Race structure and relationships among ecotypes in cultivated common bean (*Phaseolus vulgaris* L.):

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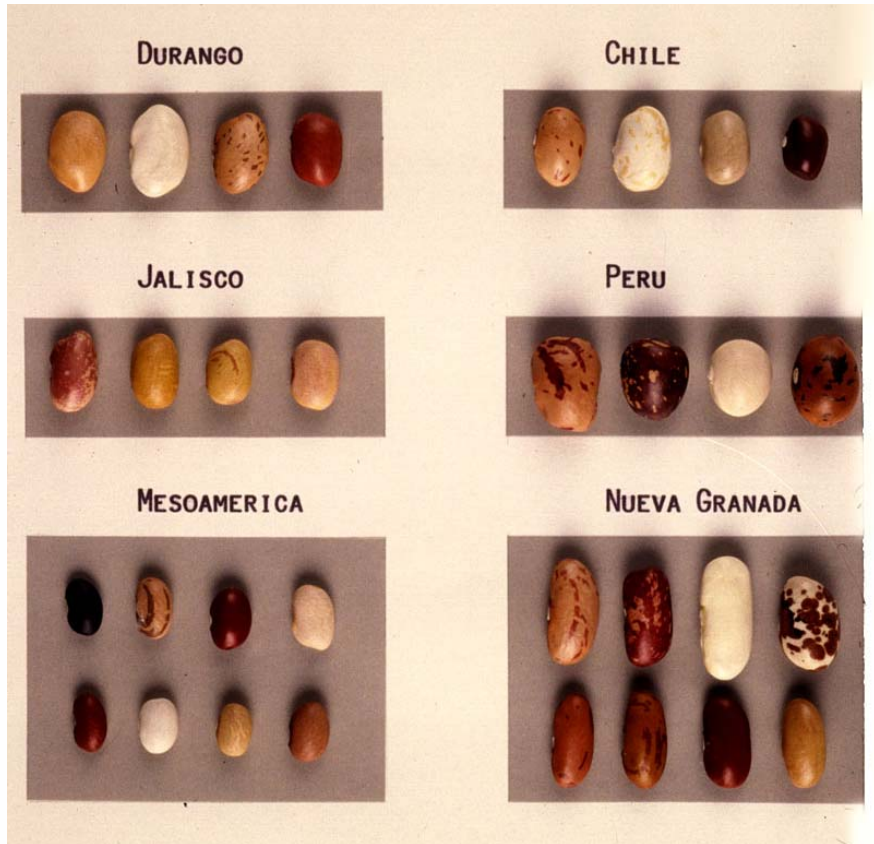
Objectives

- To survey international and national collections with microsatellite markers.

- To determine population structure and correlation of groups with morphological races of common bean.

- To identify a useful microsatellite marker set for diversity analysis in beans.

Project rationale: Understanding of Race structure



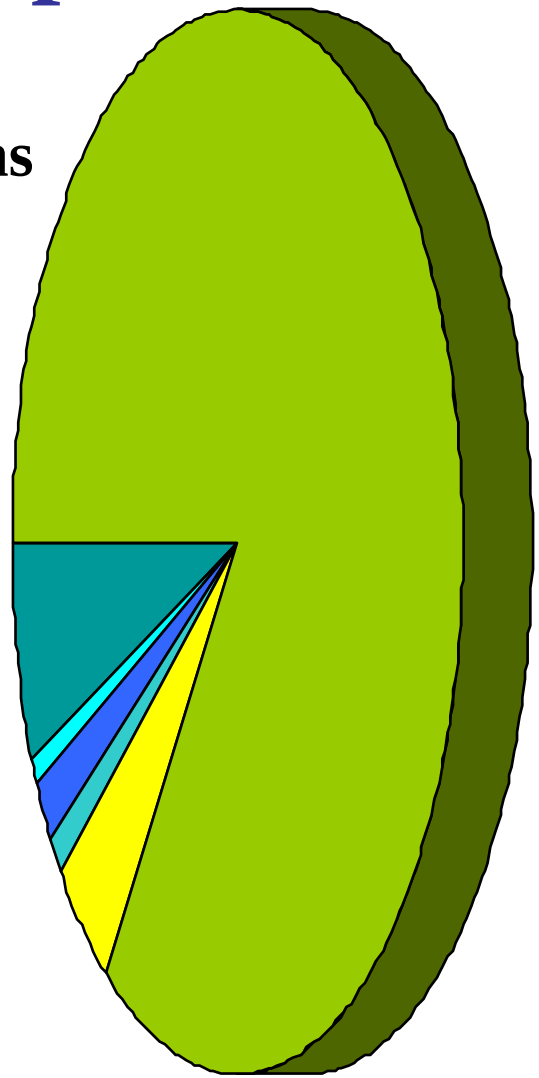
Source: Broughton et al., 2003

Source of *Phaseolus* genotypes

Complete FAO Collection = 41,000 accessions

Primary Genepool →
P. vulgaris cultivated *(29,000 acc.)*
wild *(1,315 acc.)*

Secondary / Tertiary GP
Other Phaseolus spp. →

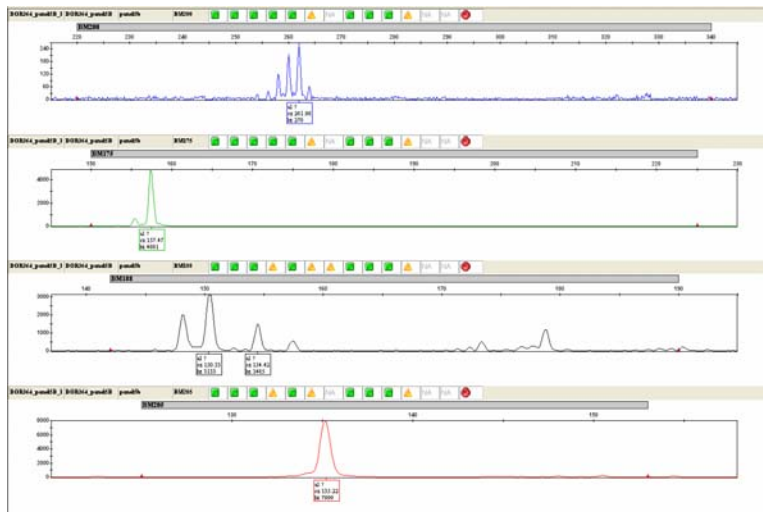


Core Collection = 1400 accessions
Supplemented with national collections (Bol., Brazil, China, Cuba)

Activities

- Fluorescent Microsatellite panels were designed based on alleles found in a mini core.
- Panels were tested for PCR multiplex capacity and fluorescence signal.
- Best 36 markers were run on capillary ABI platforms.

Panel 5



Four color dye system

Data format

a) Genotype worksheet

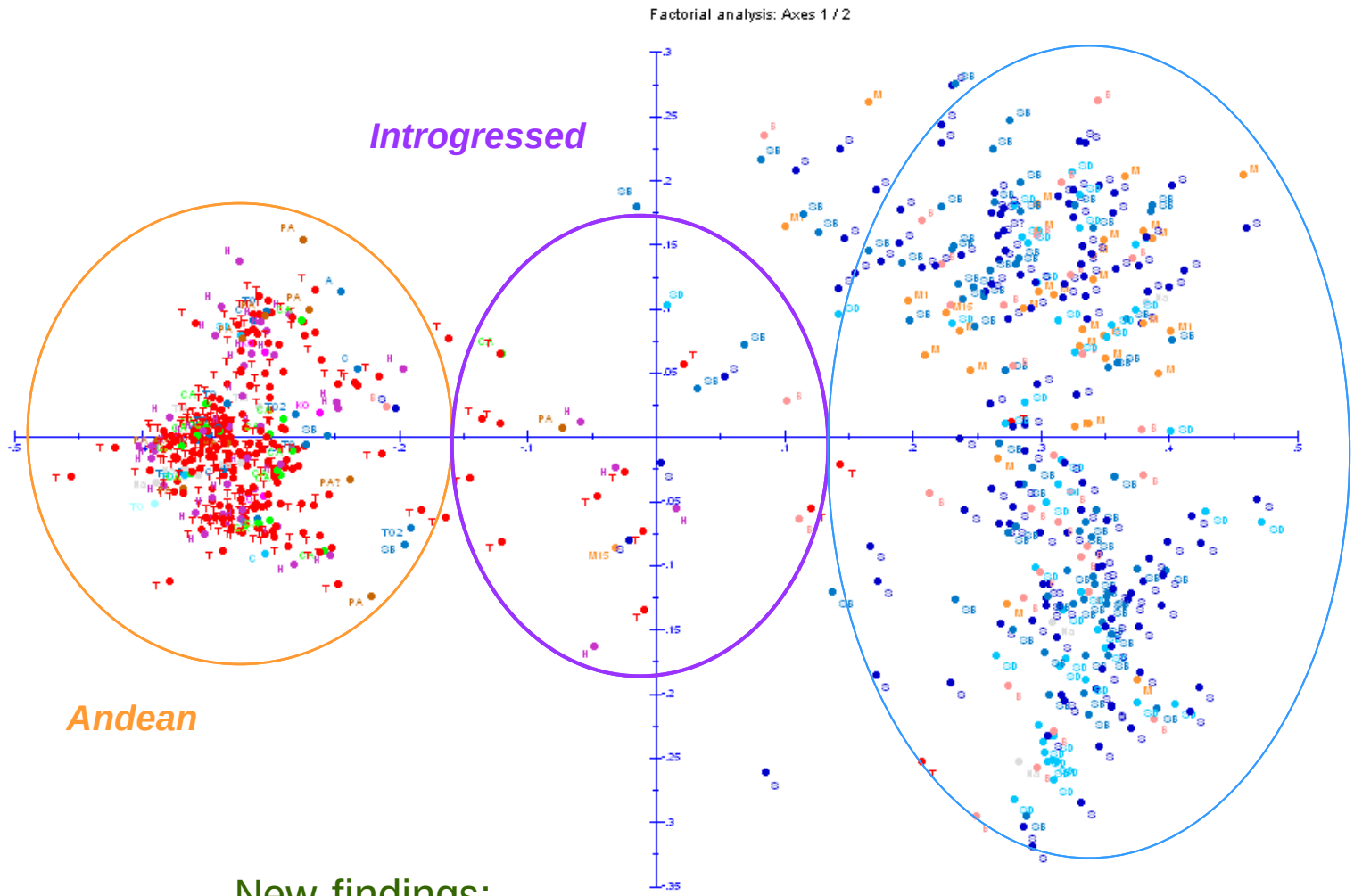
Collection name	Local unique ID	Genus	Species	Country origen	Accession name
CORE	G738	Phaseolus	vulgaris	GUATEMALA	PILIGUE
CORE	G1113	Phaseolus	vulgaris	CHILE	COSCORRON ALTO JAHUEL
CORE	G1525	Phaseolus	vulgaris	CHILE	FRUTILLA
CORE	G1678	Phaseolus	vulgaris	BRASIL	BAETAO-MANTEIGA 41
CORE	G1688	Phaseolus	vulgaris	BRASIL	PRETO FORRO 5
CORE	G1832	Phaseolus	vulgaris	COSTA RICA	GENTRY 20670 (SELECCION)
CORE	G1836	Phaseolus	vulgaris	COSTA RICA	GENTRY 20670 (SELECCION)
CORE	G1939	Phaseolus	vulgaris	MEXICO	GENTRY 21351 OJO DE LIEVRE

b) Allele worksheet

“Alellobinned” vs. “raw”

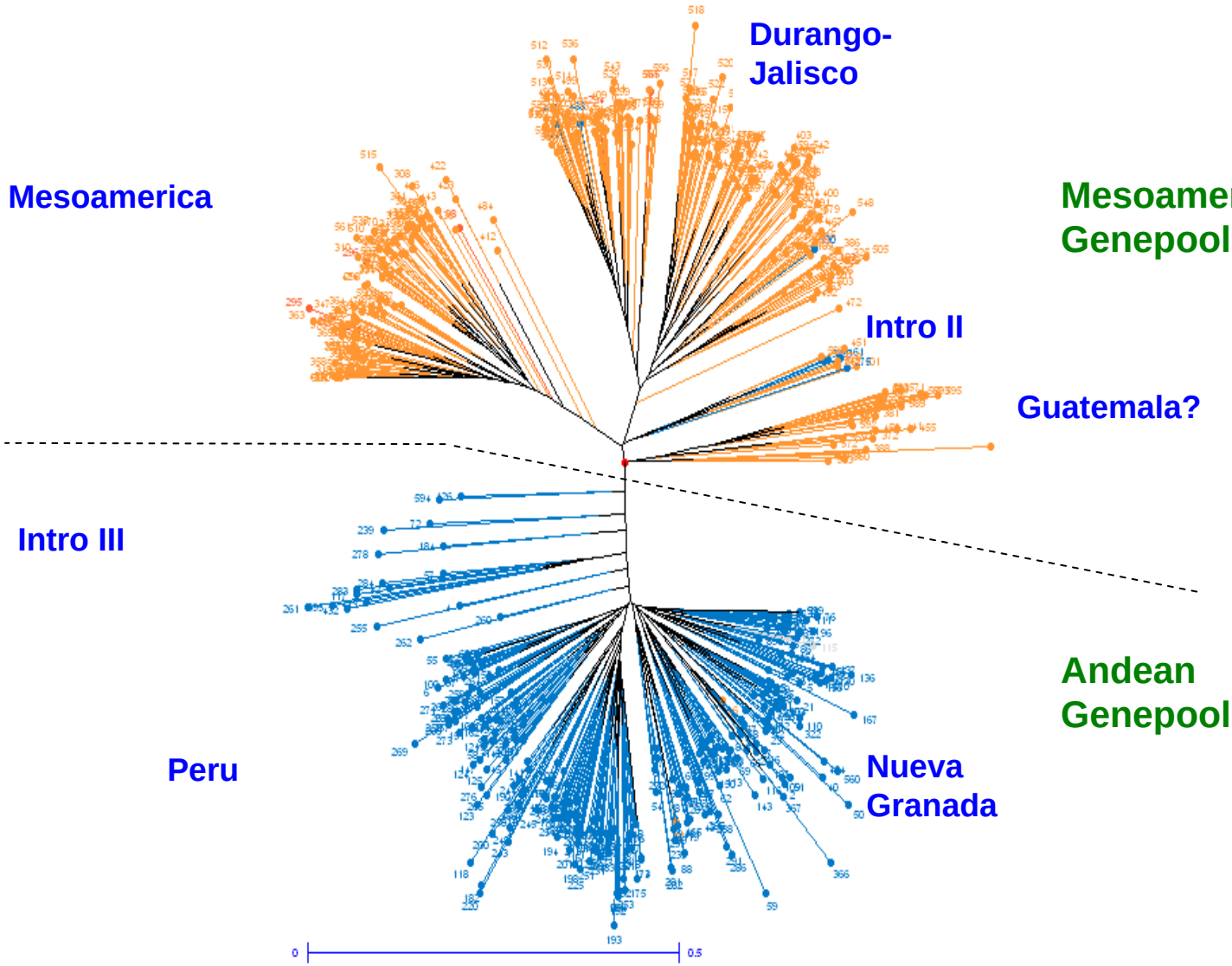
Sample ID	Accession	Marker	Gel/Run	Dye	Allele	Size
E95	G738	BM137	And1_plate21_1	Green	165/165	164.89/164.89
E95	G738	BM139	And1_plate5_1	Red	118/118	117.94/117.94
E95	G738	BM141	And1_plate22_1	Blue	216/216	215.81/215.81
E95	G738	BM143	And1_plate21_1	Red	152/152	151.71/151.71
E95	G738	BM149	And1_plate21_1	Blue	253/253	253.65/253.65
E95	G738	BM156	And1_plate5_1	Blue	257/257	257.65/257.65
E95	G738	BM160	And1_plate5_1	Yellow	211/259	209.79/258.73
E95	G738	BM172	And1_plate3_1	Red	114/114	113.54/113.54

Results – Core Collection Analysis



New findings:
Slightly more diversity in the Mesoamerican genepool
Importance of introgression between the genepools

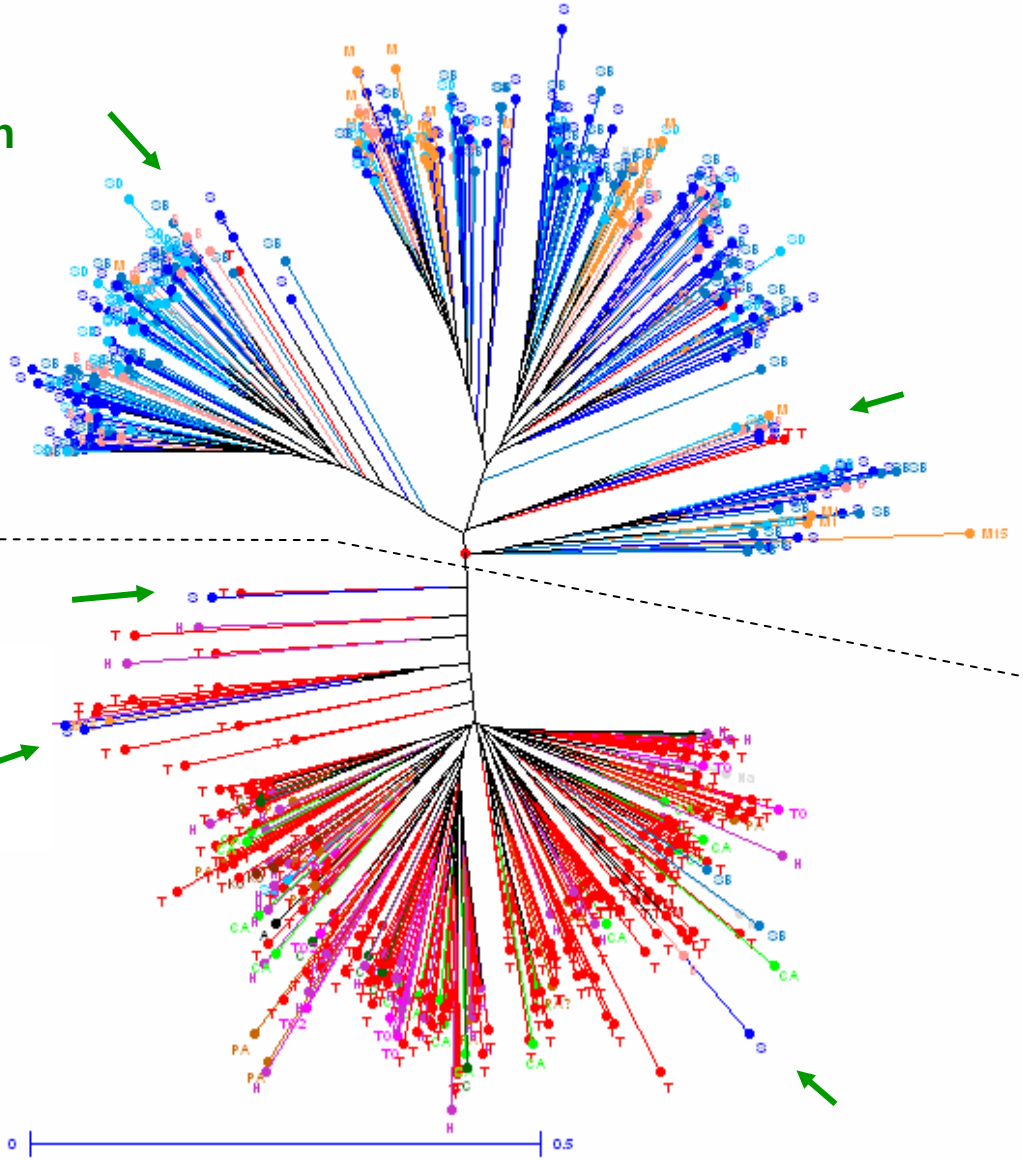
Results - Genepools and Races



Results - Distribution of Phaseolin

Mesoamerican Genepool

Andean Genepool



Principal patterns

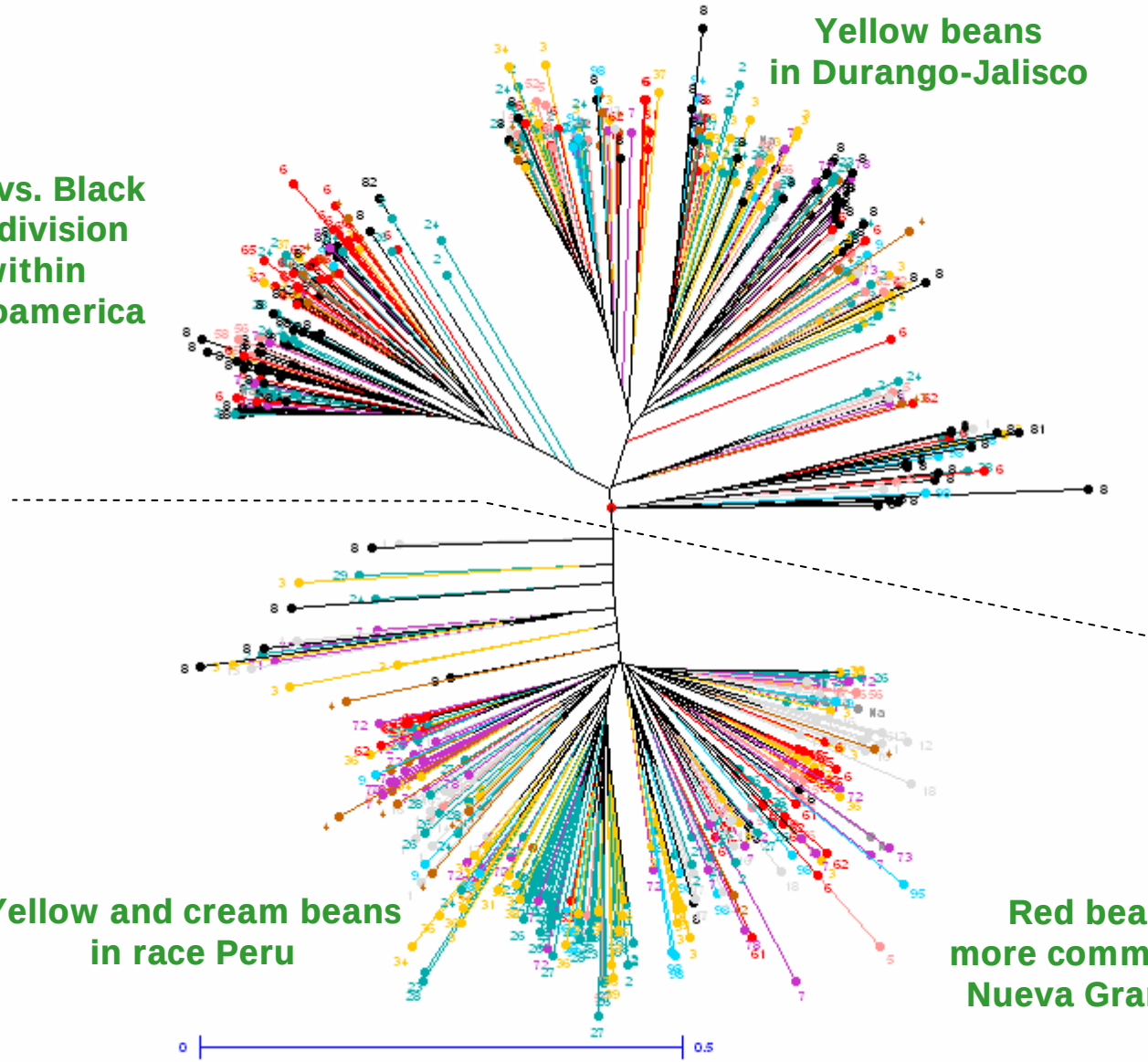
T = red

S = Blue

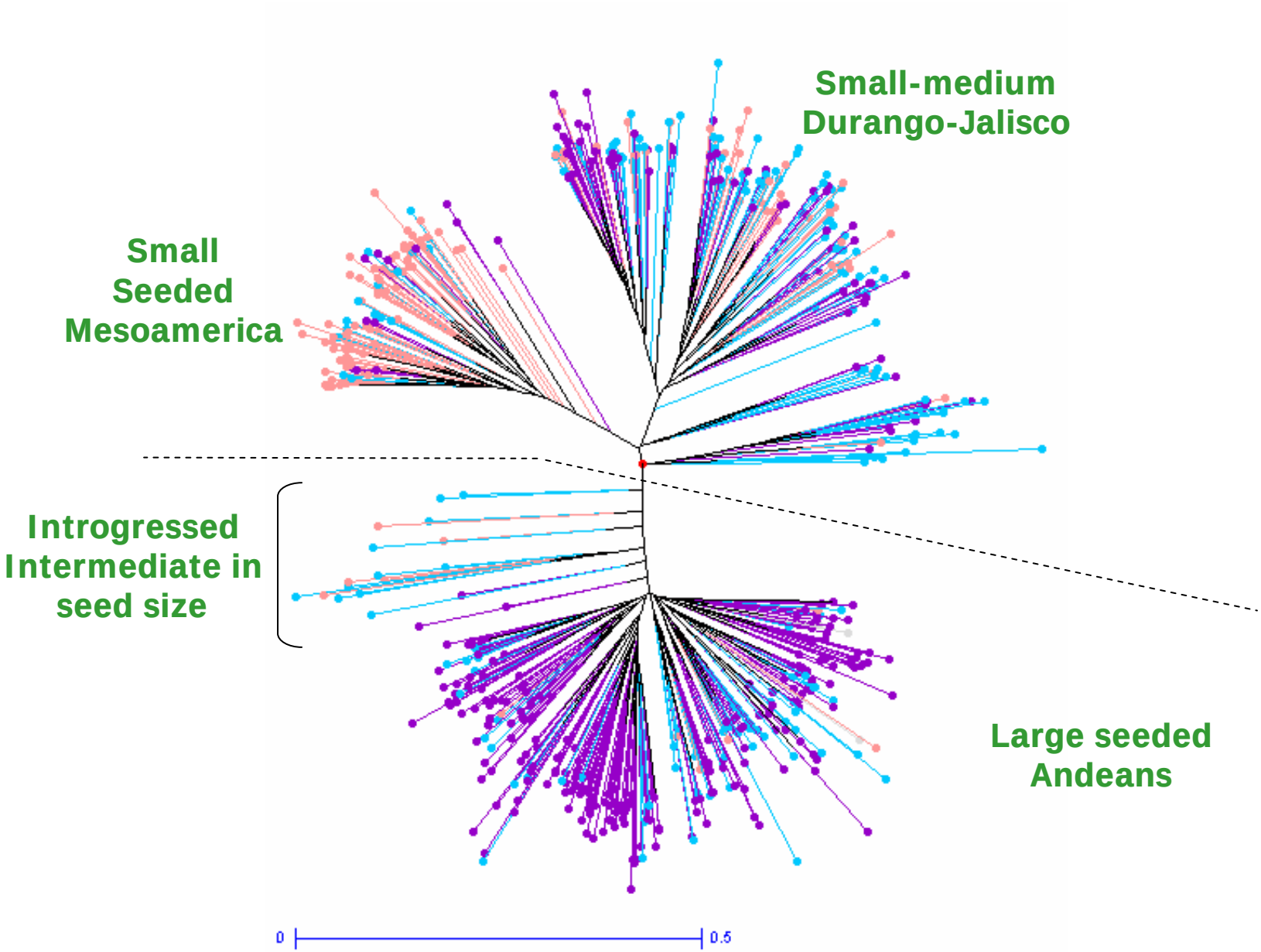
Phaseolin is a complex but single-locus, seed protein marker that distinguishes genepools but not races

Arrows indicate Introgression of phaseolin across genepools

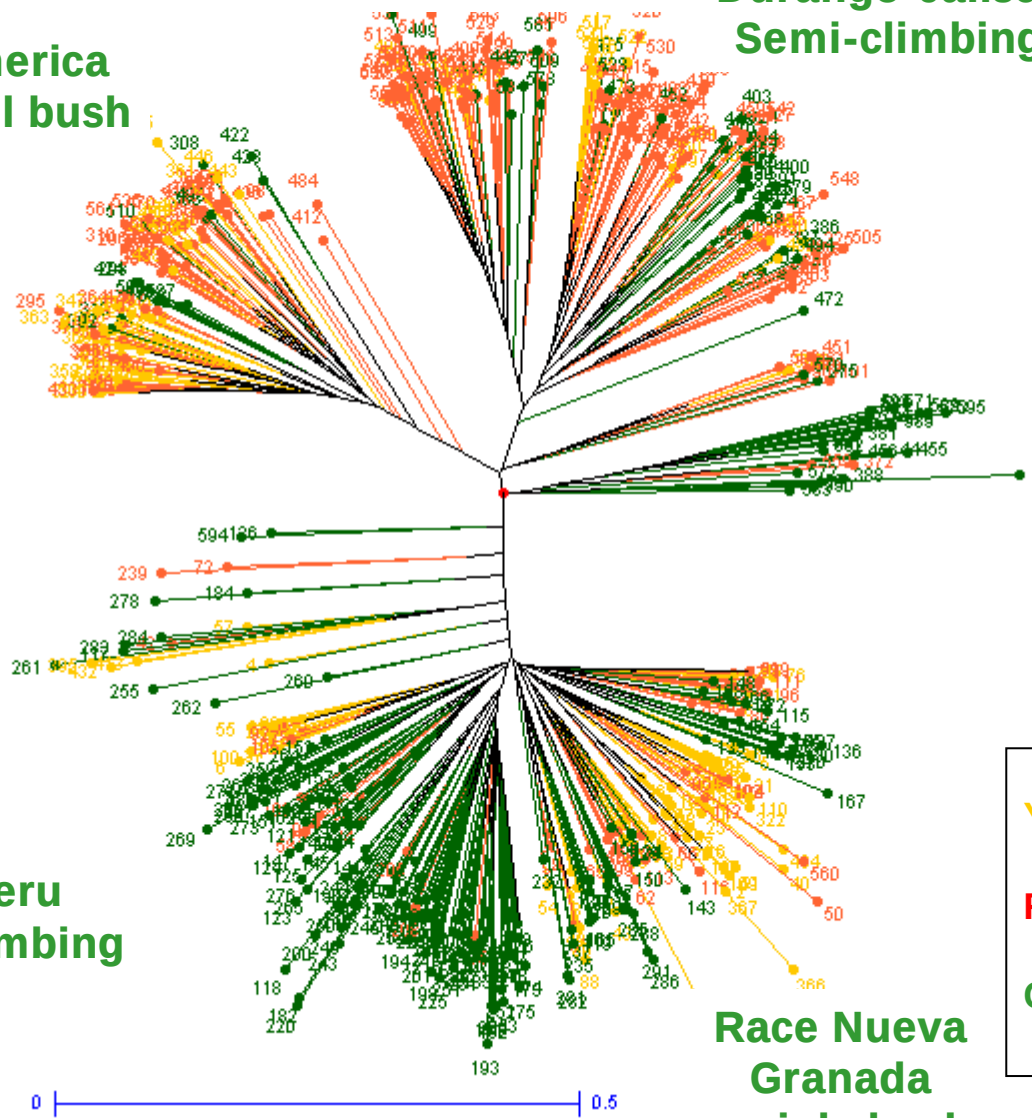
Results - Distribution of Seed Color



Results - Distribution of Seed Size



Results - Distribution of Growth Habit



Yellow = type I or II

Red = type III

Green = type IV

Bush

Climbing

Ecotypes??

Durango-Jalisco I
type III growth habit
multiple seed colors (med.)
Drought tolerance?

Durango-Jalisco II
type III and IV
multiple seed
colors – biomass?

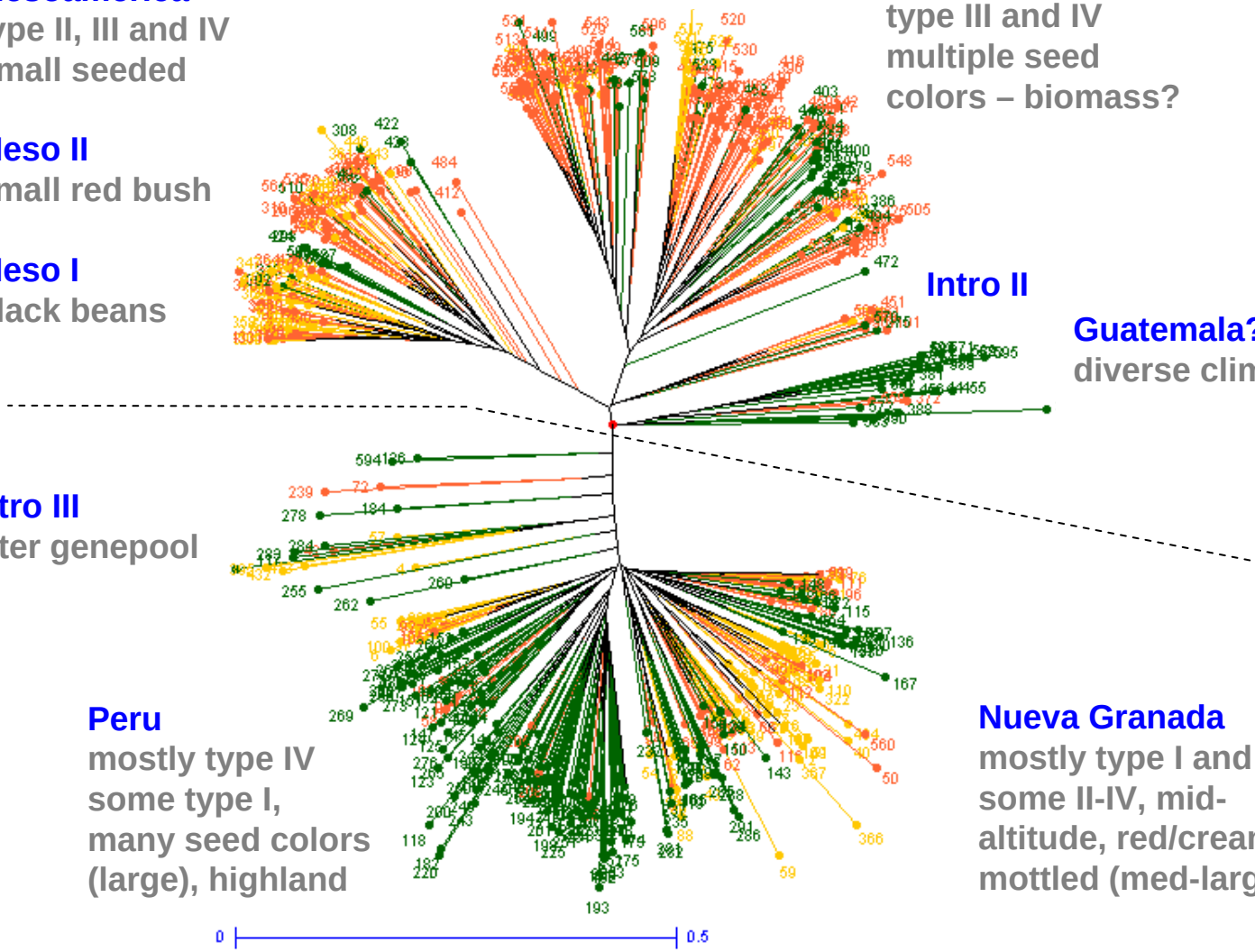
Mesoamerica
type II, III and IV
small seeded

Meso II
small red bush

Meso I
black beans

Intro II

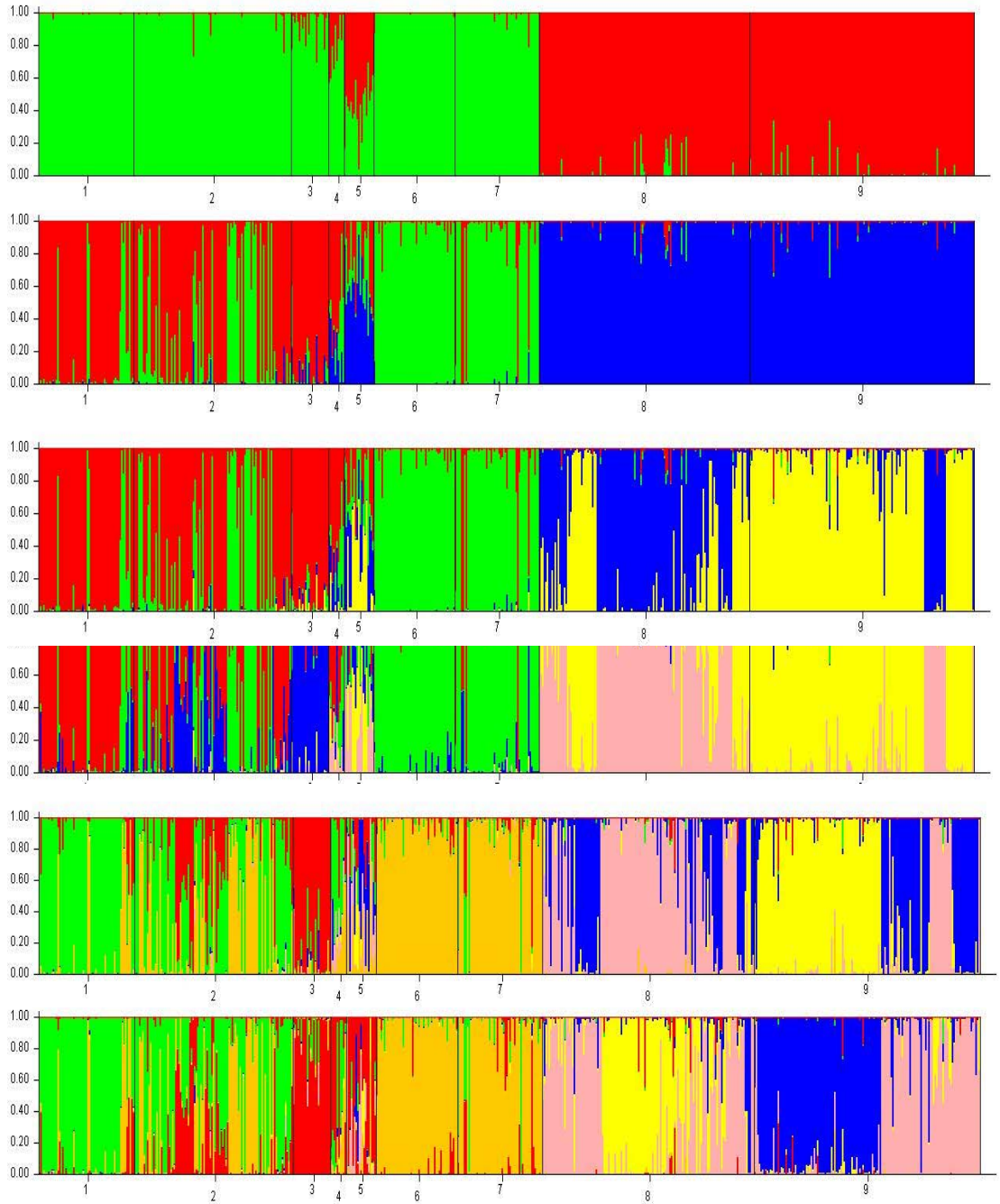
Guatemala?
diverse climbing beans



Intro III
Inter genepool

Peru
mostly type IV
some type I,
many seed colors
(large), highland

Nueva Granada
mostly type I and
some II-IV, mid-
altitude, red/cream
mottled (med-large)



Andean and Mesoamerican Genepools separate

D-J and M separate within Mesoamerican genepool

NG and P separate within Andean genepool

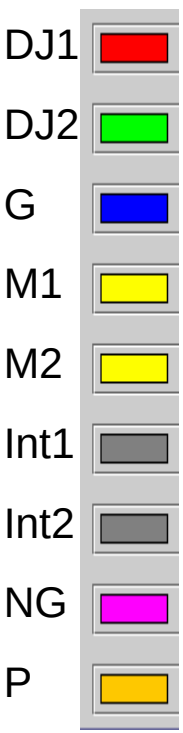
Introgression groups separate from both genepools

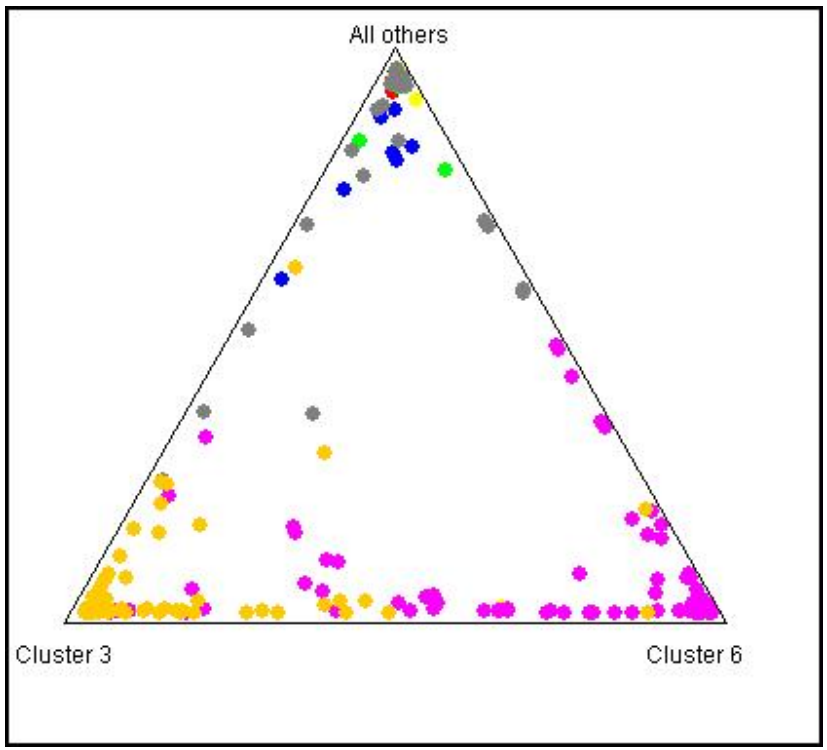
Lots of intermediate genotypes

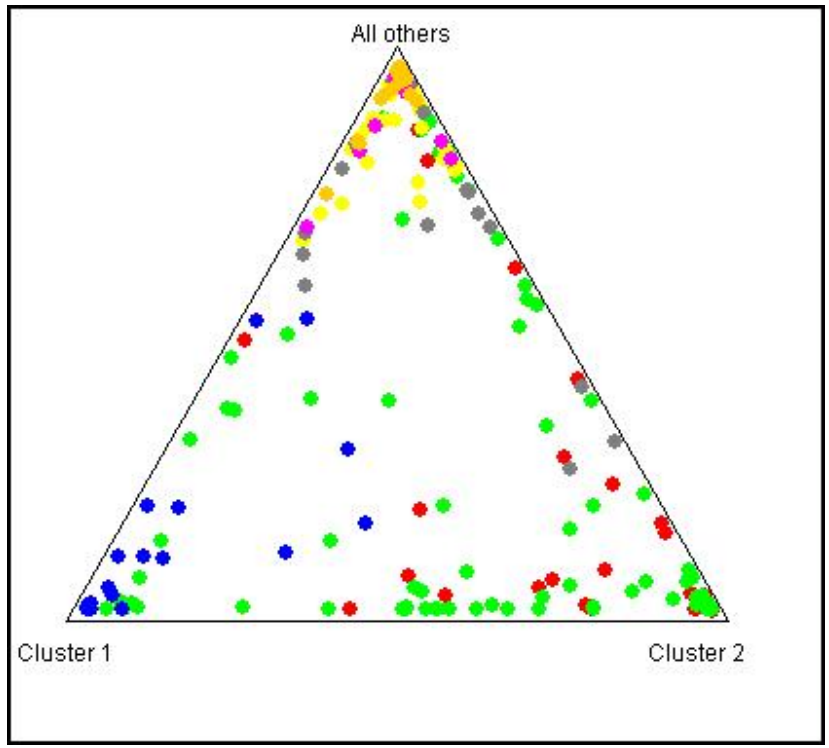
Population Structure

(K= 2 to 7)

Cluster Analysis







Andean separation
Nueva Granada vs. Peru

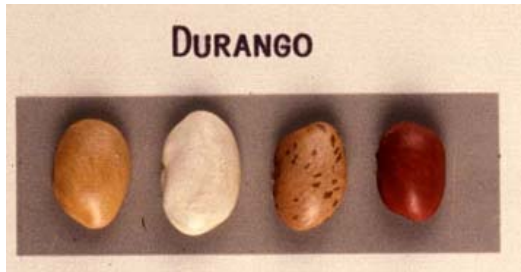
Mesoamerican separation
D-J vs. G vs. M

Product delivery and impact on users
1) Preserving diversity

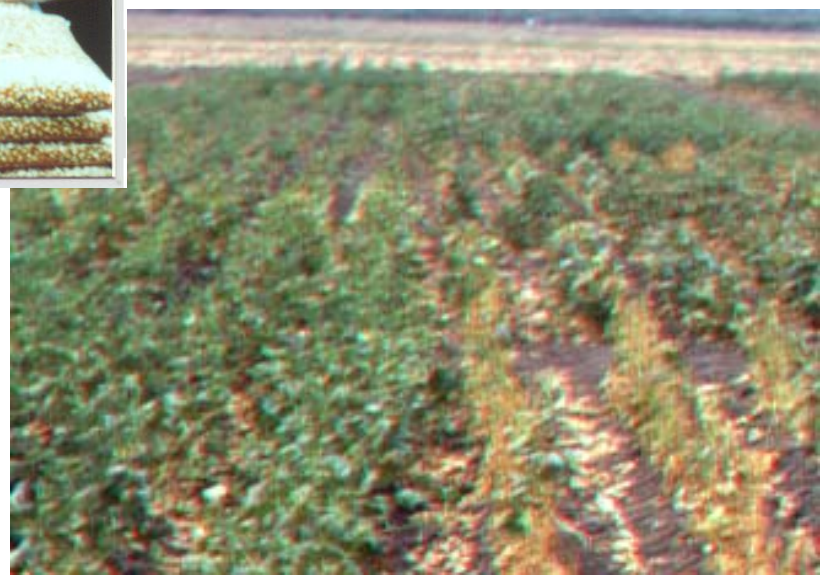
(example: genetic erosion in Bolivia due to cultural and climatic changes – usefulness of Peru climbing beans as novel sources of alleles)

2) Targeted introduction of germplasm

a) drought tolerance and commercial colors from the Durango race



Opportunities for Durango seed classes in E. and S. Africa



Many Durango beans have good commercial seed colors and high levels of drought tolerance

3) Introducing New Climbing Bean Varieties

(example: use of Mexican/Guatemalan climbing beans in Great Lakes region of Africa)

Research Summary

- Population structure in common bean is organized among gene pools (Meso and Andean) as well as races
- SSR analysis uncovers these groupings as well as finer levels of population structure which were not possible to distinguish with previous markers.
- Two major subdivisions are seen in each genepool validating the Durango-Jalisco, Mesoamerica, Nueva Granada and Peru races.
- Race Guatemala seems to be distinct and consists mainly of climbing beans.

Concluding Remarks

- Genotypic data has been uploaded to the GCP data repository and has been used to select a reference collection for further phenotypic analysis.
- We have created a marker kit that can be used for determining population structure in additional groups of genotypes.
- Impact on users will be two-fold: 1) better germplasm preservation strategies and 2) better understanding of commercial seed classes and races to use in breeding combinations or in targeted introduction of germplasm.
- These results will be used in the Tropical Legume I and II projects for improvement of drought tolerance in common beans.