Chilling paper(s) notes

Lizzie, Fredi, Jonathan Auerbach on some

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Contents

1 Meeting notes

1.1 4 December 2023: We meet again on this!

In the morning we had a big conversation about what is the model for leafout, especially for 'chilling.' Questions we ended up with:

1. Dormancy depth as measured by forcing units needed (days at 20°C in Fredi's 2021 paper for example) – is that an okay response variable or do we not understand forcing enough and days should be the response? If so, how do we model it altogether?
2. Should we model % or days or % over days?
3. Also, exciting short conversation on bet-hedging and leafout!
   (a) Should we model buds as cohorts and include variability as an expected response? (**Bet-hedging and buds**)
   (b) In Fredi's experiment, some species never burst much about 50-60% ...
   (c) If bet-hedging is happening but we assume % budburst is related to dormancy depth, we may confuse the two completely.

Then we chatted with Jonathan Auerbach – notes mainly in my green/gray notebook but a few here:

1. How to model experiments and observations together (Lizzie's eternal dream)
2. Renewal theory is basically the bucket model

3. What could we hope to do?
    (a) Figure out what our current experiments DO show. For example, can we show that chilling affects forcing? (Can we show it's not just time, but that temperature matters?)
    (b) What can we say about chilling and forcing with current data? Given this is probably not much given identifiability issues ...
    (c) What assumptions can we make that would allow us to say more?
    (d) What are the critical experiments that would test assumptions or really advance things

In the afternoon we brainstormed: **Points to cover in paper and/or /disturbing problems/issues:**

1. Is the model two-stage or parallel (or both, but depends on species ID)?
2. We cannot (and do not) fit the experimental and observational data together.
3. Models are basically made-up based on old studies ...
4. Where does evidence/theory come from for current models of chilling?
5. Models are non-identifiable
6. Hardiness vs. dormancy
7. Temperature fluctuations
8. Influence of time without any other effects
9. Photoperiod – during 'chilling' and during 'forcing'
10. List out big things that matter and maybe smaller things that matter
11. Transition time from endo to ecodormancy – is it instantaneous or gradual? What do we know from callose?
12. What is the callose model? What temperatures is it degraded at? When is it built? What exactly is it blocking between cells (hormone etc.)? – How does it compare to the two-stage and parallel model?
13. Hormones and dormancy?
14. Molecular evidence etc.
15. Corollaries with seeds
16. Dormancy depth (forcing needed after putting in warm temperatures) since budset through to next budburst

17. GDD model is based on development – but do we know if this is correct? It may be more like a timer that also runs (differently for each species). What is structural growth? Maybe none of it? GDD is from crops and is mainly structural growth, even though we don't think structural growth is happening during budburst?

18. Basically, what's chilling? And what's forcing?

19. What we don't know with chilling

    (a) What temperatures accumulate chill? Can it be really low? Can it be really high? What do freezing temperatures interrupting this do?

    (b) Can accumulated chill be negated?

    (c) Is it just time?

    (d) Just to confirm: Chilling happens below 10 C only/mostly?

20. Relevance of chilling in subtropical trees.

We need to. ...

1. Understand the progression of the major old literatures that lead to the Utah model and the other model (Fishman? This is precursor to dynamic chill?).

2. Confirm how these models were extrapolated to forest trees (or at least compare them to the current forest tree models) – we could just ask Isabelle about this and check Harrington papers and Murray et al. 1989

3. **Remember** to Never re-read chill models, just read old notes I have

4. Divide up lit review tasks ...

    (a) Fredi does all OSPREE papers with negative chill or freeze... (Lizzie sends them to him, see getchill.R)

    (b) Somebody does dormancy induction OSPREE papers

    (c) Lizzie does the old modeling papers

Tomorrow!

1. Arrive having read Isabelle's 2016 paper

2. Make a broad outline ... some points already

    (a) Callose model vs. the current models (Lizzie has old notes, see notes within `chillingrefs_holidayedi`

    (b) What determines dormancy release?

        i. Time alone

        ii. Time at different temperatures: < 0, 0-10, > 10 ...

        iii. What do high temperatures do to 'chilling'

    (c) % versus time to BB: what tells us what?

(d) What are feasible models?

i. What would be the best model?

ii. What do what know about what plants can measure?

3. Officially divide up tasks and decide when feasible/best to do them

4. If time allows, work on callose model/papers

1.2 Thinking ahead on 3 December 2023 before meeting tomorrow

I think a good lit review could be in order for this paper ... but we'd need to think hard about how to do it. We'd likely want to include endo and ecodormancy (how well they measured it and included it ...). Then I just worked up `chillingrefs_holidayedition.pdf`

1.3 Notes from very brief chat with F. Baumgarten on 1 November 2022 about writing a concept paper on chilling

Next steps:

1. Fill in outline, esp. the what we know on chilling

2. Pull the OSPREE papers and compare across the different questions (subzero temps, intermittent warm etc.) – are there any consistencies?

3. Read all the old papers I have pulled!

4. Read all our old notes, organize ...

Outline... Coming out of the dark ... the critical role of photoperiod in chilling
Fig 5.1 — Baumgarten discussion

1. What is the known (and possibly known) biology of of chilling?

   (a) Optimal chill

   (b) Intermittent warm periods

   (c) Subzero temperatues

   (d) Fall temperatures

2. What are the chilling models?

   (a) Utah

   (b) Chill portions ...

   (c) Adapting to each species' optimal chill (and Lizzie's worries over this)

3. So what do we really know (esp. maybe to improve chilling models or at least approach them with caution when we interpret them) ... What are the biases/uncertainties given all this? What is definitely known?

   (a) If we don't know chilling then we have issues with forcing also ...