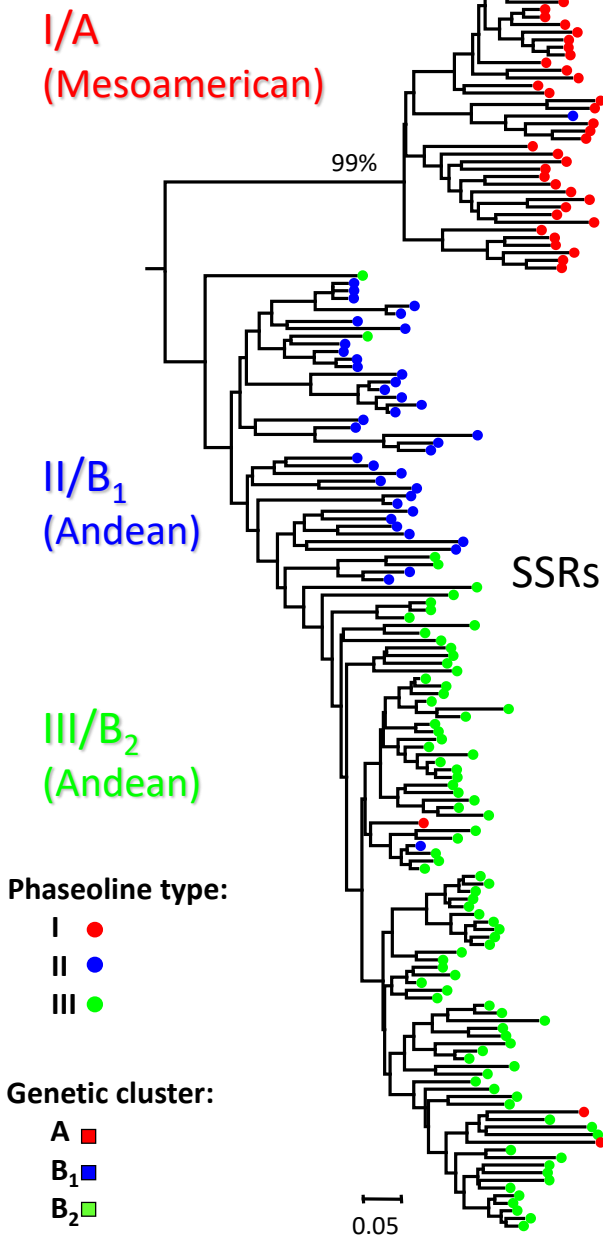
(1) Phaseoline type analysis

- three types:

1. type I - Mesoamerican ('S')
2. type II - Andean ('H' or 'C')
3. type III - Andean ('T')

(2) Microsatellite markers (SSRs)

- genetic distance: D_{psa}
- tree: Neighbor-joining method
- two well-supported clades
(Mesoamerican vs Andean)
- subclade
(Andean type III)



SSRs

(3) Microsatellites

- Bayesian model-based clustering method for inferring population structure
- proportions of membership (Q) of each accession in each genetic cluster assuming two (K2) or three clusters (K3)
- clusters / phaseoline:
 - A - type I
Mesoamerican
 - B₁ - type II
Andean
 - B₂ - type III
Andean

SNPs



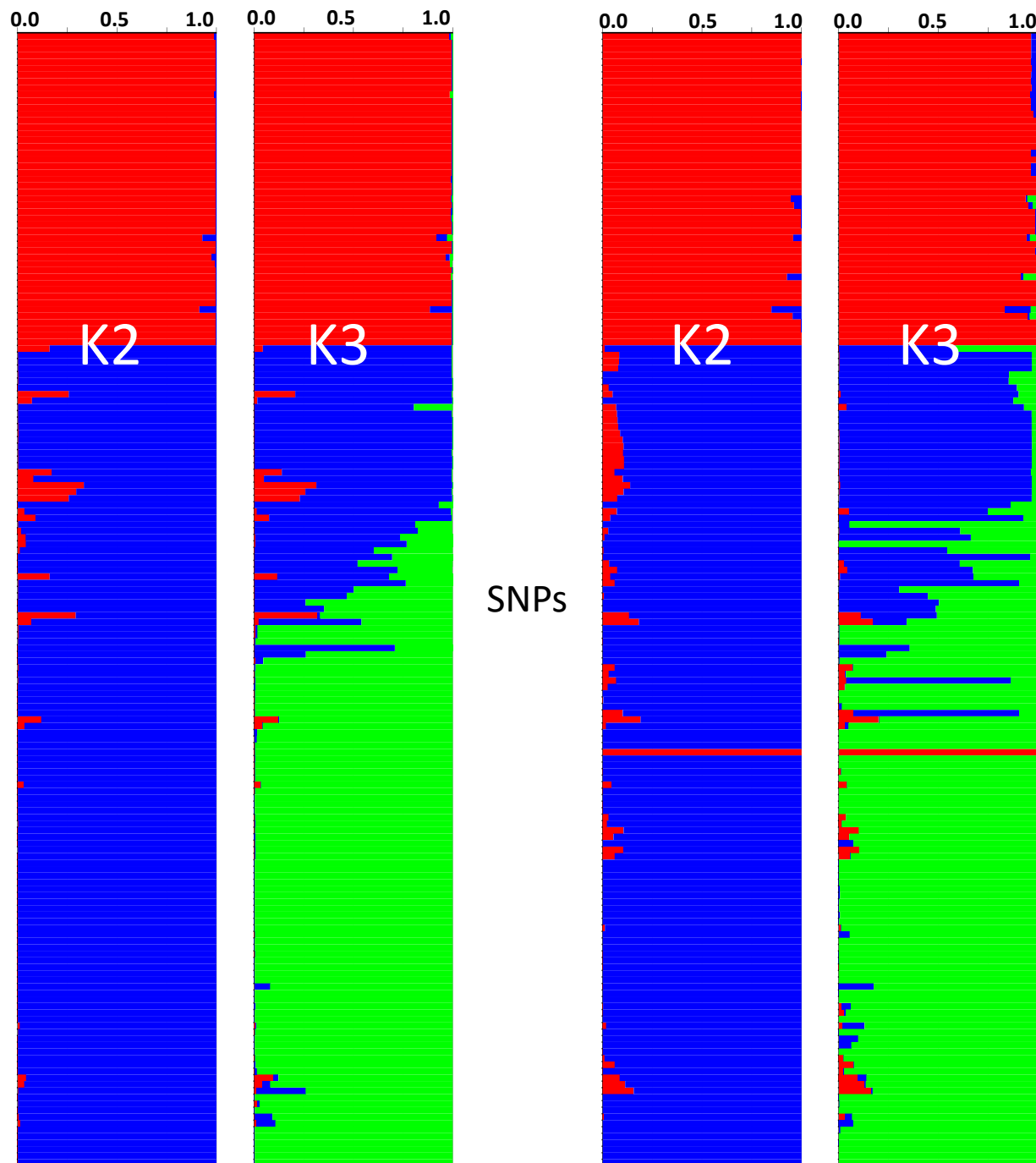
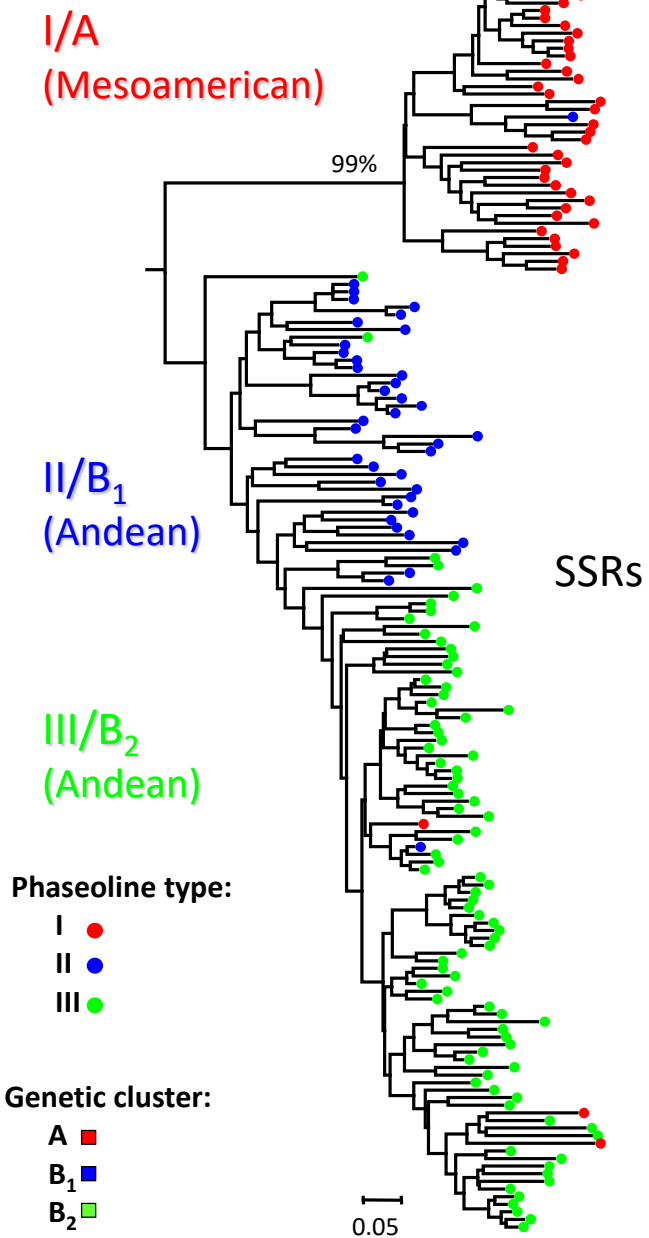
- Diversity Arrays Technology (DArT)
based on genome complexity reduction and SNP
detection through hybridization of PCR fragments

Schmutz et al. (2014) >> a reference genome for common bean

Valdisser et al. (2017) >> characterization of common bean core collection

	Valdisser et al. (2017)	This study
No. of accessions	188*	174
No. of polymorphic markers	5,961	6,599
SNP/Mbp	11.58	12.85
Observed heterozygosity (H_o)	0.037	0.009
Expected heterozygosity (H_E)	0.443	0.373

*91 landraces + 97 cultivars from all over the world



TRUE-TYPES vs OFFTYPES I

I/A
(Mesoamerican)

99%

II/B₁
(Andean)

III/B₂
(Andean)

SSRs

Phaseoline type:

I ●
II ●
III ●

Genetic cluster:

A ■
B₁ ■
B₂ ■

0.05

(1) True-types

- phaseolin type matches the cluster membership (SSRs and SNPs)
- percentage of cluster membership (Q) higher than 75%

(2) Offtypes

- putative hybrids

(2.1) Non-corresponding

no correspondence between phaseolin types and clusters

I/A
(Mesoamerican)

99%

II/B₁
(Andean)

SSRs

III/B₂
(Andean)

Phaseoline type:

I ●
II ●
III ●

Genetic cluster:

A ■
B₁ ■
B₂ ■

0.05

0.0 0.5 1.0

0.0 0.5 1.0

OFFTYPES II













(2.2) Mixed origin
- percentage of
cluster membership
(Q) lower than 75%
based on SSRs or
SNPs

MORPHO-GENETIC GROUPS













- from 10 morphotypes to 16 morpho-genetic groups

I/A (Mesoamerican)	II/B1 (Andean)	III/B2 (Andean)
 <p>'Trešnjevac' INDETERMINATE</p>	 <p>'Trešnjevac' INDETERMINATE</p>	 <p>'Trešnjevac' DETERMINATE</p>
 <p>'Kukuruzar' INDETERMINATE</p>	 <p>'Puter' INDETERMINATE</p>	 <p>'Puter' DETERMINATE</p>
 <p>'Tetovac' INDETERMINATE</p>	 <p>'Dan i noć' INDETERMINATE</p>	 <p>'Dan i noć' DETERMINATE</p>
 <p>'Biser' DETERMINATE</p>	 <p>'Sivi' INDETERMINATE</p>	 <p>'Zelenčec' DETERMINATE</p>

MORPHO-GENETIC GROUPS

I/A (Mesoamerican)	II/B1 (Andean)	III/B2 (Andean)
 <p>'Trešnjevac' INDETERMINATE</p>	 <p>'Trešnjevac' INDETERMINATE</p>	 <p>'Trešnjevac' DETERMINATE</p>
 <p>'Kukuruzar' INDETERMINATE</p>	 <p>'Puter' INDETERMINATE</p>	 <p>'Puter' DETERMINATE</p>
 <p>'Tetovac' INDETERMINATE</p>	 <p>'Dan i noć' INDETERMINATE</p>	 <p>'Dan i noć' DETERMINATE</p>
 <p>'Biser' DETERMINATE</p>	 <p>'Sivi' INDETERMINATE</p>	 <p>'Zelenčec' DETERMINATE</p>

MORPHO-GENETIC GROUPS

I/A (Mesoamerican)	II/B1 (Andean)	III/B2 (Andean)
 <p>'Trešnjevac' INDETERMINATE</p>	 <p>'Trešnjevac' INDETERMINATE</p>	 <p>'Trešnjevac' DETERMINATE</p>
 <p>'Kukuruzar' INDETERMINATE</p>	 <p>'Puter' INDETERMINATE</p>	 <p>'Puter' DETERMINATE</p>
 <p>'Tetovac' INDETERMINATE</p>	 <p>'Dan i noć' INDETERMINATE</p>	 <p>'Dan i noć' DETERMINATE</p>
 <p>'Biser' DETERMINATE</p>	 <p>'Sivi' INDETERMINATE</p>	 <p>'Zelenčec' DETERMINATE</p>

PLAN



1)

Introduction:
Common
bean origin
and
domestication



2)

Materials
and
Methods



3)

Origin and
genetic
diversity



4)

Further
research

ASSOCIATION MAPPING

- goal: Identification of SNP markers linked to the quantitative trait loci (QTL) related to bioactive nutrient contents in common bean
- 1. PGR: Croatian common bean landraces
- 2. Phenotyping: The assessment of seed mineral diversity (Mg, Ca, Fe, Zn, K, P) and phytic acid content
- 3. Genotyping:
 - SSRs - genetic diversity and structure
 - SNPs - DArTseq high-density SNP genotyping
- 3. Bioinformatics:
 - Genome-Wide Association Study (GWAS)

ACKNOWLEDGEMENTS



CoE CroP-BioDiv

Zlatko Šatović
Zlatko Liber
Monika Vidak
Jerko Gunjača
Martina Grdiša
Boris Lazarević



<http://biodiv.iptpo.hr>

