Unraveling quinoa domestication using wild ancestors

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Enhanced genepool utilization, Cambridge, June 2014

Topics of this session

- What do we know about quinoa genetic structure, relations and phylogenetics?
- What is known about its wild ancestor?
- How can research on *C. hircinum* contribute to understand quinoa domestication process and breeding?

What do we know about quinoa?

(Tapia, 1979)

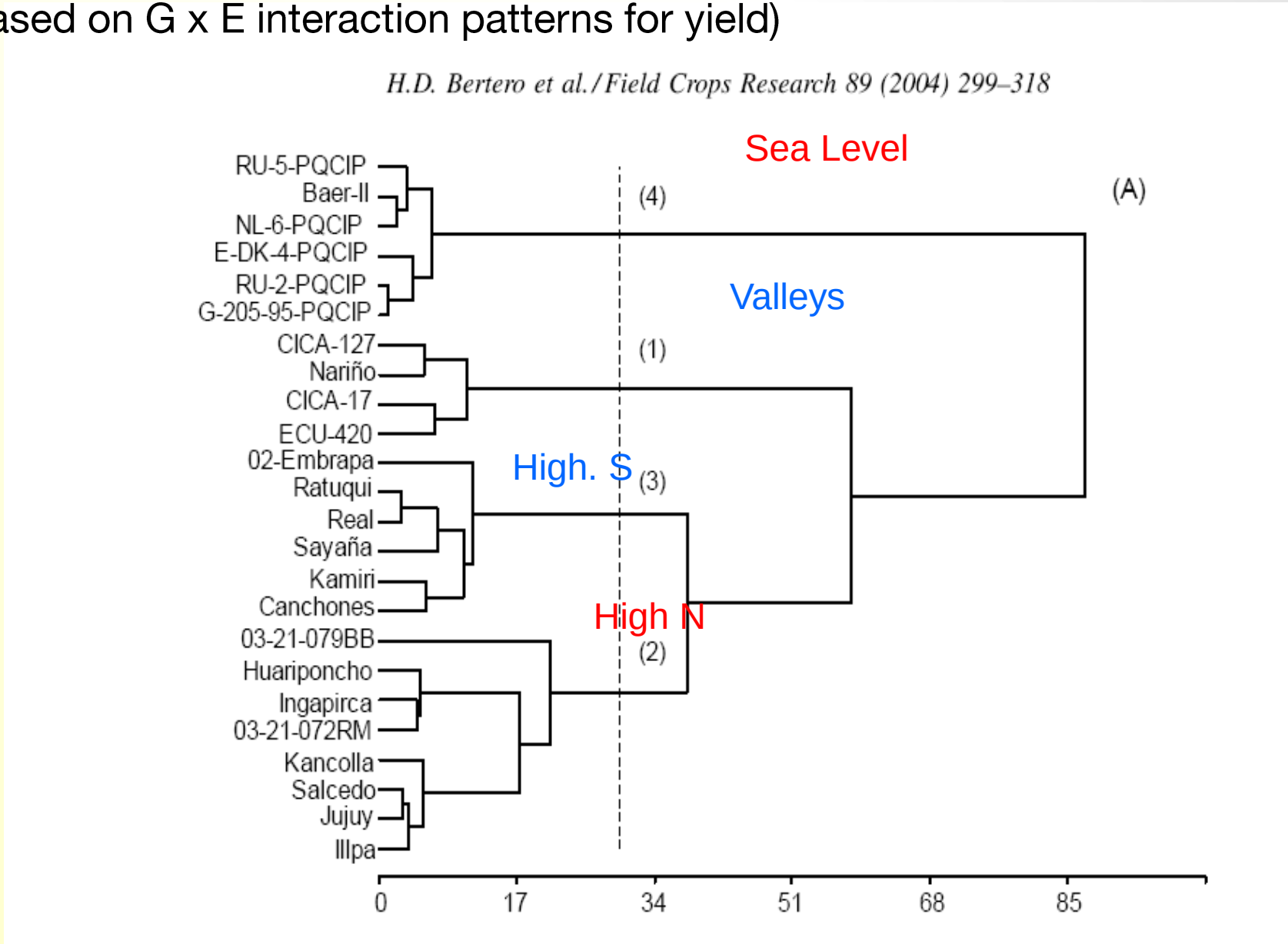
…Traditionally cultivated in

❖Central Andes: Valleys; Altiplano (highlands) and Yungas (humid valleys)

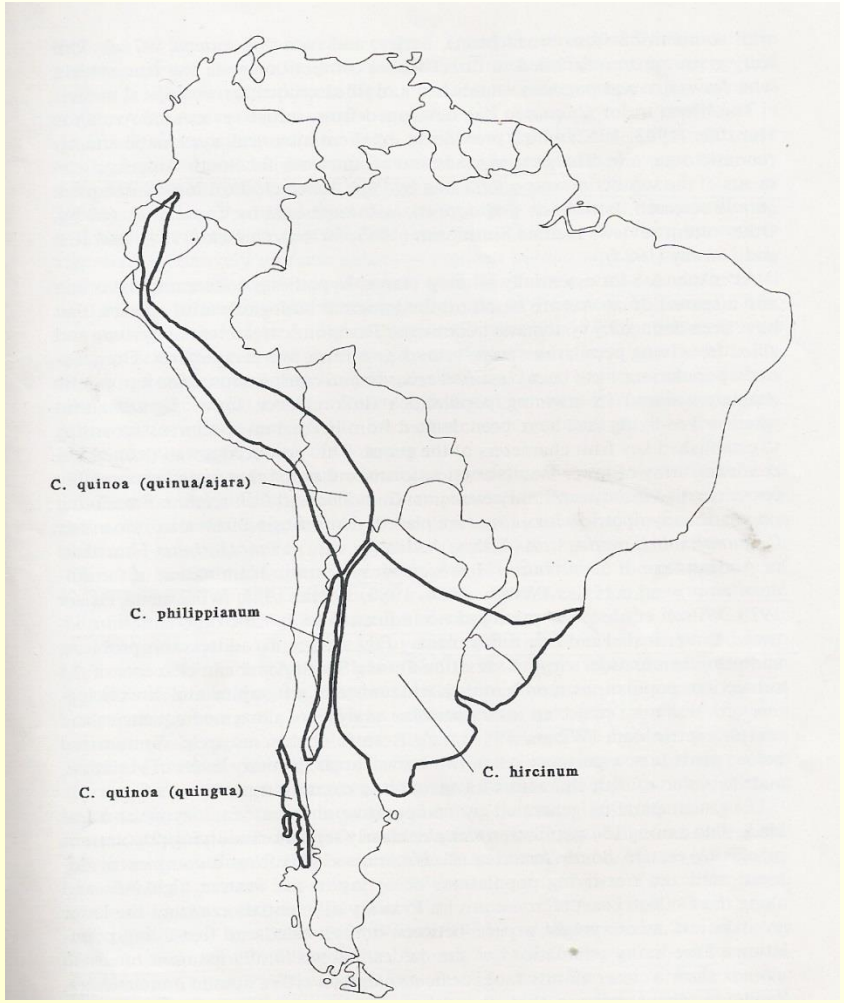
❖Central & Southern Chile

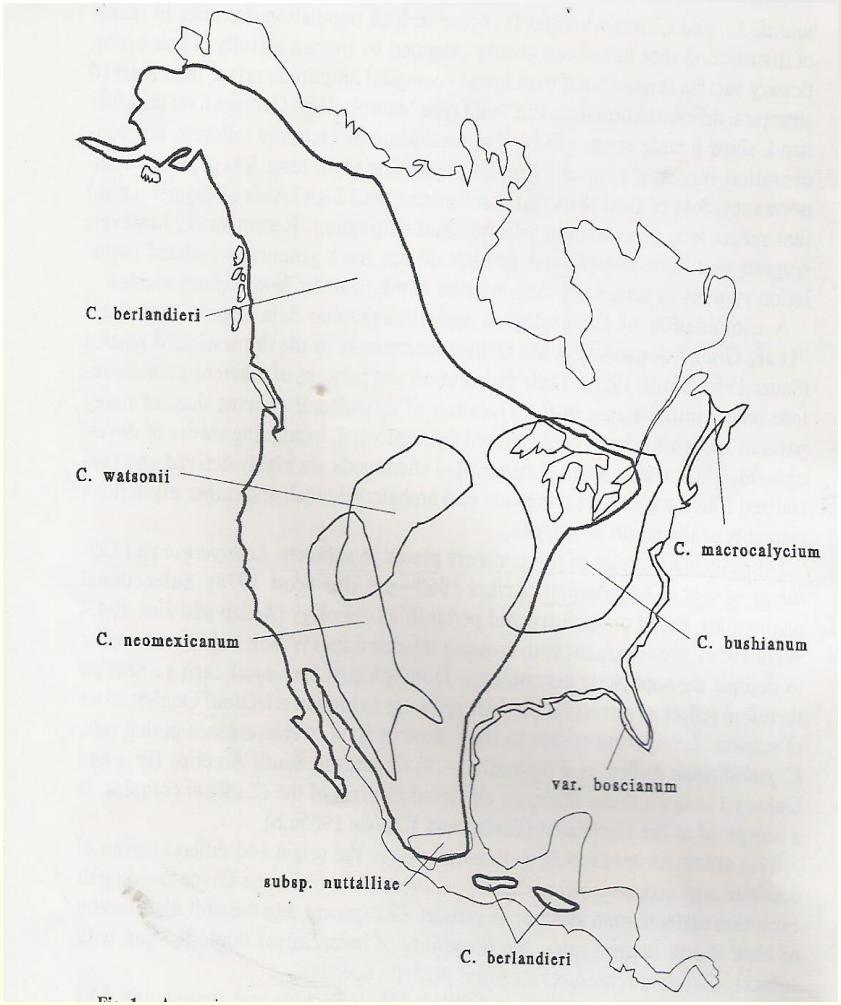
Quinoa genetic groups

(based on G x E interaction patterns for yield)



Related species (subsection *Cellulata*)





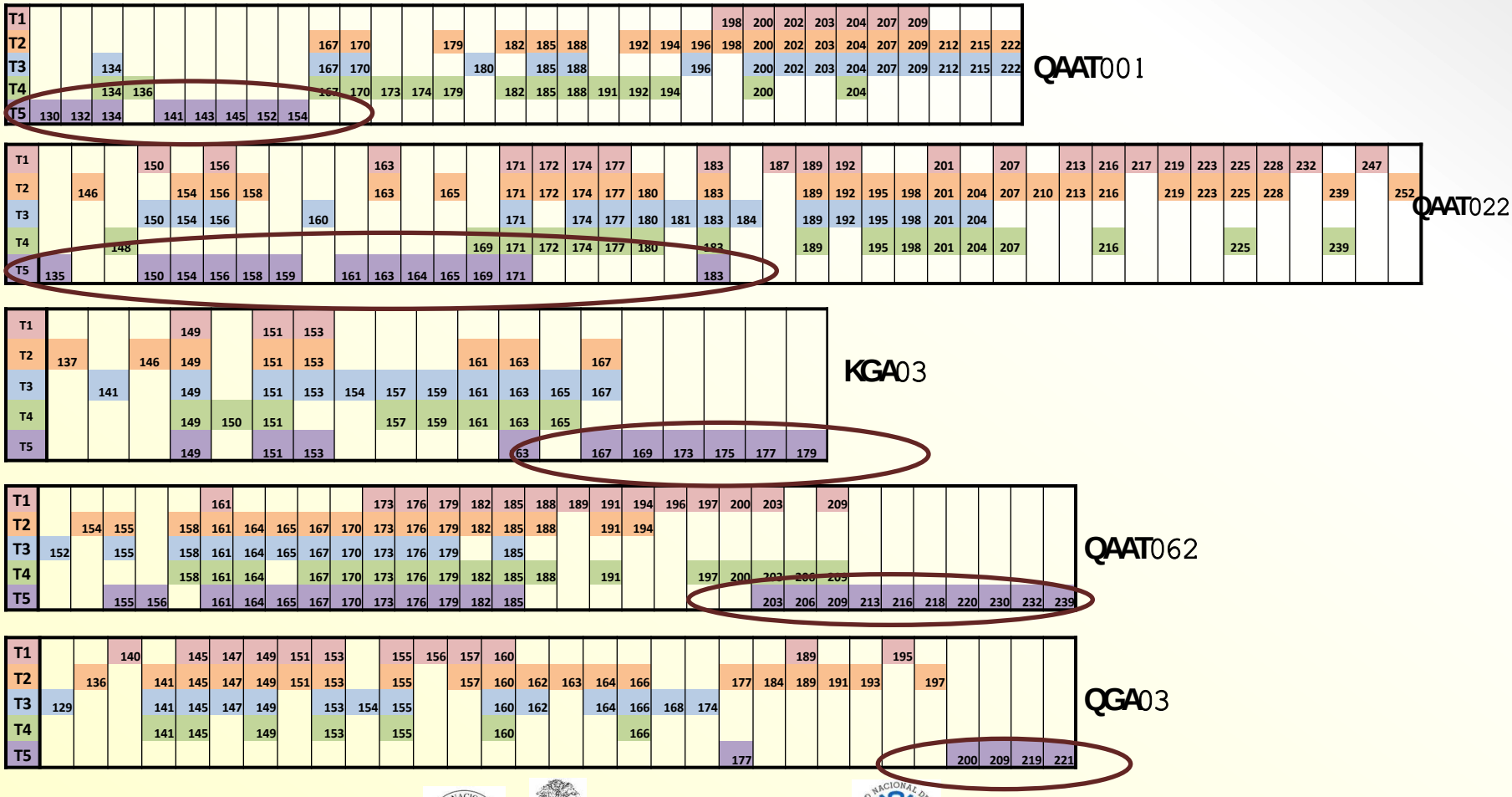
Wilson, 1990. Economic Botany 44 (3): 92-110

Five genetic groups identified

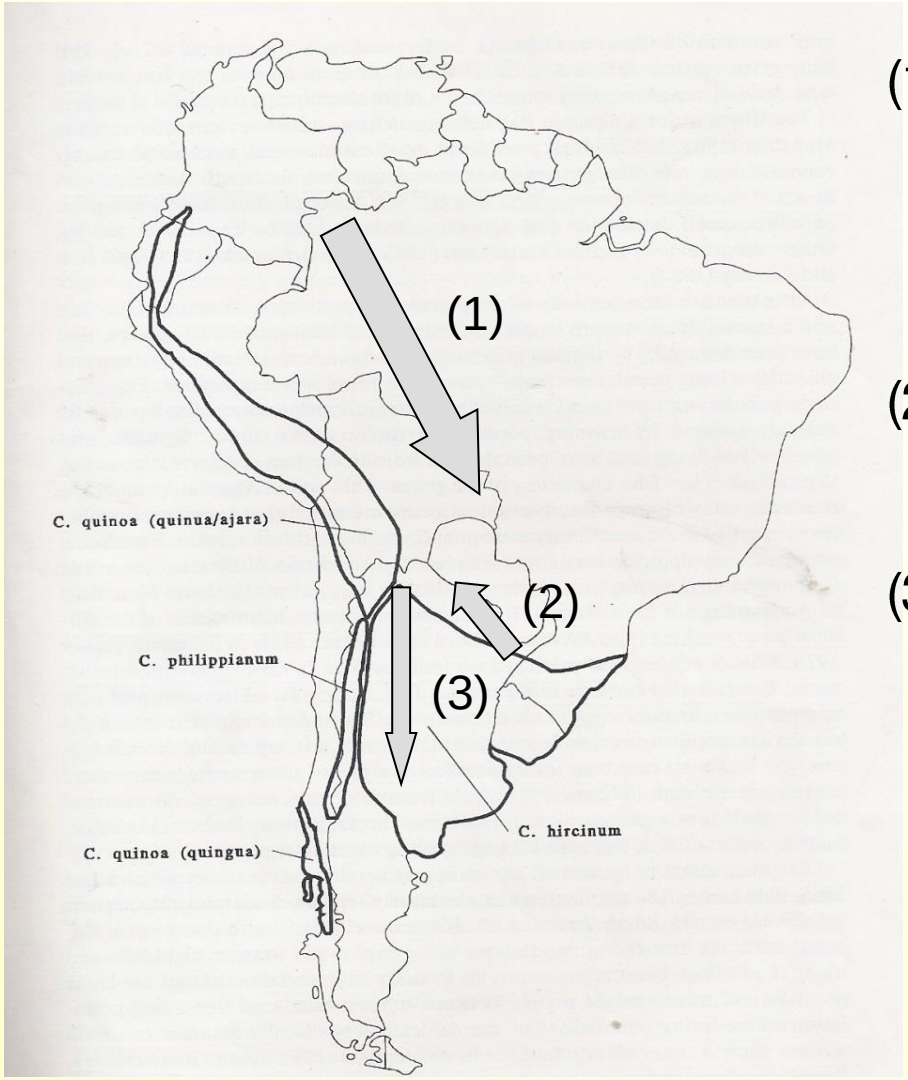
- **T1**: Dry valley: NWA and Sucre &Tarija (Bolivia);
- **T2**: Highland: NWA; S Bolivia highlands and N Chile
- **T3**: Transition: High and humid environment (NWA: Salta-Jujuy and Titicaca coast);
- **T4**: Oriental humid valley: NWA (Sta. Victoria) and Tarija Valleys, central Peru and Colombia;
- **T5**: Sea level: Central and Southern Chile (most differentiated group)

Clear differentiation between Chilean and Andean germplasm

SRR Loci QAAT001, QAAT022, KGA03, QAAT062 y QGA03 are the most influential examples



Main hypothesis about quinoa origin



(1) Tetraploids originated in North America, people or migratory birds carried seeds to South America. Origin of *C. hircinum*

(2) Domestication from *C. hircinum* (around Titicaca lake)

(3) Early migration of populations to central and Southern Chile: founder effect, lower variability than in the Andes, absence of '*ajaras*' (weedy relatives), common in the Central Andes).

Wilson, 1990. Economic Botany 44 (3): 92-110

More recent genetic studies
(relationships among *Chenopodium* sp.)

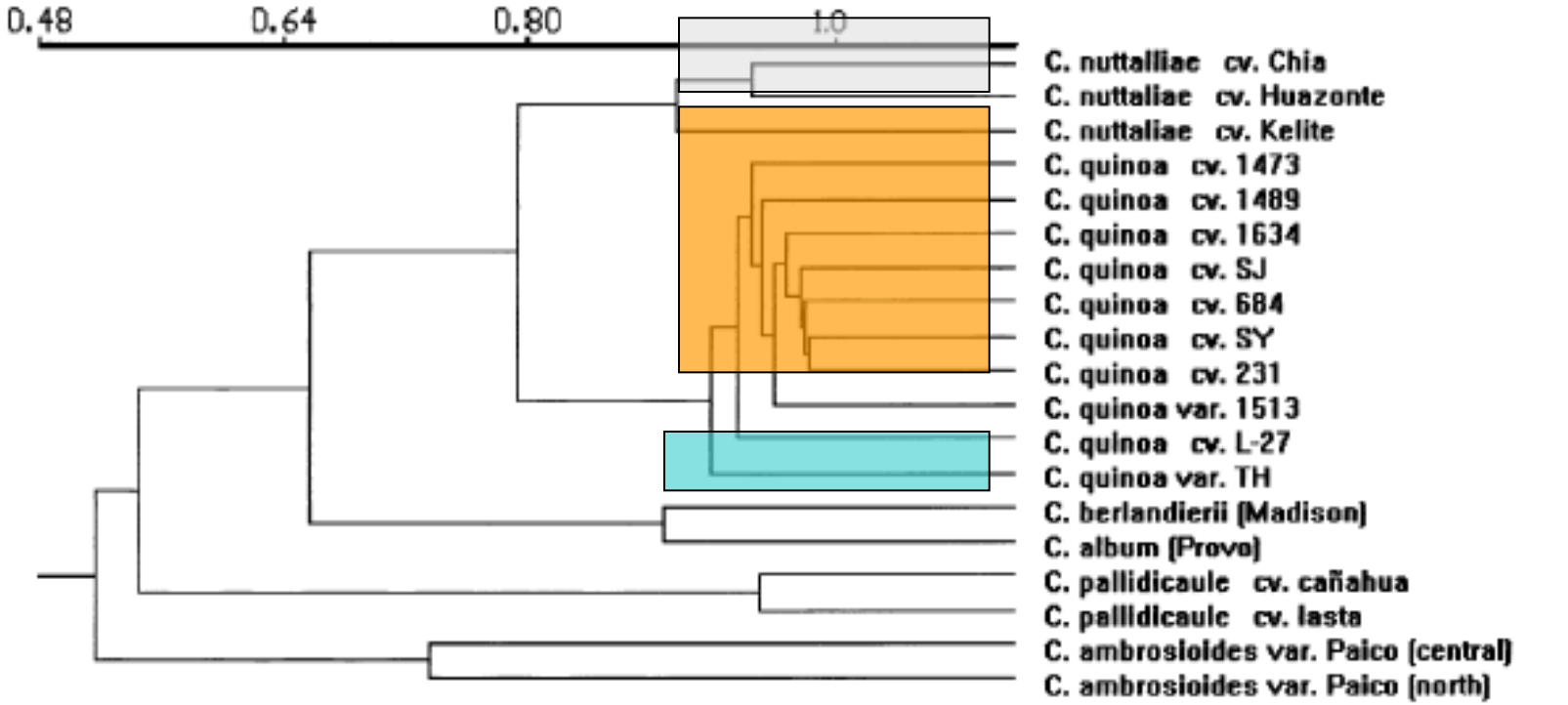
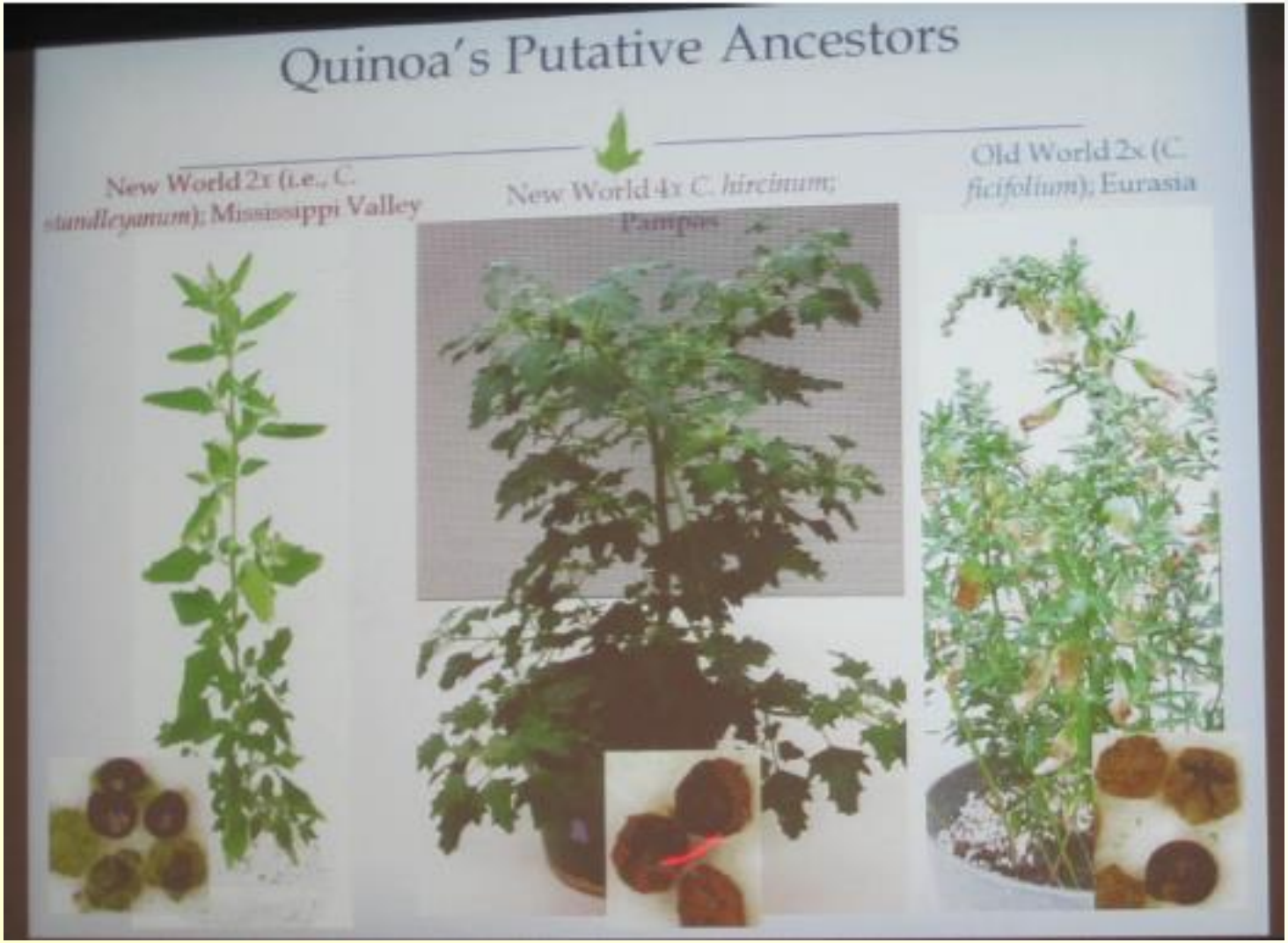


Figure 1. Genetic relationship among 19 taxa of *Chenopodium* based on molecular markers of RAPDs. The scale represents UPGMA similarity values.

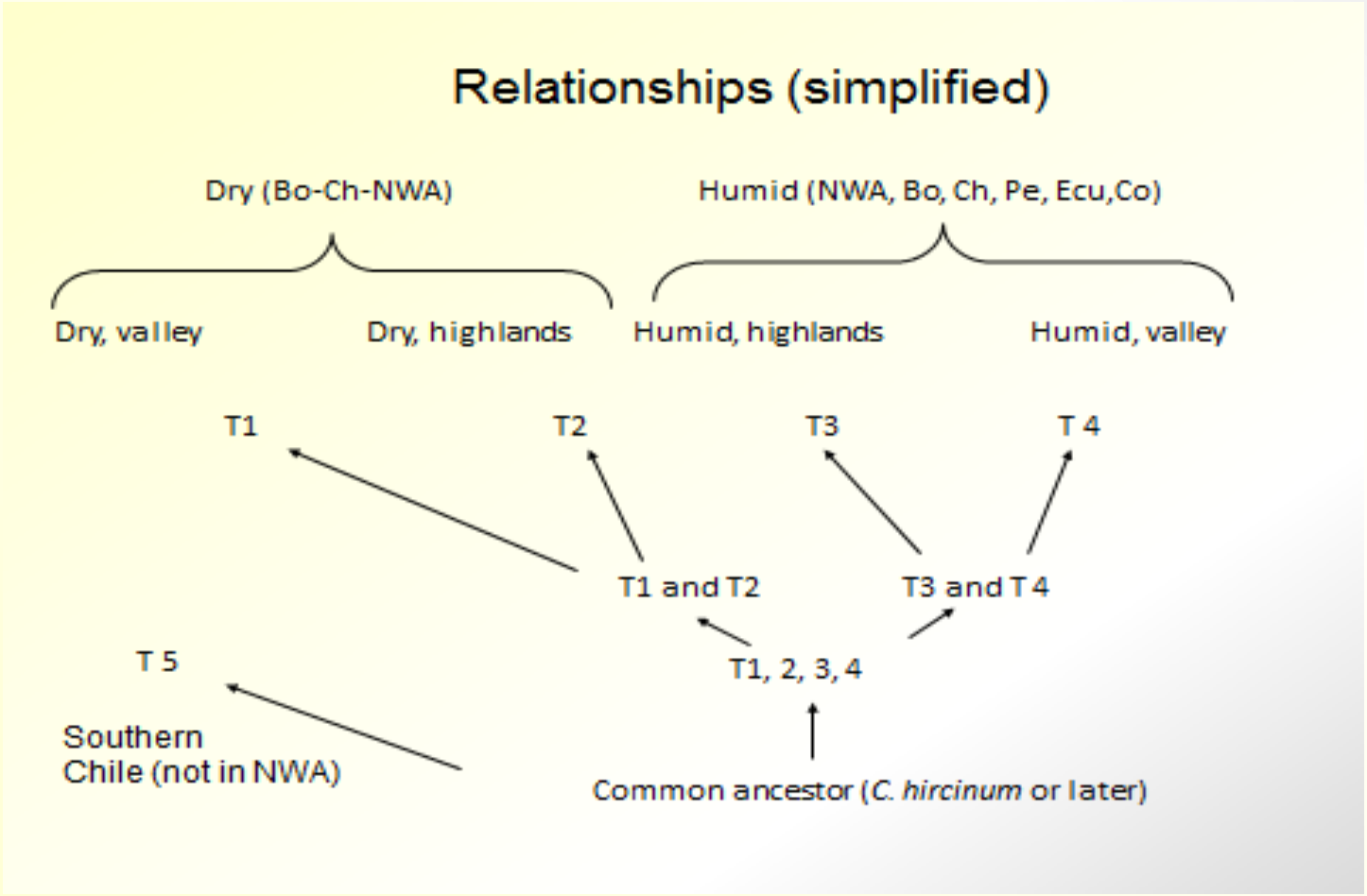
Ruas et al. 1999. RAPDs Euphytica 105: 25-32

State of the art of knowledge about quinoa phylogenetics
(putative diploid ancestors of *C. hircinum*)



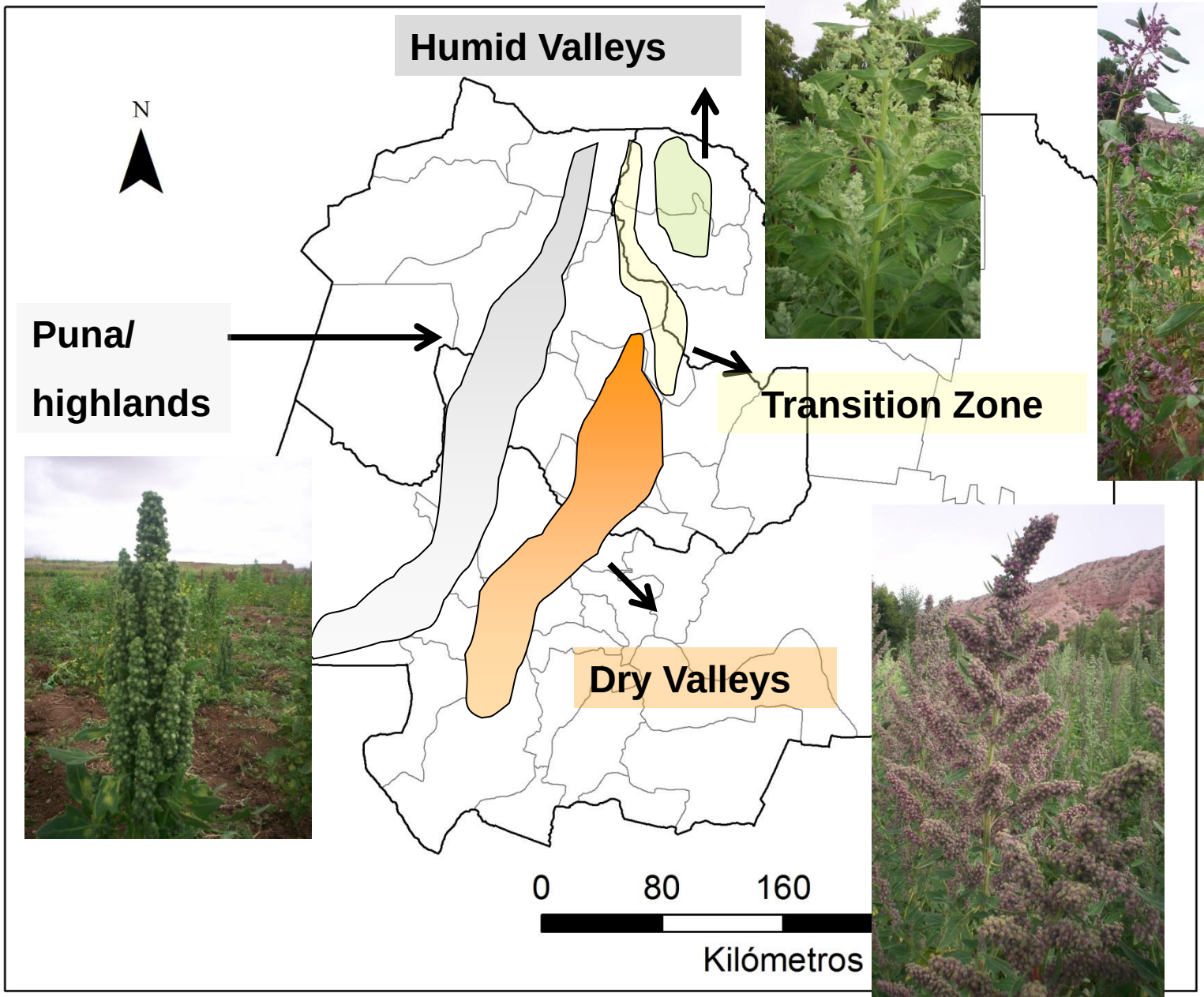
Jellen, 2013. International Quinoa Research Symposium, Pullman, WA

Recent results about quinoa genetic structure using SSR markers



Sabrina Costa Tartara (Molecular characterization of quinoa from NW Argentina and its genetic relations with the rest of the Andes)

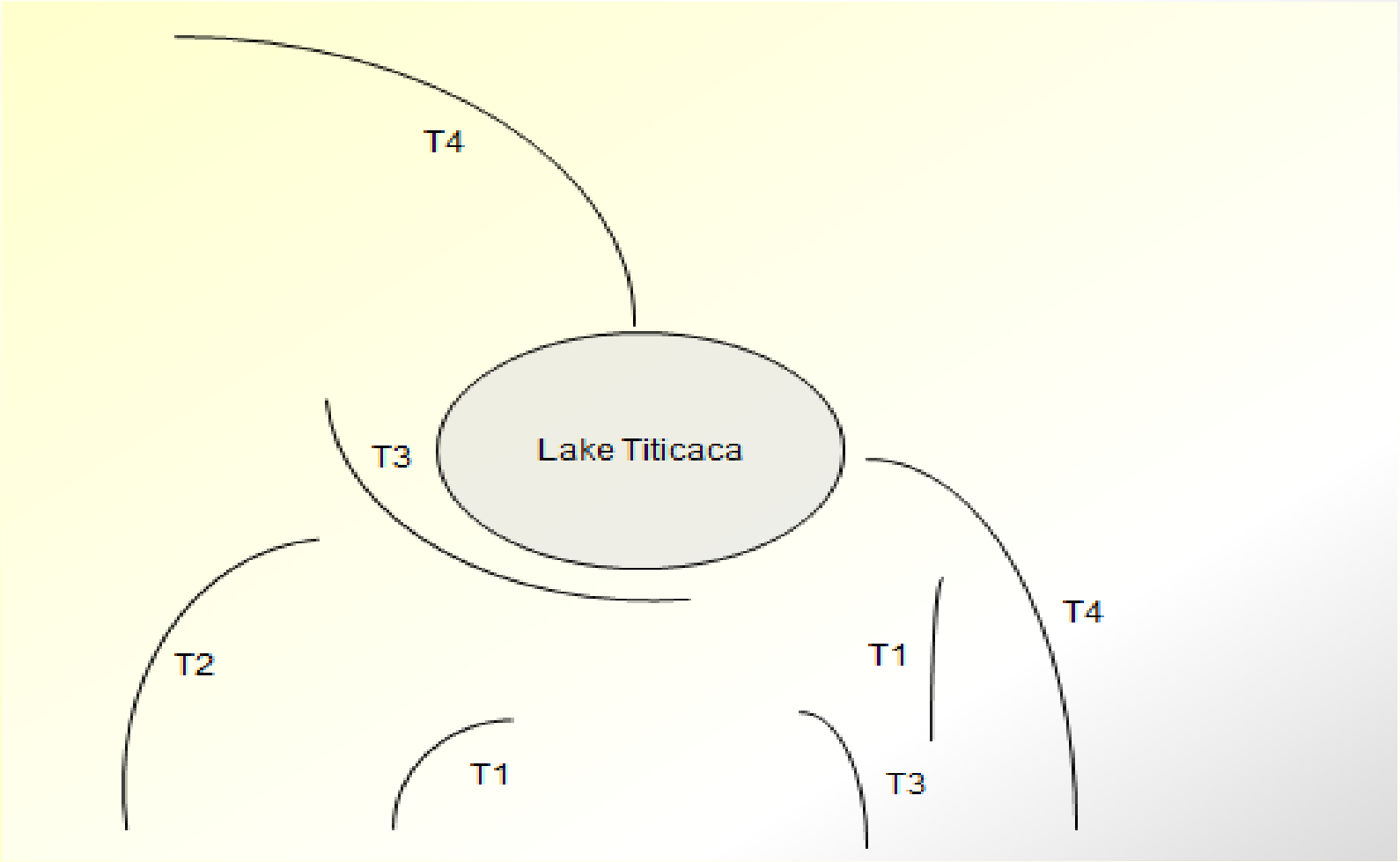
Structure of phenotypic variability

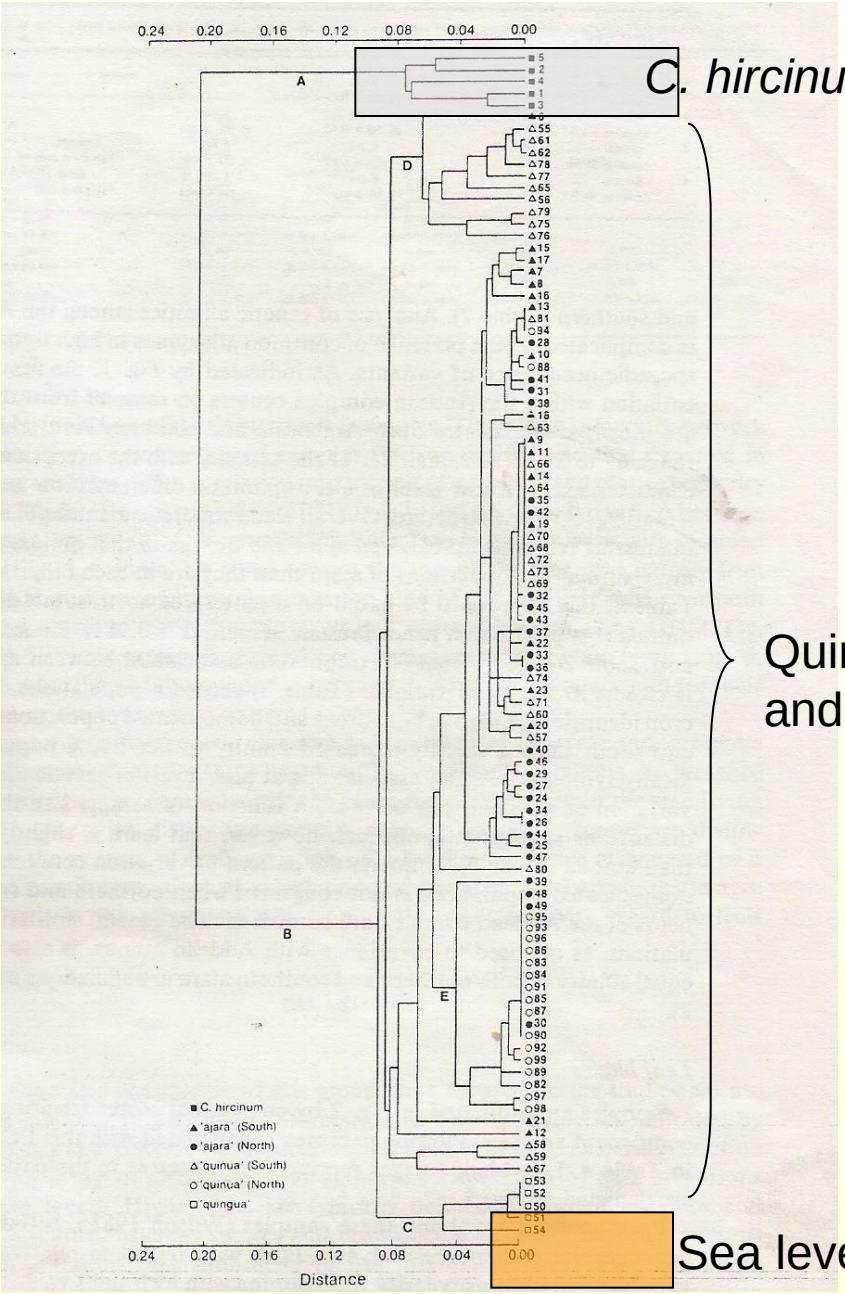


Ramiro Curti's Ph D thesis (2014)

Southern Andes whirlwind…

(distribution of the five genetic groups)





C. hircinum

What is known about *C. hircinum*?

Quinoa and *C. hircinum*

Quinuas from the Central Andes and '*ajaras*' (weedy forms)

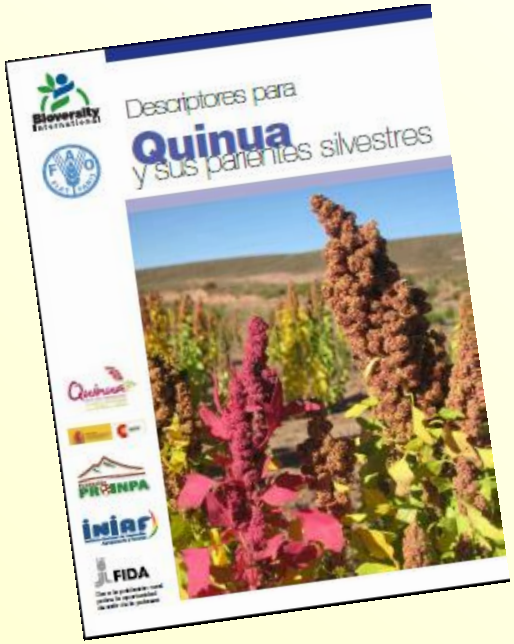
Sea level quinoa

Wilson, 1988. Economic Botany 42: 461-477 (Isoenzimas)

Variability in *C. hircinum* from central Argentina

Collection in progress (~ 15 accessions), 1 undetermined accesion with white & big seeds, high difficulties to access populations in the Central Andean countries

In this collection we already found..



Variation in:

- ✓ seed size and colour
- ✓plant growth habit)
- ✓plant colour (red and green)
- ✓leaf morphology
- ✓root growth (probably induced by environment)
- ✓two cycles per year (winter/spring and late summer/mid winter) in a very hot environment (heat scape?)

How can research on *C. hircinum* contribute to:

- Understand quinoa domestication process;

- Quinoa breeding for adaptation to new challenges (i.e. high temperature tolerance, others...)
- Needed:

  creation of a representative collection
  development of species-specific markers
  identification of "domestication traits alleles"
  .....

Marta Treuquil, Mapuche quinoa farmer, Cholila, Patagonia, Argentina