Water Deficits and Yield in Maize:
Functional Reversion of Floral Abortion

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Problem

Water deficits cause floral abortion in crops

Water deficits affect expression of most genes

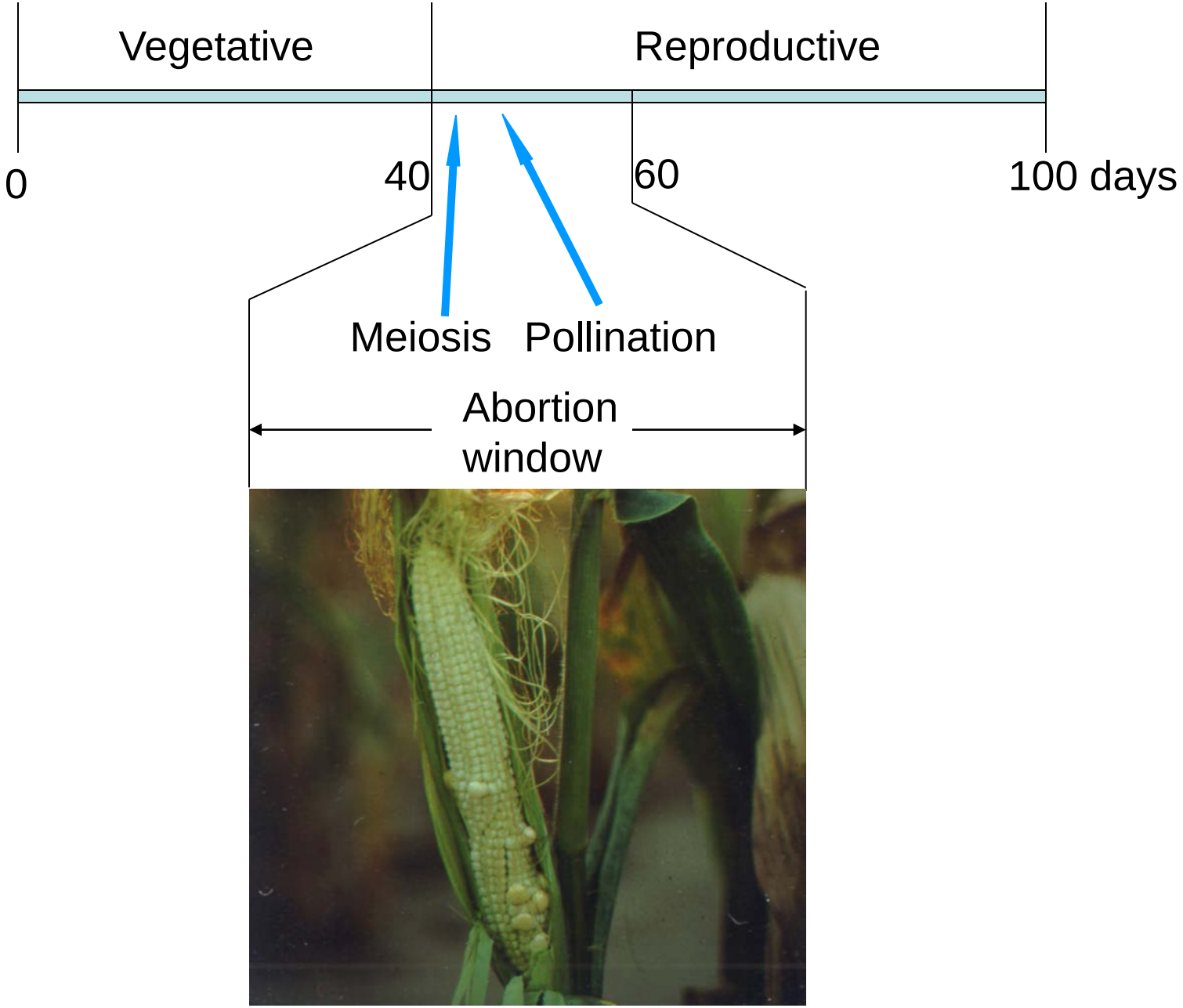
Which genes control abortion?

Drought of 1988 in Lewes, DE

50% height

15% kernels

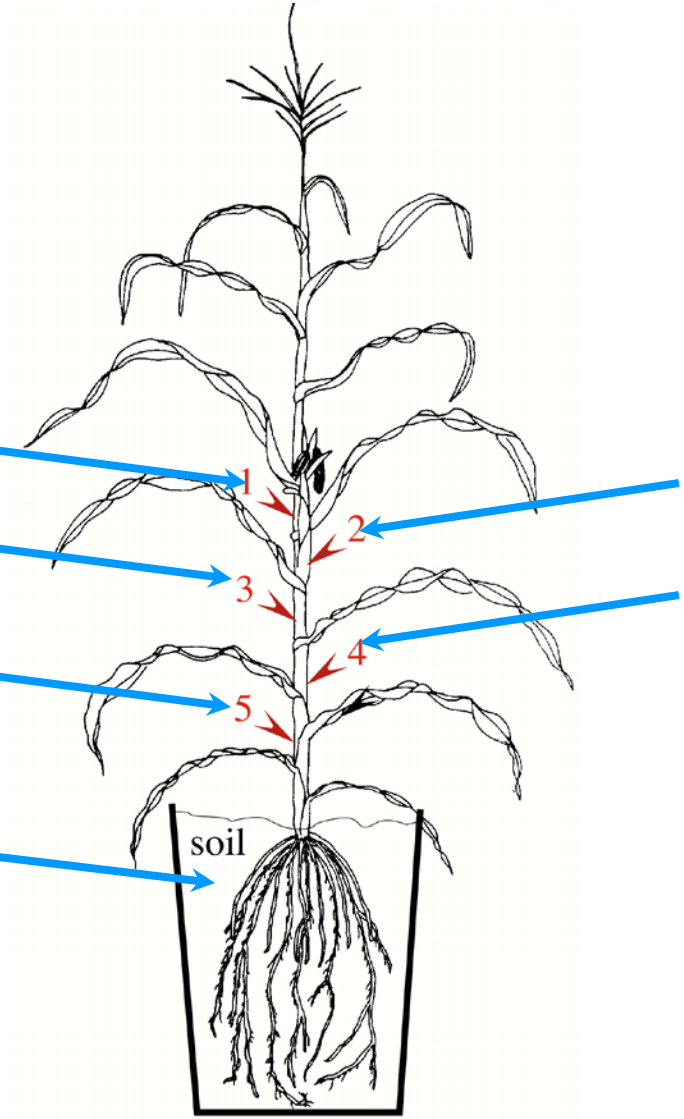
Maize Life Cycle



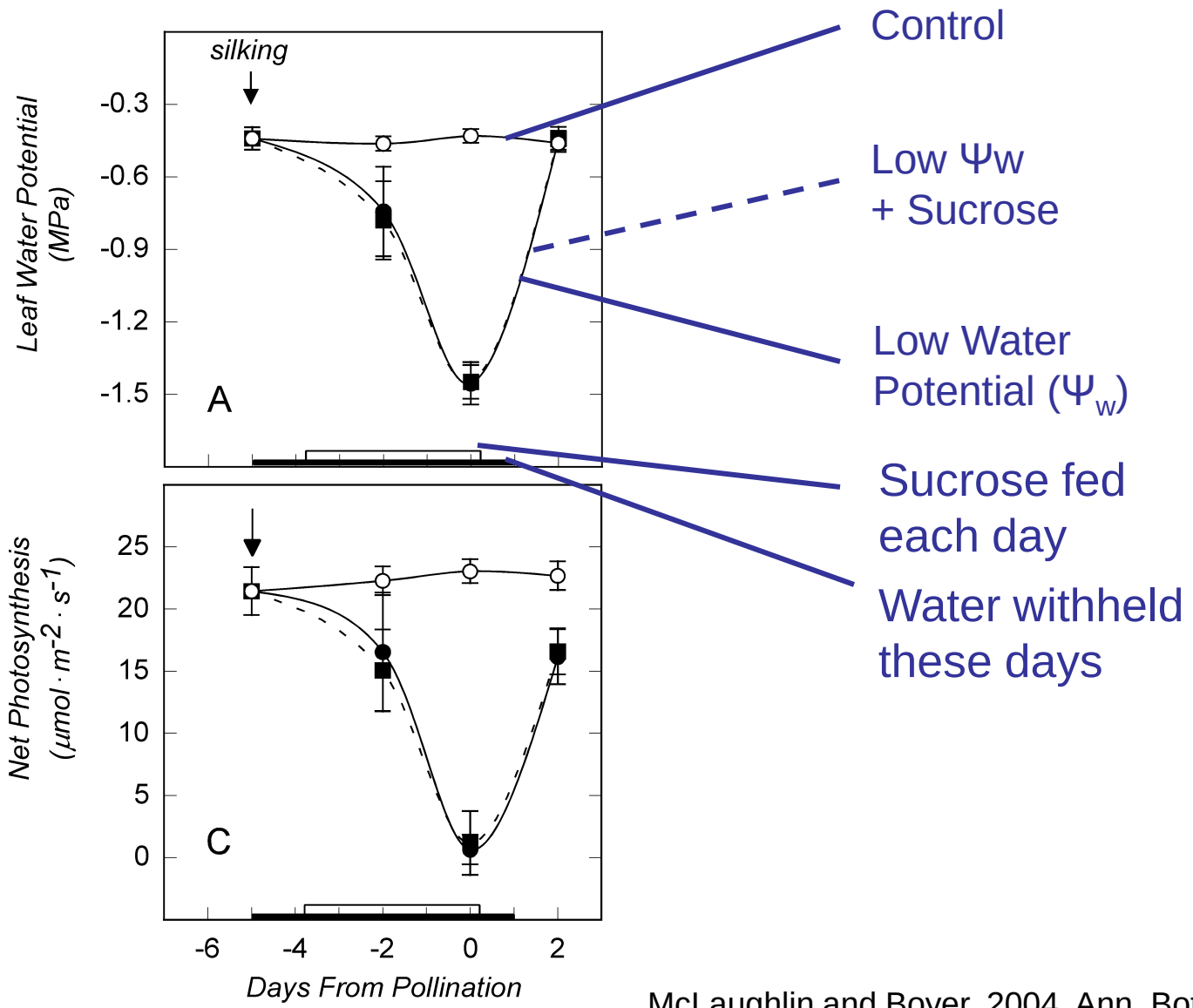
Supplying Sucrose During Water Limitation

Infuse sucrose here on first day

Withhold water
for five days



Only a Few Days of Low Water Potential and Low Photosynthesis Trigger Abortion



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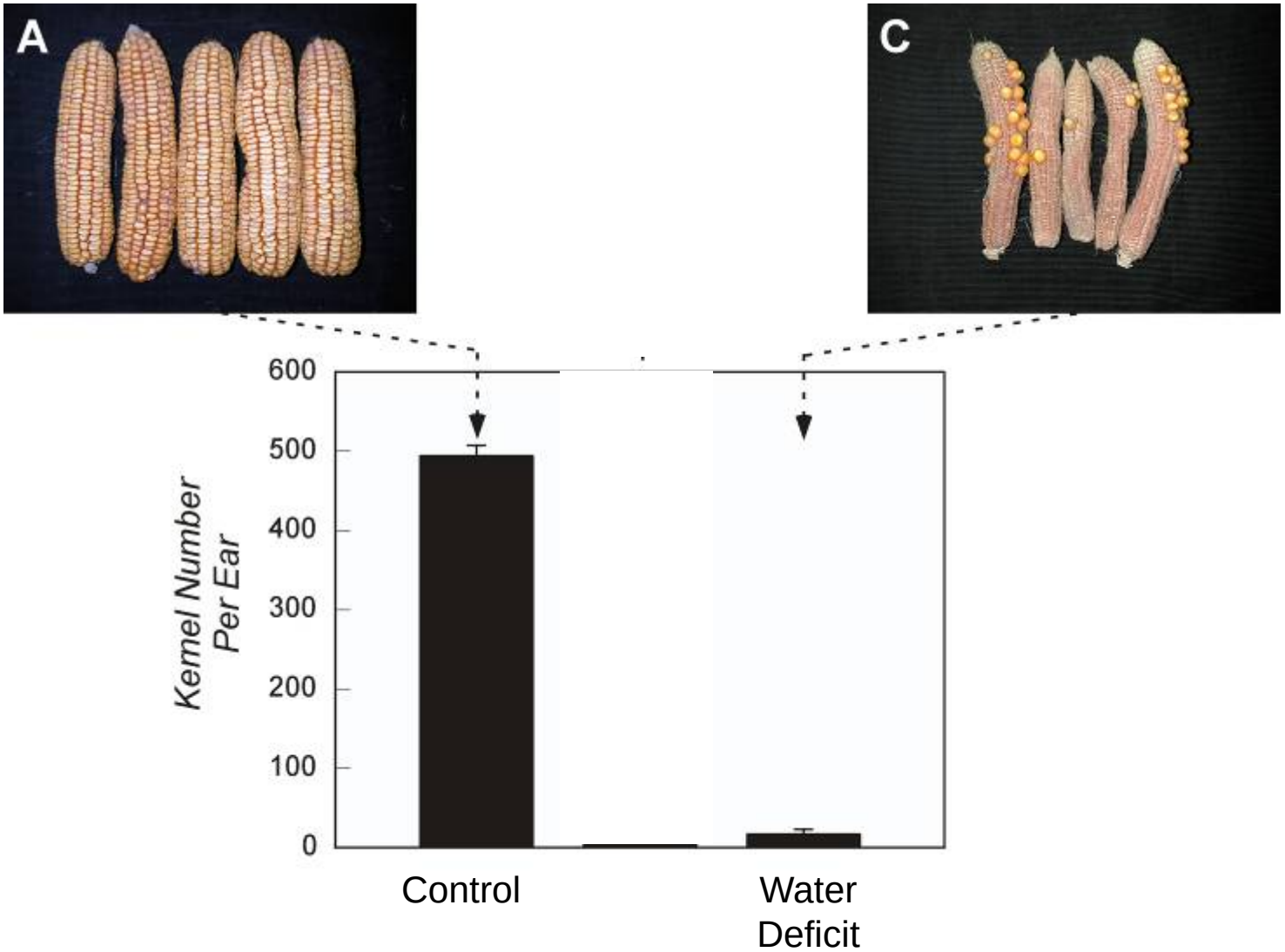
Functional Reversion



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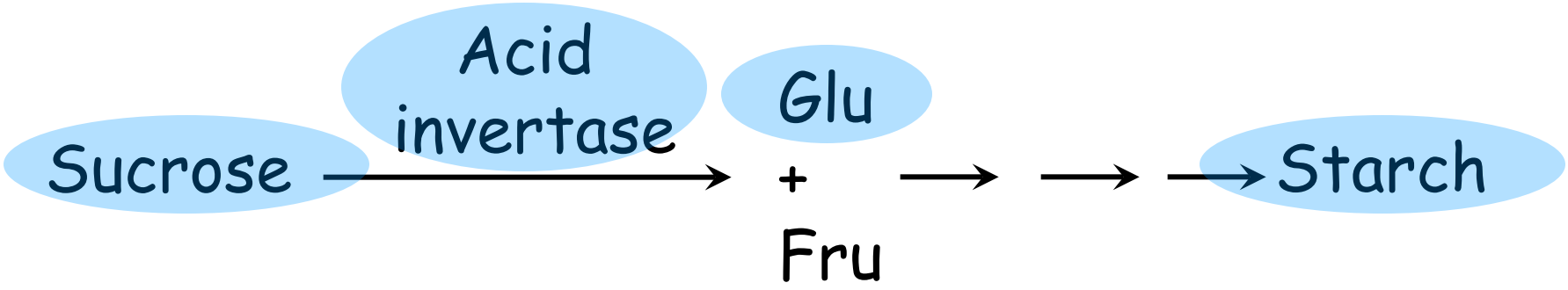
Conclusion from Field/Lab Work

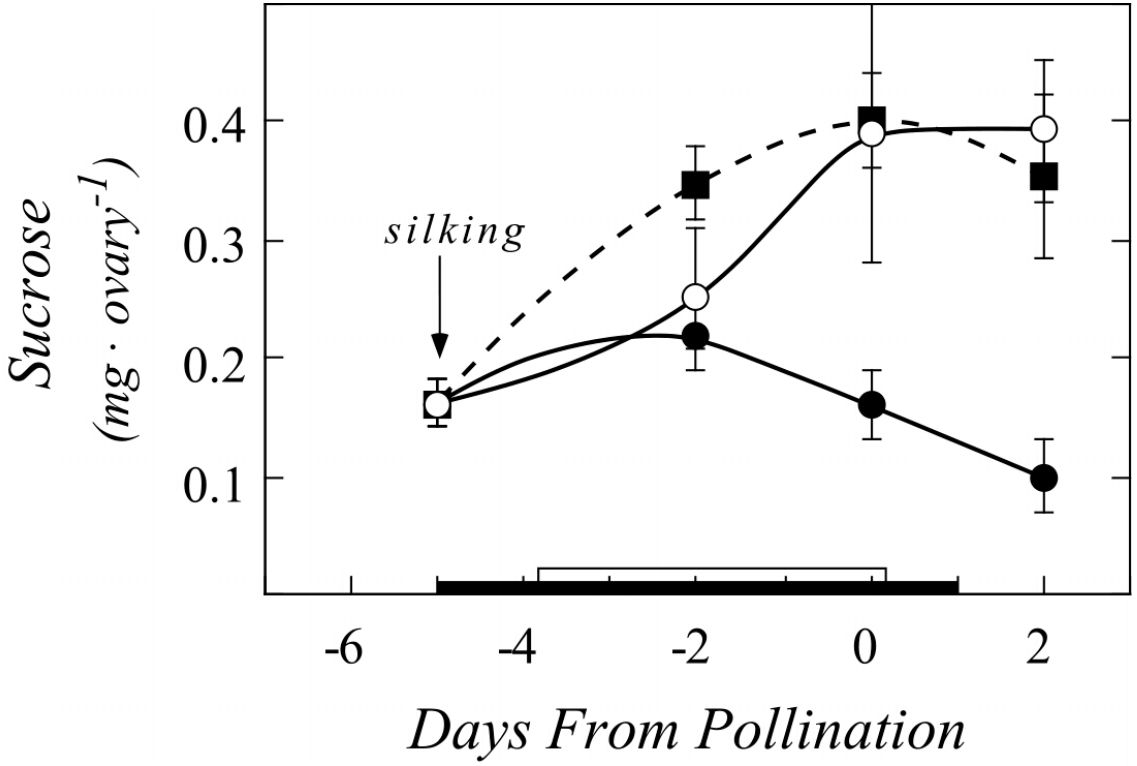
Sucrose fed to parent in photosynthetic quantity prevents abortion

What physiology/biochemistry causes abortion?

Photosynthesis Supplies Mostly Sucrose to the Ovaries, Which Hydrolyze It With Acid Invertase



Sucrose Delivery to Ovary



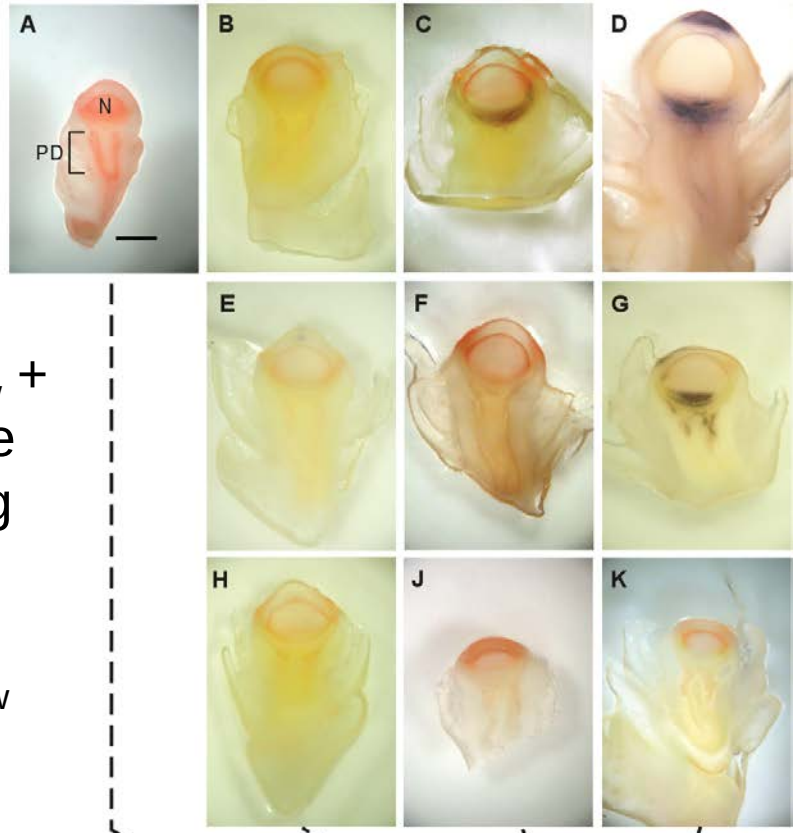
Zinselmeier et al. 1999. Plant Physiol. 121: 25

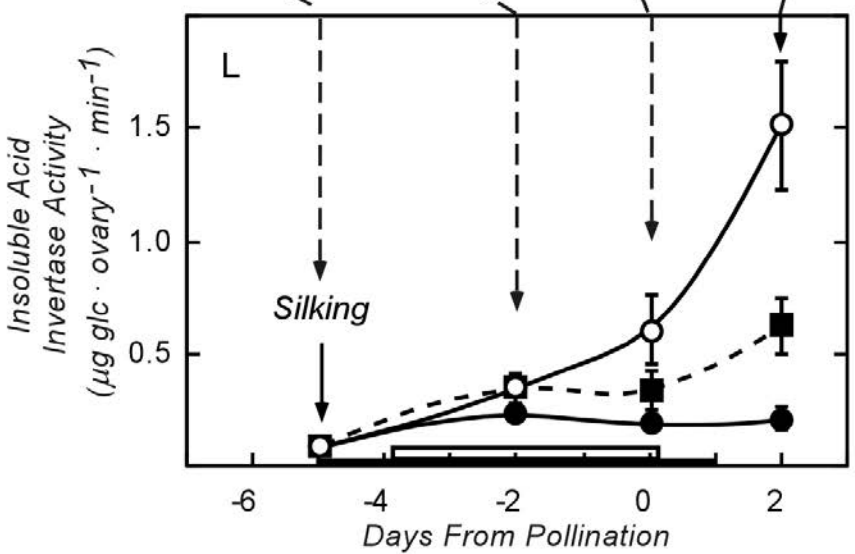
Ovary Invertase in Cell Wall

Control

Low Ψ_w + Sucrose Feeding

Low Ψ_w





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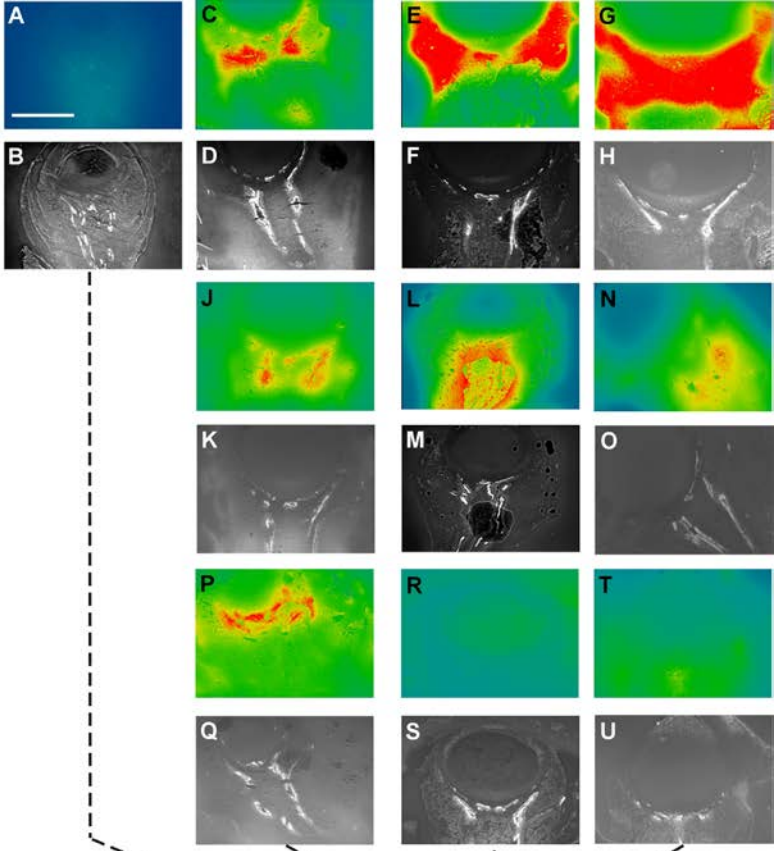
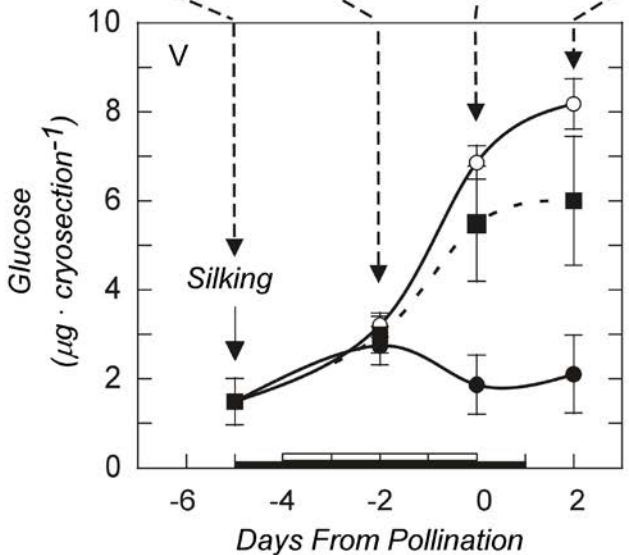
Ovary Glucose

Control

Low Ψ_w + Sucrose Feeding

Low Ψ_w





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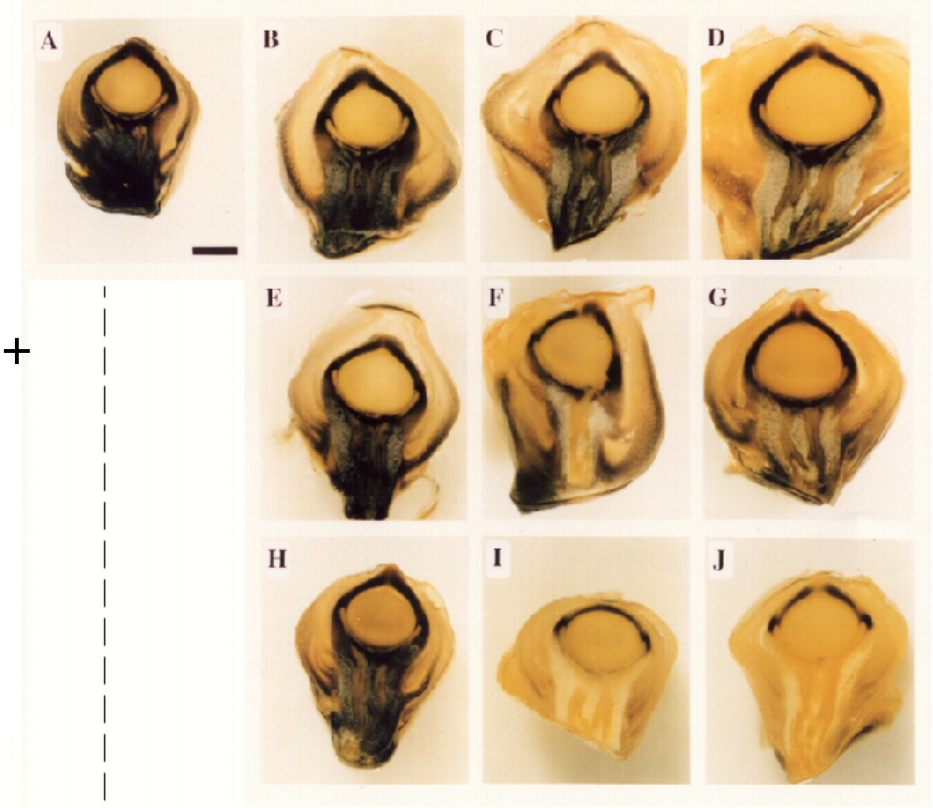
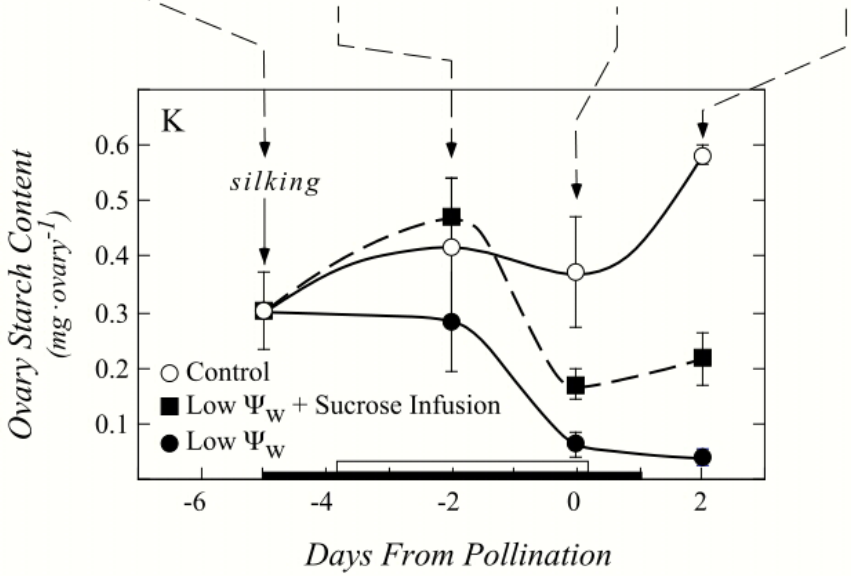
Ovary Starch

Control

Low Ψ_w + Sucrose Feeding

Low Ψ_w





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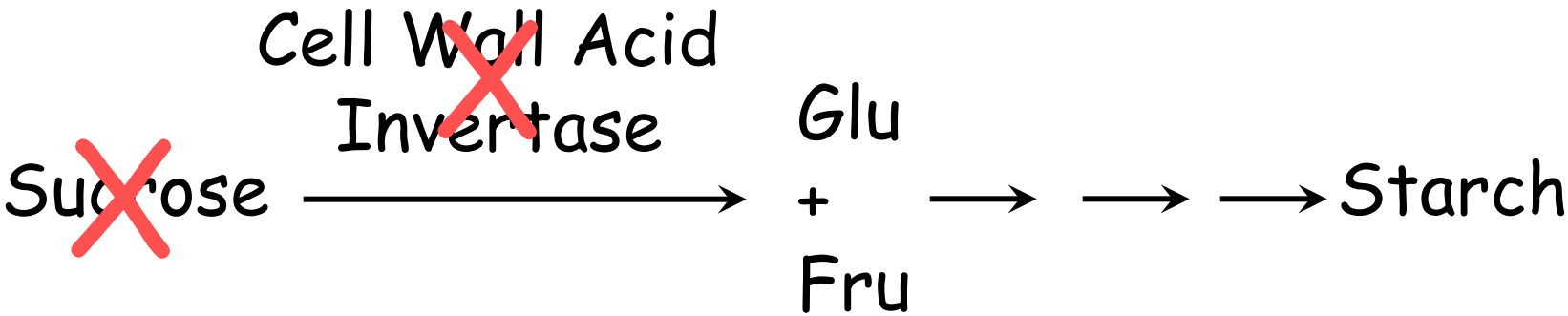
Low Sucrose Delivery + Partial Block of Invertase

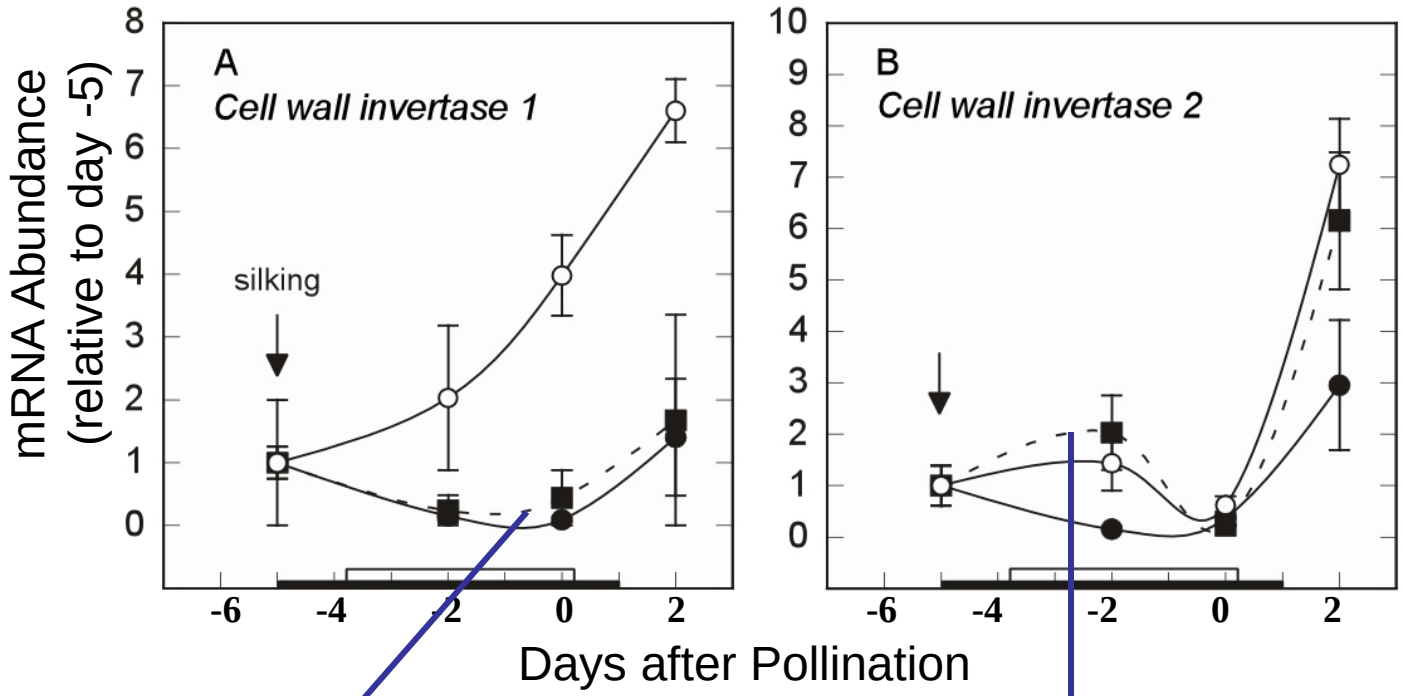


Summary

Lack of photosynthesis starves female floret, causing abortion after starch is depleted

Do florets simply starve, or is active gene regulation also involved?

mRNA Abundance for Ovary Genes for Cell Wall Acid Invertase



Not sugar-responsive

Sugar-responsive

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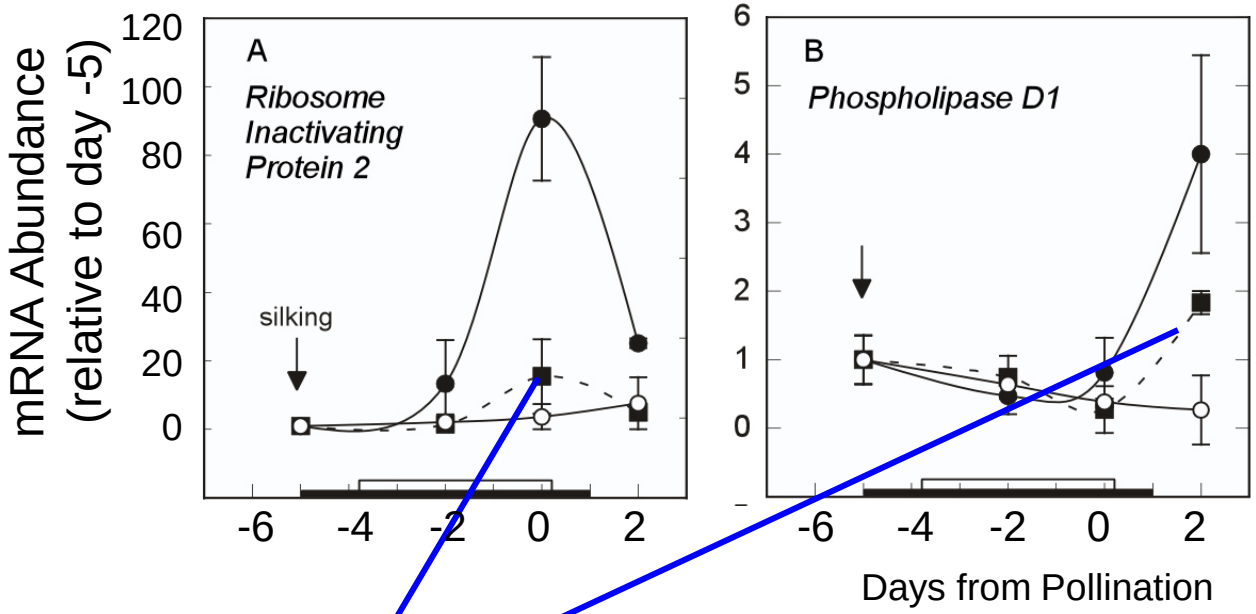
Ovary mRNA's for Senescence Enzymes



Sugar-
Responsive

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Does Senescence Occur?

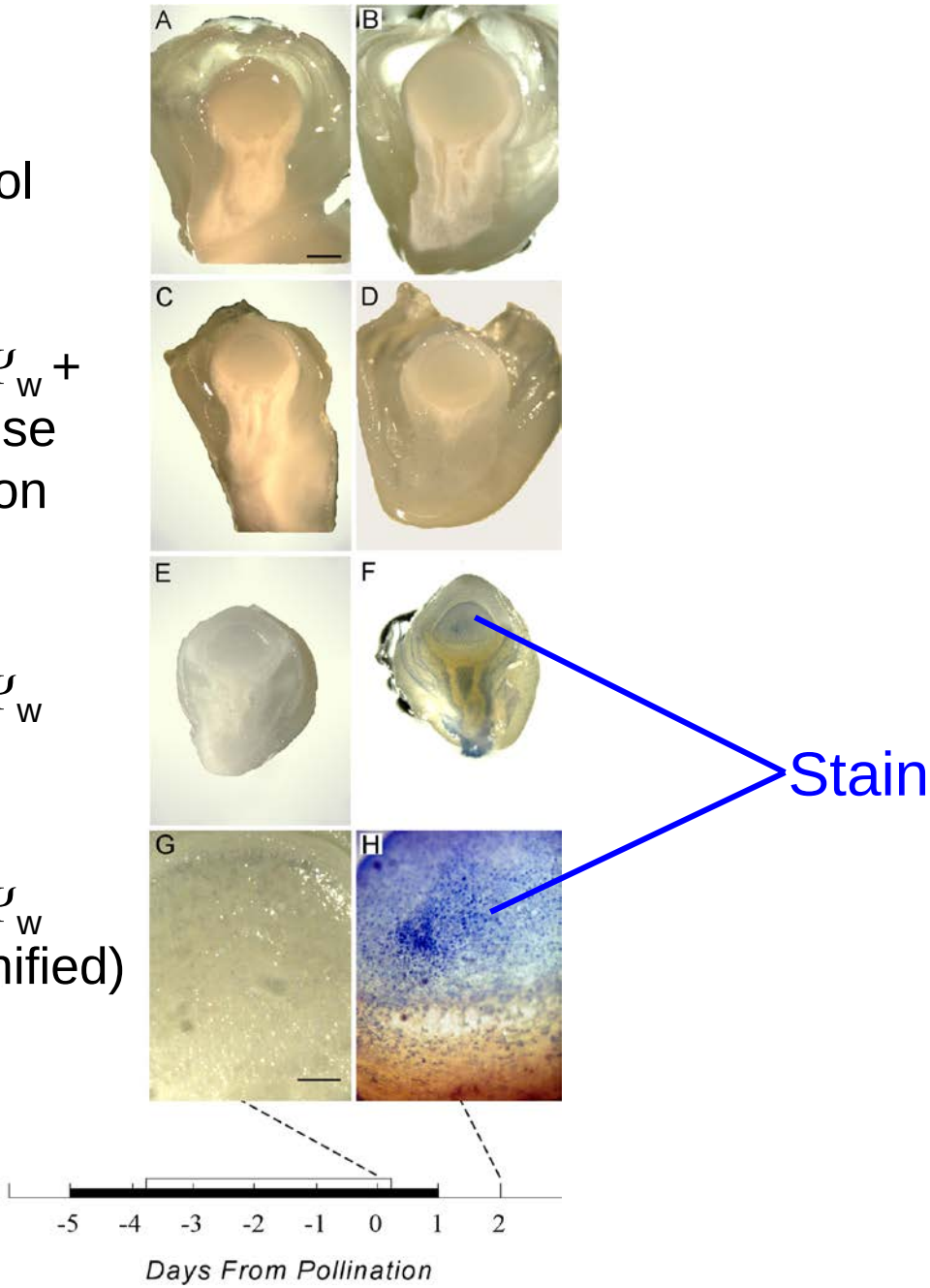
Evans Blue Stain for Loss in Membrane Integrity

Control

Low Ψ_w + Sucrose Infusion

Low Ψ_w

Low Ψ_w (magnified)



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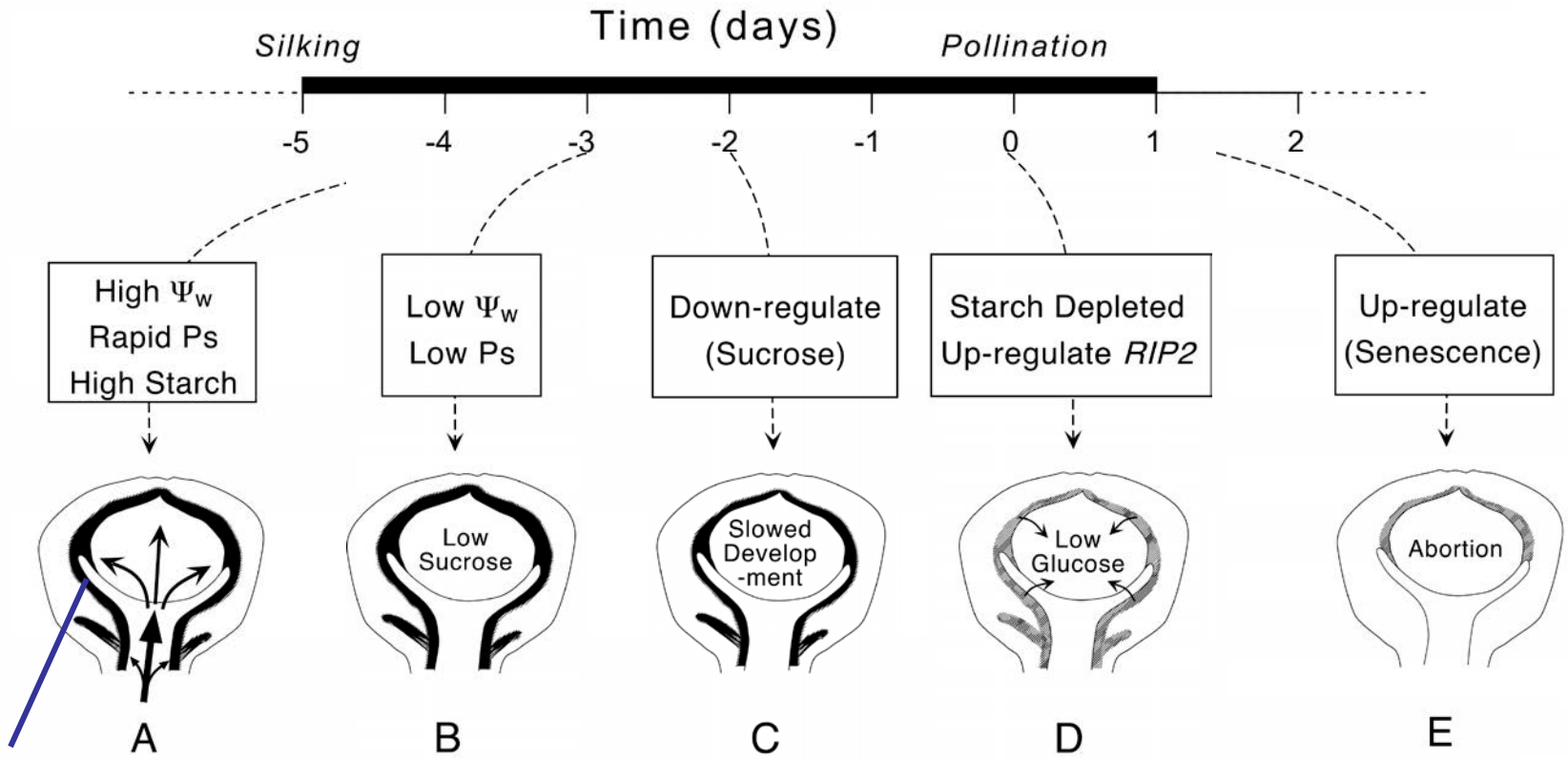
SUMMARY



Starch

Irreversible Step?

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Summary

Around the time of flowering in maize,

- hundreds of genes change expression when water becomes limited
- among the hundreds of genes, functional reversion identified four controlling ovary abortion
- the four included senescence genes that responded to sugar supply, probably glucose
- irreversibility required a few days to deplete the sugars that triggered the senescence genes

COLLEAGUES

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