Evolution of Crops

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What is evolution?

- Opening out, an unfolding, a realization of potential as the opening of a flower or the germination of a seed
- Gradual process rather than sudden or cataclysmic events
- Change with time at various magnitudes

(Harlan, 1975)

What is a crop?

"Crops are artifacts made and molded by man as much as a flint arrowhead, a stone ax-head, or a clay pot."

(Harlan, 1975)

How about evolution of crops?

From *wild* progenitors

to

fully *domesticated* races

Domesticated vs. cultivated crops?

- A domesticated crop (animal or plant) has been genetically altered from their wild state and brought into a man’s home
- A cultivated crop has been tended for afield through tilling, seedbed preparation, weeding, pruning, watering, fertilizing, etc.

Symbiotic relationship

- A fully domesticated plant cannot survive without the aid of man, but only a minute fraction of the human population could survive without cultivated plants.
- Crops and man are mutually dependent

The Gramineae

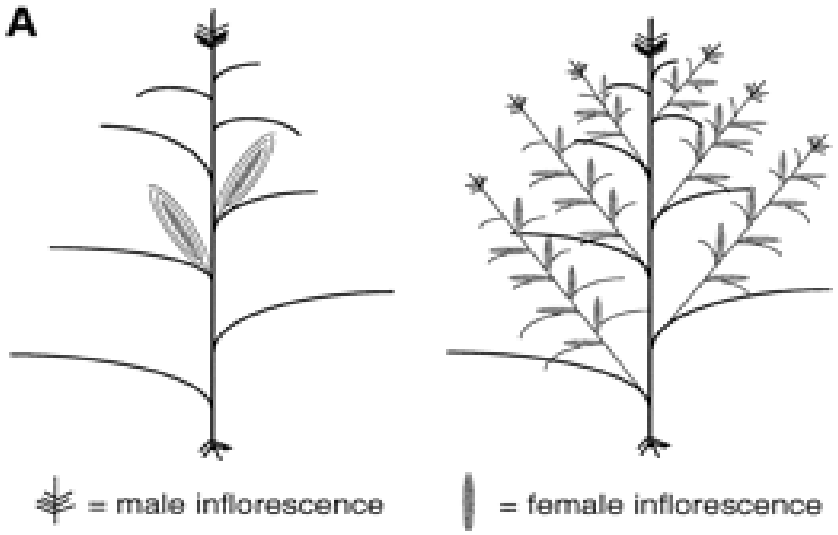
… or the Poaceae

- **Avena** (oats)
- **Hordeum** (barley)
- **Oryza** (rice)
- **Saccharum** (sugar cane)
- **Secale** (rye)
- **Sorghum** (sorghum)
- **Triticum** (wheat)

The Gramineae
… or the Poaceae

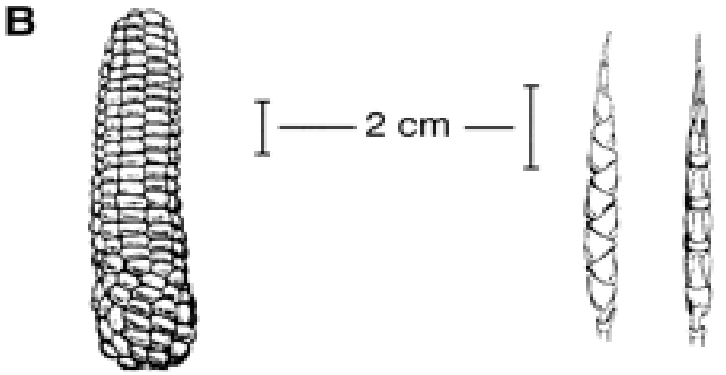
- Grass family includes the ***Maydae***
  - ***Zea*** (maize)
  - ***Euchlaena*** (teosinte)
  - ***Tripsacum***

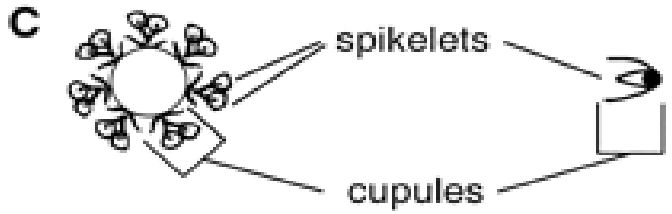
The Gramineae … or the Poaceae



Maize

Teosinte





(Lauter and Doebley, 2001)

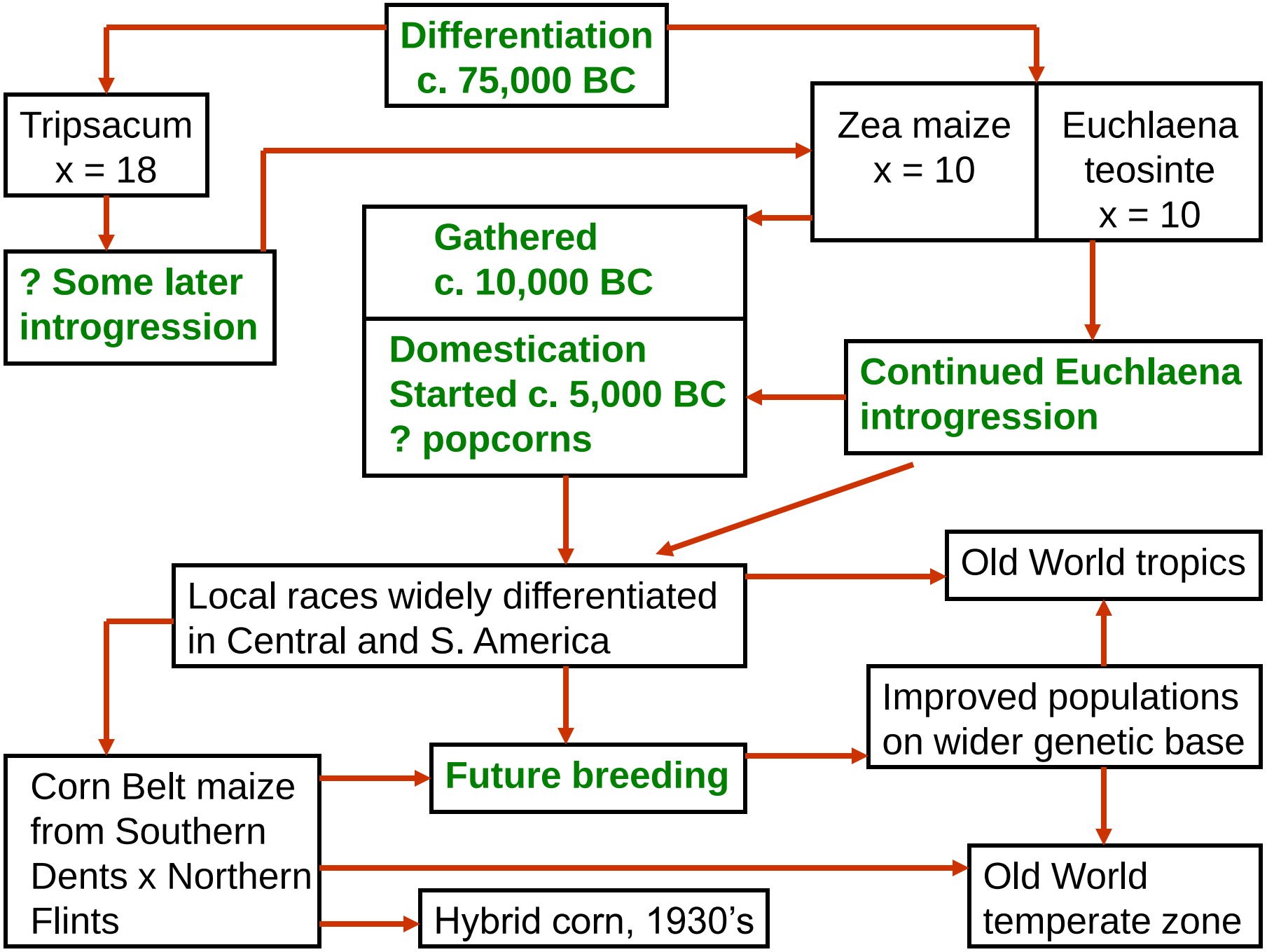
The Gramineae

… or the Poaceae

***Tripsacum* inflorescence**

Tillering *Tripsacum* grasses

Evolution of maize

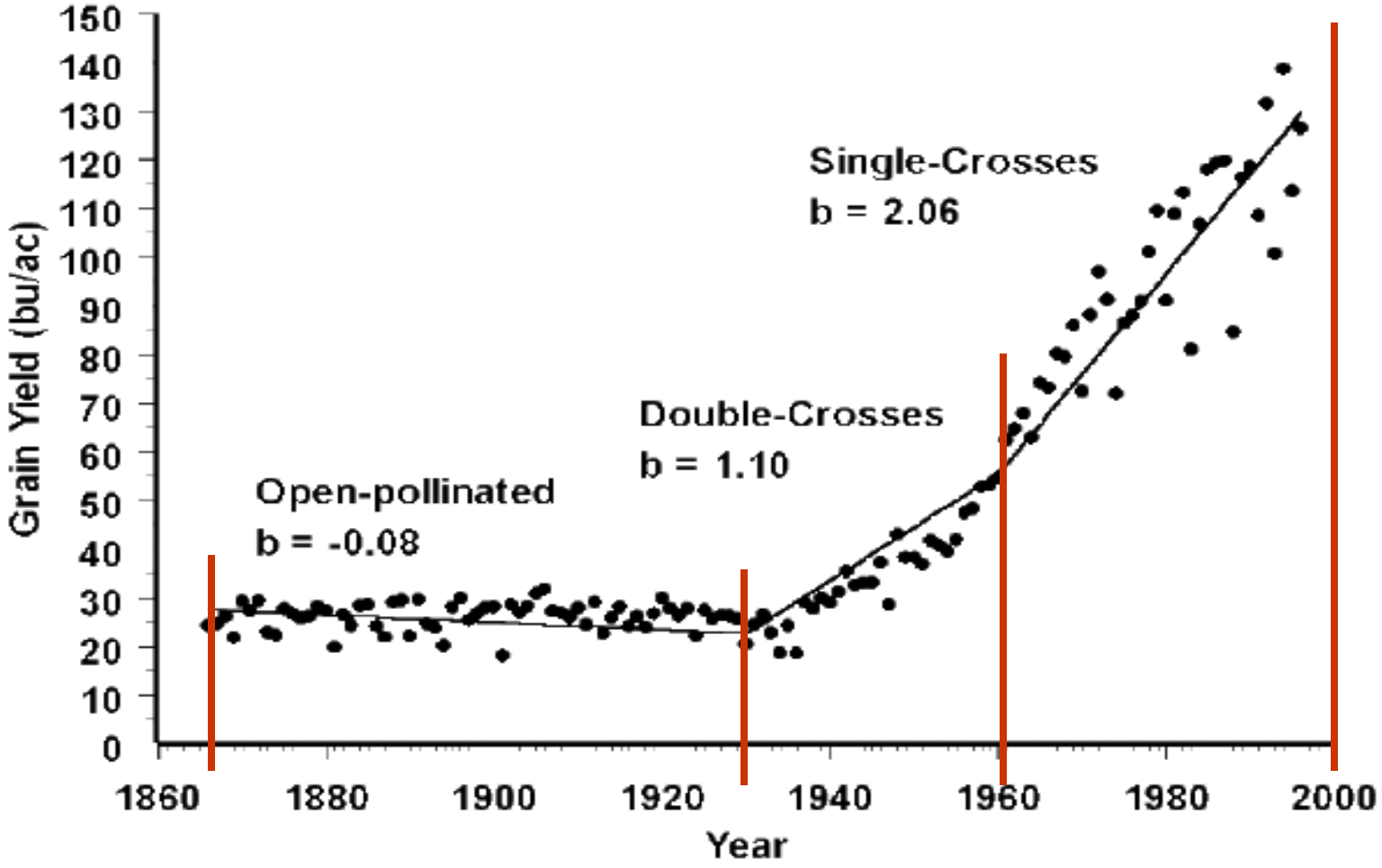

Differentiation
c. 75,000 BC
Tripsacum
x = 18
Zea maize
x = 10
Euchlaena
teosinte
x = 10
? Some later
introgression
Gathered
c. 10,000 BC
Domestication
Started c. 5,000 BC
? popcorns
Continued Euchlaena
introgression
Local races widely differentiated
in Central and S. America
Old World tropics
Improved populations
on wider genetic base
Corn Belt maize
from Southern
Dents x Northern
Flints
Future breeding
Hybrid corn, 1930's
Old World
temperate zone

Recent history

- From time of colonization of the Americas until the mid-1800s, little formal breeding
- From 1800-1900s, beginning of the “corn show era”
- From 1900s to present, open-pollinated populations to hybrid

U. S. Corn yields

1866 to 1996



Prospect

- Genetic variability: bottleneck?
- Use of tropical germplasm
- Molecular breeding: use of Marker Assisted Selection to identify genes with a great influence on agronomic traits
- Corn for food: 85% of corn production used as feed or food. Improvement of the nutritional quality of maize protein.

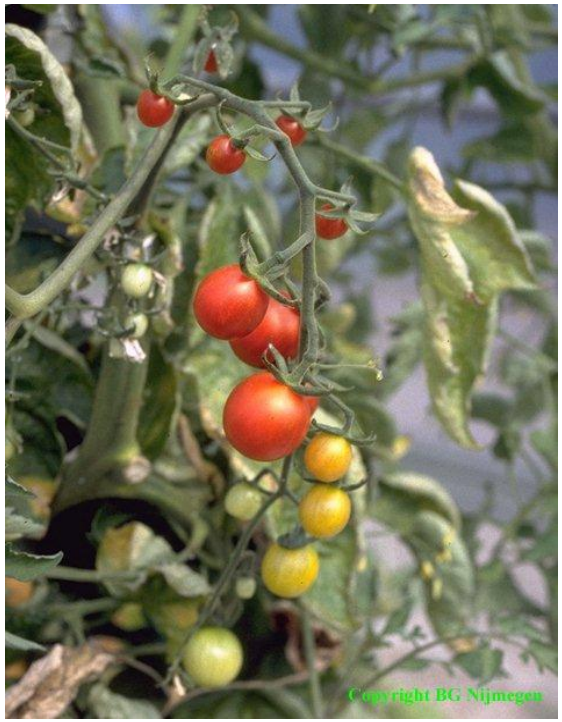
Solanaceae family

- **Lycopersicon** (tomato)
- **Capsicum** (sweet peppers, chili peppers, paprika)
- **Solanum** (potato, eggplant)
- **Nicotinia** (tobacco)
- **Physalis** (Cape gooseberry, husk tomato)

Characteristics of the Solanaceae

- **Flower**: small to large & showy, regular, perfect
- **Fruit**: capsule or berry with many seeds. Often colorful and animal dispersed
- **Pollination**: self- or insect-pollinated
- Commonly contain **alkaloids**, of which tropane alkaloids are particularly poisonous (belladonna)

Evolution of tomato



Lycopersicon *esculentum* var. *cerasiforme*

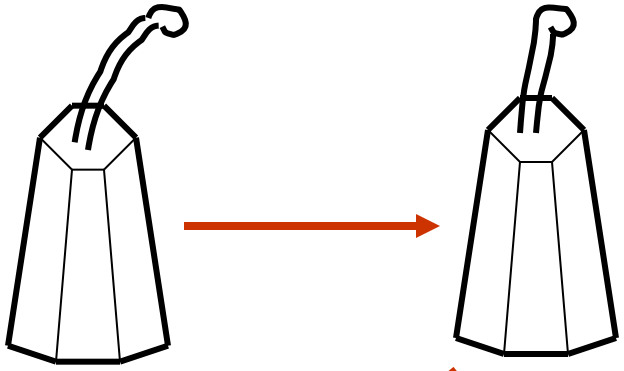
Lycopersicum *esculentum*

Cytogenetics of tomato

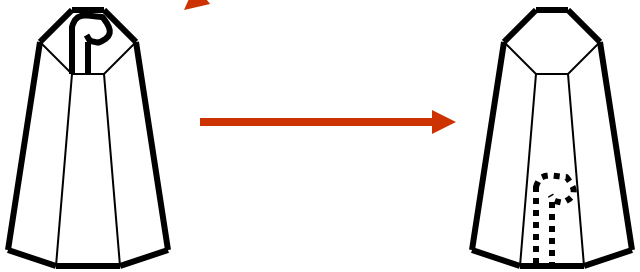
- For all species: 2n = 2x = 24
- L. *esculentum* and its near relatives are self-fertile.
- Other species display different mating systems from strict autogamy to strict allogamy in self-incompatible taxa.
- L. *esculentum* can be hybridized with all other species of Lycopersicon and certain tomato-like Solanum spp

Morphological evolution

Ancestral self-incompatible species



Var. cerasiforme Latin American cultivars



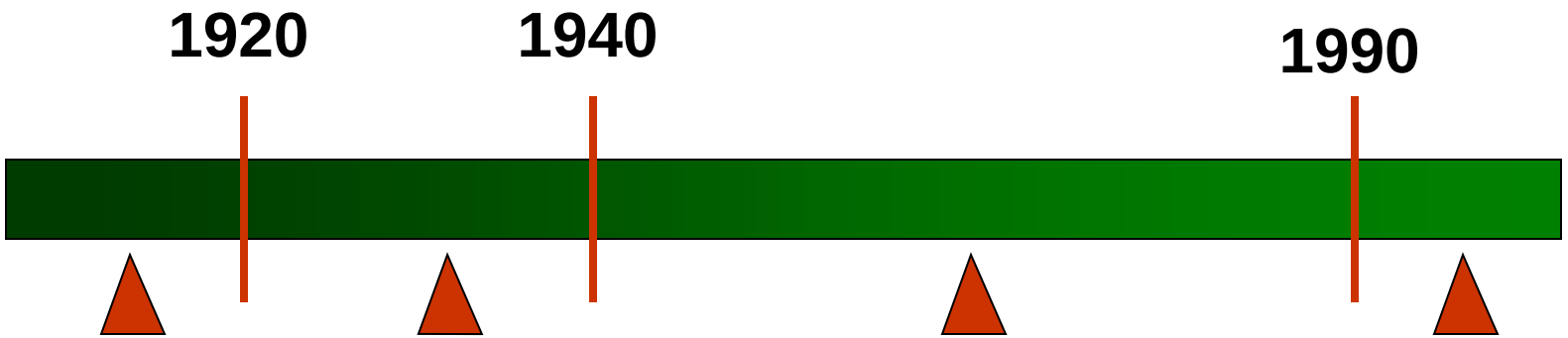
Older European & N. American cultivars

Modern Californian cultivars

Early history

- Native to western South America
- Wild form of Lycopersicon *esculentum* var. *cerasiforme*, found in Mexico, Central America, and other parts of South America
- Mexican origin of cultivated tomatoes transported to Old World

Recent history



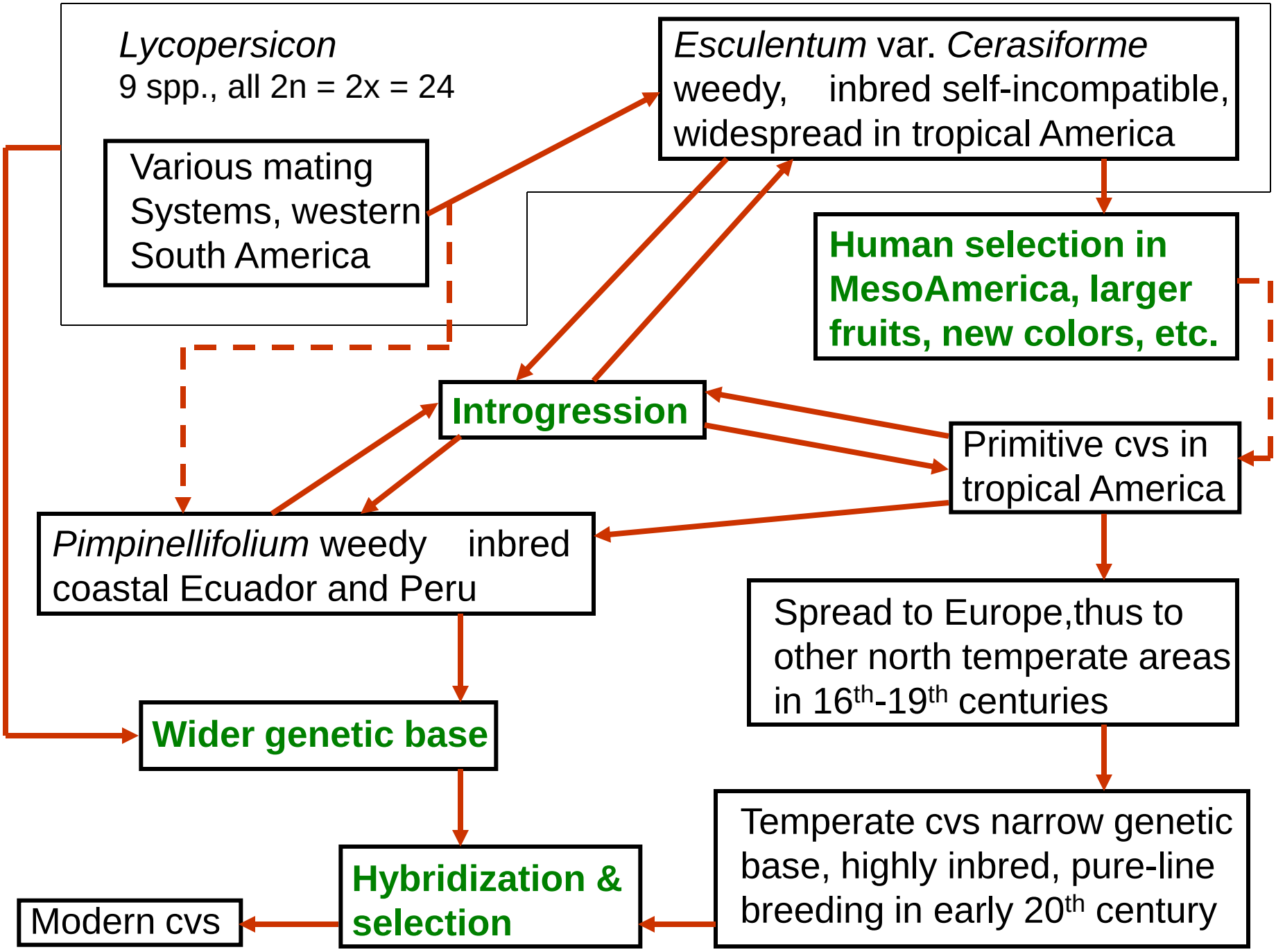
Improvement largely dependent upon selection of chance variants (mutation, spontaneous outcrossing or assortment of genetic variation

Application of standard pedigree selection, backcross

Selection for resistance; breeding methods: strains of tomato, use of related wild species and exotic germplasm; great yield increase

Development of F_1 hybrid cultivars; molecular breeding; transgenics for disease and herbicide resistance

Evolutionary relationships of tomato


Lycopersicon
9 spp., all 2n = 2x = 24
Various mating Systems, western South America
Esculentum var. *Cerasiforme* weedy, inbred self-incompatible, widespread in tropical America
Human selection in MesoAmerica, larger fruits, new colors, etc.
Introgression
Primitive cvs in tropical America
Pimpinellifolium weedy inbred coastal Ecuador and Peru
Spread to Europe,thus to other north temperate areas in 16th-19th centuries
Wider genetic base
Temperate cvs narrow genetic base, highly inbred, pure-line breeding in early 20th century
Hybridization & selection
Modern cvs

Literature cited and Literature of interest

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Websites to explore

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http://lamar.colostate.edu/%7Esamcox/Tomato.html

http://veghome.ucdavis.edu/classes/vc221/tomato/tref01.doc

http://ucce.ucdavis.edu/universal/gallery.cfm?group=1165&picnum=1

http://scottlab.agron.iastate.edu/

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http://maize.agron.iastate.edu/