A Brief Overview of Citrus Breeding in Florida

UF UNIVERSITY of FLORIDA
IFAS
Citrus Research and Education Center

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CRDF Select Committee Meeting
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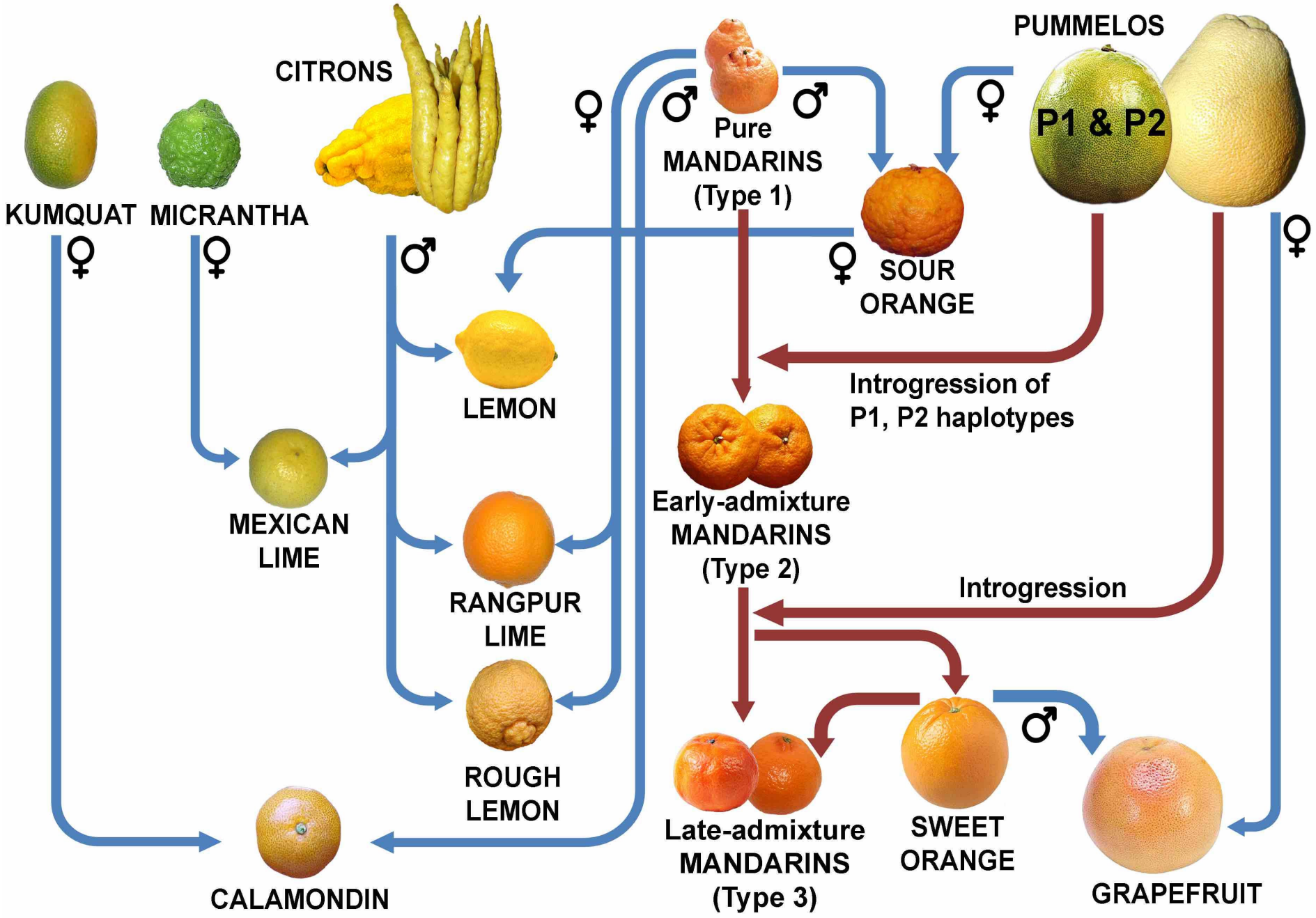

CITRONS
PUMMELOS
P1 & P2
KUMQUAT
MICRANTHA
Pure
MANDARINS
(Type 1)
SOUR
ORANGE
LEMON
Introgression of
P1, P2 haplotypes
MEXICAN
LIME
Early-admixture
MANDARINS
(Type 2)
RANGPUR
LIME
Introgression
ROUGH
LEMON
Late-admixture
MANDARINS
(Type 3)
SWEET
ORANGE
GRAPEFRUIT
CALAMONDIN

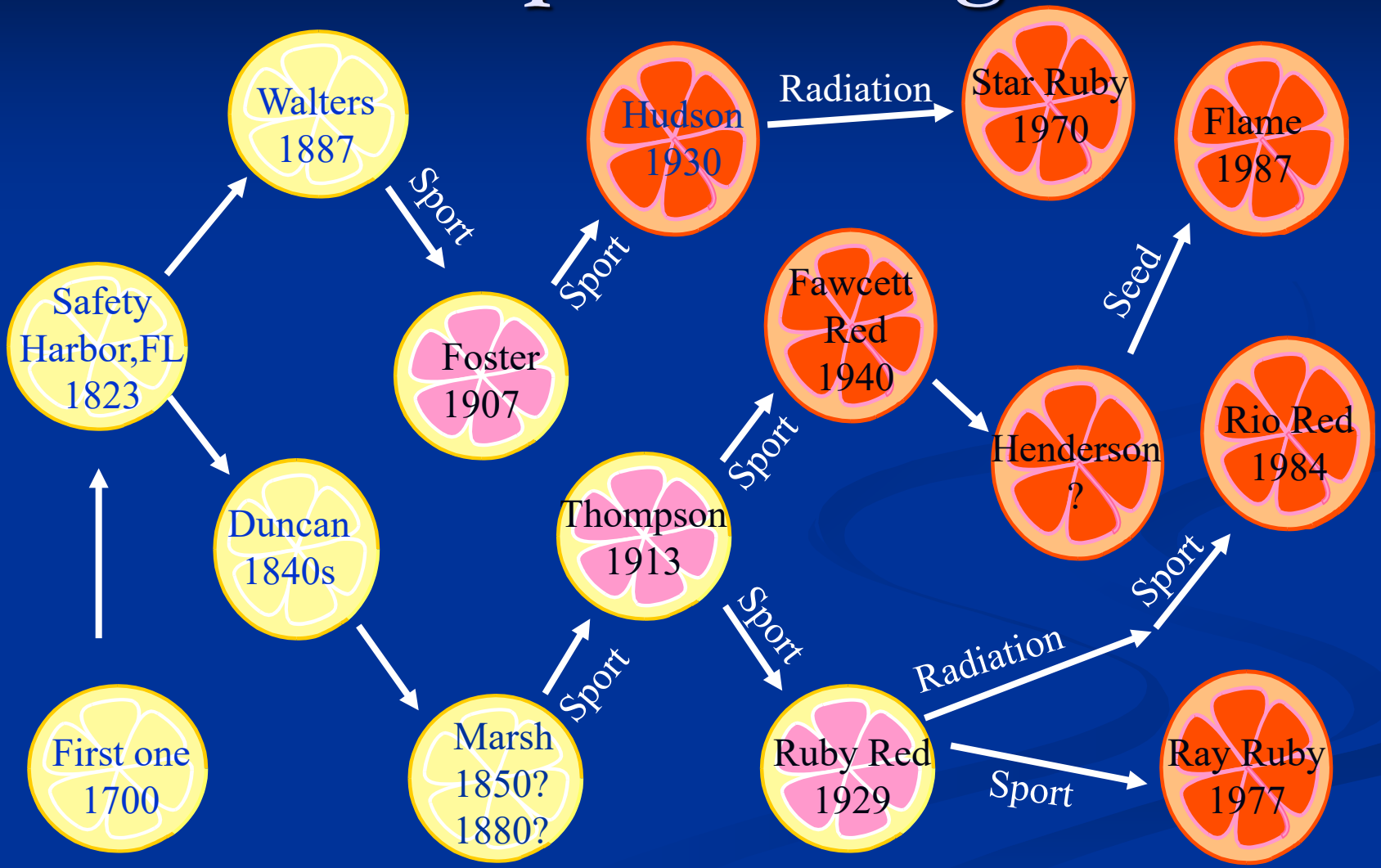
From Ancient Times

- Citrus origins in Asia
  - Natural species and hybrids
  - >3000 years of cultivation in China and India
- First wave migration to Persia 6th century BCE, then to the Mediterranean 4th century BCE(citron)
- Second wave migration to N Africa, Sicily, Italy and Spain, 8th century CE (Sour orange and lemon)
- Sweet orange from S China to Europe, 15th-16th century
- Mandarins to England, 1805

Citrus to the Americas

- European settlers brought:
  - Sour orange to St. Augustine
  - Sweet orange to Brazil and elsewhere
  - Mandarins
  - Pummelo from SE Asia to the Caribbean
  - This latter introduction gave rise to grapefruit

Grapefruit Origins



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From where did new varieties come?

- ALL citrus previously came from seedlings or chance bud sport mutations
- Mendel developed the science of genetics
- Swingle began a few years BEFORE the rediscovery of Mendel's work
- Swingle and Webber, USDA, began breeding at a time when most sweet oranges in the US came from a handful of trees (1st crosses in 1893)
- 2nd crosses: *Citrus* x *Poncirus* for cold hardiness
- Tangelo breeding started in 1897 and proceeded to 1911: led to Minneola and Orlando

Next generations

- Robinson followed Swingle, then a host of others leading through Carpenter and Reece, Hearn, Wutscher, Bowman, McCollum, and Stover
- USDA breeders have contributed substantially to the development and advancement of Florida citrus
- And UF-CREC? Some dabbling with rootstocks, clonal selection, and other breeding efforts
- …until 1984-85: Grosser and Gmitter hired to work with Castle, a new team with new technology

Thirty+ years ago

- Mutation breeding of most scion types
- Rootstock and mandarin breeding by sexual hybridization of seedy parents
- Little or no genetic information of key traits
- Tissue culture techniques newly available for use
- First reports of genetic transformation in plants
- Molecular markers were leaf isozymes or RFLPs
- “We have too many varieties already!”

Today

- Methods to produce seedless mandarins
- Research reveals genetic control of key traits
- Tissue culture techniques widely adapted
- Targeted genetic modifications undertaken
- Genetic transformation of citrus is commonplace
- The impact of the “Genomic Revolution” is at hand

Factors Impacting the Development and Commercialization of New Citrus Cultivars

- Availability of new tools to facilitate breeding
- Rapid evolution of consumer demands for products and their characteristics
- Globalization of production, marketing, and cultivar management vs. localized market niche opportunities
- Global proliferation of insect pests and devastating diseases, such as Huanglongbing
- Societal expectations for “safe” foods and citriculture

Citrus Genetic Improvement Needs

- New sweet oranges to improve fresh and OJ quality
- New seedless and easy to peel mandarins
- New consumer friendly grapefruit types: No GJE
- New product forms, to renew consumer excitement and retain interest in fresh citrus
- Rootstocks that overcome stresses and improve quantity and quality of citrus products
- **Disease resistance, or extinction!**

Sweet Orange Improvement

- Selection of Mutations
  - Naturally occurring
  - Somaclonal variation

- Hybridization
  - Genome sequencing and fruit metabolites redefine “orange”
  - Unique orange hybrid: HLB tolerant?
  - Mandarange: Interploid hybrids

Variant Selection

- **Midsweet 11-1-24 (irradiation)**
- **Valquarius**
- **Valenfresh**
- **OLL Series: #8, and others**
- **Budwood selection: DPI Budwood program, Hughes nucellars, etc.**

Grapefruit Improvement

- Naturally occurring mutations
- Cybridization
- Sexual hybridization; e.g. UF 914 and others

Seedless Mandarin Improvement

- Mutation selection
- Diploid hybridization
- Interploid hybridization
- Parental development

- **Selection from the wild, foraging, and domestication**
- **Global movement of the most desirable types, expanded planting but a reduction of genetic variation**
- **Mutant selection first from seed, then from sports, made practical following the use of rootstocks**
- **First efforts at targeted genetic improvement by hybridization**
- **Currently, an explosion in breeding programs and new cultivars, globally!**

- **1980s: a new generation of scientists came to tackle the ancient challenge of citrus genetic improvement**

- **1980-now: Advances in genetics, genomics, and information technologies have taken the dreams of our earlier years and brought them closer to reality**

- **A multitude of tools are available and still rapidly evolving, to address the many current needs of the industry and to provide new opportunities for the future**

- **Rootstocks and scions, both vigorously pursued**

- **What works? How do we know? On what basis have growers made their decisions in the past? And now?**