The Photoperiod Response Pathway in *Physcomitrella Patens*

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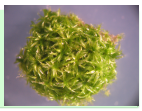


Abstract

The generation of reproductive structures in most flowering plants is controlled by a pathway that responds directly to photoperiod length. This pathway contains several components including the circadian clock, and down stream genes that regulate flowering, including CONSTANS and FLOWERING TIME (FT). Certain aspects of this pathway, like FT genes, are believed to have evolved from genes in pathways in ancestral plants. *Physcomitrella patens*, a moss that is ancestral to many plants, has a reproductive pathway that is not well known, though we believe it has a few similarities to the angiosperm pathway and is photoperiod dependent. This study used seventeen European accessions of *P. patens* that have been reproductively isolated in different photoperiods to explore how similar the reproductive pathway is to that of angiosperms. After the accessions were grown in different photoperiodic conditions, we observed differential responses in various accessions, confirming some preliminary predictions about response. Next, the expression levels of genes called MFT, that are believed to be similar to FT, a crucial gene involved in the pathway in angiosperms, will be analyzed. This research will determine whether or not these genes in *P. patens* are photoperiod dependent, if these genes play a role in the photoperiod response pathway, and whether they play a similar role as the genes in angiosperms.

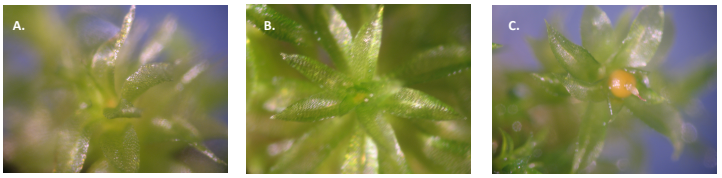
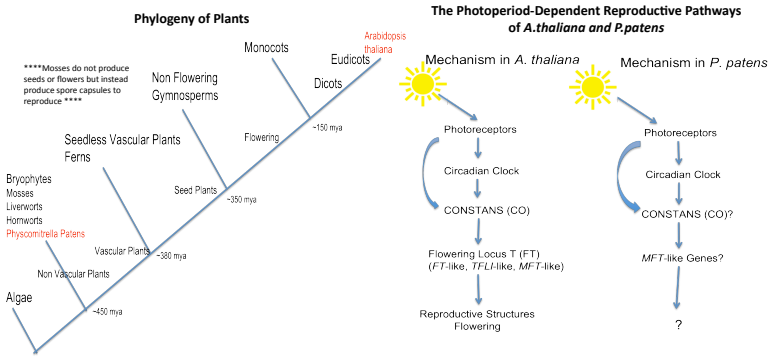


Figure 3: *P. patens* antheridia, archegonia, and spore capsule. **A**. Antheridia, the male reproductive parts, typically emerge first, and are characterized by orange/brown ball shaped structures within the stem. **B.** Archegonia, female parts, emerge next, and are characterized by white stalk-like structures that hang over the antheridia. **C.** Spore capsules (sporophytes), the diploid offspring, emerge last, and begin as light green capsules on the end of the stem, eventually turning brown and splitting open.



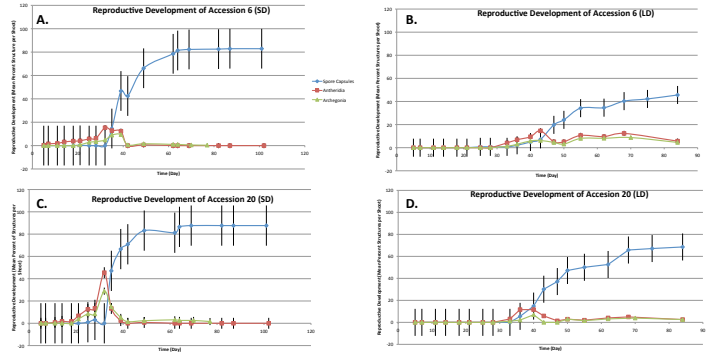
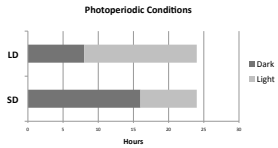


Figure 4: *Reproductive Development of Selected Accessions in Short and Long Day Conditions.* **A.** and **B.** Development of antheridia, archegonia, and spore capsules for accession 6 SD (A) and LD (B) conditions. **C.** and **D.** Development of antheridia, archegonia, and spore capsules for accession 20 in SD (C) and LD (D) conditions. Error Bars =95% CI.

Accession #	Locality
2	Cholsey-K5 (UK)
3	Gmünd-K4 (GER)
4	Gmünd-K3 (GER)
5	Gmünd-K1 (GER)
6	Gmünd-K2 (GER)
7	Honnef (GER)
9	Martinshof-K2 (GER)
10	Helmerbrühl-K3 (GER)
13	Haute Saone-K4 (FR)
19	Nene Washes-K1 (UK)
20	Trondheim -K2 (NOR)
29	Helmerbrühl-K1 (GER)
31	Nene Washes-K2 (UK)
32	Nene Washes-K3 (UK)
33	Cholsey-K1 (UK)
34	Cholsey-K2 (UK)
37	Uppsala-K1 (SWE)
38	Uppsala-K2 (SWE)

Figure 1: Selected accessions from various regions are shown. Note the variation in latitude of the regions. Place markers with a dot correspond to patterned rows in the table above.



P. patens was grown in short day and long day conditions (13°C) on BCDppm plates (8 clumps/plate). At least one plate of each accession was grown in both SD and LD conditions, certain accessions had multiple replicates.

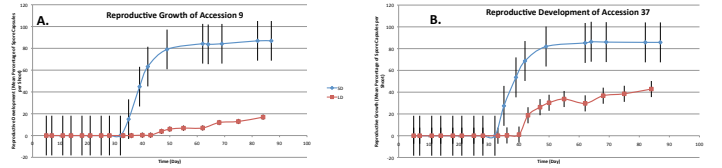


Figure 5: *Comparing Growth of Accessions in SD and LD Conditions.* **A.** Development of spore capsules for accession 9 in SD and LD conditions. Accession 9 developed earlier and produced more spore capsules in SD conditions than in LD conditions (ANOVA, DF=1, F=13.30, P=0.001). **B.** Development of spore capsules for accession 37 in SD and LD conditions. Accession 37 developed and produced more spore capsules in SD than in LD conditions (ANOVA, DF=1, F=6.97, P=0.012). Error Bars =95% CI

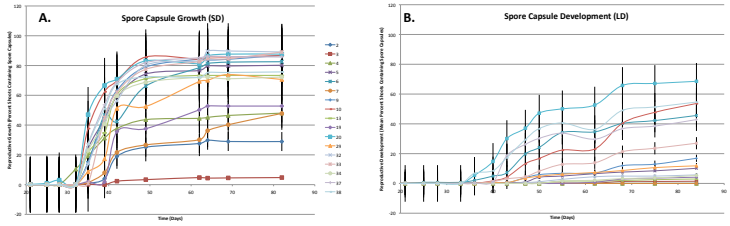


Figure 2: *Spore Capsule Development in Short and Long Day Conditions*. **A**. "Spore Capsule Development In Short Day Conditions." Development of spore capsules in all 19 accessions grown in SD conditions. **B**. "Spore Capsule Development in Long Day Conditions." Development of spore capsules in all 19 accessions grown in LD conditions. Error Bars =95% CI. All plates containing moss of every accession were examined under the microscope at least two times a week since 07/03/2012. The number of spore capsules (Fig. 3) and the number of shoots in each clump were recorded for every plate.

Conclusions and Future Work

As expected, reproduction in most accessions of *P. patens* was photoperiod dependent, although there were varying levels of photoperiod sensitivity. There was no obvious correlation between photoperiod response and latitude of origin.

The next step in this project involves expression analysis of *MFT* in *P. patens* grown in the SD and LD conditions. RNA will be isolated from moss tissue of each accession, and we will measure the expression of the *MFT*-like genes that we suspect respond to photoperiod to control the generation of reproductive structures.

Future work will include re-sequencing of the entire *P. patens* genome from these accessions, which will then be compared to the phenotypic responses. This will allow a more in depth understanding of what controls the photoperiod-dependent pathway in *P. patens.*

Citations

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Acknowledgements

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