Pollination Requirements, Fruit Set and Blanking

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Botany-Flowering

- Pistachio is dioecious:
  - Pistillate and staminate flowers on different trees
- Pinnately compound leaf
- Each leaf subtends a single axillary bud
- Axillary buds inflorescence primordia
  - Produce nut bearing rachis the following year

Photo:
Maksim (Wikipedia.org)

Botany:
Inflorescence

- Panicle
  - Hundreds of flowers
  - Set less than 4%
  - Average 14 nuts/cluster
- Apically dominant
  - Most nuts terminal flowers
- Parthenocarpy

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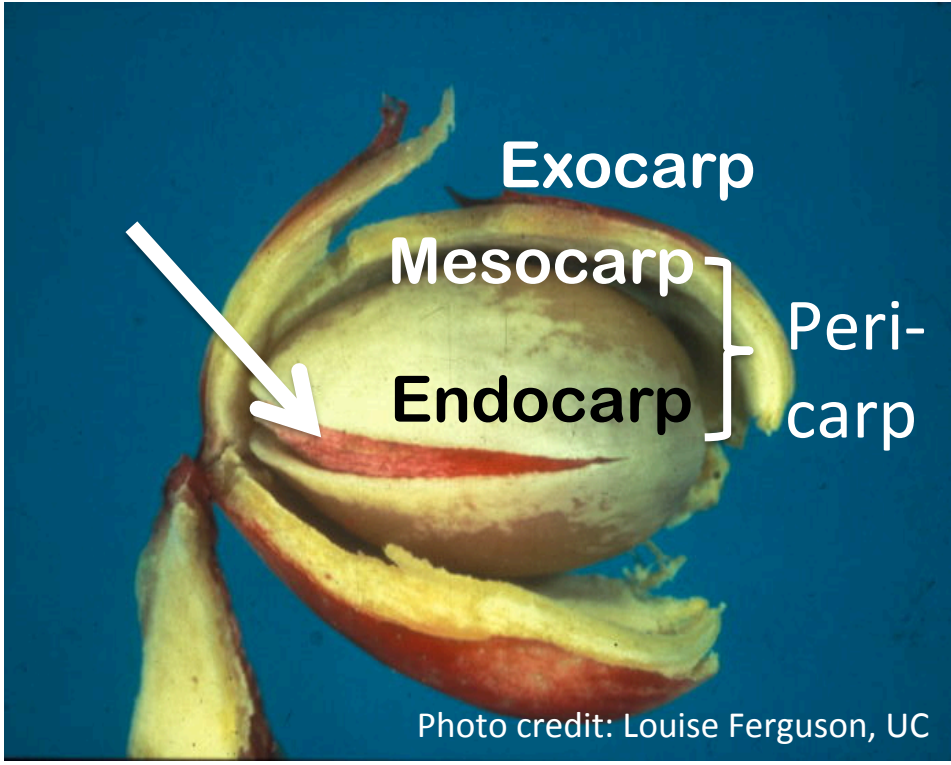
Photo: Gurreet Brar, UCCE

Botany- Fruit

- Fruit is a drupe
- Consists of three parts:
  - An exocarp
  - A fleshy mesocarp
  - An Endocarp (encloses a seed)

  In pistachio seed is consumed



Pollination

- Definition: Transfer of pollen grains from anthers to the stigma by wind or by pollinators (agents of pollen transfer)
- Pistachios are wind pollinated

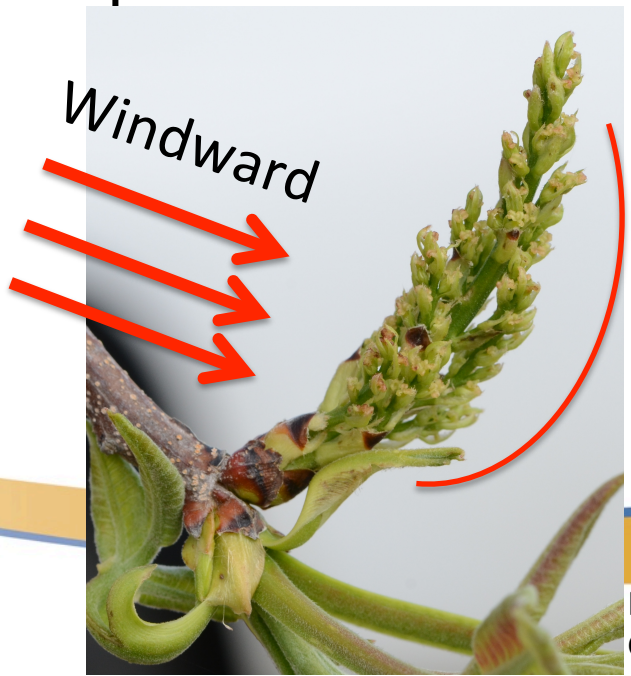
Photo: Gurreet Brar, UCCE

Factors affecting pollination

- Type and placement of pollinizers (male tree)
- Wind speed
- Heat
- Frost
- Rain

Placement of pollinizers

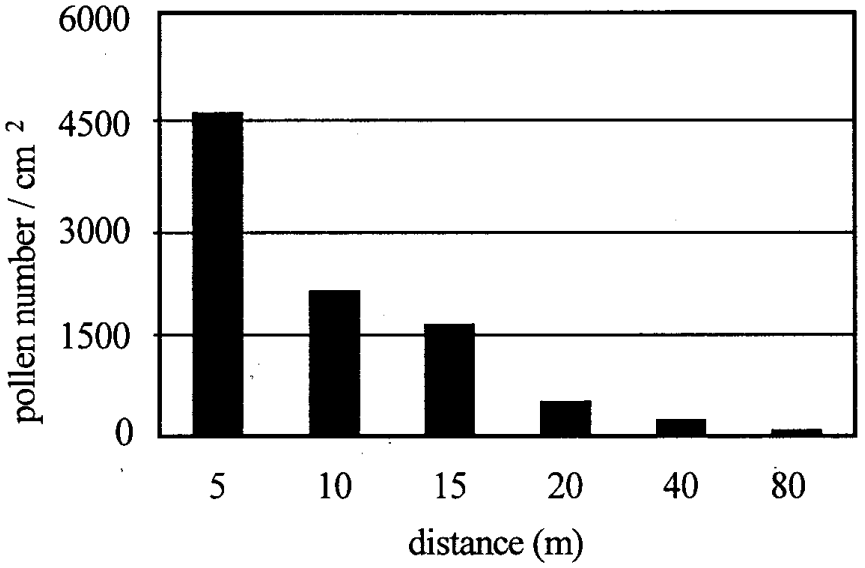
- Pollen 20-30 µm dia., circular to elliptical
- Pollen dispersal-
  - Direct inertial collision on windward surface
  - Sedimentation on leeward surface
  - High wind speed reduced capture on leeward



Photos:
Gurreet Brar, UCCE

Pollen distribution

- Erdogan et al., 1998:
  - Vaseline coated glass traps- 2 m above ground
- Pollen concentration decreased with distance
- Maximum distance of 20m



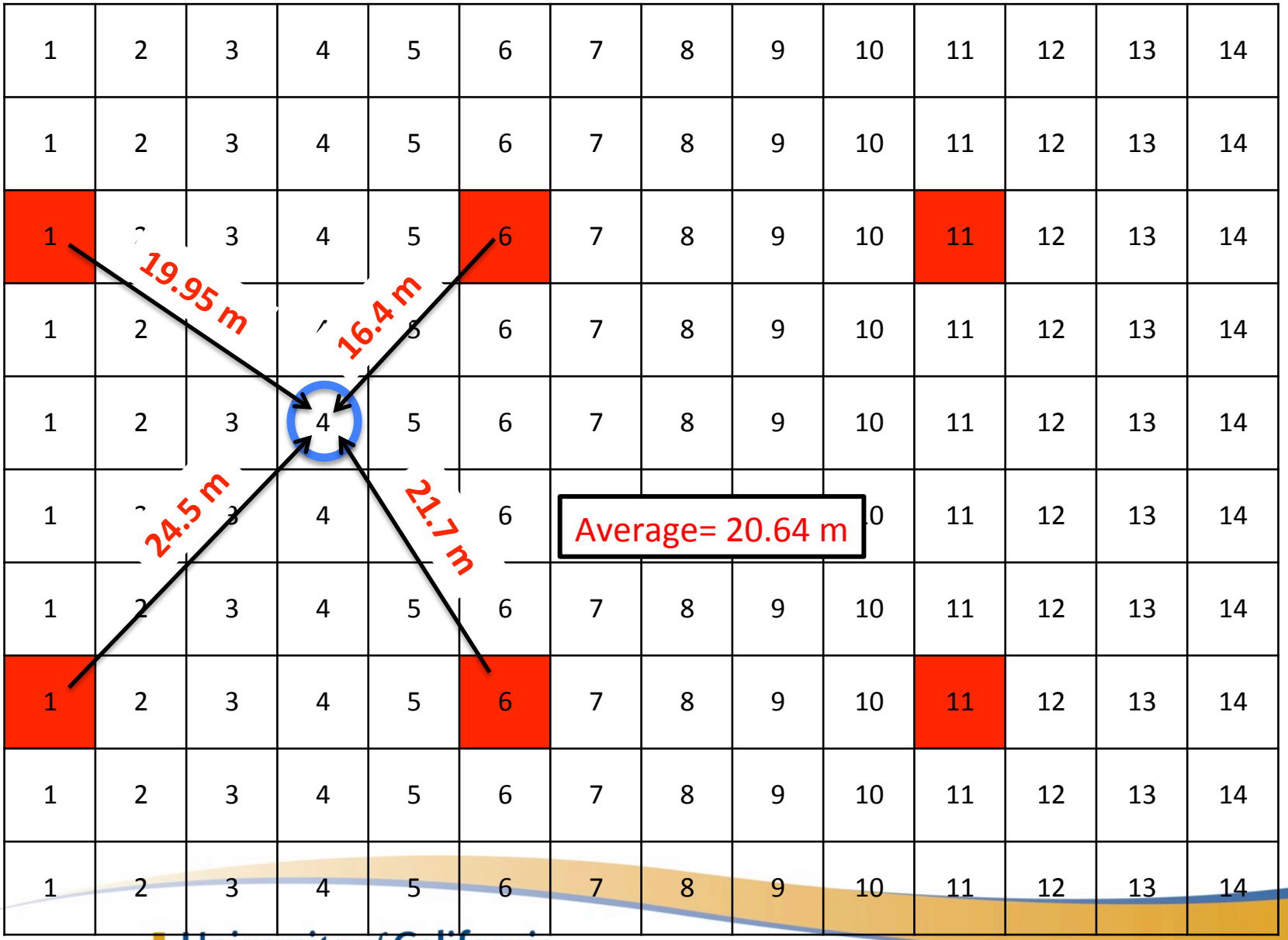
Ratio of male: female trees

Australia- 1:9

Iran- 1:30

California- 1:24

Male tree placement: Every 5th tree every 5th row



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Bloom period

- Overlapping of bloom is essential
  - Specially during initial portion of female bloom
- Peak male bloom=First 2-3 days of female flowers receptivity

- Polito & Pinney (2000): Timing of pollination
  - Early pollination- set twice fruit than late
  - However, had greater number of blanks

Bloom period

- Unsatisfactory pollination
  - Variable flowering period in females & male trees
  - Incorrect ratio of males
- Porlingis & Voyiatzis, (1993)- Paclobutrazol effective in delaying anthesis
- Pontikis (1975): DNOC sprays in late Jan.- females flower early 7-15 days/shorter bloom

Bloom period

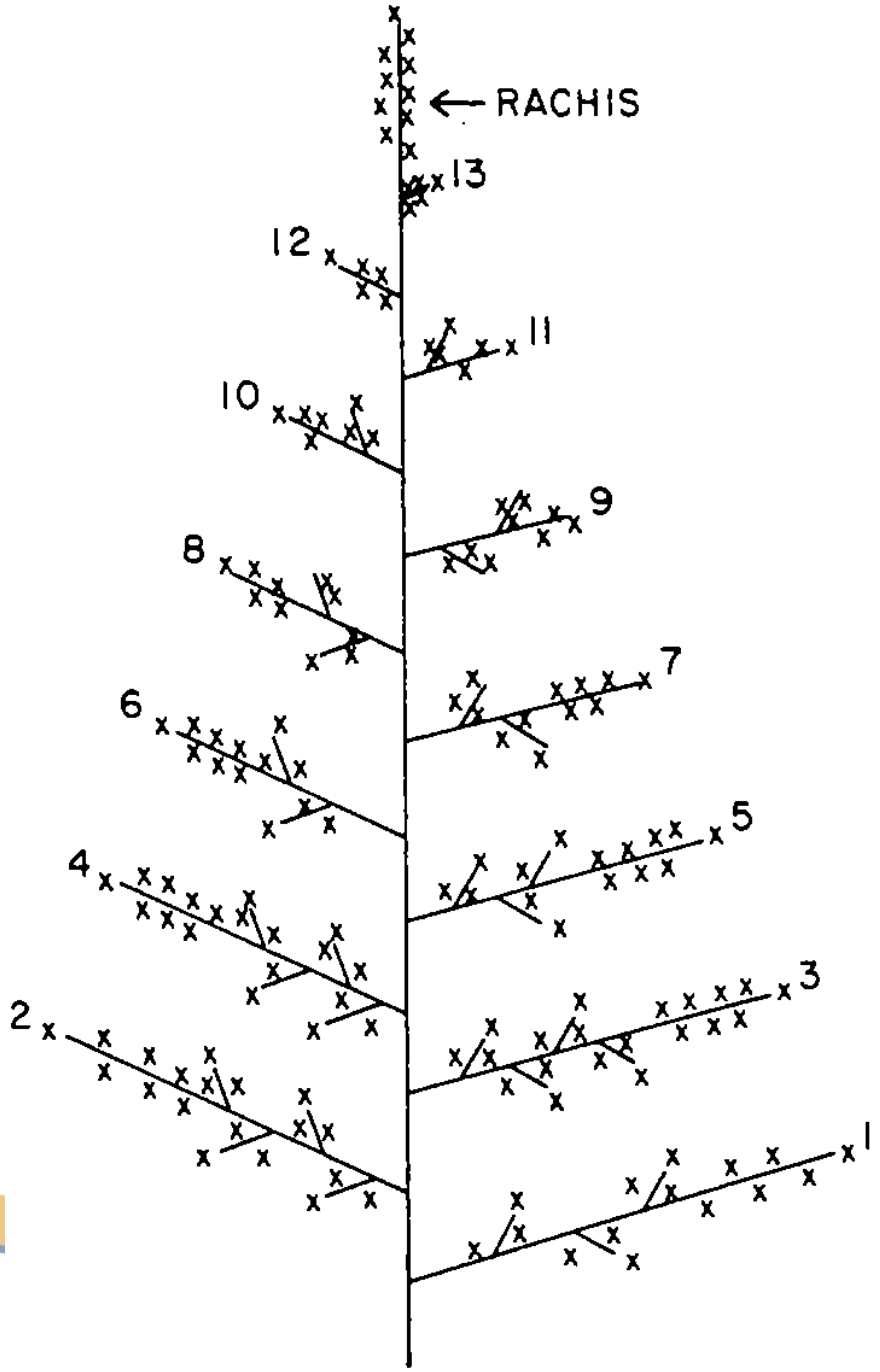
- Beede et al., 1997-2002: Dormant oil
  - Oil assists in overcoming delayed leafing and erratic bloom caused by inadequate chilling
    - May have phytotoxicity issues (use with caution!)

- Ferguson et al.1996,: Dormex (Hydrogen cyanamide)
  - Significantly higher % split in-shell on PG-1, UCB-1
  - Less number of blanks
  - Dormex: significantly better results in a low chill year

Supplemental pollen?

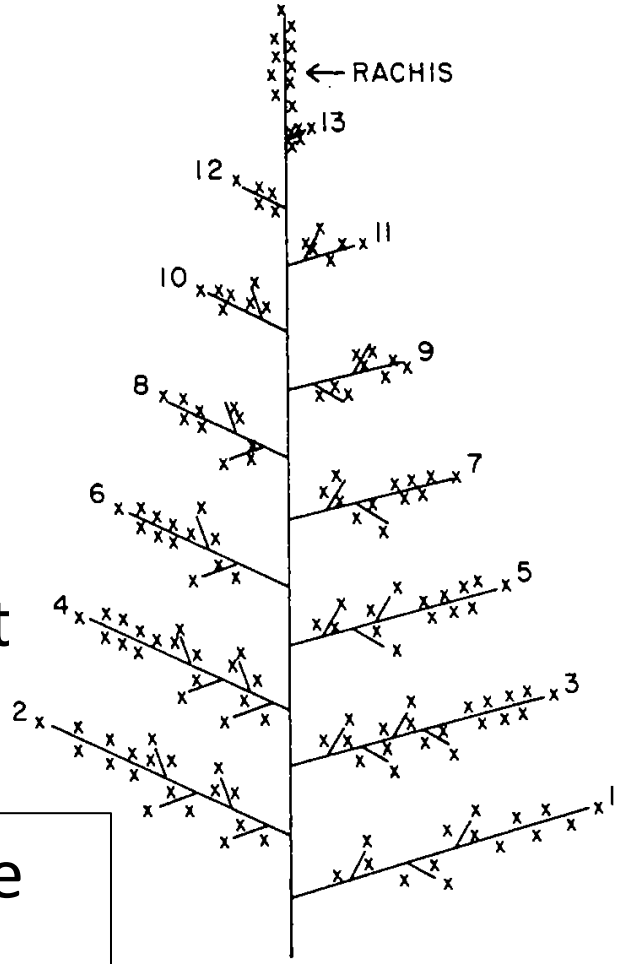
Crane and Iwakiri (1983)

- Studied inflorescence & artificial pollination
- Diagram of average inflorescence studied:
    - A central axis (rachis)
    - 13 primary laterals
    - Each bearing one terminal & 5-19 lateral



What they found?

- Although 92% of flowers borne laterally, only 5% of them set fruits
- Only 8% flowers were terminal, 66% of them set fruits
- Evidence of strong apical dominance
- Flowers become receptive at different times



Supplemental pollination not effective when abundant pollen available

Supplemental pollen?

- Supplemental pollen treatments increased fruit set to 12% vs 6% (control) [Caglar *et al*., 1995)
- 16.2% more fruitlets/cluster [Vaknin *et al*., 2001]
- % blank nuts down to 6.32% & 10.9% vs 20.05% for control

Supplemental pollen?

- Abu-Zahra & Al-Abbadi (2007):
  - Tested 2,4,6,& 8% mixture with soft wheat flour

Supplemental pollination

-not effective when abundant pollen

-may benefit when there is lack of pollen

  - Excessive pollen germination on stigma negative correlation with yield (Vaknin et al., 2002)

Other factors affecting pollination

- Frost:
- Gholipour (2006): Critical temps. for chilling injury
  - Injury levels ~ phenology of blooming
  - -4^0 C at bud stage; -2^0 at blooming; $+2^0$ at flowering

Nut set & development

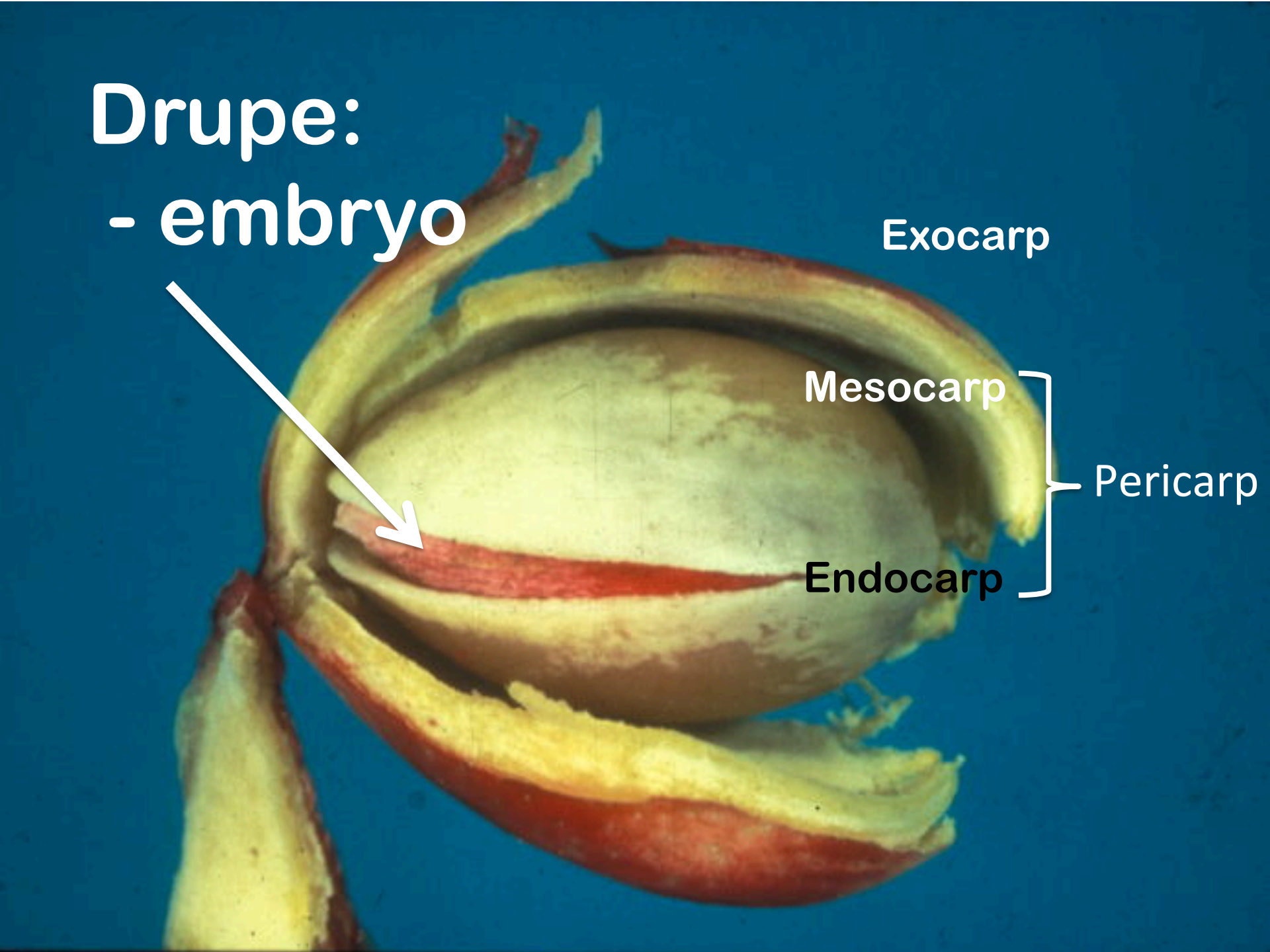
- 2 days after pollination: Fertilization takes place
- 11 days after pollination: Many embryo sac contents degenerate due to lack of pollination
- First 10 weeks: considerable shell size growth, but little kernel development
- 10-12 weeks after pollination: kernel begins to enlarge


May


June


July


August


Drupe:
- embryo
Exocarp
Mesocarp
Pericarp
Endocarp

Nut Blanking

- Blank nuts- the shell is present, but no kernel
- Possible causes-
  - Inadequate pollination?
  - Ineffective fertilization?
  - Competition among developing kernels?
  - Parthenocarpy?
  - Blockage of Vascular transport (work by Polito, V.)

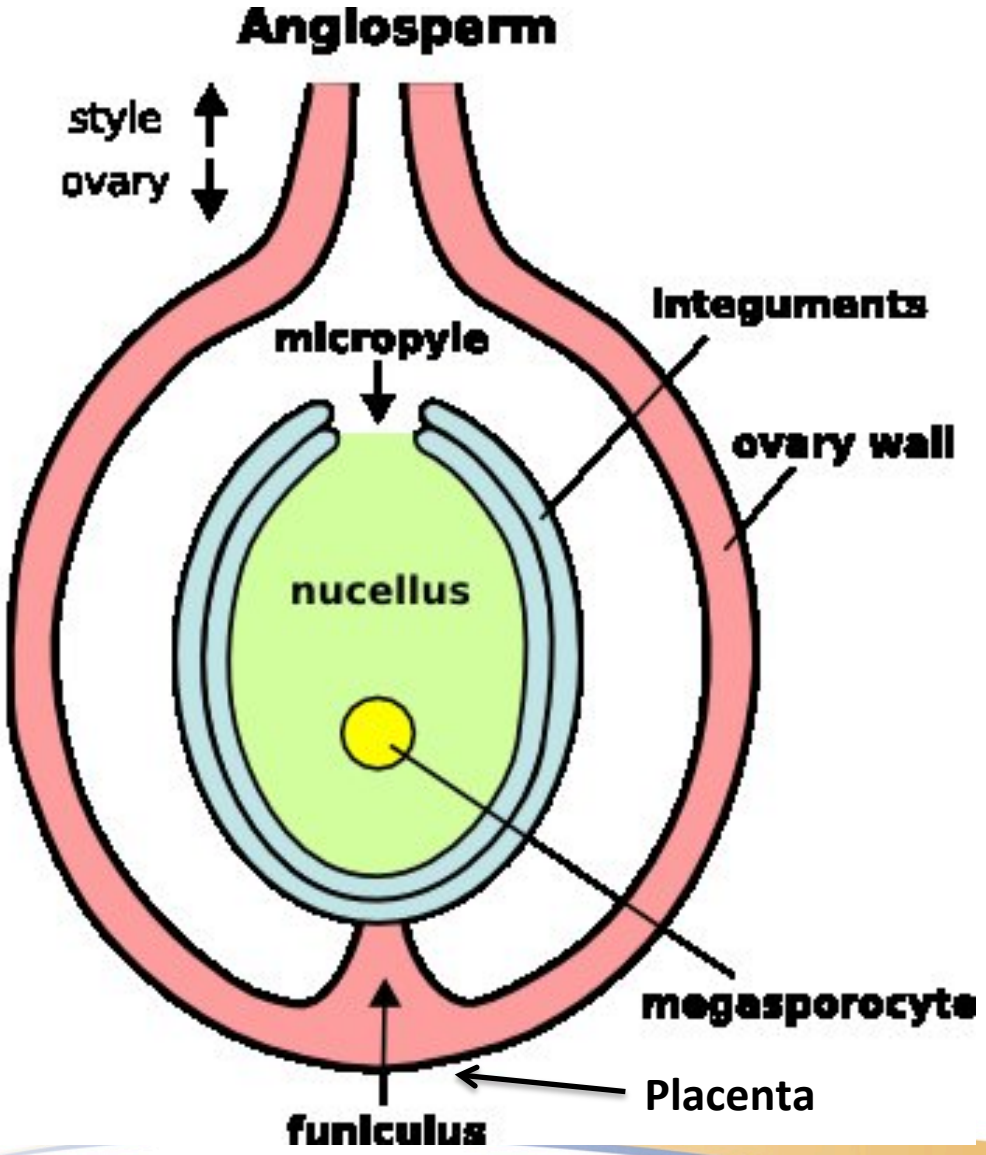
Seedlessness

Parthenocarpy: Fruit formed without fertilization

Example: Seedless citrus

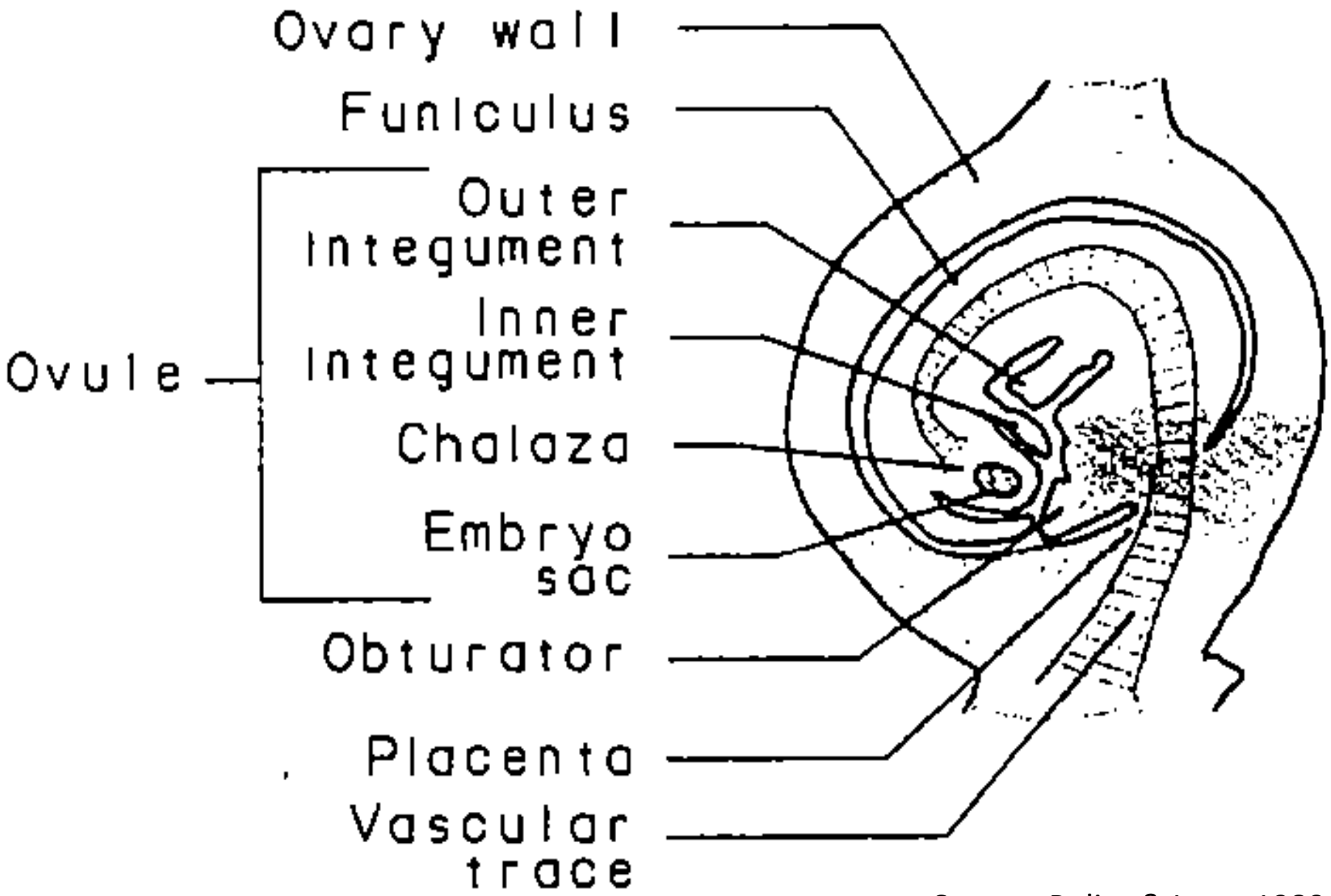
Stenospermy: Post-fertilization embryo abortion;

- Fertilization & some degree of embryo growth needed
- Example: Seedless grapes



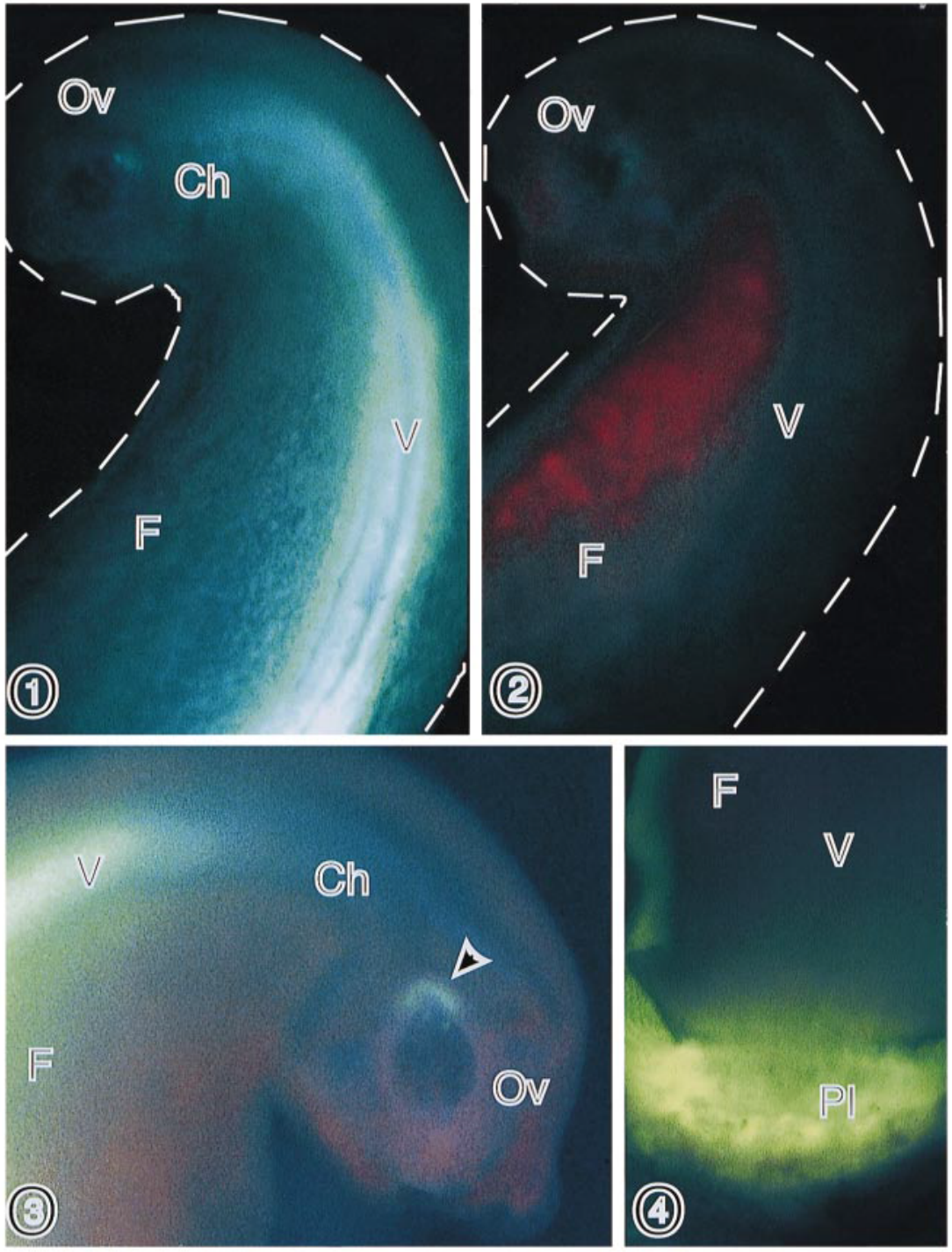
In pistachio, single ovule is **anatropous**: The funiculus is curved such that micropyle points to the placenta

Source: Wikipedia



Source: Polito & Luza, 1989


May

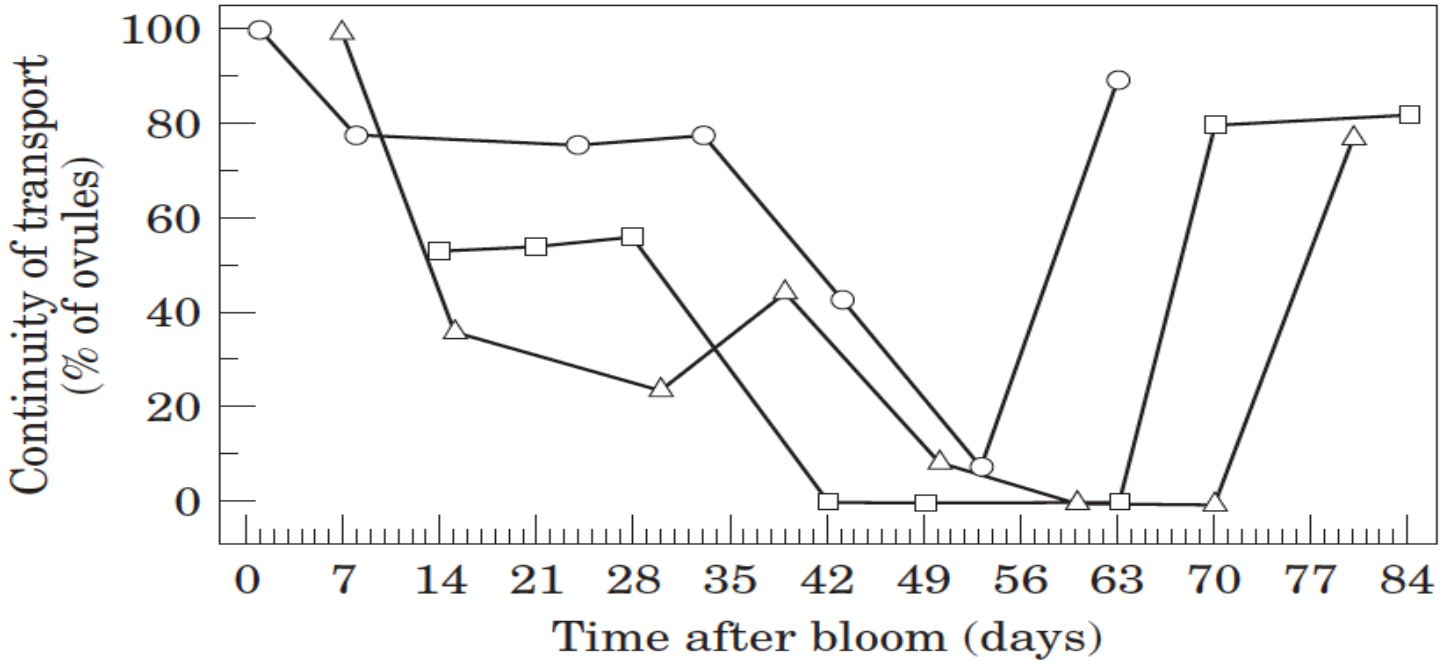


1. Vascular transport active through funiculus to ovule

2. Vascular transport blocked

Breakdown in kernel development- sometime between fruit's full size attainment & start of kernel development

Source: Polito (1999)

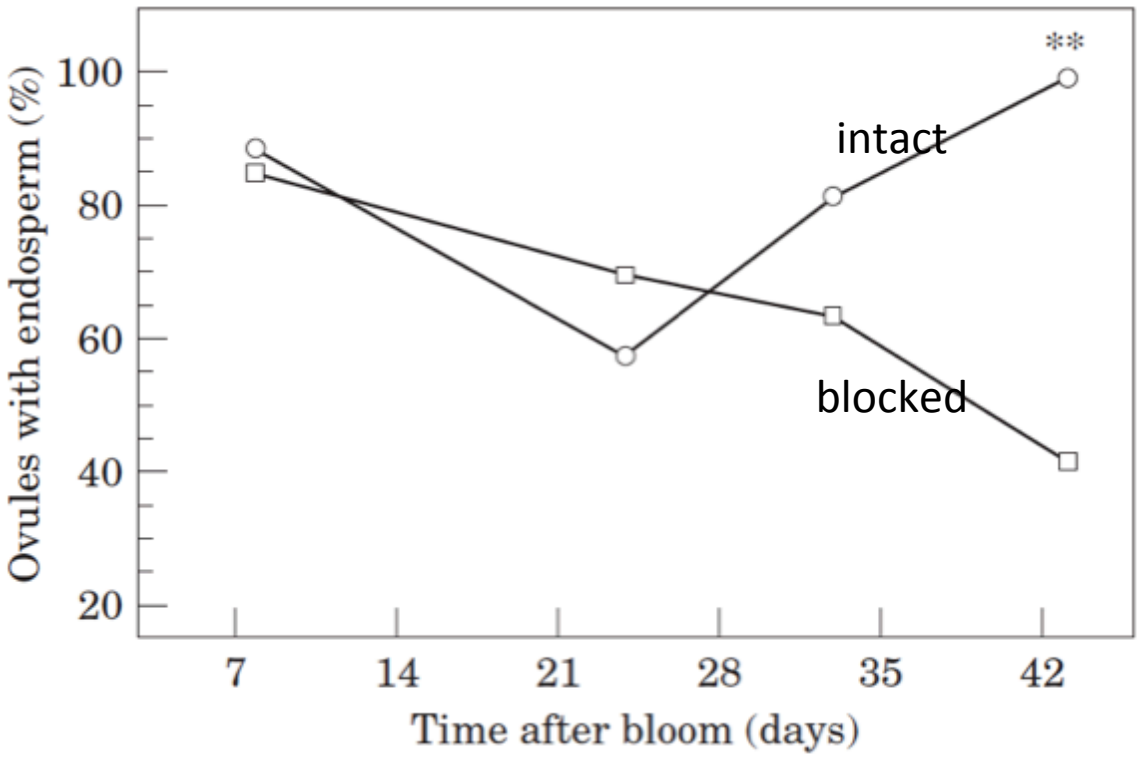


- At full bloom: All ovules showed transport
- 1 week after bloom: 78%; 2 weeks: 53% & 63%
- 7-8 weeks after bloom: Transport blocked in all
- 9-1 ned, in 78, 82 & 90%

Correlated well with percentage of blanks!

Source: Polito (1999)

Presence of endosperm



Early on, similar % of samples lacked endosperm

6 weeks after bloom: Intact VT - **100%** ovules had endosperm;

Ovules with blockage: only **59%** had endosperm

This suggests:

- That vascular conductivity **ceases** during pericarp growth; intense metabolic activity
- And **resumes** when ovule begins to grow
- Resumption in ovule with endosperm; not in ovules **lacking** endosperm

Unfertilized ovules?

Parthenocarpic fruit set - an important factor in nut blanking

Post-fertilization factors?

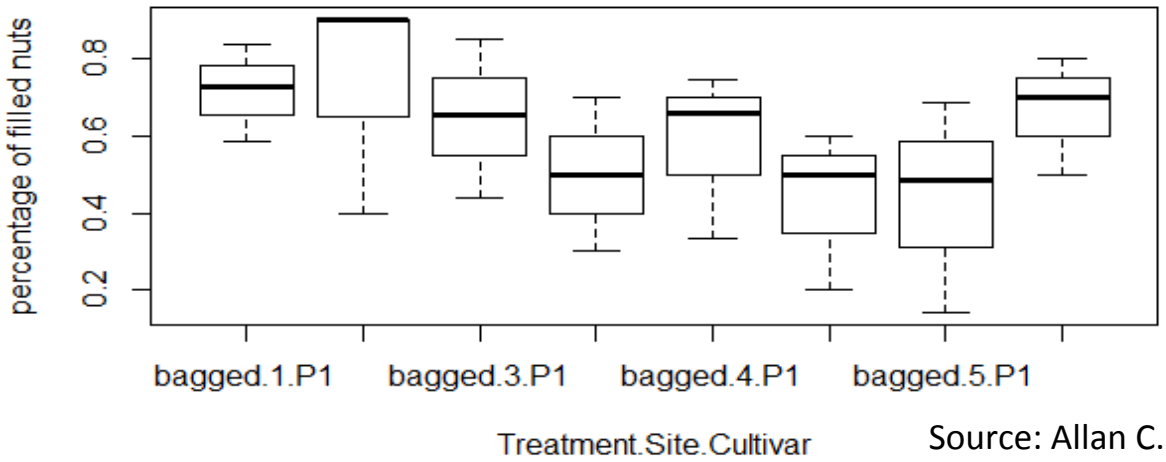
- Abnormal fruits/ovule degeneration:
  - Deformed/absent embryo sac
  - Early degenerated embryo
  - Funiculus degeneration
  - Lack of pollen tube penetration
  - Endosperm growth interruption
  - Embryo destruction during globular stage

Post-fertilization causes?

- Due to stress-
  - Water
  - Nutrients
  - High sink demand
  - Insect pests?

Insect Exclusion Studies

Cara Allan & Louise Ferguson (2013,14)



Source: Allan C. & Ferguson, L. (2014)

- Pete 1: Bagged vs. Un-Bagged Clusters
- No difference in average % of filled split nuts
- Bagged clusters had fewer nuts

Thinning Trial

Cara Allan & Louise Ferguson (2013,14)

Treatment	Weight of Harvest (lbs)	% Edible Split	% Total Edible
Control	69.44	58.66	67.15
Thinning half of each cluster	69.83	57.01	65.45
Thinning to one cluster/branch	51.06	61.76	70.03

Source: Allan C. & Ferguson, L. (2014)

- No increase in the percentage of edible split nuts or the percentage of edible nuts (splits, kernels, and close-shelled nuts)

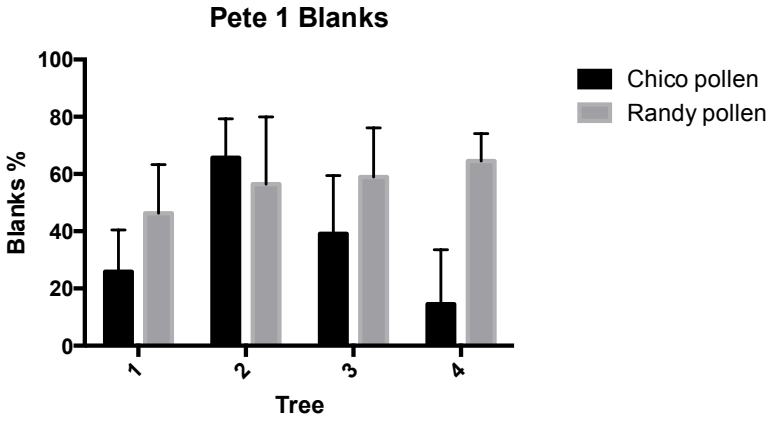
Xenia & Metaxenia

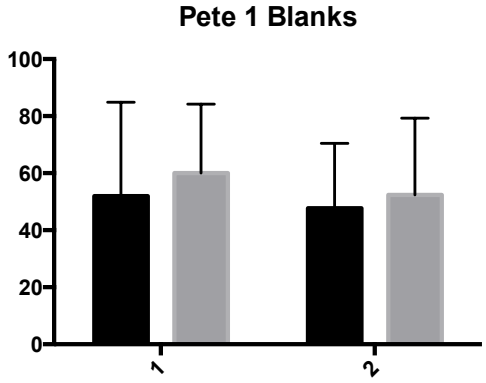
- Effect of pollen source on seed (Xenia) and on fruit (Metaxenia)

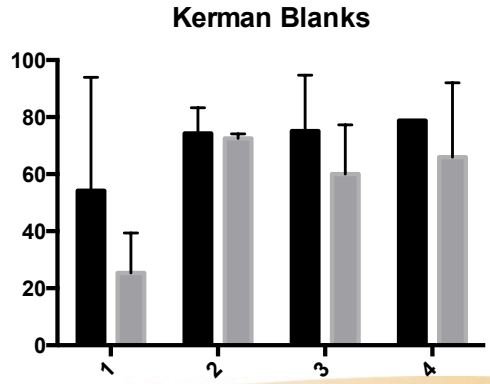
- Hormaza & Herrero, 1998:
- Interspecific:
  - *P. atlantica* pollen on *P. vera* – some traits
- Intraspecific:
  -Within the *P. vera* cultivars- no effect

Xenia & Metaxenia

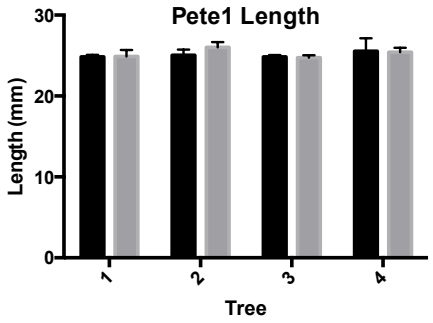
Gurreet Brar & Louise Ferguson (2013,14)

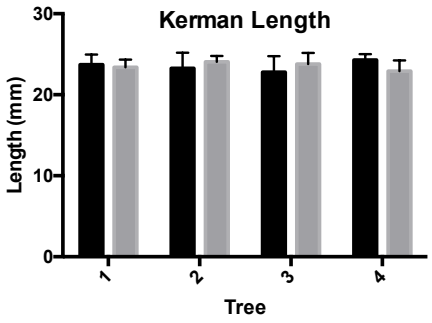


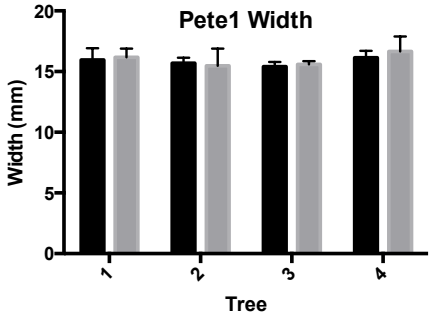


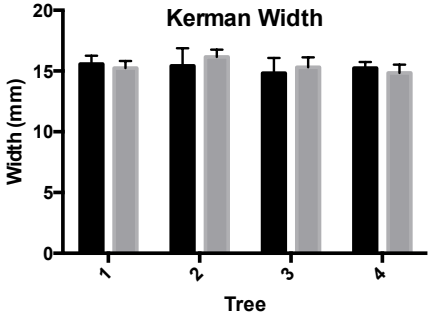


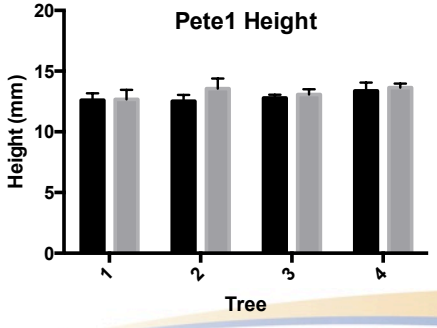
Xenia & Metaxenia

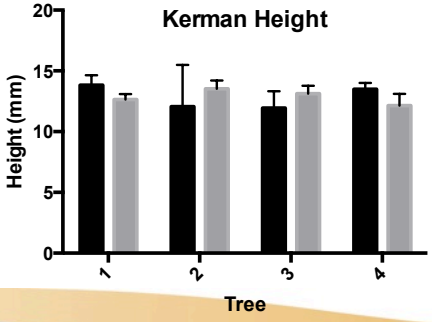






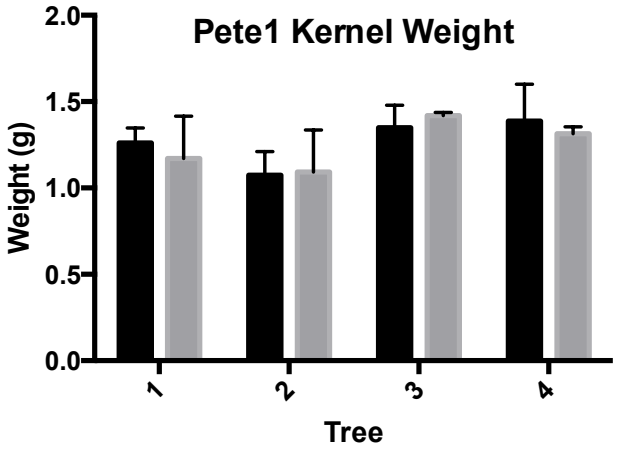


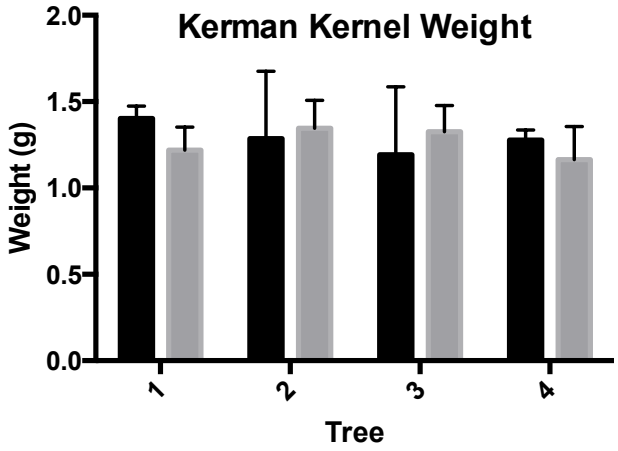


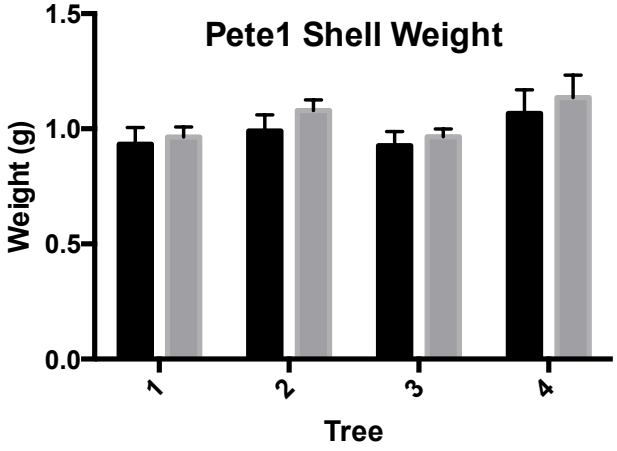


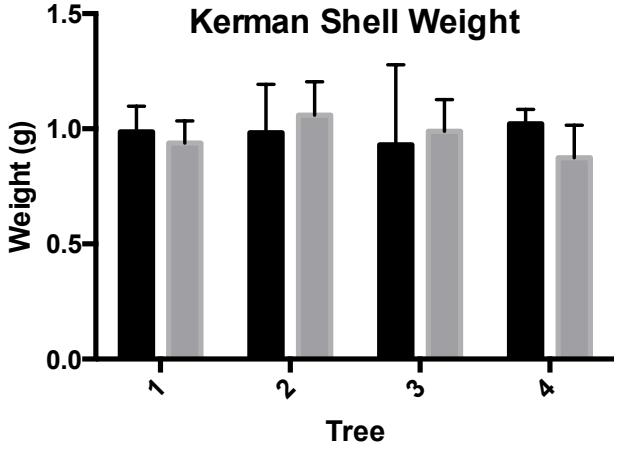
- 2 sites, 2cultivars
- 4 clusters/tree bagged
- Pollination:
  - 4 clusters with Chico
  - 4 with Randy pollen
- Blanks counted
- 5 nuts/cluster for size & weight measurements

Xenia & Metaxenia









In a  -Shell

- Supplemental pollination
  - not effective when abundant pollen
  - may benefit when there is lack of pollen
- Lack of pollen: Understanding chill better
- Time to revisit dormant oil or Dormex?
- Source-sink relations on nut blanking
  - Parthenocarpy vs. carbohydrate allocation
- Post-fertilization stress may contribute to blanks

Thank you!

- Acknowledgements:
  - Dr. Louise Ferguson
  - California Pistachio Research Board