DIVERSITÉ GÉNÉTIQUE TEMPORELLE (1984-2020) ET SPATIALE D'UNE POPULATION DE BLÉ SAUVAGE SOUS L'EFFET DU CHANGEMENT CLIMATIQUE

Avi Levy, March 2021

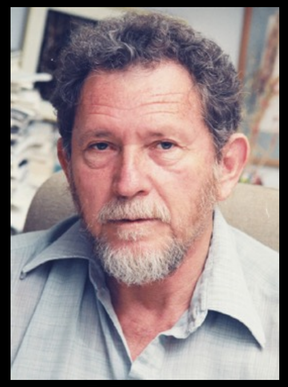
KIBBUTZ AMMIAD

מכון ויצמן למדע
WEIZMANN INSTITUTE OF SCIENCE

Ammiad wild wheat population

- A project that started in 1984 under the umbrella of the Israeli Gene bank as a test case for *in situ* conservation
- Located at the center of distribution of the species as suggested by high genetic and phenotypic diversity
- Declared in 2007 by SPNI as a natural reserve for *in-situ* wheat biodiversity conservation
- Test case for spatial and temporal adaptation

Yehoshua Anikster (Head) TAU



Moshe Feldman WIS

SPNI

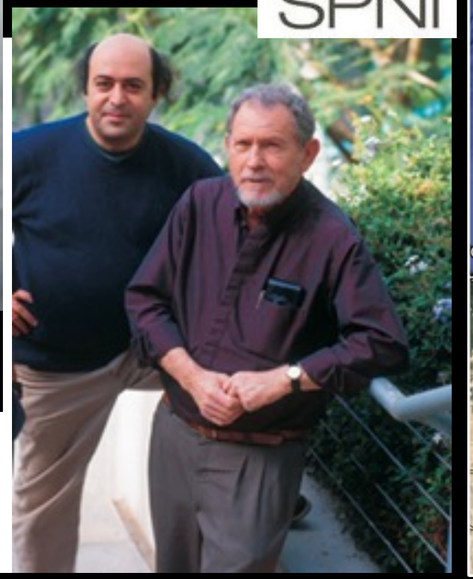
Theor Appl Genet (1988) 75:651–658

Ecogeographical distribution of HMW
in populations of the wild tetraploid w
Triticum turgidum* var. *dicoccoides

A. A. Levy and M. Feldman *
Department of Plant Genetics, The Weizmann Institute of Science, Rehovot 76 100, Israel

Magnus Nordborg GMI

Tal Dahan-Meir



Wild emmer wheat distribution in the fertile crescent

Triticum turgidum ssp. dicoccoides

Self-pollinating ~ 99%

Annual plant (1 generation/year)

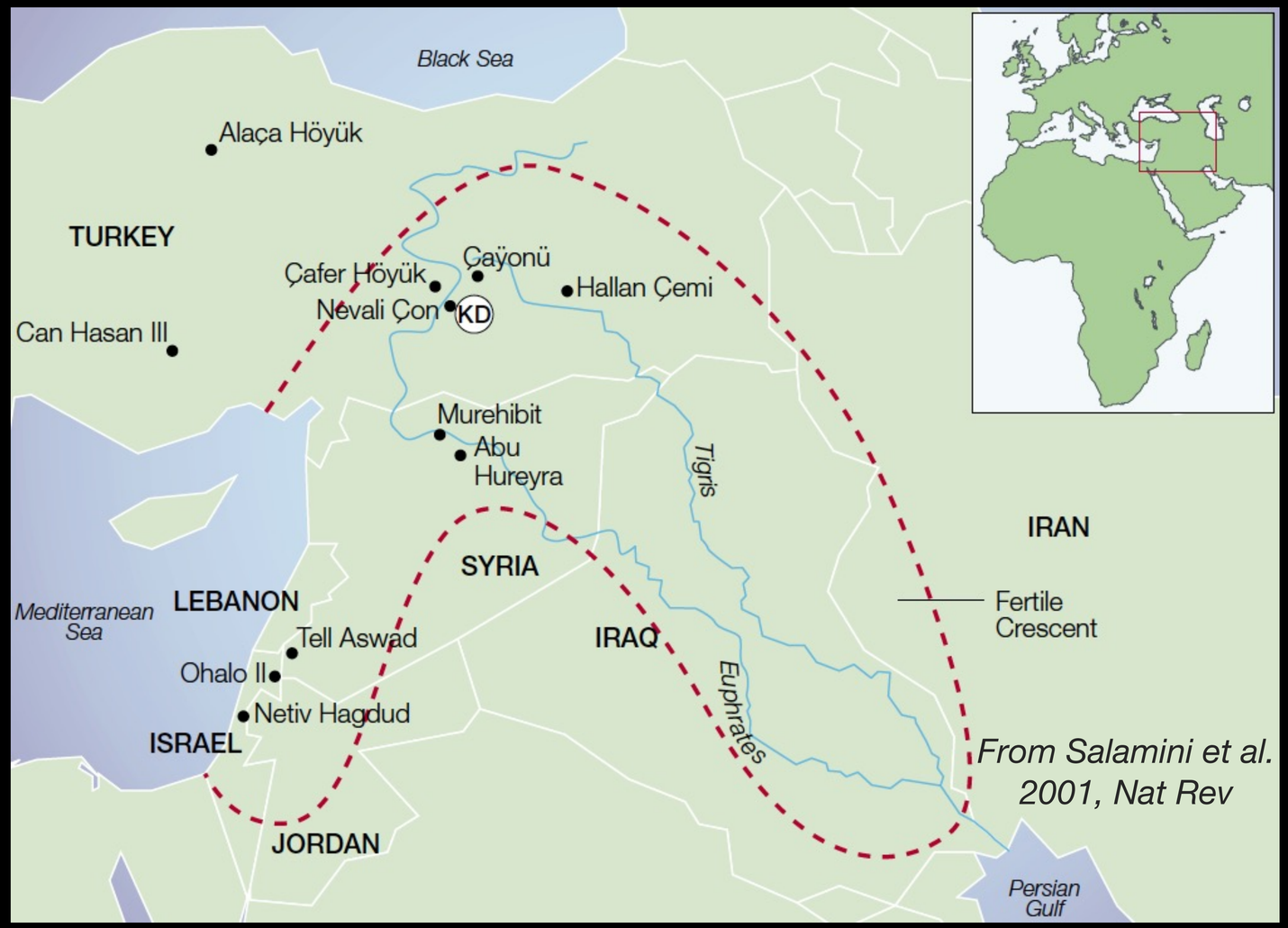
Tetraploid genome (2n=4x=28, BBAA)

Approximately 12 Gbp

Sequenced in 2017 (Avni et al. science)

80% repetitive elements

~65,000 genes



From Salamini et al. 2001, Nat Rev

South Levant: Center of variation (= Center of origin?)
Center of domestication of wild emmer wheat

Wild emmer: direct progenitor of modern wheat; rich source for genes conferring resistance to diseases, abiotic stress, yield and quality

durum wheat
BBAA

T. dicoccum
Wild emmer → domestic emmer
BBAA → BBAA

Aegilops tauschii
DD

Bread wheat
BBAADD

20% calories consumed by Human

20% proteins

750Mt/Yr

AABBDD

Important for food security:

- Conservation
- Characterization
- Exploitation

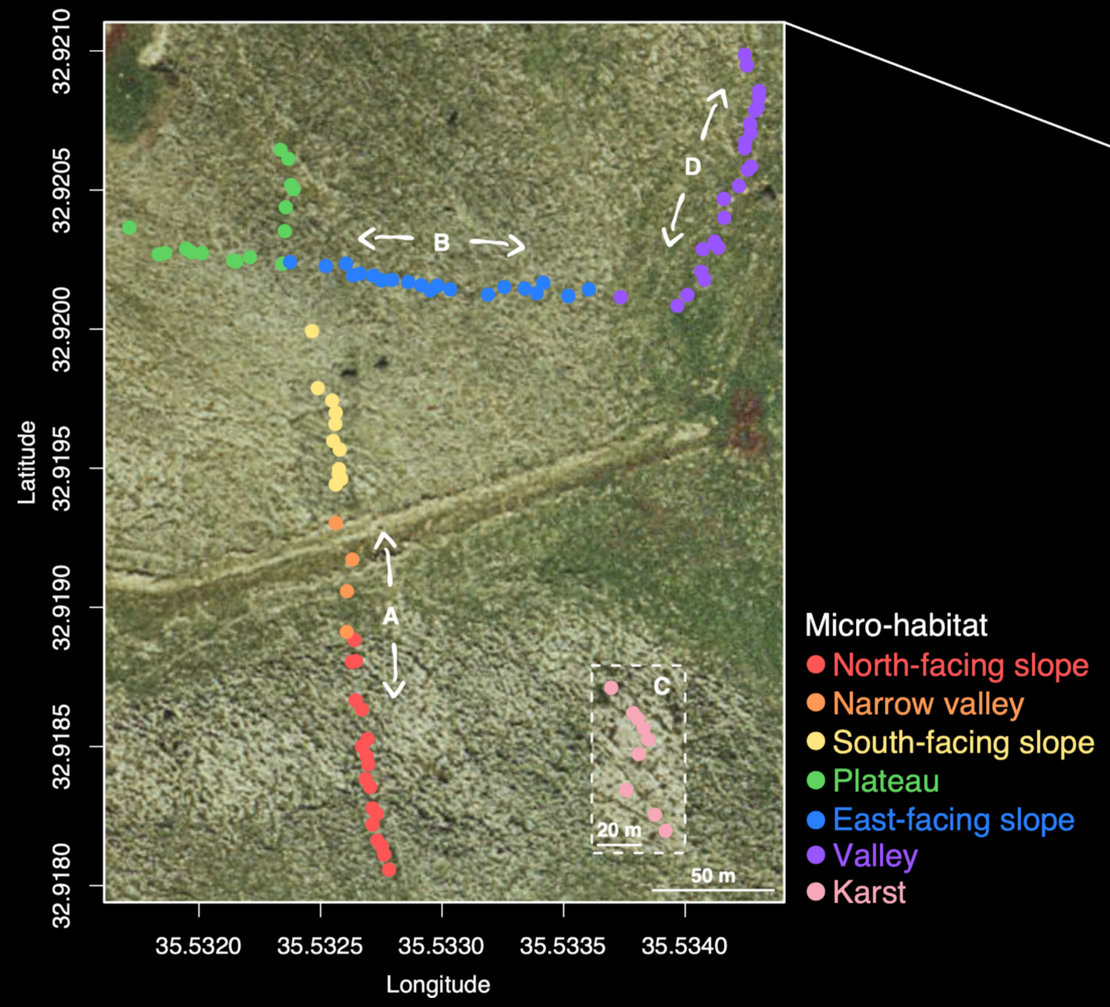
AMMIAD POPULATION

- Four transects - 100 marked (GPS+Peg) points, sampled between 1984 to 2020
- Transects diverse in topography, soil/rock composition and flora

Collection in:

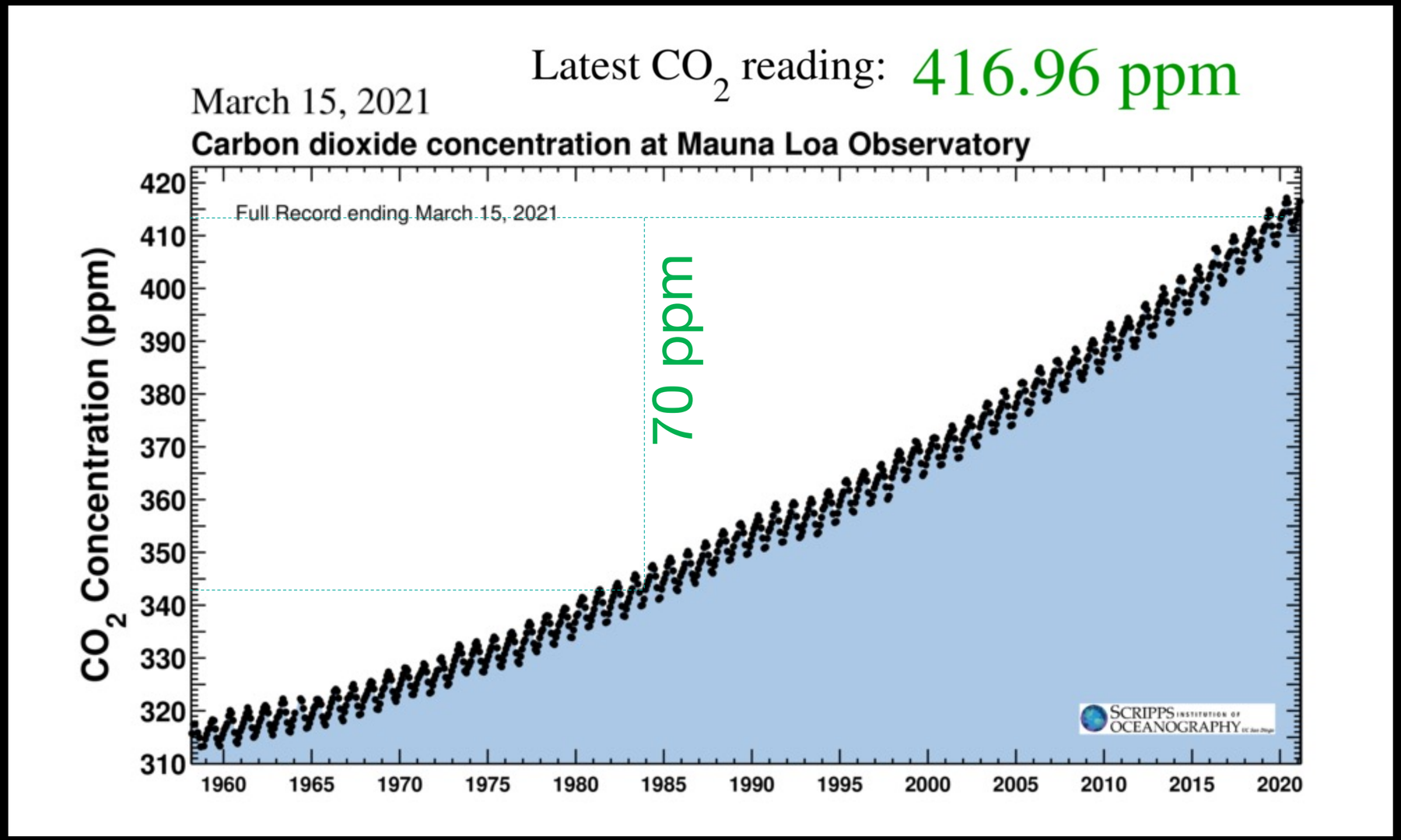
1984
1988
1992
1996
2002
2014
2016
2018
2020

Total ~900 samples

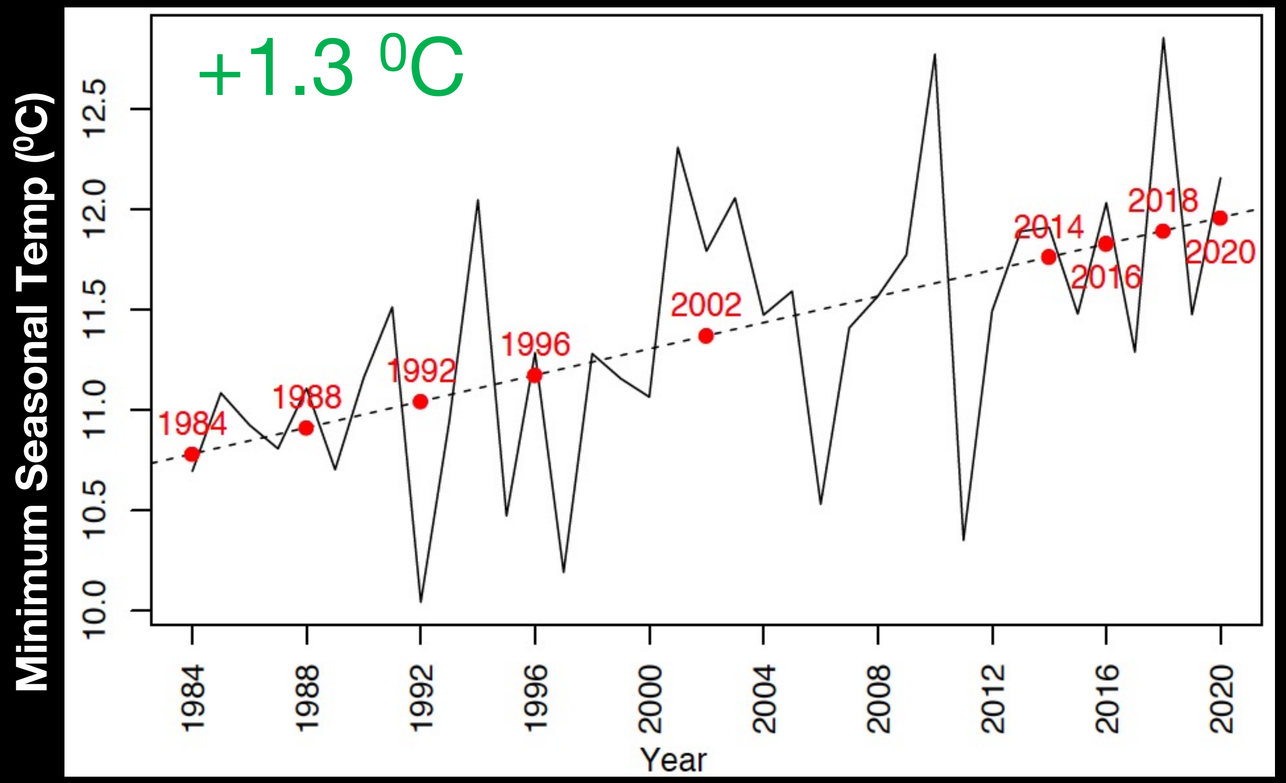


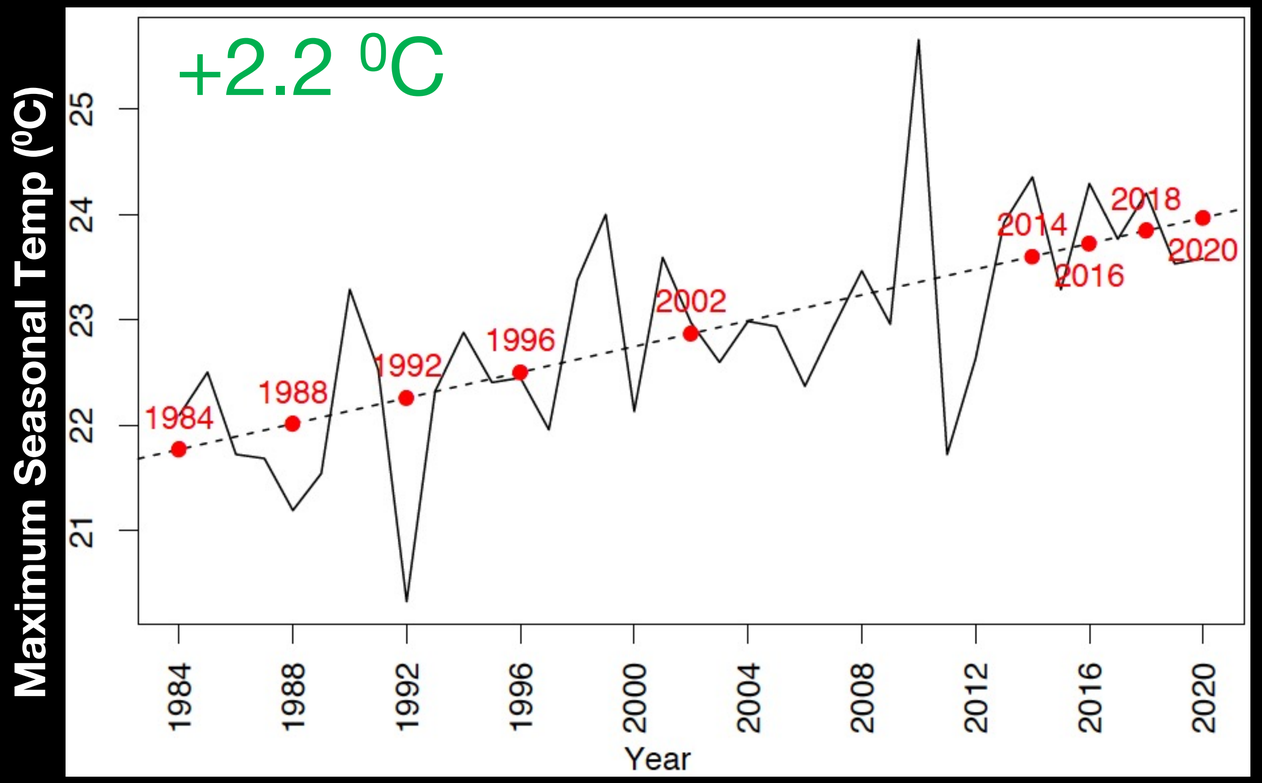
70 ppm increase (~20%) in atmospheric CO_2 concentration between 1984-2020

THE KEELING CURVE



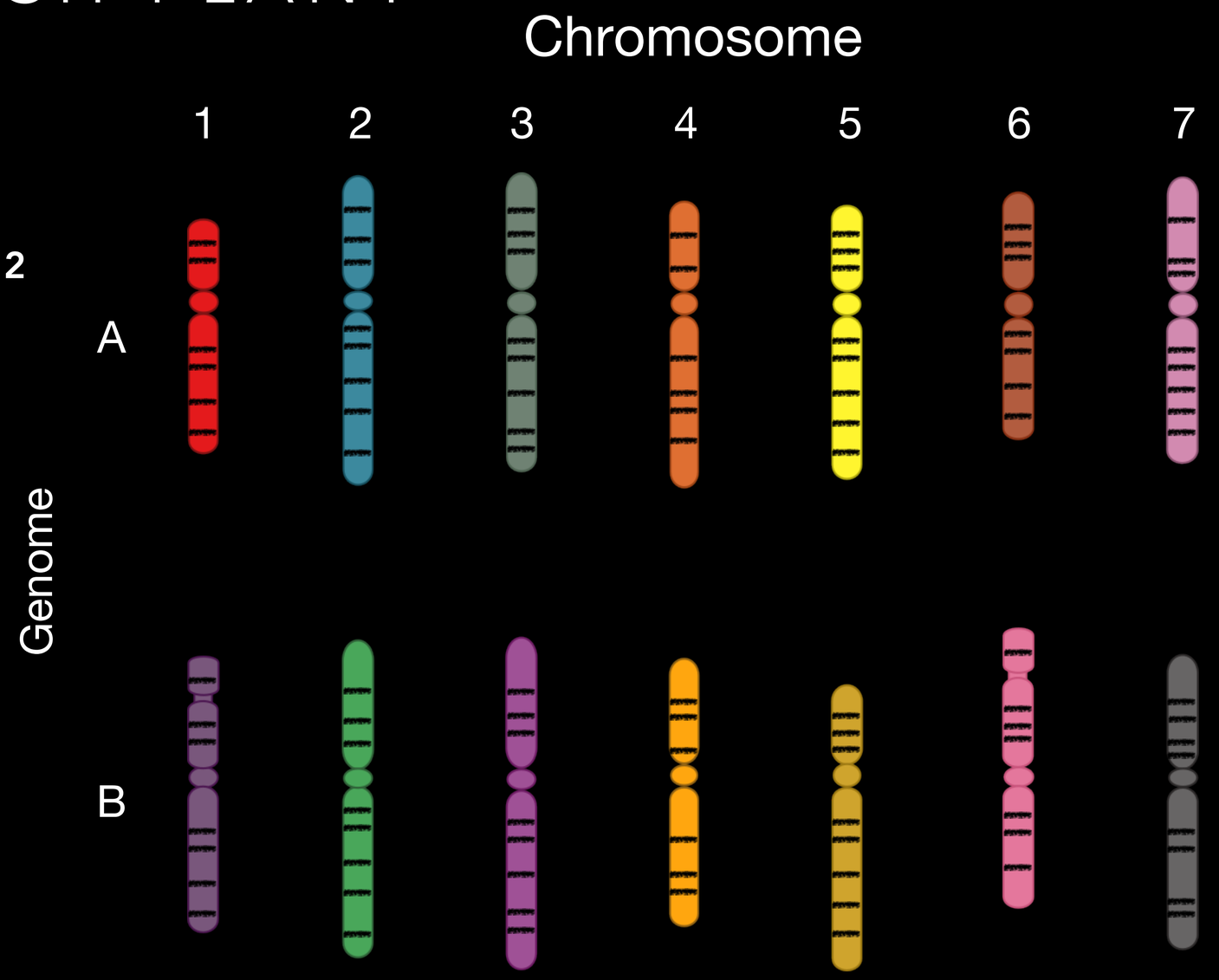
Temperature increase between 1984-2020 during growth season (Nov-May) near Kibbutz Ammiad





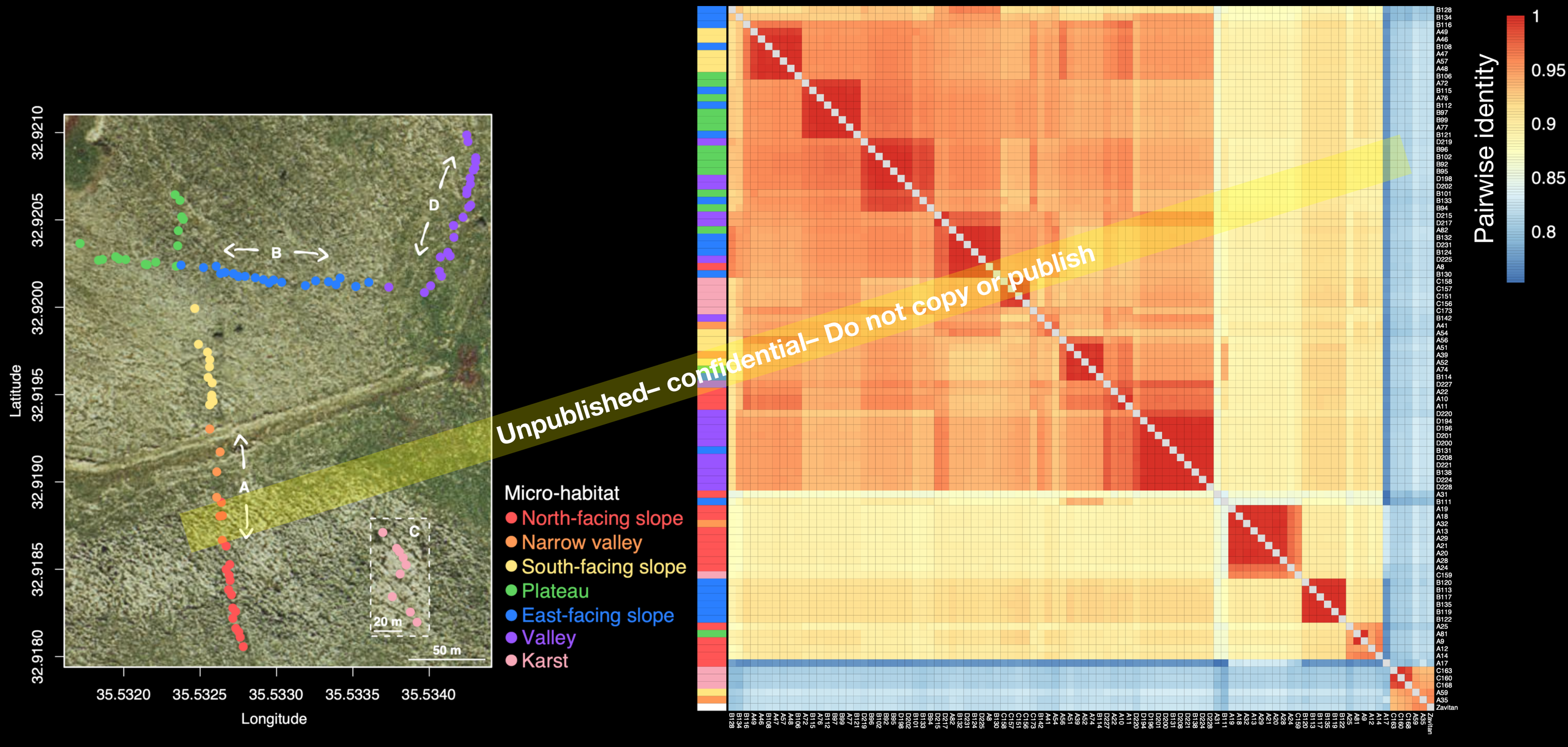
GENOTYPING OF EACH PLANT

- Genotyping-by-Sequencing (GBS - ddRADSeq) **Poland et al. 2012**
- Reduced representation of the wheat genome (<1%)
- Filtering for coverage >6x
- Filtering for unique sequences
- Identification of heterozygotes



4286 POLYMORPHIC MARKERS ALONG THE GENOME

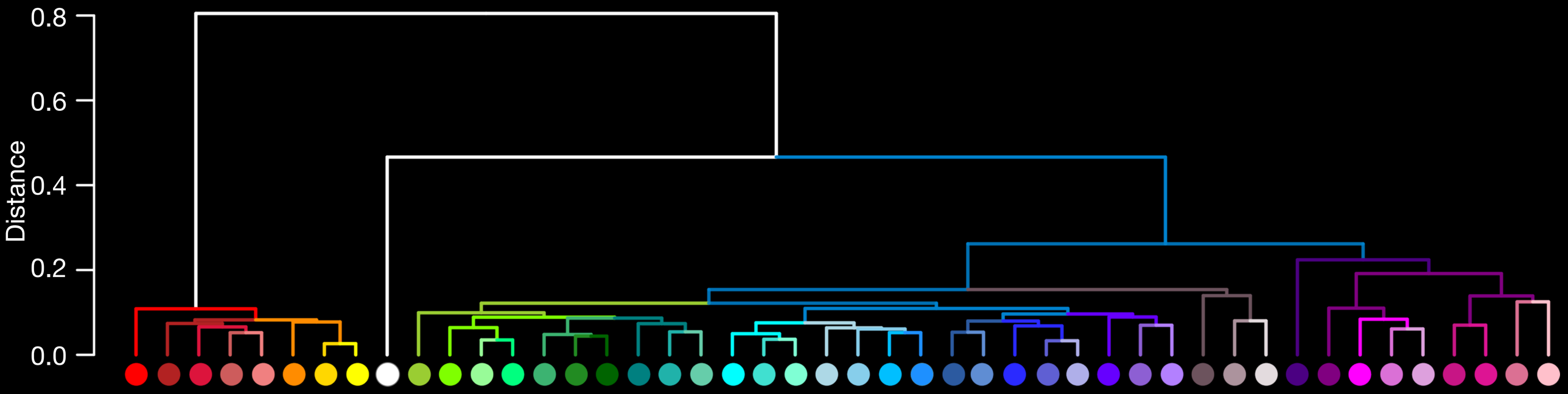
WHAT IS THE POPULATION STRUCTURE? 1984



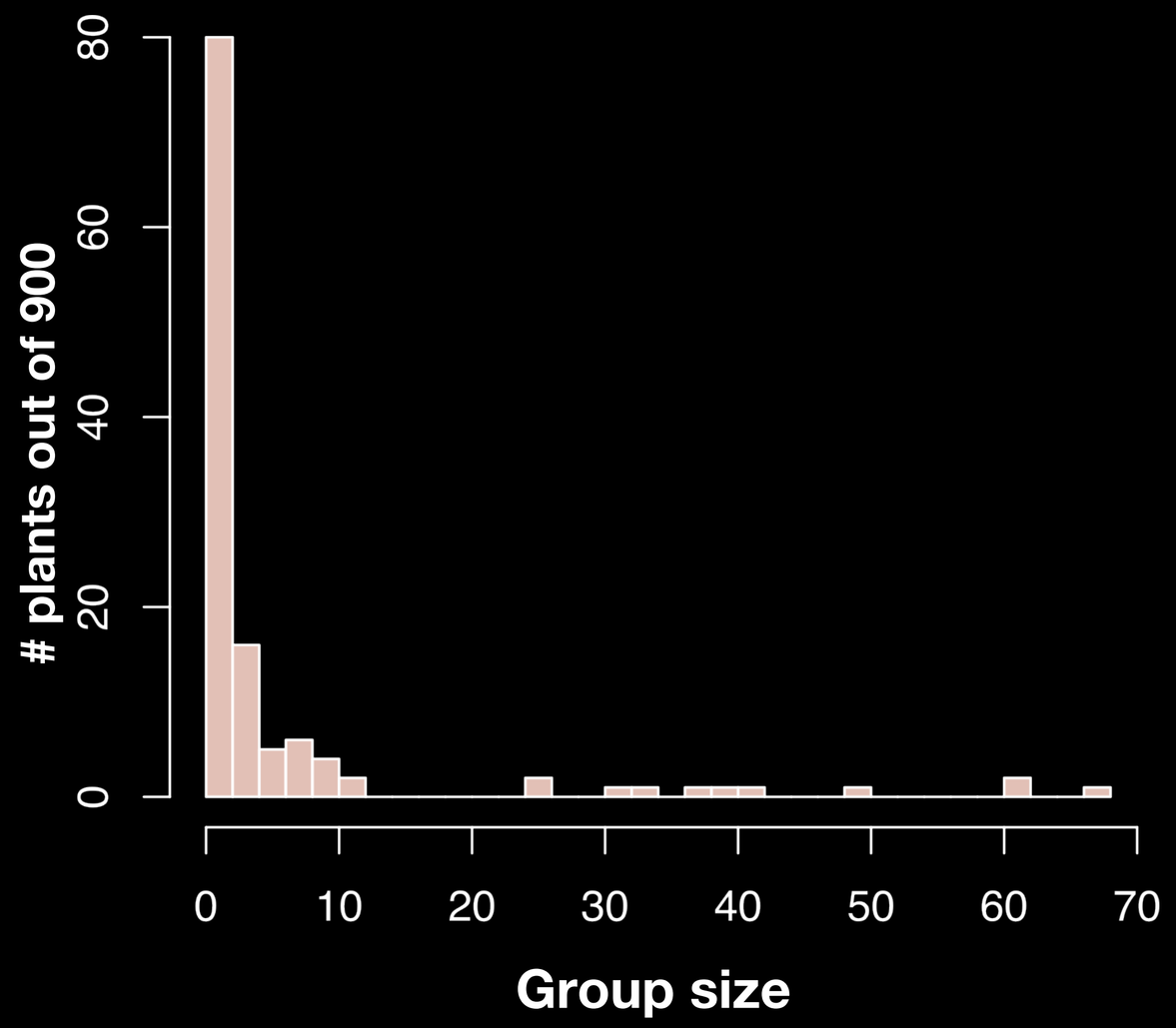
IDENTICAL GENOTYPE GROUPS (IGGs)

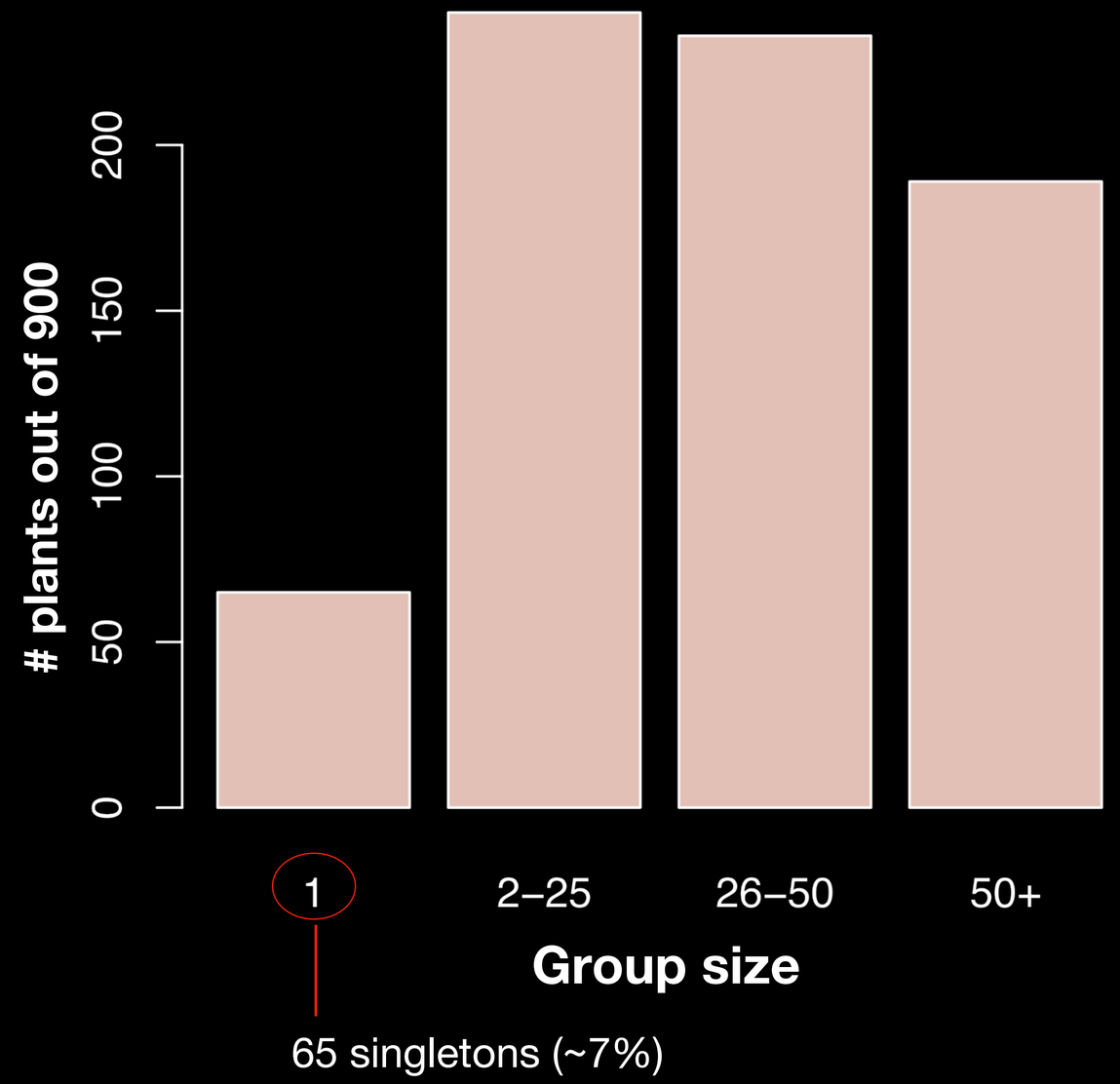
IGGs = Groups with >99% pairwise identity

- 127 IGGs out of 900 plants

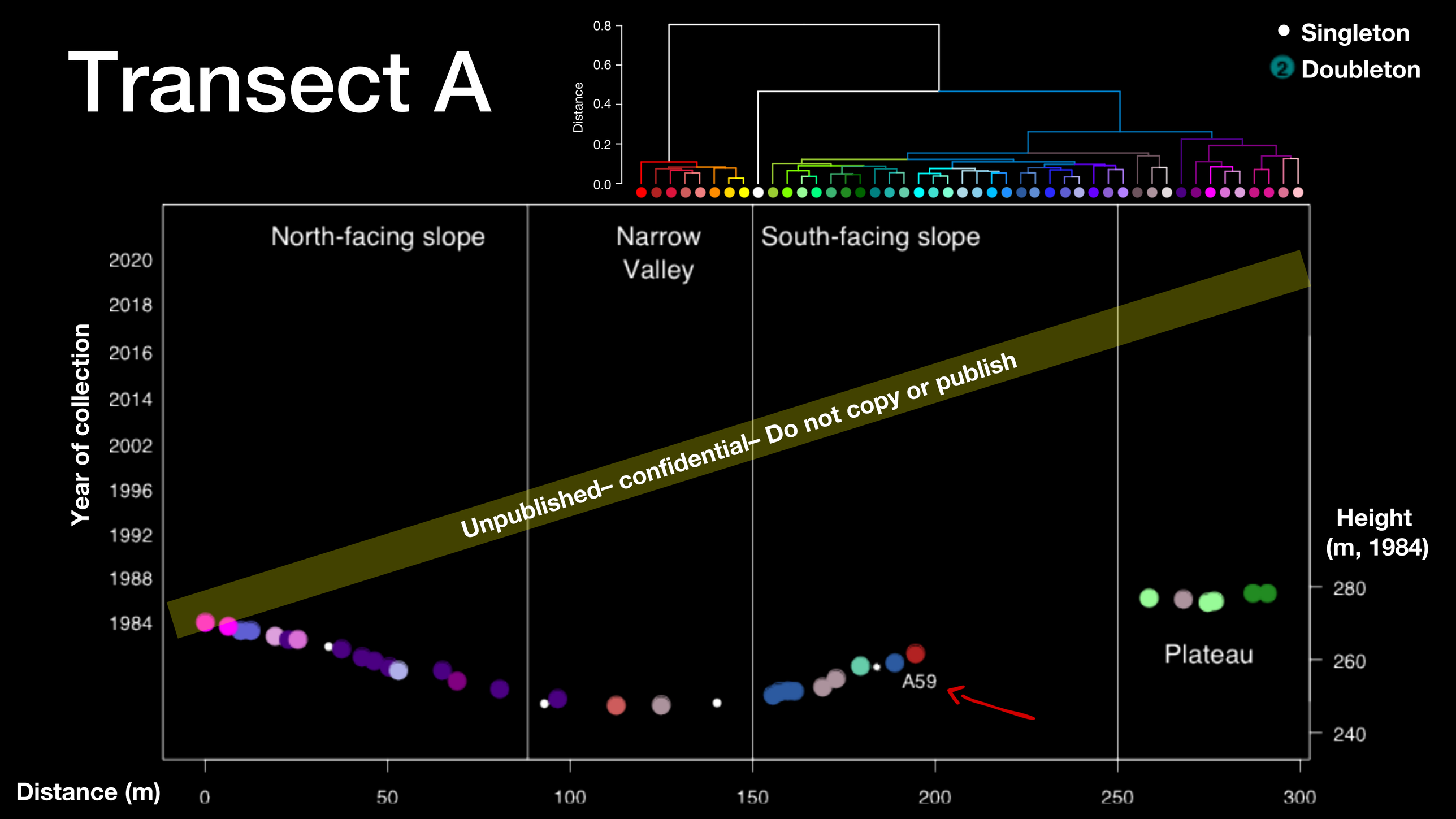


Sizes of Identical Genotype Group (IGGs)

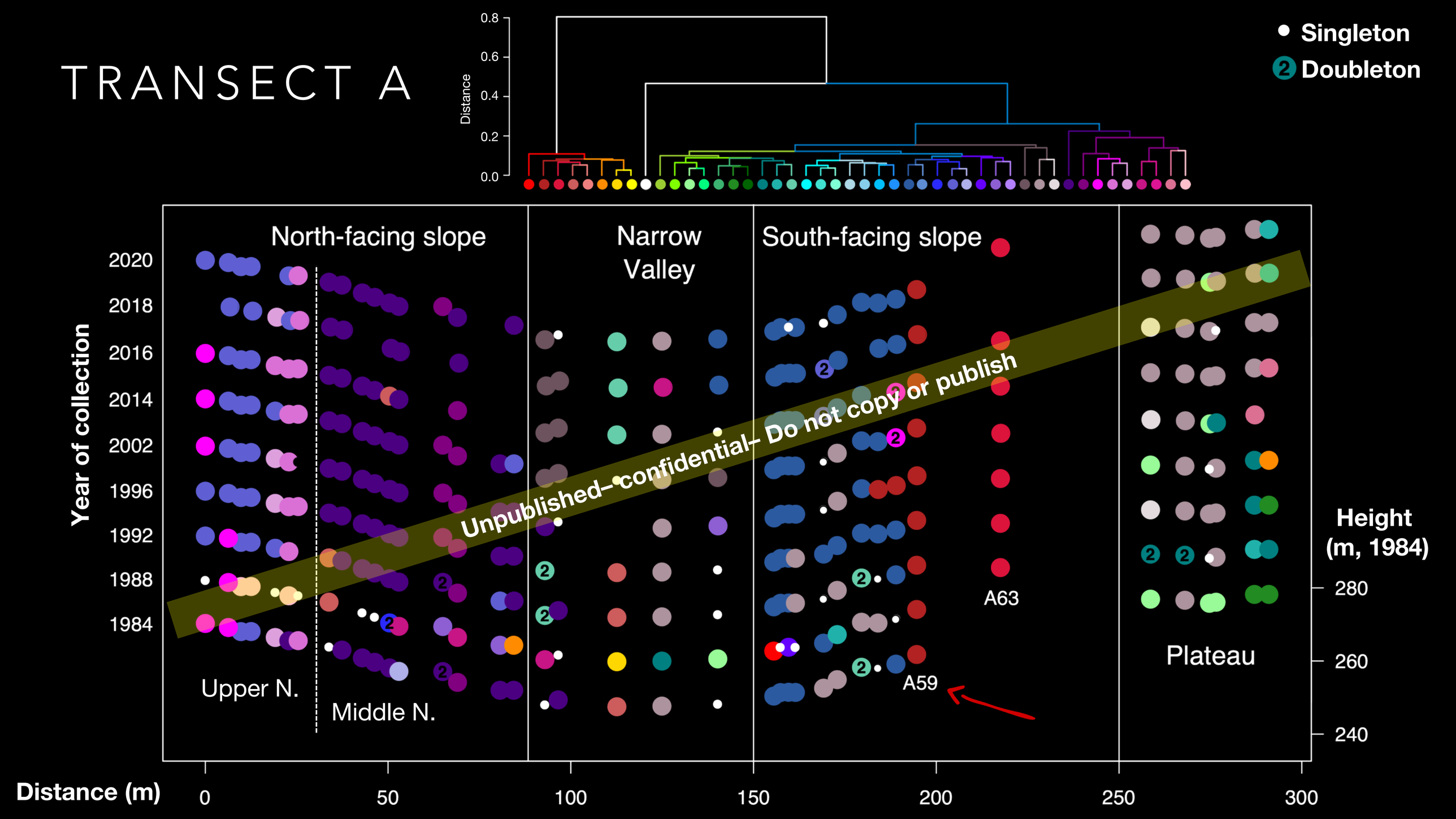




Transect A


Singleton
Doubleton
Distance
0.8
0.6
0.4
0.2
0.0
North-facing slope
Narrow Valley
South-facing slope
Plateau
A59
Year of collection
2020
2018
2016
2014
2002
1996
1992
1988
1984
Height (m, 1984)
280
260
240
Distance (m)
0
50
100
150
200
250
300
Unpublished– confidential– Do not copy or publish

TRANSECT A


Distance
0.8
0.6
0.4
0.2
0.0
Singleton
Doubleton
North-facing slope
Narrow Valley
South-facing slope
Plateau
Upper N.
Middle N.
A59
A63
Year of collection
2020
2018
2016
2014
2002
1996
1992
1988
1984
Height (m, 1984)
280
260
240
Distance (m)
0
50
100
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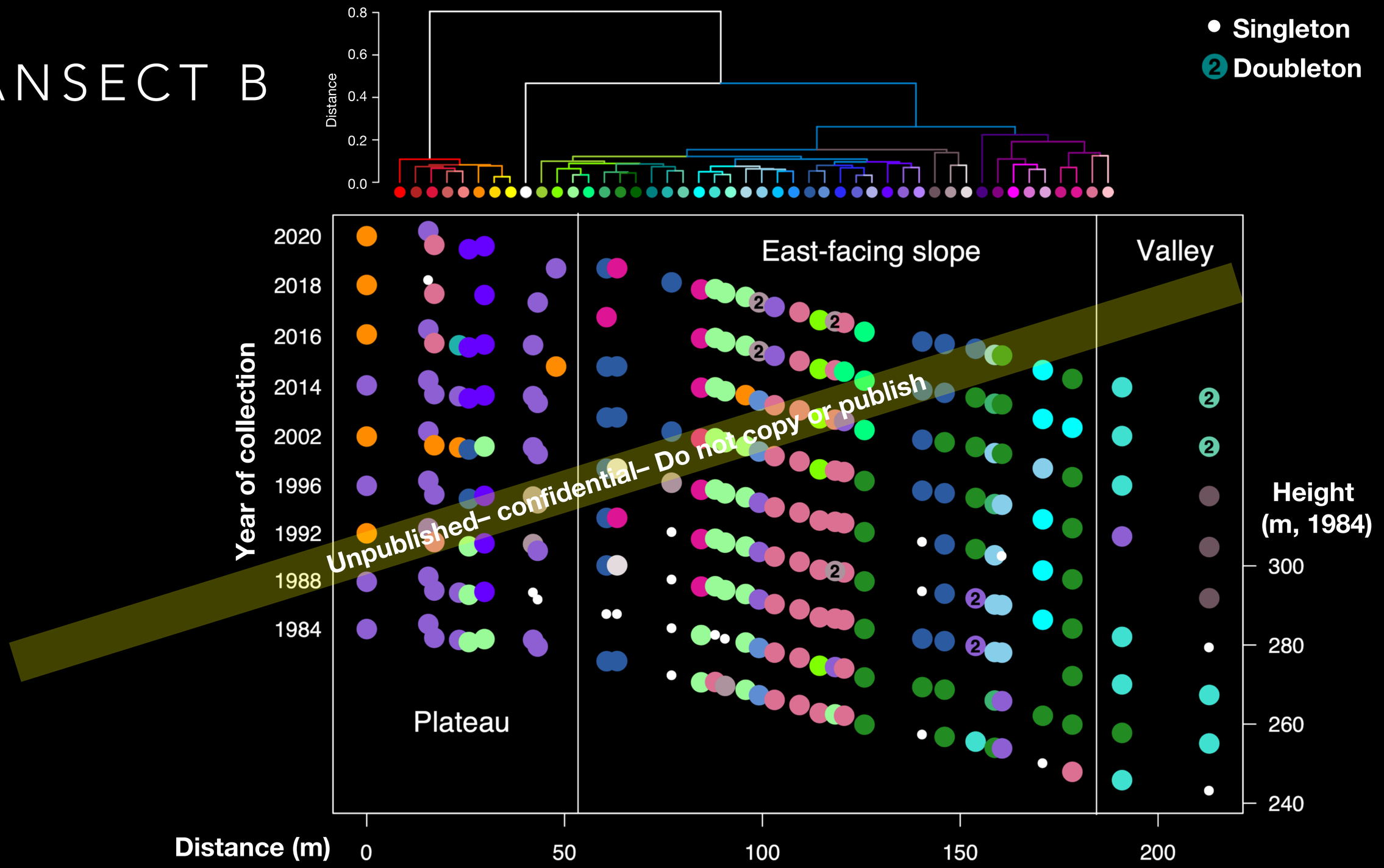
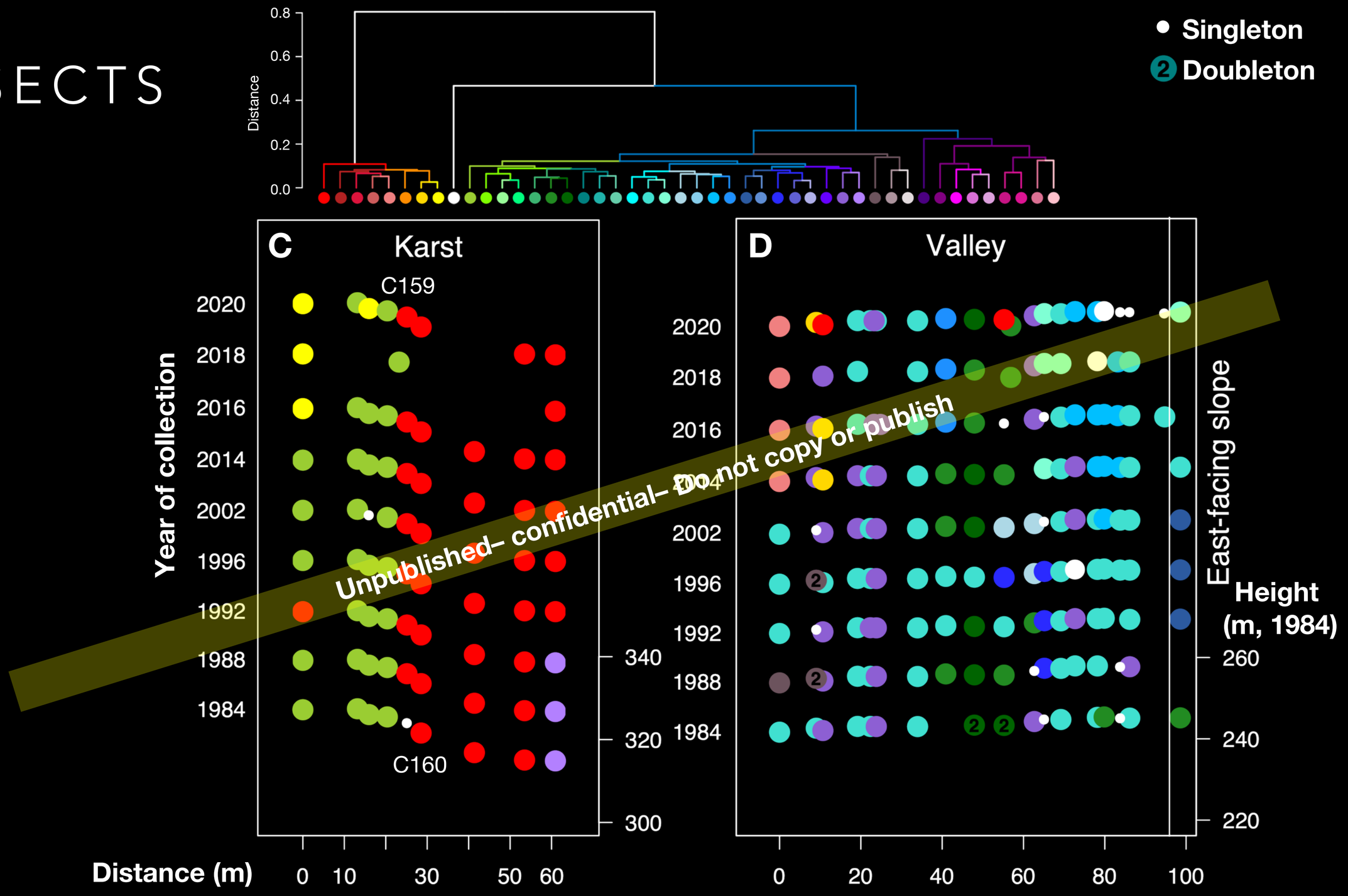
TRANSECT B



TRANSECTS C, D



SIMULATIONS, MODELLING & STATISTICS- TOM (NORDBORG GROUP)

Thomas Ellis

Could the spatial and temporal structuring of IGGs be explained by neutral processes?

On-Going analysis:

- **What is the probablility for IGGs to be found in clusters assuming random order?**
- **What is the probability that a given sampling point will be occupied by the same genotype over years of collection?**
- **Indications for adaptation?**

CONCLUSIONS

- Highly structured population
- Genetic structure and diversity are robust through time despite climatic changes during the past 36 years
- Highly unlikely that the population stability can be explained by neutral processes
- *In situ* conservation of wild wheat biodiversity:
    - Sample once in a few decades
    - Collect taking microhabitats into consideration to cover most genetic diversity
    - Importance of keeping undisturbed and protected habitats, even if of limited size. (several wild wheat populations are disappearing due to urbanization or over grazing)

MERCI 🙏 THANK YOU!

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