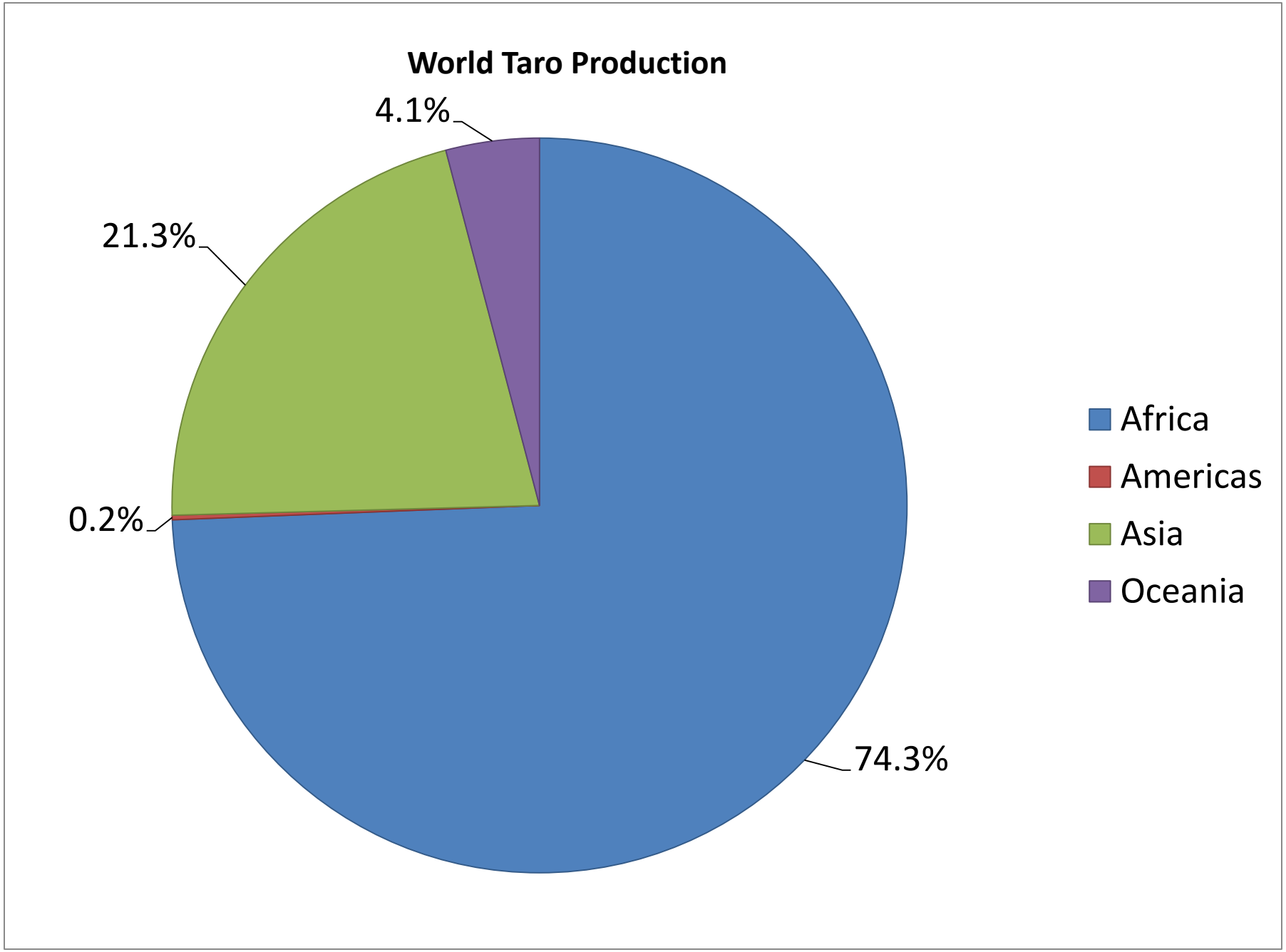
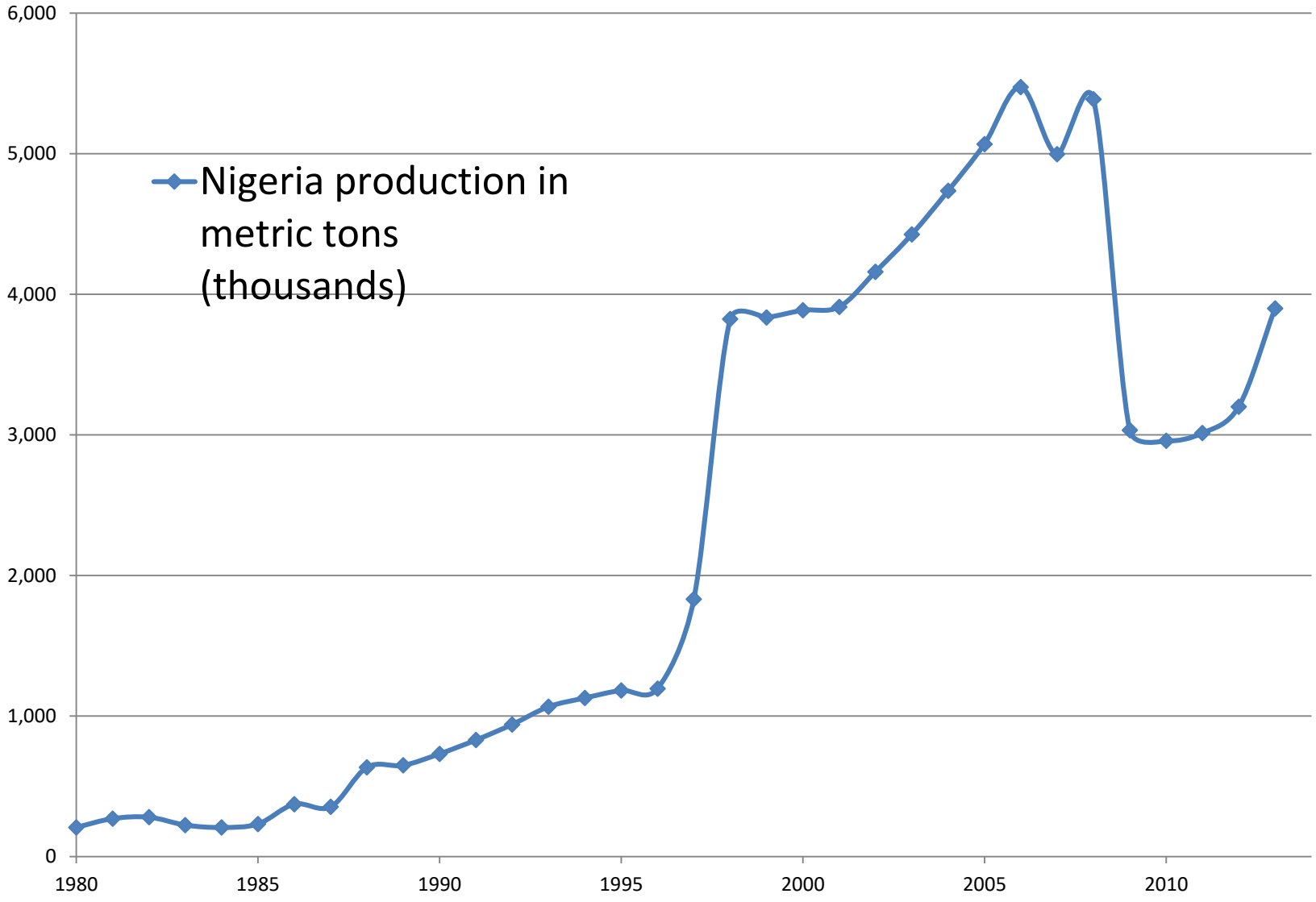
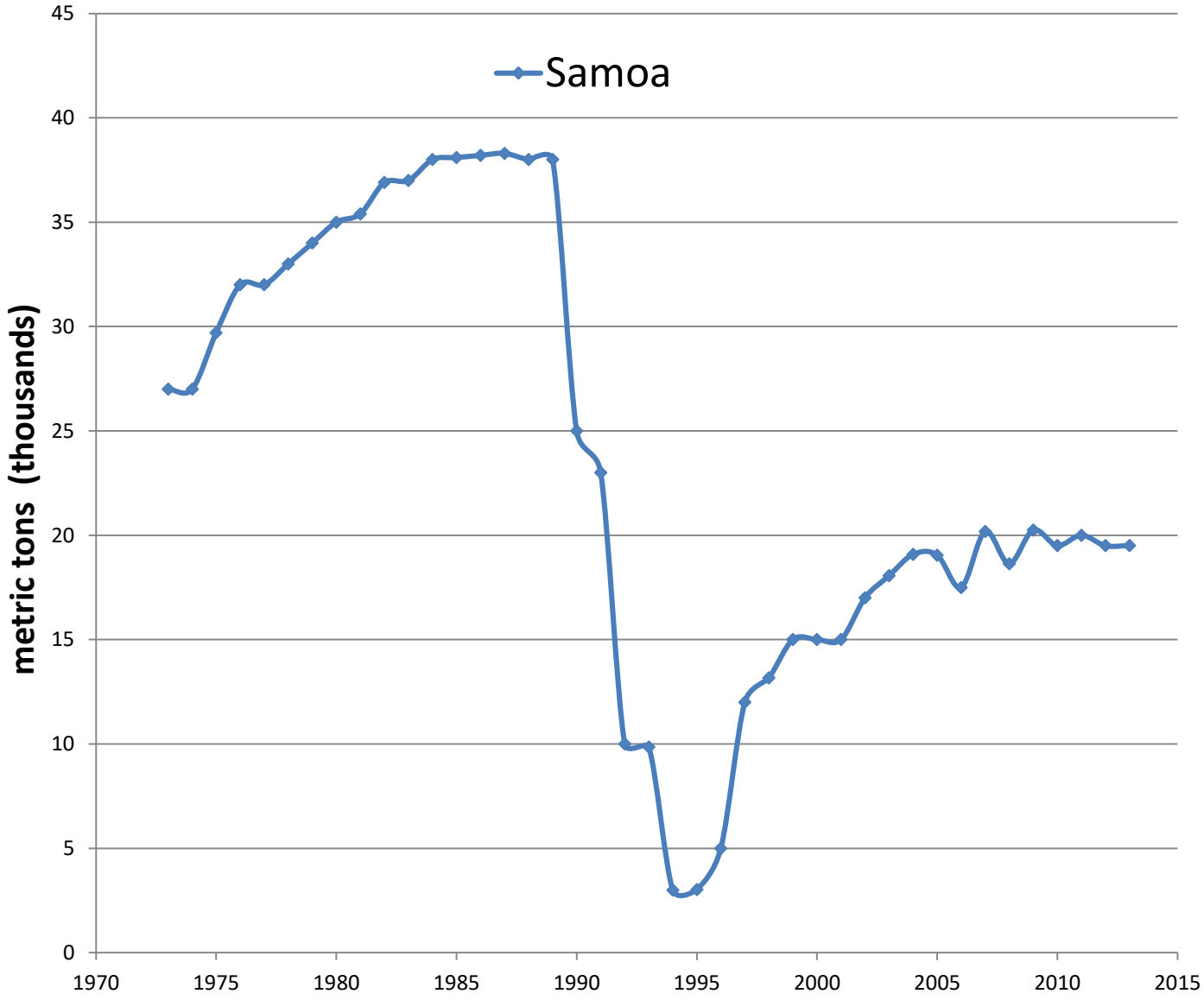
Developing Genomic Tools for the Protection and Improvement of Taro

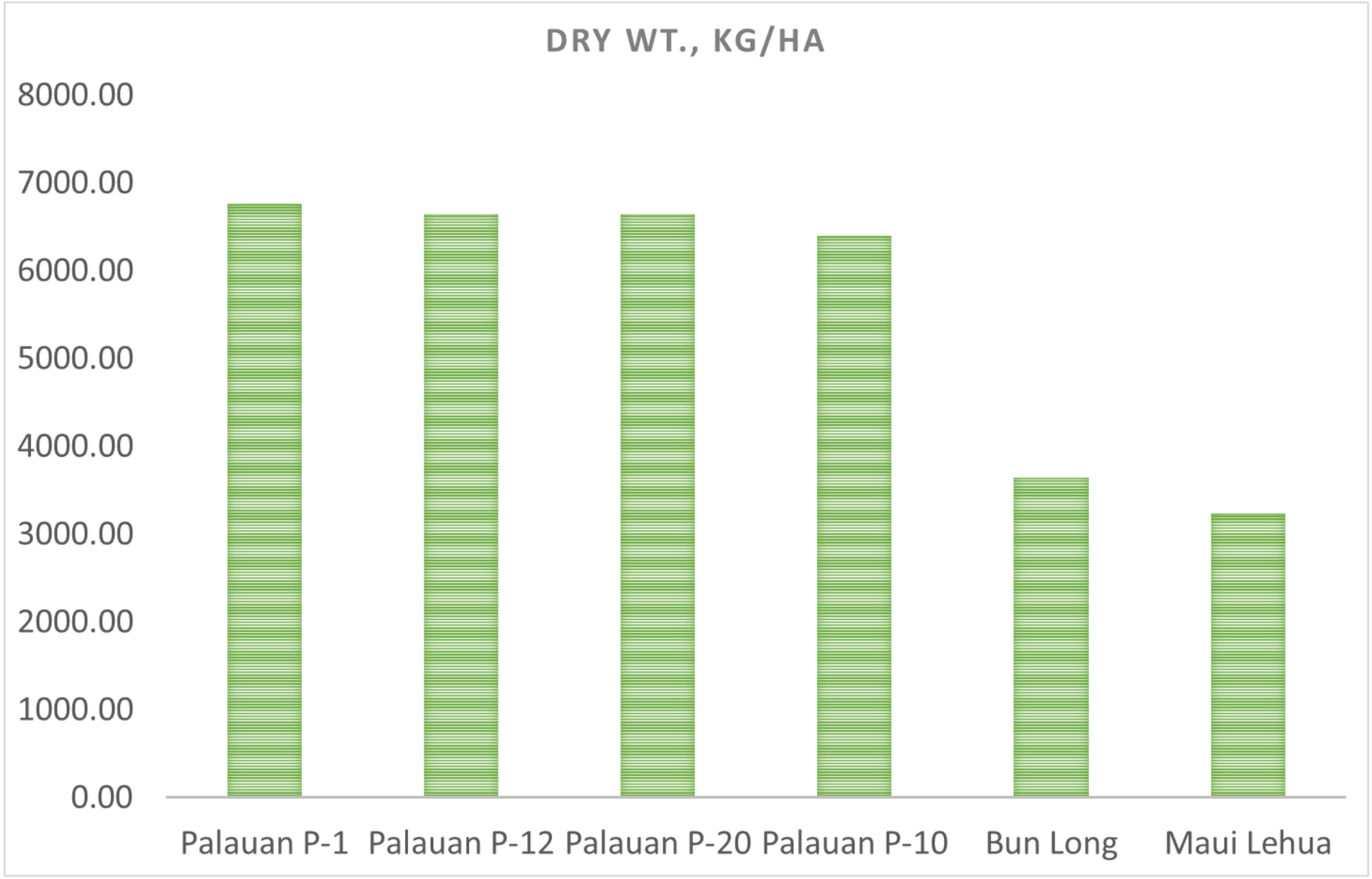

World Taro Production
4.1%
21.3%
0.2%
74.3%
Africa
Americas
Asia
Oceania

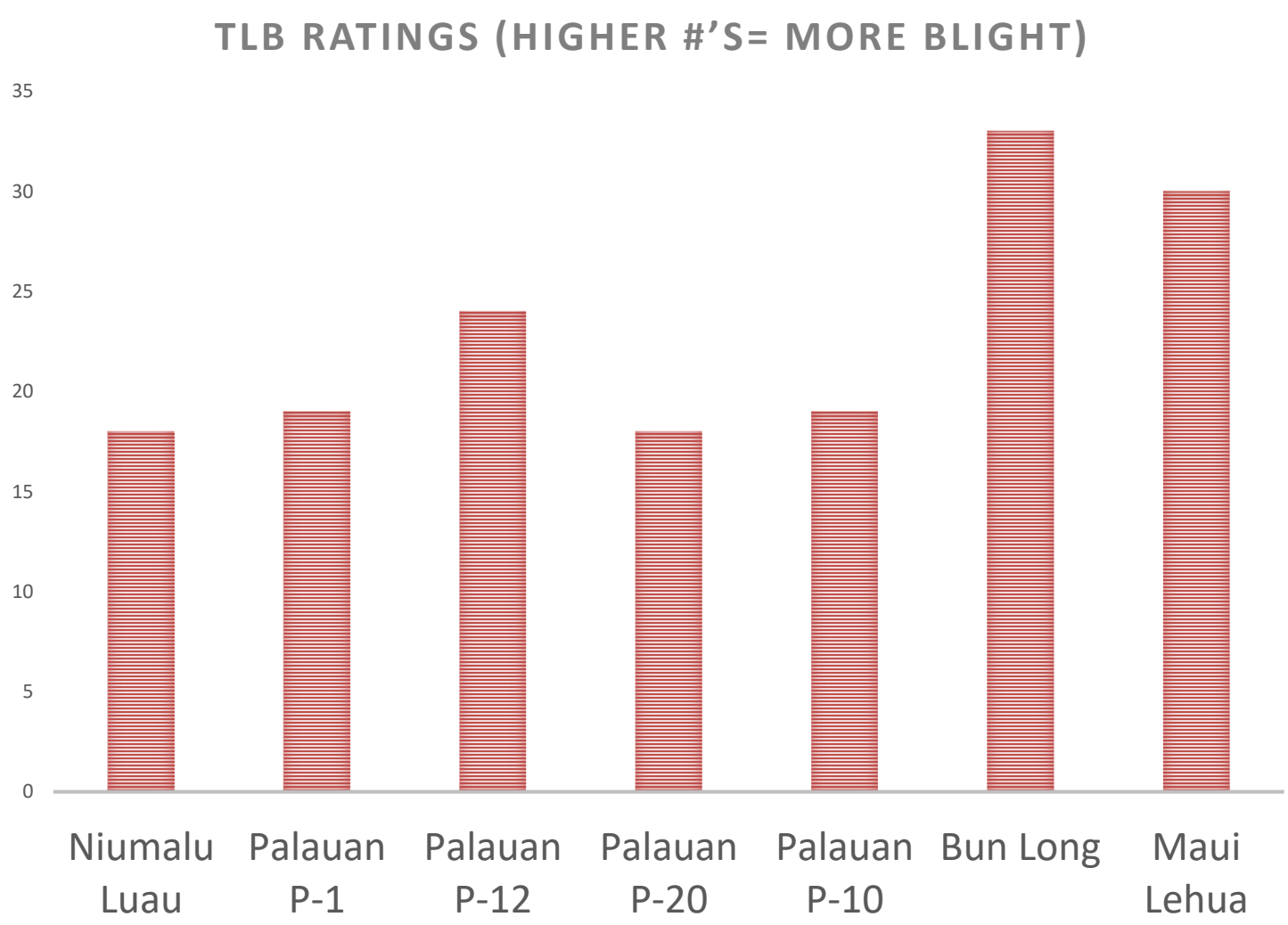

6,000
5,000
4,000
3,000
2,000
1,000
0
1980
1985
1990
1995
2000
2005
2010
Nigeria production in metric tons (thousands)

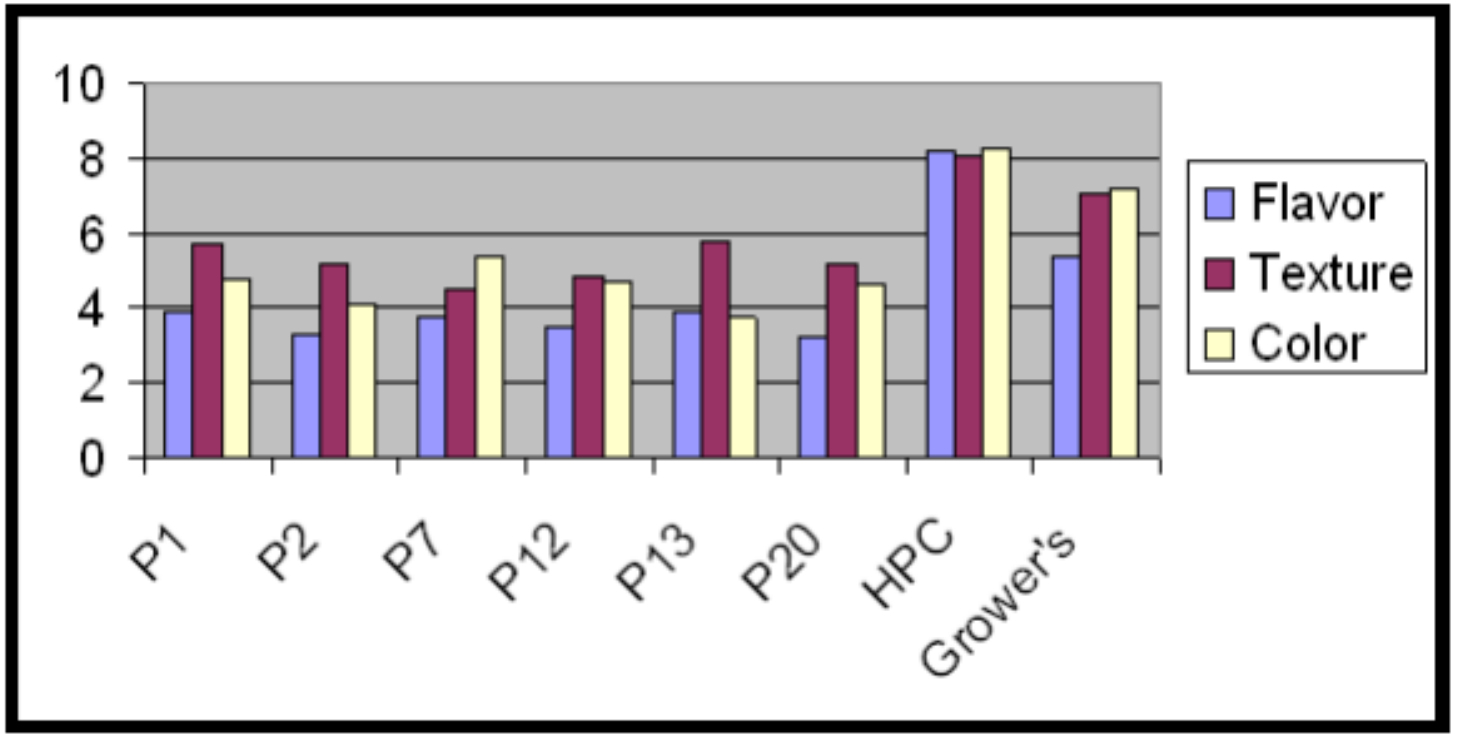

Samoa
metric tons (thousands)
45
40
35
30
25
20
15
10
5
0
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015

Taro Leaf Blight (TLB) *Phytophthora colocasiae*

Taro Cultivar Trials 1994-2006




TLB RATINGS (HIGHER #'S= MORE BLIGHT)
35
30
25
20
15
10
5
0
Niumalu Luau
Palauan P-1
Palauan P-12
Palauan P-20
Palauan P-10
Bun Long
Maui Lehua



PALAUAN VARIETIES:
P1 = Ngesuas
P2 = Terrekakl
P7 = Ochelochel
P12 = Merii
P13 = Dirraiuosch
P20 = Dirratengadik
The following were included in the taste test for comparison:
HPC = Taro Brand Poi
Grower's = Poi from Kauai Wetland

"Poi products made from the Palauan taros all failed at the grower and processor level in relation to color and taste." D. Sato 1999

Arnold Melim of Palolo was crossing Hawaiian taro varieties in the 1970's.

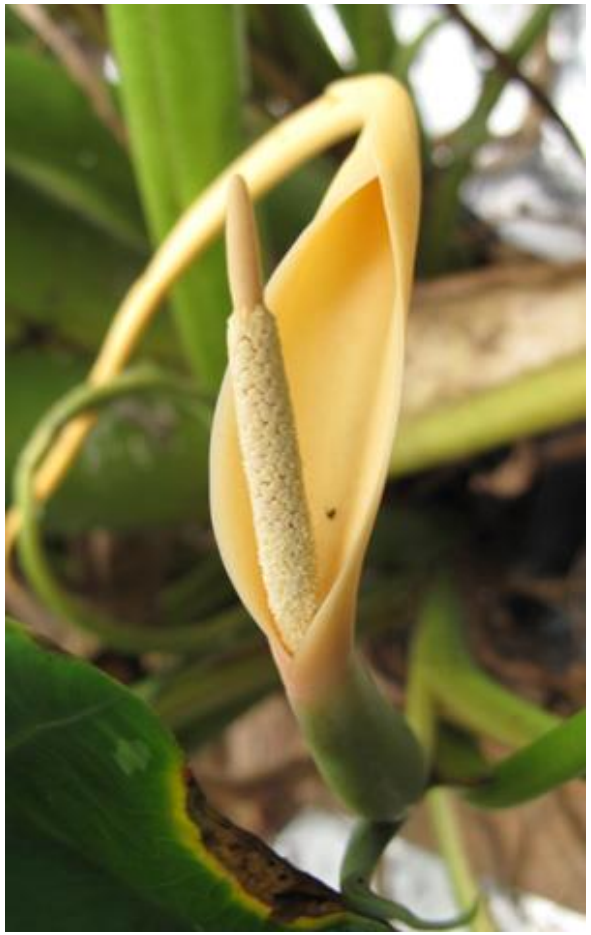
In the 1980's, Dr. Ramon Dela Pena on Kauai crossed Hawaiian and South Pacific varieties.

In the early 1990's, Dr. Eduardo Trujillo crossed Hawaiian and Palauan taro varieties.

In the early 2000's, Dr. John Cho on Maui crossed Hawaiian varieties with varieties from throughout the Pacific and Southeast Asia

Hand pollination required

- Male flowers produce pollen approx. 1-2 days **after** female flowers ready
- Cross-pollination is required for fertilization
- Insect that naturally pollinates taro in Australia, Papua New Guinea & Indonesia isn’t found in Hawaii



Seed pods and Taro seedlings

One seed pod of taro could produce up to 4000 seedlings

Slide courtesy Dr. Susan Miyasaka

June 9, 2016

July 20, 2016
(6 weeks later)

Taro seedlings

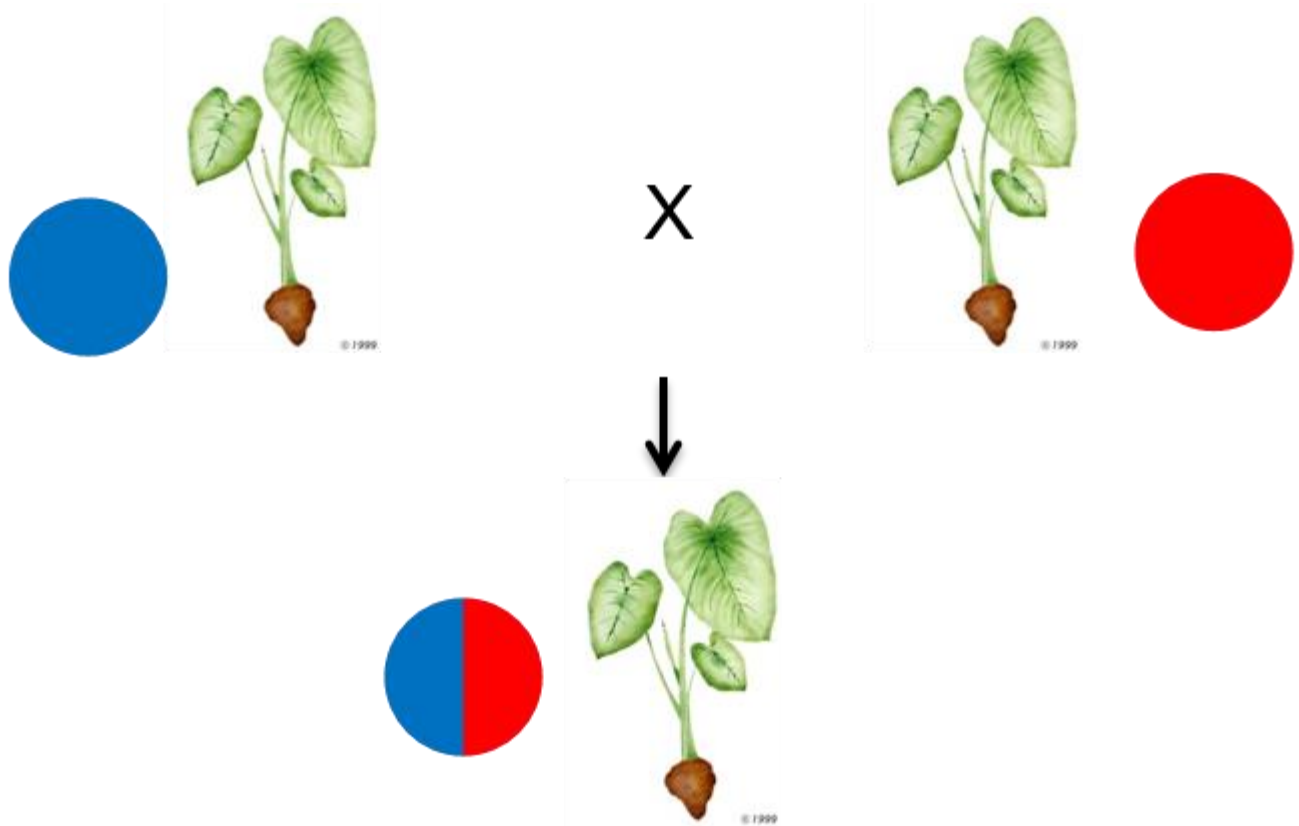
Agricultural Technician C. Bernabe with 4-5 month-old taro seedlings in greenhouse

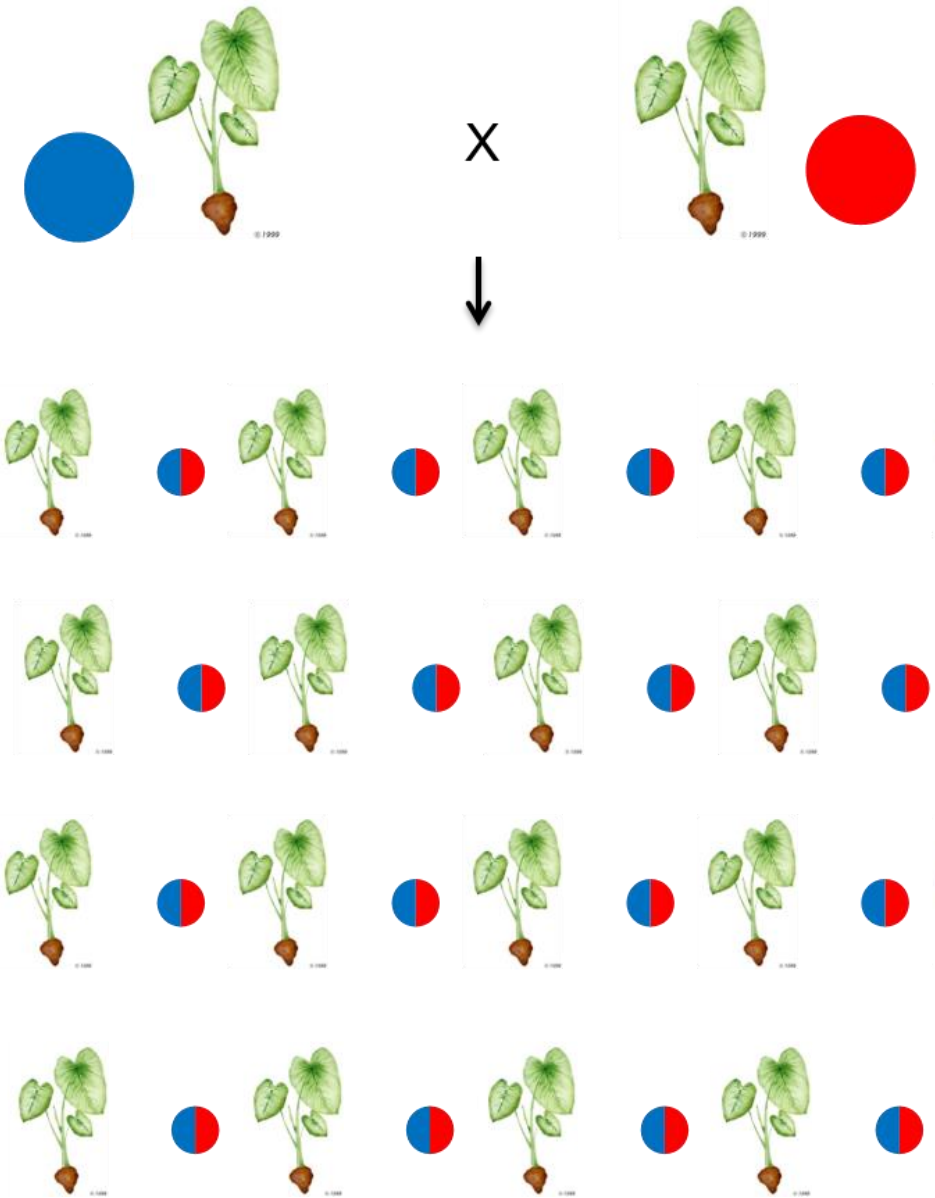
- Taro seedlings are evaluated in field over 1-2 years
- Most promising genotypes are multiplied and evaluated in replicated plots

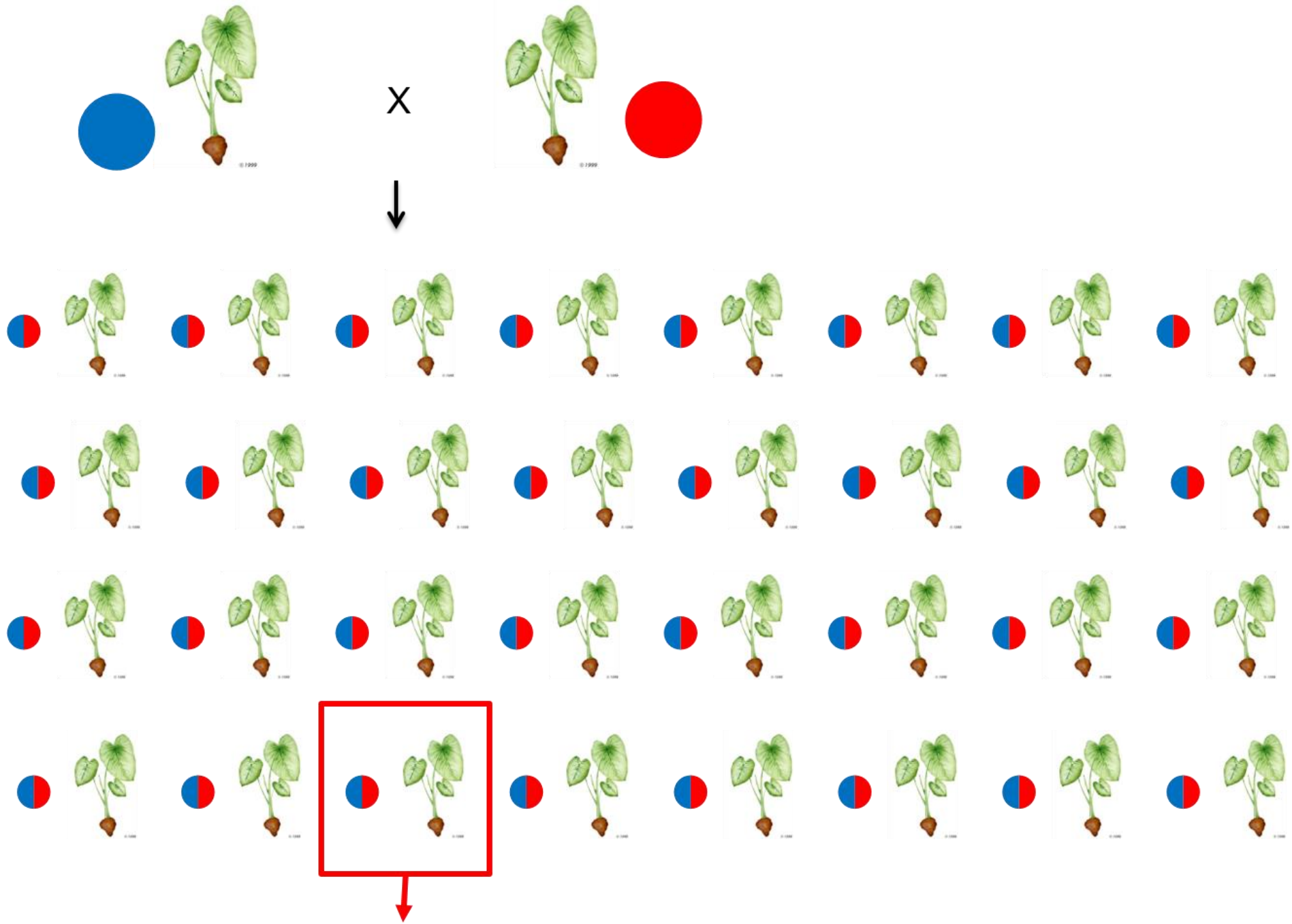
Field of taro seedlings 2 months after planting

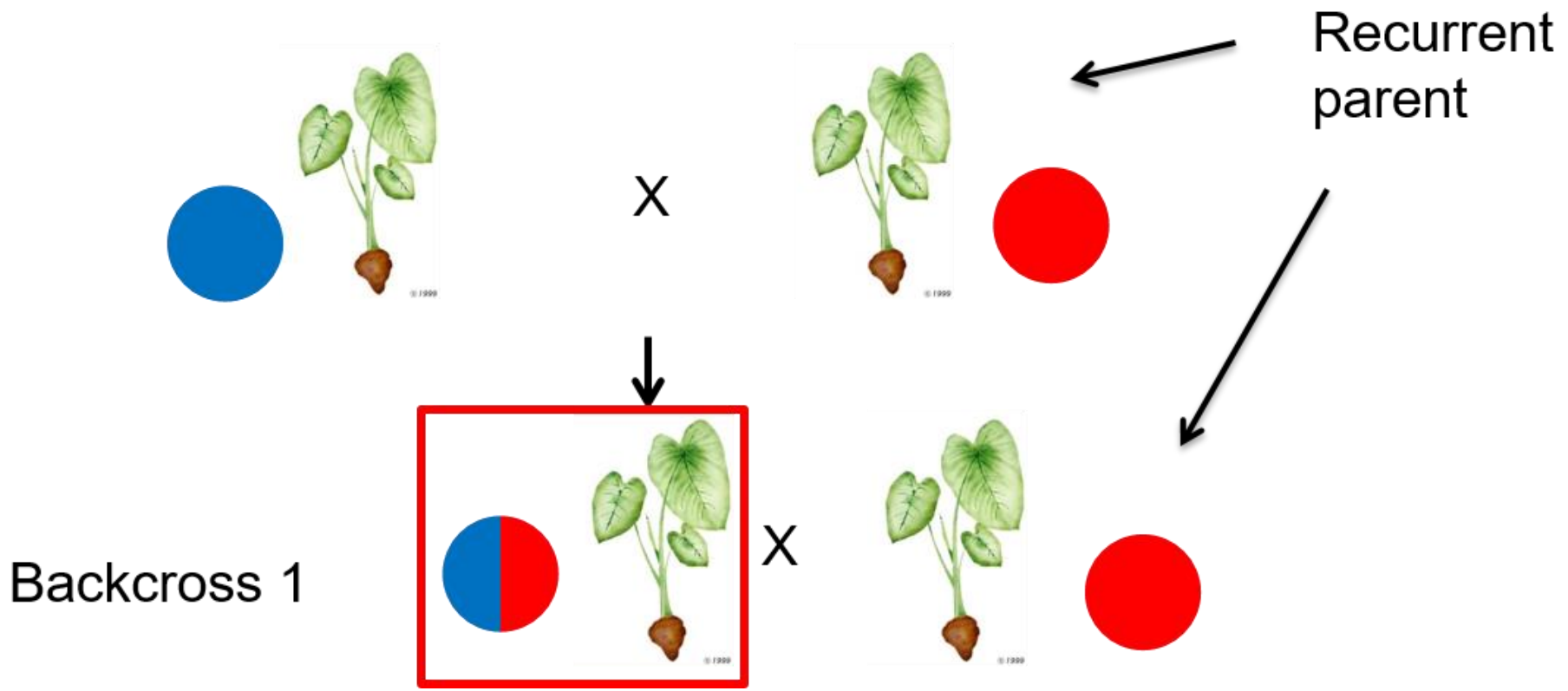
Slide courtesy Dr. Susan Miyasaka

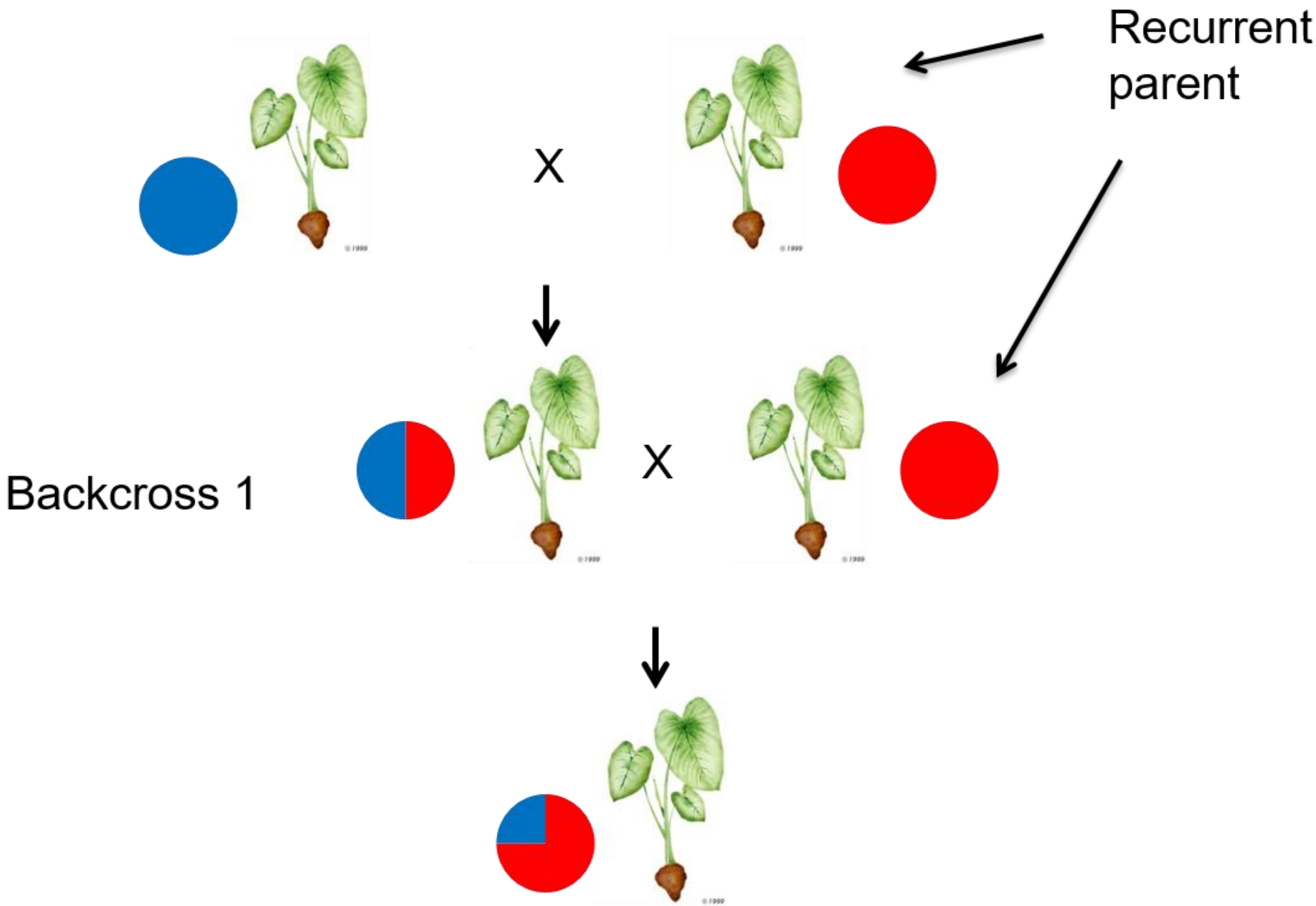

Maui Lehua
1050
1048
1048
1050
1047
1048
1050
1047
Bun Long
1048
1047
1047
1050
1048

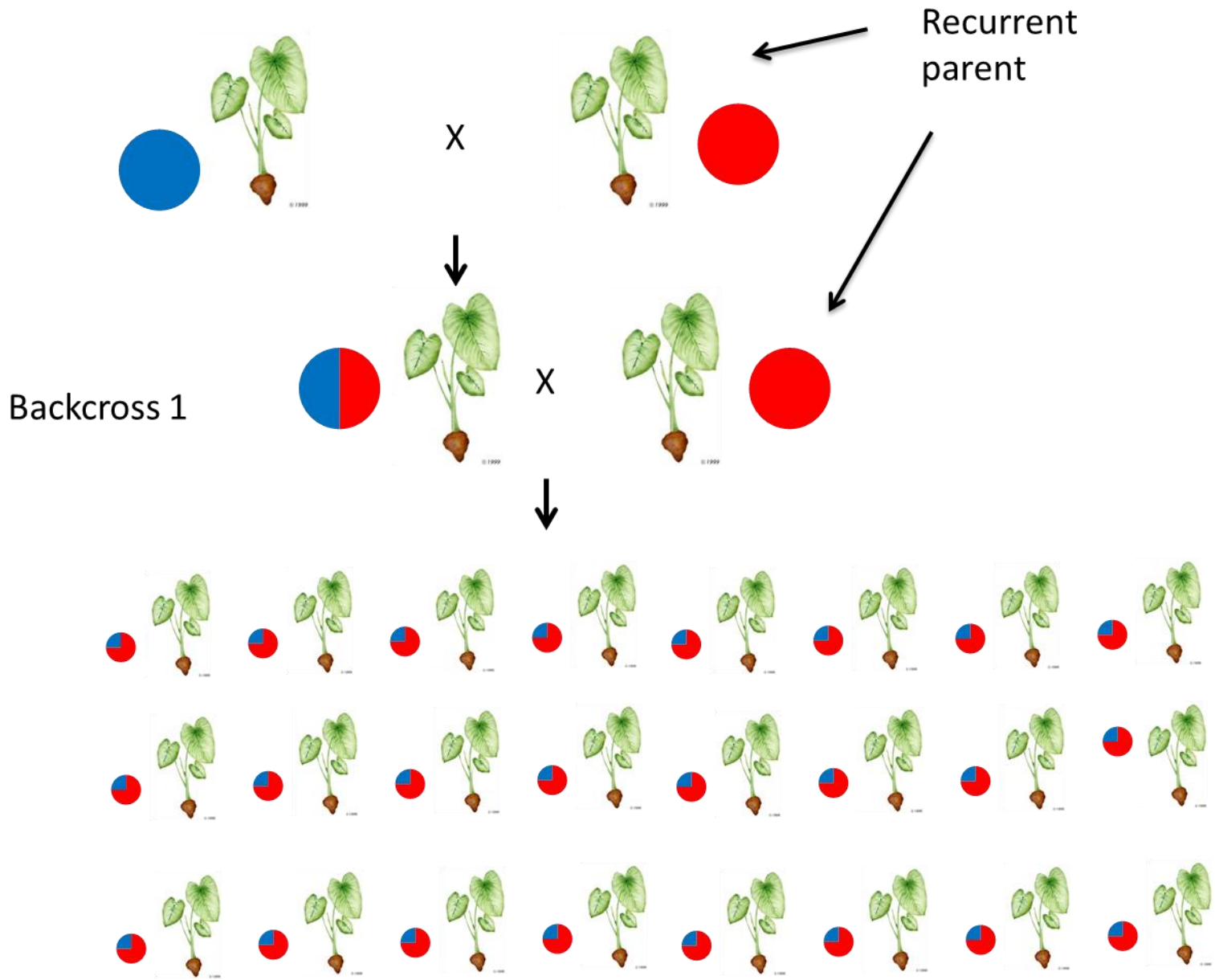


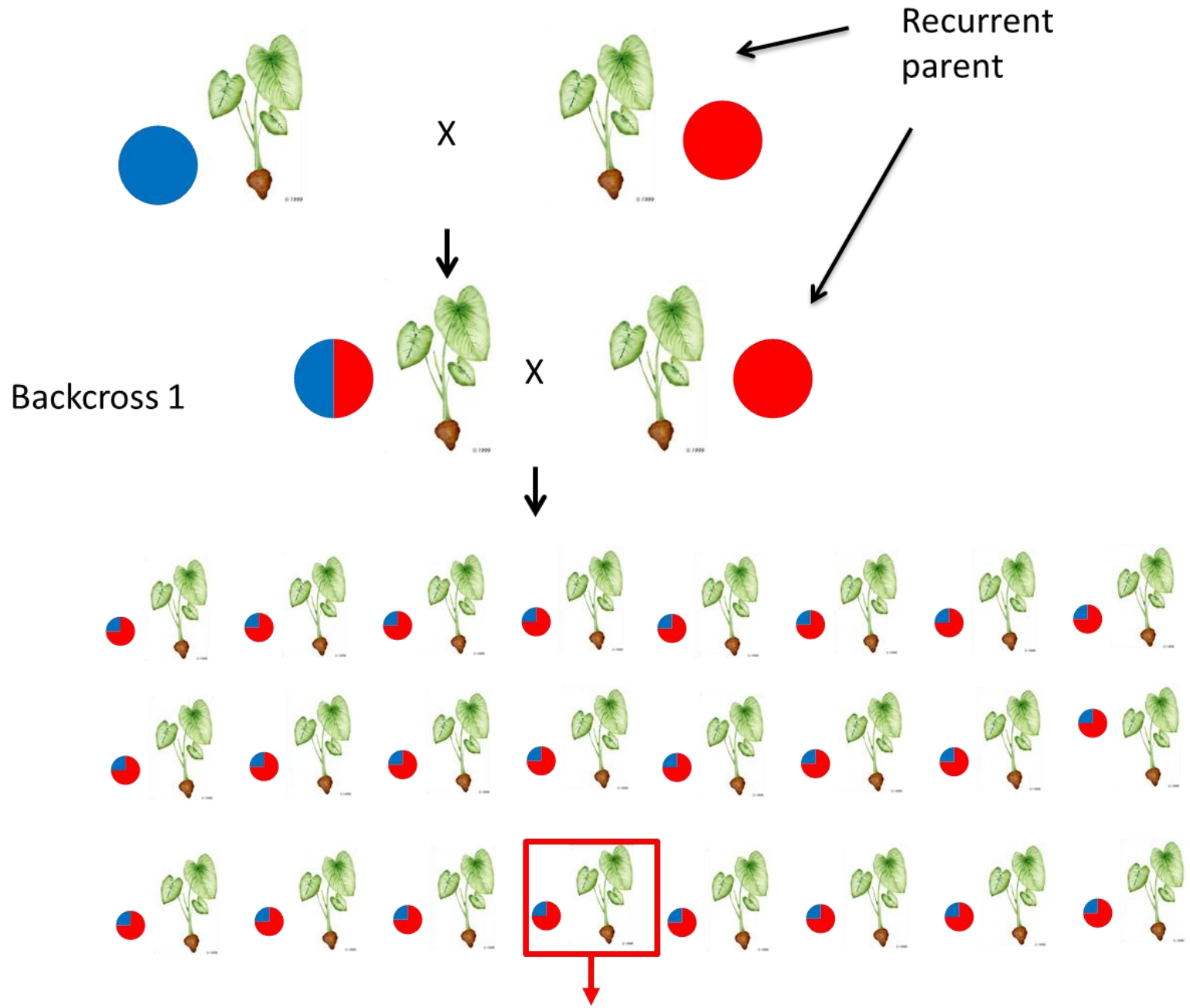


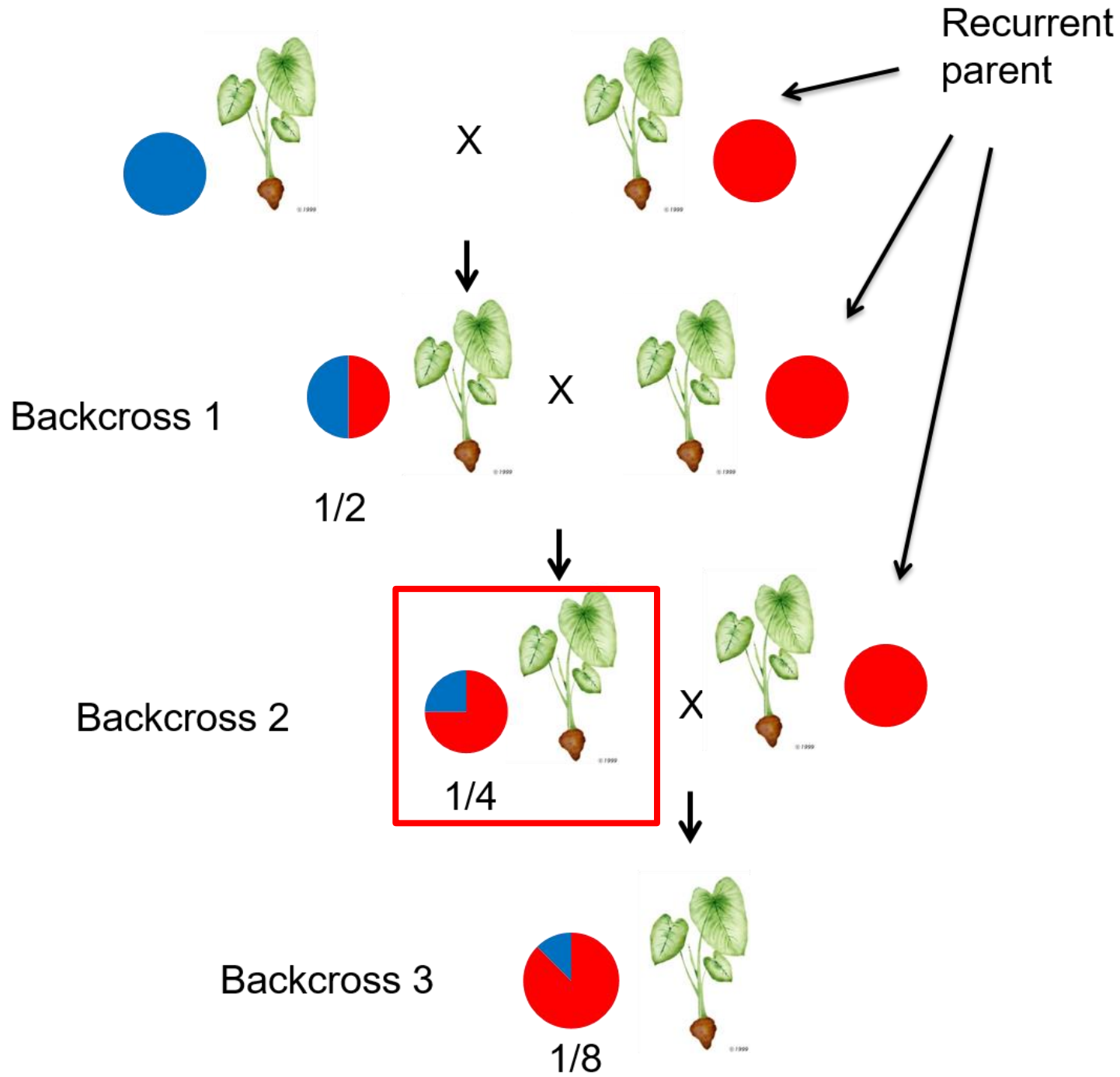


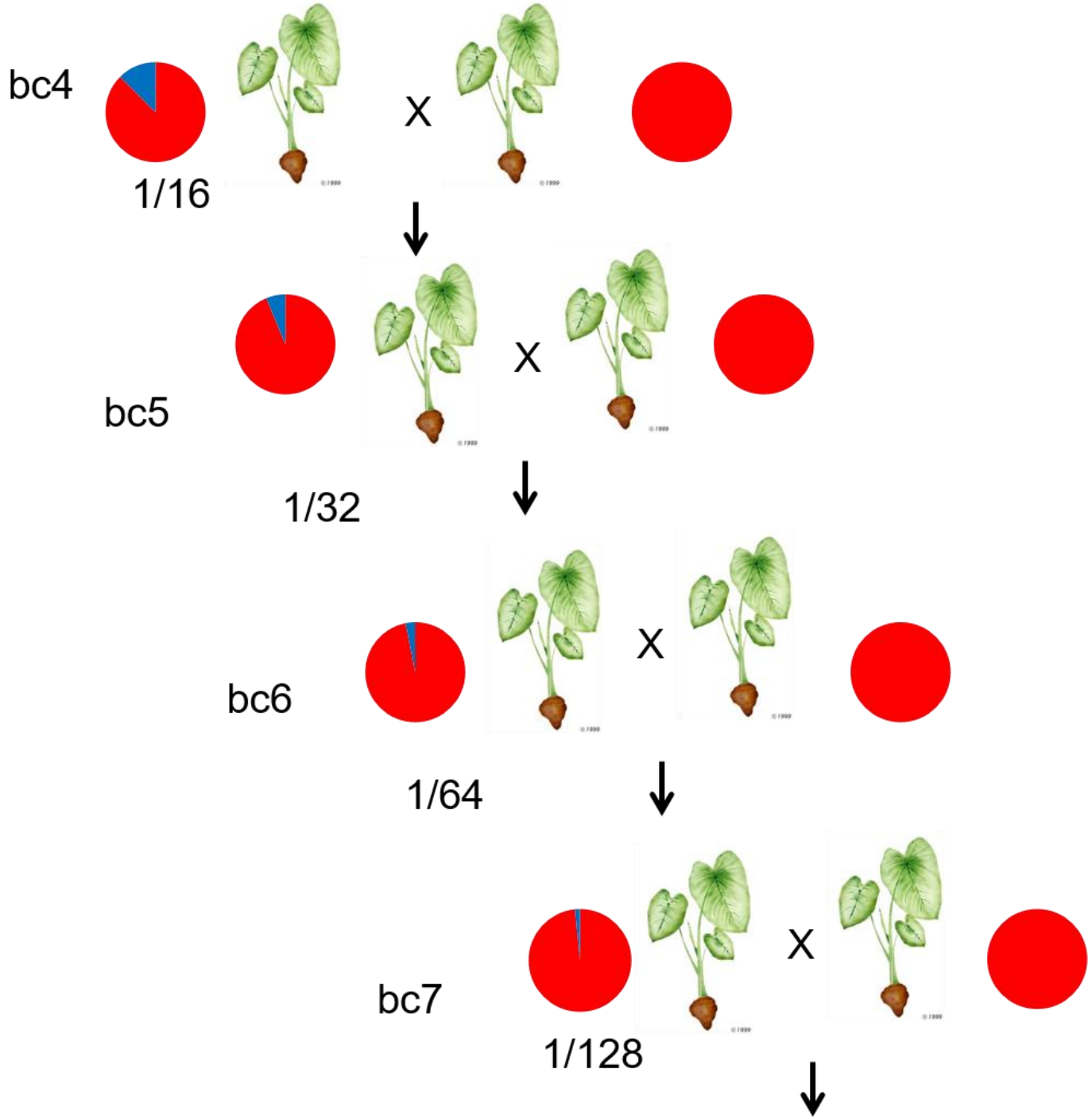

Recurrent parent
X
Backcross 1
X


Recurrent parent
X
Backcross 1
X


Recurrent parent
X
Backcross 1
X


Recurrent parent
X
Backcross 1
X


Recurrent parent
X
Backcross 1
X
1/2
Backcross 2
X
1/4
Backcross 3
1/8

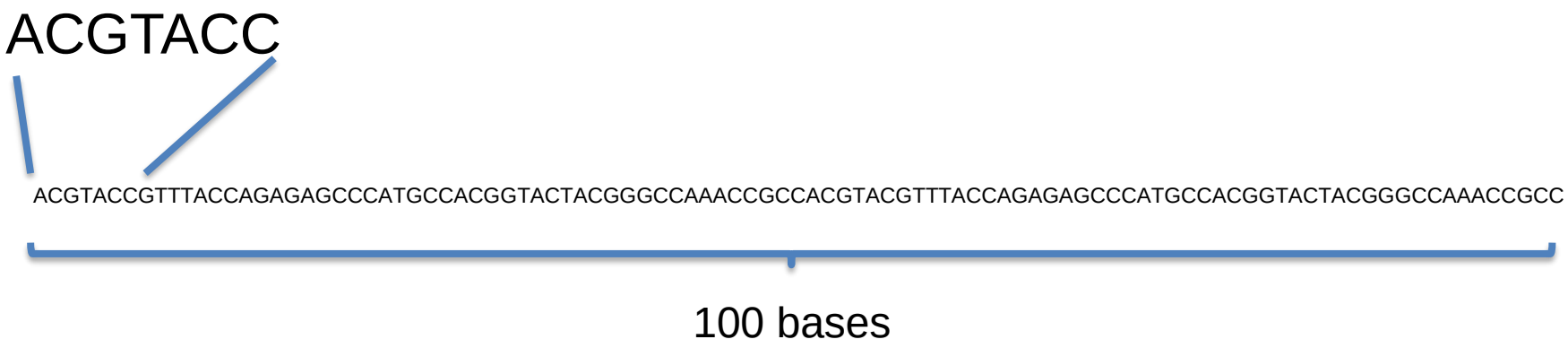

bc4
X
1/16
bc5
X
1/32
bc6
X
1/64
bc7
X
1/128

DNA Sequencing

- Extracted DNA from
  - 73 Hawaiian varieties
  - 12 hybrids
  - 6 Palauan

- Over 220 million DNA reads, about 100 bases each

- Over 220 million DNA reads, about 100 bases each

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ACGTACCGTTTACCAGAGAGCCCATGCCACGGTACTACGGGCCAAACCGCCACGTACGTTTA...
ACGTACCGTTTACCAGAGAGCCCATGCCACGGTACTACGGGCCAAACCGCCACGTACGTTTA...

SNPs = Single nucleotide polymorphisms

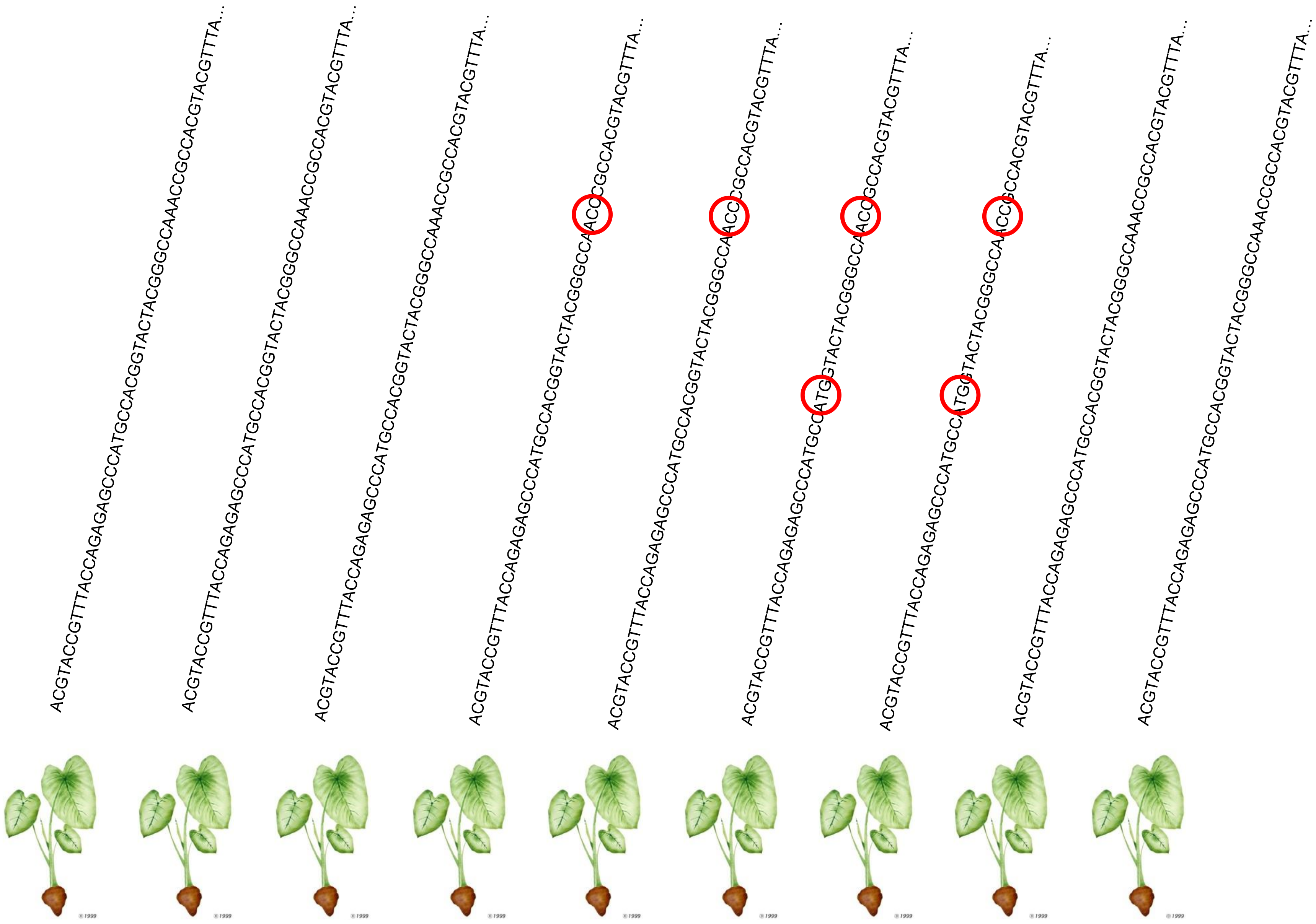
5′–GGCAACACATTGCC–3′

5′–GGCAACGCATTGCC–3′

SNPs = Single nucleotide polymorphism

5′–GGCAACACATTGCC–3′

5′–GGCAACGCATTGCC–3′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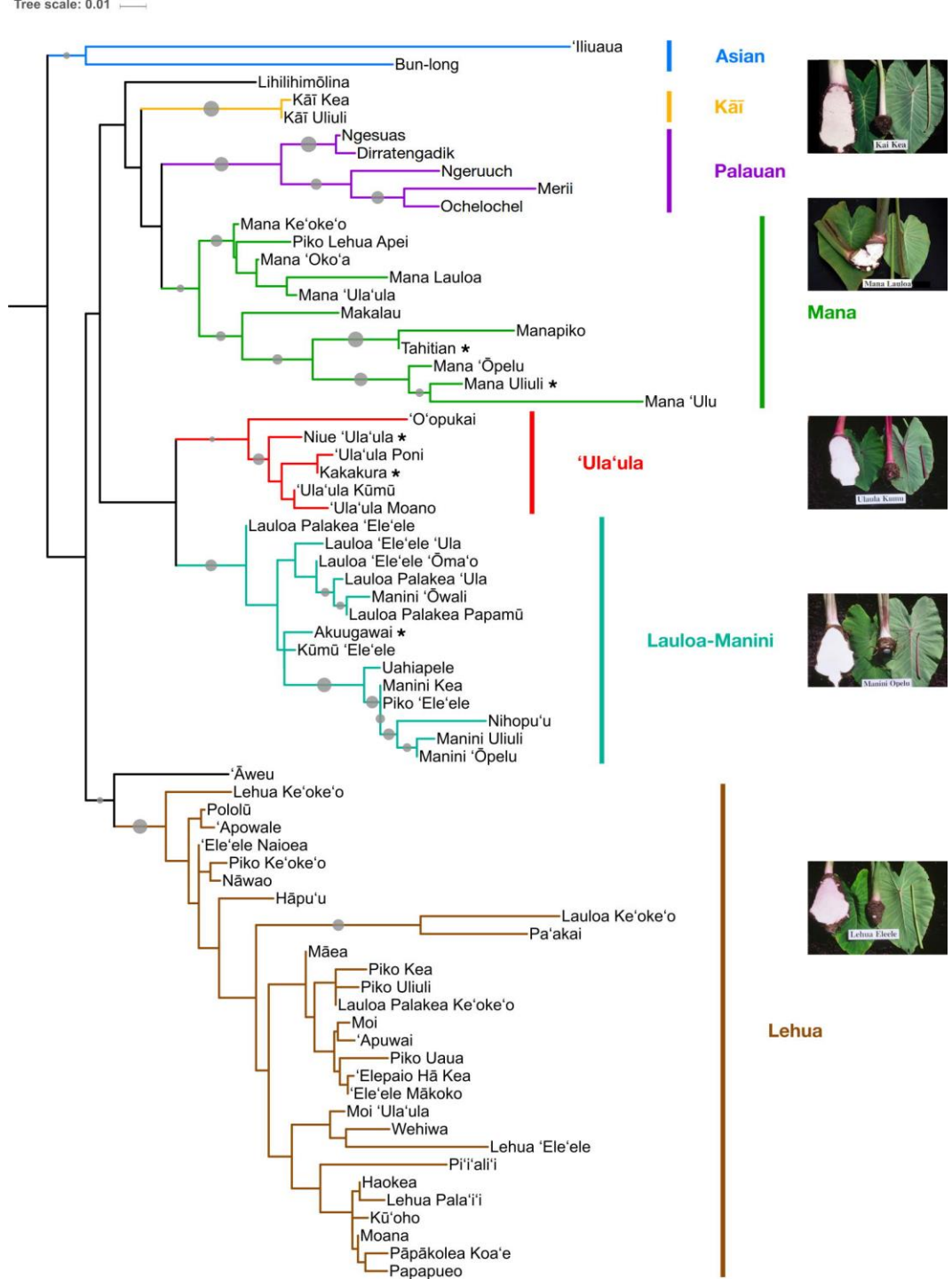
ACGTACCGTTTACCAGAGAGCCCATGCCACGGTACTACGGGCCAAACCGCCACGTACGTTTA...
ACGTACCGTTTACCAGAGAGCCCATGCCACGGTACTACGGGCCAAACCGCCACGTACGTTTA...


Tree scale: 0.01
ʻIliuaua
Bun-long
Asian
Lihilihimōlina
Kāī Kea
Kāī Uliuli
Kāī
Ngesuas
Dirratengadik
Ngeruuch
Merii
Ochelochel
Palauan
Mana Keʻokeʻo
Piko Lehua Apei
Mana ʻOkoʻa
Mana Lauloa
Mana ʻUlaʻula
Makalau
Manapiko
Tahitian ⋆
Mana ʻŌpelu
Mana Uliuli ⋆
Mana ʻUlu
Mana
ʻOʻopukai
Niue ʻUlaʻula ⋆
ʻUlaʻula Poni
Kakakura ⋆
ʻUlaʻula Kūmū
ʻUlaʻula Moano
ʻUlaʻula
Lauloa Palakea ʻEleʻele
Lauloa ʻEleʻele ʻUla
Lauloa ʻEleʻele ʻŌmaʻo
Lauloa Palakea ʻUla
Manini ʻŌwali
Lauloa Palakea Papamū
Akuugawai ⋆
Kūmū ʻEleʻele
Uahiapele
Manini Kea
Piko ʻEleʻele
Nihopuʻu
Manini Uliuli
Manini ʻŌpelu
Lauloa-Manini
ʻĀweu
Lehua Keʻokeʻo
Pololū
ʻApowale
ʻEleʻele Naioea
Piko Keʻokeʻo
Nāwao
Hāpuʻu
Lauloa Keʻokeʻo
Paʻakai
Māea
Piko Kea
Piko Uliuli
Lauloa Palakea Keʻokeʻo
Moi
ʻApuwai
Piko Uaua
ʻElepaio Hā Kea
ʻEleʻele Mākoko
Moi ʻUlaʻula
Wehiwa
Lehua ʻEleʻele
Piʻiʻaliʻi
Haokea
Lehua Palaʻiʻi
Kūʻoho
Moana
Pāpākolea Koaʻe
Papapueo
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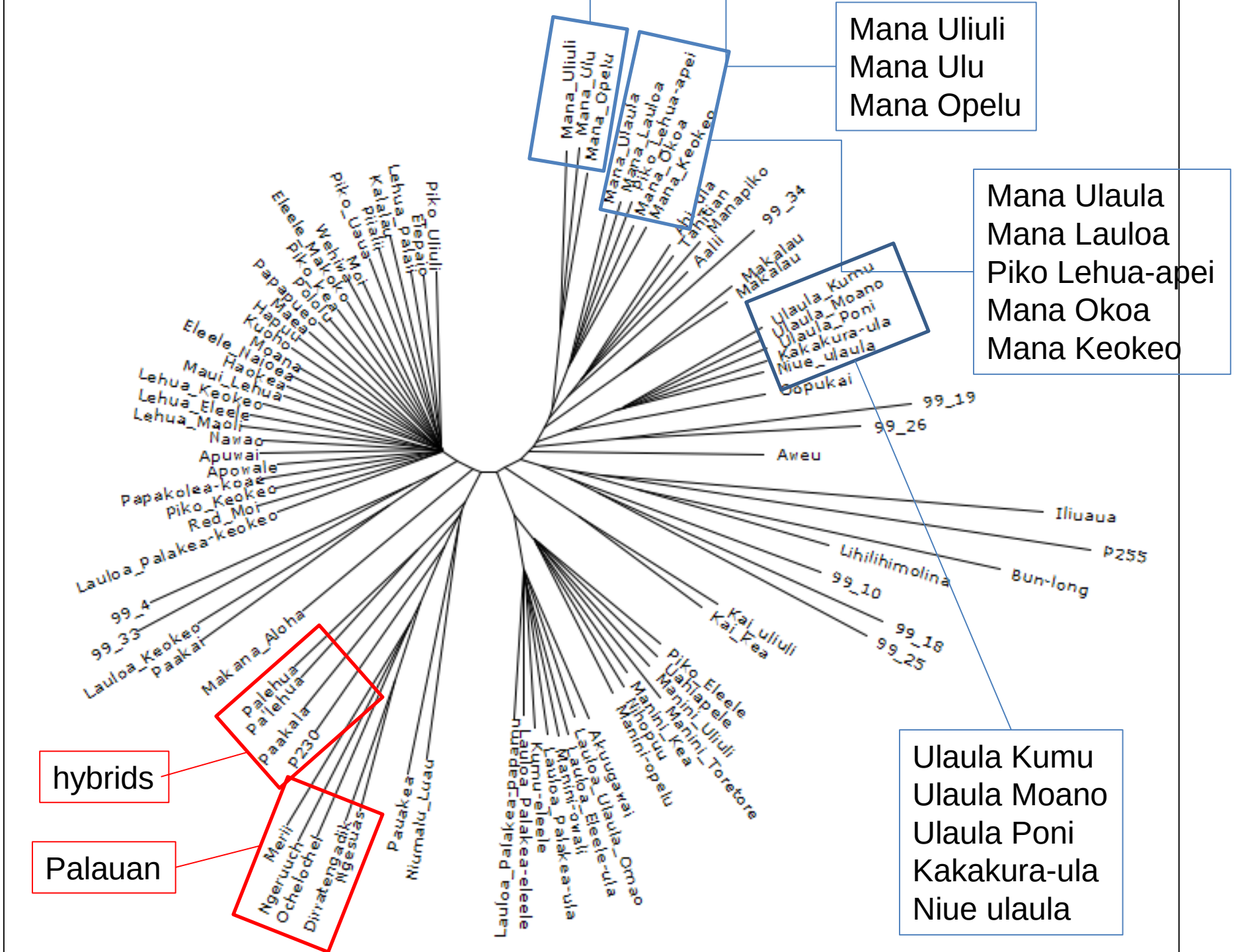
Mana Lauloa
Ulaula Kumu
Manini Opelu
Lehua Eleele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Mana Ulu
Mana Opelu
Mana Ulaula
Mana Lauloa
Piko Lehua-apei
Mana Okoa
Mana Keokeo
Ulaula Kumu
Ulaula Moano
Ulaula Poni
Kakakura-ula
Niue ulaula
hybrids
Palauan

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Roshan Paudel UHM-CTAHR
Heather Kimball UHH
Ashley Brown UHH (currently Quidel Corp., Ohio)
Anne Veillet UHH
Andrew Read UHH (currently Cornell University)
Jerry Konanui