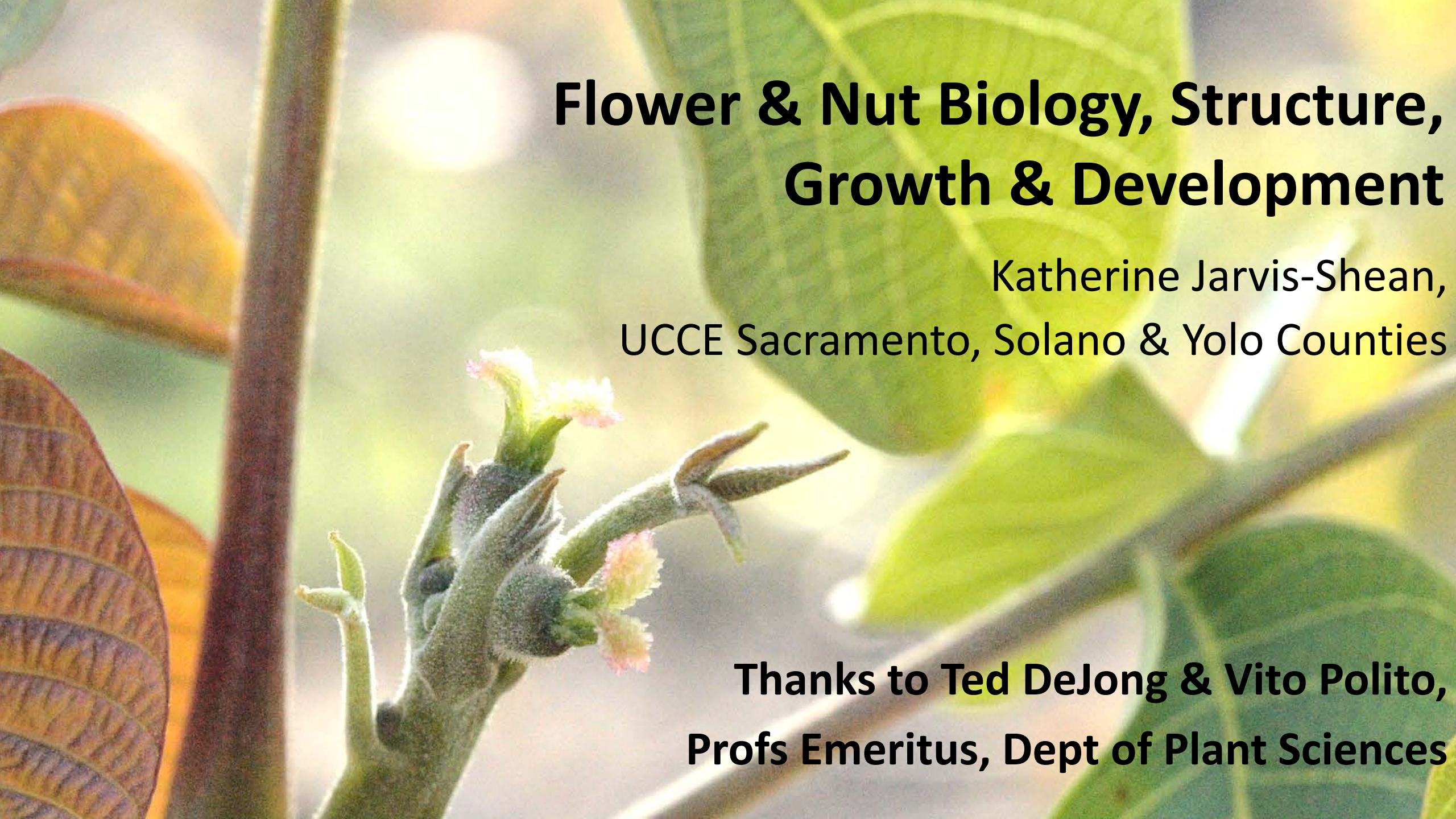


Flower & Nut Biology, Structure, Growth & Development

Katherine Jarvis-Shean,
UCCE Sacramento, Solano & Yolo Counties

Thanks to Ted DeJong & Vito Polito,
Profs Emeritus, Dept of Plant Sciences

Context

Shoot Growth – How the tree grows

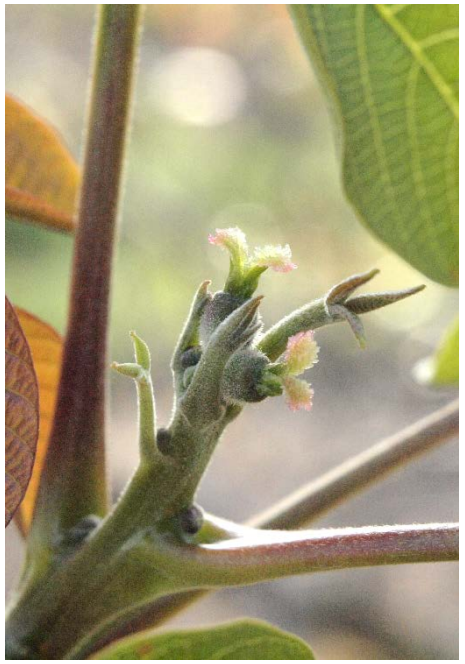
Carbohydrates – How the trees get, store and circulate the energy to grow

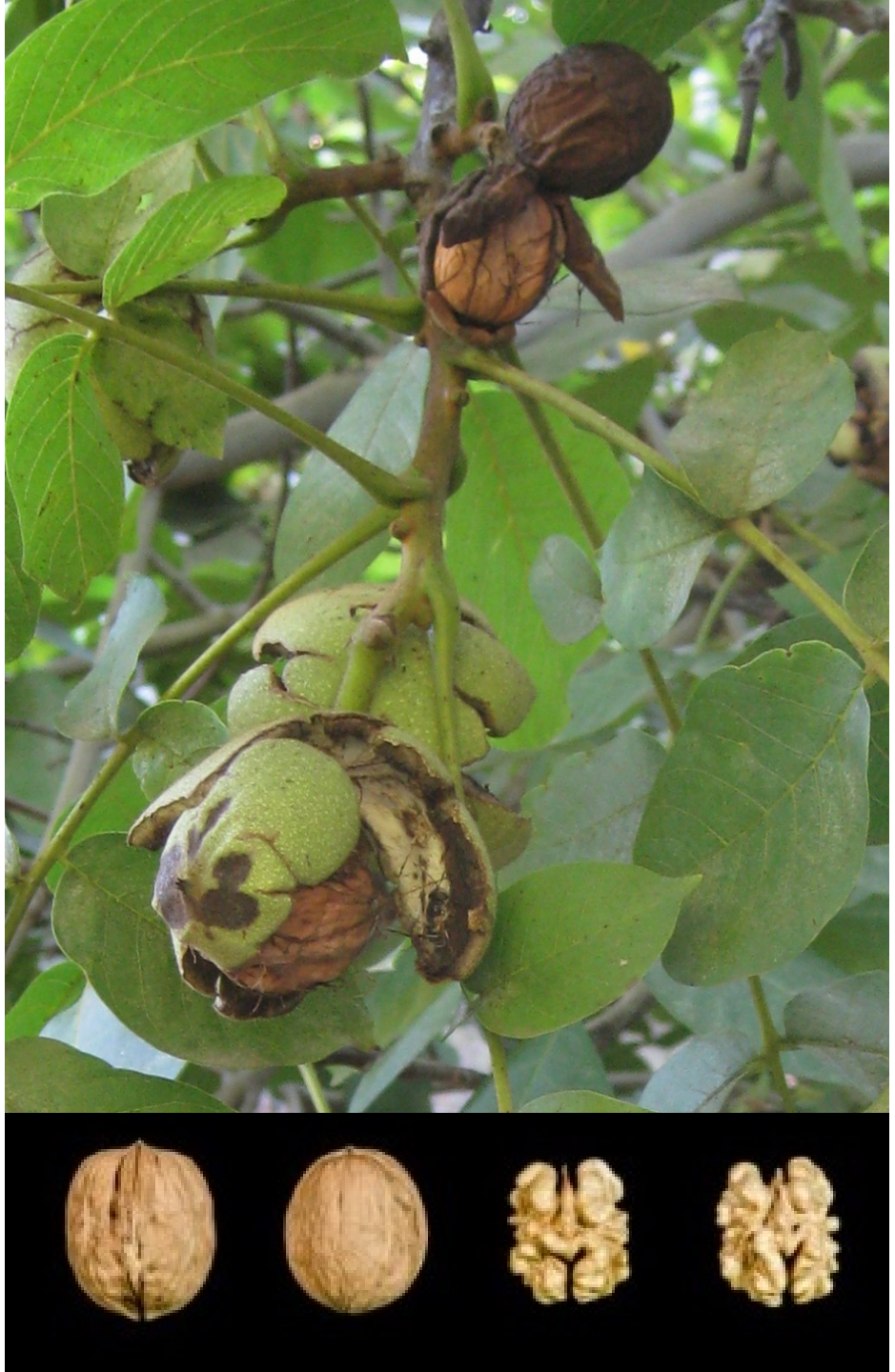
Root Growth – How the trees get water and nutrients to grow

But why are we bothering to grow these trees in the first place?

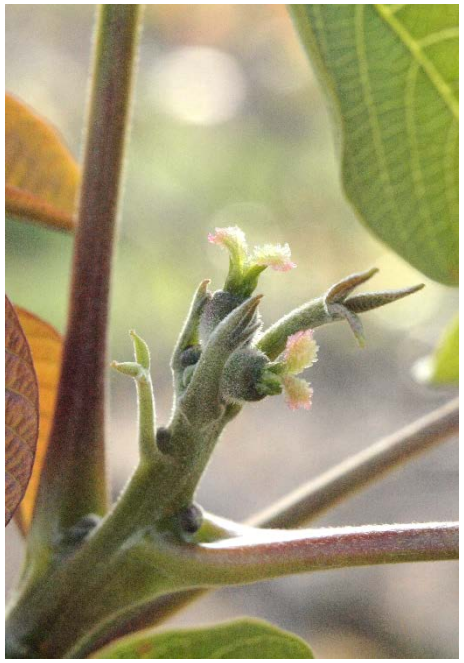
Goal: Lots of full-sized, plump, right-colored nuts

Goal: Lots of full-sized, plump, right-colored nuts





Floral initiations & Bud development



Mixed Bud contains vegetative shoot + female flower

Catkin contains male flowers

Both female & male flowers on one tree = “Monoecious”

But female receptivity & male pollen shedding don’t coincide. Need pollenizers.

Terminal or lateral bearing?

- **Terminal Bearing:** mixed buds only at a terminal position on shoots (or spurs).

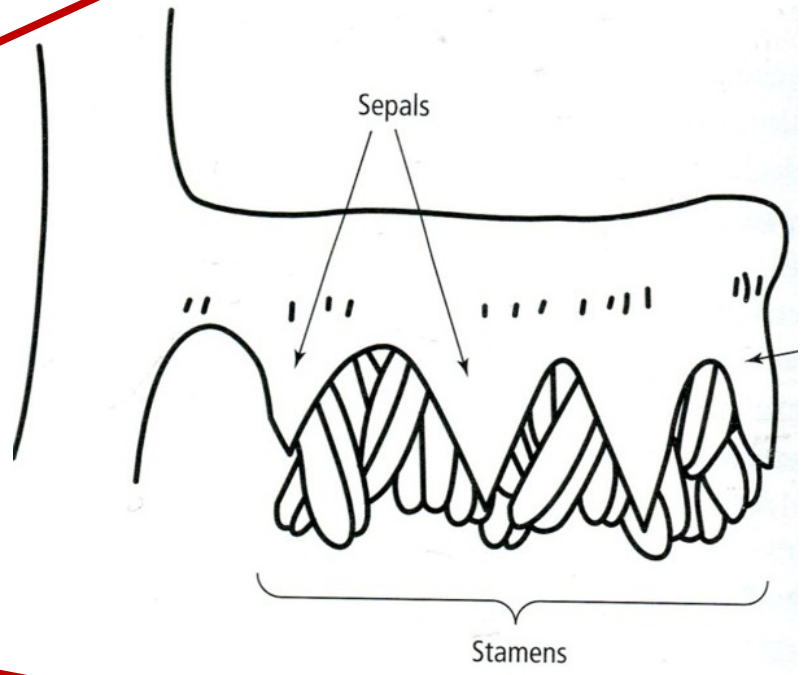
  Ex: Hartley, Franquette

- **Lateral Bearing:** mixed buds on terminal & lateral positions along a shoot or spur.

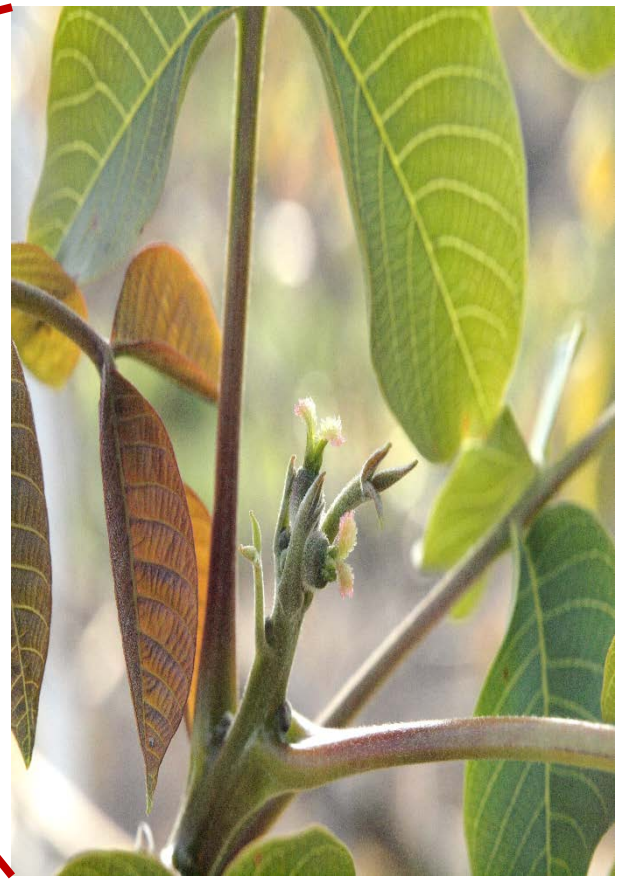
  Ex: Chandler, Tulare, most recent Calif cvs

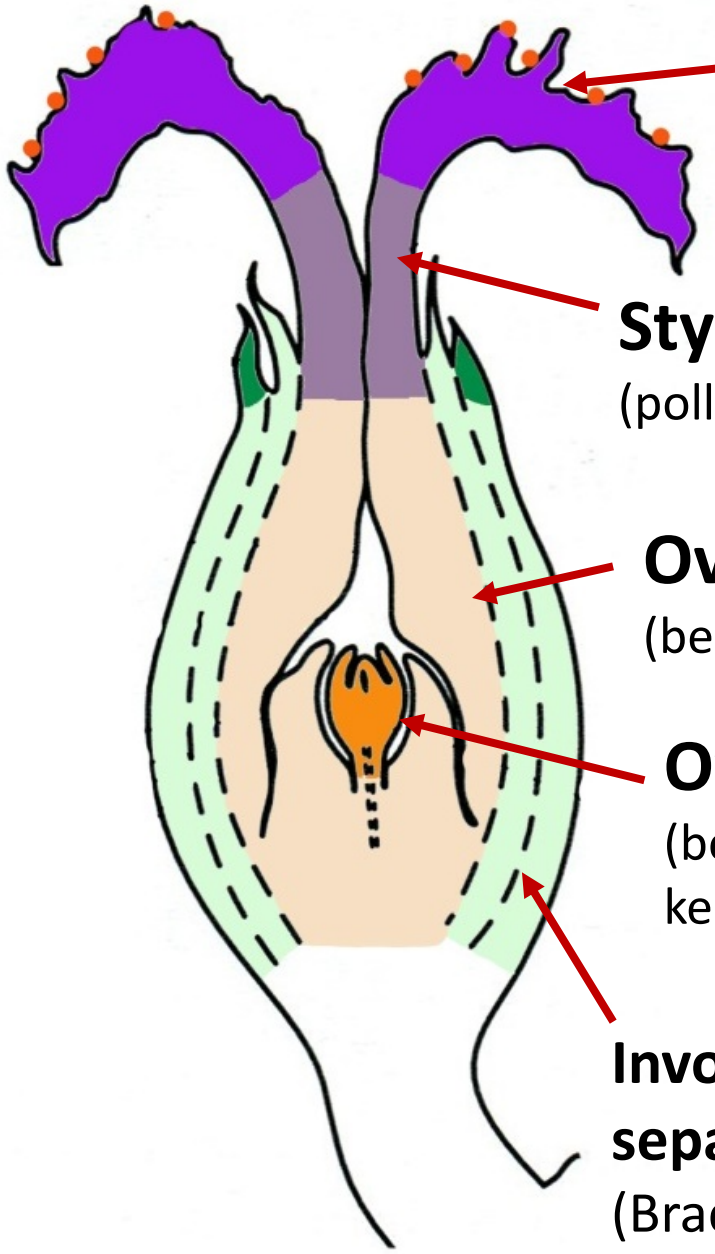
- *Female flowers* are always at the end of the shoot that grows out of the mixed buds ("born terminally"), regardless of variety.
- *Catkins* are always produced laterally.

Male (staminate, catkins)



Female (pistillate)





Stigma
(pollen catcher)

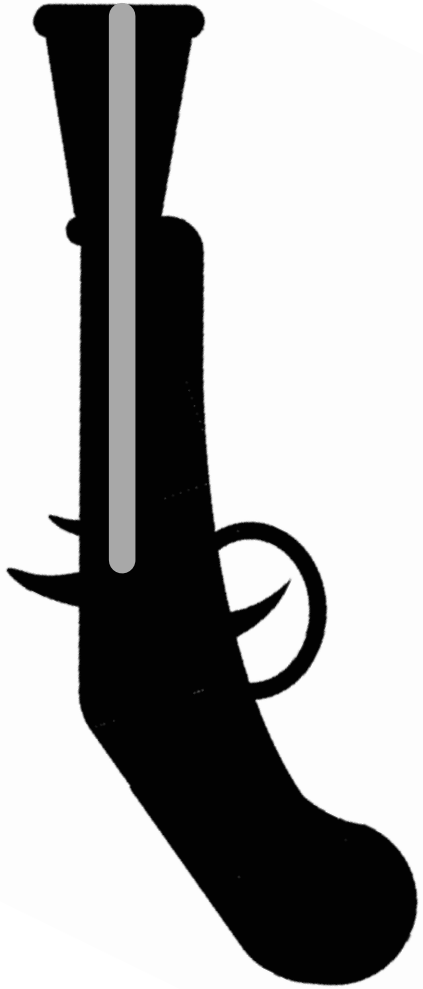
Style
(pollen tube highway)

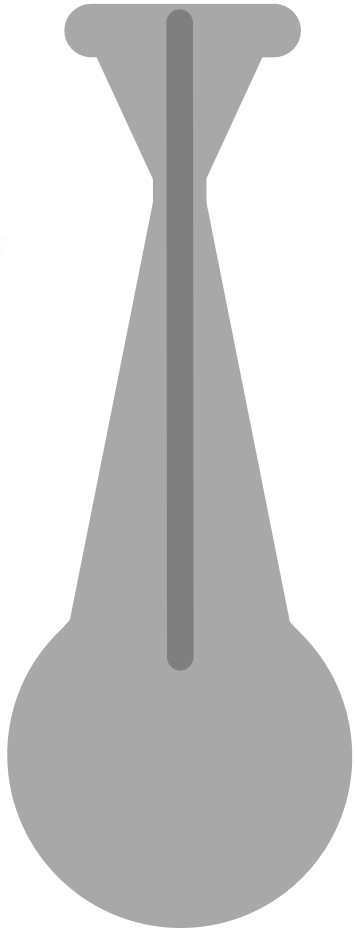
Ovary wall
(becomes hull/husk)

Ovule
(becomes embryo, kernel)

Involucre & sepal base
(Bract is dark green)

Pistillate? How do I remember that?





Timing of floral bud development

Spring
Apr, May, Jun

Summer

Fall

Winter

Spring

Pistillate bloom

Vegetative shoot tip

Flattening of apical meristem
(Pistillate flower initiation)
8-10 weeks after bloom

Involucre appears
2-3 weeks later

Development resumes 2-3 weeks before anthesis (pollen shedding)

Timing of floral bud development

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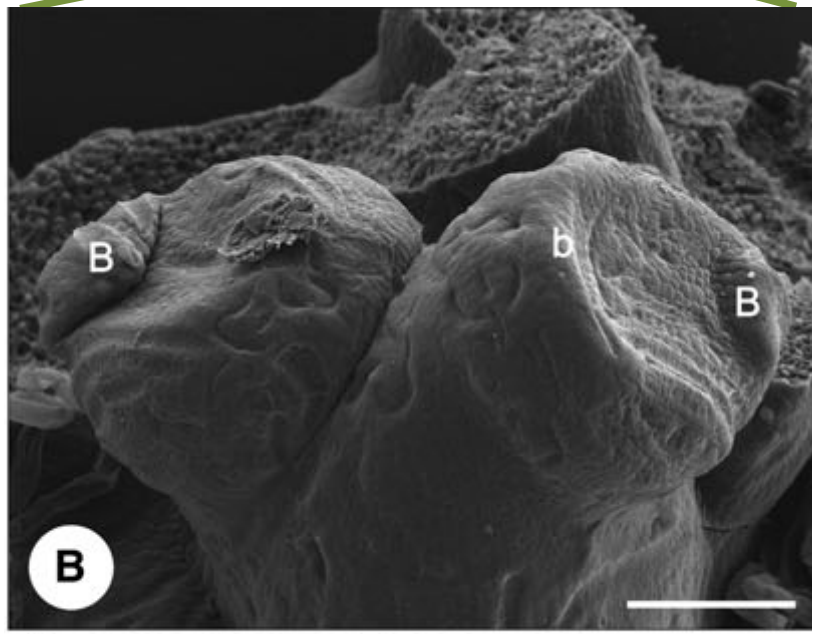
Bloom

Veg bud initiation

Pistillate initiation
8-10 wks
Post-bloom

Involucre appears
2-3 weeks later

Dev'lpmt resumes
2-3 weeks before pollen shed



Polito and Li, 1985 Scientia Hort. 26:333-338.
Lin et al, 2016. Botanical J. Linnean Society 181: 279-293

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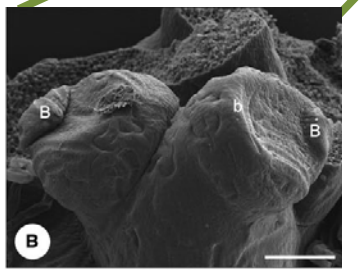

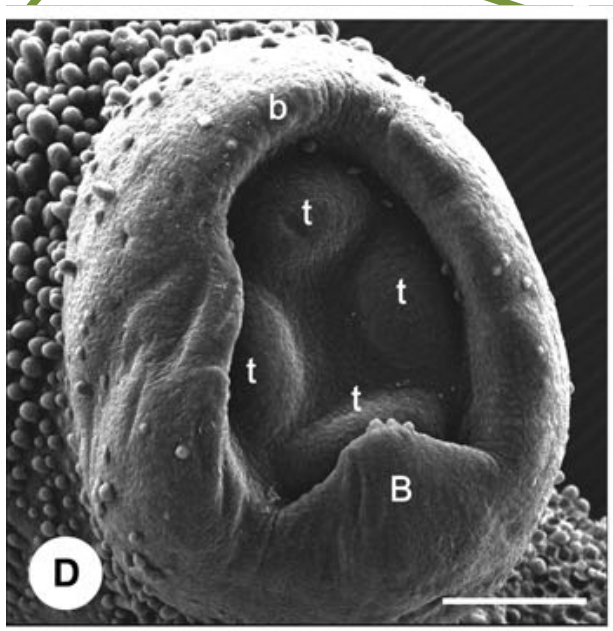

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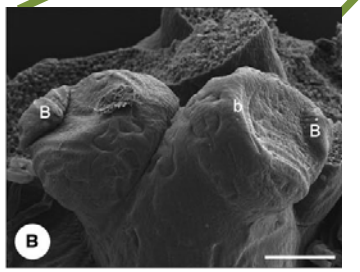

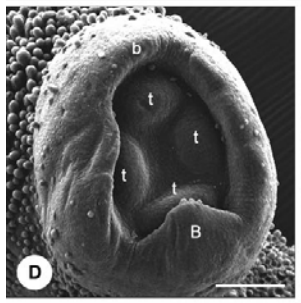

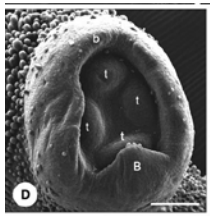

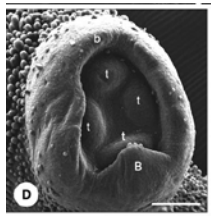

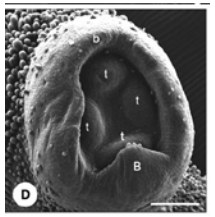

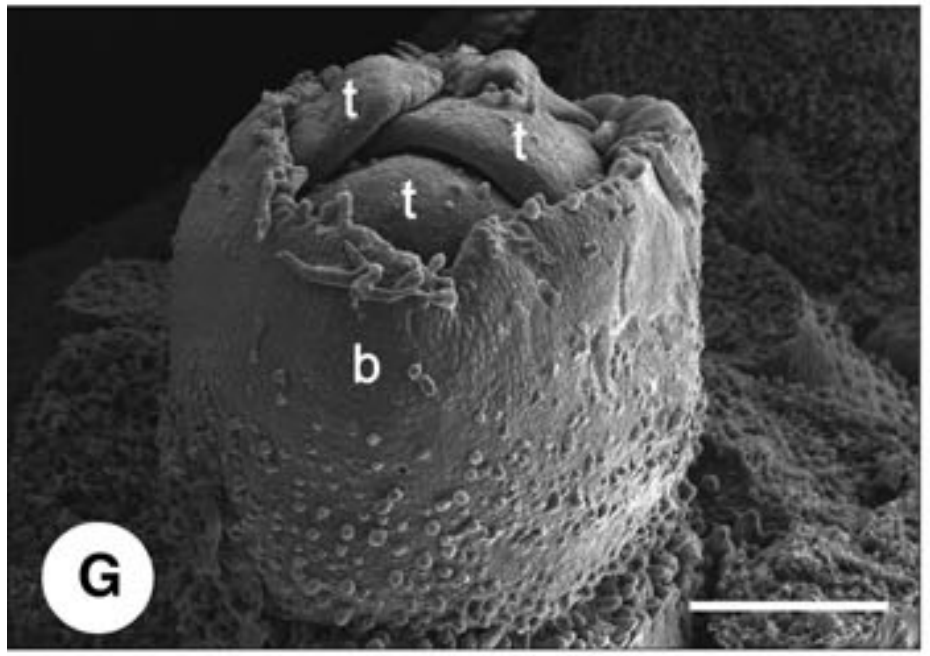

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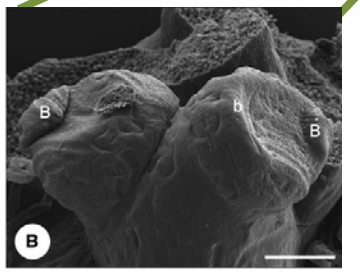

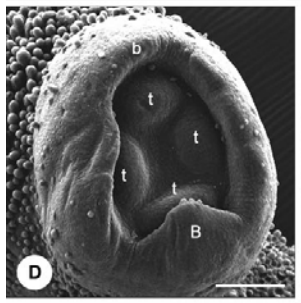

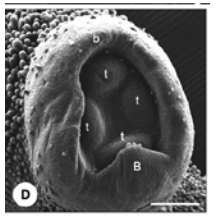

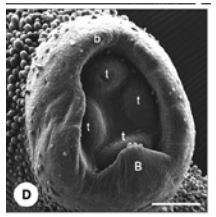

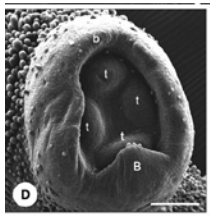

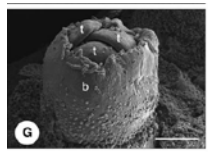

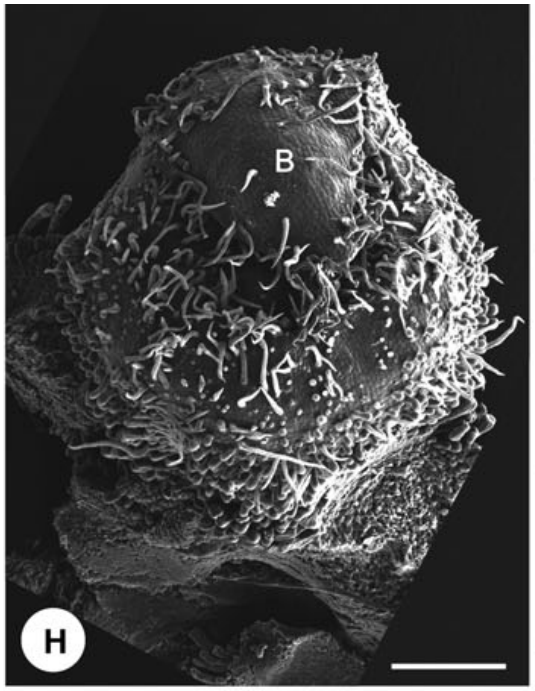

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8-10 wks
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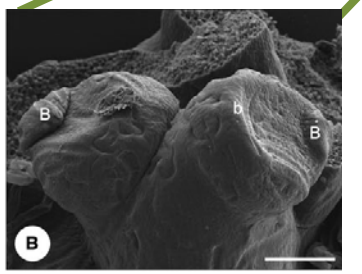
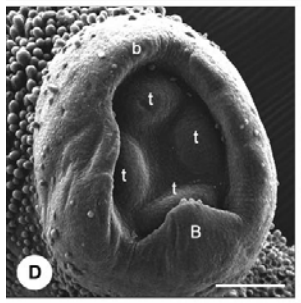
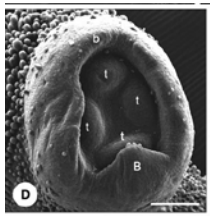
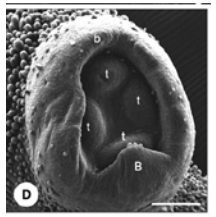
Involucre appears
2-3 weeks later

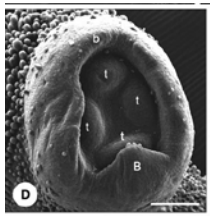
Dev'lpmt resumes
2-3 weeks before pollen shed

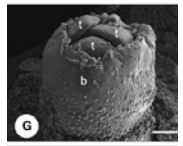


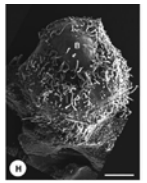


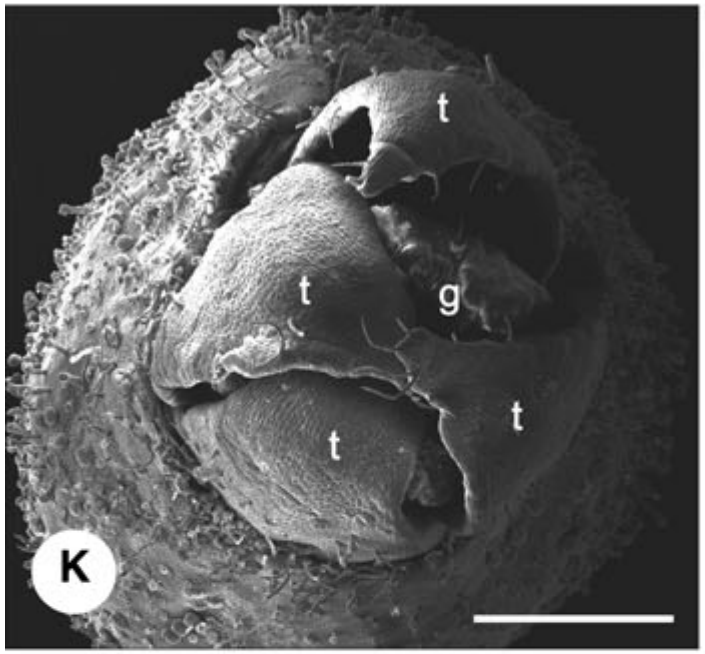












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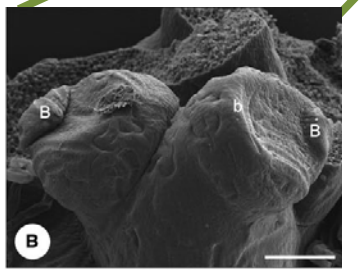

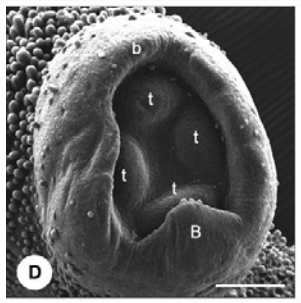

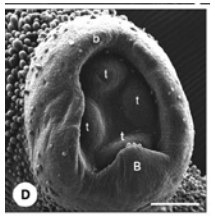

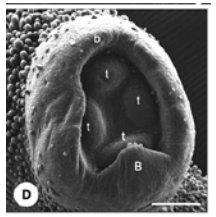

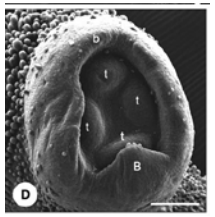

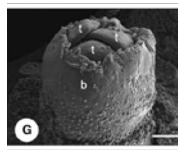

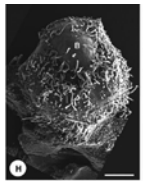

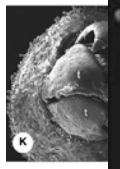

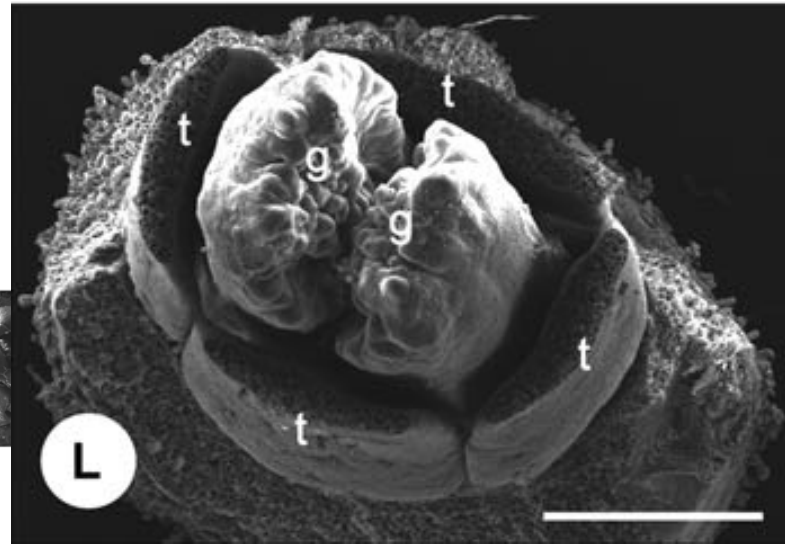

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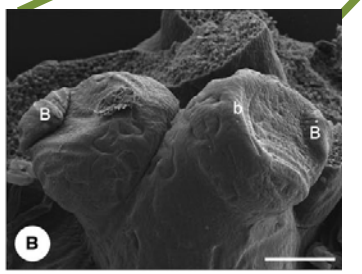

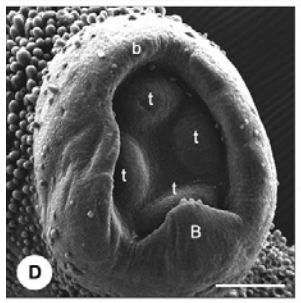

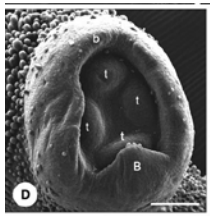

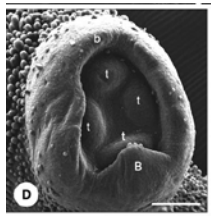

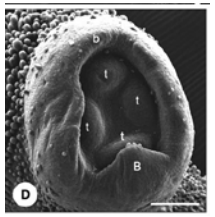

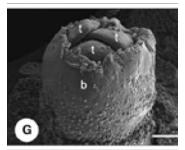

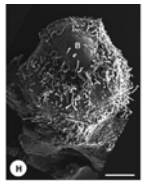

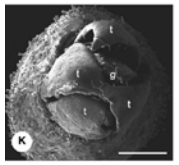

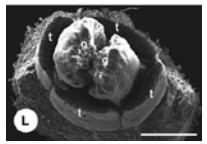

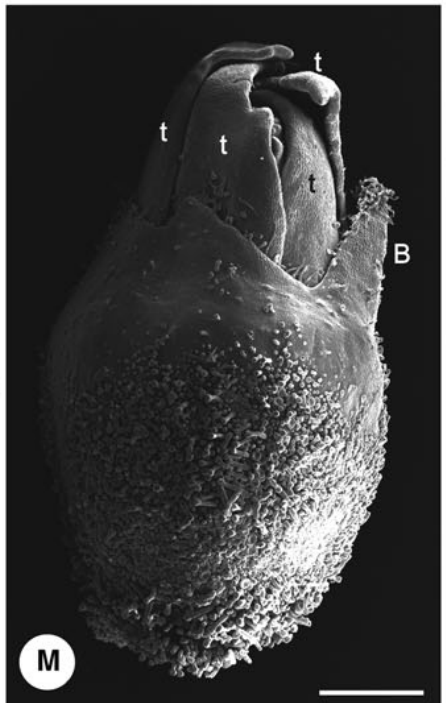

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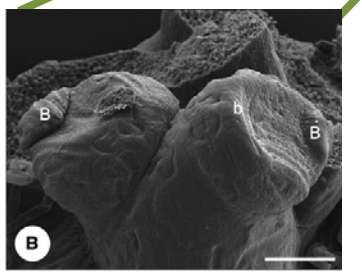
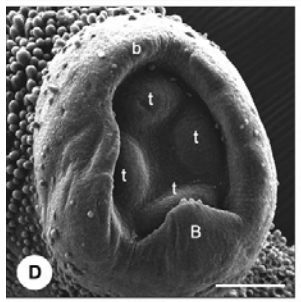
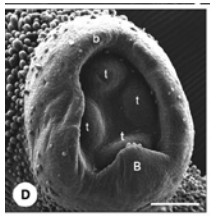
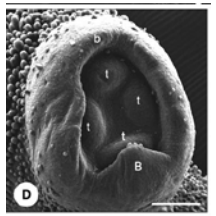
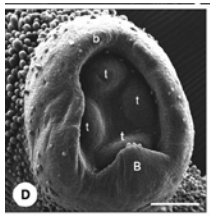
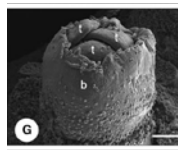


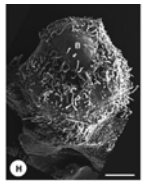


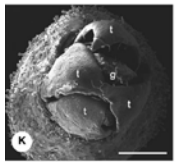


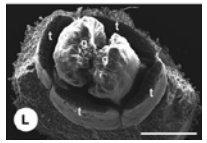


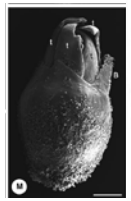


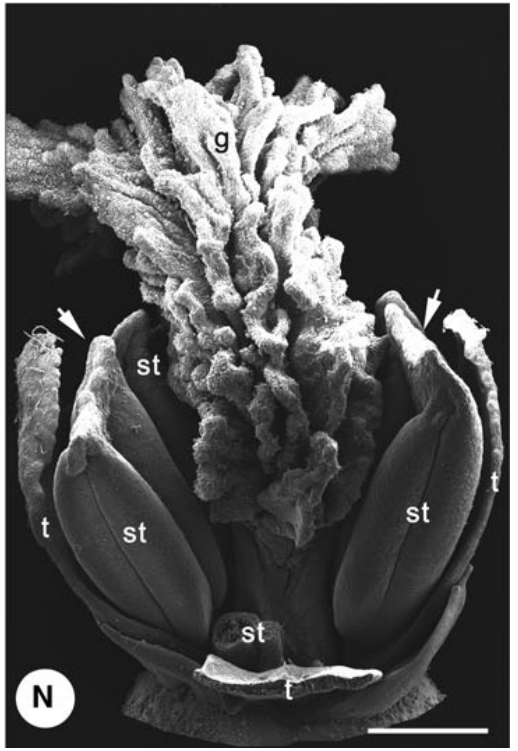












Timing of floral bud development

Spring
Apr, May, Jun

Summer

Fall

Winter

Spring

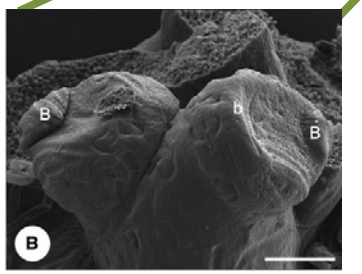
Bloom

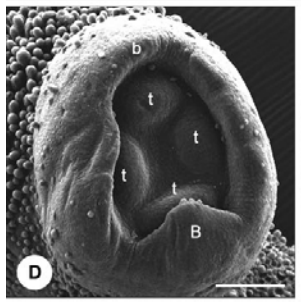
Veg bud initiation

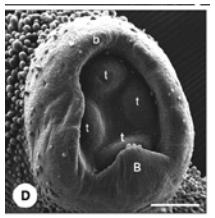
Pistillate initiation
8-10 wks
Post-bloom

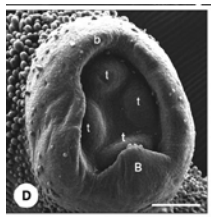
Involucre appears
2-3 weeks later

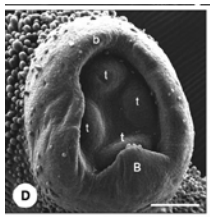
Dev'lpmt resumes
2-3 weeks before pollen shed

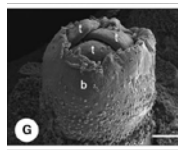


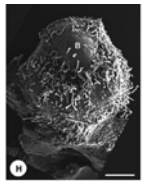


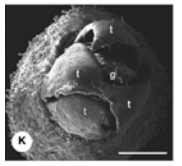


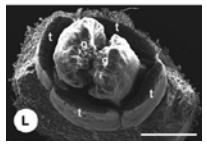


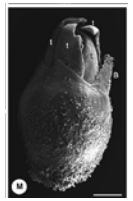


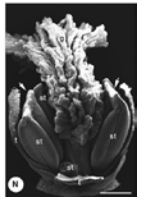










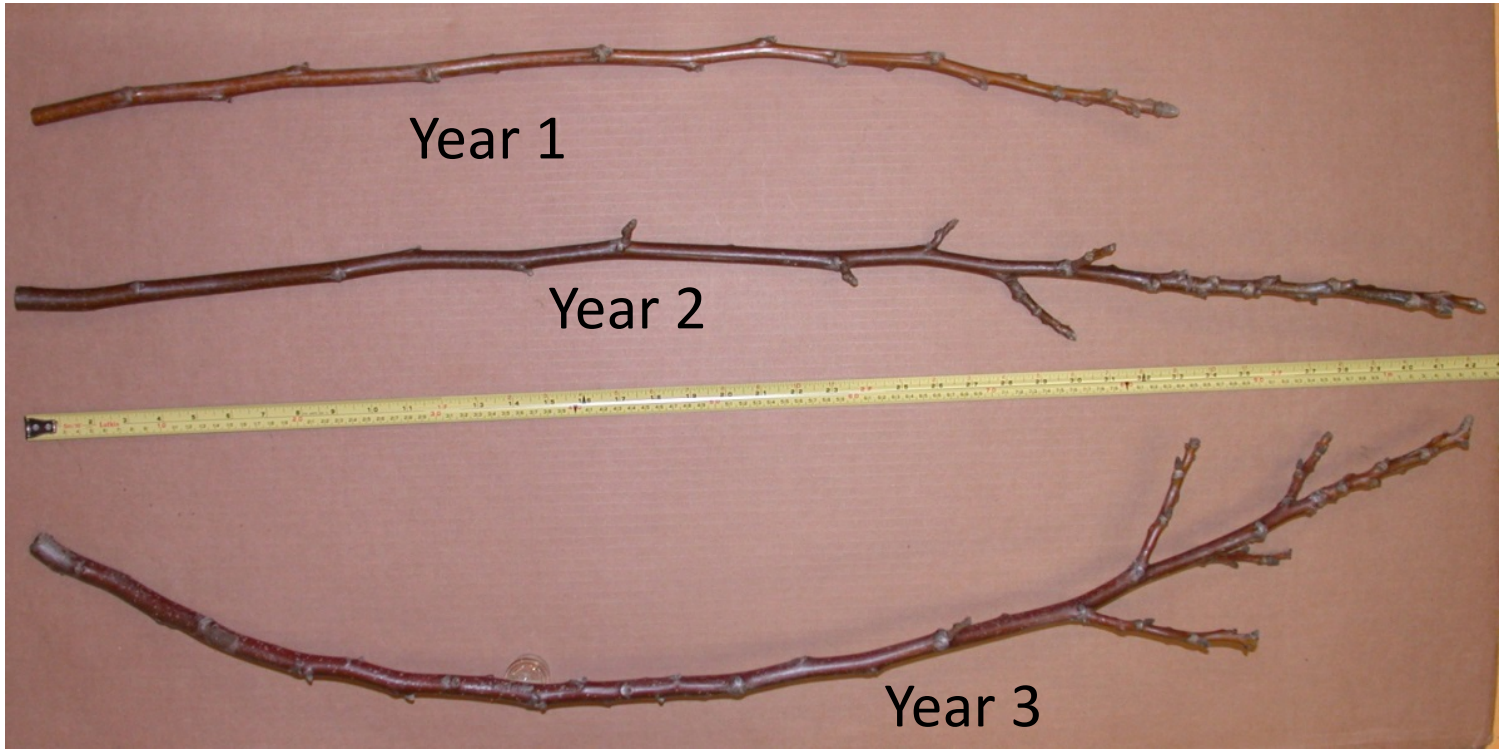


Where are the flowers borne?

Spurs are the primary bearing unit in a walnut tree.

Productive trees must have a healthy population of spurs.

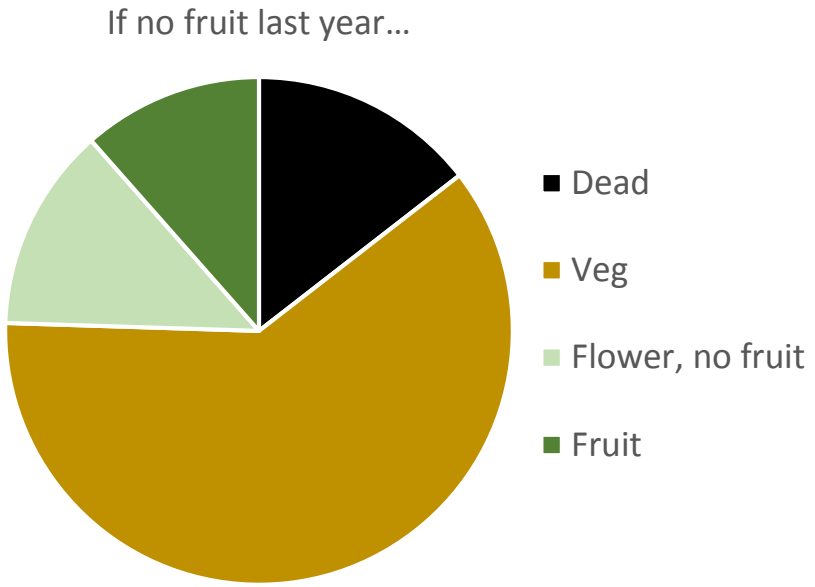
Spurs take time to develop.

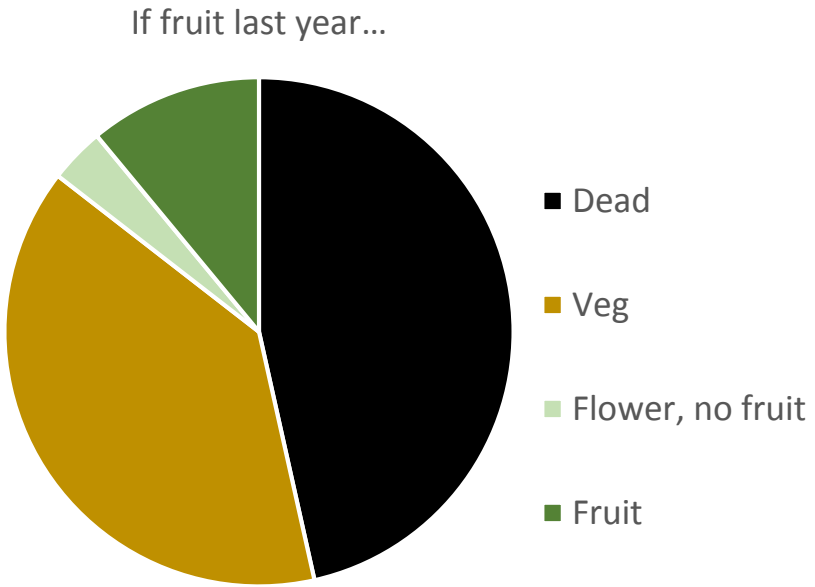


Light & Flowering

- Greater light intensity → greater vegetative growth, higher % return bloom and higher pistillate flowers per spur.
  - Leaves, fruit and spurs are larger in sun than shade.
  - Leaf area, leaf weight and chlorophyll content are higher in sun than shade.

Ryugo, 1978; Klein et al. 1991 JASHS 116(3):426-429





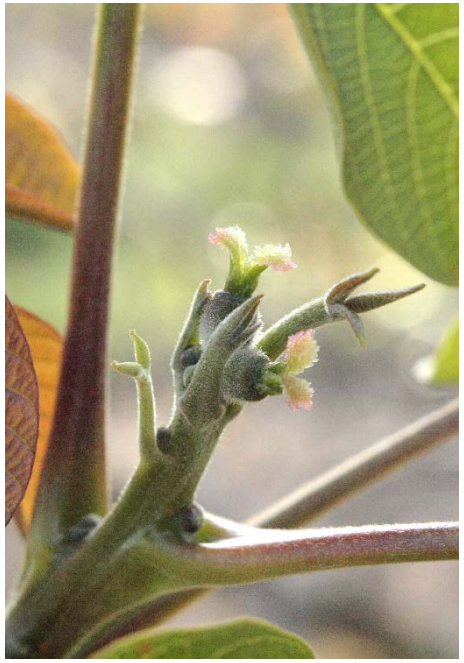
Klein et al. 1991 JASHS 116(3):426-429

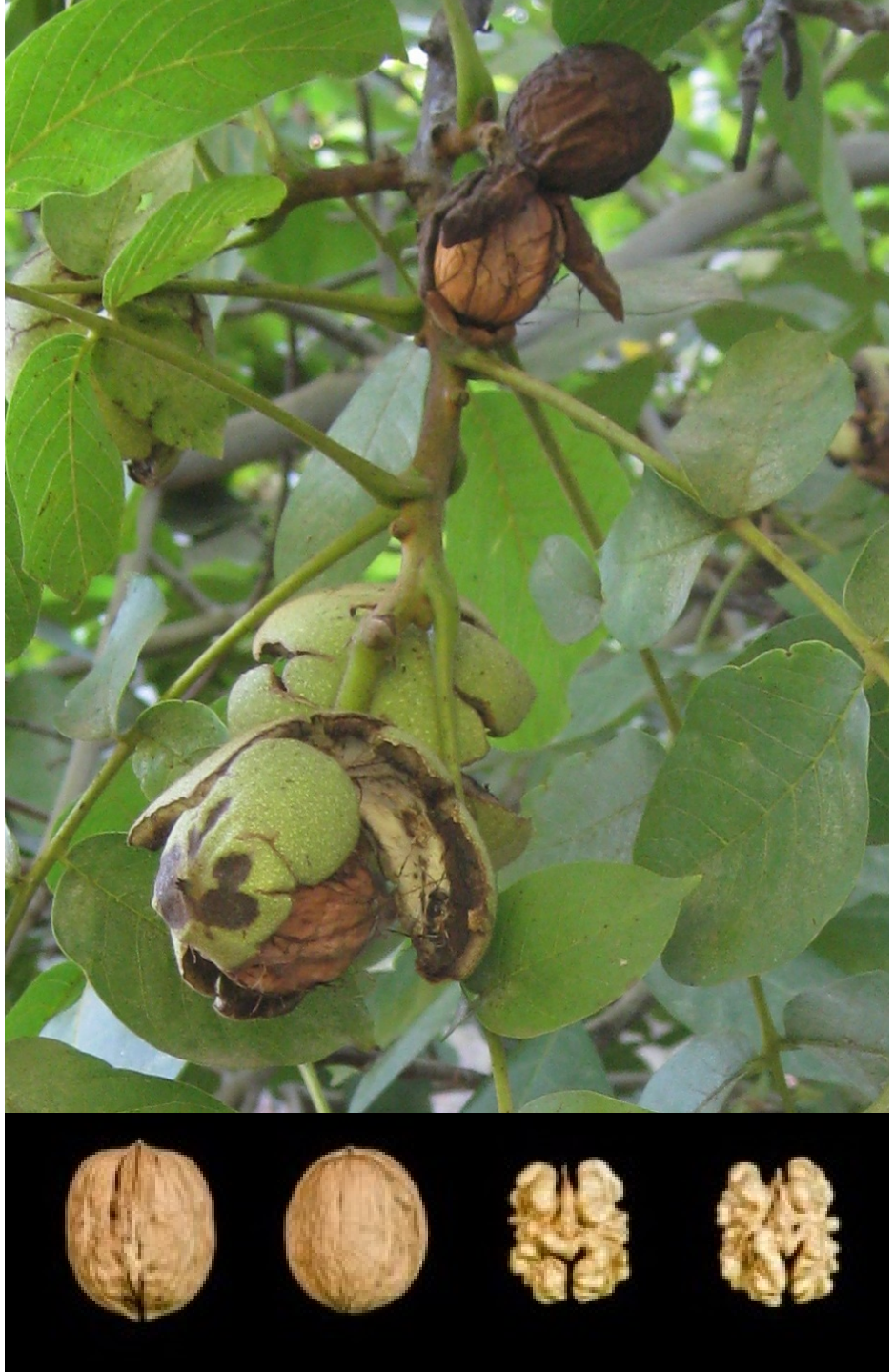
Although the spur dynamics of walnut trees have not be studied as thoroughly as they have for almonds, some of the lessons of those studies pertain to walnuts:

- The crop is mainly borne on spurs.
- The spur population is made up of (a) vegetative, (b) flowering but not fruiting and (c) fruiting spurs.
- Spur flowering and fruiting is dependent on available light and spur leaf area.
- Spurs tend to alternate bear
- Spur mortality is a function of previous year bearing, spur light exposure and spur leaf area.
- Quite a large percent of spurs die in any given year
- **This means that replacement of dead spurs is important for continued cropping.**
- **Continued cropping is largely a function of managing a balanced population of healthy spurs.**

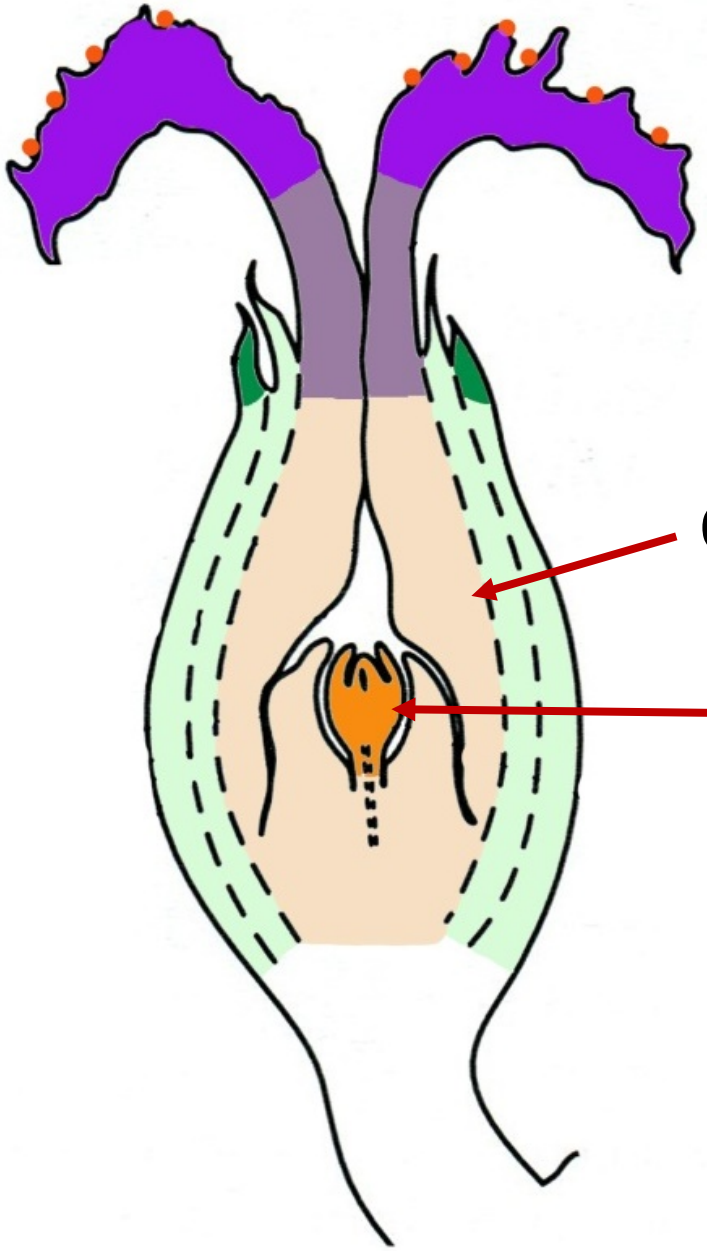
Implications – Timing of stress, Pruning

Fruit Growth & Development



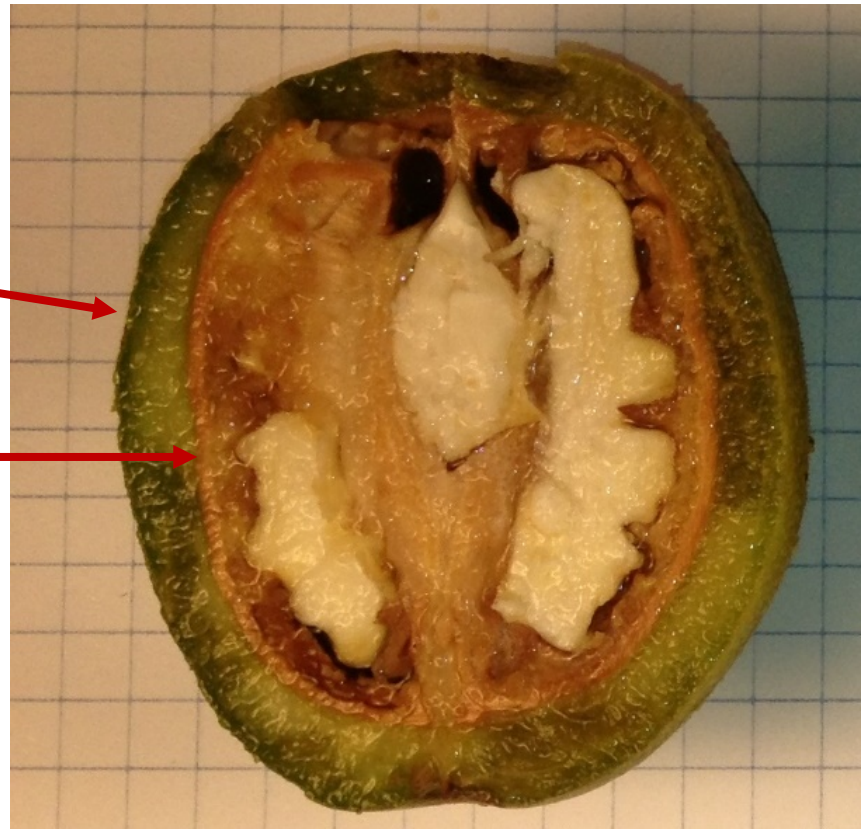


Parts of the flower and the fruit.



Ovary wall (→ hull/husk)

Ovule (→ kernel)

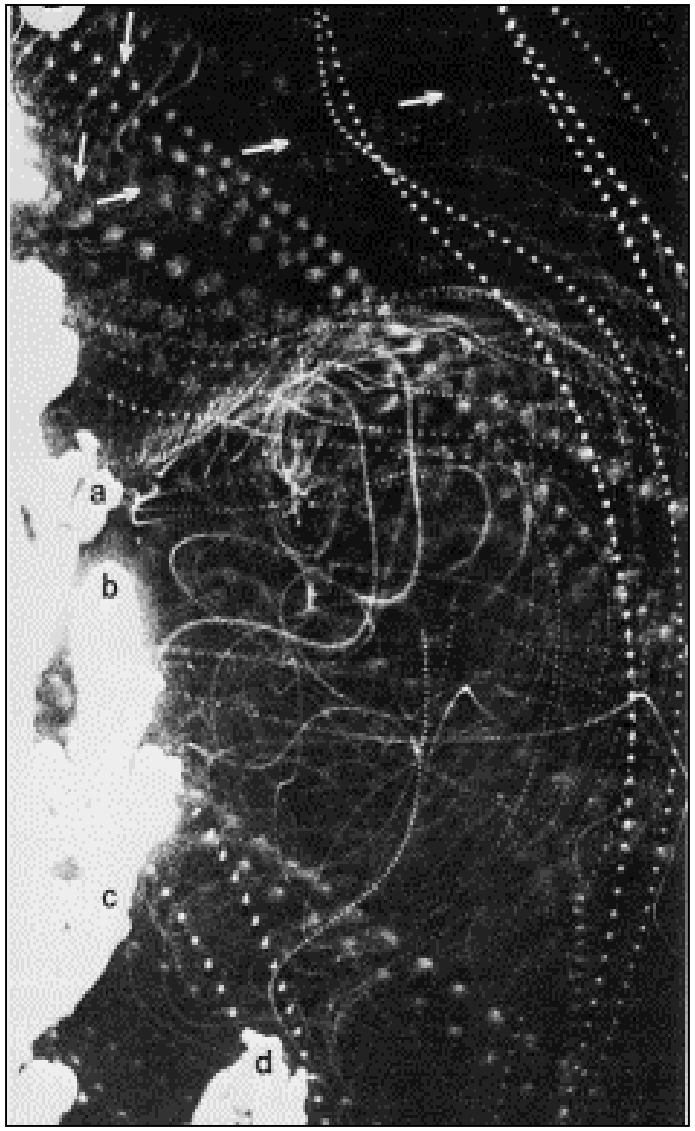


Pollen capture in wind pollinated flowers

Micro-scale wind tunnel experiments

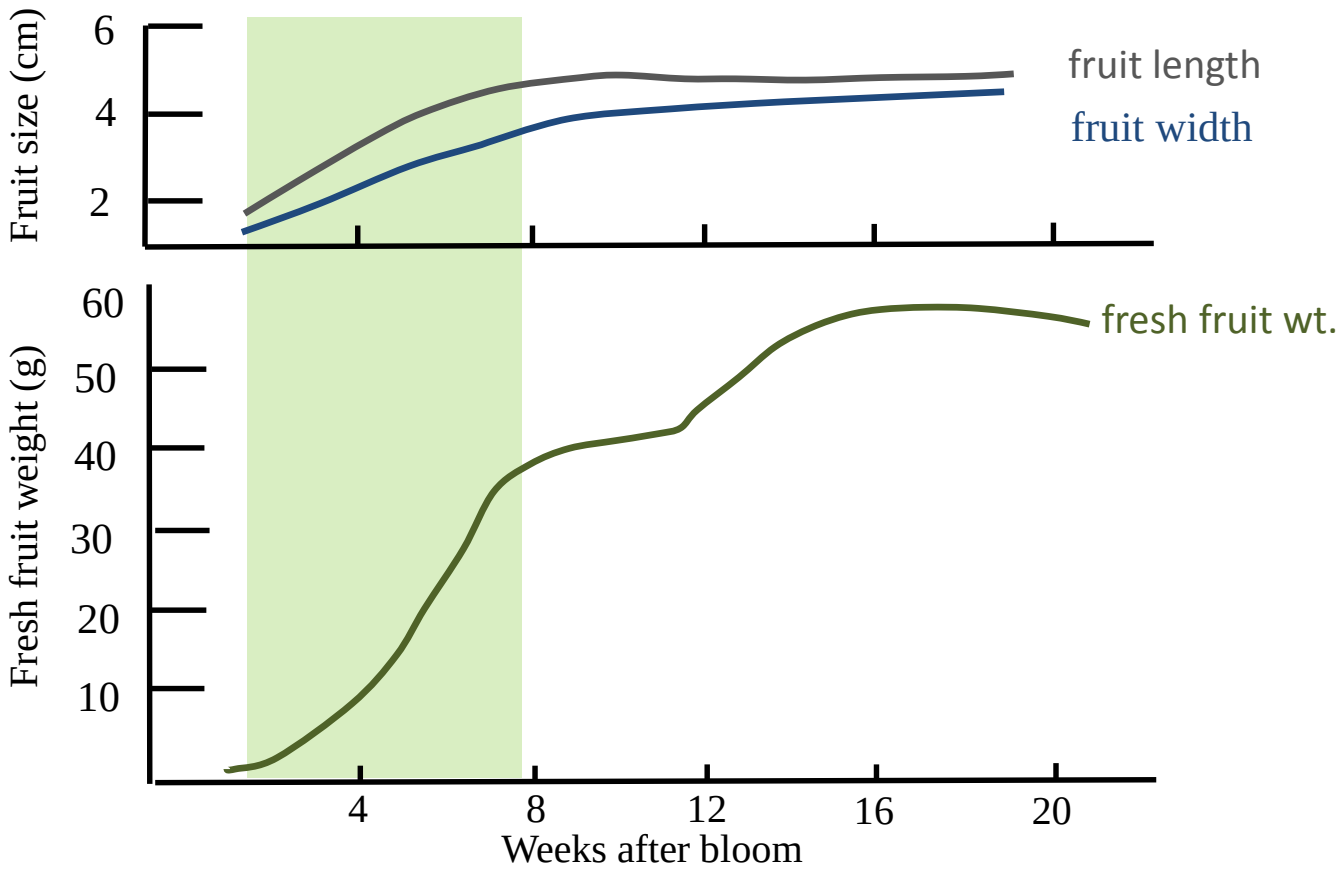
- pollen is not captured at random
- shape and form of the flower structures create air flow patterns that direct the pollen to the stigma surfaces

(Joe Grant will cover pollination more in depth in the next talk)



Walnut fruit development

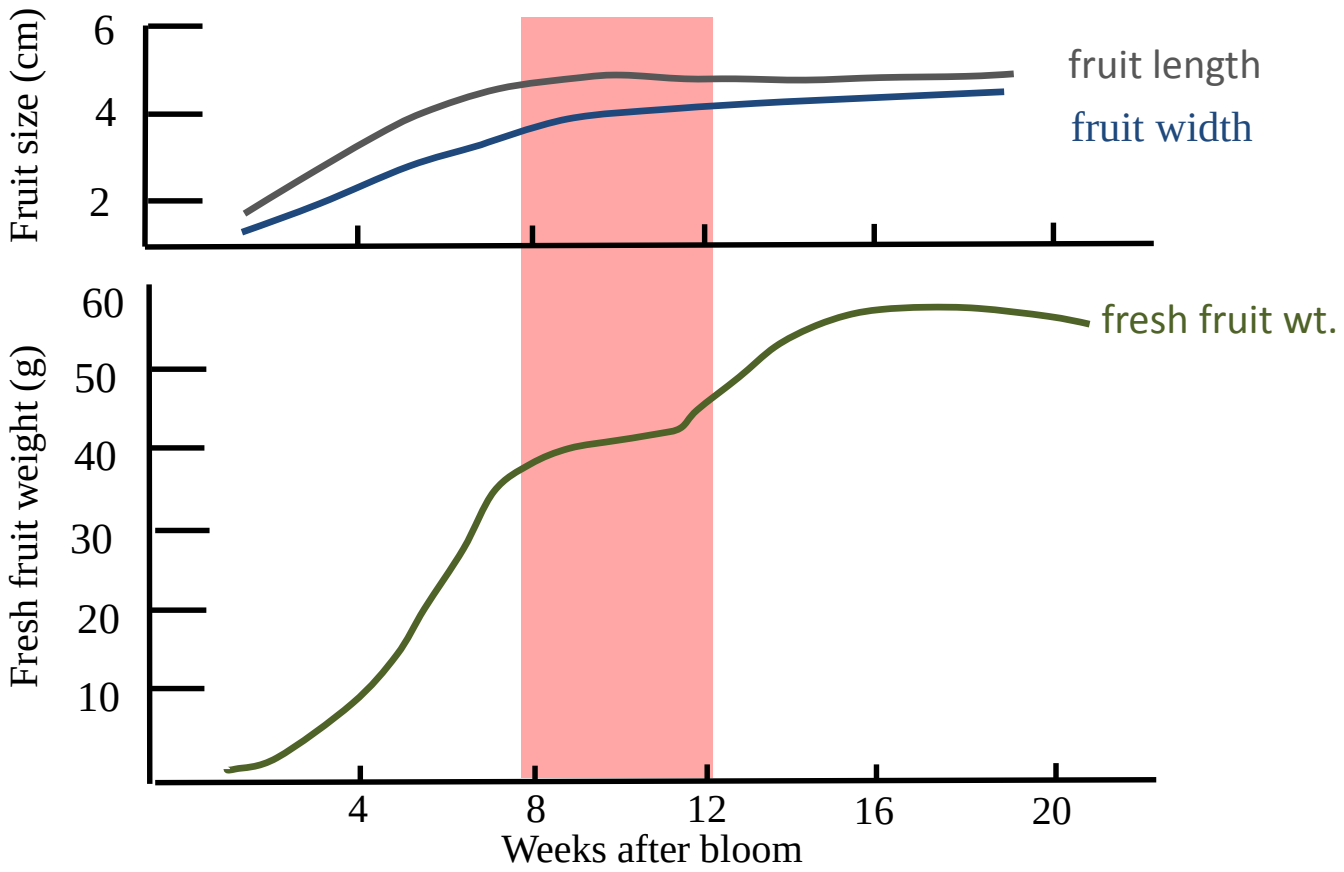
- Rapid initial growth in fruit fresh weight and size through 8 weeks after bloom (usually April through May)



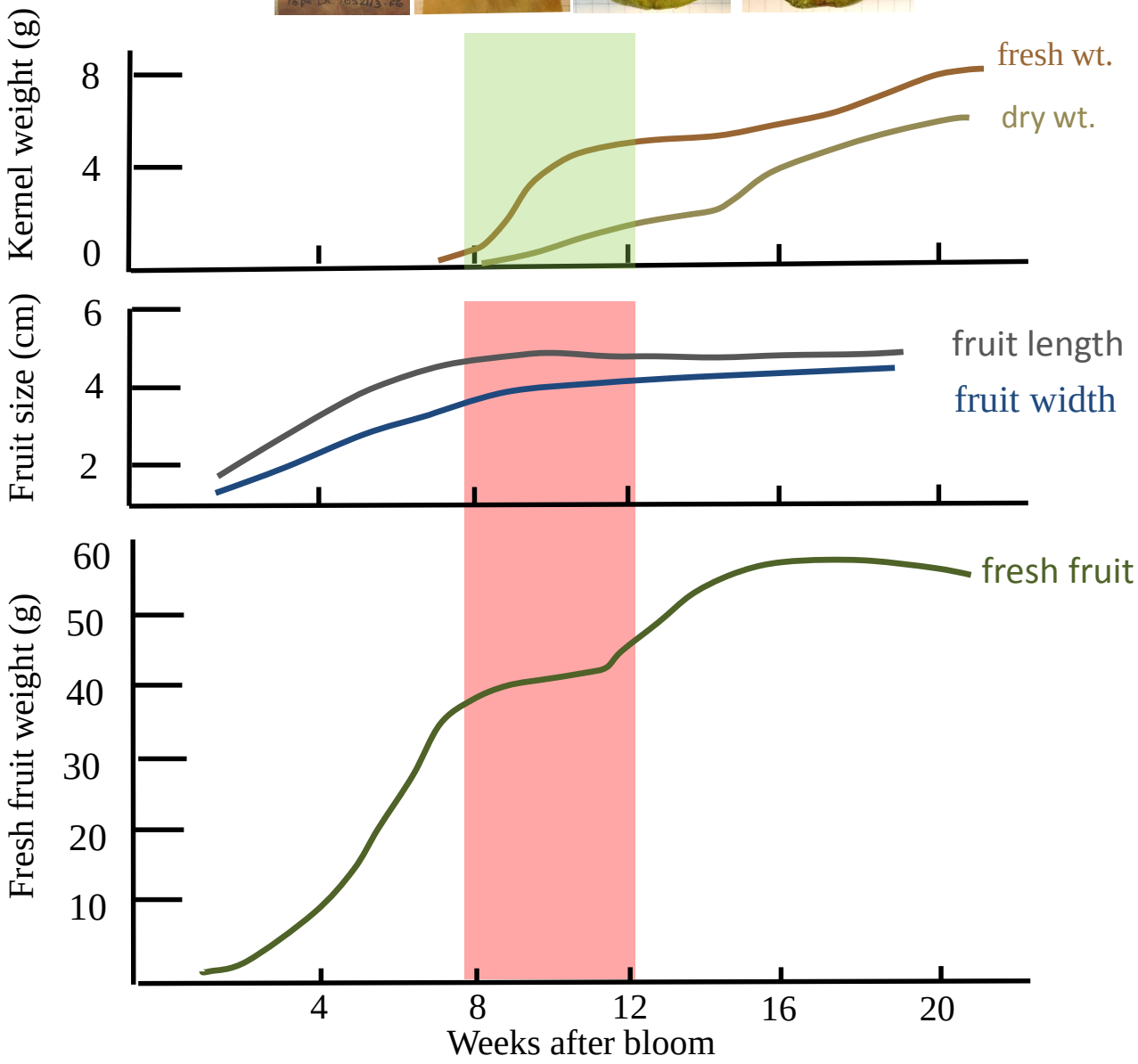
Walnut fruit development

- Rapid initial growth in fruit fresh weight and size through 8 weeks after bloom (usually April through May)

- Brief period of slow growth mid-season, 8 to 12 weeks after bloom (usually during month of June)



Walnut fruit development



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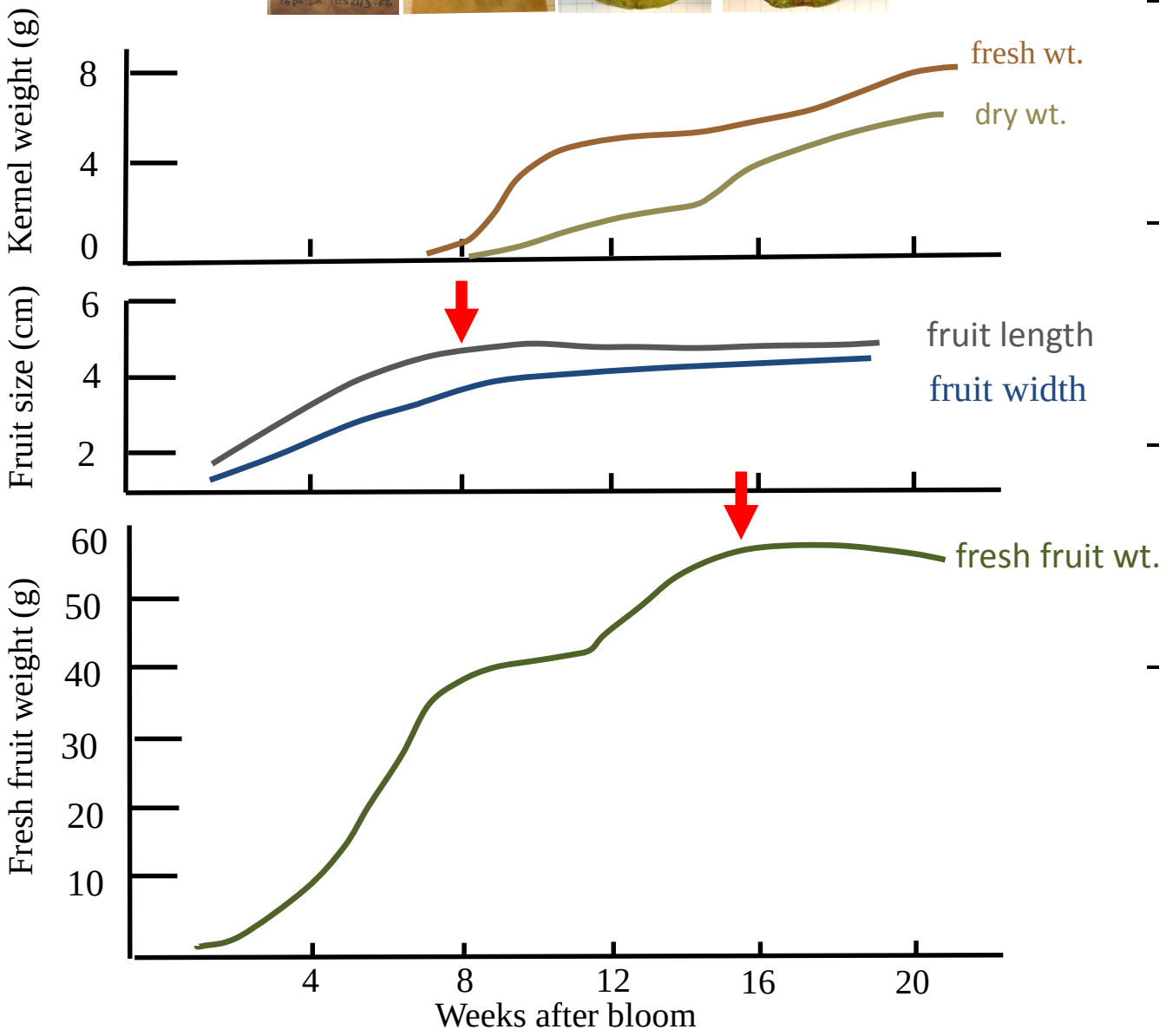
- During this period of slow fruit growth the kernel grows rapidly and the shell hardens (usually end of June)

Walnut fruit development



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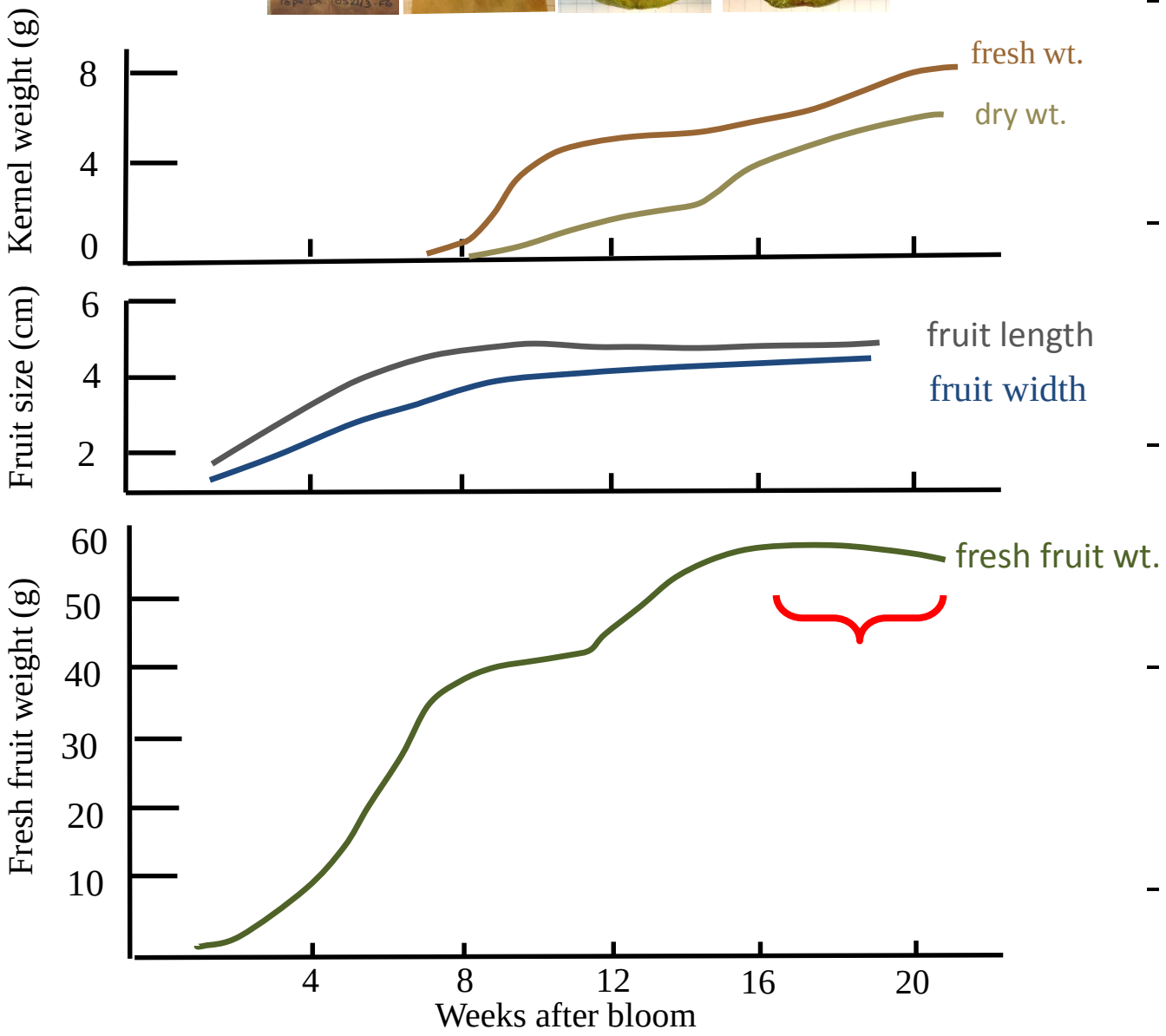
Walnut fruit development



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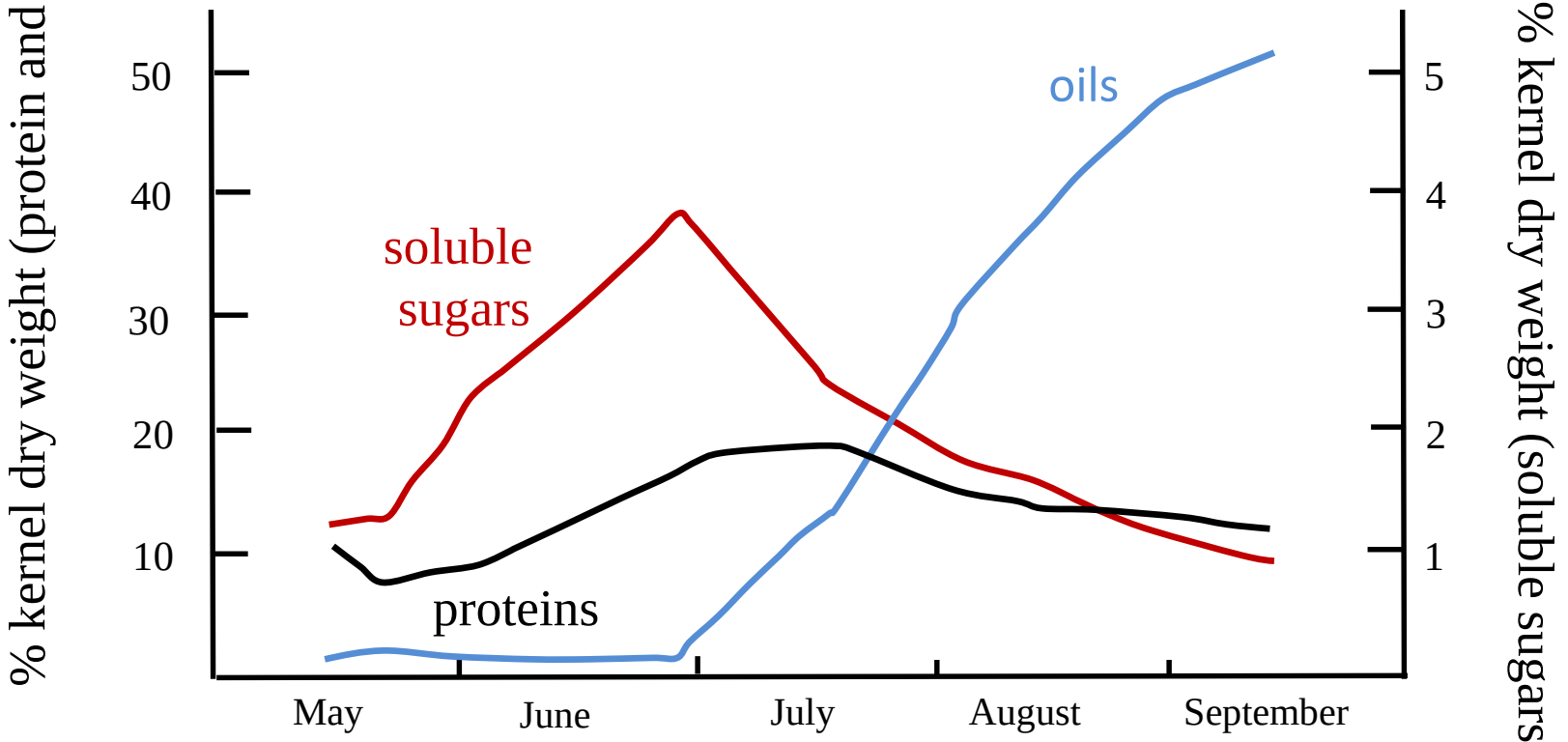
- Decrease in fruit fresh weight after week 16 occurs when the hull loses water

Walnut fruit development

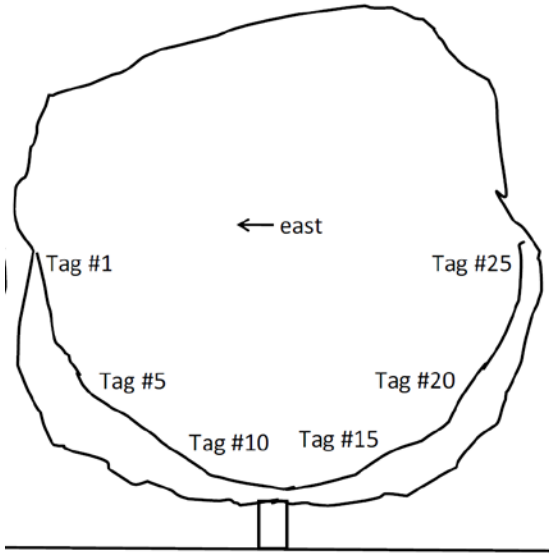


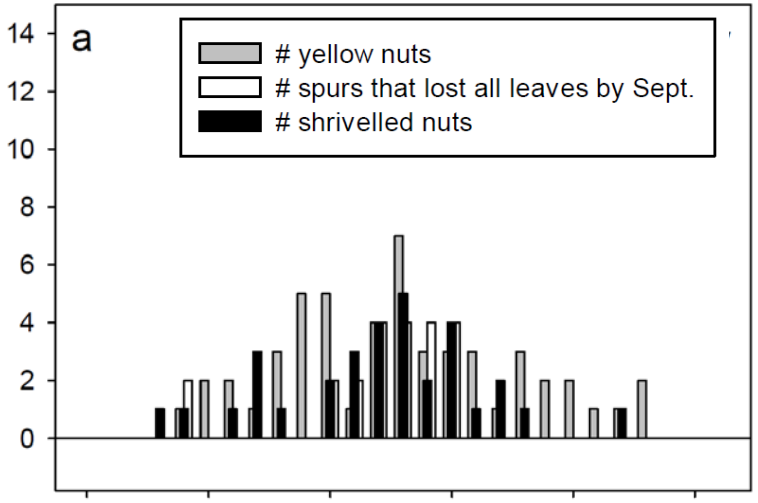
Changes in proportion of fats (oils), proteins, and soluble sugars in an Ashley walnut kernel during development

Implications: Timing of stress & it’s impacts

Shading stress & quality

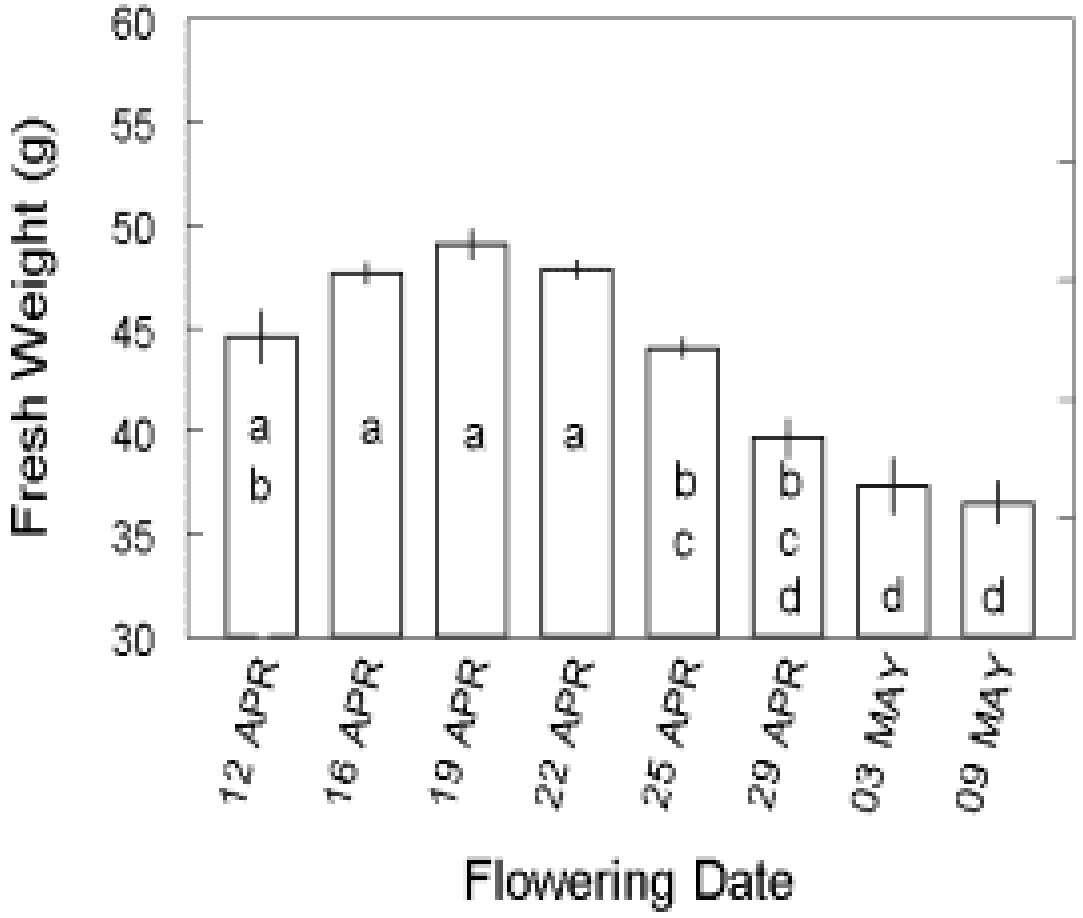
- Yellowing pellicle correlates with full sun early in season, shading later in season.
- Shading relates to pellicle darkening, kernel shrivel.





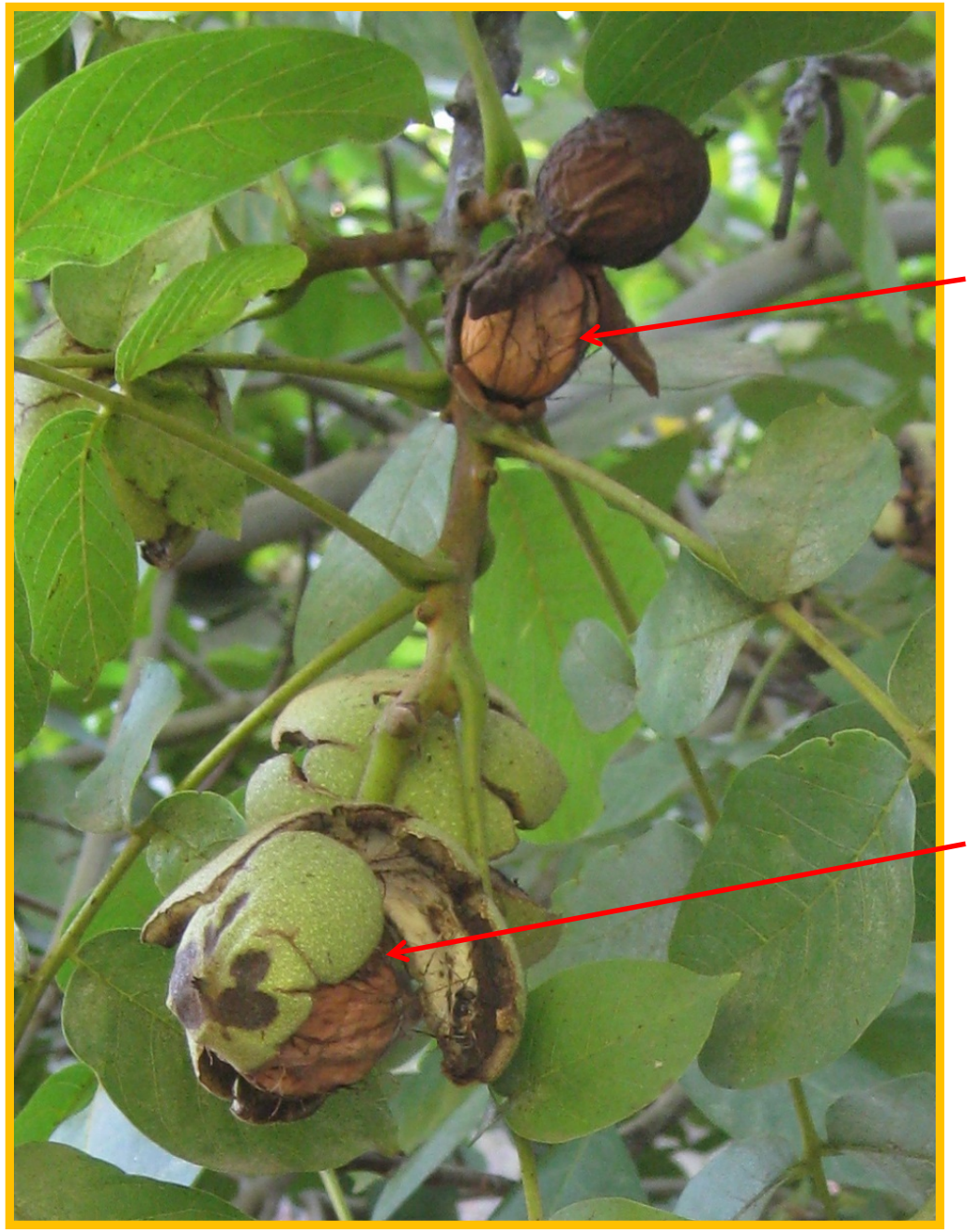
Lampinen et al. 2008. CWB Research Report

Flowering date can affect fruit size.



Fresh weight of Chandler nuts developing from flowers from different bloom dates.

Polito et al. 2006 Acta Hort 705: 465-472



Pee wee nuts (small size is likely related to late bloom and the fact that there is only one leaf on the spur)

Normal large nut (note multiple leaves on the spur)


Questions?