



Conservation and Use of Wild Populations of *Coffea arabica* in the Montane Rainforests of Ethiopia

Genetic diversity of wild Coffee (*Coffea arabica*) and its implication for conservation

Kassahun Tesfaye, Feyera Senbeta, Tamiru Oljira,
Solomon Balemi, Govers, K., Endashaw Bekele, Borsch, T.

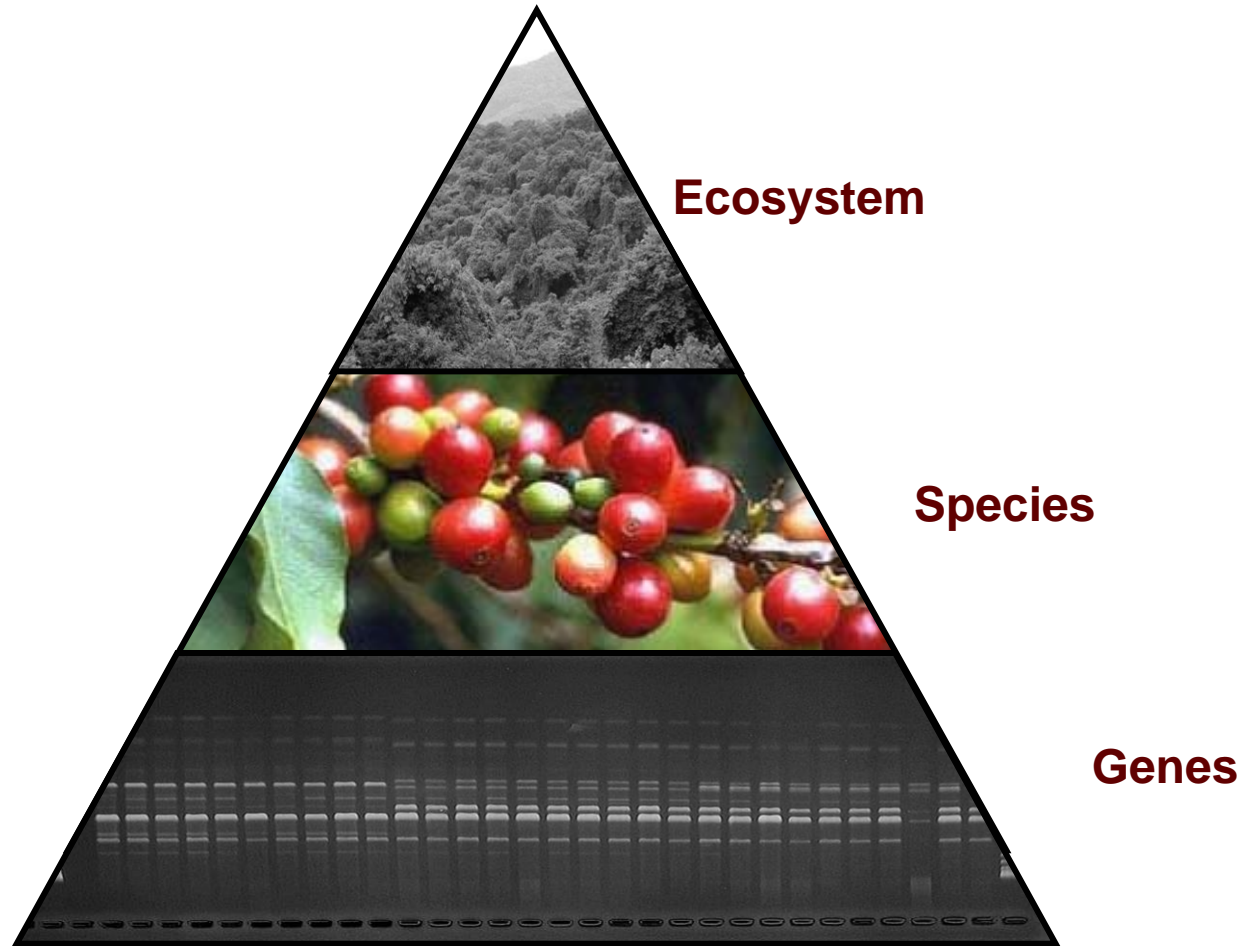
Biodiversity of Africa –
Observation and Sustainable Management for our Future!
September 29 – October 3, 2008
Spier / Stellenbosch / Republic of South Africa





Conservation and Use of Wild Populations of *Coffea arabica* in the Montane Rainforests of Ethiopia

Biodiversity





Objectives:–

- To clarify the maternal parentship among closely related *Coffea* species.
- To characterize cpDNA microsatellites & to detect SNPs within *C. arabica* to observe infraspecific variation among wild populations *C. arabica*.
- To evaluate if individuals from wild populations in forests are genetically different from landraces.
- To evaluate the relationships of wild *C. arabica* populations throughout Ethiopia & also to understand the patterns of distribution.



Conservation and Use of Wild Populations of *Coffea arabica* in the Montane Rainforests of Ethiopia

**Chloroplast DNA
Microsatellites**
-High level-

**Interregional
Genetic Diversity**
-Medium level-

**Intraregional
Genetic Diversity**
-Low level-



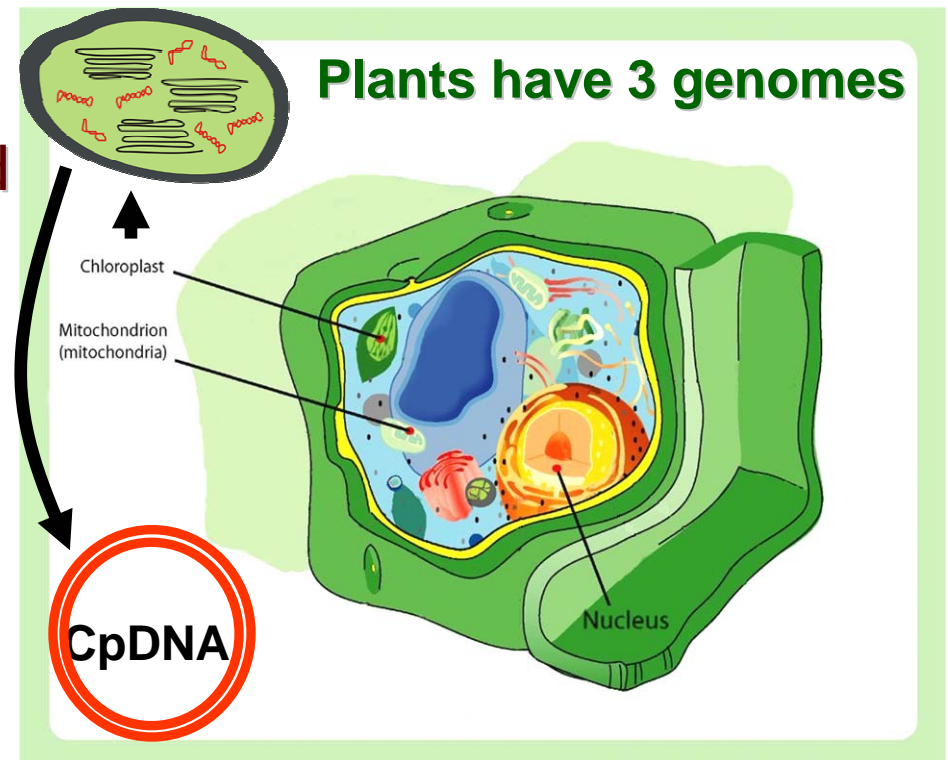
Genetic Diversity of *Coffea arabica* in Ethiopia



Conservation and Use Planning

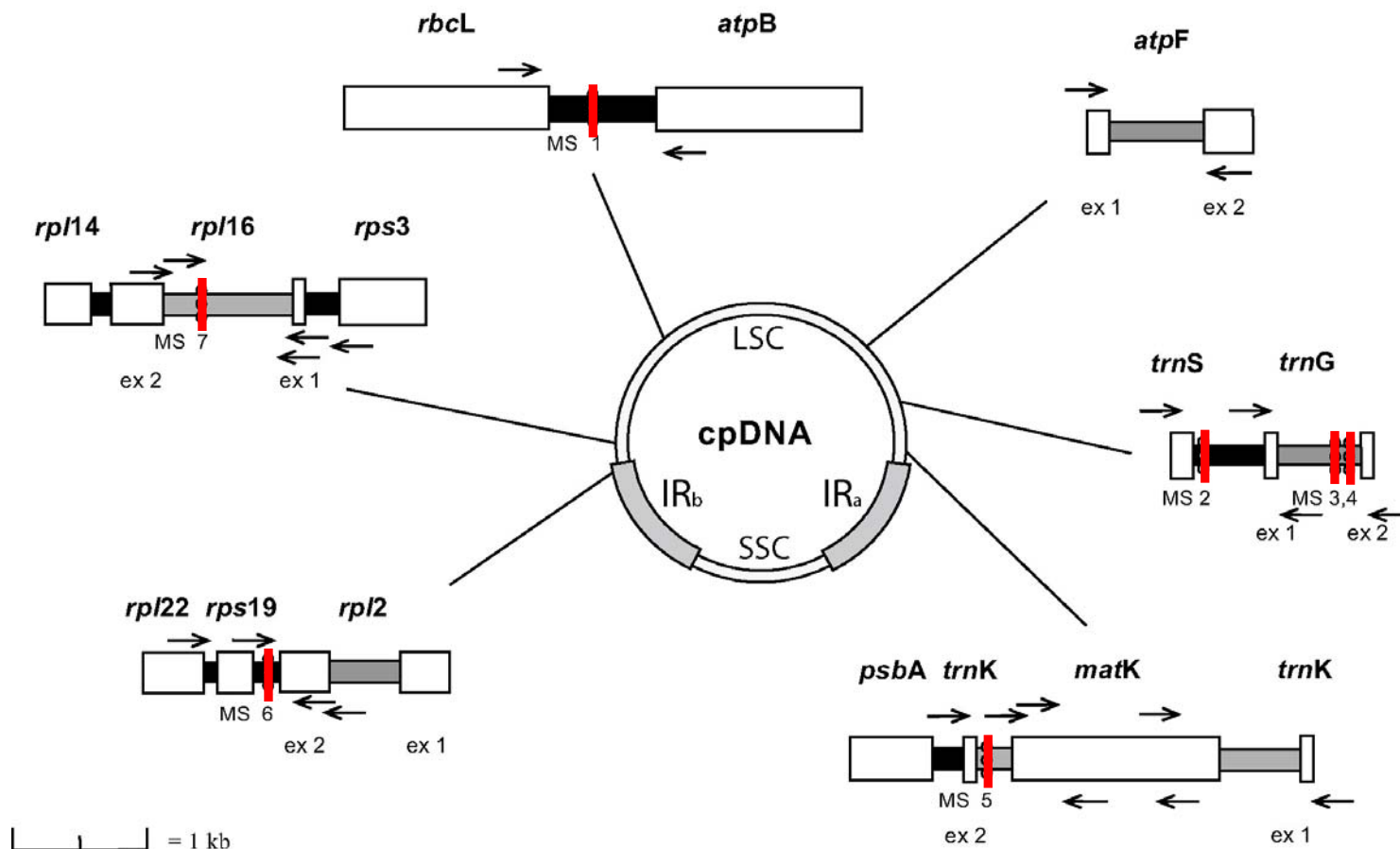
Chloroplast DNA Microsatellites

- CpDNA is maternally inherited
- Intron & spacer usually variable within species
- Contain hyper-variable microsatellites
- To explain the genetic diversity in an evolutionary context



Chloroplast regions selected

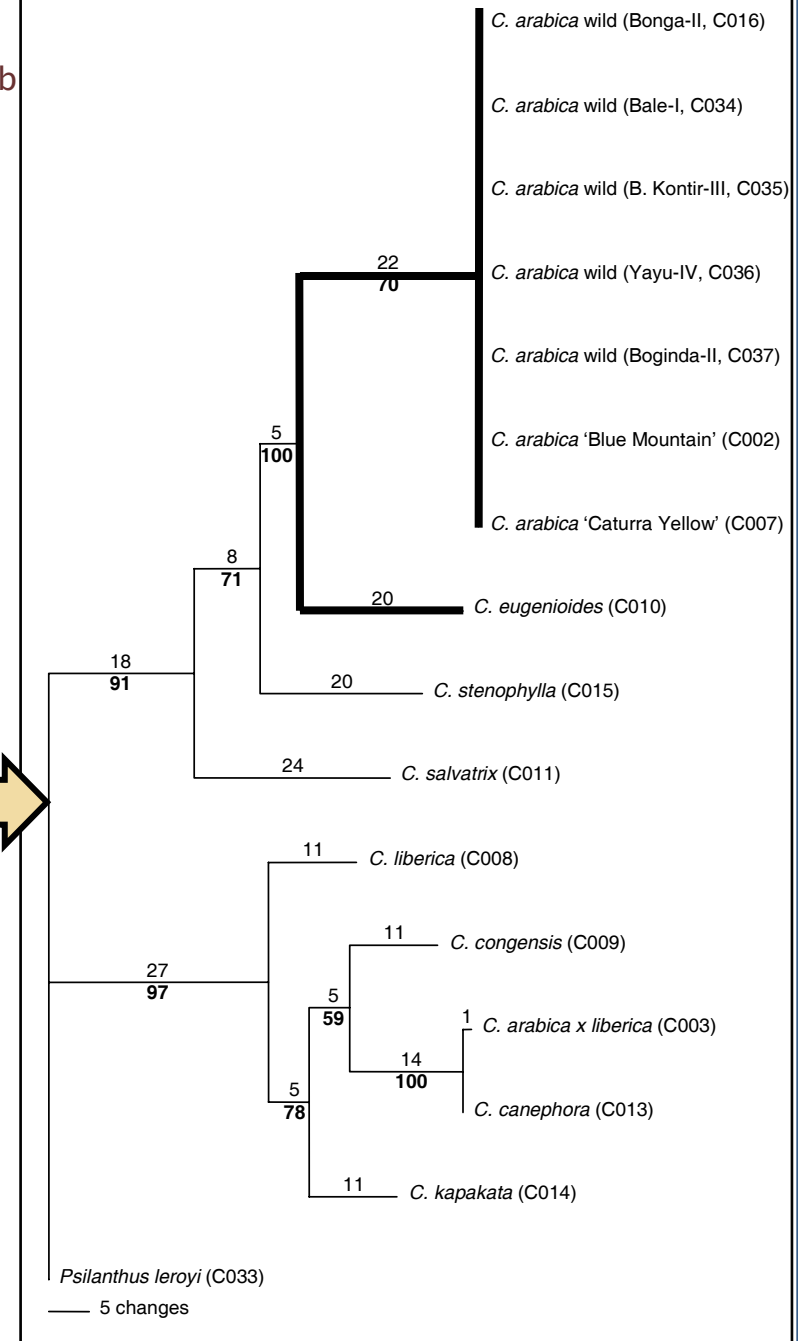
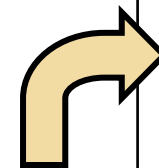
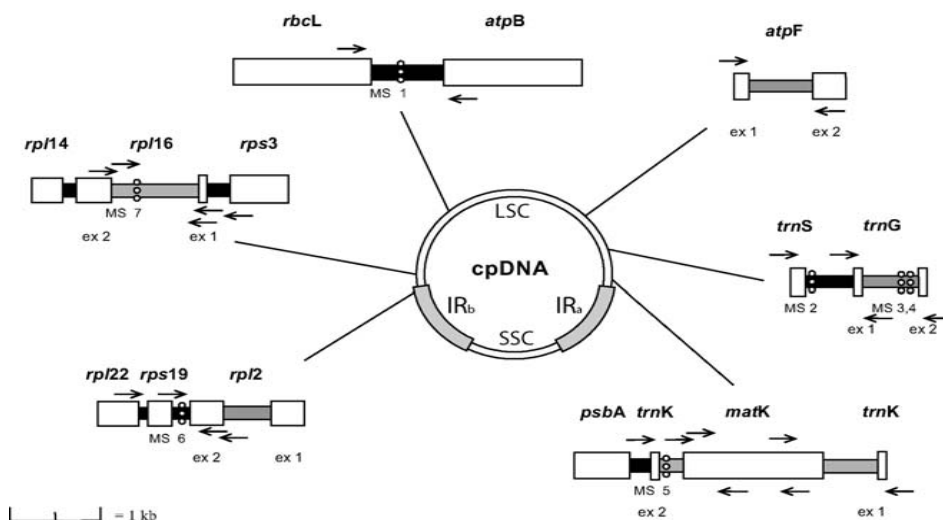
- Screening cpDNA for its most variable regions for 17 taxa (5.5 %)
- Seven microsatellites (MS1, MS2, MS3, MS5, & MS7)





Conservation and Use of Wild Populations of *Coffea arabica*

- 7.2 kb of cp-genome sequenced for 17 taxa
- *C. arabica* exhibits no cp-genome diversity (unlike most plants!)
- Very recent origin
- *C. eugenioides* sister to *C. arabica*





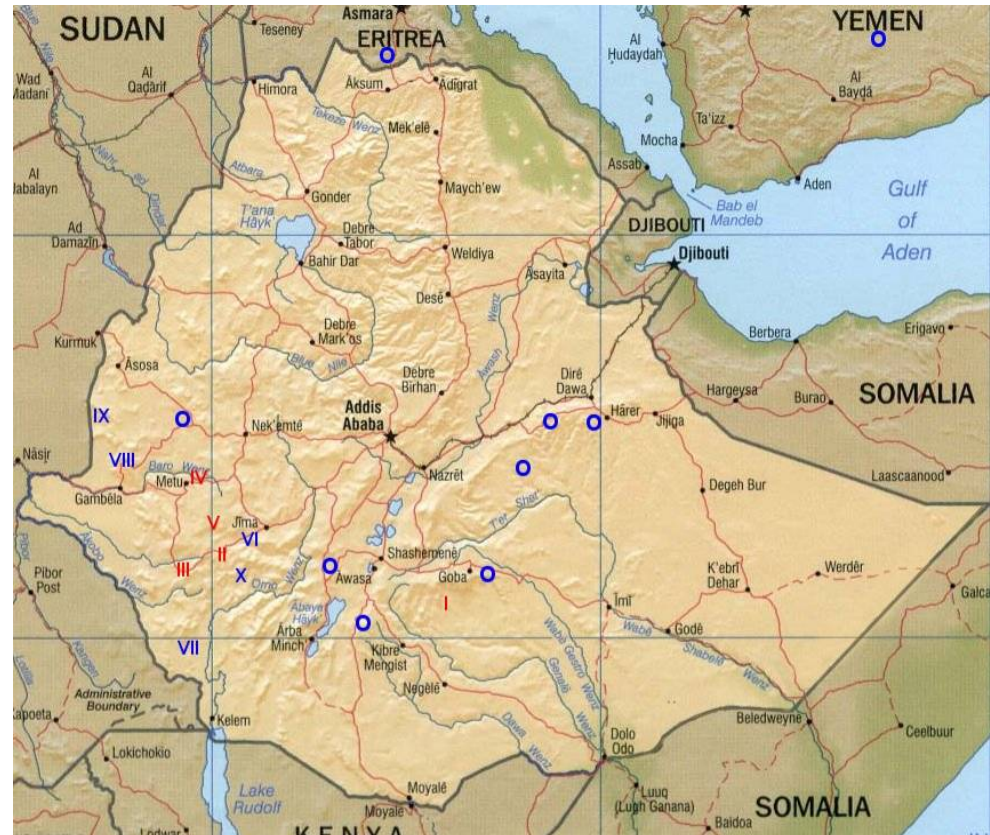
Summary of Chloroplast data

- An ancestor of *C. eugenioides* is evidenced to be the maternal parent for *C. arabica*.
- Both *C. arabica* & *C. eugenioides* are recently diverged within *Coffea*.
- *C. arabica* has a single origin (one polyploidisation event).



Interregional diversity assessment

- 10 regions of wild coffee
- 1 sample per landrace
- 150 individuals



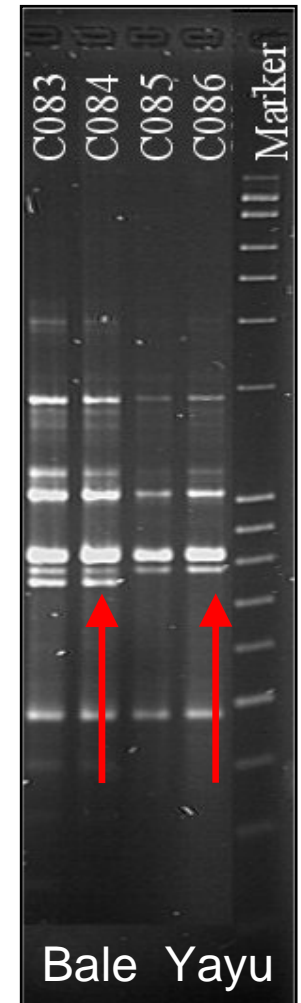
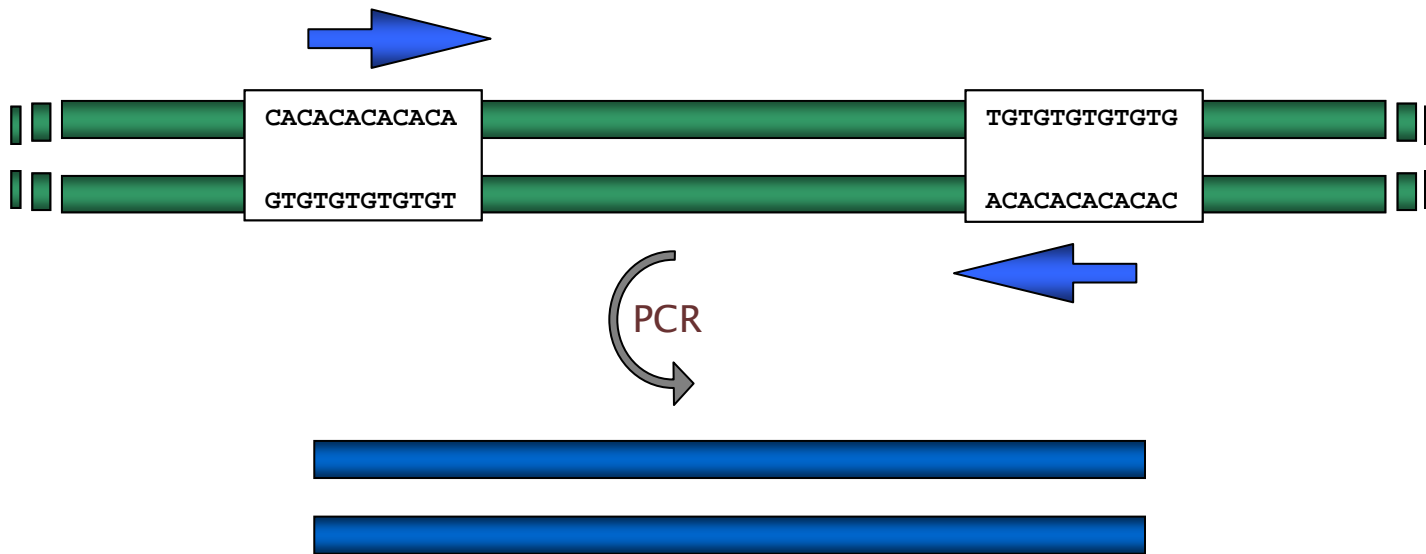
I to IV - Core CoCE sites (wild Coffee)

V to X - Additional wild Coffee sites

O - Landraces (Farmer's varieties)



- Inter Simple Sequence Repeats–ISSR

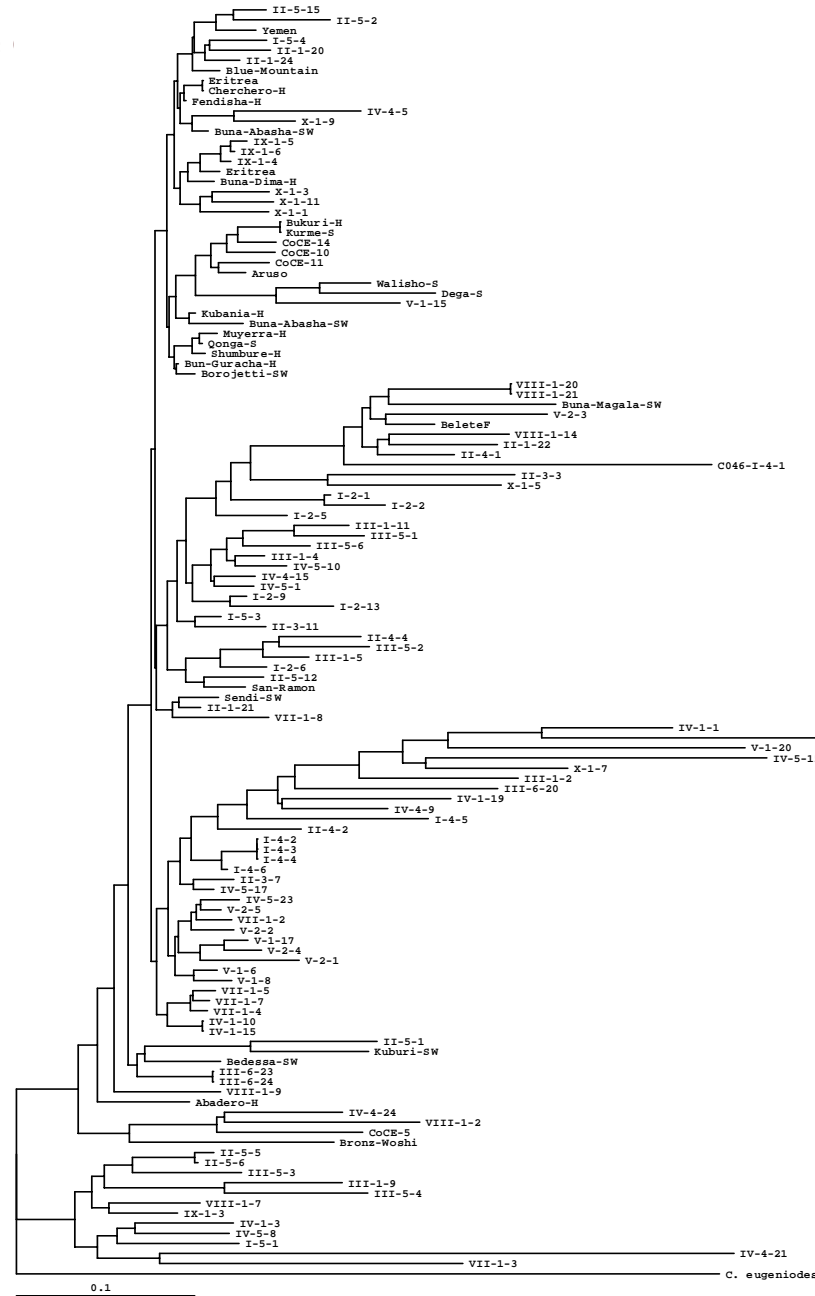




Conservation and Use

Interregional NJ tree

Landraces &
Cultivars
different
from
Wild
individuals



parts of Ethiopia

Landraces &
Cultivars

Wild
individuals

Wild
individuals

Wild
individuals
Wild Yayu
& B. Kontir

INTER REGIONAL



Conservation and Use

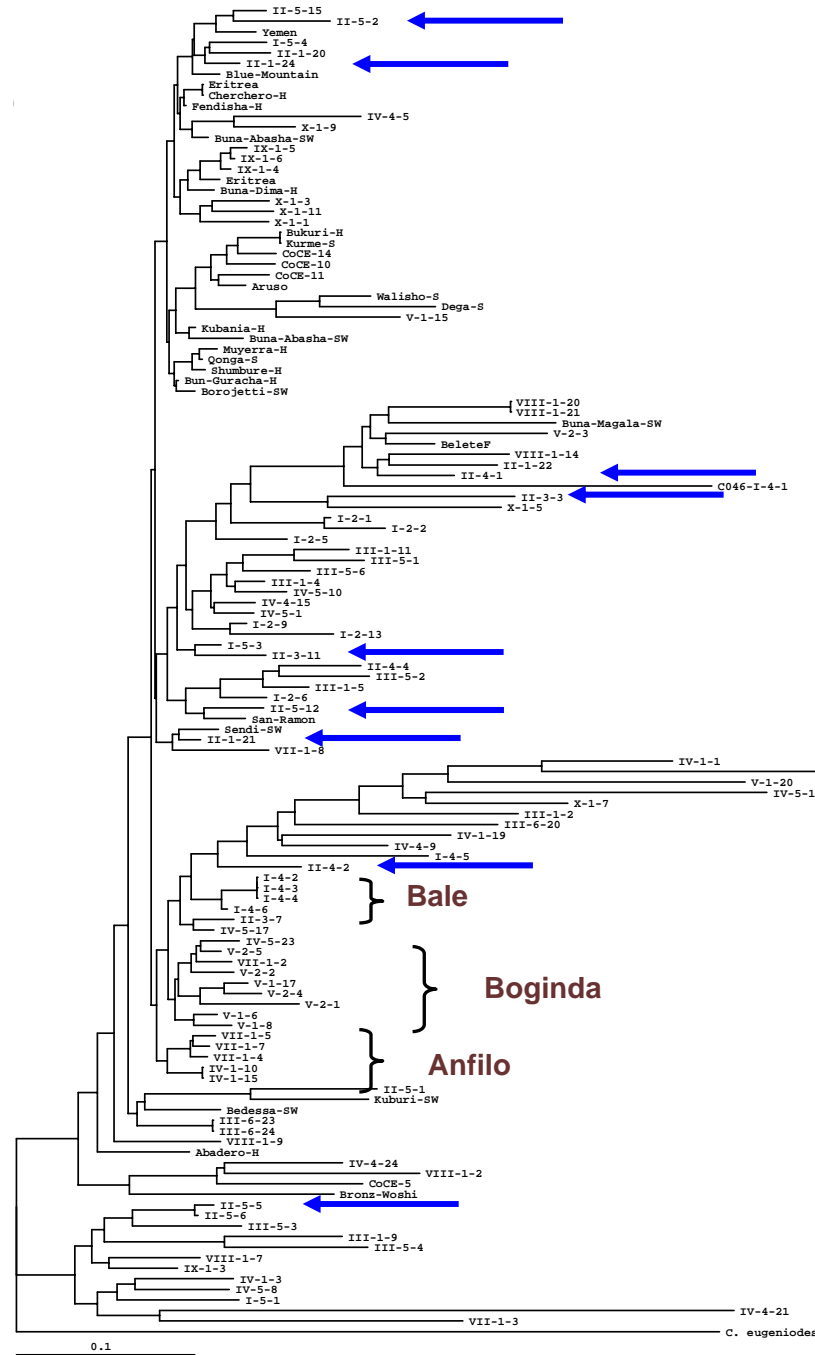
Interregional NJ tree

Bonga

– Spread all over the tree

Boginda,
Bale/Harrena &
Anfilo;

– Form its own groups



Parts of Ethiopia

Landraces & Cultivars

Wild individuals

Wild individuals

Wild individuals
Wild Yayu & B. Kontir

INTER REGIONAL



Shannon's diversity index (H) & percentage of ISSR band polymorphism (P)

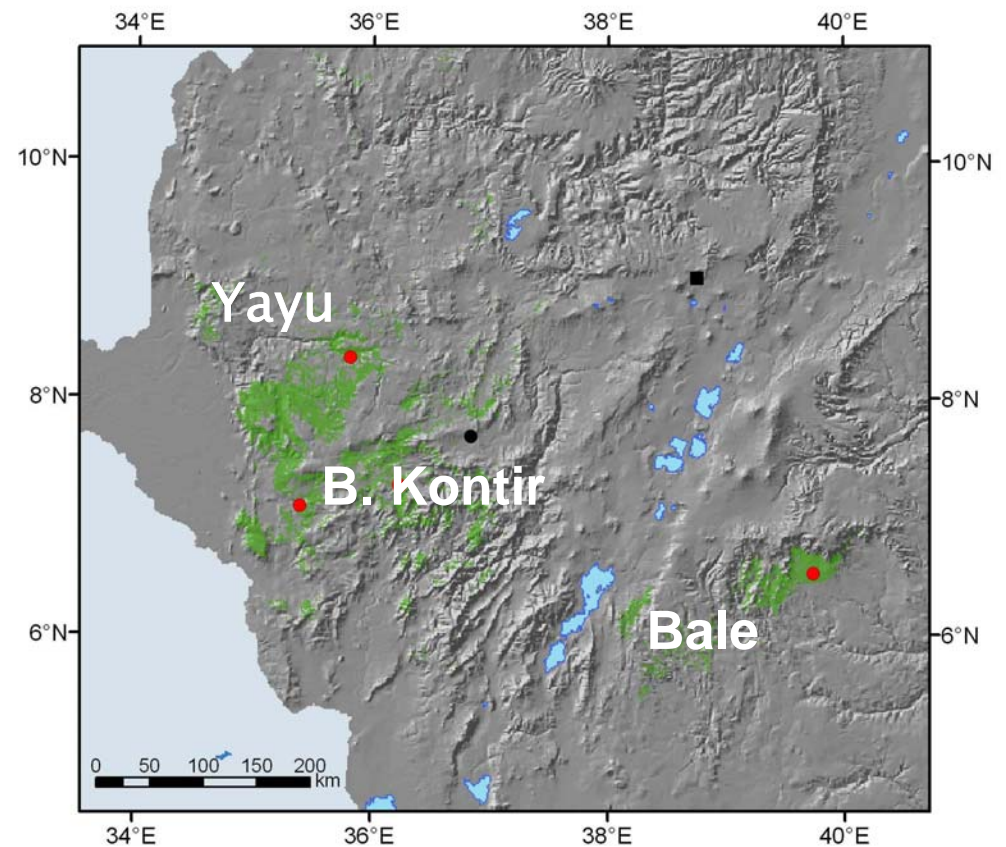
Region	Percent Polymorphism (%P)		Over all %P	Shannon's diversity Index (I)		Over all Index (I)
	Di/tri_ Primers	Tetra_ Primer	All primers	Di/tri_ Primers	Tetra_ Primer	All primers
Bale (Harrena)	13.7	80.7	27.7	0.18	0.53	0.25
Bonga	28.2	93.6	41.9	0.31	0.71	0.40
Berhane Kontir	20.5	87.1	34.5	0.28	0.56	0.34
Yayu/Geba Dogi	20.5	93.6	35.8	0.30	0.76	0.40
Boginda	16.3	83.9	30.4	0.18	0.59	0.27
Bench Maji	5.1	67.7	18.2	0.13	0.54	0.22
Anfilo	7.7	67.7	20.3	0.21	0.53	0.28
Daphe	2.6	71.0	16.9	0.17	0.60	0.25
Mankira	10.3	83.9	25.7	0.20	0.75	0.31
Sidamo	7.7	54.8	17.6	0.14	0.46	0.21
Hararegh	10.3	80.7	25.0	0.08	0.49	0.17
South West	15.4	58.1	24.3	0.17	0.40	0.22

INTER REGIONAL



Intraregional diversity assessment

- Three regions (Yayu, B.Kontir & Bale)
- 250 individuals (Yayu & B.Kontir)
- ISSR marker system





ISSRs show that: –

- Wild coffee populations can be clearly distinguished from landraces "true wild coffee".
- High levels of genetic diversity within geographical regions and vary from region to region.
- Even though Bonga, Yayu and Berhane Kontir showed higher diversity indices, it is observed that most regions have their unique genotypes.
- Individuals belonging to landraces often have lower genetic distances to each other than individual of wild populations.
- There is fine scale spatial genetic structuring among populations of Berhane Kontir and Yayu.
- Semidisturbed plots tends to show higher diversity than undisturbed.



Recommendations for conservation & use planning

- Genetic evidence for true wild coffee – Justify conservation
- Unique genotypes in different regions – Multi-site in situ conservation approach
- The existing genetic divergence among regions –
Prospects for use in national breeding (heterosis)



Implementation-oriented research activities

● Establishing coffee *in situ* gene bank:–

- The aim is to have a ‘copy’ of the genetic diversity in the natural populations at the forest margin.
- To re-introduced elite breeding materials originally came from the same forest into the forest margin to increase the yield and income of the local farmer.
 - *In situ* gene bank have both conservation and use value for the local farmers who are fully dependent on wild coffee.



In situ gene bank-Yayu

Naturally regenerated seedlings were collected from different forest population





In situ gene bank

- Totally 5,000 coffee seedlings were disseminated for the 3 farming community-Year 2007





Conservation and Use of Wild Populations of *Coffea arabica* in the Montane Rainforests of Ethiopia

Seeds of forest tree species like *Cordia africana*, *Albizia grandibracteata*, *Albizia gummifera*, *Acacia abyssinica*, & *Acacia mellifera* were collected and raised in Nursery

–2,000 seedlings were disseminated





Local Youth Association
Agreement were made with Youth Association organized to manage of the forest

– 10,000 seedlings of coffee along with 6,200 tree species were given for the association in Yayu.



Leaders of the Association





Selection of elite individual coffee for re-introduction to the forest margin –Jima Agricultural Research Center





CoCE

Capacity Building and Research Activities in AAU





CoCE

Capacity Building and Research Activities in AAU





Capacity Building and Research Activities in AAU





Conservation and Use of Wild Populations of *Coffea arabica* in the Montane Rainforests of Ethiopia



Nees



AAU



ZEF Bonn



CIAT



IBC



universität bonn



BioTeam



Federal Ministry
of Education
and Research