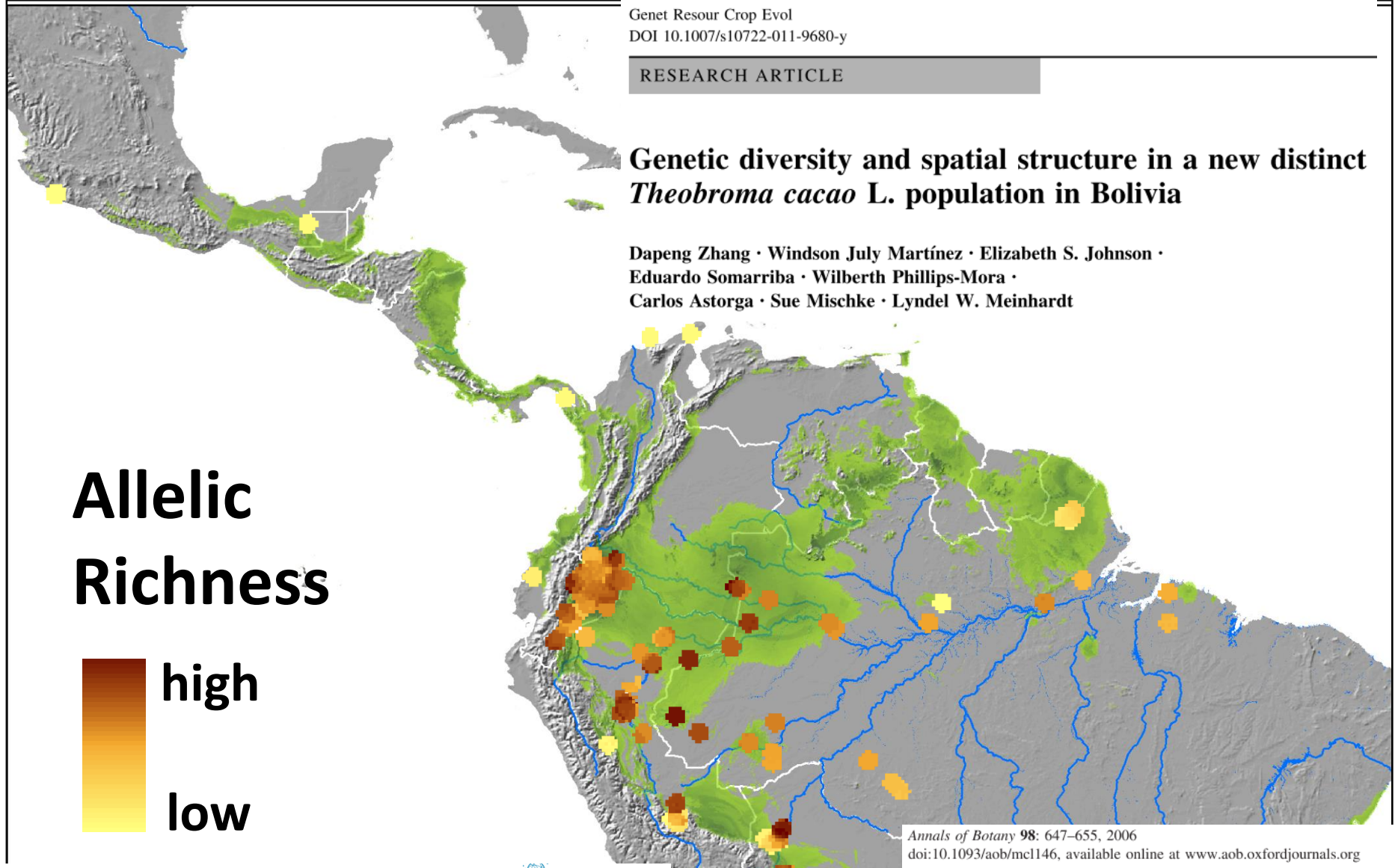
A genetic origin of fine or flavour cacao in southern Peru?

Evert Thomas, Thibault Chaillon, Bertus Eskes, Wilbert Cruz, Carlos Rodriguez, Odicio Campana, Wilton Cespedes

Bioversity International



Genet Resour Crop Evol
DOI 10.1007/s10722-011-9680-y

RESEARCH ARTICLE

Genetic diversity and spatial structure in a new distinct *Theobroma cacao* L. population in Bolivia

Dapeng Zhang · Windson July Martínez · Elizabeth S. Johnson · Eduardo Somarriba · Wilberth Phillips-Mora · Carlos Astorga · Sue Mischke · Lyndel W. Meinhardt

Annals of Botany **98**: 647–655, 2006
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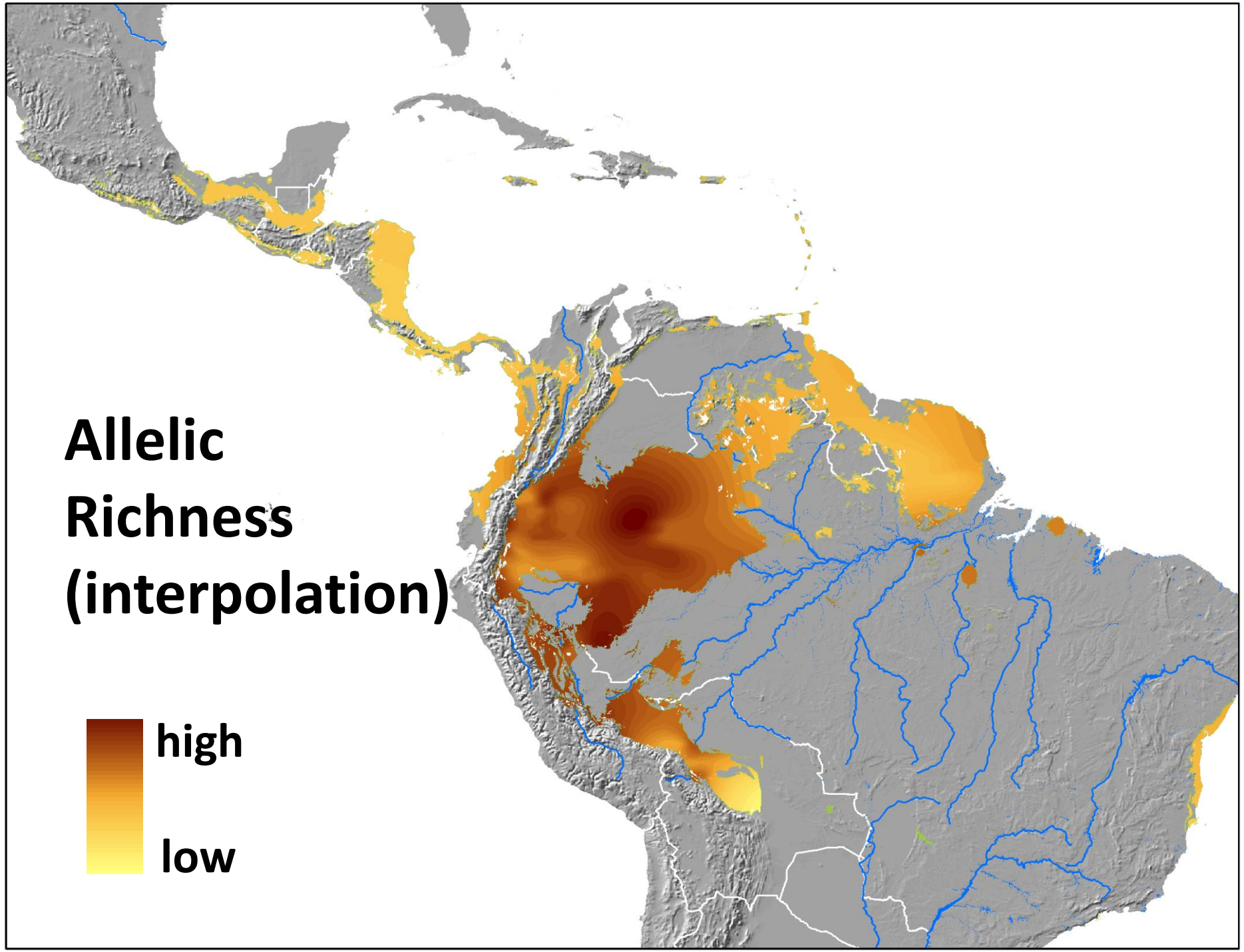
PLoS one

Geographic and Genetic Population Differentiation of the Amazonian Chocolate Tree (*Theobroma cacao* L)

Juan C. Motamayor[1,2]*, Philippe Lachenaud[3], Jay Wallace da Silva e Mota[4], Rey Loor[5], David N. Kuhn[1], J. Steven Brown[1], Raymond J. Schnell[1]

Genetic Diversity and Structure of Managed and Semi-natural Populations of Cocoa (*Theobroma cacao*) in the Huallaga and Ucayali Valleys of Peru

DAPENG ZHANG[1,*], ENRIQUE AREVALO-GARDINI[2], SUE MISCHKE[1], LUIS ZÚÑIGA-CERNADES[2], ALEJANDRO BARRETO-CHAVEZ[2] and JORGE ADRIAZOLA DEL AGUILA[2]



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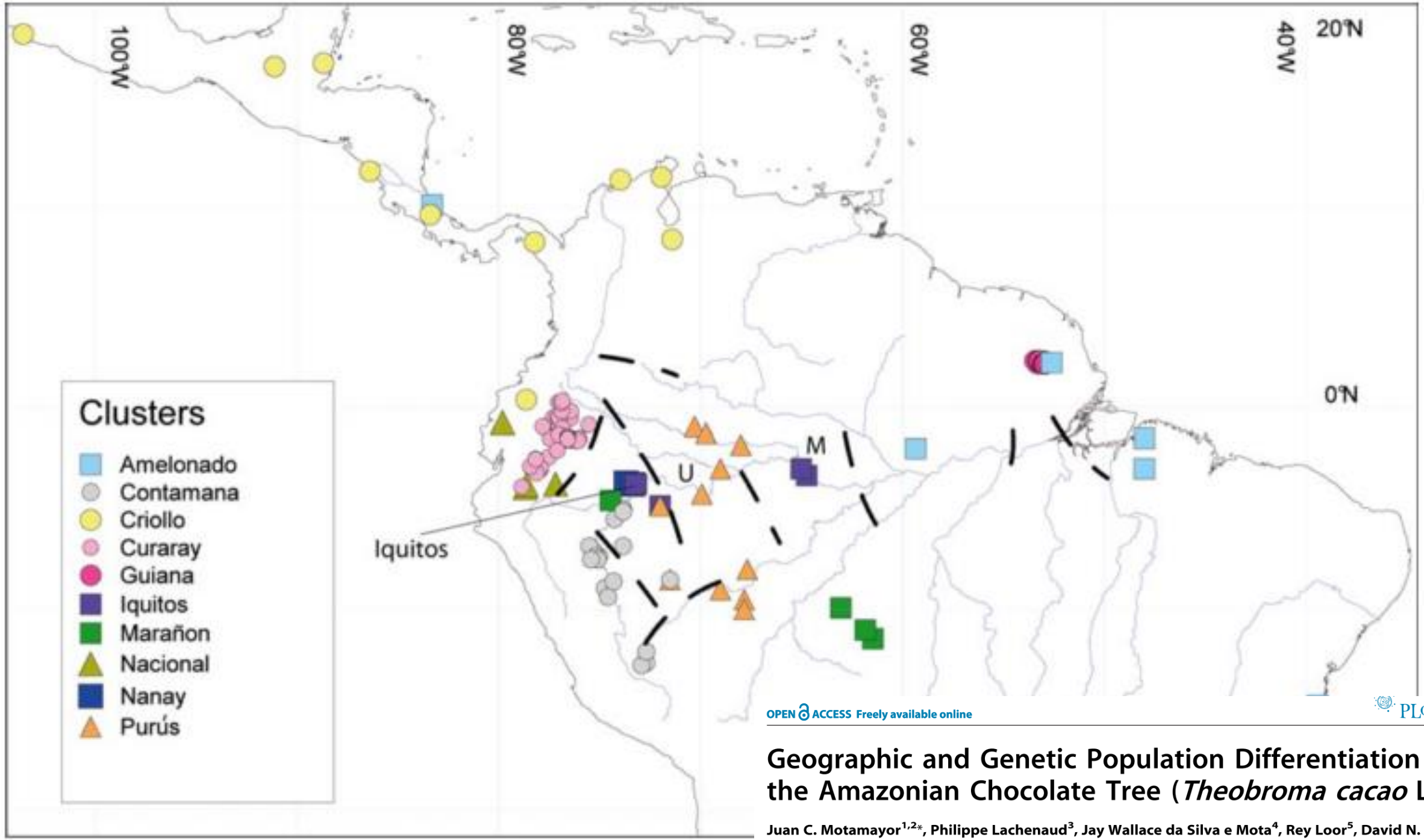

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PLoS one

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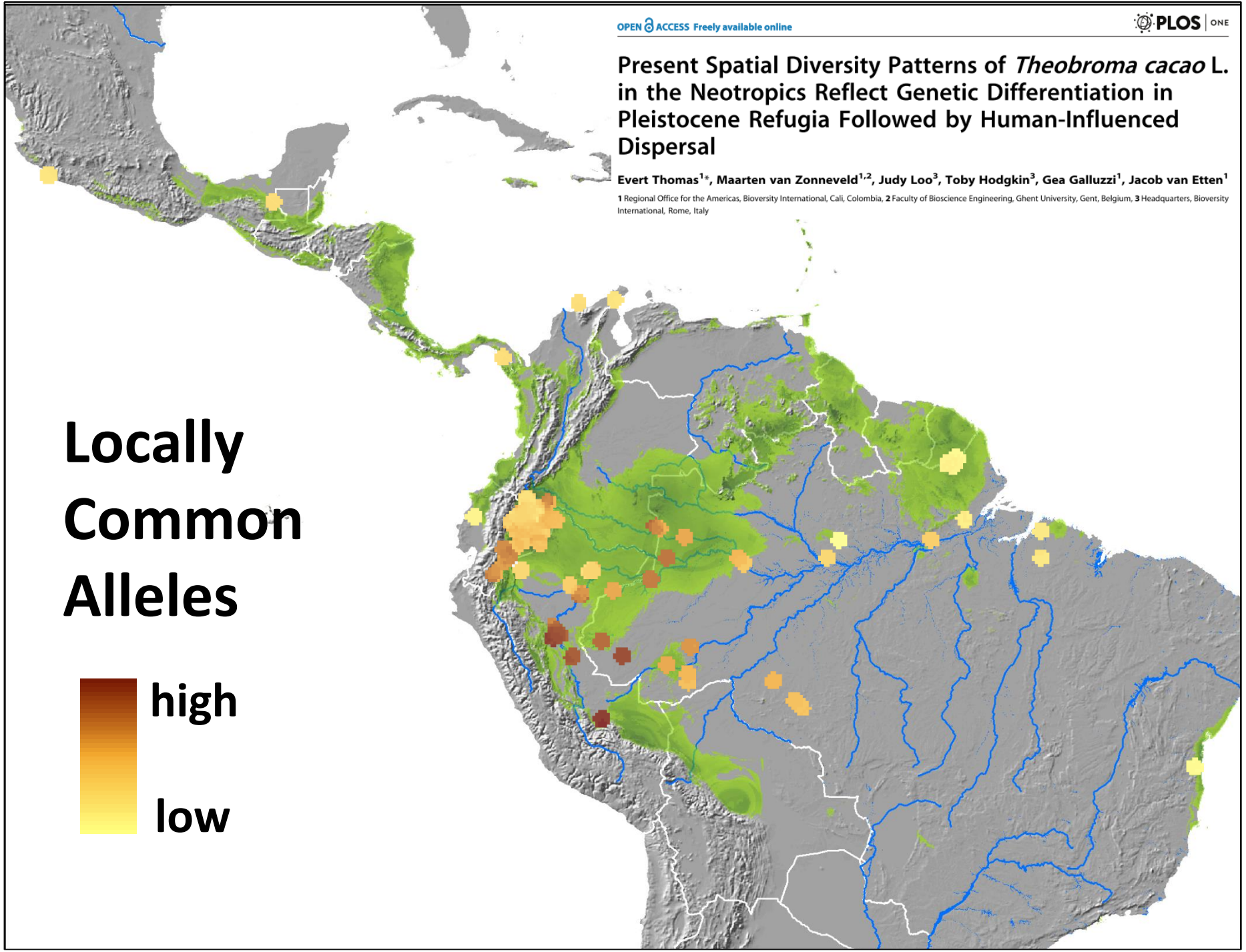
Juan C. Motamayor[1,2*], Philippe Lachenaud[3], Jay Wallace da Silva e Mota[4], Rey Loor[5], David N. Kuhn[1], J. Steven Brown[1], Raymond J. Schnell[1]

present



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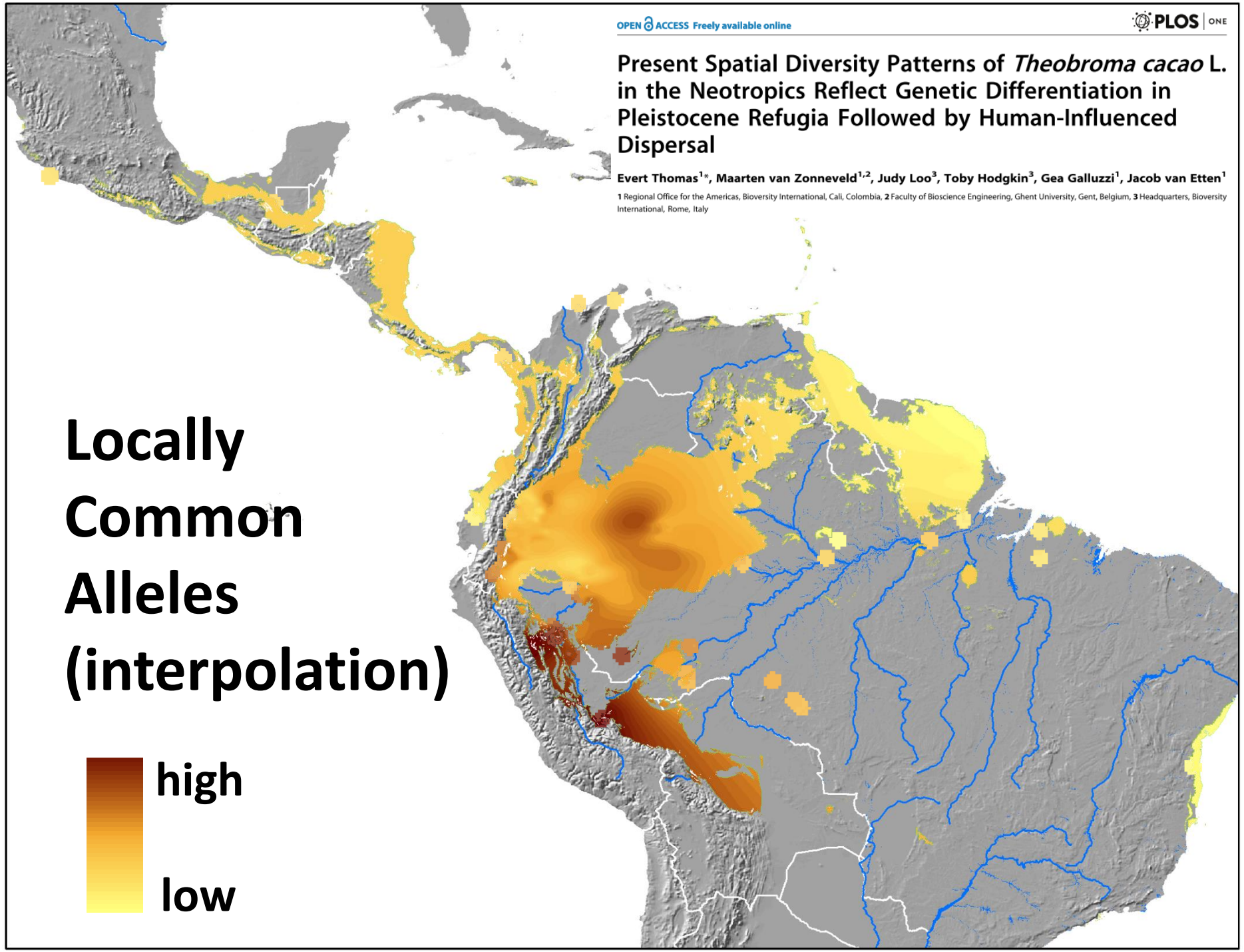

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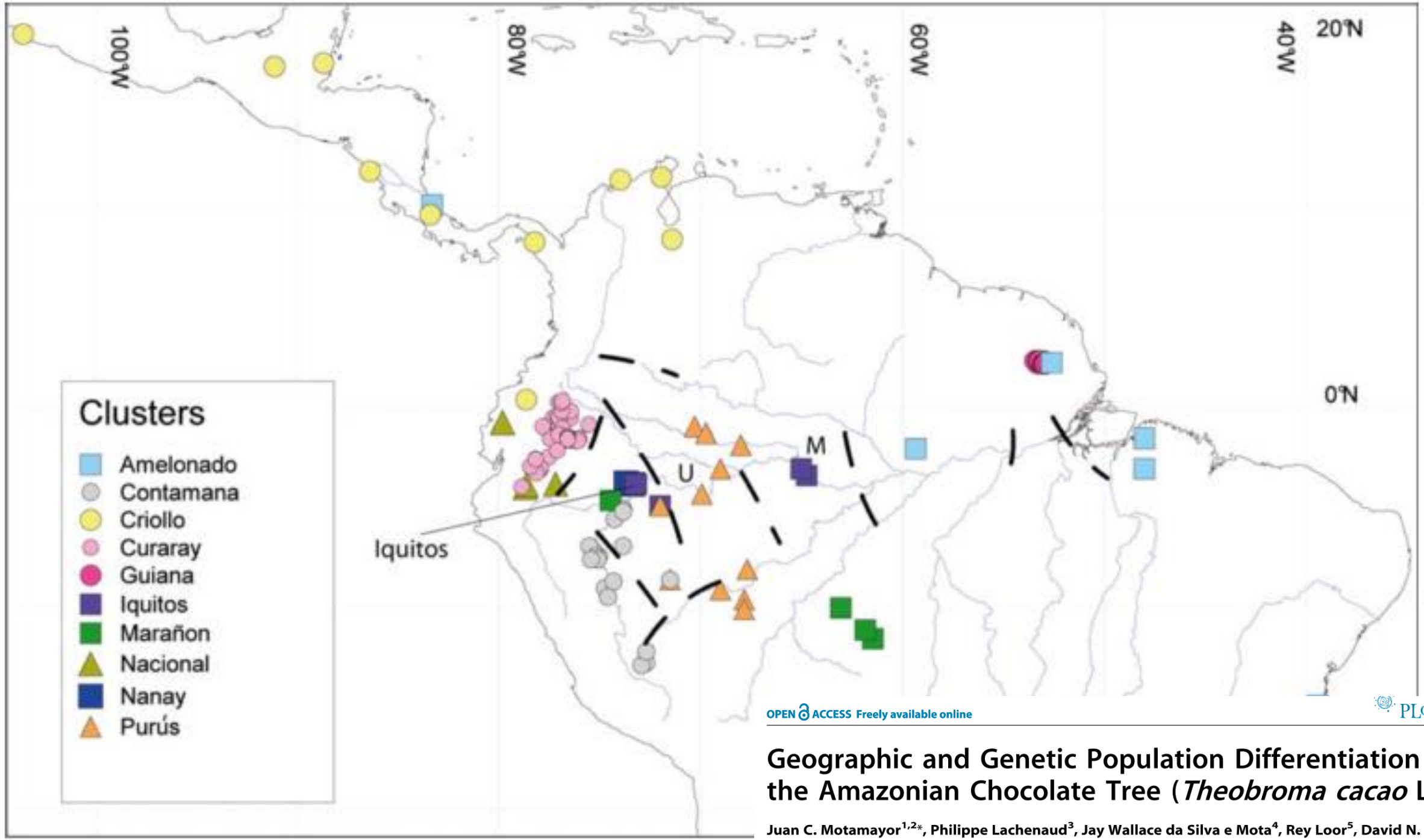
PLOS ONE

Present Spatial Diversity Patterns of *Theobroma cacao* L. in the Neotropics Reflect Genetic Differentiation in Pleistocene Refugia Followed by Human-Influenced Dispersal

Evert Thomas[1]*, Maarten van Zonneveld[1,2], Judy Loo[3], Toby Hodgkin[3], Gea Galluzzi[1], Jacob van Etten[1]

1 Regional Office for the Americas, Bioversity International, Cali, Colombia, **2** Faculty of Bioscience Engineering, Ghent University, Gent, Belgium, **3** Headquarters, Bioversity International, Rome, Italy

Bioversity International



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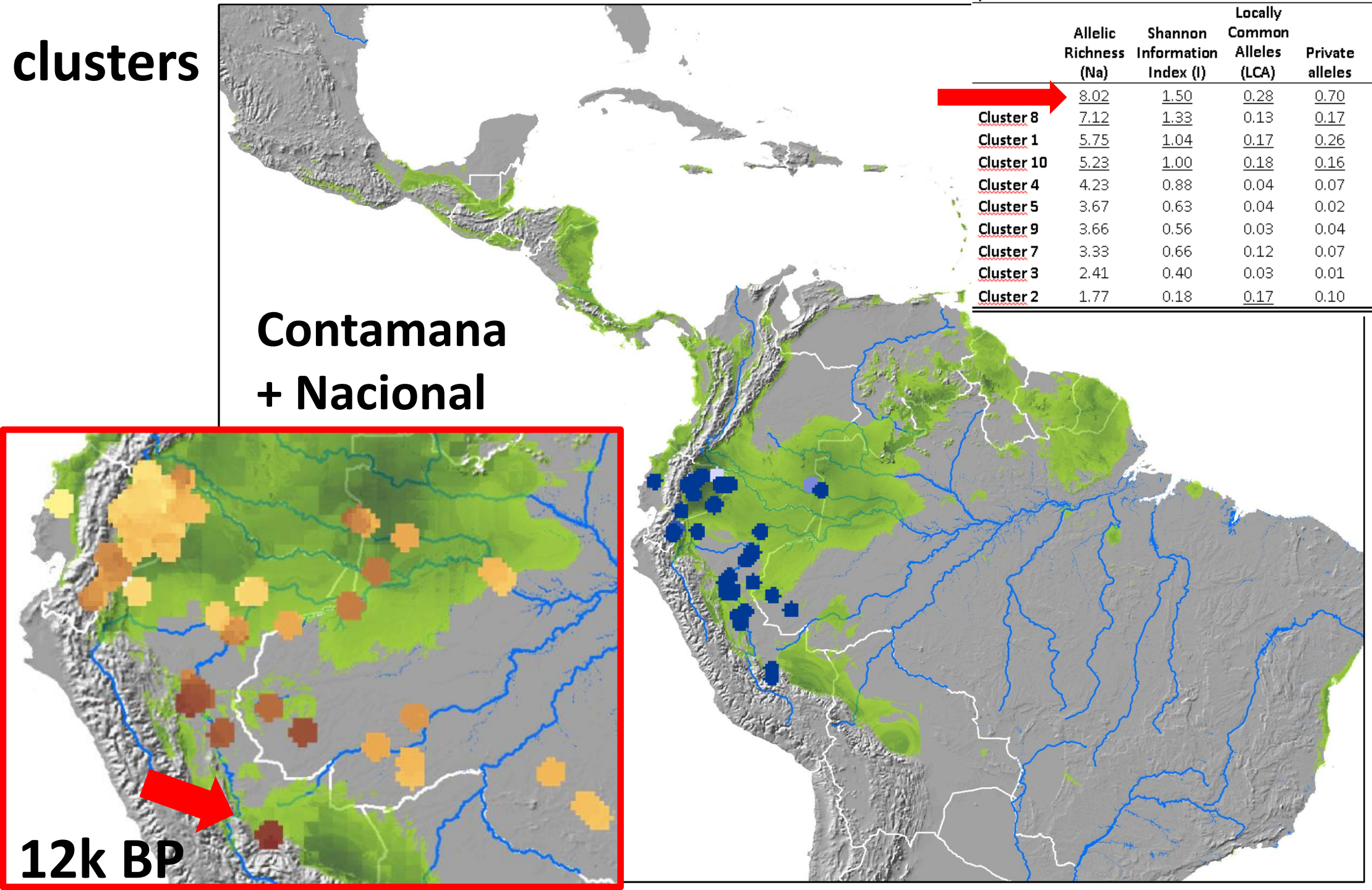
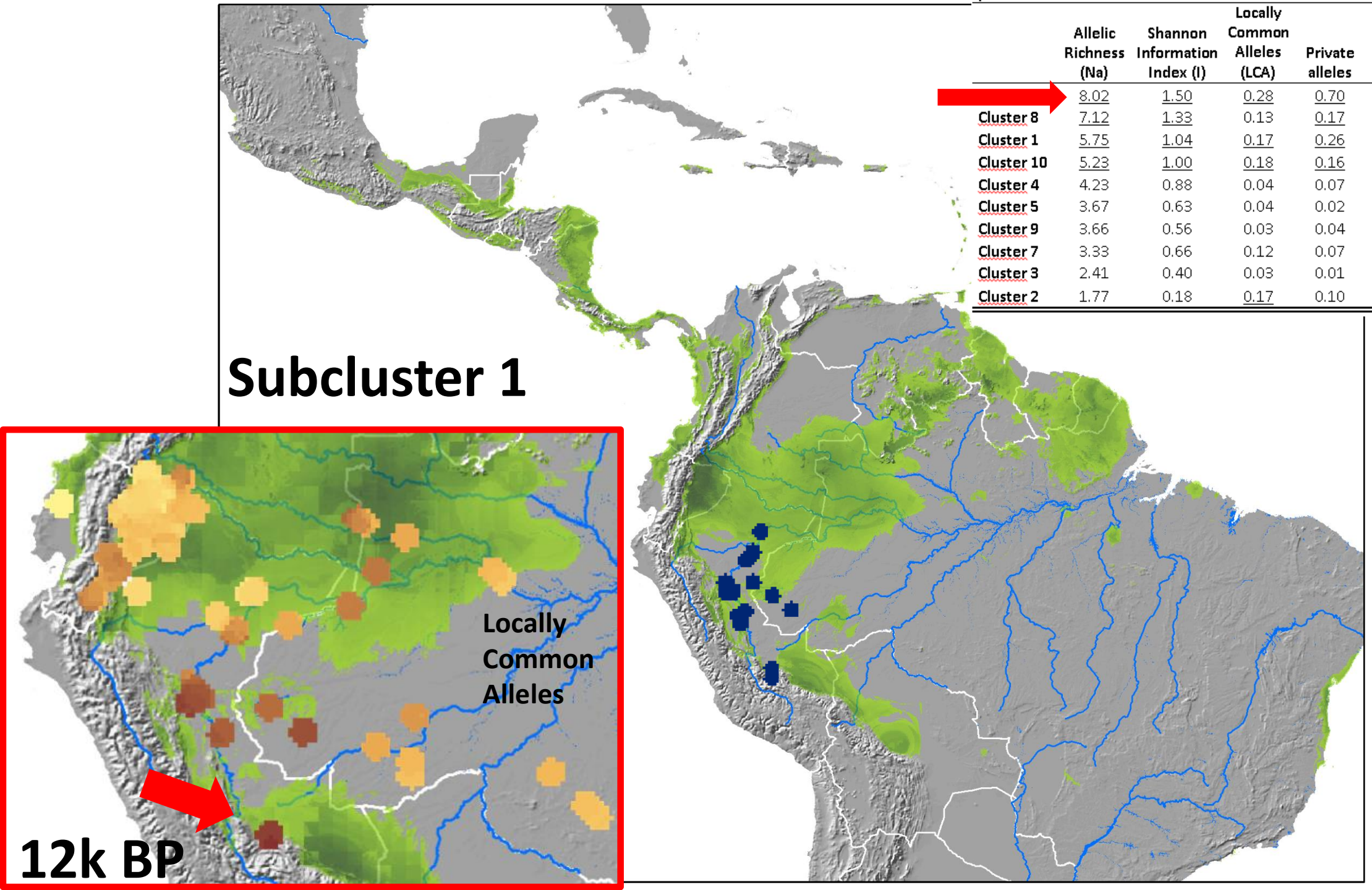
clusters



	Allelic Richness (Na)	Shannon Information Index (I)	Locally Common Alleles (LCA)	Private alleles	Ho	He	Fixation index (F)
	8.02	1.50	0.28	0.70	0.40	0.68	0.41
Cluster 8	7.12	1.33	0.13	0.17	0.55	0.63	0.12
Cluster 1	5.75	1.04	0.17	0.26	0.40	0.51	0.21
Cluster 10	5.23	1.00	0.18	0.16	0.36	0.50	0.28
Cluster 4	4.23	0.88	0.04	0.07	0.45	0.47	0.04
Cluster 5	3.67	0.63	0.04	0.02	0.15	0.33	0.54
Cluster 9	3.66	0.56	0.03	0.04	0.25	0.29	0.13
Cluster 7	3.33	0.66	0.12	0.07	0.30	0.36	0.18
Cluster 3	2.41	0.40	0.03	0.01	0.11	0.23	0.49
Cluster 2	1.77	0.18	0.17	0.10	0.02	0.10	0.77



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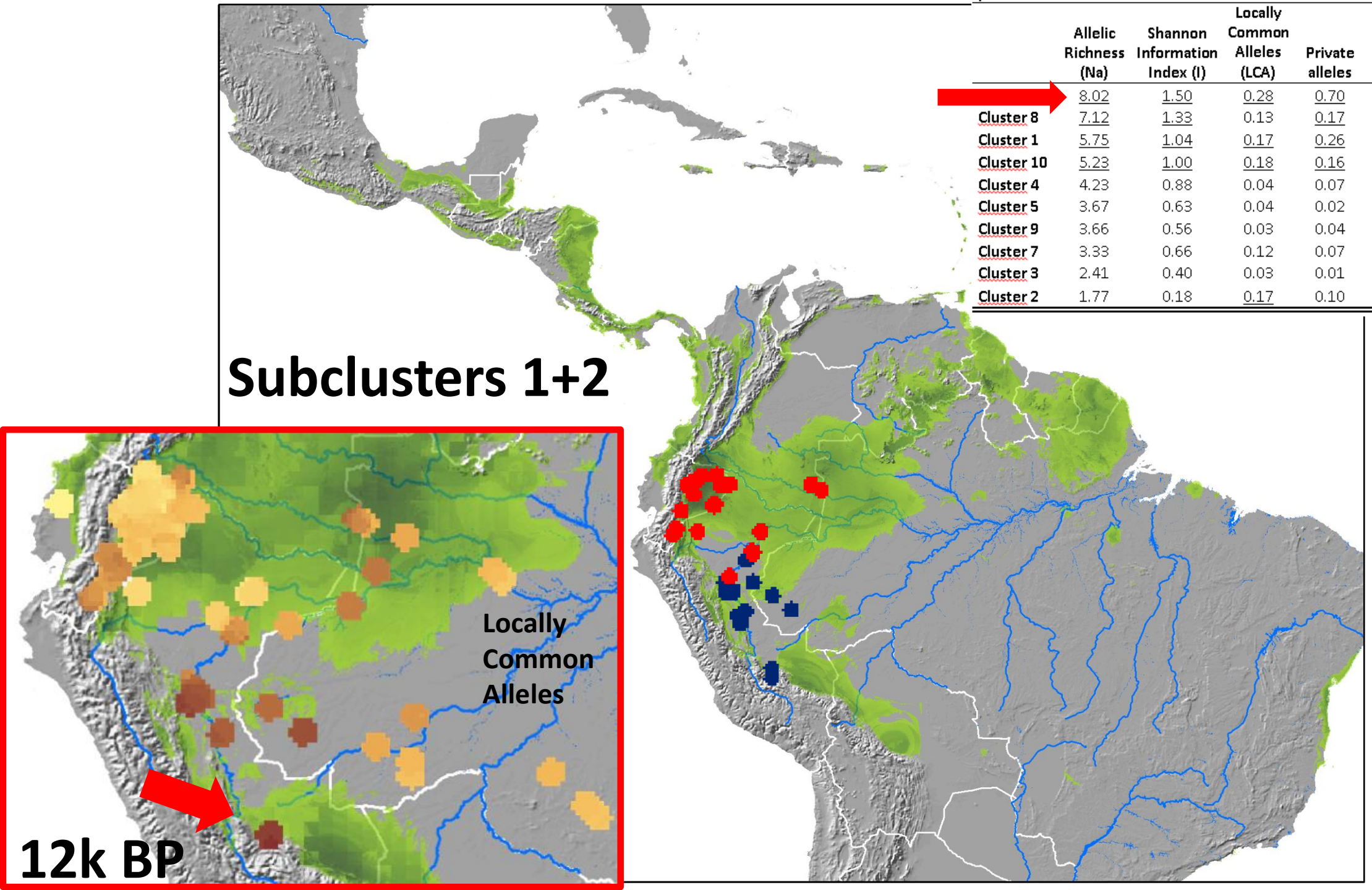

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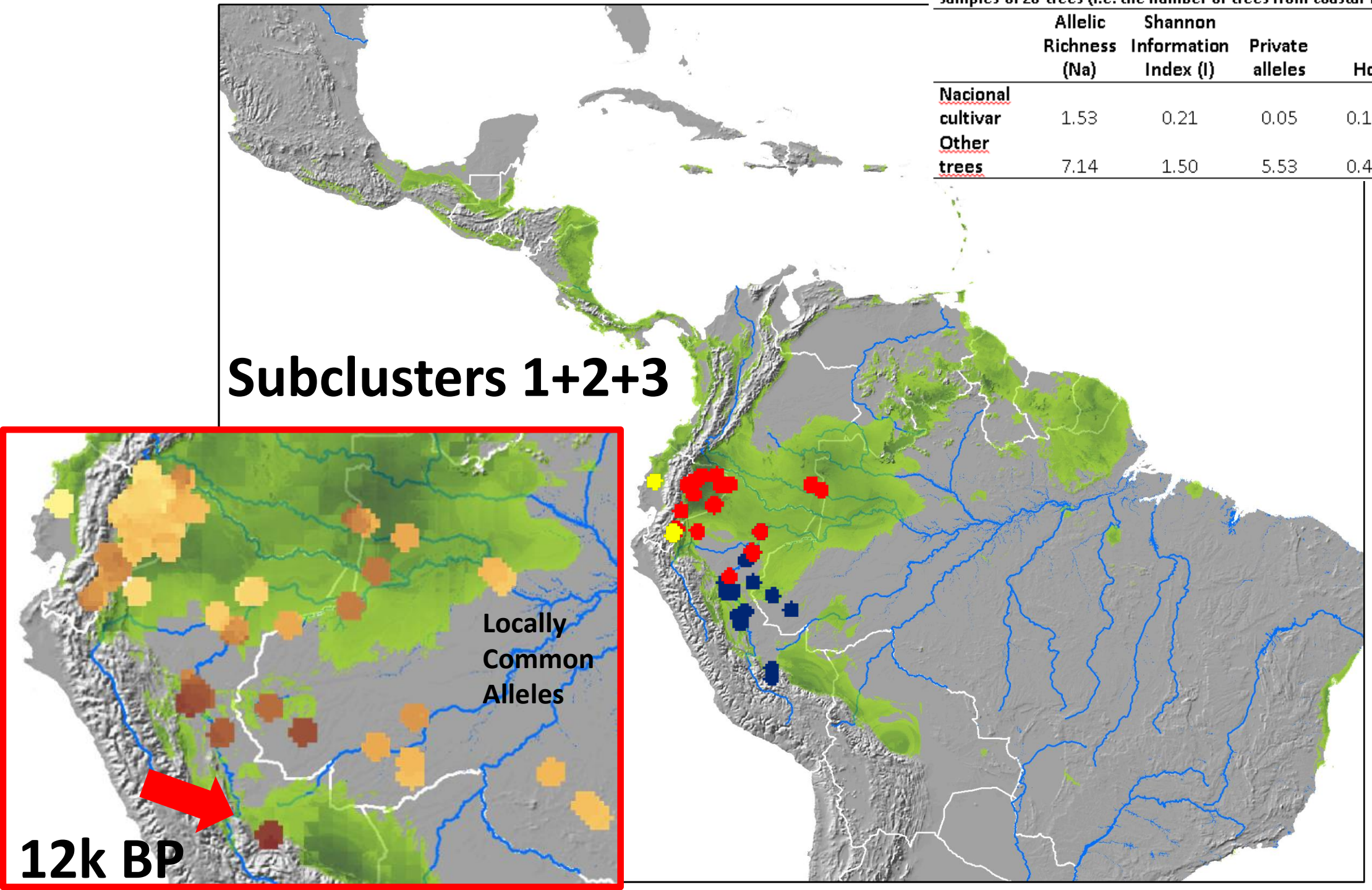
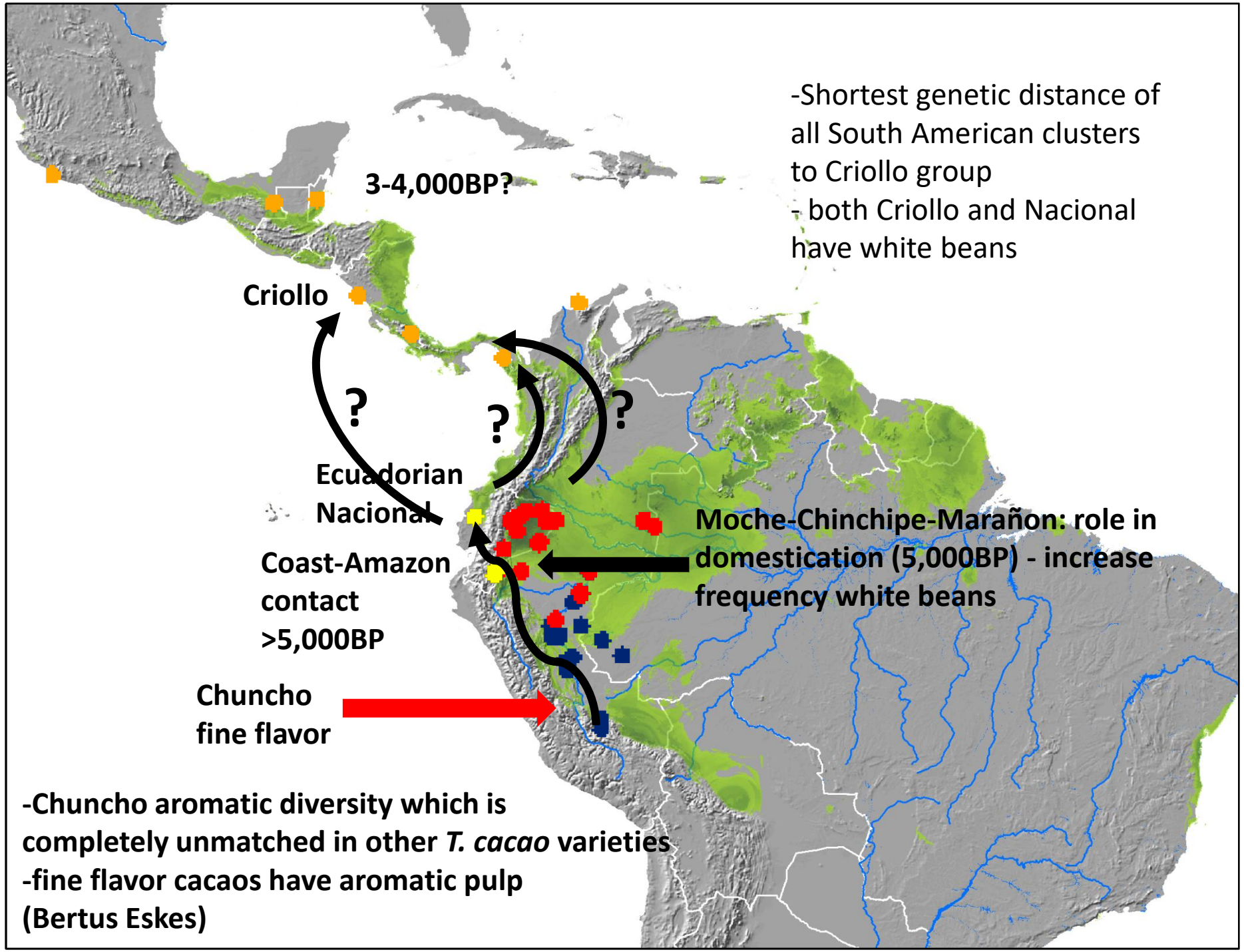
Cluster 9	3.66	0.56	0.03	0.04	0.25	0.29	0.13
Cluster 7	3.33	0.66	0.12	0.07	0.30	0.36	0.18
Cluster 3	2.41	0.40	0.03	0.01	0.11	0.23	0.49
Cluster 2	1.77	0.18	0.17	0.10	0.02	0.10	0.77

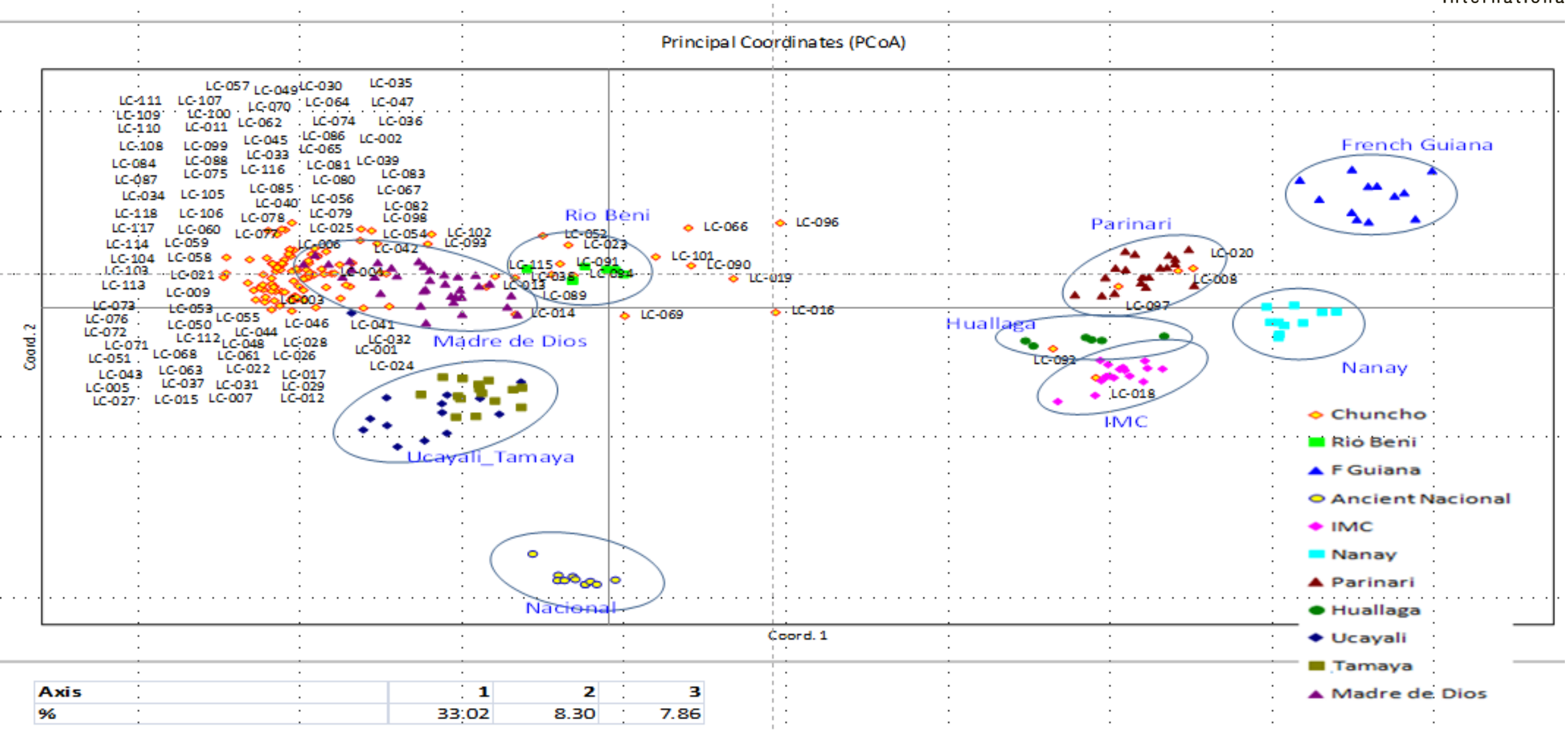
samples of 28 trees (i.e. the number of trees from coastal Ecuador).

	Allelic Richness (Na)	Shannon Information Index (I)	Private alleles	Ho	He	Fixation index (F)
Nacional cultivar	1.53	0.21	0.05	0.12	0.13	0.08
Other trees	7.14	1.50	5.53	0.44	0.69	0.36

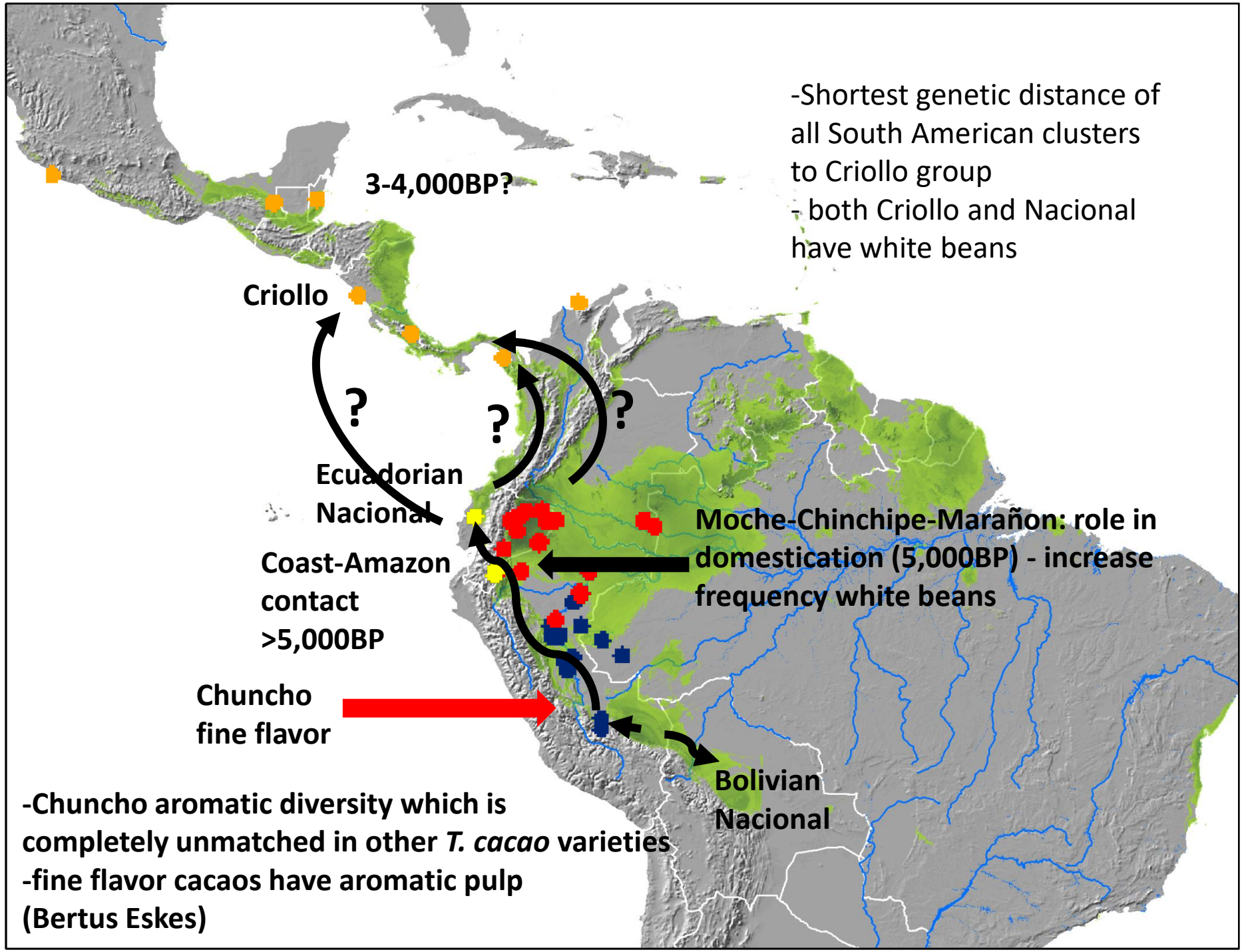



-Shortest genetic distance of all South American clusters to Criollo group
- both Criollo and Nacional have white beans
3-4,000BP?
Criollo
?
?
?
Ecuadorian Nacional
Coast-Amazon contact >5,000BP
Moche-Chinchipe-Marañon: role in domestication (5,000BP) - increase frequency white beans
Chuncho fine flavor
-Chuncho aromatic diversity which is completely unmatched in other T. cacao varieties
-fine flavor cacaos have aromatic pulp (Bertus Eskes)

Chuncho La Convencion (Zhang et al unpublished)



Axis	1	2	3
%	33.02	8.30	7.86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?
?
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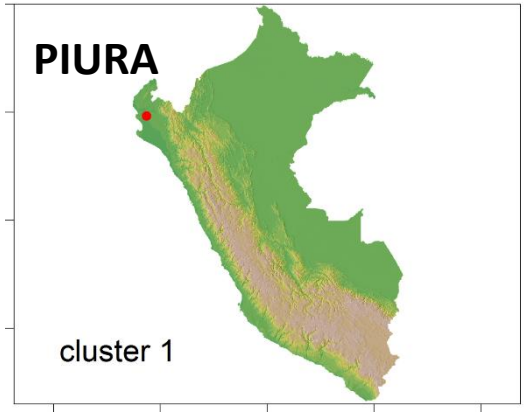
Chuncho fine flavor
Bolivian Nacional
-Chuncho aromatic diversity which is completely unmatched in other T. cacao varieties
-fine flavor cacaos have aromatic pulp (Bertus Eskes)

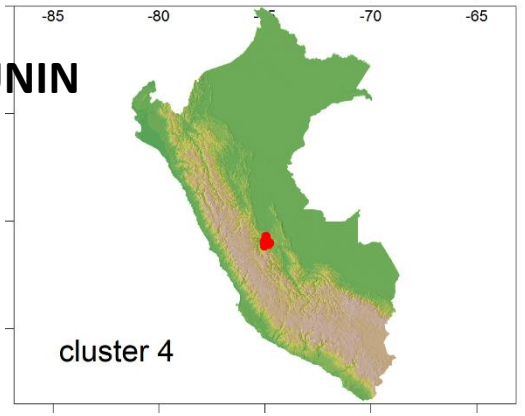
- 178 genotypes from Cuzco, Junin, Piura)
- Flavours and aroma
- 71 SNP markers
- Cluster analysis:
  1. *Discriminant Analysis of principal components*
  2. *Structure*

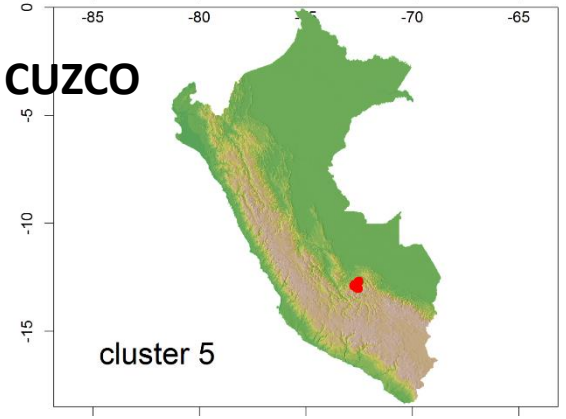
K=5 → K=11

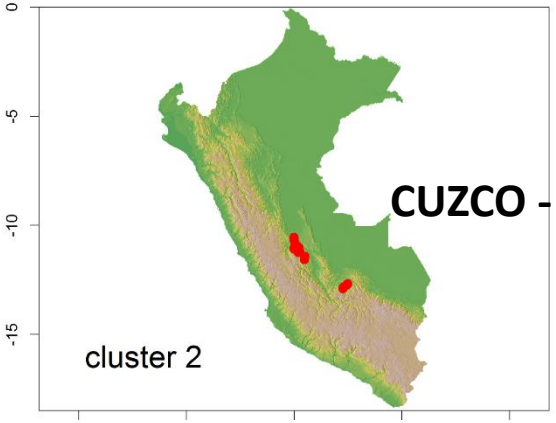
DAPC K=5

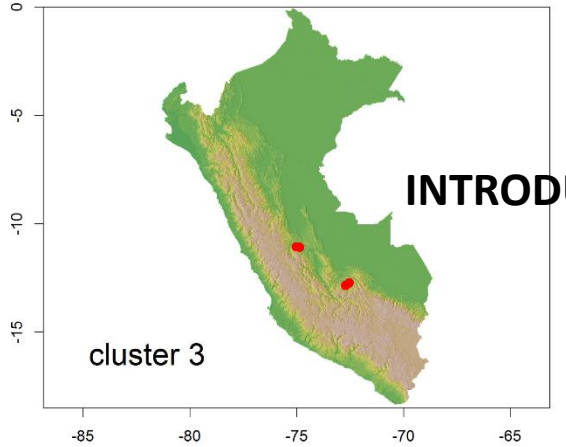

1
2
2

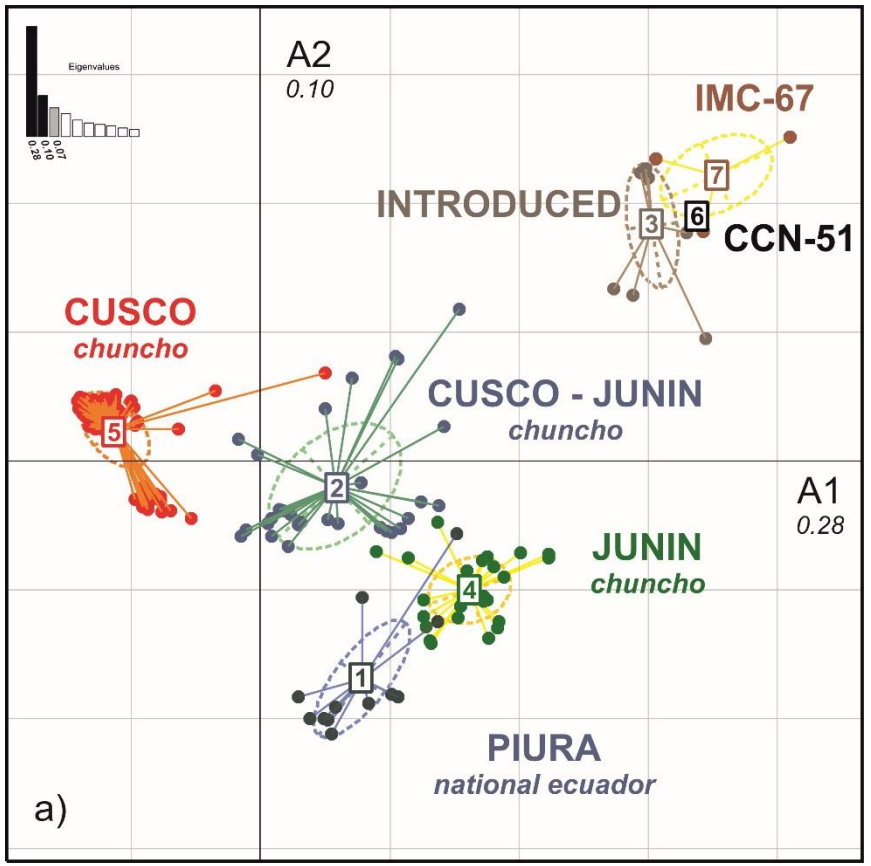

PIURA
cluster 1


JUNIN
cluster 4

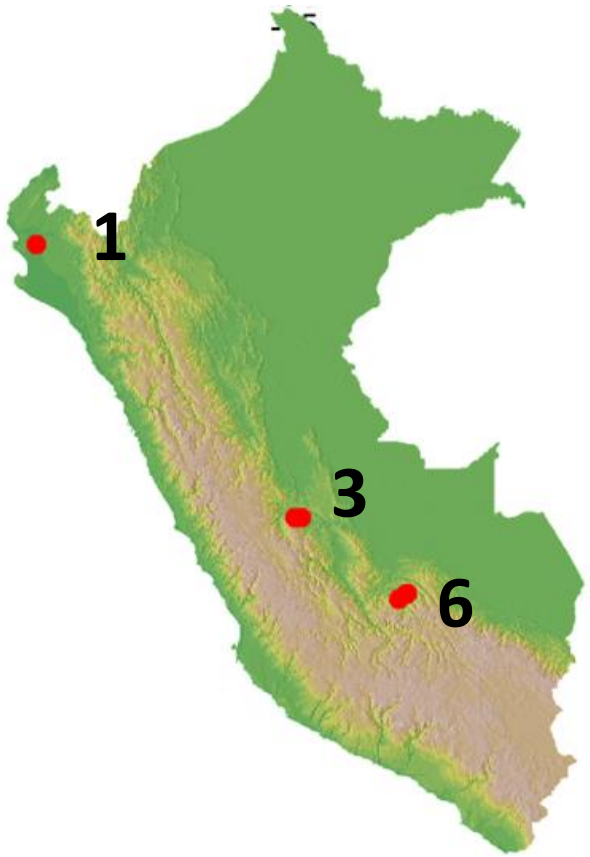

CUZCO
cluster 5

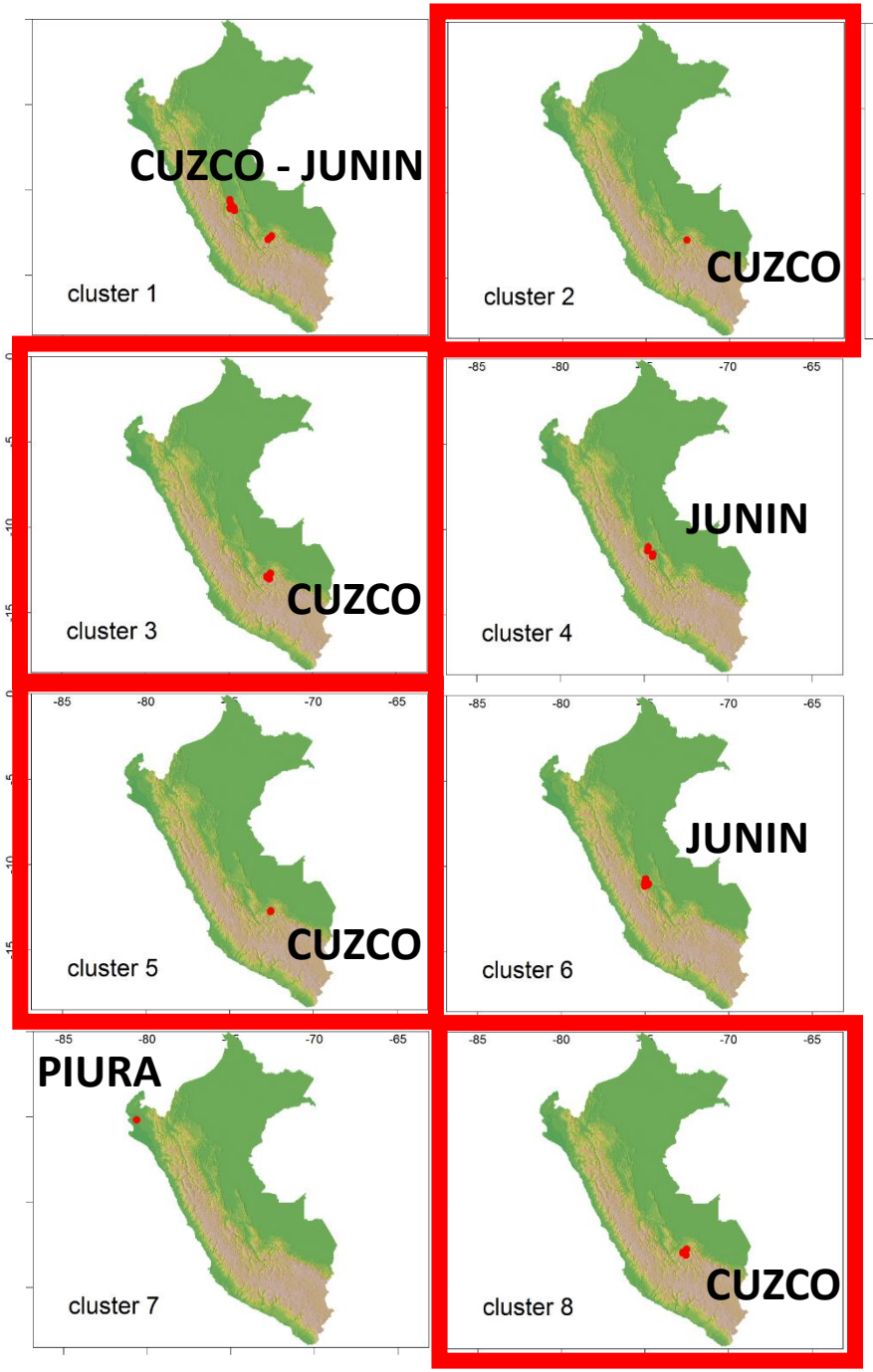

CUZCO - JUNIN
cluster 2

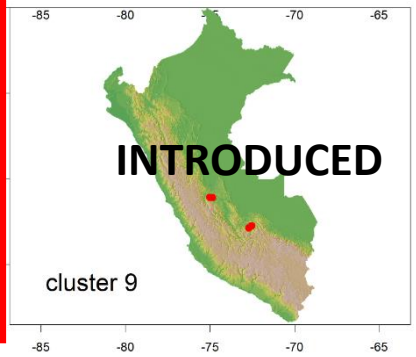

INTRODUCED
cluster 3

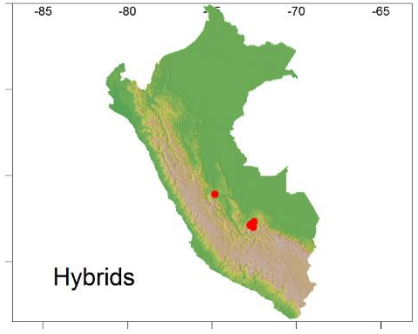

Eigenvalues
A2
0.10
IMC-67
INTRODUCED
CCN-51
CUSCO
chuncho
CUSCO - JUNIN
chuncho
A1
0.28
JUNIN
chuncho
PIURA
national ecuador
a)

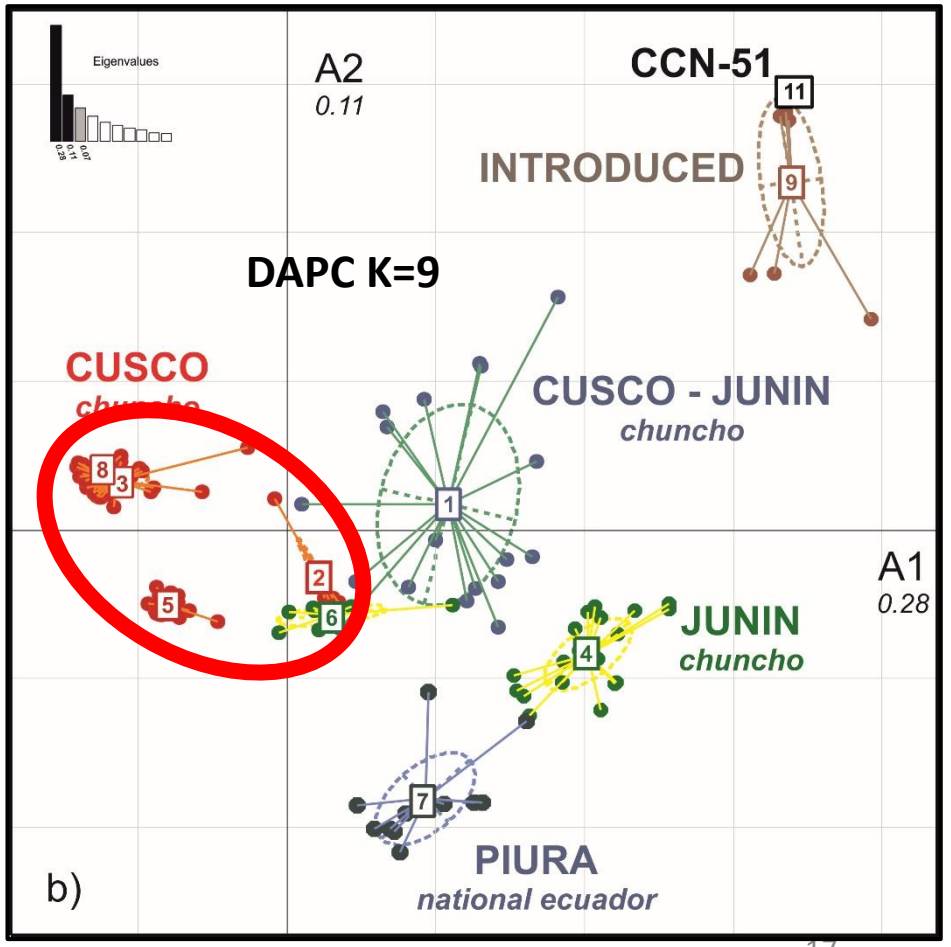
DAPC K=9


1
3
6

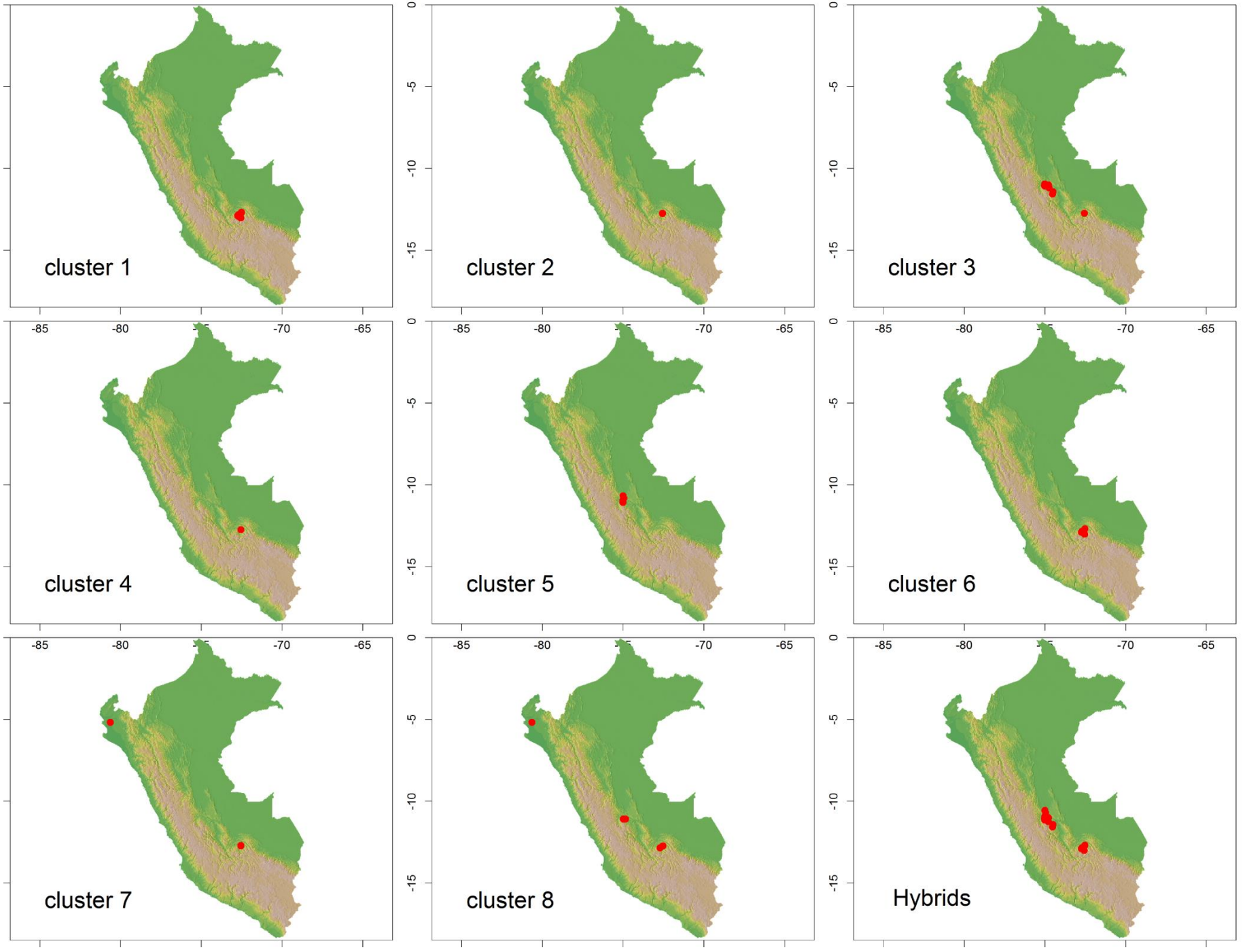

CUZCO - JUNIN
cluster 1
CUZCO
cluster 2
CUZCO
cluster 3
JUNIN
cluster 4
CUZCO
cluster 5
JUNIN
cluster 6
PIURA
cluster 7
CUZCO
cluster 8


INTRODUCED
cluster 9

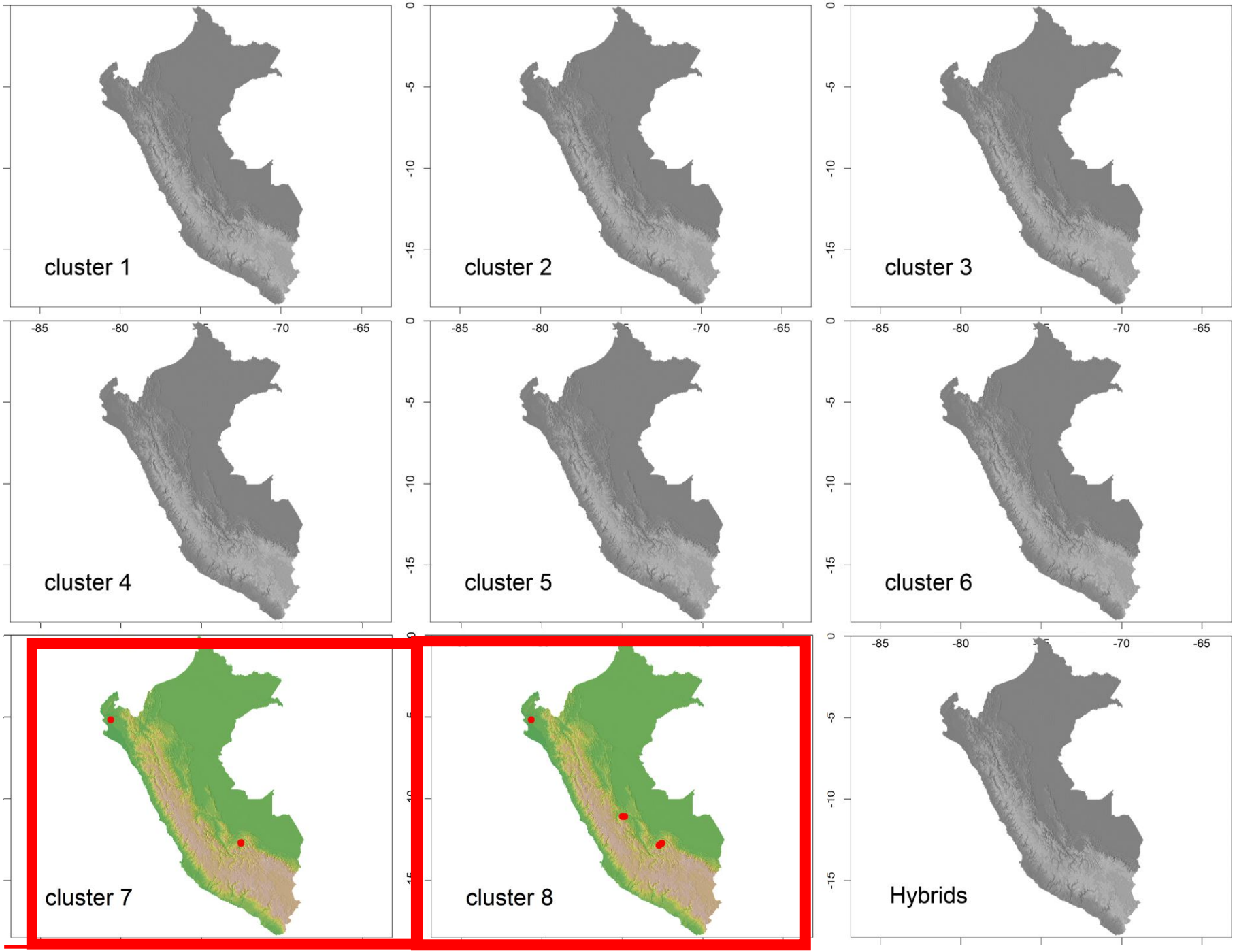

Hybrids

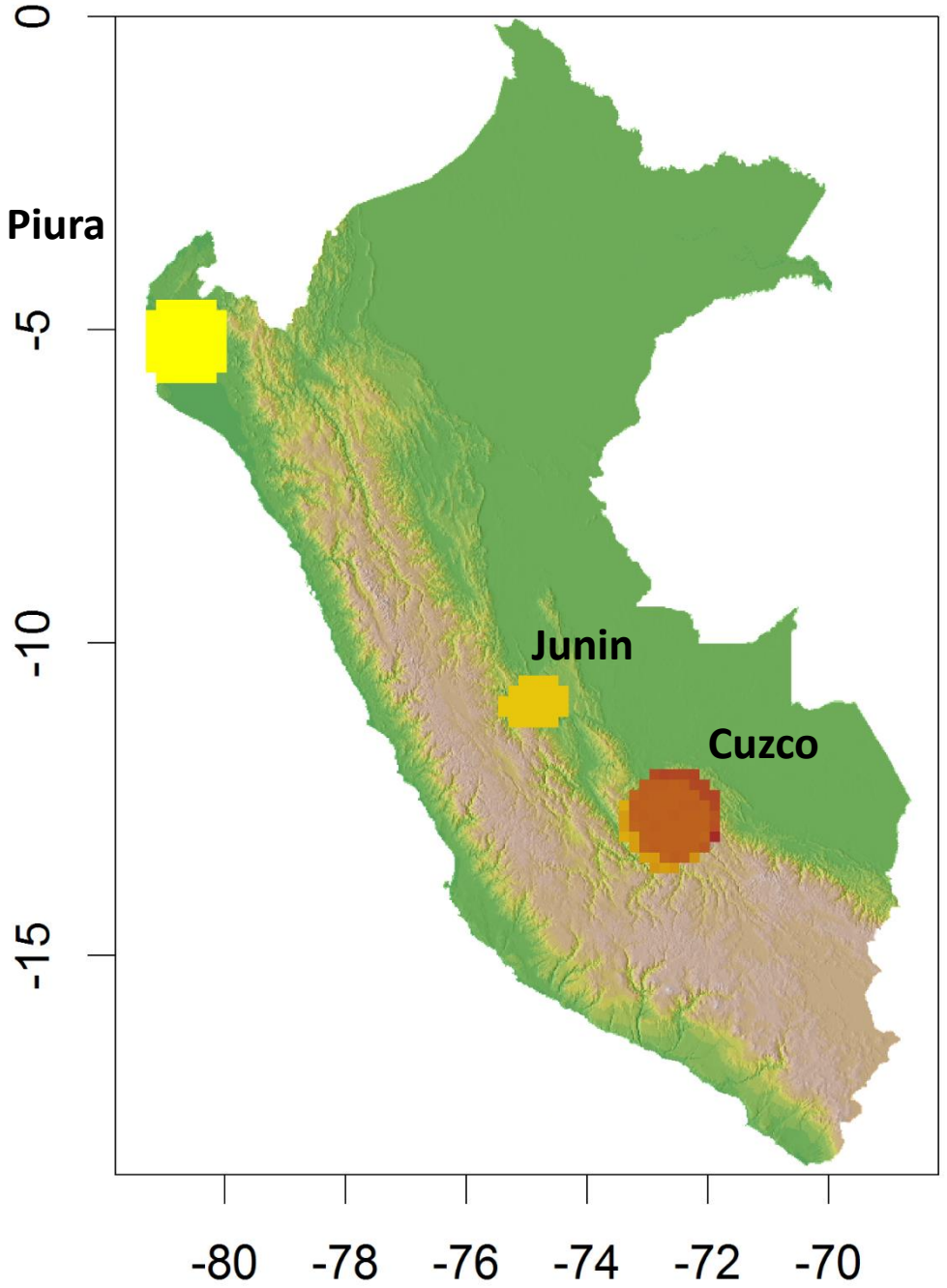

Eigenvalues
A2
0.11
CCN-51
INTRODUCED
DAPC K=9
CUSCO
CUSCO - JUNIN
chuncho
A1
0.28
JUNIN
chuncho
PIURA
national ecuador
b)

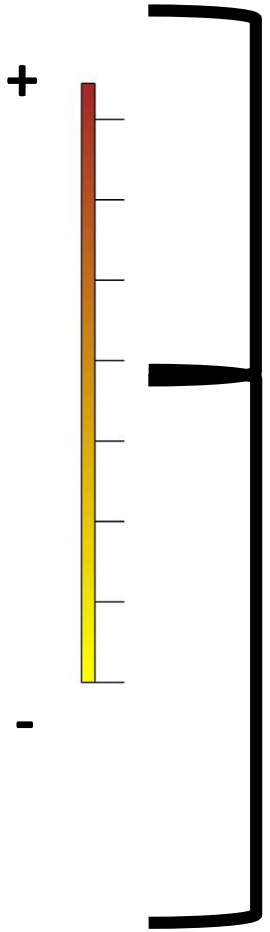
STRUCTURE
K=8



STRUCTURE
K=8



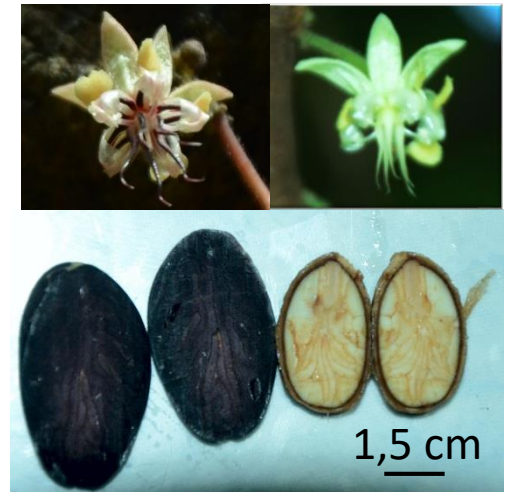




Acidic
Lemon

Mandarin
Banana
Mango
Grape
Inga
Honey

Origin of fine or flavour cacao in southern Peru?



- Unmatched diversity in genetic, organoleptic and morphological diversity (typical for centers of origin)
- Indications of genetic linkages between Nacional/Porcelana cacao and southern Peru (Cuzco)
- Presence of white beans in southern Peru + white bean cacao genotypes with hexamerous flowers
- Anecdotal evidence of unique use and management of cacao among local indigenous group
    - Consumption of beans (fermented and roasted) during travel
    - Management of cacao stands in “natural” forest
- But…we are´nt there yet: chloroplast markers, new genetic analyses, ethnographic work

Thank you

Evert Thomas
e.thomas@cgiar.org

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