

Plant Responses to Light Independent of  
Photosynthesis: Qualification and Quantification of  
Photoreceptors and Light Dependent Morphological  
Traits Throughout Development Stages in a  
Nonphotosynthetic Plant

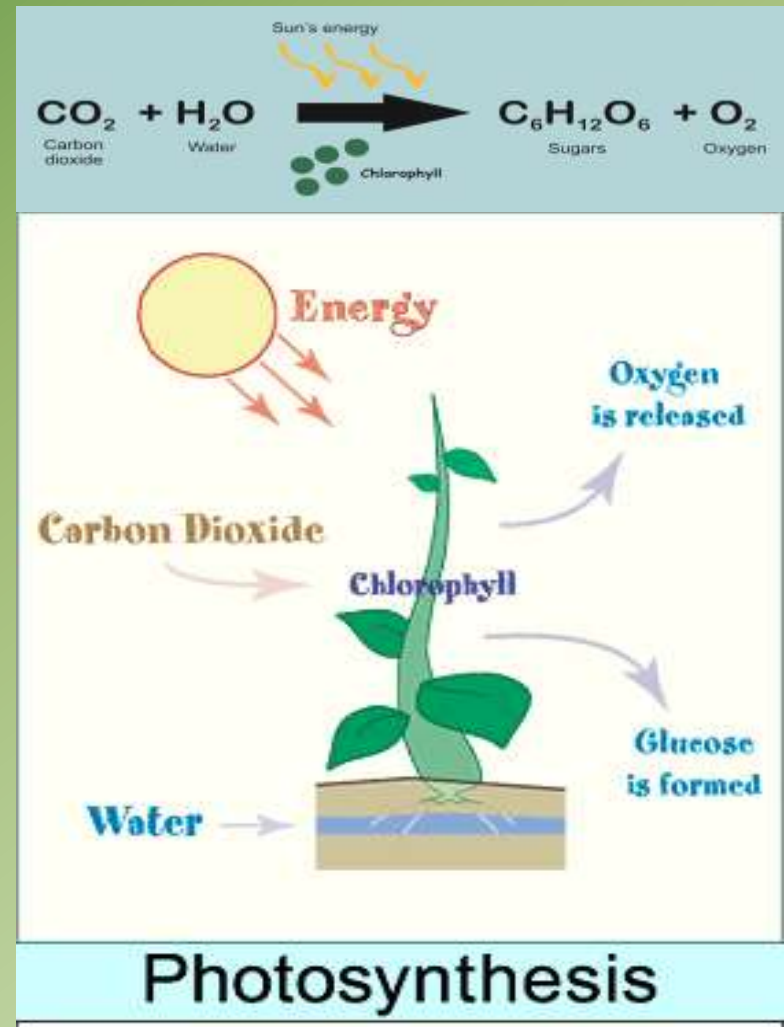


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Botany/Microbiology



# Photosynthesis

- Process that drives life as we know it.
- Conversion of solar energy to chemical energy.
- Occurs in most plants and some bacteria



# Mycoheterotrophs

- Non-photosynthetic plants(Leake 1994).
- Chlorophyll content disputed (Bakshi 1959, Cummings Welschmeyer 1998).
- Tri-part system involving a conifer, a fungus, and the mycoheterotroph. (Leake 2005).

Conifer



<http://www.forestresourceinstitute.com/pico.php>



Fungus

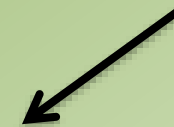


<http://www.natruffling.org/rhsa.htm>

Mycoheterotroph



<http://www.flickr.com/photos/ken-ichi/3696629211/sizes/m/in/photo/stream/>



# *Pterospora andromedea*

## Local Populations



Google maps

## Annual Stalk Formation



## Growth Stages

- Mycoheterotrophic plant
- Local populations
- Annual stalk formation (Schori 2002)
- Growth stages occur in two week intervals (Schori 2002)

# Focus of Research

- Determine the response that non-photosynthetic, mycoheterotrophic plants have to various wavelengths of light with respect to photoreceptor concentrations and morphology



# Hypotheses

1. The quantity of photoreceptors will increase when suitable wavelengths of light are present for that photoreceptor.
2. Chlorophyll *a* will be present in higher concentrations at earlier stages of development but photosynthesis will be negligible.
3. Flowering and subsequent capsule formation will be delayed or aborted in plants excluded from irradiance with red light.
4. Stalks will deviate from linear growth in the absence of blue light due to a lack of phototropic response

# Light Control Devices

- Built so that all light reaching the plant was filtered
- Built to insure air flow was unrestricted



# Tissue Collection

- Three types of tissue were collected: bract, stem, capsule
- Collected every two weeks

Bracts



Stem



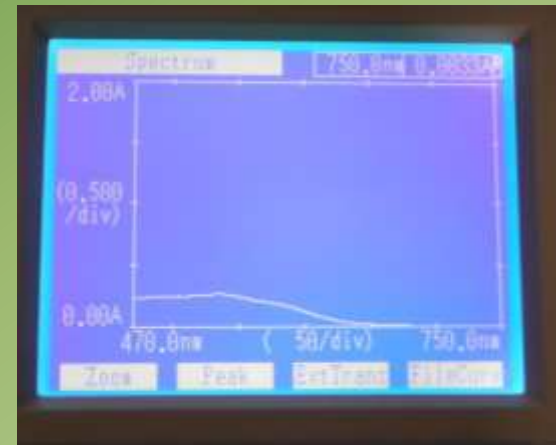
Capsules





# Pigment Extraction

- Acetone extraction using 100% acetone.
- Absorbance read on a spectrophotometer at specific wavelengths (470nm, 645nm, 662nm, 750nm).
- Equations used to determine pigment concentration (Costache 2012).



Chlorophyll *a*:  $(11.24 \times A_{662}) + (-2.04 \times A_{245})$   
 Chlorophyll *b*:  $(20.13 \times A_{645}) + (-4.19 \times A_{662})$   
 Chl *a*:*b* ratio:  $(7.05 \times A_{662}) + (18.09 \times A_{645})$   
 Xanthophylls  
 and Carotenoids :  $((1000 \times A_{470}) + (-1.9 \times \text{Chl } a) + (-63.14 \times \text{Chl } b))/214$

# Plant Morphology

- Capsule number
- Height
- Overall growth pattern



# Hypothesis 1

The quantity of photoreceptors will increase when suitable wavelengths of light are present for that photoreceptor

– There was no distinguishable difference in photoreceptors between differing wavelengths of light, only difference was seen in the control group.

		Clear	Blue Limiting	Green Limiting	Red Limiting
Chl a	Clear		0.0071*	0.0068*	0.0053*
	Blue Limiting	0.0071*		0.99956	0.7606
	Green Limiting	0.0068*	0.99956		0.73104
	Red Limiting	0.0053*	0.7606	0.73104	
Chl b	Clear		0.00595*	0.00584*	0.00431*
	Blue Limiting	0.00595*		0.97866	0.76566
	Green Limiting	0.00584*	0.97866		0.721
	Red Limiting	0.00431*	0.76566	0.721	
Xanthophylls and	Clear		0.0983***	0.0645***	0.00973*
	Blue Limiting	0.0983***		0.75737	0.25007
Carotenoids	Green Limiting	0.0645***	0.75737		0.45616
	Red Limiting	0.00973*	0.25007	0.45616	
Chl a:b	Clear		0.669	0.3569	0.9168
	Blue Limiting	0.669		0.55631	0.6683
	Green Limiting	0.3569	0.55631		0.2695
	Red Limiting	0.9168	0.6683	0.2695	
Height	Clear		0.03614**	0.04214**	0.00025**
	Blue Limiting	0.03614**		0.33189	0.7859
	Green Limiting	0.04214**	0.33189		0.24855
	Red Limiting	0.00025**	0.7859	0.24855	
Capsule #	Clear		0.0263**	0.07043***	0.00009978*
	Blue Limiting	0.0263**		0.29837	0.6678
	Green Limiting	0.07043***	0.29837		0.31358
	Red Limiting	0.00009978*	0.6678	0.31358	

# Hypothesis 2

Chlorophyll *a* will be present in higher concentrations at earlier stages of development but photosynthesis will be negligible

- Chlorophyll *a* concentration over the stages of development was not fully determined for a number of reasons

# Hypothesis 3

Flowering and subsequent capsule formation will be delayed or aborted in plants excluded from irradiance with red light.

- There were no recorded differences in capsule formation in any group

# Hypothesis 4

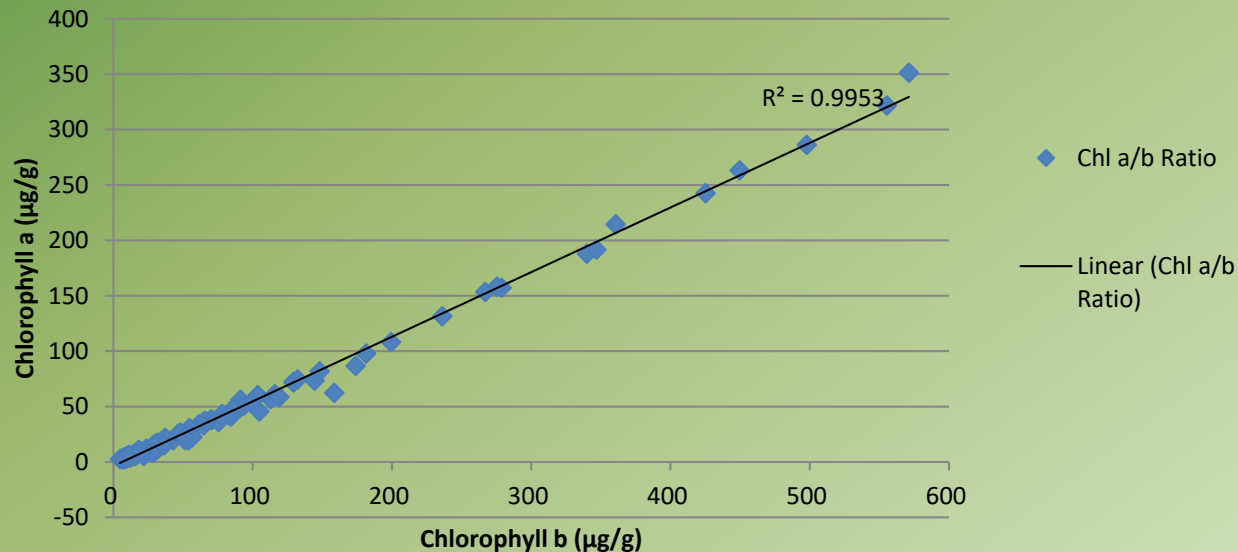
Stalks will deviate from linear growth in the absence of blue light due to a lack of phototropic response

- Two individuals had slight morphological anomalies, however the majority of individuals did not

# Chlorophyll *a* and *b*

- Chlorophyll *a* and chlorophyll *b* detection.
- Chlorophyll *a*:*b* ratio.

Regression of Chlorophyll *a* vs. Chlorophyll *b*



Regression analysis of chlorophyll *a* vs chlorophyll *b* showing a consistent 1:2 ratio of *a*:*b* indicating similar chlorophyll production stimulus regardless of light color.

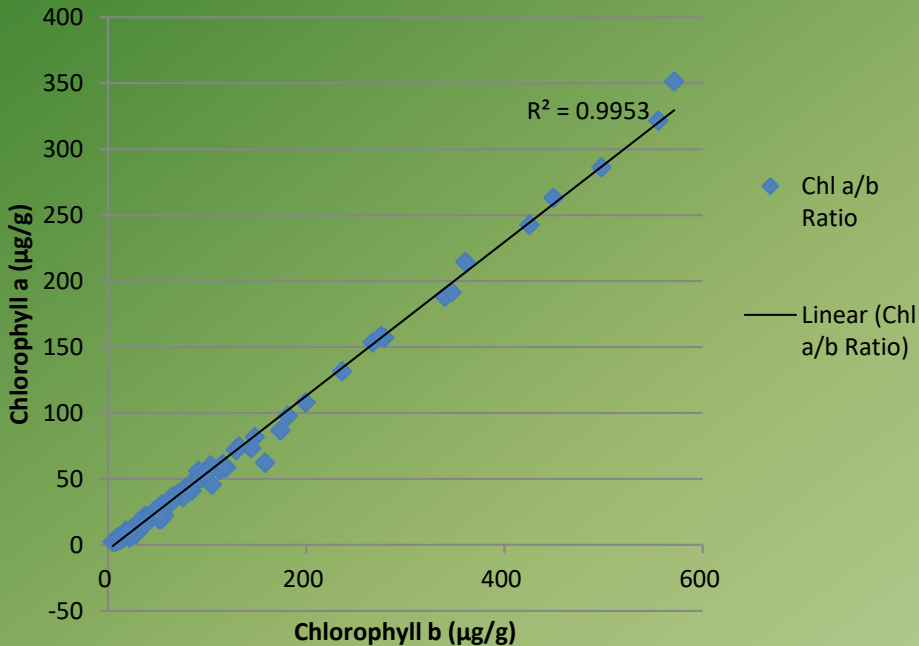
# Discussion

- Chlorophyll detection is a significant find.
- Ratio significant compared to normal photosynthetic plants.
- Unanticipated variable.



# Discussion

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p-values of measured variables. A p-value of less than 0.01 is indicated by \*, less than 0.05 by \*\*, and less than 0.1 by \*\*\*, values with no marks have a p-value greater than 0.1.

# Continuing Research

- A second field season
  - Asses affects of luminous flux
  - More samples, this past season 148 devices were placed, only 31 plants grew
  - Missed periods of growth

# Acknowledgements

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