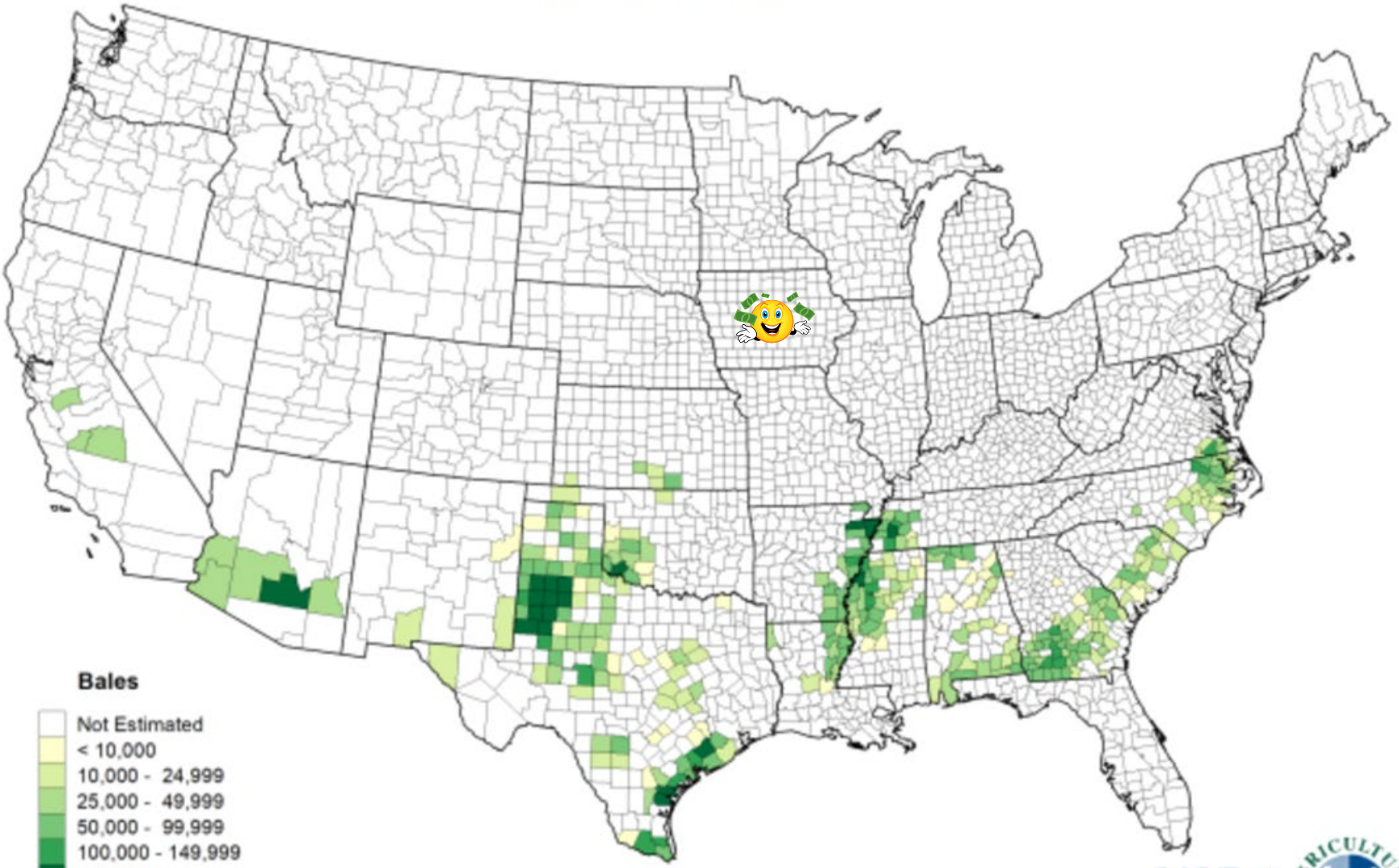
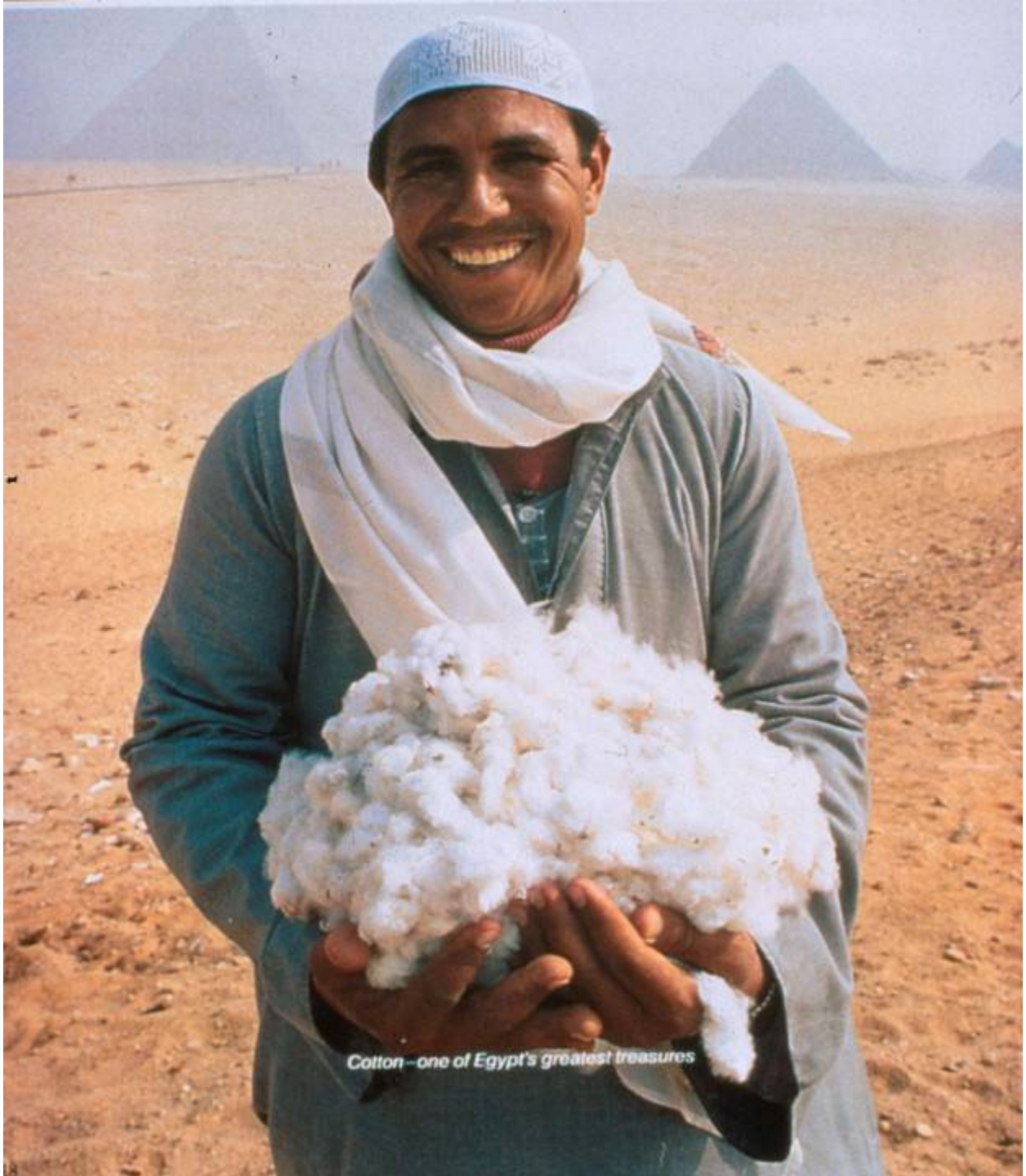

Introduction to *Gossypium*
Taxonomy, how we know what we know
Extraordinary evolutionary history
New species, genomic mergers and reunions
Why this perspective might matter to you

Upland Cotton 2019
Production by County
for Selected States



U.S. Department of Agriculture, National Agricultural Statistics Service

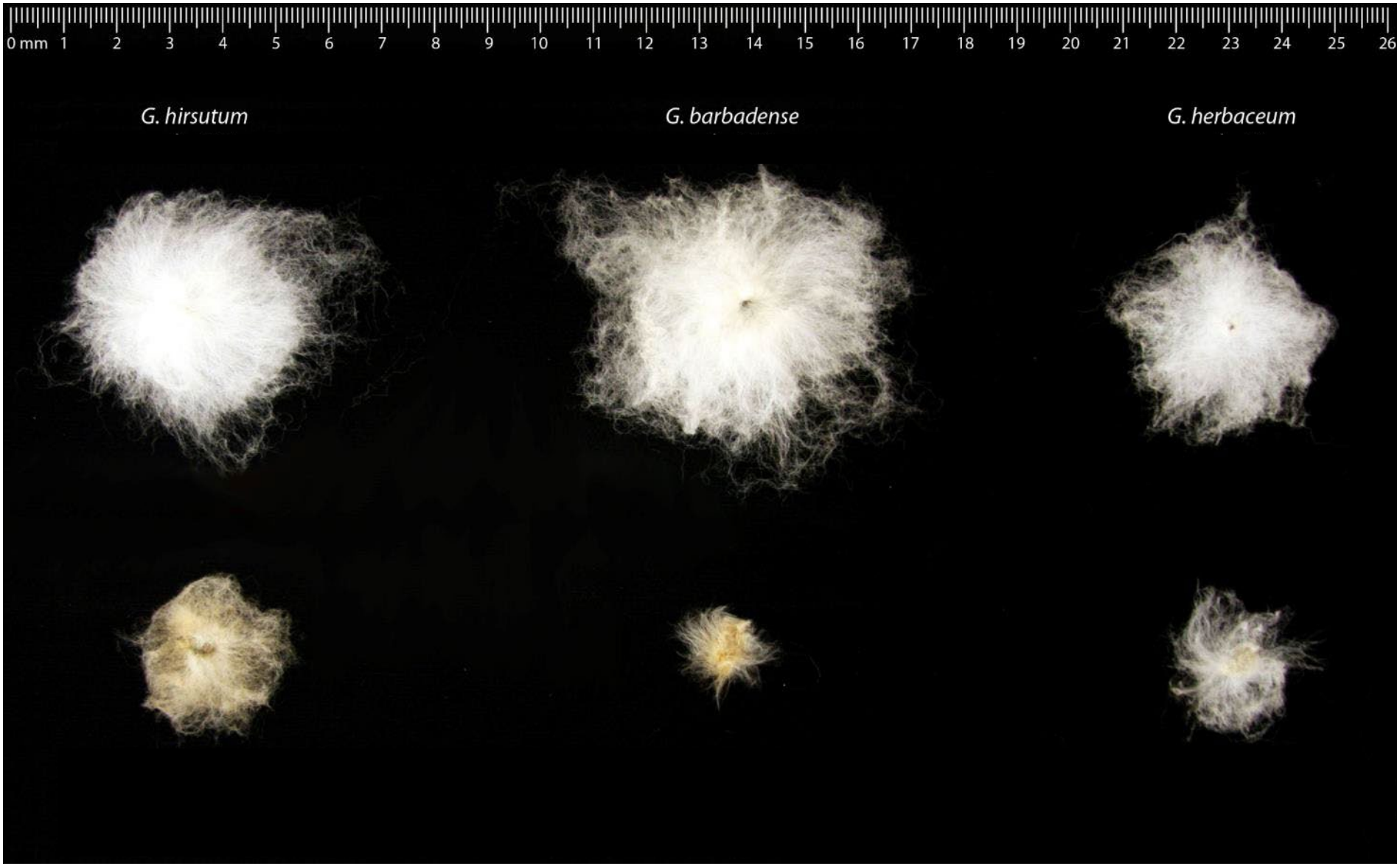


Cotton – one of Egypt's greatest treasures

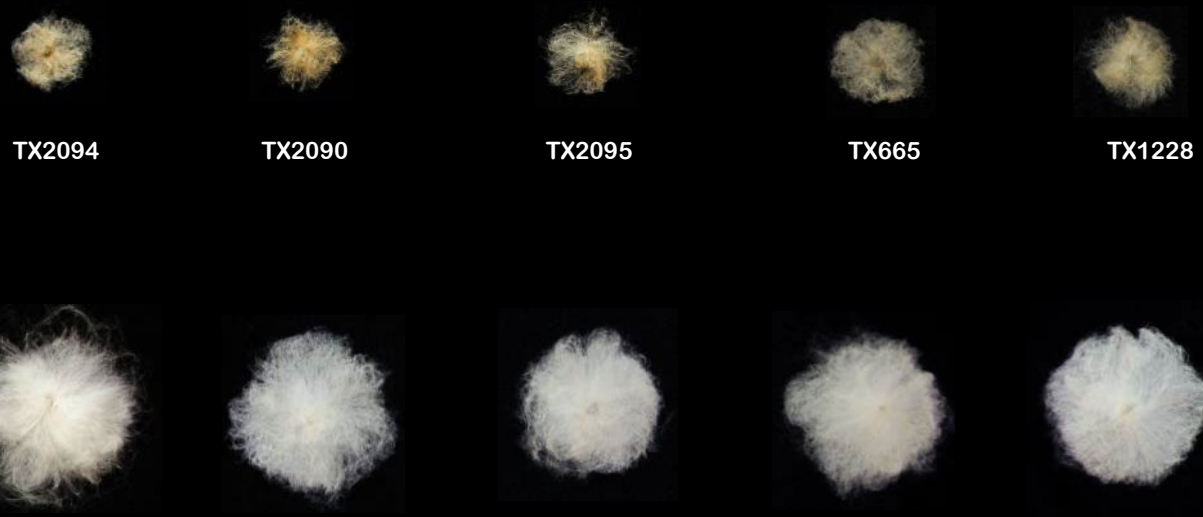
Parallel domestication

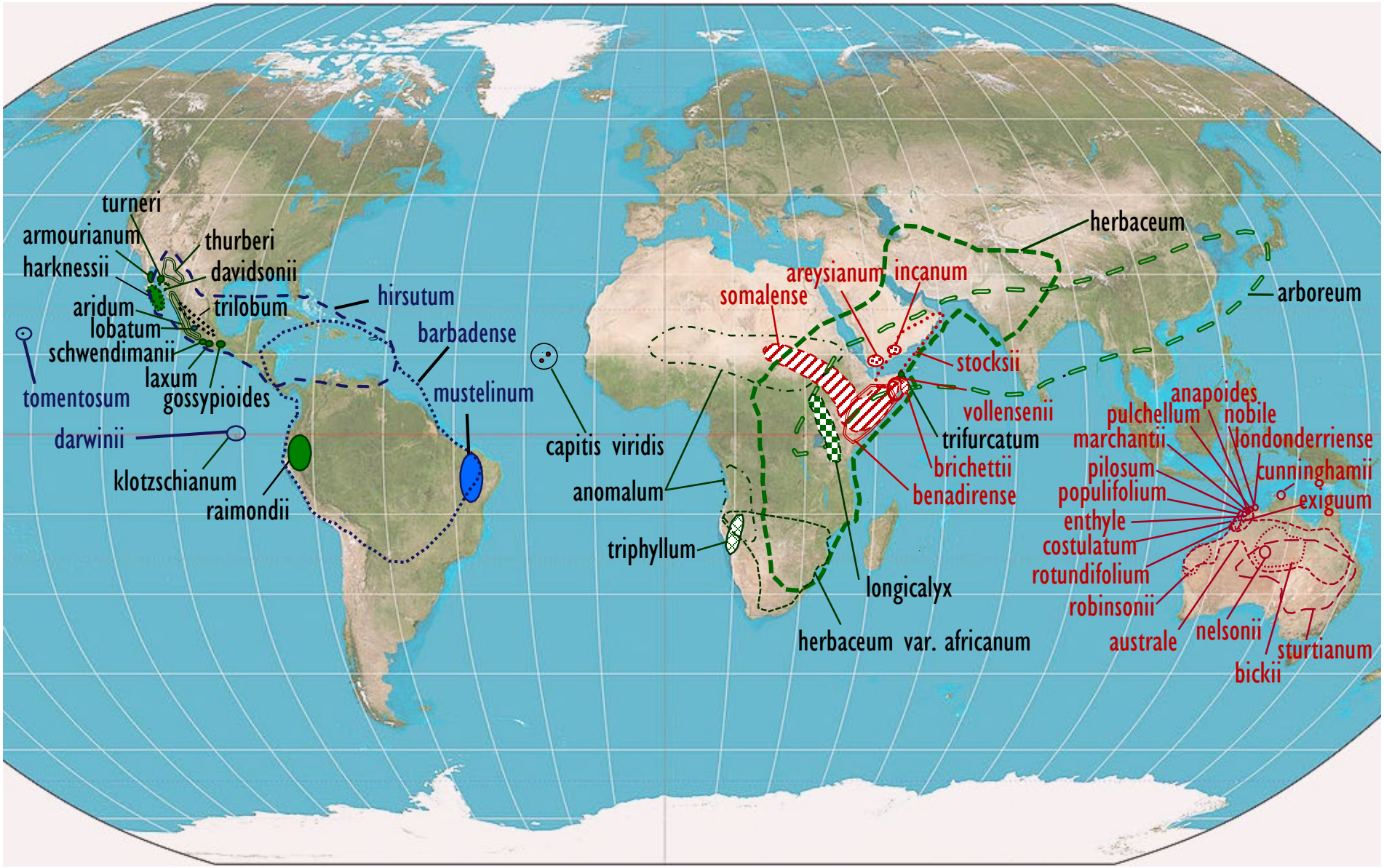
- Two Old World, Diploid
- Two New World, Allopolyploid


RAM


0 mm 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
G. hirsutum
G. barbadense
G. herbaceum

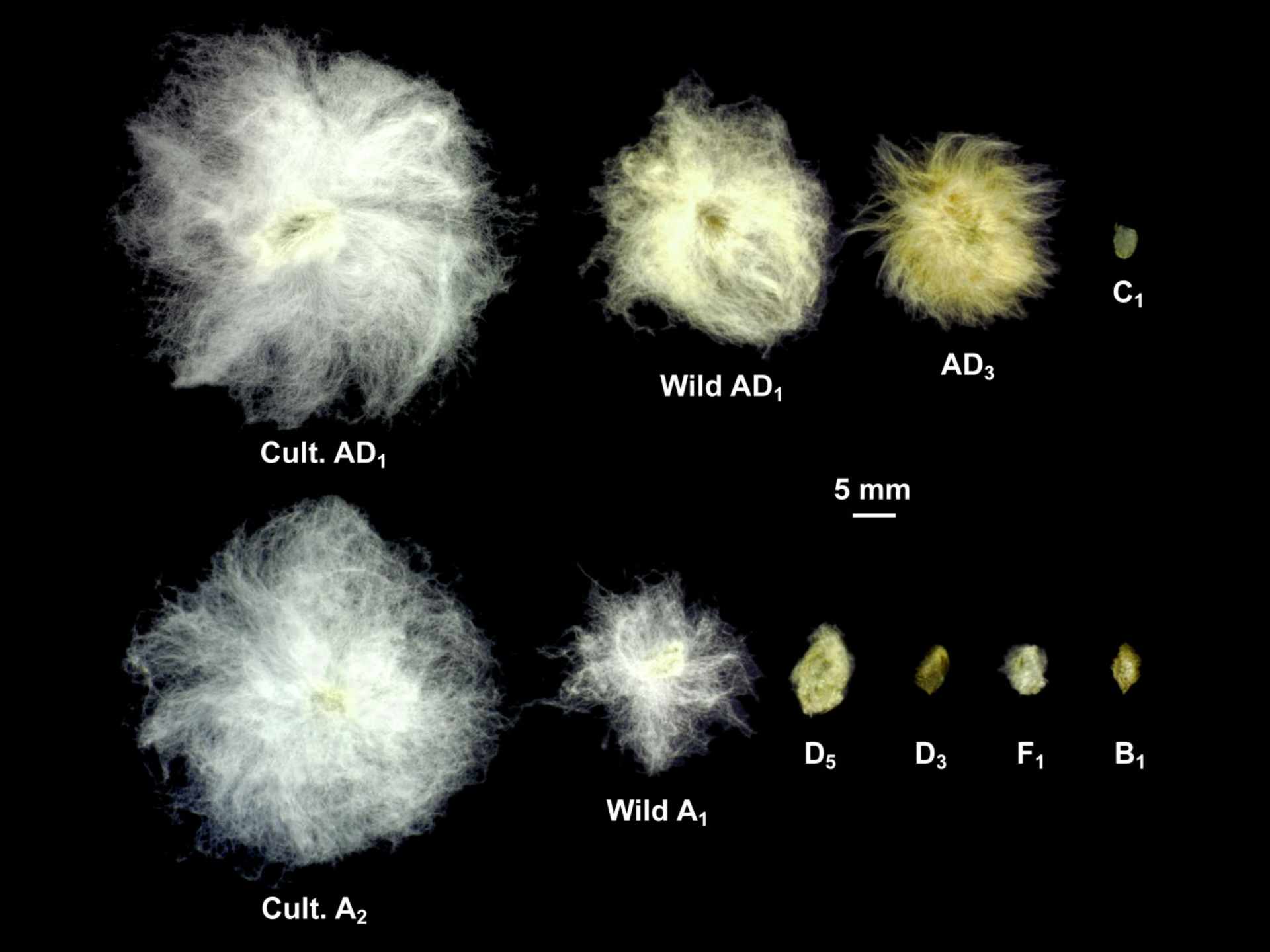
Wild vs. domesticated *G. hirsutum*




turneri
armourianum
harknessii
aridum
lobatum
schwendimanii
laxum
gossypioides
tomentosum
thurberi
davidsonii
trilobum
hirsutum
barbadense
mustelinum
darwinii
klotzschianum
raimondii
capitis viridis
anomalum
triphyllum
somalense
areysianum
incanum
herbaceum
arboreum
stocksii
vollensenii
trifurcatum
brichettii
benadirense
longicalyx
herbaceum var. africanum
anapoides
pulchellum
nobile
marchantii
londonderriense
pilosum
cunninghamii
populifolium
exiguum
enthyle
costulatum
rotundifolium
robinsonii
australe
nelsonii
sturtianum
bickii


J. Stewart


NT
Qld
WA
SA
NSW
Vic
Tas


Cult. AD1
Wild AD1
AD3
C1
5 mm
Cult. A2
Wild A1
D5
D3
F1
B1

Hi! I'm a new species; my name is *G. anapoides*

I have a huge genome and I am a member of the K-genome from NW Australia!

It doesn't rain for 9 months/year, but I don't mind

Sir George Watt
1851-1930

Agostino Todaro
1818-1892

THE

WILD AND CULTIVATED

COTTON PLANTS

OF

THE WORLD

A REVISION OF THE GENUS GOSSYPIUM

FRAMED PRIMARILY
WITH THE OBJECT OF AIDING PLANTERS AND
INVESTIGATORS WHO MAY CONTEMPLATE THE SYSTEMATIC
IMPROVEMENT OF THE COTTON STAPLE

BY

SIR GEORGE WATT
C.I.E., M.B., C.M., LL.D. (ABD. AND GLASG.), F.L.S.
OFFICIER D'ACADÉMIE
CORRESPONDING MEMBER ROYAL HORTICULTURAL SOCIETY OF ENGLAND
HONORARY MEMBER OF THE PHARMACEUTICAL SOCIETY OF GREAT BRITAIN
DANIEL HANBURY GOLD MEDALLIST
FORMERLY
PROFESSOR OF BOTANY, CALCUTTA UNIVERSITY, AND REPORTER ON ECONOMIC PRODUCTS
TO THE GOVERNMENT OF INDIA

LONGMANS, GREEN, AND CO.
39 PATERNOSTER ROW, LONDON
NEW YORK, BOMBAY, AND CALCUTTA
1907

"It would not be far from correct to describe cotton as the central feature of the world's modern commerce" (Ch. 1)

HEREDITY VOLUME 5 PART 2 AUGUST 1951

INTRA-SPECIFIC DIFFERENTIATION IN
GOSSYPIUM HIRSUTUM

J. B. HUTCHINSON
Empire Cotton Growing Corporation Cotton Research Station, Namulonge, Uganda

Joseph B. Hutchinson
1902-1988

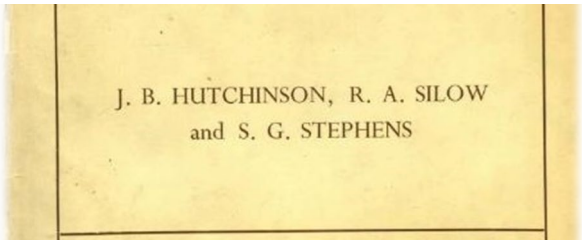
Stanley G. Stephens
1911-1986

Gavriil S. Zaitsev
1887-1929

Vol. 100, No. 912 The American Naturalist May–June, 1966

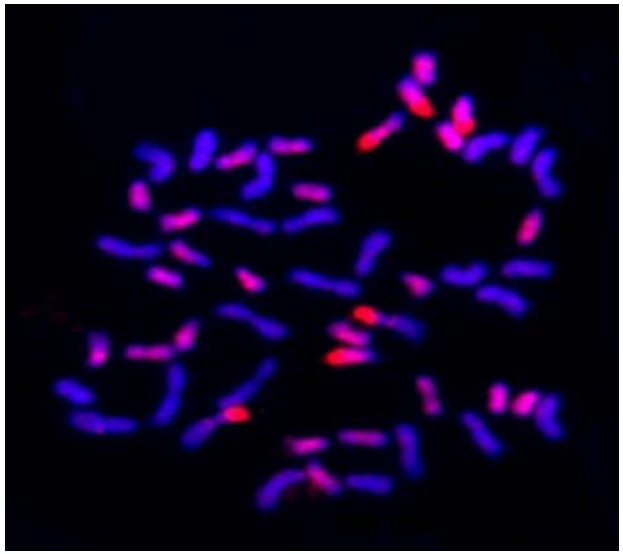
THE POTENTIALITY FOR LONG RANGE OCEANIC DISPERSAL OF COTTON SEEDS*

S. G. STEPHENS



Wendel and Goodman, 2011, Nat. Acad. Sci. Biograph. Memoirs

- Denham (1924)
- Longley (1930)
- Webber (1935)
- Skovsted (1933, 1937)



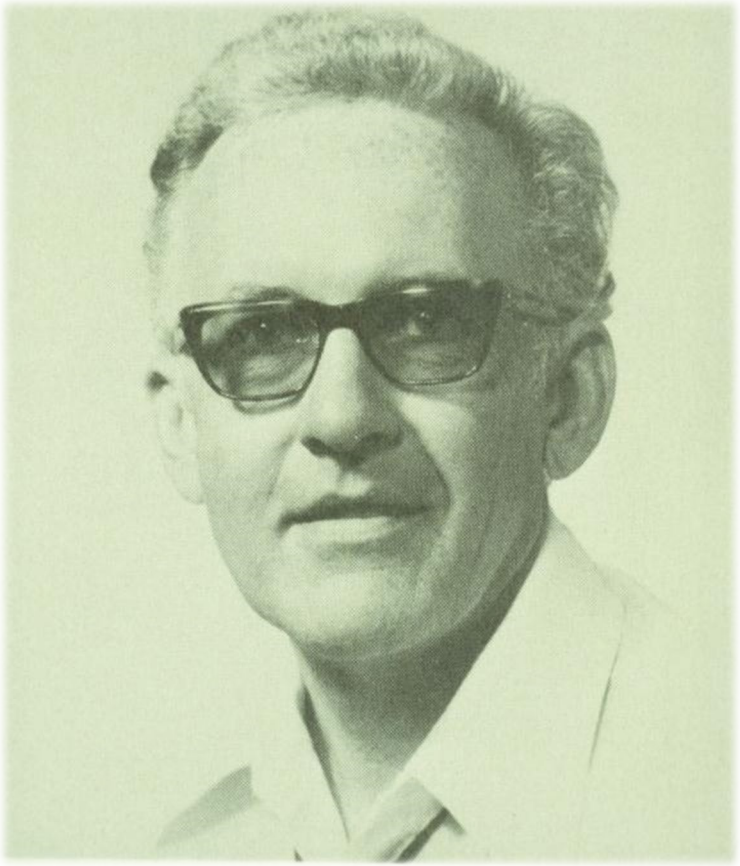
James Otis Beasley
1909-1943

The American Naturalist, Vol. 74, (1940)

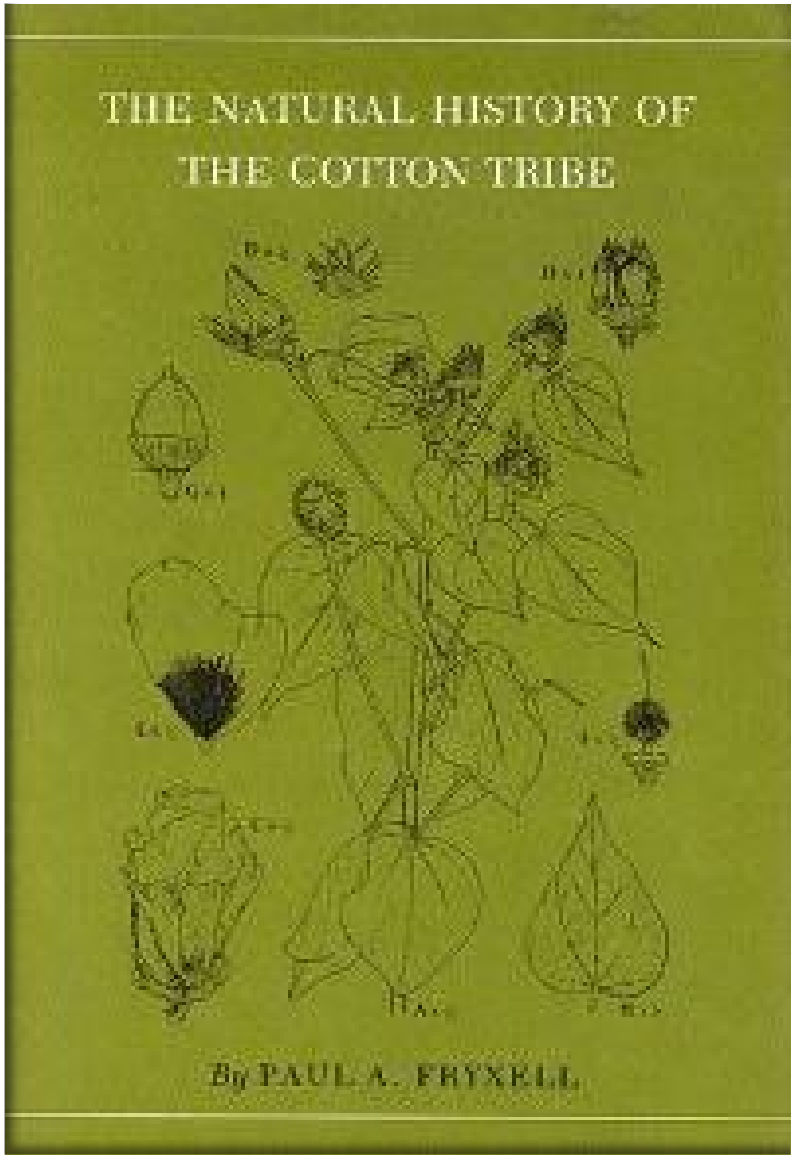
THE ORIGIN OF AMERICAN TETRAPLOID GOSSYPIUM SPECIES[1]

13-chromosome with Asiatic 13-chromosome species. In the present work tetraploids of this type were produced by doubling the chromosome number in hybrids of *G. therberi* Tod. × *G. arboreum* var. *neglectum* Hutchinson and Ghose.

ploid type. These facts leave no doubt that the American 26-chromosome cottons are allotetraploids, with one parent species similar to existing American 13-chromosome species and the other similar to Asiatic 13-chromosome species. The synthesized tetra-

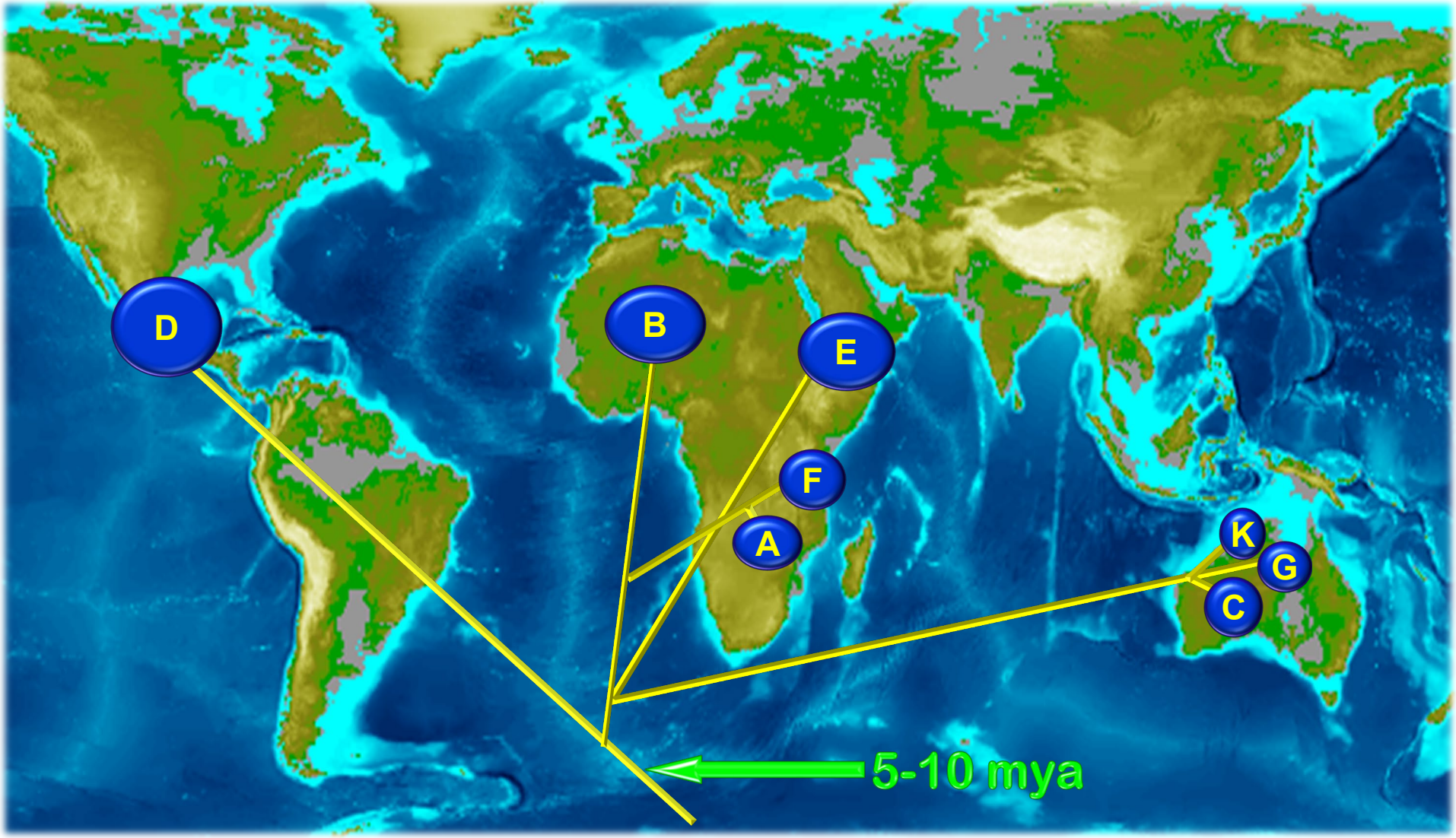


Paul Fryxell

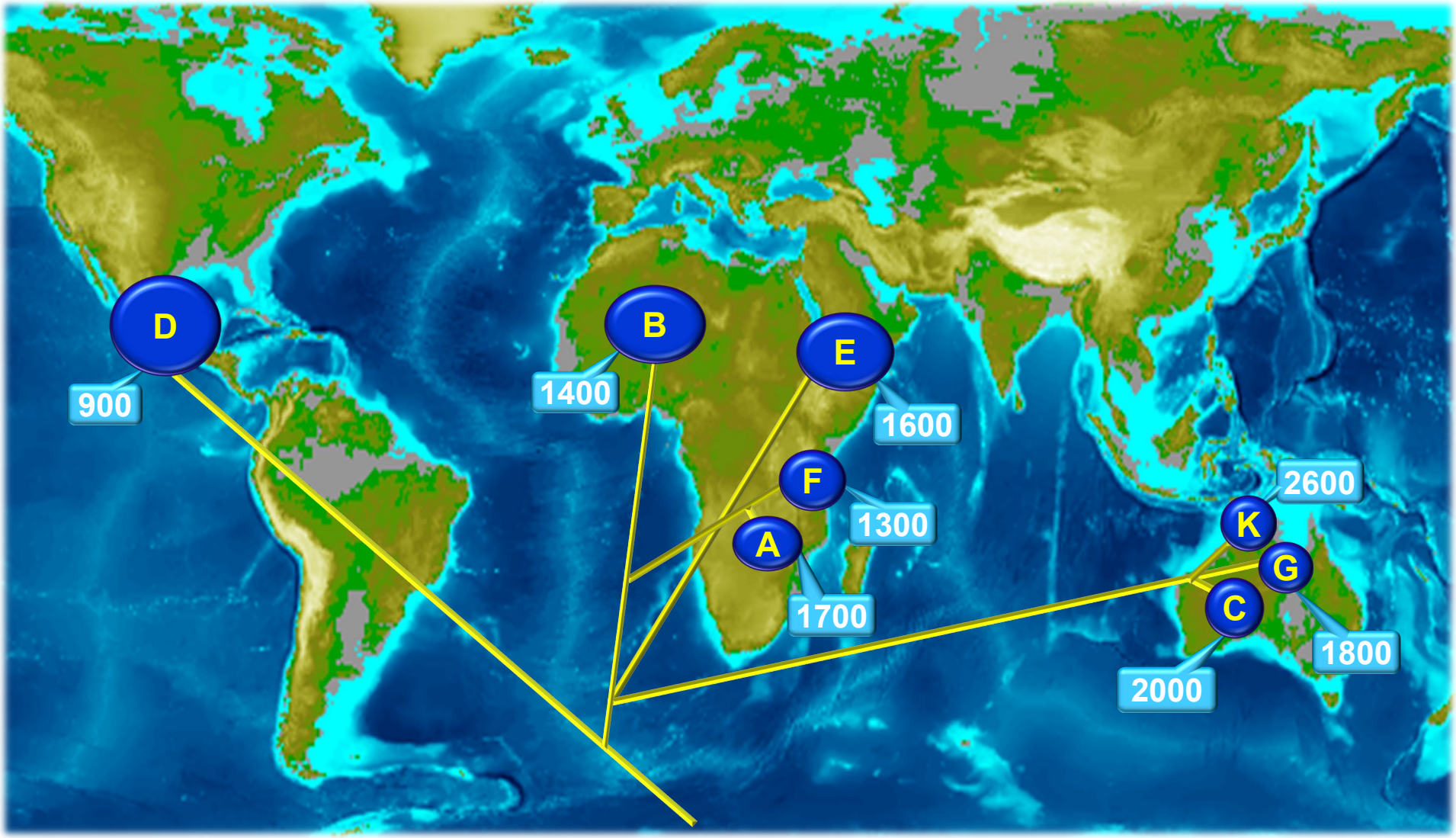


“We were dwarfs on the shoulders of giants ….we are carried high and raised up by their giant size”

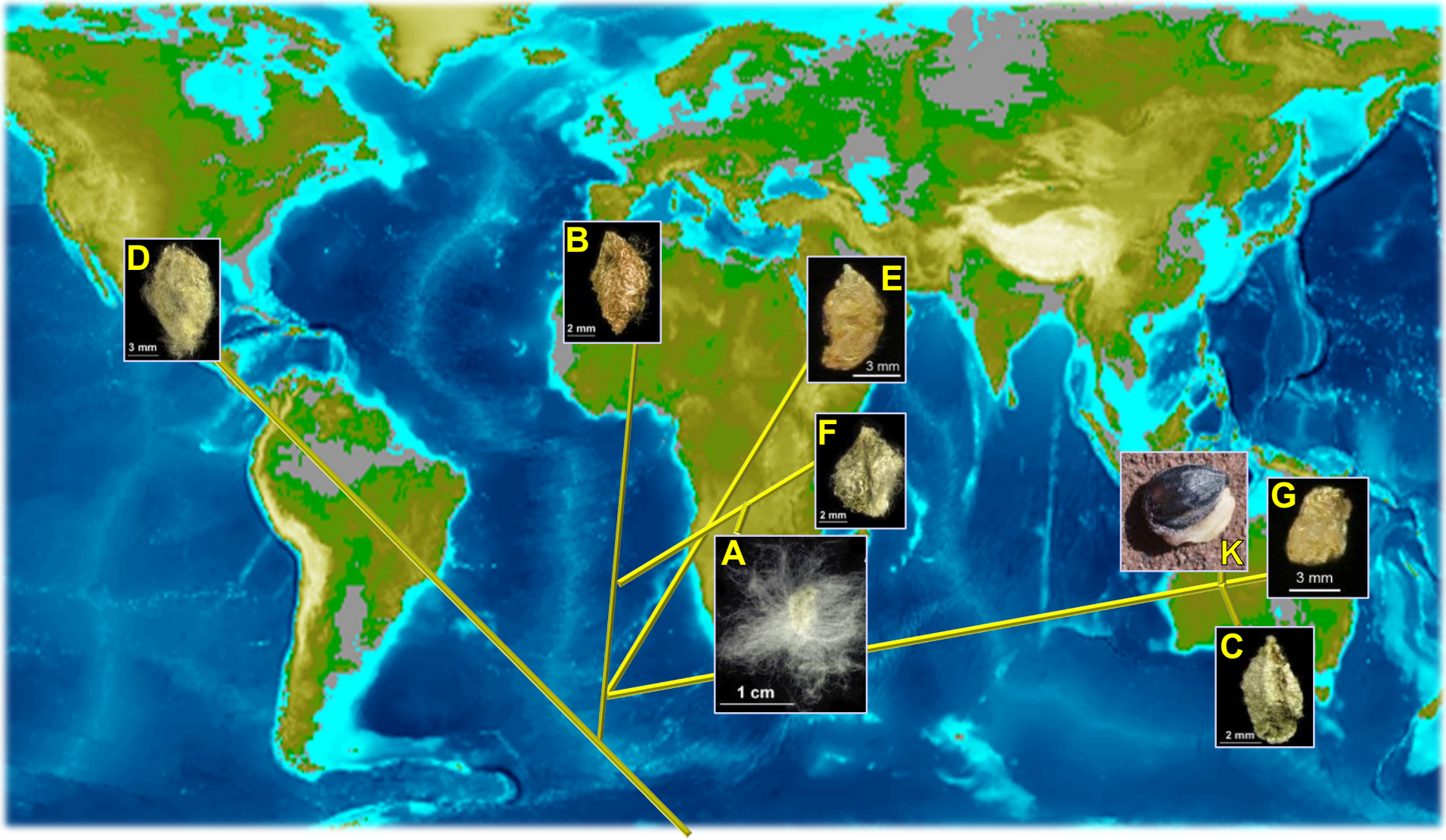
Phylogenetic history of *Gossypium*



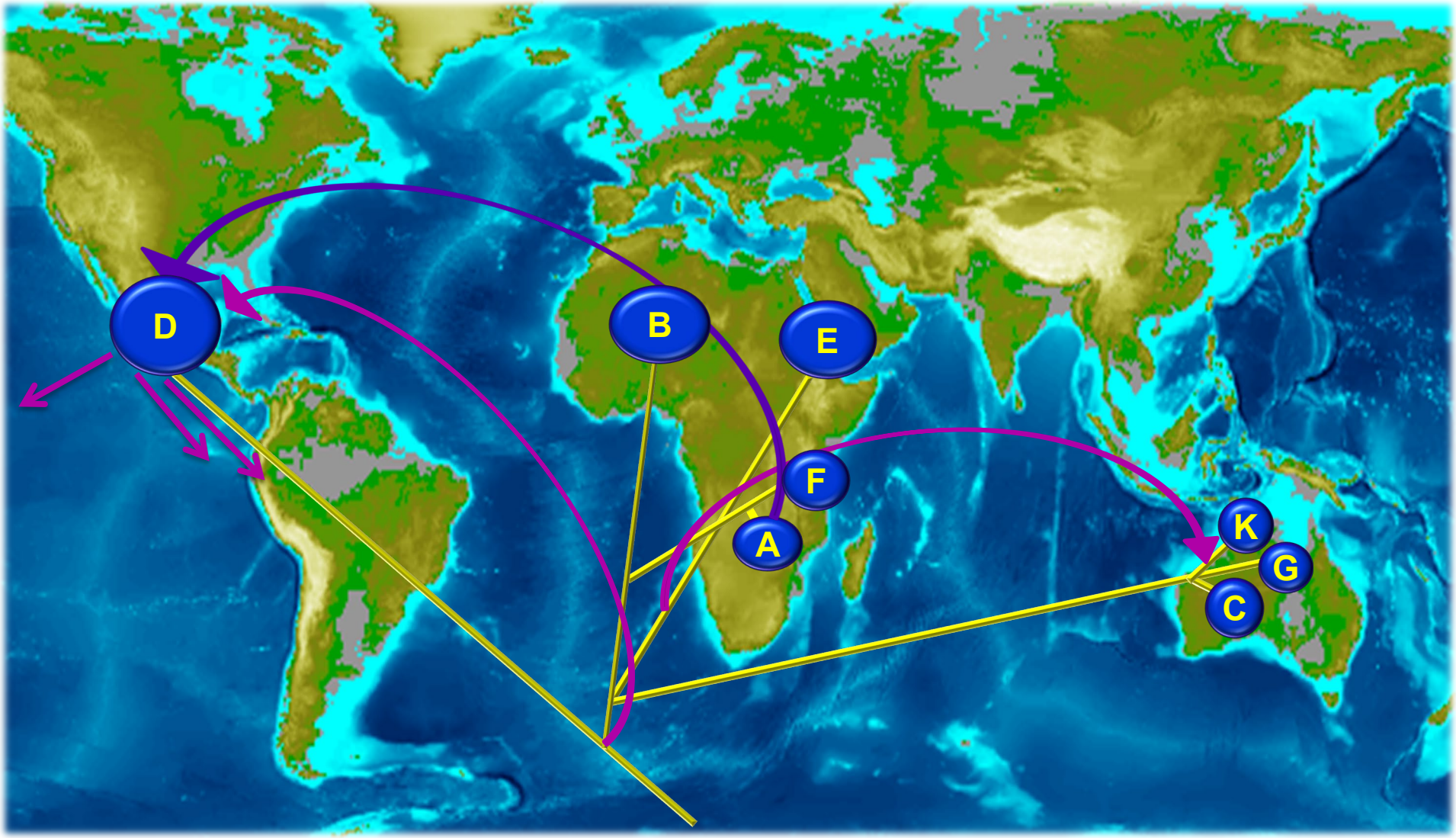
Genome evolution, n = 13

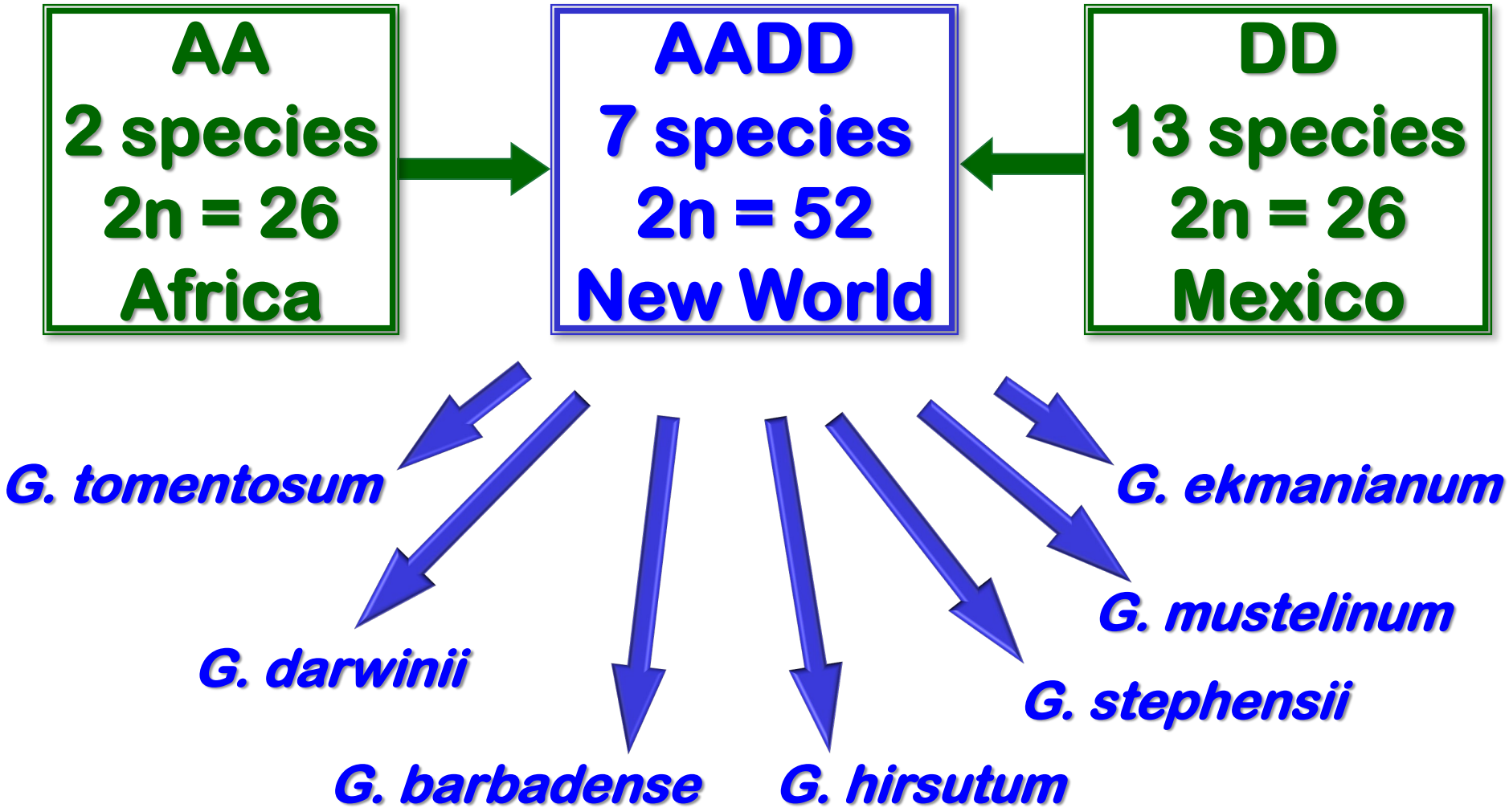


Key morphological innovations

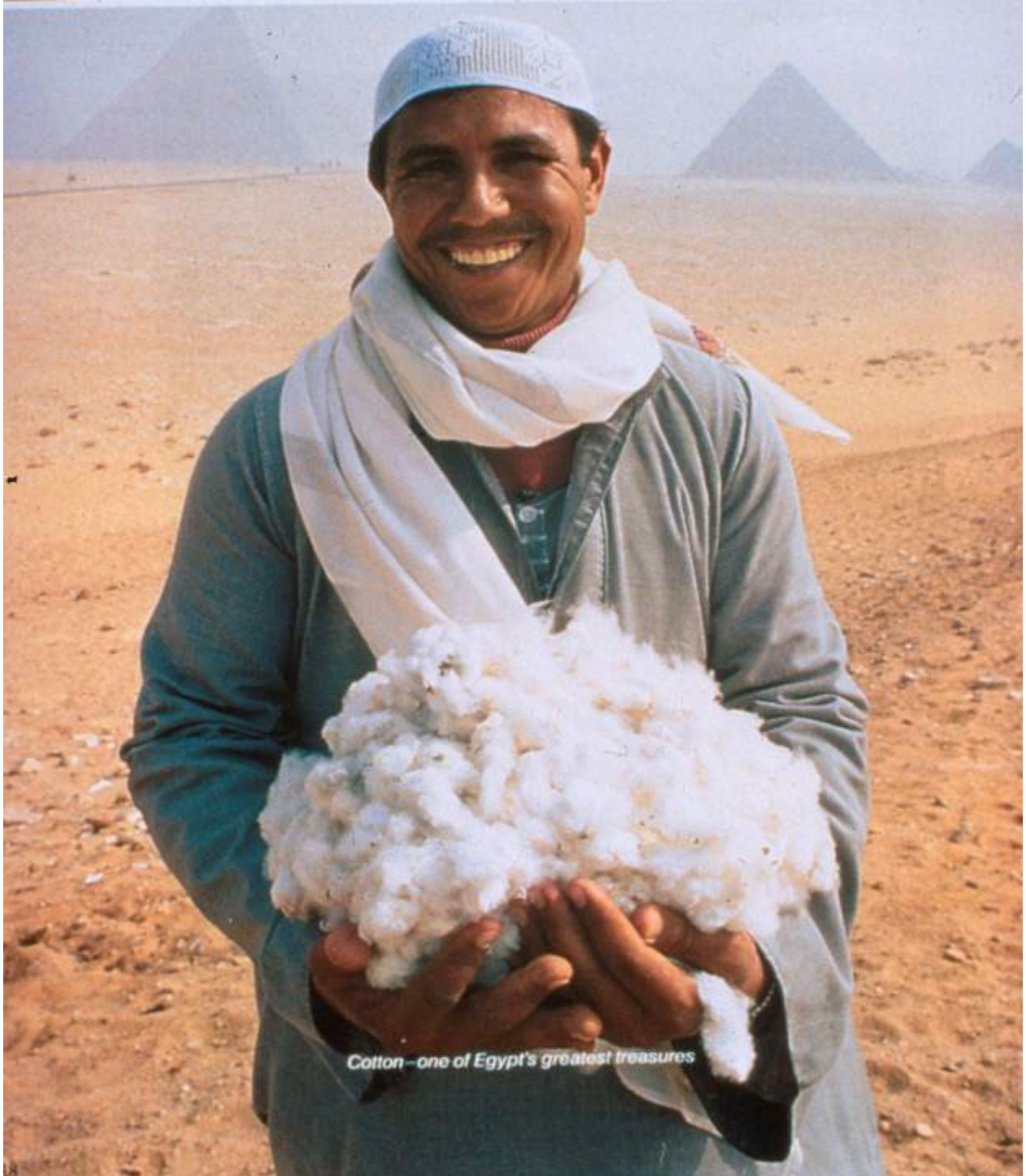


Multiple trans-oceanic voyages




AA
2 species
2n = 26
Africa
AADD
7 species
2n = 52
New World
DD
13 species
2n = 26
Mexico
G. tomentosum
G. darwinii
G. barbadense
G. hirsutum
G. stephensii
G. mustelinum
G. ekmanianum

Origin of *G. hirsutum* (upland cotton)

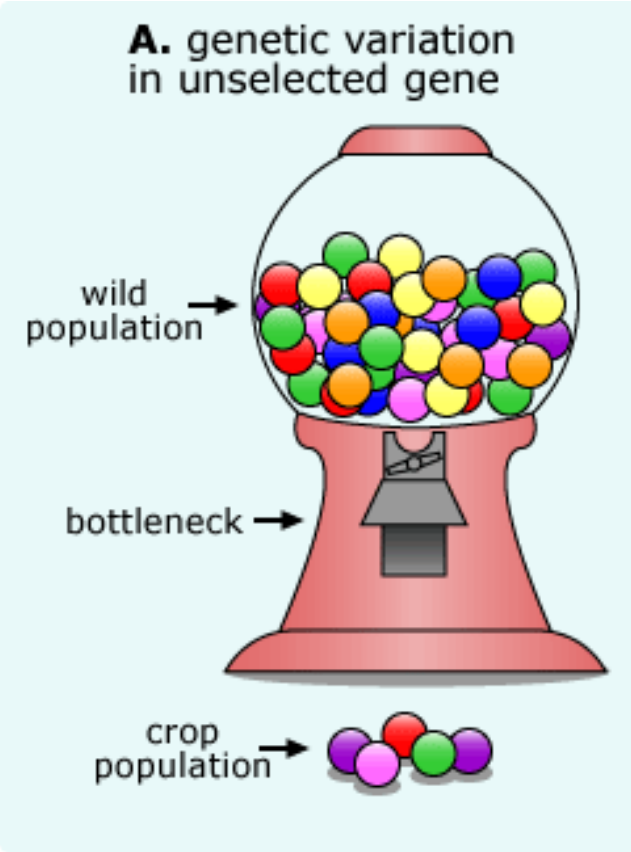


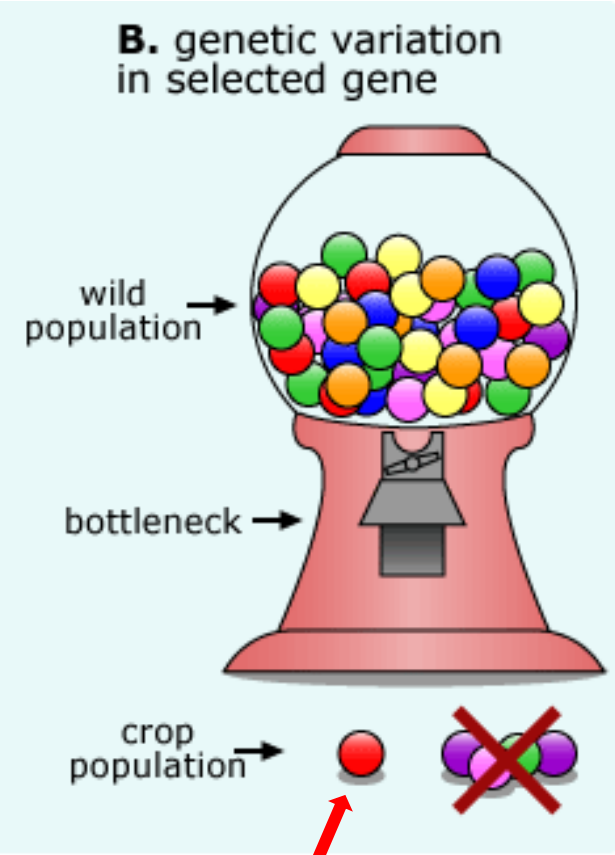
Cotton – one of Egypt's greatest treasures


© Y. Arthus-Bertrand

1. Where did all of this happen?
2. How much diversity was captured in the modern crop gene pool?
3. What proportion of the total diversity was captured?
4. What was left behind that might be valuable?

Sequential genetic bottlenecks



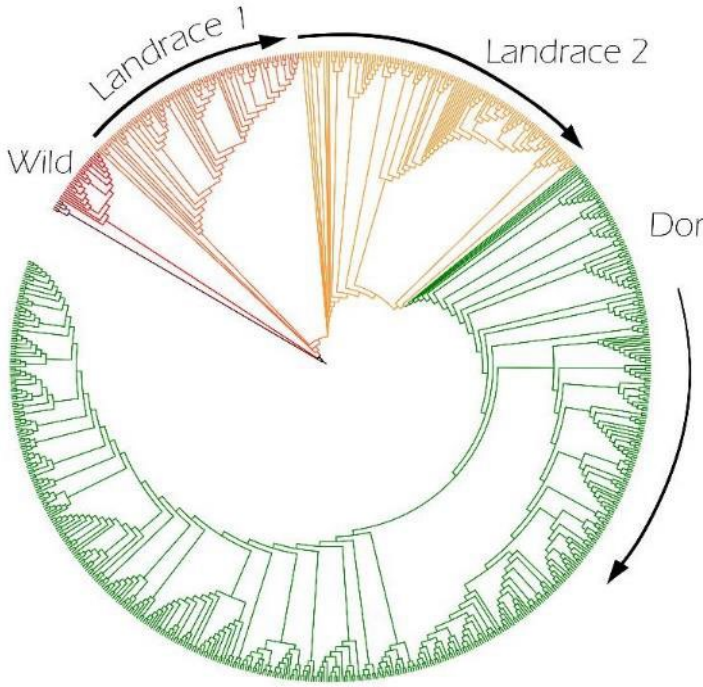


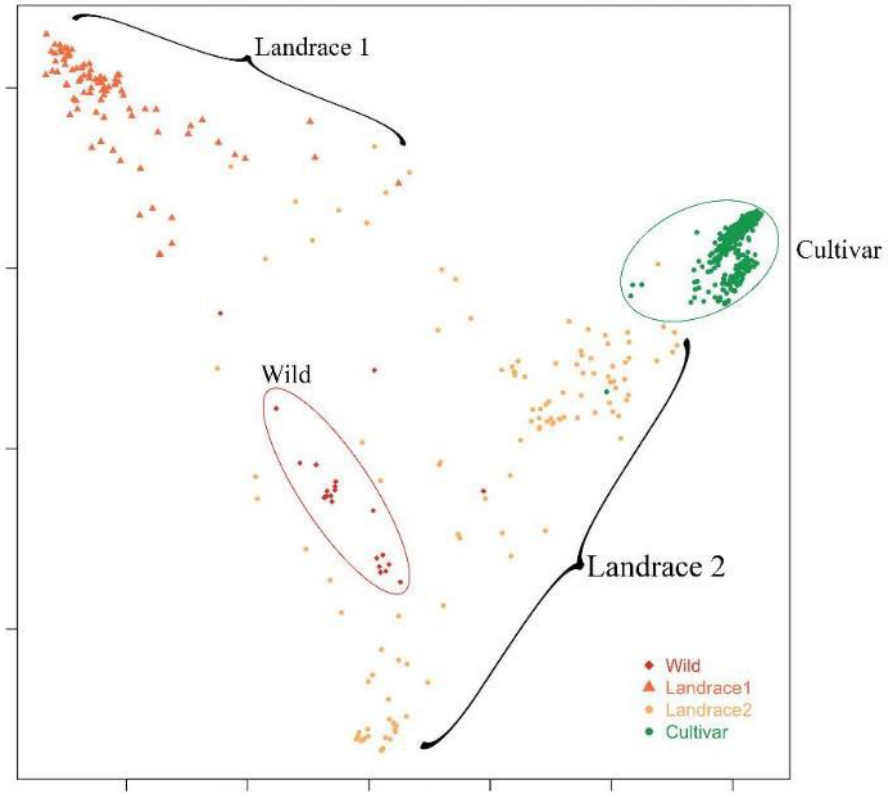
Semi-wild perennials
Feral forms
Landraces
Obsolete cultivars

Modern cultivars

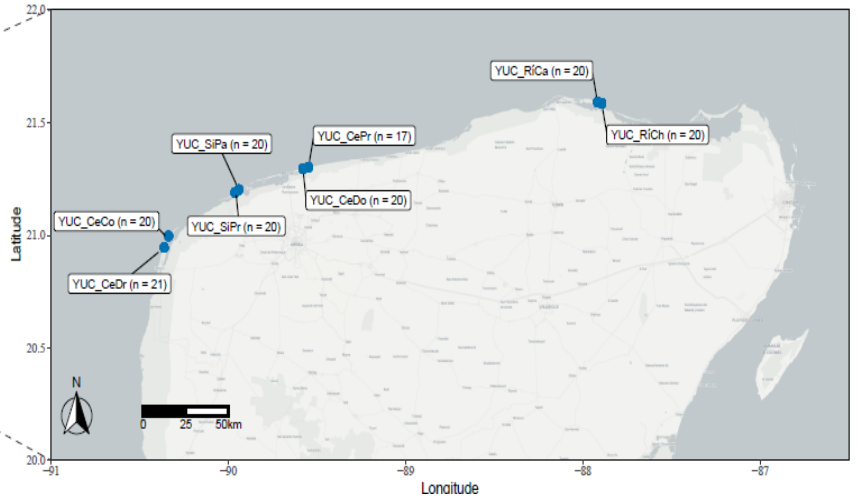
Parallel and Intertwining Threads of Domestication in Allopolyploid Cotton

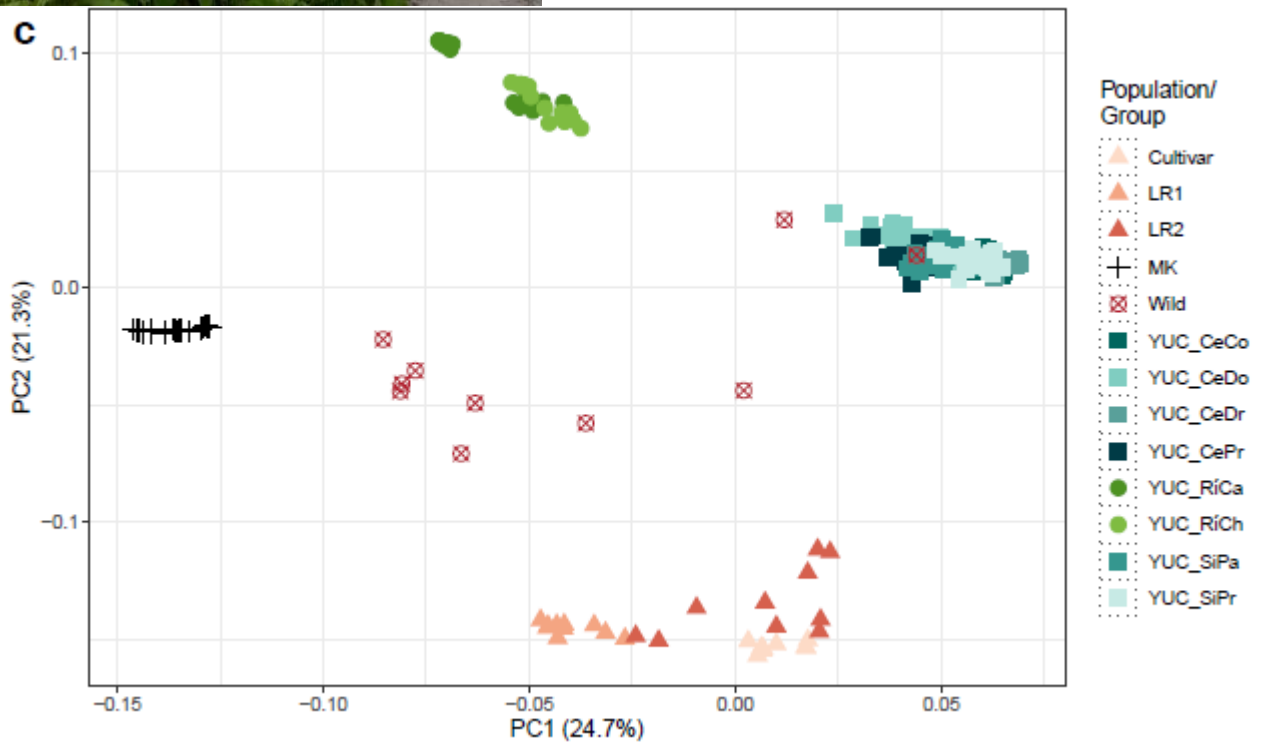
Daojun Yuan, Corrinne E. Grover, Guanjing Hu, Mengqiao Pan, Emma R. Miller, Justin L. Conover, Spencer P. Hunt, Joshua A. Udall,* and Jonathan F. Wendel*





Yuan et al., 2021, Adv. Sci.

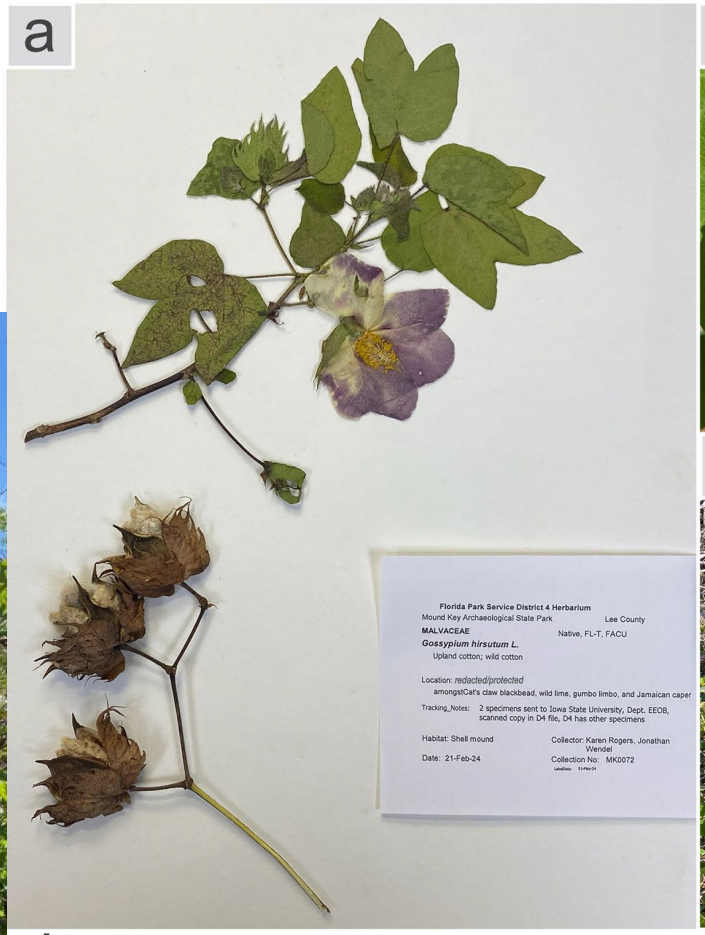

YUC_RíCa (n = 20)
YUC_RíCh (n = 20)
YUC_CePr (n = 17)
YUC_SiPa (n = 20)
YUC_CeDo (n = 20)
YUC_CeCo (n = 20)
YUC_SiPr (n = 20)
YUC_CeDr (n = 21)
Latitude
Longitude
N
0 25 50km


C
PC2 (21.3%)
PC1 (24.7%)
Population/
Group
Cultivar
LR1
LR2
MK
Wild
YUC_CeCo
YUC_CeDo
YUC_CeDr
YUC_CePr
YUC_RíCa
YUC_RíCh
YUC_SiPa
YUC_SiPr

Origin and diversity of the wild cottons (*Gossypium hirsutum*) of Mound Key, Florida

Weixuan Ning[1], Karen M. Rogers[2], Chuan-Yu Hsu[3], Zenaida V. Magbanua[3], Olga Pechanova[3], Mark A. Arick II[3], Ehsan Kayal[1], Guanjing Hu[4,5], Daniel G. Peterson[3], Joshua A. Udall[6], Corrinne E. Grover[1,7] & Jonathan F. Wendel[1,7]✉

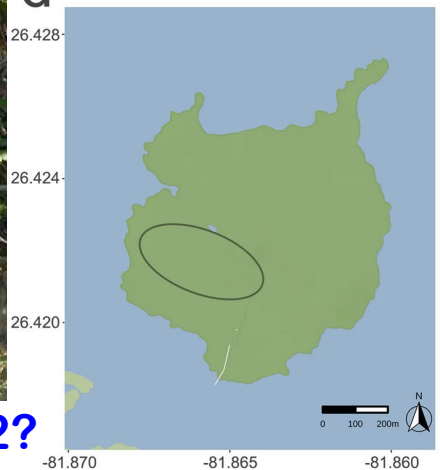
a



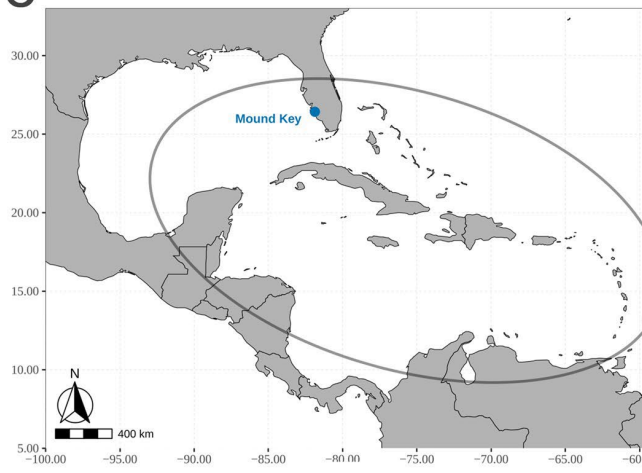
b

c

d

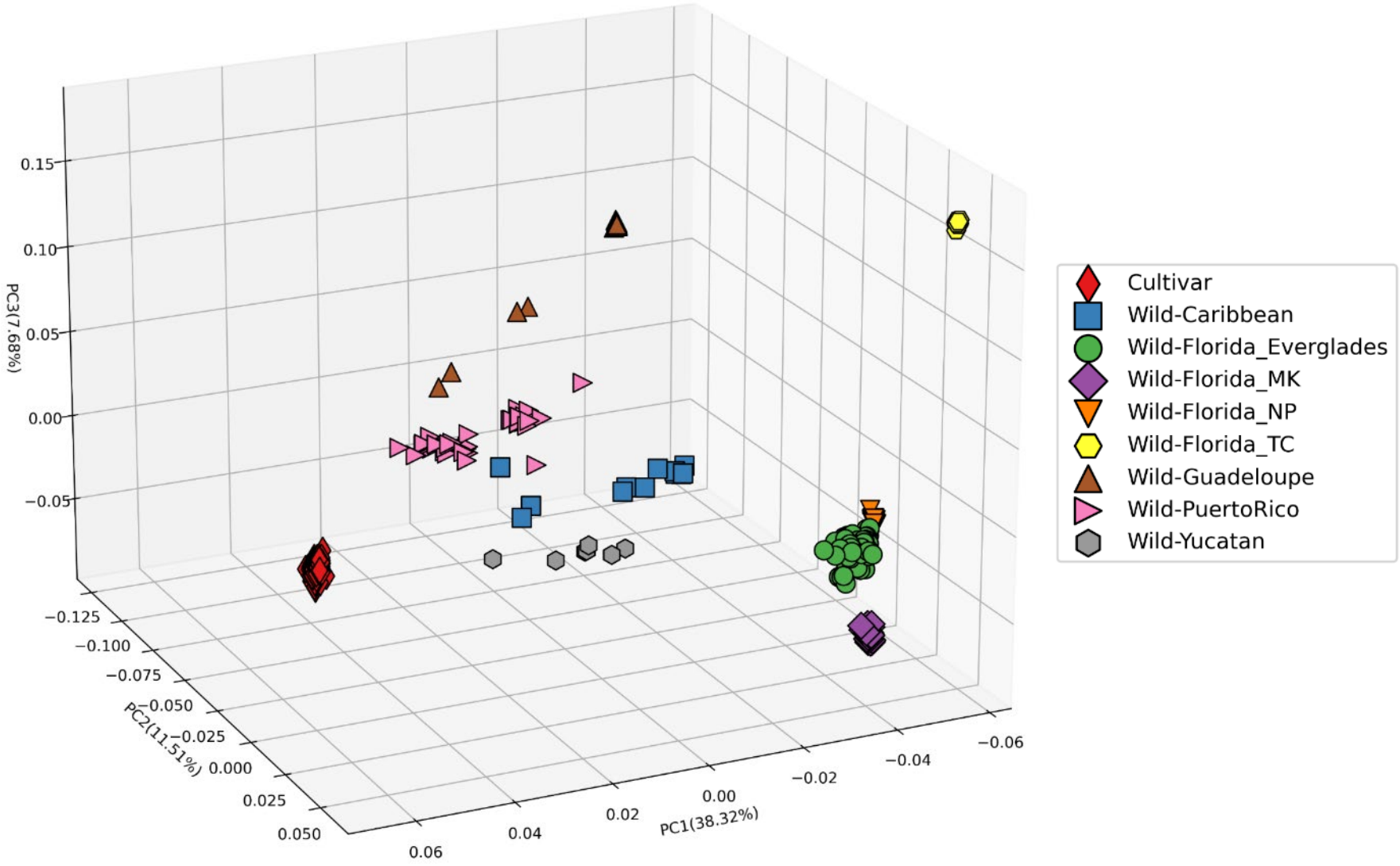


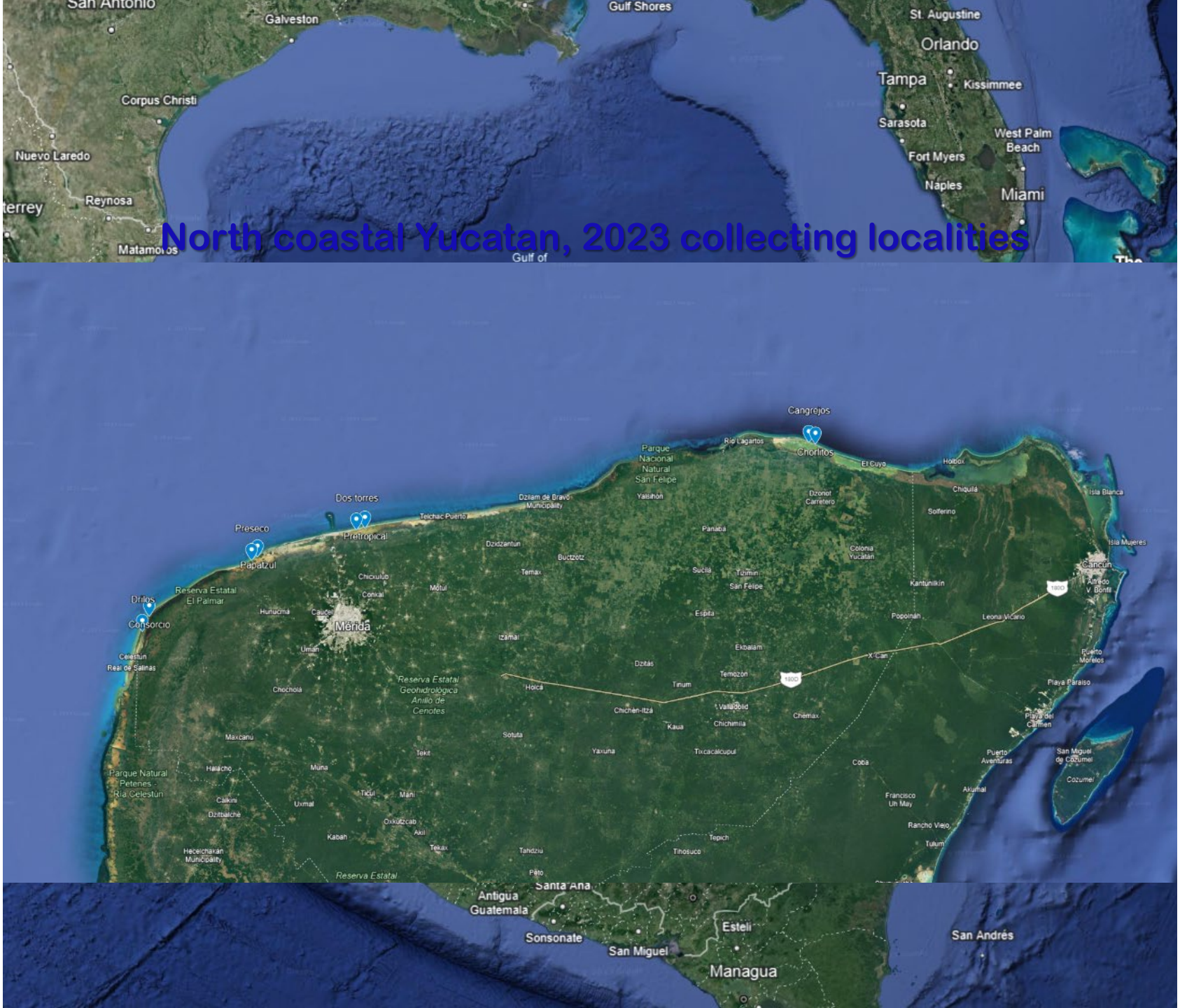
e



Remember Hurricane Ian, 9-28-22?

392 genomes…

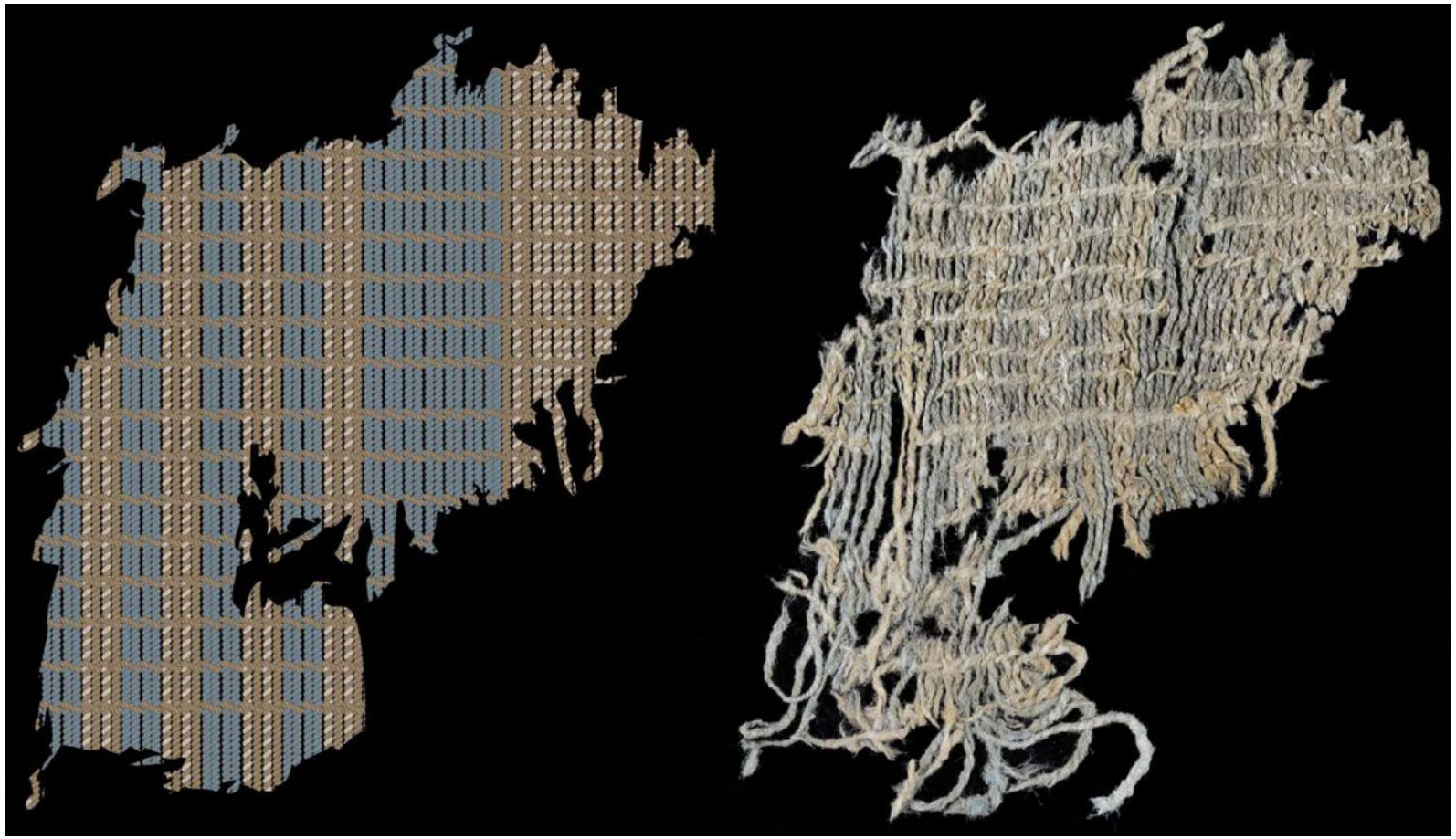

0.15
0.10
0.05
0.00
−0.05
PC3(7.68%)
−0.125
−0.100
−0.075
−0.050
−0.025
0.000
0.025
0.050
PC2(11.51%)
0.06
0.04
0.02
0.00
−0.02
−0.04
−0.06
PC1(38.32%)
Cultivar
Wild-Caribbean
Wild-Florida_Everglades
Wild-Florida_MK
Wild-Florida_NP
Wild-Florida_TC
Wild-Guadeloupe
Wild-PuertoRico
Wild-Yucatan



North coastal Yucatan, 2023 collecting localities

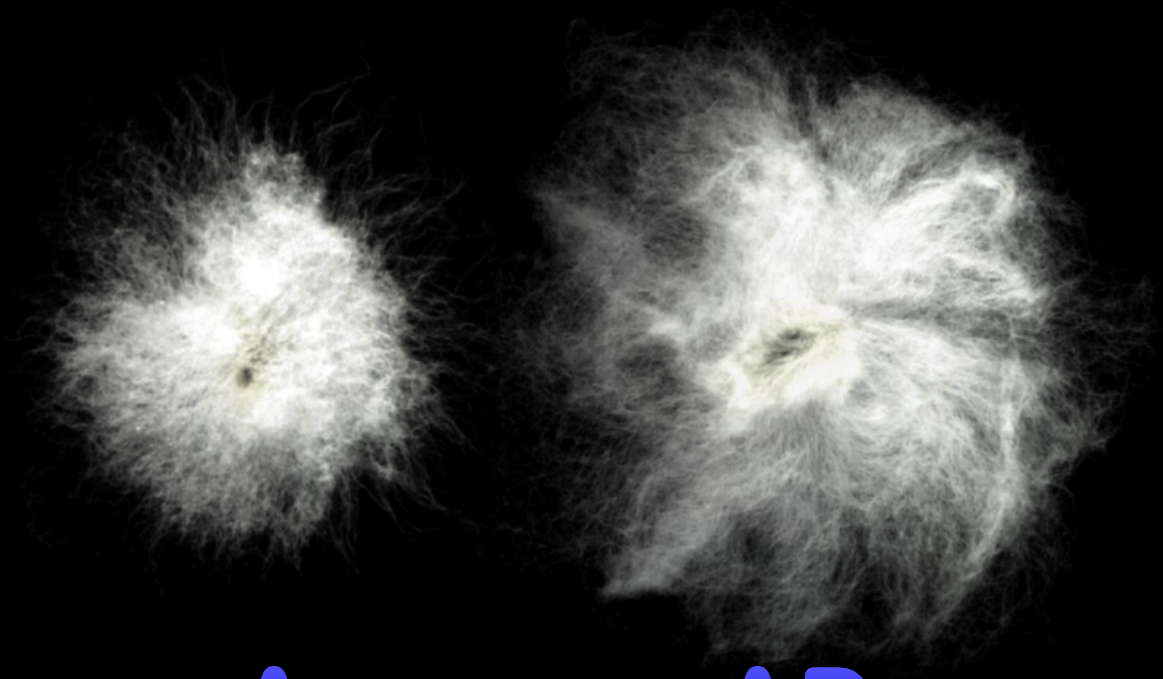
Origin of *G. barbadense* (pima cotton)

6000 year old blue jeans



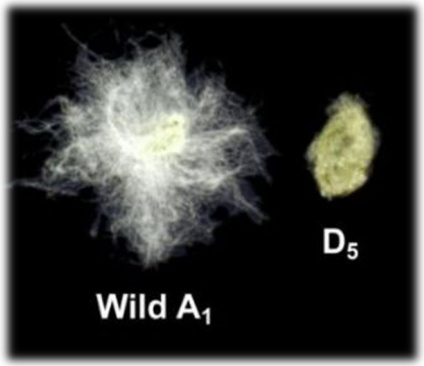
Splitstoser et al. Sci. Adv. 2016

G. raimondii



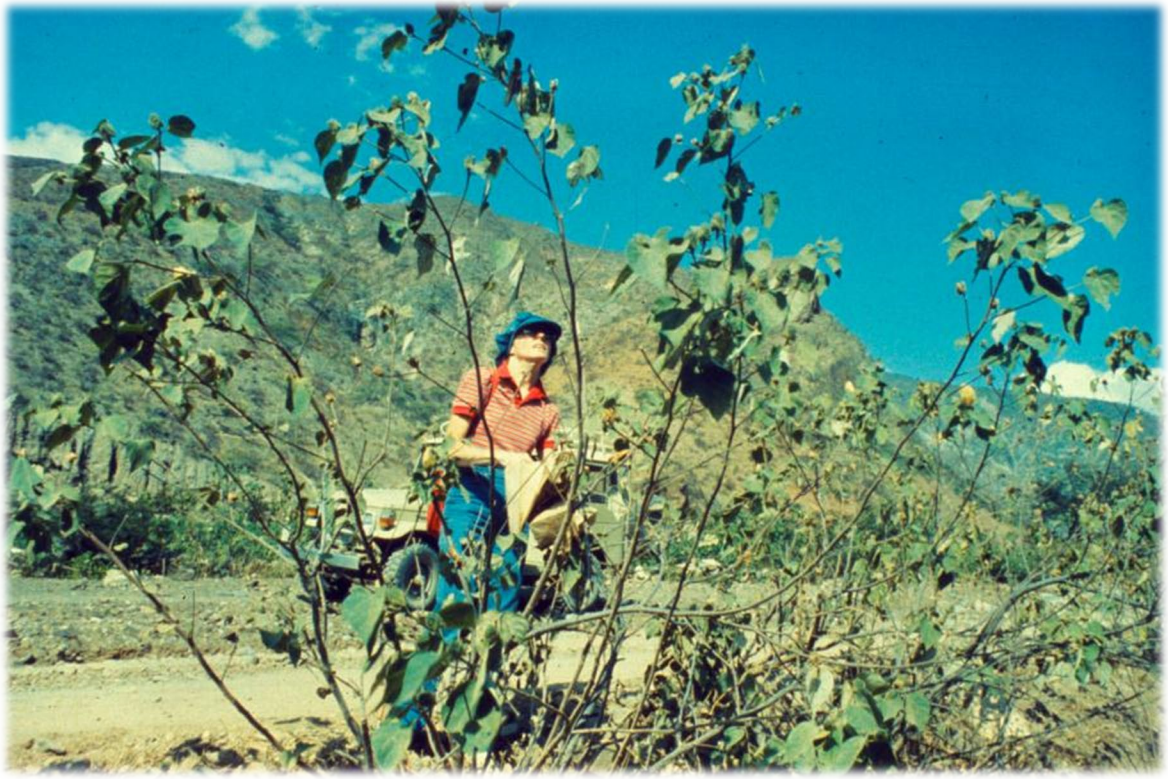
A AD D

Gossypium raimondii



- Not even described until 1932 (by Oskar Ulbrich)
- Work by Harland, Gerstel, Phillips, Stephens, showed that this is among the best models of the D-genome ancestor of the allopolyploids
- Phillips (1966) states that the species was "represented by a relatively few individuals, and that these are confined to a narrow geographical range
- Intentional eradication as a “dangerous plant” (along with many other Malvaceae) by the Peruvian government

Gossypium raimondii



Gossypium raimondii

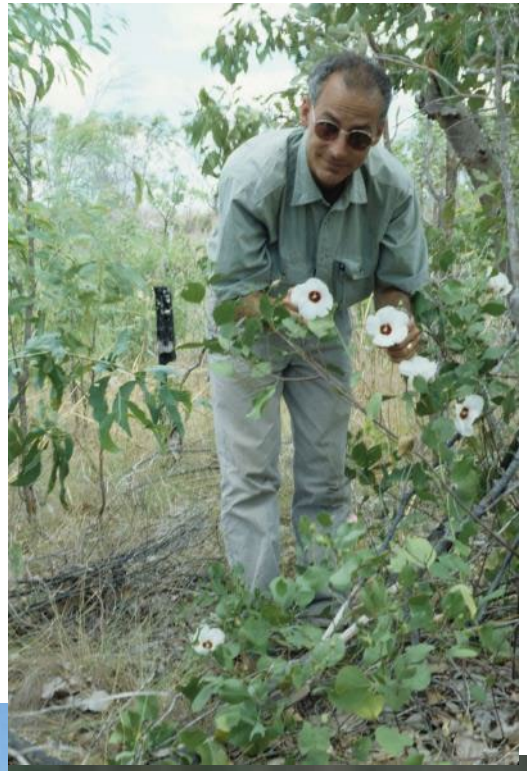
Collections in Northern Peru

Plant Genetic Resources Newsl., 1985

B.B. Simpson 1/, J.M. Vreeland 2/ and R. Ferreyra 3/

James “Mac” McD. Stewart

Ed Percival



Gossypium anapoides
Stewart et al., *Novon*, 2015

Krapovickas, A. & G. Seijo. 2008. *Gossypium Ekmanianum* (Malvaceae), algodónsilvestre de la República Dominicana. Bonplandia 17: 55-63.

- First proposed as a species in 1928 by Wittmack
  - Endemic to the the Dominican Republic; “perfectly wild” characteristics
- Reclassified as *G. latifolium* var. *ekmanianum* by Roberty in 1942
- Reclassified as *G. hirsutum* var. *ekmanianum* by Roberty in 1950
- Reclassified as *G. tricuspidatum* var. *ekmanianum* by Mauer in 1954
- Treated as a form of *G. hirsutum* by Fryxell and modern workers

Cotton Collecting on Caribbean Islands and South Florida

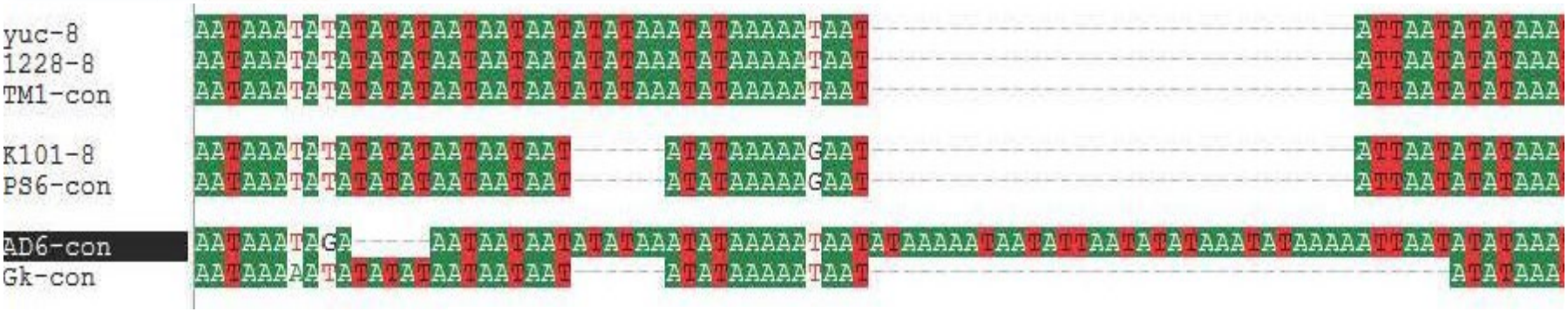
J. Schwendiman, [1/] A.E. Percival [2/] and J.L. Belot [3/]

DOMINICAN REPUBLIC (A.S. 1211 to A.S. 1225)

In the Dominican Republic collecting was carried out in only a very limited area, namely the areas bordering the old and new highways (Carretera Sanchez) between Azua and Barahona. A collecting mission was undertaken in this country in 1980 and, in an electrophoretic survey of this material carried out by Bourdon (1984), samples from this area showed a surprising degree of enzymatic variability.

2245	JAMAICA															
2246	JAMAICA	466	4	4	4	4	4	4	4	6	4	6	4	1	4	4	4
2247	JAMAICA	467	4	4	4	4	4	8	4	2	4	N	4	2	4	4	4
2249	GRAND CAYMAN	468	4	4	4	4	4	8	4	2	4	N	4	2	4	4	4
2250	GRAND CAYMAN	469	4	4	4	4	4	8	N	2	4	6	5	2	4	4	4
2252	GRAND CAYMAN	470	4	4	4	4	4	2	4	6	4	6	4	2	4	4	4
2253	GRAND CAYMAN	471	4	4	4	4	4	2	4	2	4	6	4	2	4	4	4
2254	GRAND CAYMAN	472	4	4	4	4	5	2	4	2	4	6	4	2	4	4	4
2255	GRAND CAYMAN	473	4	4	4	4	4	2	4	2	4	6	4	2	4	4	4
2265	DOMINICAN REP	474	4	4	4	4	5	2	4	2	6	6	5	2	4	4	4
2266	DOMINICAN REP	475	2	4	4	4	4	2	4	2	4	4	4	1	4	4	4
2267	DOMINICAN REP	476	4	4	4	4	4	4	5	6	4	6	4	2	4	4	4
2268	DOMINICAN REP	477	4	4	4	4	4	4	4	6	4	6	4	1	4	4	4,6
2270	DOMINICAN REP	478	4	4	4	4	4	4	4	6	4	N	4	2	4	4	4,6
2271	DOMINICAN REP	479	4	4	4	4	4	4	4	6	4	6	4	2	4	4	4,6
2272	DOMINICAN REP	480	4	4	4	4	4	4	4	6	4	6	4	2	4	4	4
2274	DOMINICAN REP	481	4	4	4	4	4	4	4	6	4	6	4,N	1,2	4	4	4
2276	DOMINICAN REP	482	4	4	4	4	4	8	4	6	4	N	4	1	4	4	4,6
2277	DOMINICAN REP	483	4,2/4	4	4	4	4	4	5	6	4	6	4	1	4	4	4
2278	DOMINICAN REP	484	4	4	4	4	4	8	4	2	4	N	5	2	4	4	4
2280	PUERTO RICO	485	4	6	4	4	4	8	4	2	4	N	4	2	4	4	4
2283	PUERTO RICO	486	4	4	4	4	4	8	4	6	4	4,N	5	2	4	4	4
2284	PUERTO RICO	487	4	4	4	4	4	8	N	6	4	6,N	5	2	4	4	4
2285	PUERTO RICO	488	4	4	4	4	4	8	4	6	4	6,N	5	2	4	4	4
		489	4	4	4	4	4	8	4	2	4	N	4	2	4	4	4

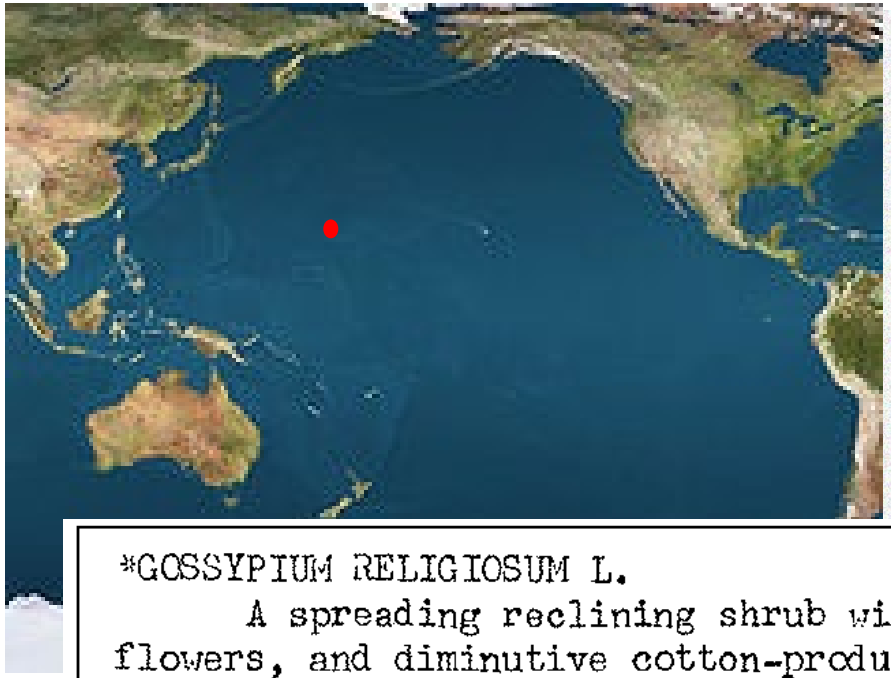
G. ekmanianum: a sixth polyploid species



Molecular confirmation of species status for the allopolyploid cotton species, *Gossypium ekmanianum* Wittmack

C. E. Grover · X. Zhu · K. K. Grupp · J. J. Jarecczek · J. P. Gallagher · E. Szadkowski · J. G. Seijo · J. F. Wendel

Genet. Res. Crop Evol. 2015



ATOLL RESEARCH BULLETIN

No. 67

Vegetation and flora of Wake Island

by

F. R. Fosberg

*GOSSYPIUM RELIGIOSUM L. Wild Cotton.

A spreading reclining shrub with grayish leaves, light yellow flowers, and diminutive cotton-producing fruits. Bryan reported one clump in 1923, but in 1952 fairly common especially around old Japanese installations on Wake Islet. Native in the Pacific, but rare and known from very few specimens, probably but not certainly an introduced plant on Wake, first found there in 1923. Fosberg 34469. (Christophersen 1931, p. 13, as G. hirsutum var. religiosa Watt; Drummond-Hay 1939; Bryan 1942, p. 213, also as G. hirsutum var. religiosa.)

il

forms of the same species from the Caribbean area and from Wake Island. The Wake Island cotton does not resemble closely either the Caribbean or other Pacific forms. The Caribbean forms are much more variable in all

Paul A. Fryxell, 09:42 PM 8/20/98 , Wake Island cotton

Date: Thu, 20 Aug 1998 21:42:41 -0500 (CDT)
To: jfw@iastate.edu
From: pfryxell@mail.utexas.edu (Paul A. Fryxell)
Subject: Wake Island cotton

Dear Jonathan:

A seed sample of the Wake Island cotton is on its way to you. It is not a large sample, but I am sending half to you and half to Ed Percival to put in the germplasm collection -- and presumably be multiplied. The seed comes courtesy of Derral Herbst of the Bishop Museum in Honolulu. I have seen a poor herbarium specimen of this many years ago, and could only learn enough to be intrigued. Derral calls it G. hirsutum and it may be kin to the G. hirsutums from Tahiti, but my recollection from seeing the herbarium sheet (collected by the late Ray Fosberg) was that it might show some kinship with G. tomentosum. Having living material should put that question to rest. Cheers. --Paul

Paul A. Fryxell
Dept. Botany
University of Texas

Examined for
Cat. Micron. Pl.

PLANTS OF WAKE ISLAND

Gossypium hirsutum var. religiosum (L.) Watt
Det. F. R. Fosberg

Locality Wake Islet

Occurrence Occasional, especially around old Japanese installations.
coral sand, gravel, ~~debris~~

Date April 20-21, 1952 Alt. 1-3m.

Coll. F. R. Fosberg No. 34469

Remarks Sprawling shrub with elongate branches; flowers cream-yellow.

Wake Island Cotton: a *seventh* polyploid species

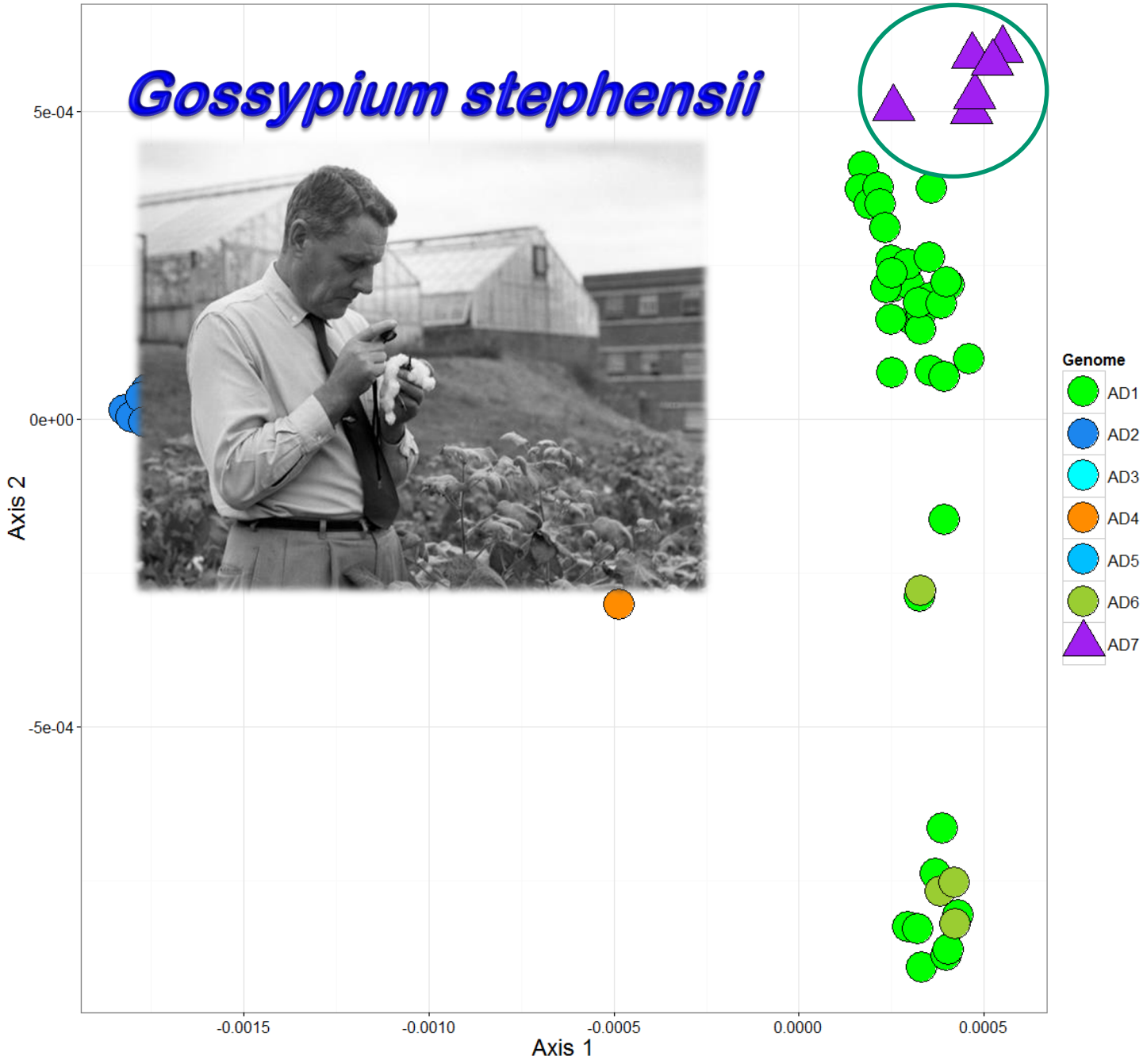
Systematic Botany (2017), 42(1): pp. 115–123

DOI 10.1600/036364417X694593
Date of publication March 1, 2017

A New Species of Cotton from Wake Atoll, *Gossypium stephensii* (Malvaceae)

Joseph P. Gallagher,[1] Corrinne E. Grover,[1] Kristen Rex,[2] Matthew Moran,[3] and Jonathan F. Wendel[1,4]

➢ Sequenced ~600 genes in a diverse panel of all allopolyploids



- We are the beneficiaries of generations of taxonomists, cytogeneticists, plant collectors…
- Recognition of the genus *Gossypium*; that is contains more than 50 species
- Over the last 5-10 million years, the genus has achieved a global distribution, remarkable history of long-distance oceanic travel, and of polyploidy
- Importance of biodiversity, of germplasm banks, and how thin that enterprise is; much remains to be learned, studied, preserved, utilized

Why diversity matters

Top 10 list

1. *Introgression of traits from wild species*
2. *Gene pools that are unexplored*
3. *History of introgression between AD1 and AD2*
4. *Learn from nature - Wild species and drought*
5. *Learn from nature - G. hirsutum and salt tolerance*
6. *Wild vs. domesticated, twice! Insights into fiber development*
7. *Why does 1+1 not equal 2? Molecular biology*
8. *Transposable elements and traits*
9. *Polyploidy evolutionary genomics, e.g., transcription factors*
10. *Philosophical: So that we know better the world we were born into*


The end…, except…

Many thanks to:

All of my mentors, colleagues, and nearly 40 years of students and post-docs and collaborators

Many thanks to:

Keith Adams, Wendy Applequist, Ying Bao, Curt Brubaker, Jeff Chen, Justin Conover, Rich Cronn, Lex Flagel, Joe Gallagher, Lei Gong, Corrinne Grover, Candace Haigler, Jennifer Hawkins, Ran Hovav, Guanjing Hu, Jinping Hua, Joe Jareczek, Don Jones, Bao Liu, Rick Masonbrink, Weixuan Ning, Andy Paterson, Dan Peterson, Ryan Rapp, Armel Salmon, Joel Sharbrough, Dan Sloan, Mac Stewart, Josh Udall, Mi-Jeong Yoo, Daojun Yuan, Maojun Wang, many, many others (sorry if I missed you!)