Flower Power:
Pollen Tube Growth and its Management

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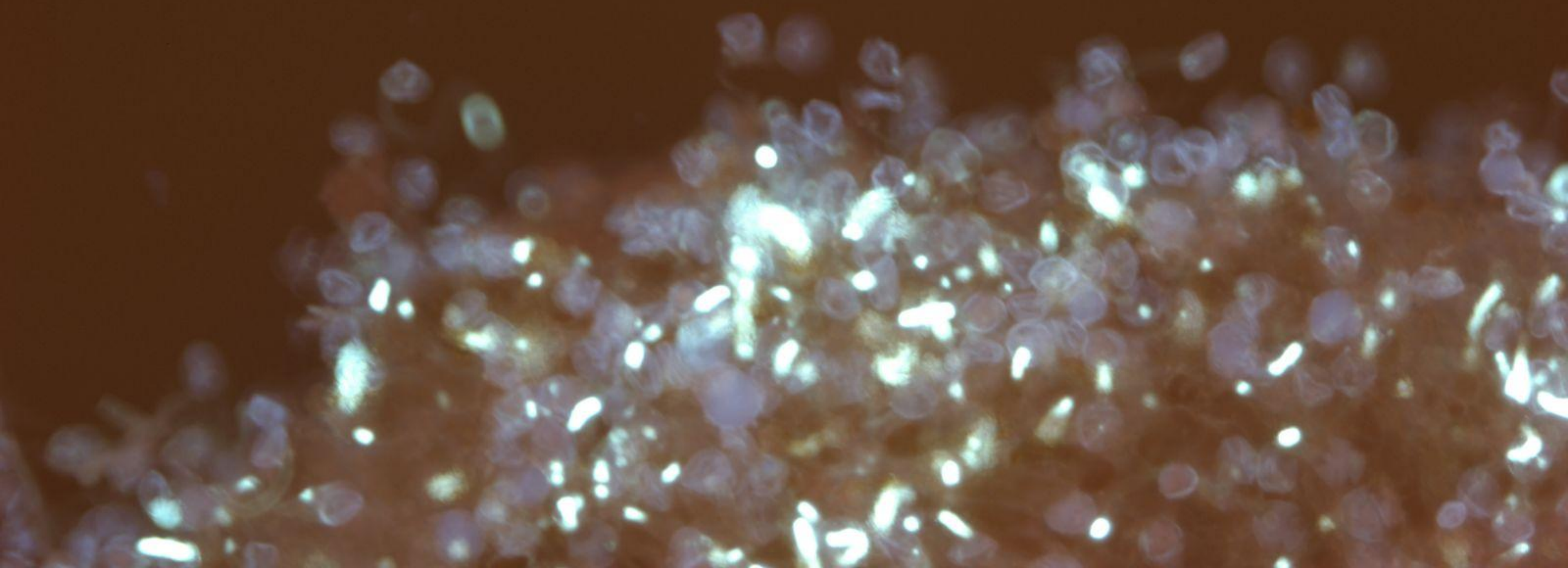


What happens after the bees fly away?

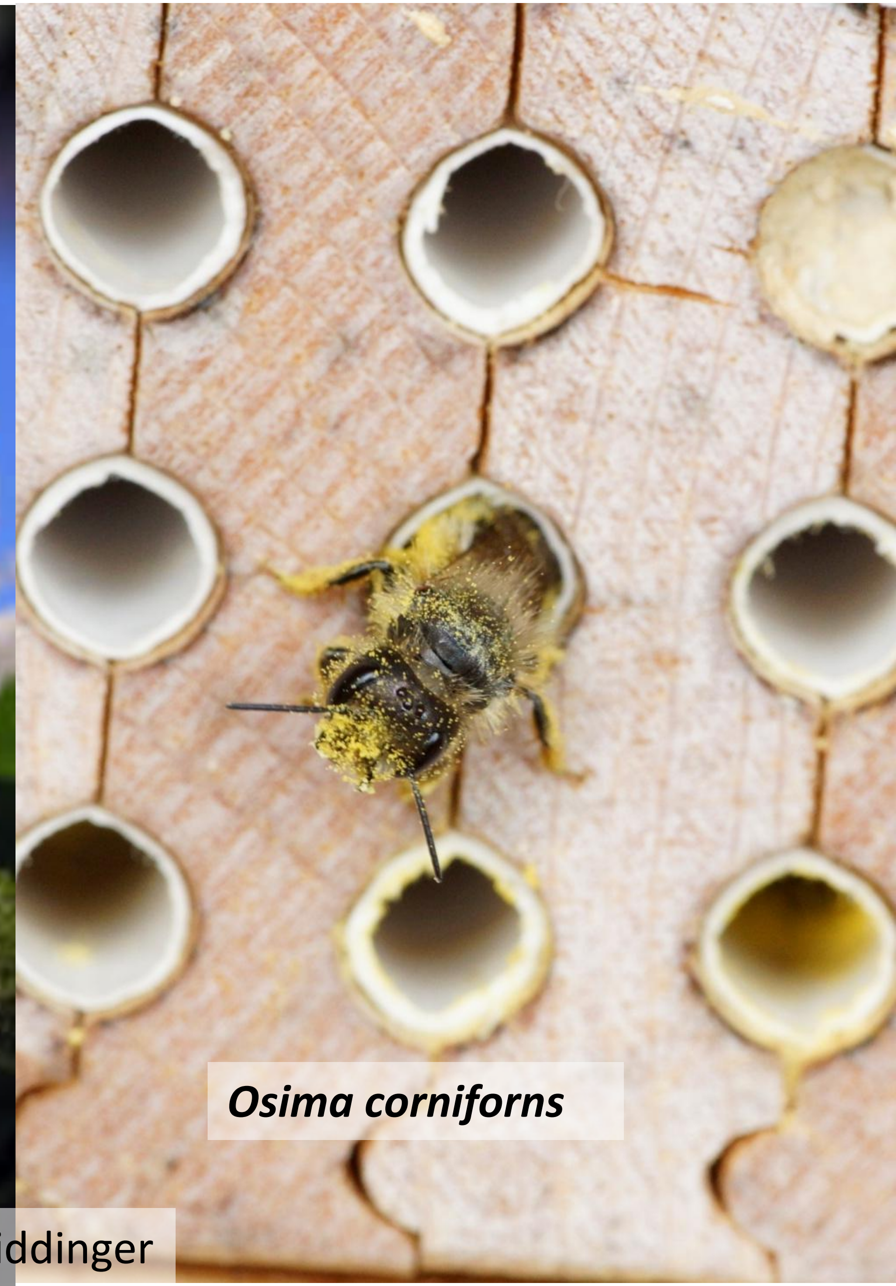


Image credit: David Biddinger

Outline

I. Overview of pollen tube growth in apple
   i. Programic phase → The 10 mm journey

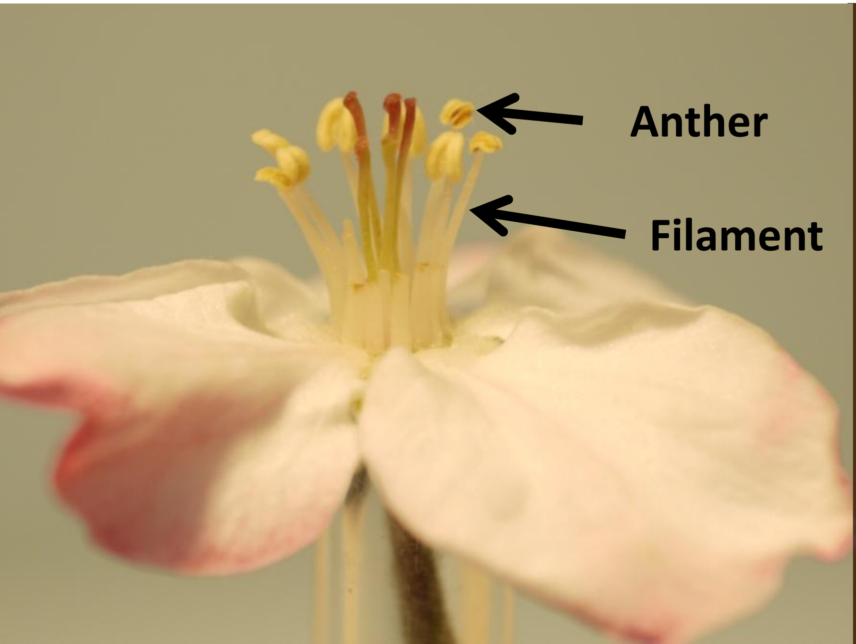
II. Practices that influence pollen tube growth
   i. Promoting Floral Longevity / Promote Growth
   ii. Hasten Floral Degradation / Inhibit Growth

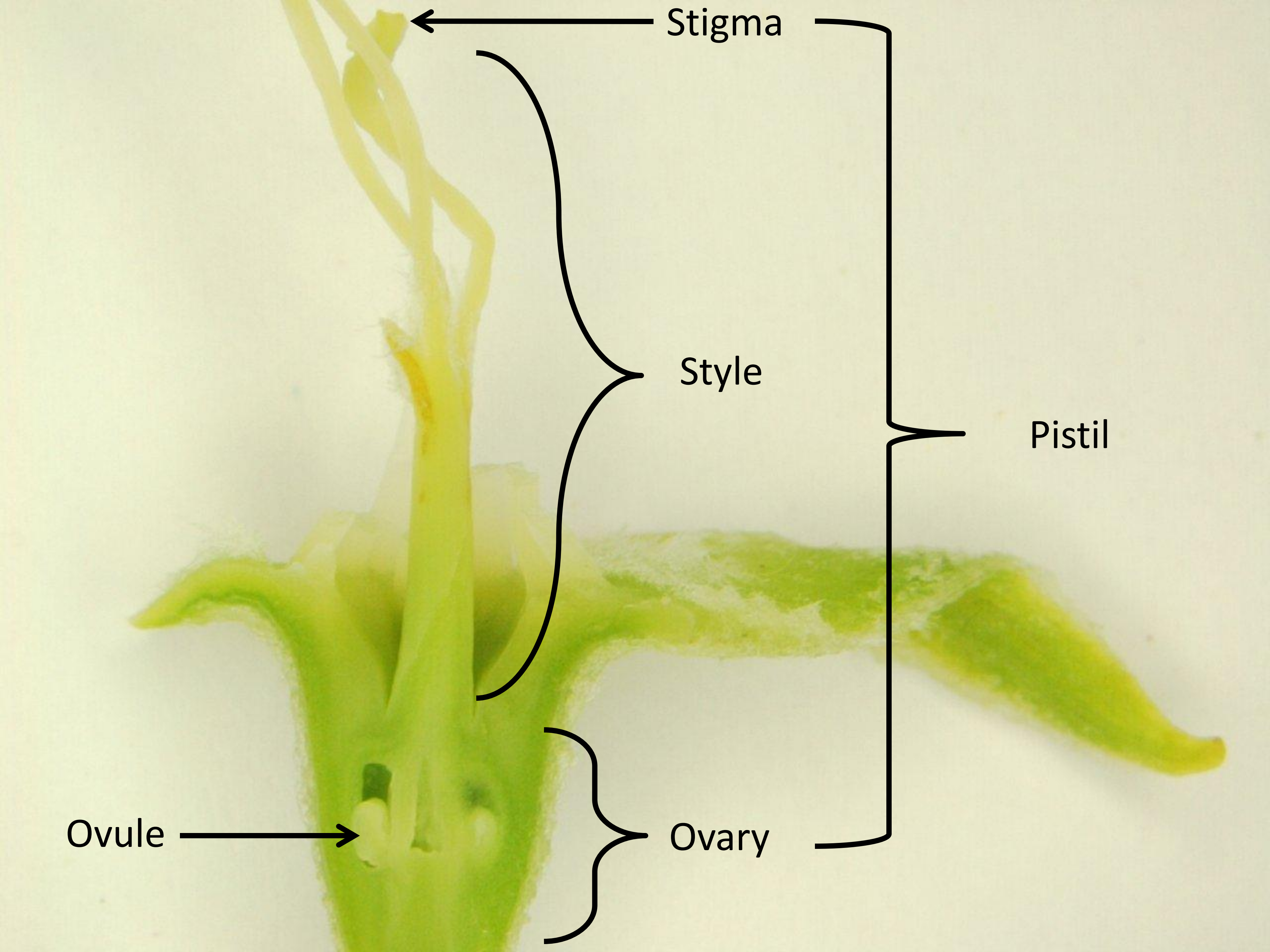
The programic phase

- The period from pollen deposition to fertilization
- Pollination and fertilization is a requisite for the formation of apple fruit
- Blossoms are comprised of specialized tissues that are short-lived and fragile
- Crop potential is partly determined by the amount of time that these tissues are functional

Pollen grains

- Develop in anthers (9-20)
  - Up to 104,000 grains/flower
- Growth occurs at the tip
- Rapid plant cell growth




Stigma
Style
Pistil
Ovule
Ovary

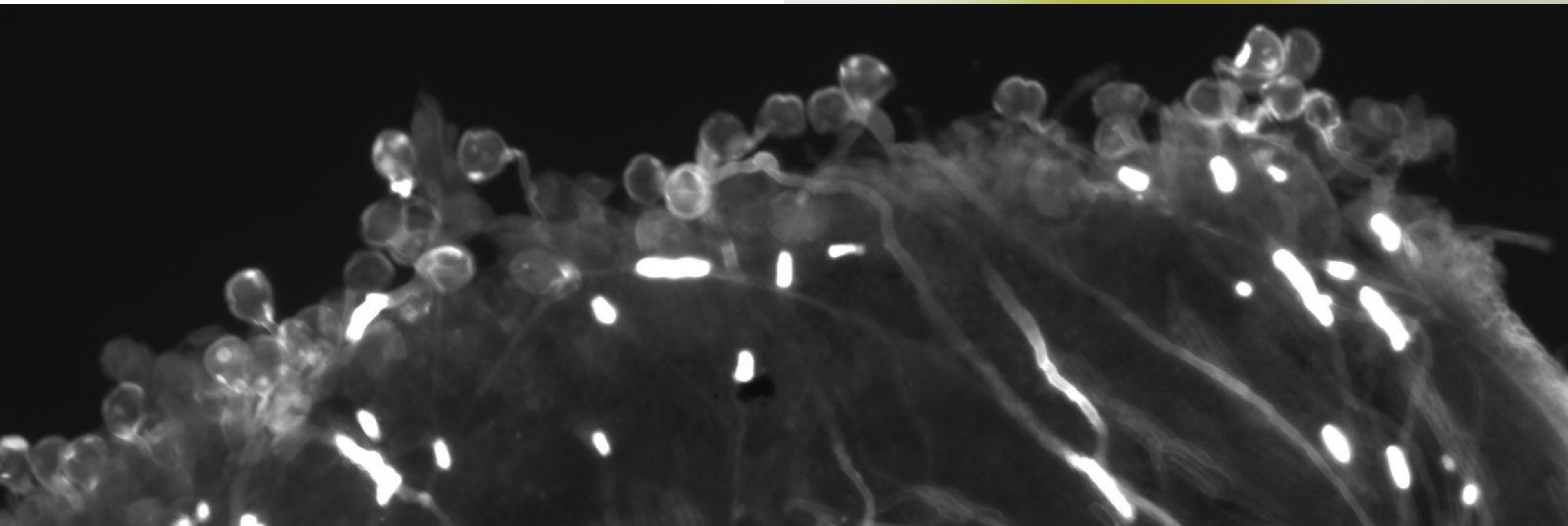
Stigmatic Surface

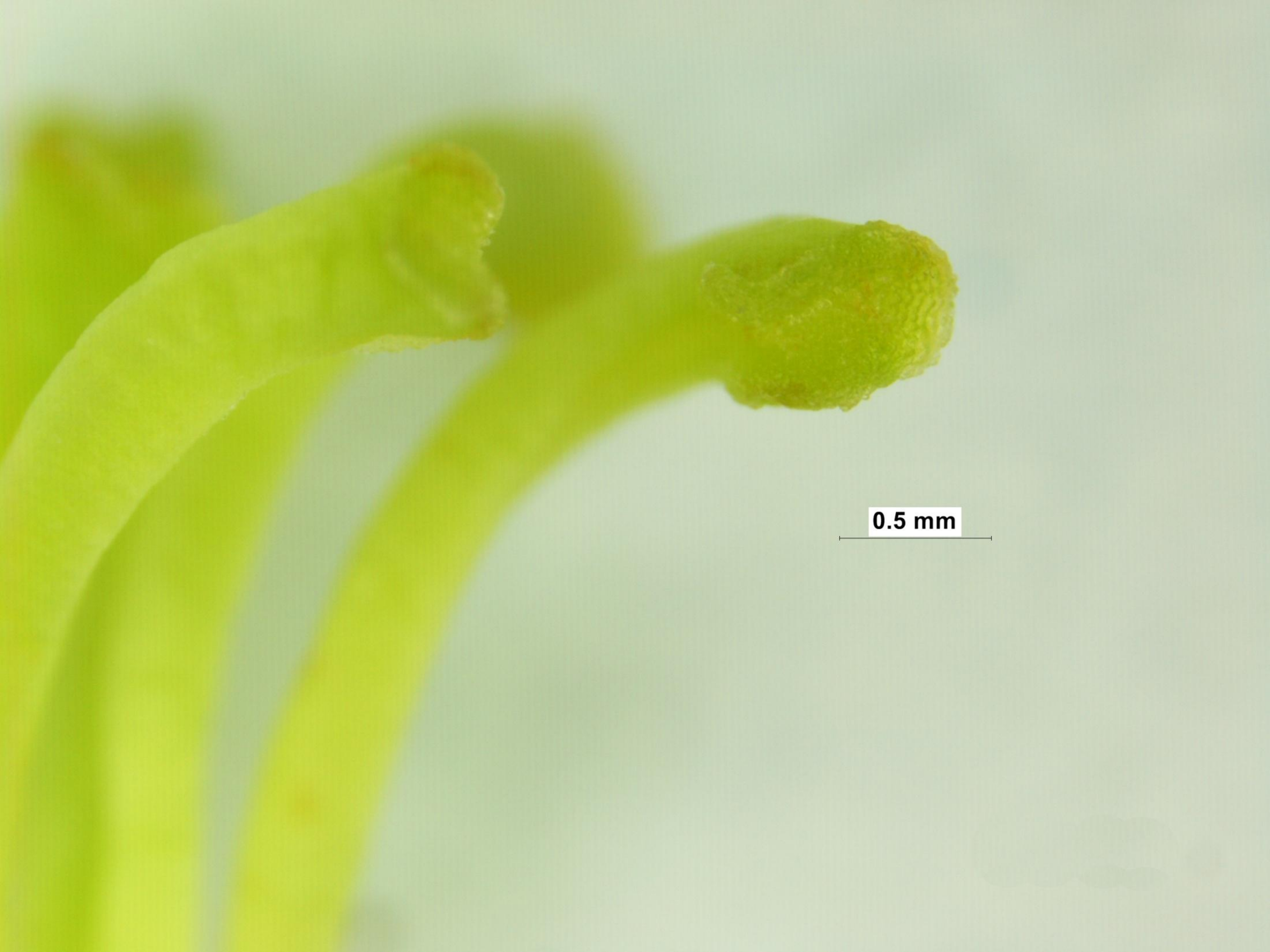
- <u>Papillae</u> –emit secretion: primarily composed of complex sugars (49.6%) and proteins (45.9%)
- Maximal receptivity is observed at anthesis

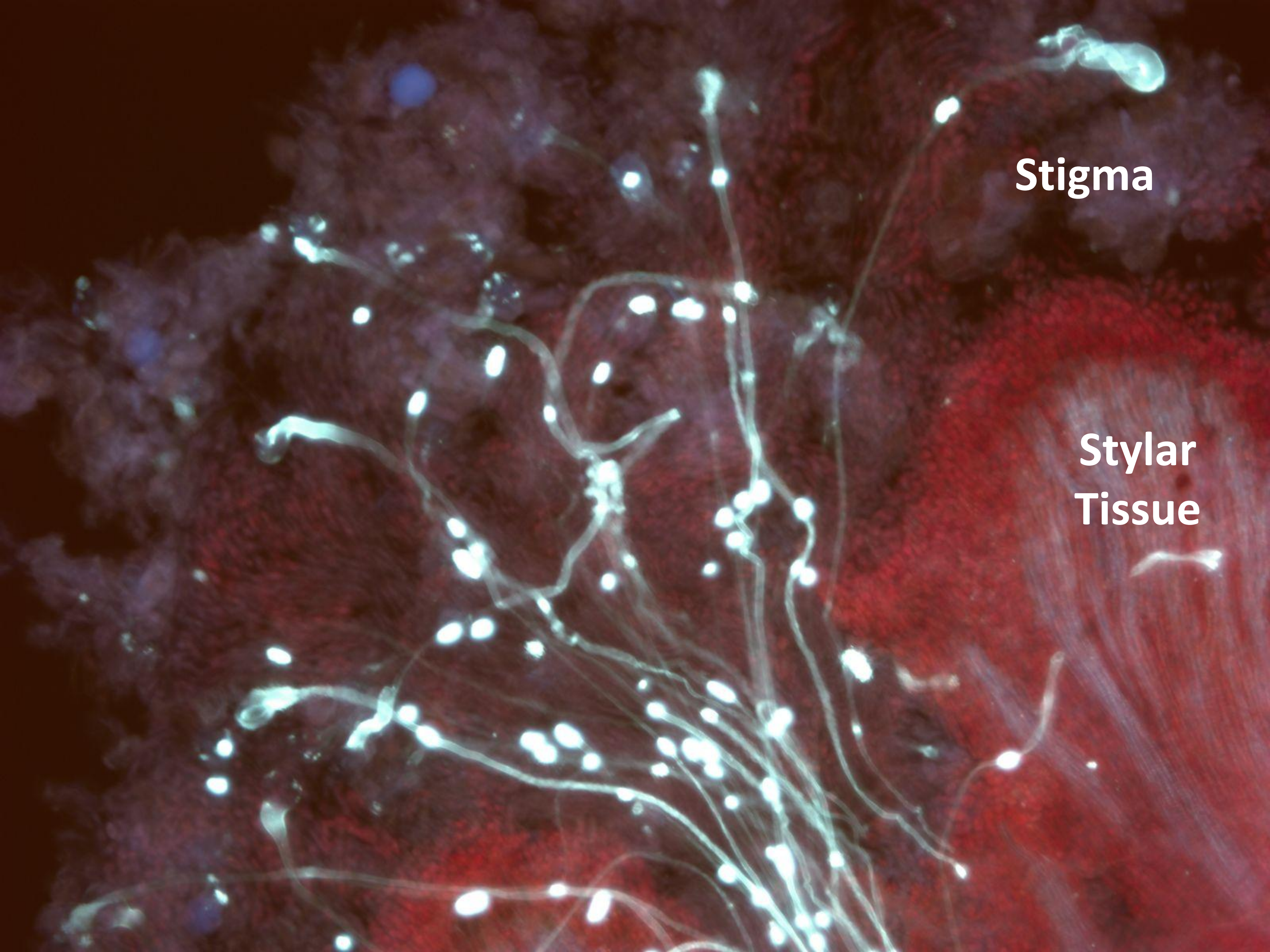
- After deposition, pollen grains interact with stigmatic secretion to:

  1) hydrate pollen grains

  2) orient pollen tube growth




0.5 mm


Stigma
Stylar
Tissue

Self-Incompatibility Reaction

- Most apple varieties require cross pollination
- Styles produce toxic proteins that can attack the growing pollen tubes
- Compatible pollen: genetic information carried by the pollen tubes inactivates toxic proteins
- If the genes of the pollen tube and style are identical: unable to combat the toxic proteins, and pollen tube growth is arrested

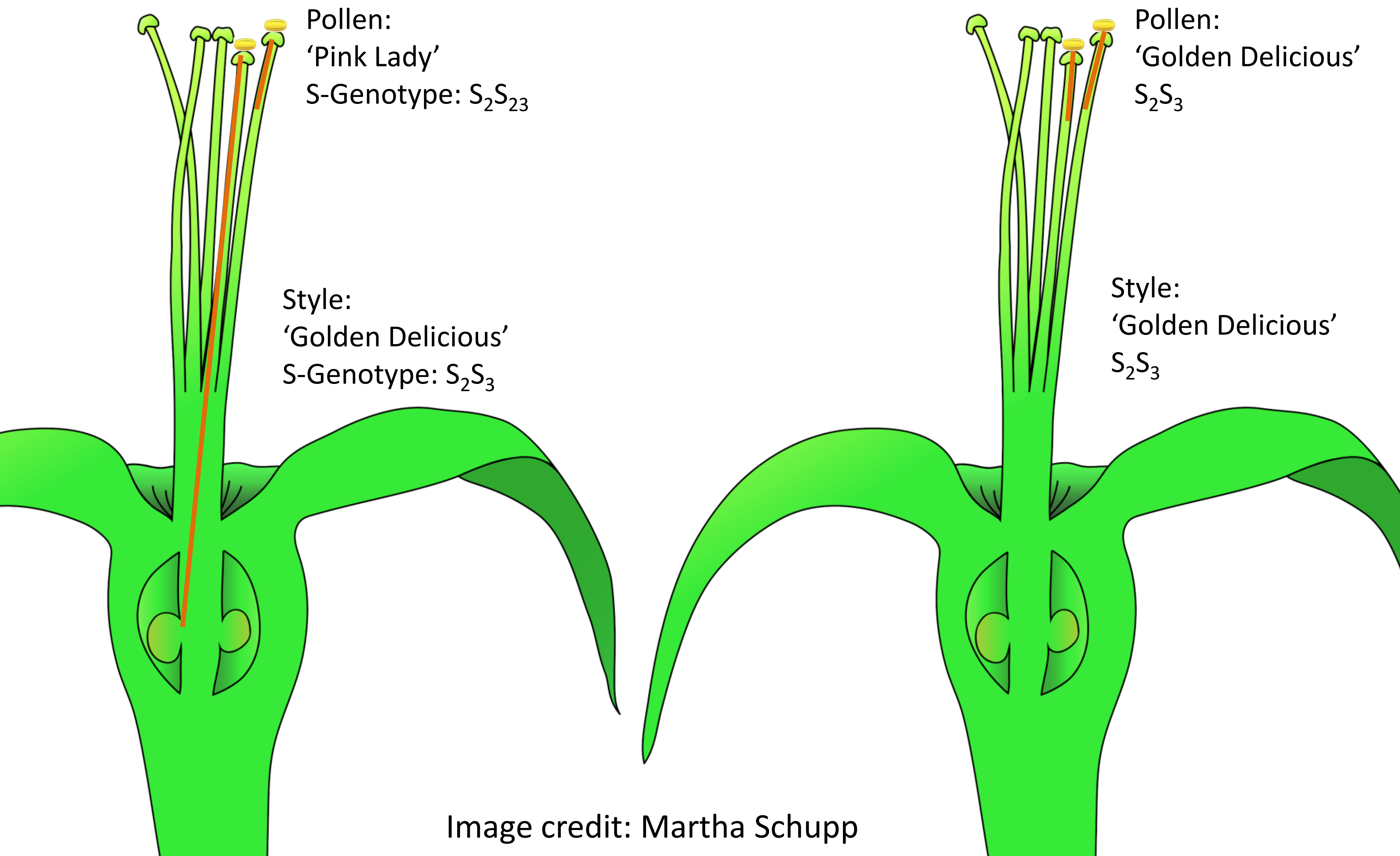
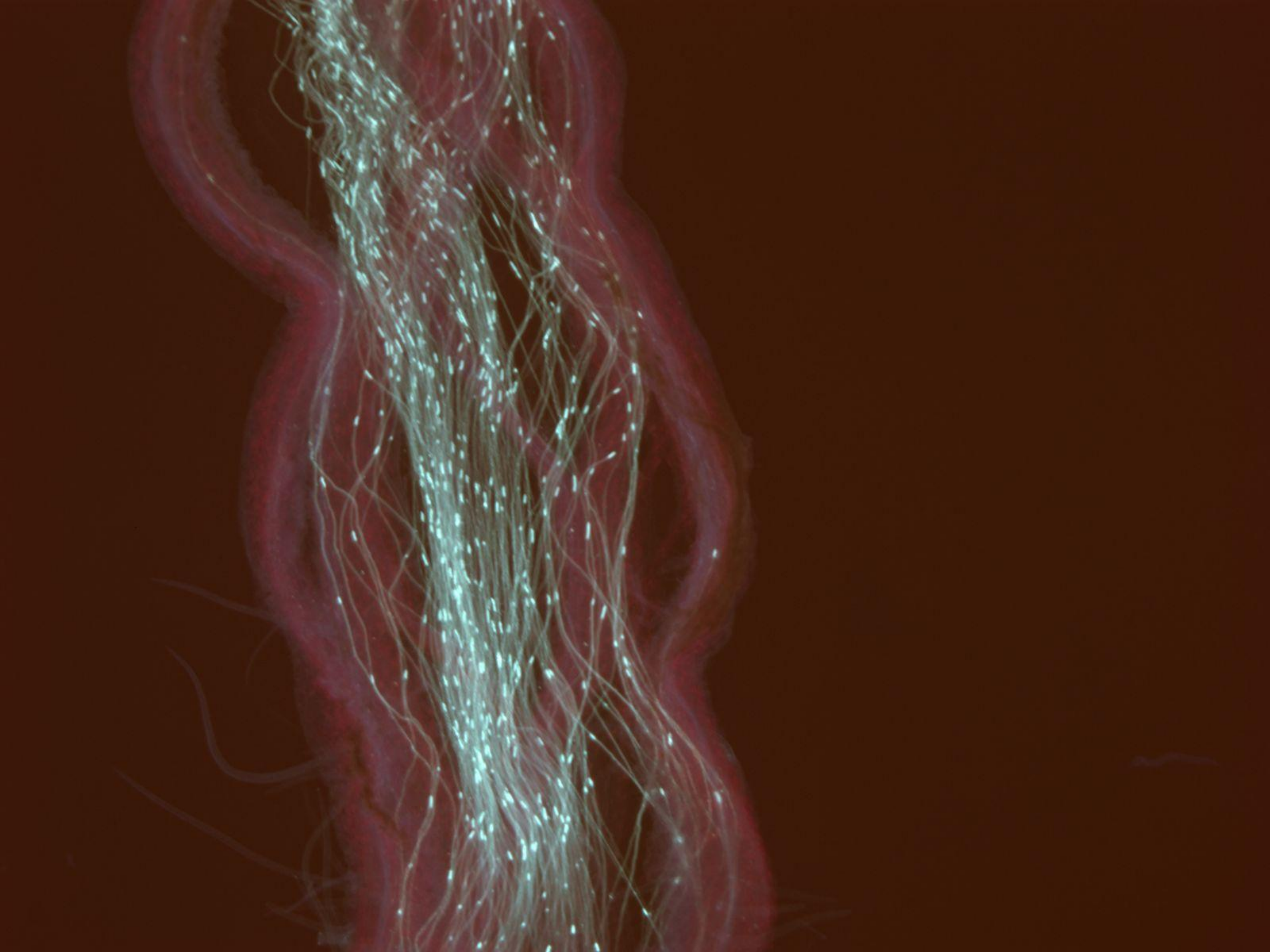
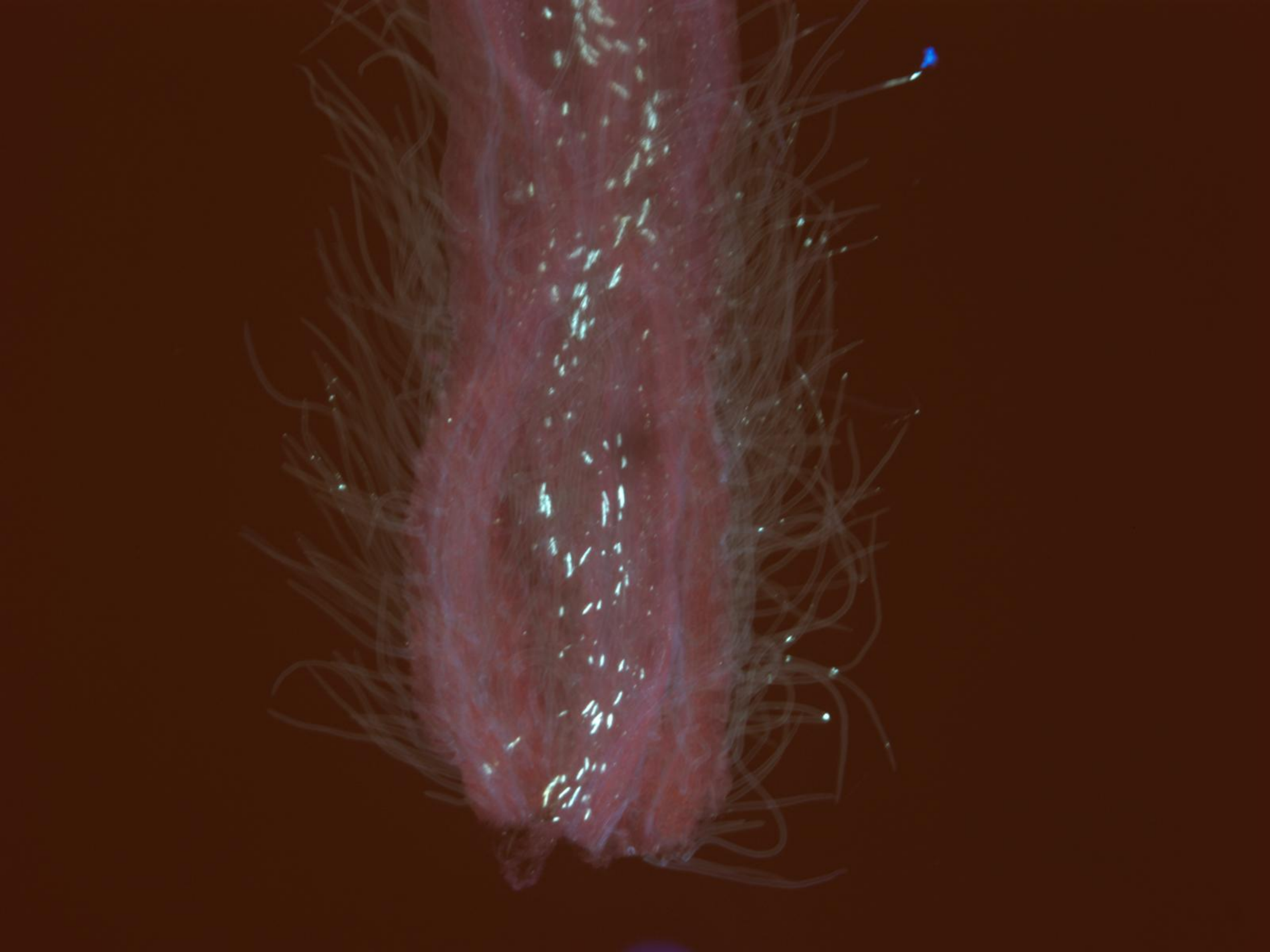


Image credit: Martha Schupp





Pollen tube growth is directed by resources and signals emitted by style and ovary tissues.

Factors that influence pollen tube growth

- Temperature
- Variety – Pistil and Pollen
- “Floral Strength” / “Flower Quality”

Temperature

- Warm temperatures
  - increase pollen tube growth rate
  - hasten the degradation of the stigmas and ovules
  - increase pollinator activity
- Cool temperatures
  - reduce pollen tube growth rate,
  - increase duration of stigmatic and ovule receptivity
  - Limit pollinator activity

- Extreme temperatures during bloom can be detrimental to fruit set

Crop load

- Crop load in previous year can influence floral structure

- While still functional, flowers from heavily cropped trees have a shorter EPP.

Limb angle

- Duration of ovule viability is shorter in upright limbs

Wood / Tree Age

- Blossoms from young wood and trees contain ovules of poor quality
- Exceptions to the rule? Gala?

Take Home Messages

- After pollen is deposited on the stigma, the course of pollen tube growth is dictated by chemical signals, genetics, and environmental conditions
- Temperature is a key factor in reproductive success - Mother Nature can be a cruel partner
- Crop load management, plant nutrition, and tree training can improve flower quality and the potential for initial fruit set

Practices that Hasten Floral Degradation / Inhibit PT Growth

- Significant emphasis is placed on *increasing* the number of blossoms that are pollinated and fertilized in commercial apple blocks
- An equally (or more) important effort is placed in *reducing* initial fruit set during and after bloom by **thinning**
- This is a glaring contradiction → yield, fruit size, and quality are met on an annual basis

Background

Benefits of blossom thinning include:

- ➢ Increased fruit size
- ➢ Improved return bloom

- Small fruited, biennial, and/or high value

- There has been a considerable research effort to develop new apple blossom thinners
- Several thinners have shown promising results
- Lack registered products

Limiting Pollen Tube Growth

- In the 1980's, several compounds were evaluated as bloom thinners on peach (Ross Byers)
- Surfactants, desiccants, long-chain fatty acids, coatings/films, and oils

2% ATS

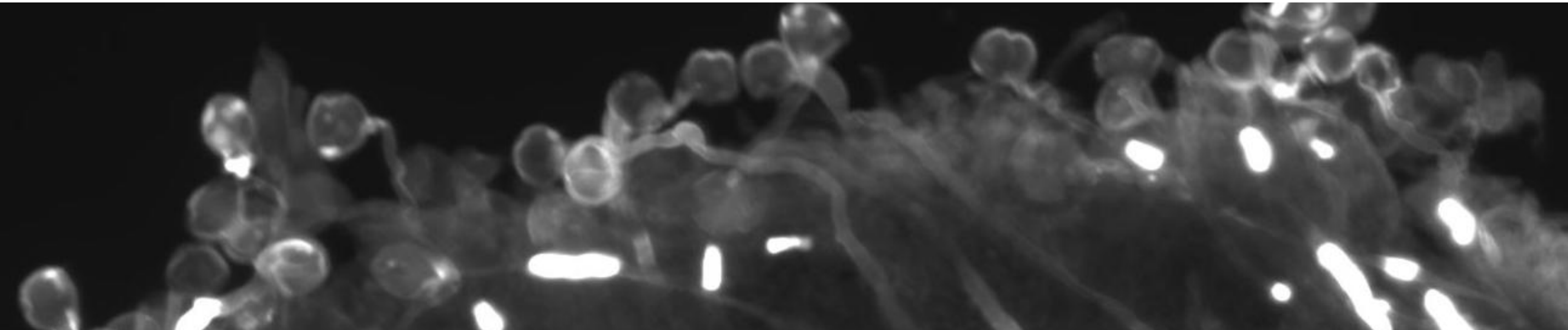
2% Lime Sulfur + 2% Stylet Oil

Blossom thinning treatments that only influence the **target**?


Milwaukee
HEAVY-DUTY

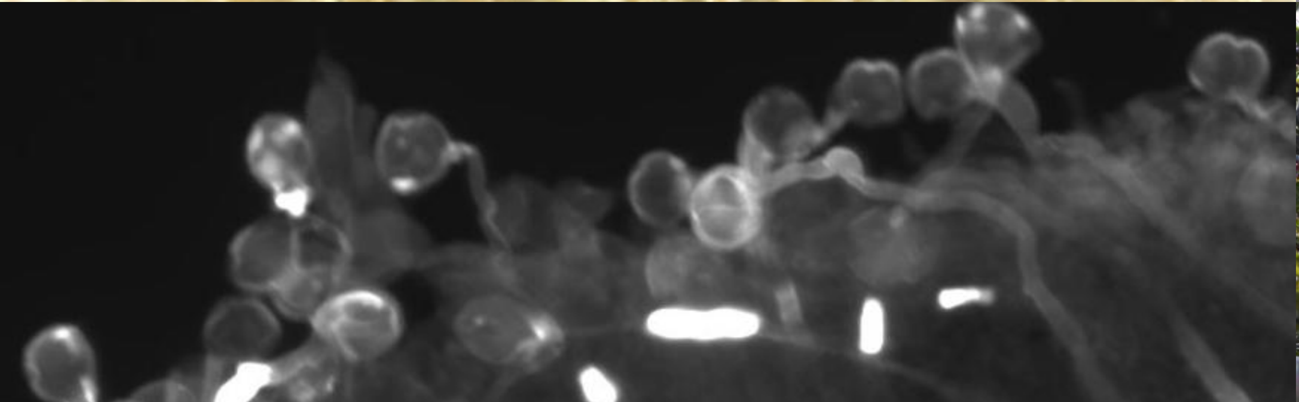
Objectives

- Evaluate the use of short duration forced heated air treatments (thermal shock; TS) as a blossom thinning strategy
- Determine effects of TS output temperature and treatment duration on:
  - Pollen tube grow in vivo
  - Spur leaf injury



Materials and Methods

- 'York' –solitary king blossoms
- Emasculated at late balloon stage
- Excluded from pollinators
- Hand pollinated with 'Rome' pollen
- Treatments applied 24 h after pollination

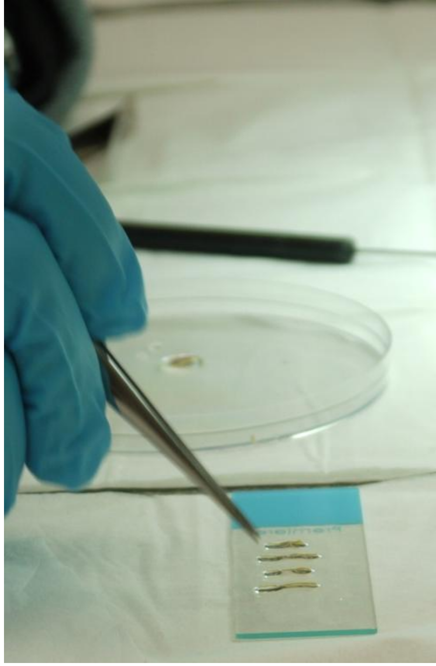
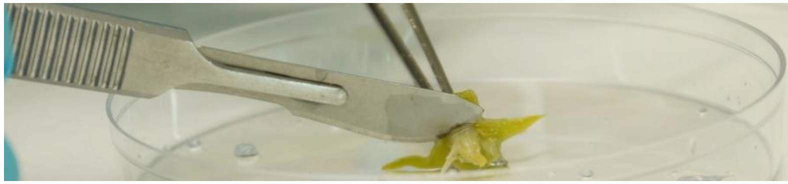


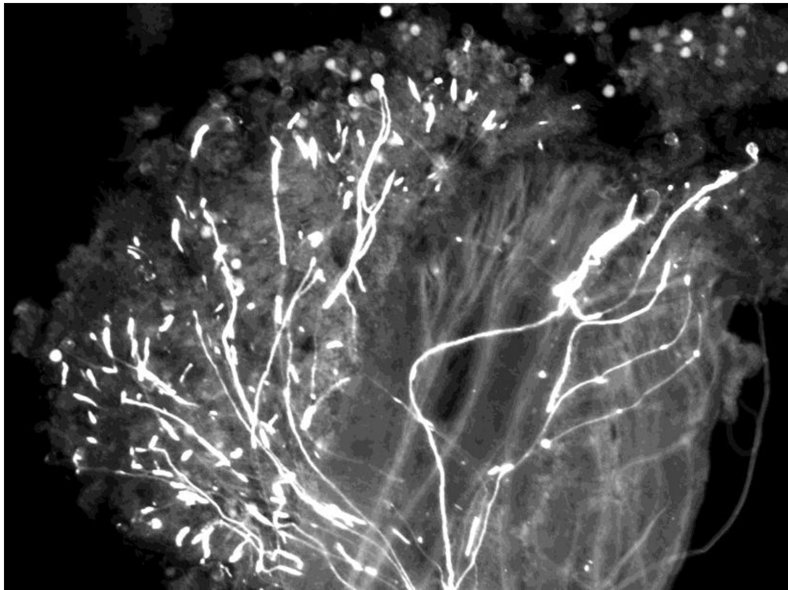
- Range of temperatures [64 ˚F - 181 ˚F]
  - Variable temperature heat gun
  - Data logging thermocouple
  - Constant distance from target (2 cm)

- 4 levels of duration (s) [0.5, 1, 2, 4]

Materials and Methods

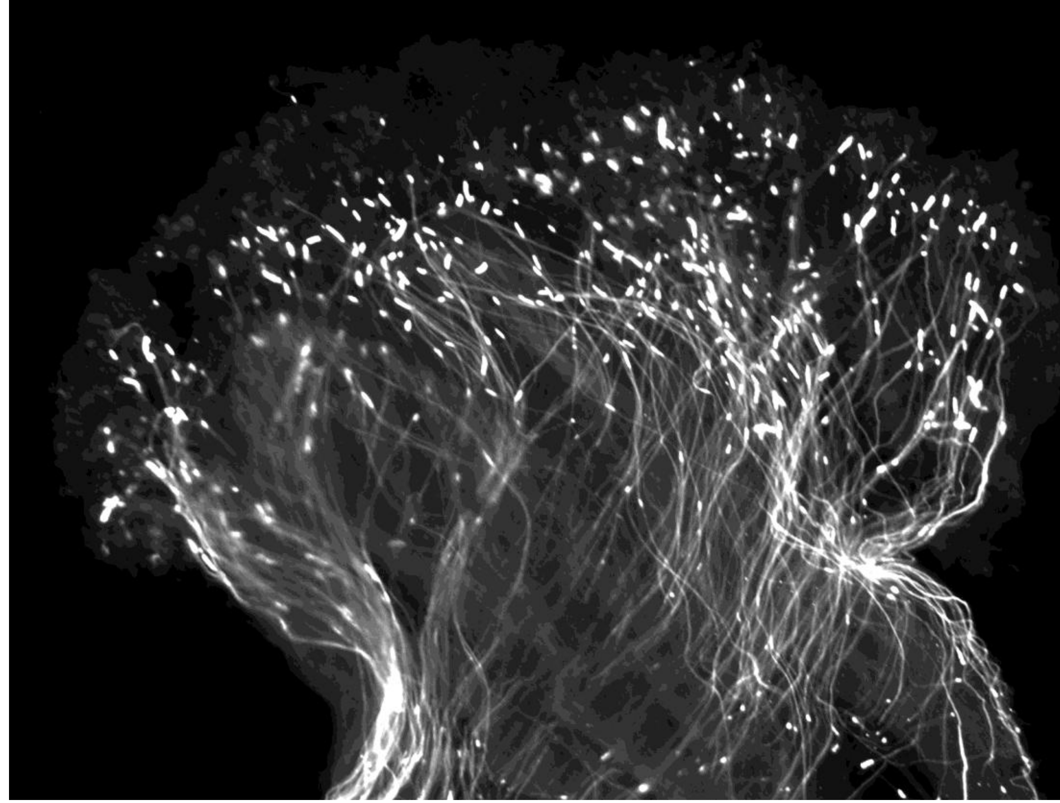
- Blossoms collected 96 h after pollination
  - 5% sodium sulfite; stored at 4 ˚C
- Pollen tube growth was visualized using fluorescence microscopy

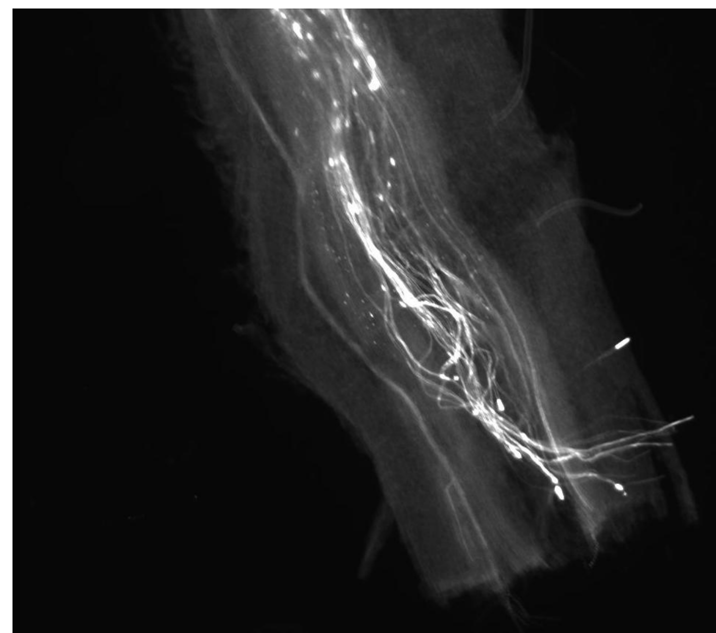






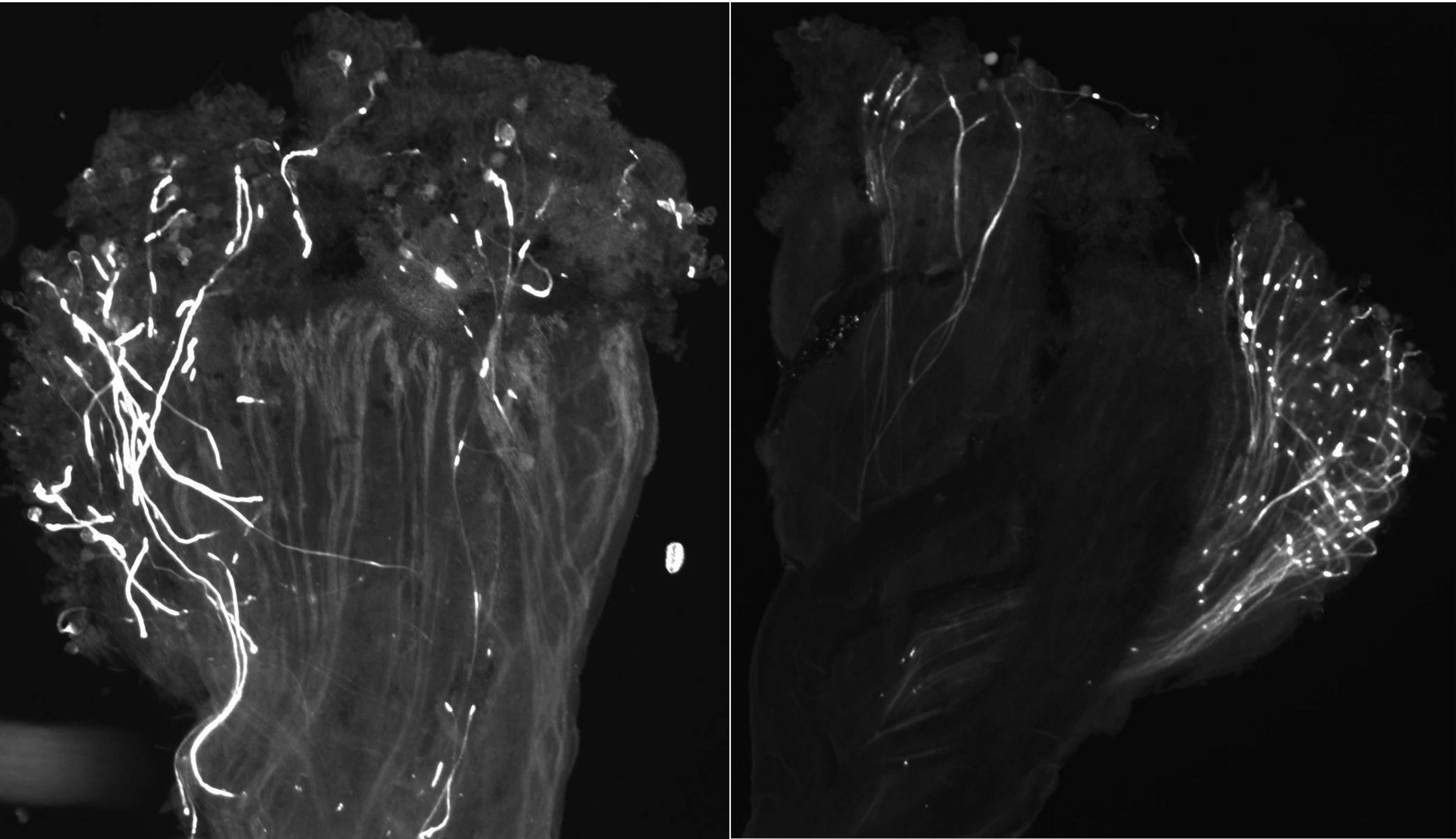
Response Variables

- Pollen density rating on stigmatic surface
- No. pollen tubes entering the style
- Length of longest tube
- No. pollen tubes at style base





Pollen density and # of pollen tubes entering the style – were not influenced



Thermal shock effects on visible spur leaf injury

- A range of heat treatments [133 – 198 ˚F] and durations [0.5, 1, 2, 4 s] were applied directly to spur leaves
- Visible leaf injury was evaluated 7 d after treatment

Rating Scale
1 = none visible;
2 = trace to 10% leaf;
3 = 11-24% leaf;
4 = 25-49% leaf;
5 = 50% - 74%;
6 = 74% - 100%

Summary

- At the temperatures tested,

  - Short duration treatments (0.5 and 1.0 s) did not reduce pollen tube length

  - Pollen tubes still reached the base of the style

- Pollen tube growth was reduced/arrested at:
  - >133 ˚F at both 2 and 4 s durations

- Effective treatments reduced/arrested pollen tube growth 24 h after pollination

Summary

- > 10% visible spur leaf injury occurred:

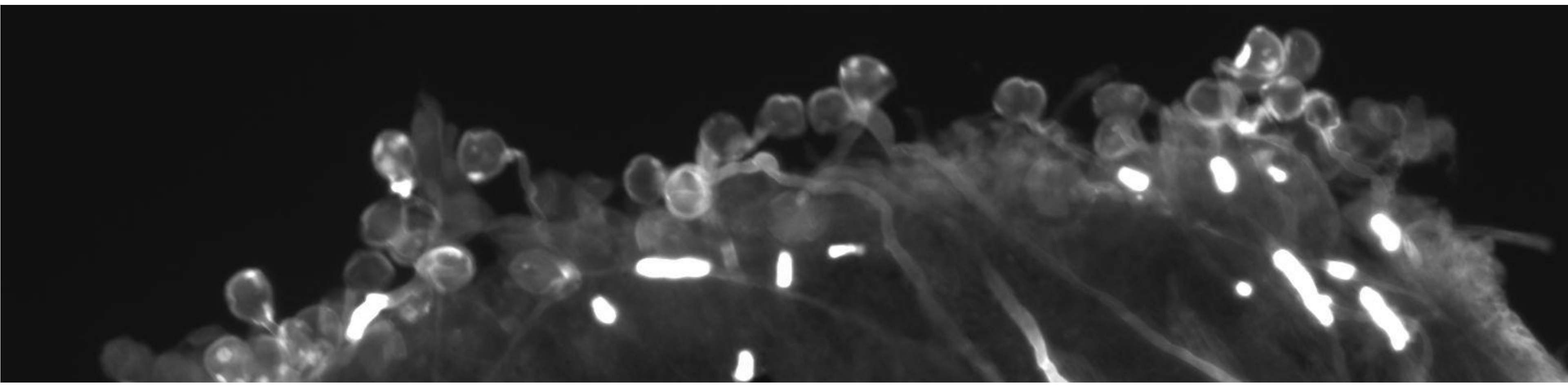
  >158 ˚F @ 2 s

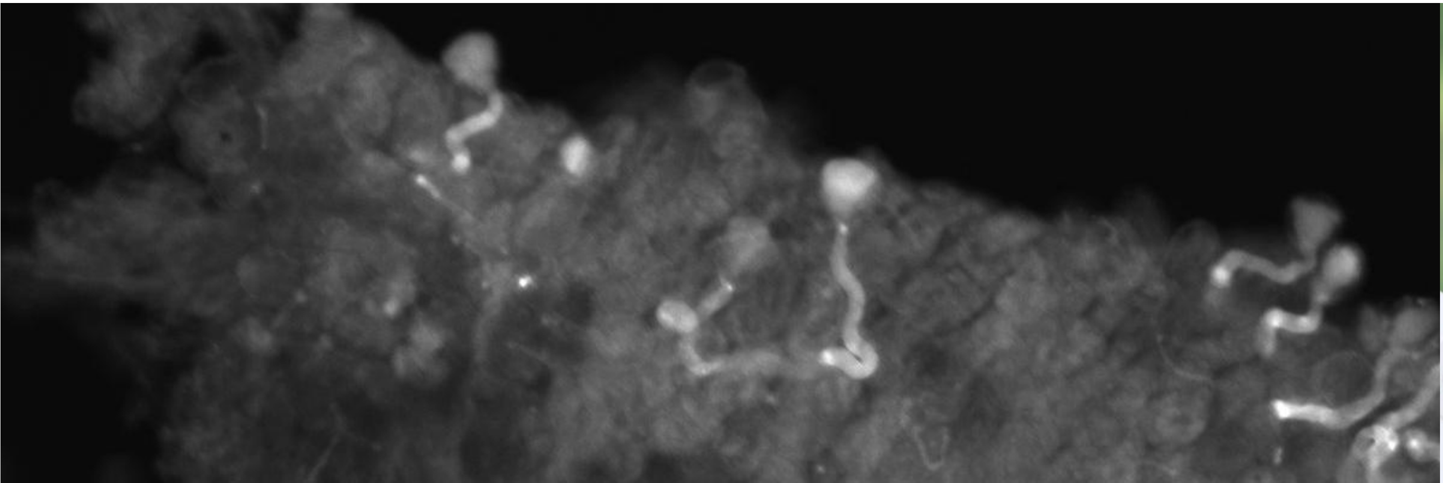
  >133 ˚F @ 4 s

Pollen tube growth was reduced/arrested with treatments that caused minimal visible injury to spur leaves

Suggests a difference in thermal sensitivity between tissues

- The duration of stigmatic receptivity can be reduced via thermal shock treatments
  - However, these treatments damaged spur leaves
  - Not a key factor in the mode of action





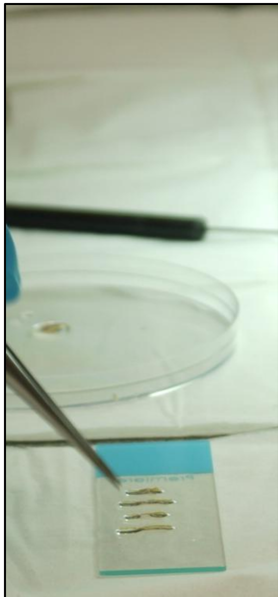
Summary

- Early thinning options in the Mid-Atlantic are limited
- Our research was intended to determine if thermal shock has potential as a blossom thinning strategy
  - On a small scale, outcomes appear promising
- Next Steps?

Acknowledgements

- Melanie Schupp, Edwin Winzeler
- Rob Crassweller, Paul Heinemann, Rich Marini
- Keith Yoder, Greg Peck, Leon Combs
- Kari Peter
- Student Interns: Brady Griest, Martha Schupp, Mason Unger, Tyler Van Dyke, Matthew Wagner
- Eric Anderson and Freeman Showers
- Plant Science Department: Penn State



Thank you for your attention!

We gratefully acknowledge the State Horticultural Association of Pennsylvania for providing funding for this work!