

GENOMICS ILLUMINATES THE ORIGIN AND DISPERSAL OF CITRUS



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Pure species, admixtures and hybrids in the Genus Citrus

Common name	Species name	Common name	Species name
Common citron	<i>C. medica</i> L.	Sau-ai-tyo pummelo	<i>C. maxima</i> (Blume) Merr.
Mac Veitchon	<i>C. medica</i> L.	Dai-tai-yo pummelo	<i>C. grandis</i> (Swingle, Tanaka)
Budha's hand citron	<i>C. aurantium</i> (L.) Retz.	Grapefruit	<i>C. maxima</i> (Blume) Merr.
Huangpi citron	<i>C. medica</i> L.	Sweet orange	<i>C. grandis</i> (Swingle, Tanaka)
Shu Chu Sha Kat mandarin	<i>C. reticulata</i> (Blanco)	Sour orange	<i>C. x sinensis</i> L. (Cobock)
Var. Sarcocaulis	<i>C. reticulata</i> (Blanco)	Sour orange	<i>C. x aurantium</i> L.
Hangkong citron	<i>C. reticulata</i> (Blanco)	Lemon	<i>C. x limon</i> (Blume) Merr.
Tachibana mandarin	<i>C. reticulata</i> (Blanco)	Australian desert lime	<i>Eleocharis glauca</i> (Lindl.) Swingle
Suki mandarin	<i>C. aurantiifolia</i> Hort. ex Tanaka	Australian desert lime hybrid	<i>C. x glauca</i> (Lindl.) Swingle
Yao mandarin (sours)	<i>C. reticulata</i> (Blanco)	Australian finger lime	<i>Eleocharis glauca</i> (Lindl.) Swingle
Chappata mandarin	<i>C. reticulata</i> (Blanco)	Australian finger lime	<i>C. aurantiifolia</i> F. Muell.
Changshu mandarin	<i>C. reticulata</i> (Blanco)	Australian round lime	<i>Microrhiza australis</i> Swingle
Hangkonghuo mandarin	<i>C. reticulata</i> (Blanco)	Australian round lime	<i>C. australis</i> (A. Cam. ex Muell)
Satsuma (unshū) mandarin	<i>C. reticulata</i> (Blanco)	Kumquat, Nagami	<i>Fortunella margarita</i> (Lour.) Swingle
(su. Daidi)	<i>C. reticulata</i> (Blanco)	Calamondin	<i>C. aurantiifolia</i> (Lour.) Swingle
Ponkan (Chinese honey orange)	<i>C. reticulata</i> (Blanco)	Muscadinia lime	<i>C. x aurantiifolia</i> (Christie) Swingle
Dancy mandarin	<i>C. reticulata</i> (Blanco)	Micrantha, Boeang	<i>C. micrantha</i> (Westerl.) Swingle
Dancy tangarine	<i>C. reticulata</i> (Blanco)	Mangshan mandarin	<i>C. micrantha</i> (Westerl.) Swingle
Wilkef mandarin	<i>C. reticulata</i> (Blanco)	Ichang papada	<i>C. ichangensis</i> (Swingle)
Chamtrina mandarin	<i>C. reticulata</i> (Blanco)	Tribulus orange	<i>Poncirus trifoliata</i> (L.) Raf.
(su. Clematis de Nolas)	<i>C. reticulata</i> (Blanco)	Chinese tea orange	<i>Sesuvium huibollii</i> (Poir.) Florsch.
King mandarin	<i>C. reticulata</i> (Blanco)		
W. Murcott mandarin	<i>C. reticulata</i> (Blanco)		
Rangpur lime	<i>C. reticulata</i> (Blanco)		
Rat rough lemon	<i>C. reticulata</i> (Blanco)		
Loai rock pummelo (Siamese Sweet)	<i>C. grandis</i> (Swingle, Tanaka)		
Chander pummelo	<i>C. maxima</i> (Blume) Merr.		

Pure species, admixtures and hybrids in the Genus Citrus

PURE SPECIES

- Citrons
- Pummelos
- Tachibana mandarins
- Sun Chu Sha Kat mandarins
- Australian desert limes
- Australian finger limes
- Kumquats
- Micranthas
- Mangshan mandarins
- Papedas
- Poncirus

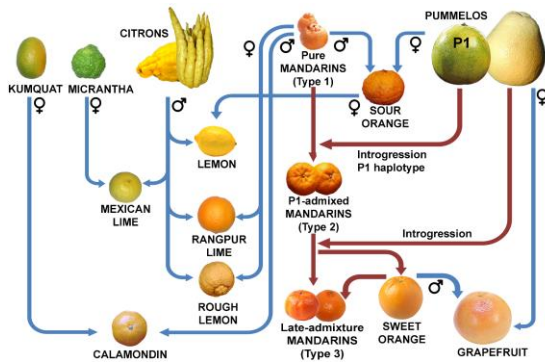
HYBRIDS

- Sour oranges
- Rangpur limes
- Rough limes
- Mexican limes
- Emeragores
- Calamondins

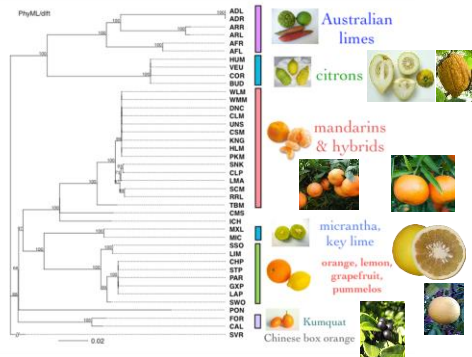
ADMIXTURES

- Mandarins
- Sweet oranges
- Grapefruits
- Lemons

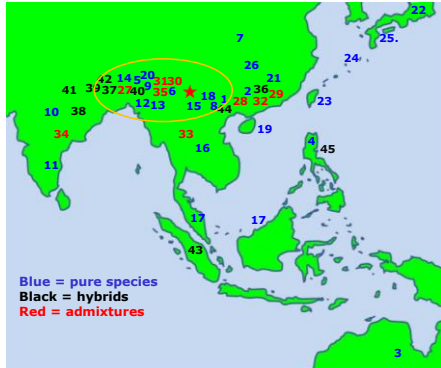
Genealogy of domesticated citrus



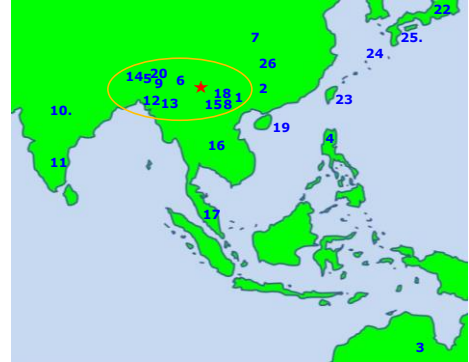
Chloroplast phylogenetic tree of the genus Citrus



Biogeography of the genus Citrus



Biogeography of the pure Citrus species



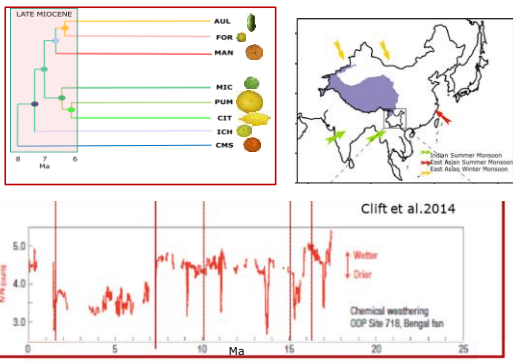
Biogeography of the pure Citrus species



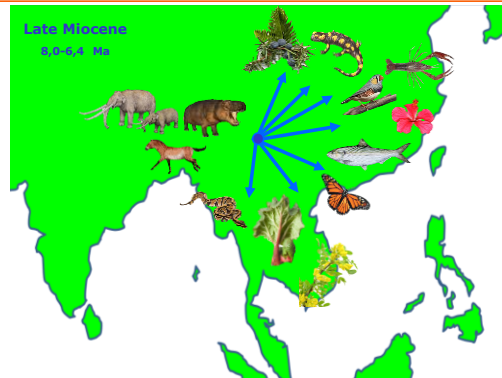
The center of origin of citrus



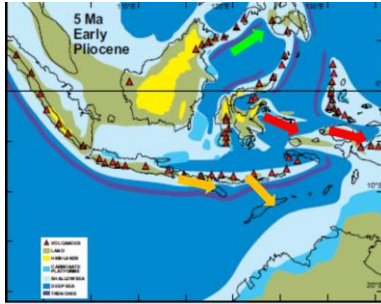
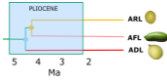
The Asian radiation and the monsoon



Radiations during Late Miocene in the foothills of the Himalaya



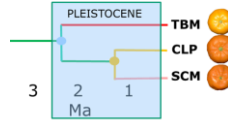
The Australian radiation. Land bridges between Wallacea and Australia



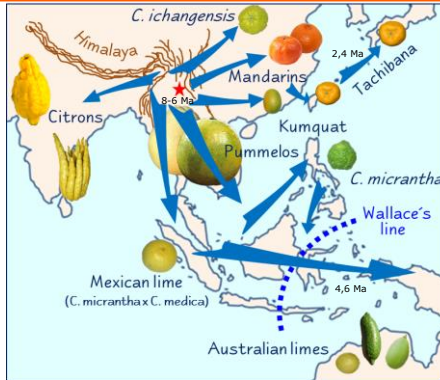
WEST → EAST

- Aglaia
- Alocasia
- Begonia
- Pseuduvaria
- Neonauclea
- Uvaria
- Palm lineages
- Bridelia
- Begonia
- ... etc

The Tachibana speciation. Land bridges between main land and Taiwan, the Ryukyu archipelago and Japan



The center of origin of citrus and ancient dispersal routes



Summary



Genomic analysis has revealed that the genus Citrus is formed by pure species, admixtures and hybrids. Based on the analyses of the pure species, we propose that:

- The center of origin of citrus was located in Southeast Asia between the provinces of Assam and Yunnan and northern Myanmar.
- The dispersal of citrus followed a predominant west to east direction with three main radiations:
 - The Asian radiation occurred in the Late Miocene and was driven by a dramatic climate change of the intensity of the Indian summer monsoon.
 - The Australian radiation was enabled by the Early Pliocene orogeny that provoked the emergence of submerged land and corridors between the Wallacea and Australia
 - Radiations in islands of Eastern Asian during the Early Pleistocene were due to expansion of glaciers that reduced sea levels rising land bridges between continental Asia and Japan.



EL PAIS
La orgía de los cítricos

