THE DUAL ORIGIN OF CULTIVATION IN COCONUT AND ITS IMPLICATIONS FOR BREEDING

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Bee F Gunn

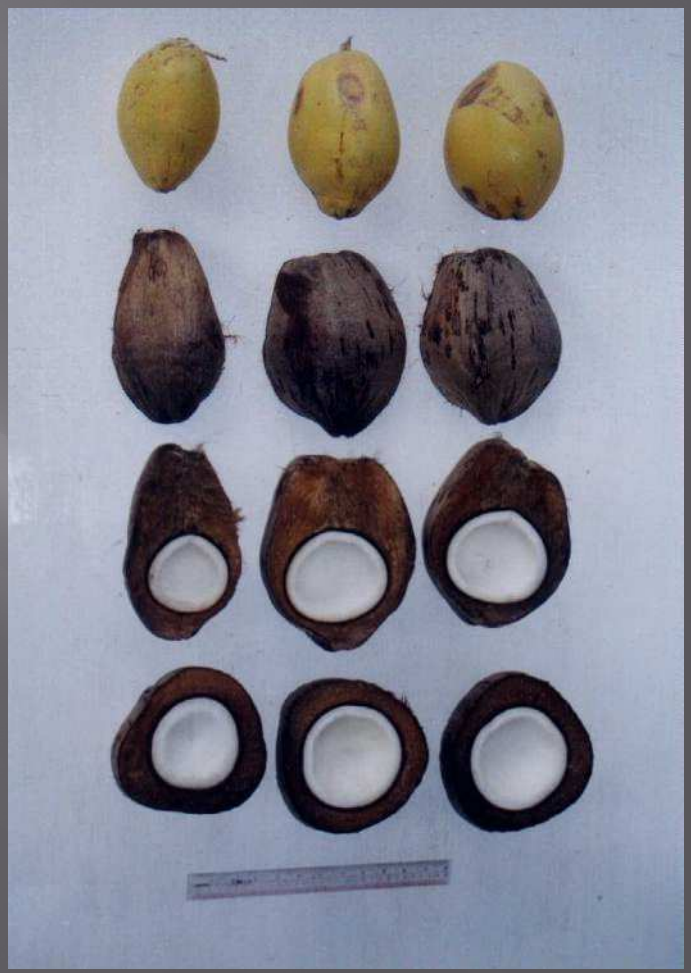
Introducing the tree of life

- Food
  - Immature nuts (meat and water)
  - Mature nuts (grated meat, milk, copra oil, virgin oil)
  - Terminal bud (Millionaire's salad)
  - Sap (Palm wine, spirit, Sugar, vinegar)
  - Others…
- Non food
  - Oil (Soap, cosmetics, biodiesel, dynamite)
  - Palms (roofs etc.)
  - Wood (Construction, furniture)
  - Shell (Coal,
  - Husk (Doormats, Carpets, ropes, geotextile)
  - Roots (medicinal)
  - Etc.

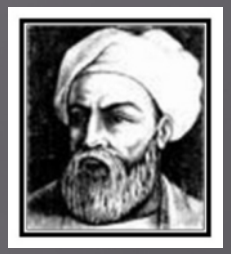
West African Tall

Rennell Island Tall

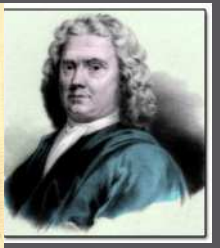
Malayan Yellow Dwarf



Plurydisciplinary approach



- Molecular markers
  - RFLP, AFLP, DArT, **Microsatellites**
  - Molecular taxonomy
- Plant morphology
  - Especially fruit morphology
- Palaeobotany
  - fossils
- Linguistics
  - Names for “coconut” or various coconut parts
- History
  - Austronesian, arab and european navigations

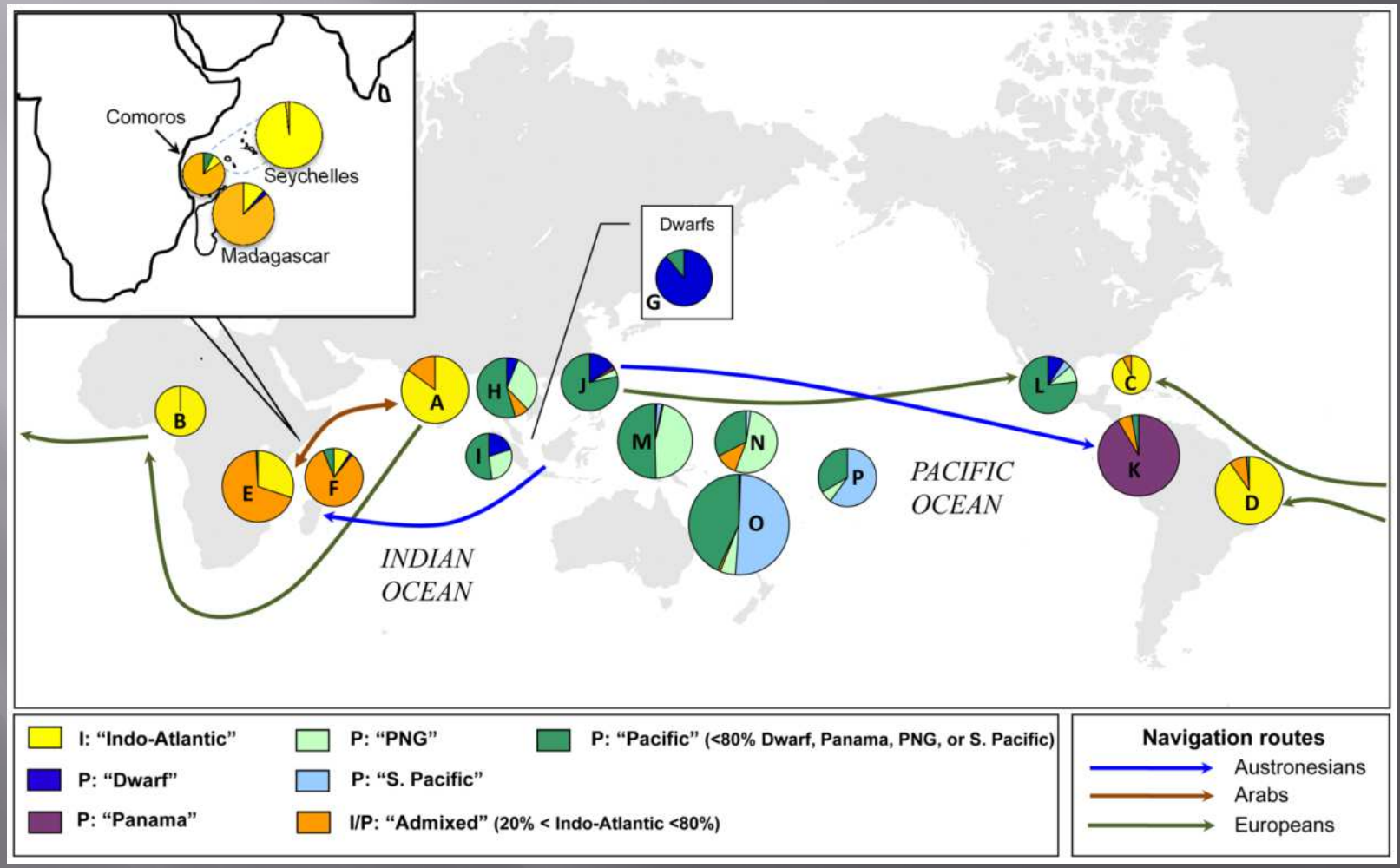


Microsatellite diversity studies

- 1322 individuals
- 140 origins
- 32 producing countries
- 10 SSR markers
- Statistical analyses
  - Structure
  - AMOVA
  - Geneclass 2

Gunn BF, Baudouin L, Olsen KM (2011) Independent Origins of Cultivated Coconut (*Cocos nucifera* L.) in the Old World Tropics. PLoS ONE 6(6): e21143. doi:10.1371/journal.pone.0021143

Distribution of genetic diversity in coconut



Genetic distances (RFLP Nei 1978)

COCONUT 21 RFLP

- Pacific 228 indiv. S.E.A. Melanesia, Polynesia, Panama
- Indo-Atlantic. 40 indiv.

OIL PALM 37 RFLP

- *E. o.* 245 indiv. Peru, Brazil, French Guyana, Central America, Suriname
- *E. g.* 38 indiv. Africa

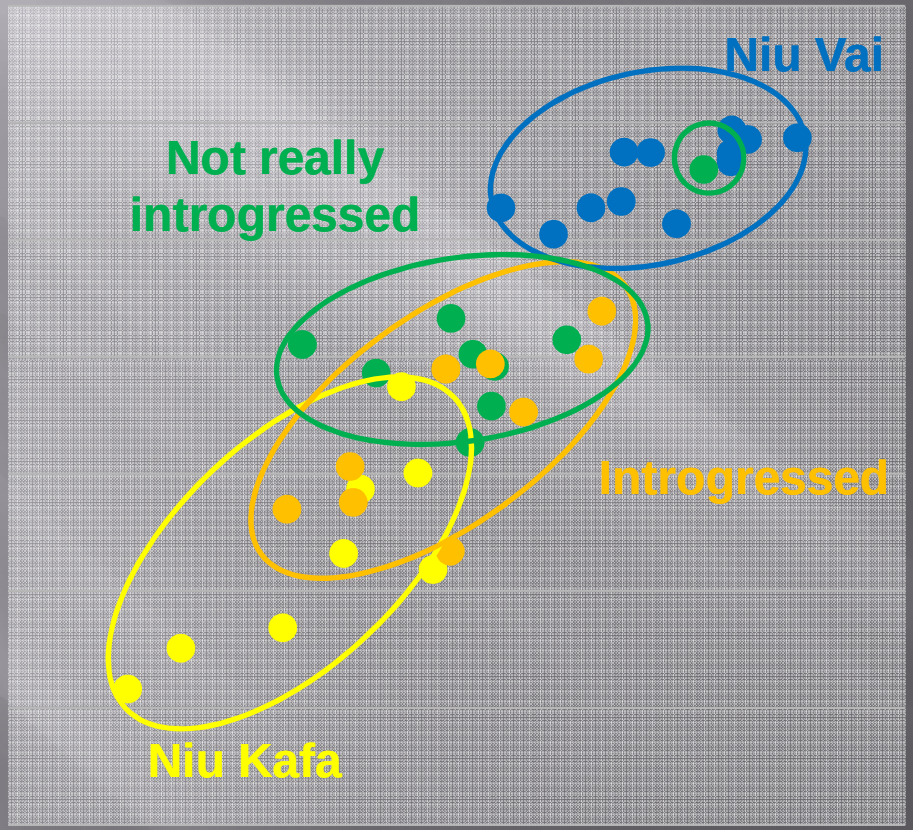
Cocos nucifera	Min	Max
Between Indo-Atlantic and Pacific	0.493	0.695
Within Pacific	0.023	0.309

Based on RFLP, SSR, AFLP
suggest 2 (sub-)species
No fertility barrier!

Elaeis spp	Min	Max
Between *E. guinenensis* and *E. oleifera*	0.276	0.321
Within *E. oleifera*	0.114	0.425

Based on RFLP and AFLP
E. g. is within the range of variation of *E. o.*
But F_1 parly sterile!

Synthetic representation of diversity of fruit morphology



Higher% water
Lower % meat

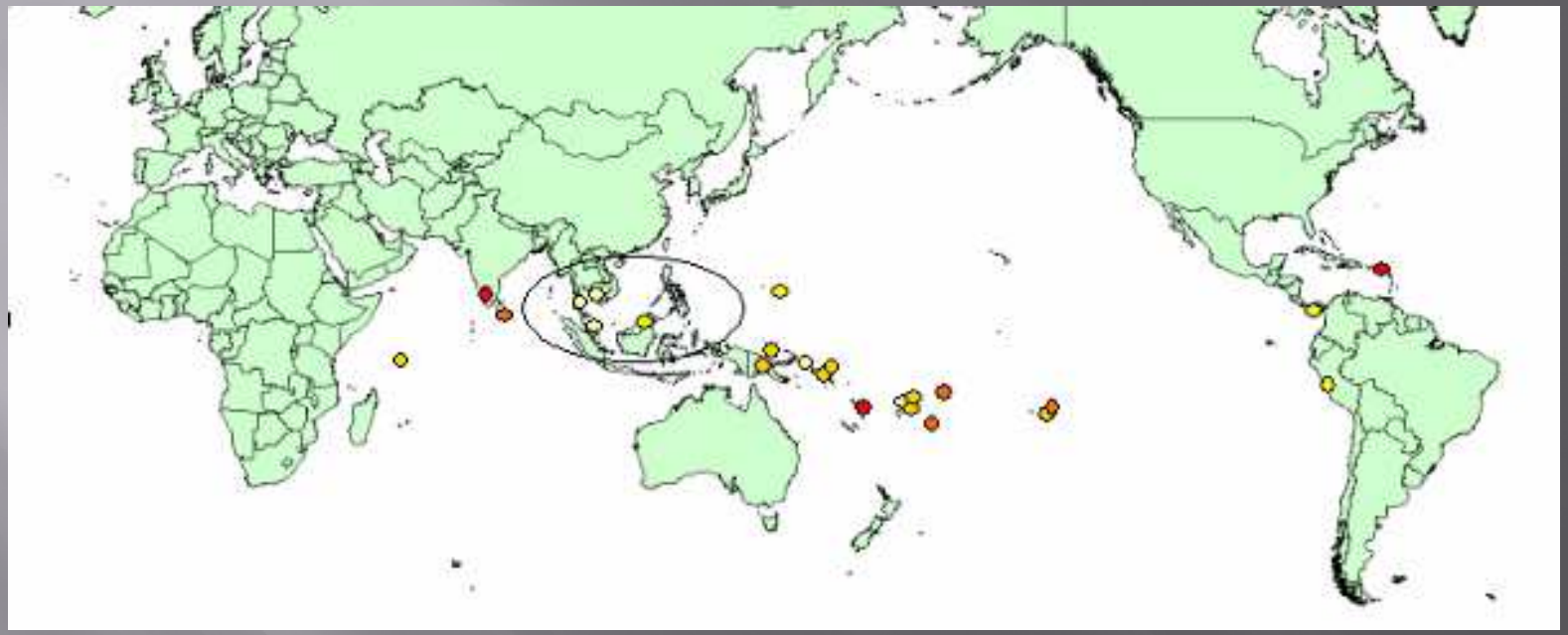
Higher fruit weigth
lower % husk

- S.E. Asia
- South Pacific
- Indo-Atlantic
- Introgressed I. A.

Ref: Harries 1978

Lethal yellowing field testing

(Case of Jamaica, after Been 1981)

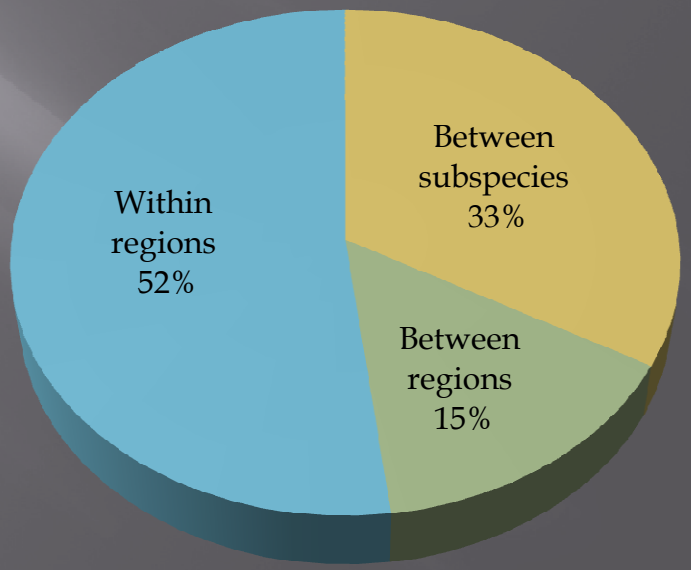


South-east Asian and related populations tend to behave better and more consistantly than populations from the rest of the world
Indo-Atlantic populations are susceptible

Challenges for coconut breeding

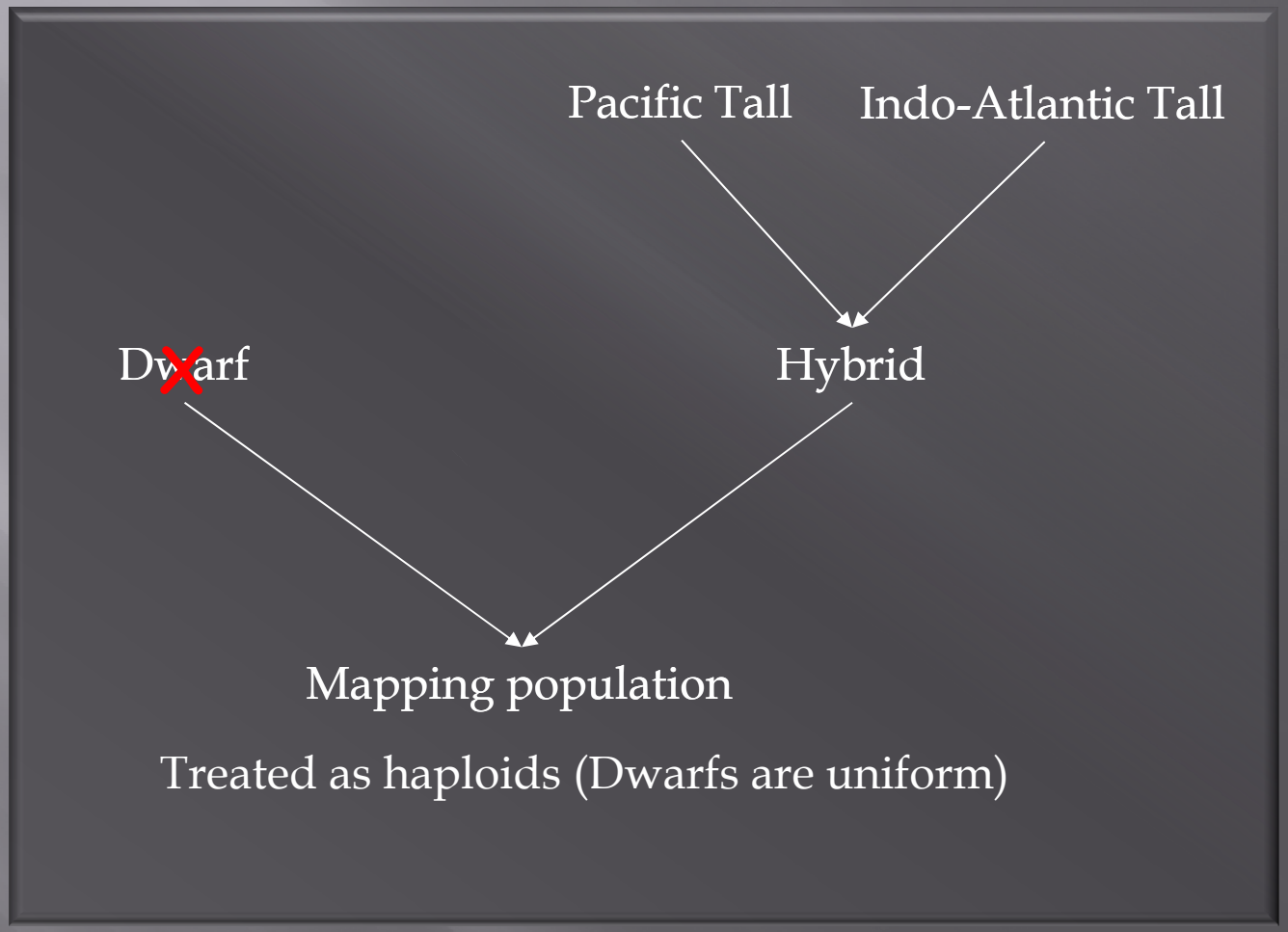
- Large seeded tree crop
  - Requires large surfaces
  - Long generation time
  - Low prolificacy
  - Limits genetic progress
- Smallholder crop
- Multipurpose crop
- Generally poor acceptance of high producing hybrids

STRUCTURE OF GENETIC DIVERSITY
AMOVA(10 SSR markers)



Mapping "large spectrum" QTLs for coconuts

Principle



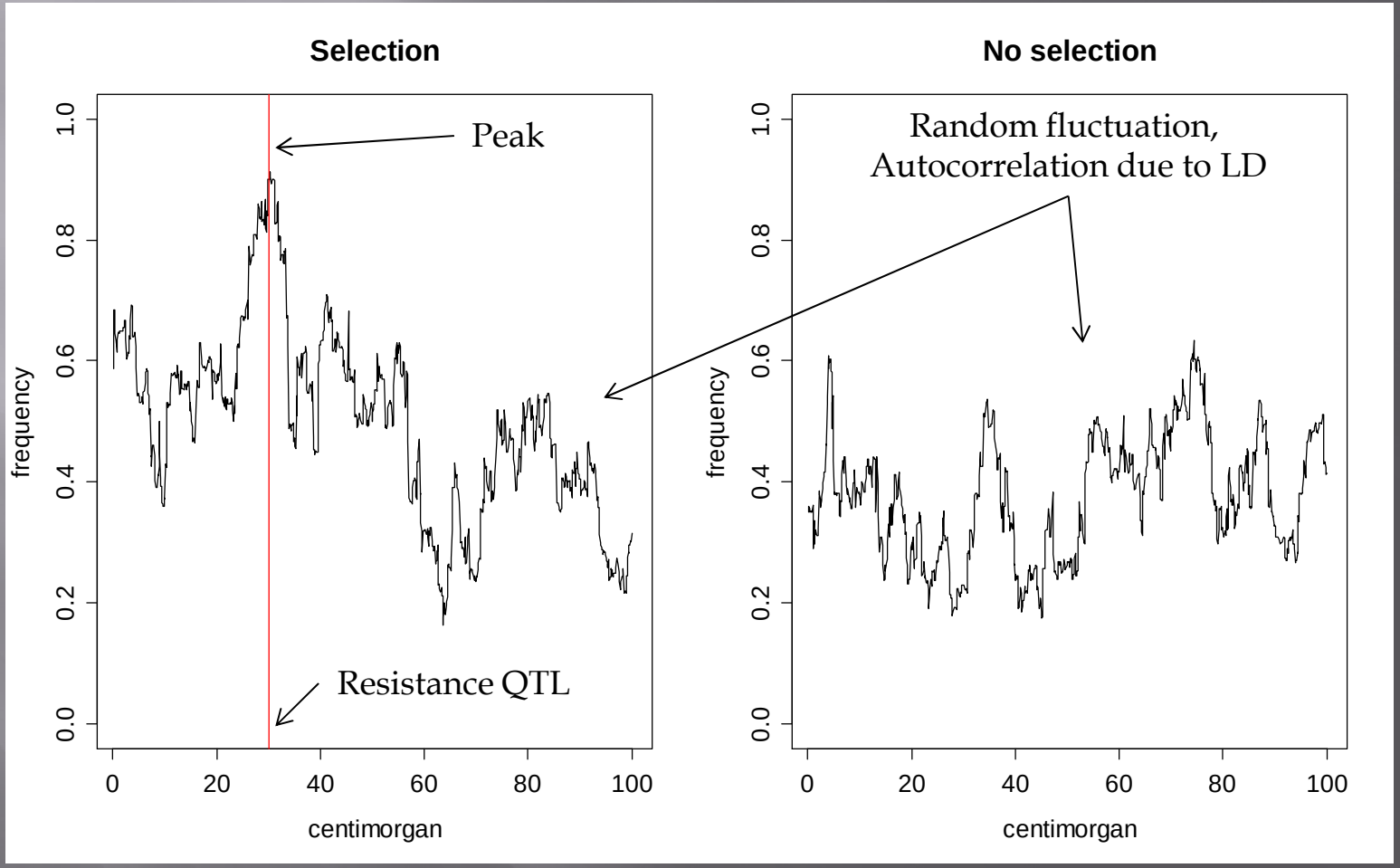
Lethal disease in Tanzania

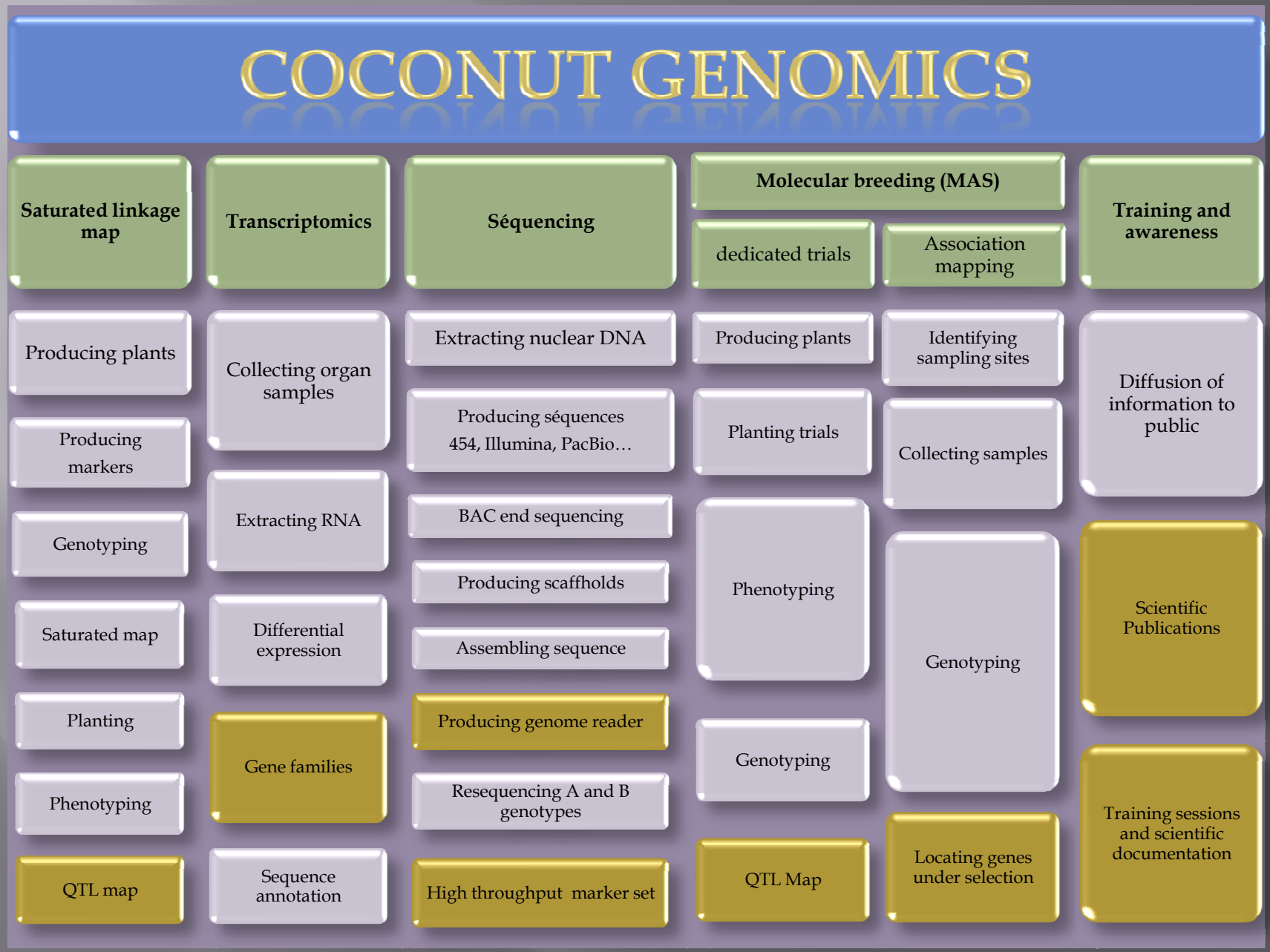
- All populations studied:
  - 33% South-east Asian alleles,
  - 67% Indian alleles
- North: Arabo-persian influence (mid 19th century)
  - Disease appeared earlier
  - Partial resistance detected
- South German influence (Late 19th – early 20th century)
  - Disease appeared later
  - No known resistance
- Approach:
  - High throughput genotyping
  - Identify geographic variations
  - Locate loci under selection
  - Search for putative R-genes

Tanzania

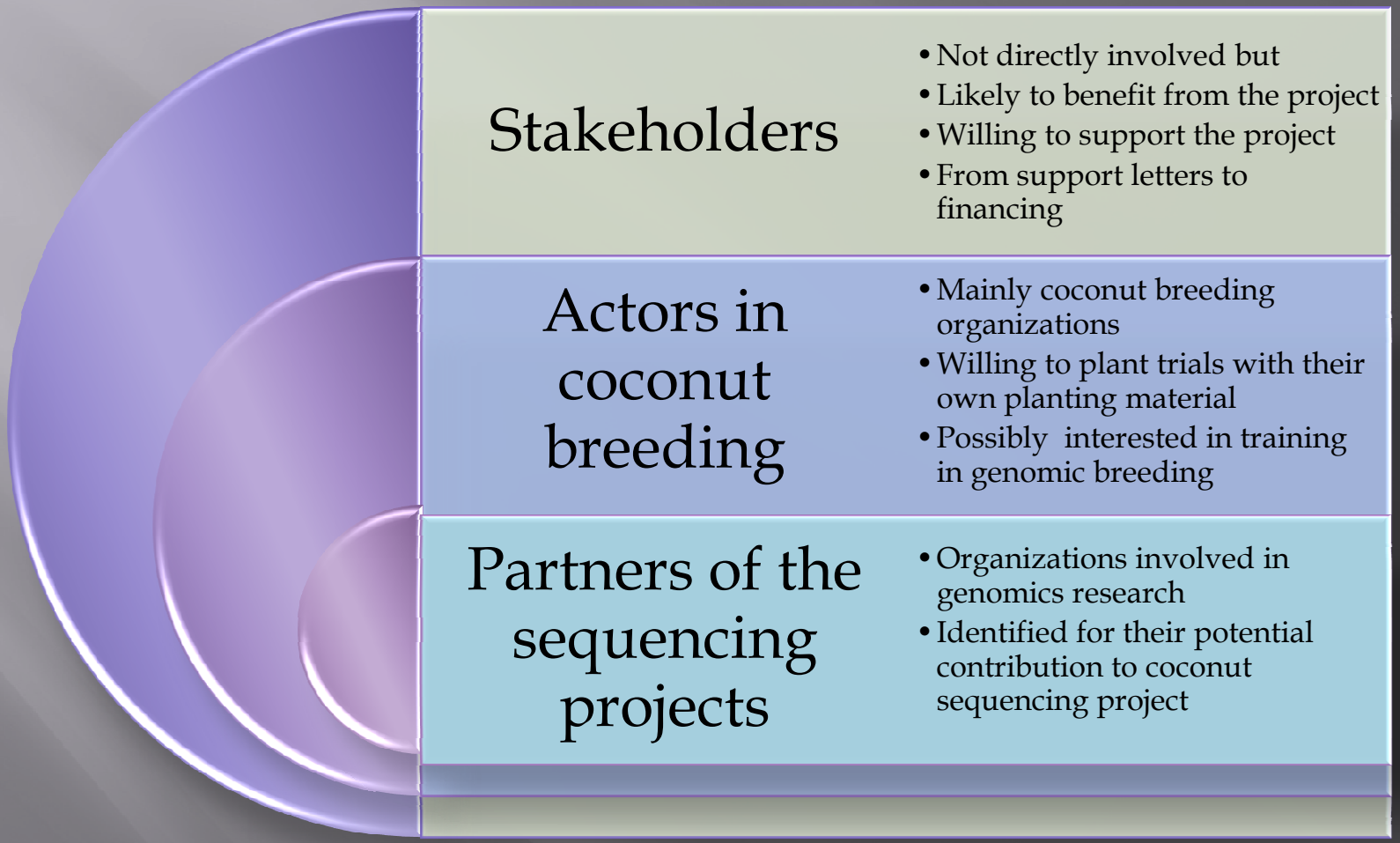
Detecting genes under selection in farmer's fields

Simulated data. s=1.25. 32 generations. Initial frequency: 0.33




COCONUT GENOMICS
Saturated linkage map
Transcriptomics
Séquencing
Molecular breeding (MAS)
dedicated trials
Association mapping
Training and awareness
Producing plants
Producing markers
Genotyping
Saturated map
Planting
Phenotyping
QTL map
Collecting organ samples
Extracting RNA
Differential expression
Gene families
Sequence annotation
Extracting nuclear DNA
Producing séquences 454, Illumina, PacBio…
BAC end sequencing
Producing scaffholds
Assembling sequence
Producing genome reader
Resequencing A and B genotypes
High throughput marker set
Producing plants
Planting trials
Phenotyping
Genotyping
QTL Map
Identifying sampling sites
Collecting samples
Genotyping
Locating genes under selection
Diffusion of information to public
Scientific Publications
Training sessions and scientific documentation

WAYS OF PARTICIPATING



In conclusion

- Molecular studies reveal a major subdivision between Indo-Atlantic and Pacific populations
- Breeding programs should take advantage of this genetic structure
- Sequencing coconut genome will help
- Large SNP marker sets are needed
  - Between sub-species polymorphism should be goven priority
- Anticipate different varietal output
  - Dwarf x Tall population hybrids
  - Composite varieties
  - Improved traditional varieties Tall and Dwarfs

Thank you

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