

**IPS-141**

# **Sensory and Physiological Ecology of Plants**

x: Stomata and gas-exchange

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Stomata

Stomata, responses to light

Measurement of leaf conductance

Thermography and non-contact sensors

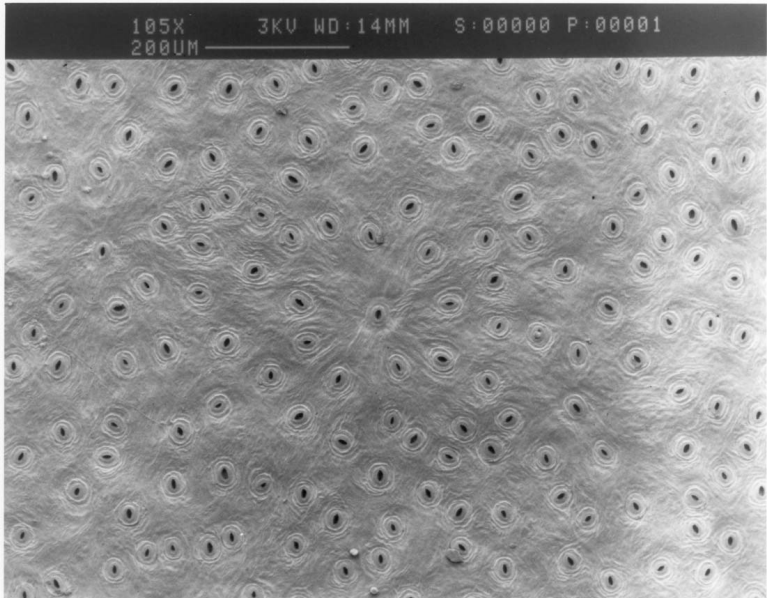
Measurement of spectral irradiance

Measurement of gas-exchange

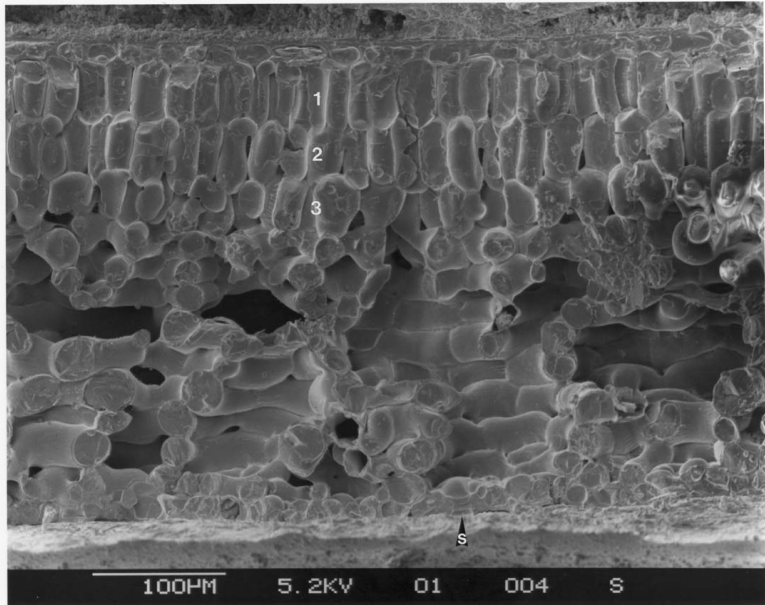
# **Stomata**

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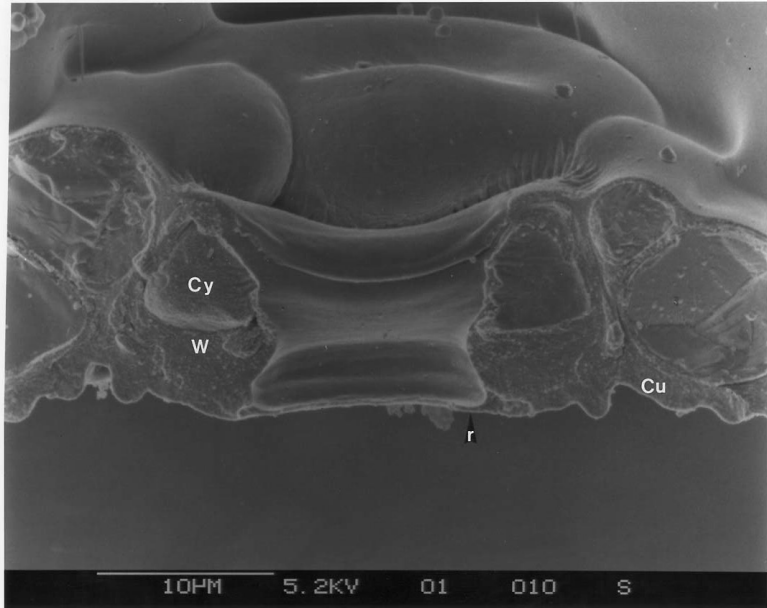
# Stomata on the abaxial epidermis (*Hedera helix* L.)



## Cross-section of a juvenile leaf (*Hedera helix* L.)



## Cross-section of a stoma (*Hedera helix* L.)



## **Stomata, responses to light**

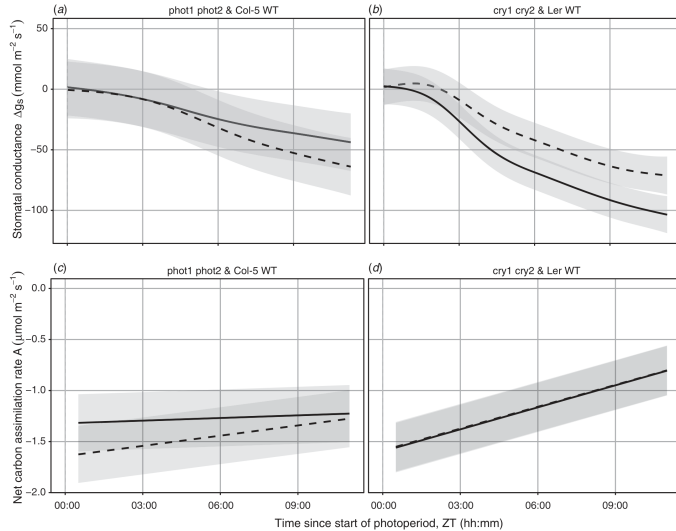
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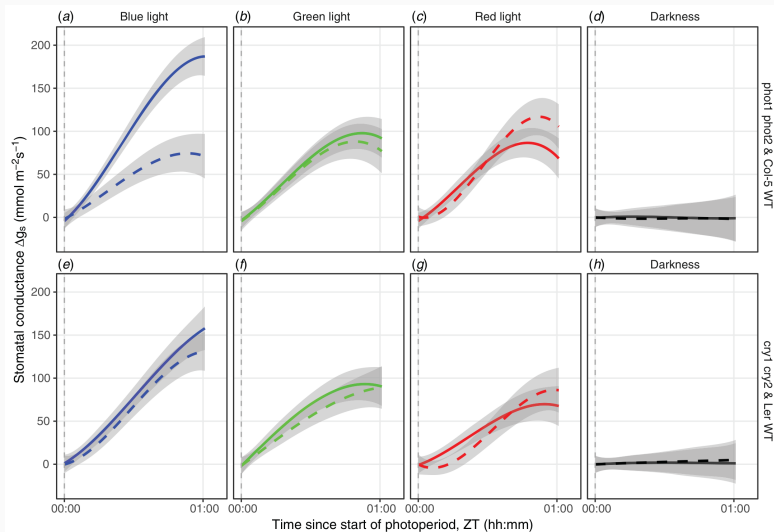
## Time course of $g_s^w$ (*A. thaliana*)

- Experiment with *phot1 phot2* and *cry1 cry2* mutants plus two WT.
- Growth under photoperiod 12 h, 200  $\mu\text{mol m}^{-2} \text{s}^{-1}$  PAR from white light.
- Gas-exchange measured continuously for 23 h in whole rosettes (1 rosette at a time).
- Measurements in same photoperiod, 200  $\mu\text{mol m}^{-2} \text{s}^{-1}$  PAR from red, green or blue light from LEDs, and in darkness.
- (Wang2020)

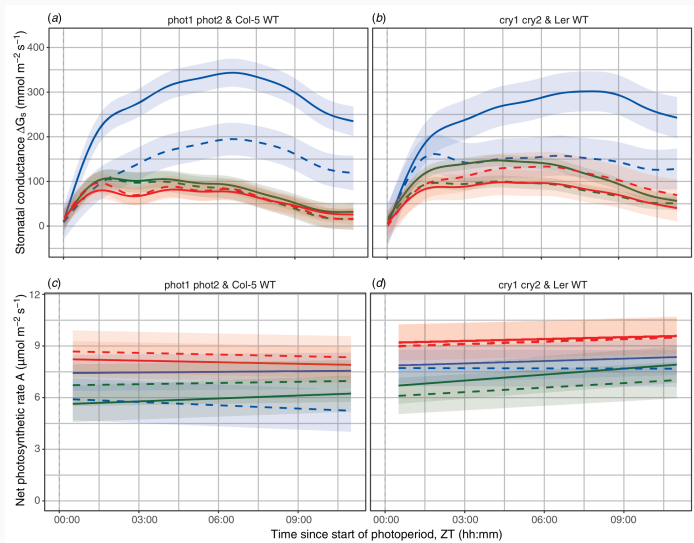
# Time course of $g_s^w$ (*A. thaliana*)



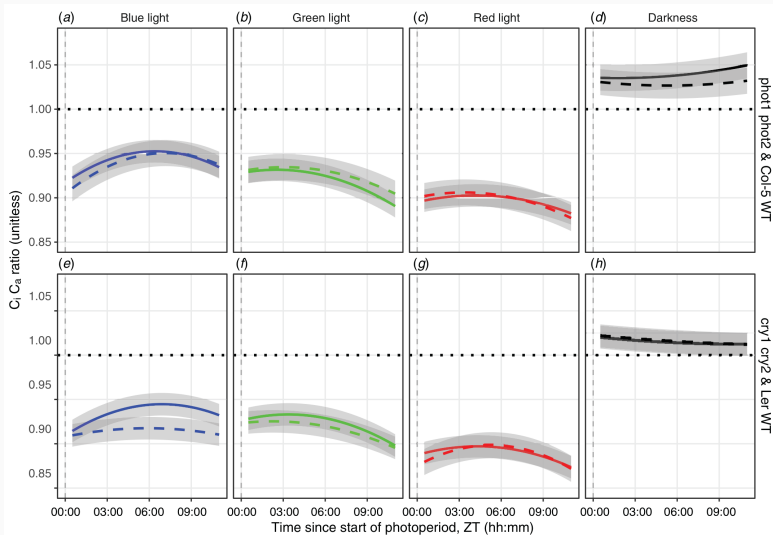
# Time course of $g_s^w$ (*A. thaliana*)



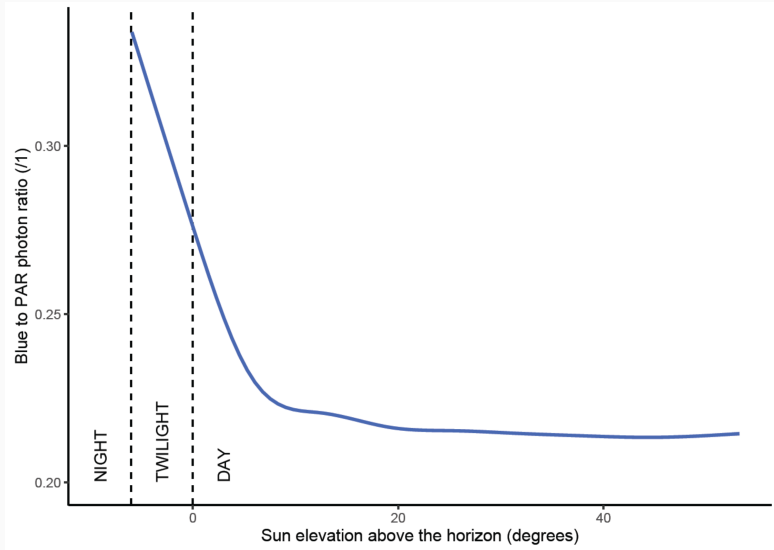
# Time course of $g_s^w$ (*A. thaliana*)



# Time course of $g_s^w$ (*A. thaliana*)



# Blue component of sunlight



# Measurement of leaf conductance

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Video describing the AP4 porometer from Delta-T



# **Thermography and non-contact sensors**

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# Thermal camera



from **Optris**

# Measurement of spectral irradiance

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Video describing a spectrometer from Ocean Insight

# Measurement of gas-exchange

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# Open gas-exchange system



- Most current gas-exchange systems used for measuring photosynthesis are open systems in which air flows at a constant rate through a chamber where a leaf is enclosed.
- The flow rates and the differences in concentration of CO<sub>2</sub> and water vapour between the air entering the chamber and that coming out of the chamber are used to calculate the flows in or out of the leaf.
- From the flows of CO<sub>2</sub> and water in or out of the leaf, and the enclosed leaf area, the CO<sub>2</sub> and water fluxes per unit leaf area can be calculated.

# Open vs. closed systems

**Open system:** Environmental conditions in the chamber do not vary during measurement.

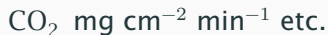
**Closed system:** Environmental conditions in the chamber change during measurement. With transpiration humidity increases, with photosynthesis  $\text{CO}_2$  concentration decreases.

- Modern: using moles



**Water vapour**  $\text{mmol m}^{-2} \text{ s}^{-1}$

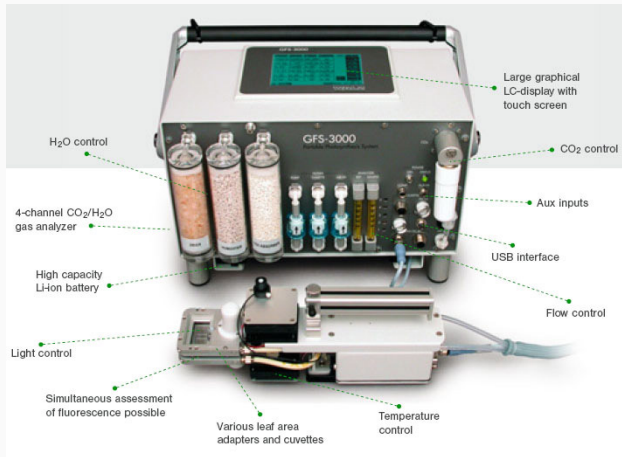
- Old: mass



**Water vapour**  $\text{g cm}^{-2} \text{ min}^{-1} \text{ etc.}$



# Gas-exchange system



GFS-3000 (Walz, Germany) (<http://www.walz.com/>).

# Measuring



from <http://www.walz.com/>.

# Measuring



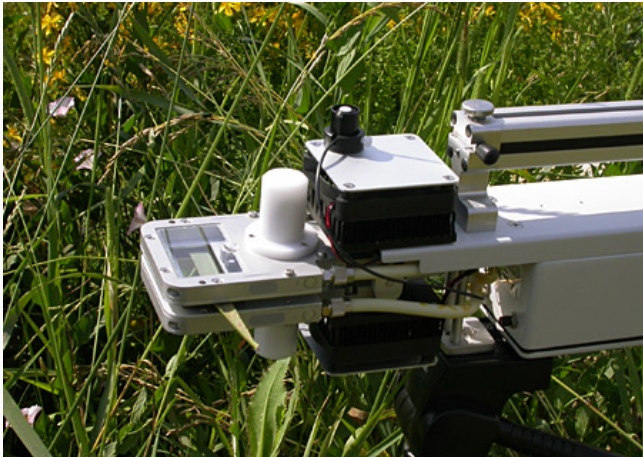
from <http://www.walz.com/>.

# Chamber



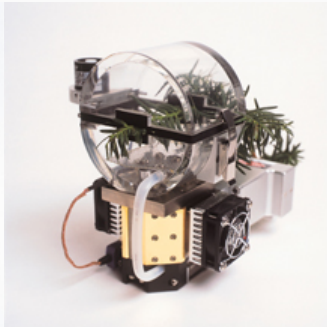
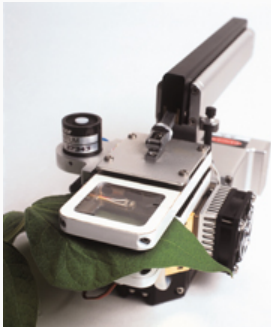
from <http://www.walz.com/>.

## Chamber (measuring)



from <http://www.walz.com/>.

# Standard and conifer chambers



Standard chamber (for flat leaves) and conifer chamber (for twigs) for the LI-6400 gas-exchange system (Li-Cor, USA) (from <http://www.licor.com/>).

## References

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## References

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Kotilainen, T., P. Aphalo, C. Brelsford, H. Böök, S. Devraj, A. Heikkilä, R. Hernández, A. Kylling, A. Lindfors and T. Robson (2020). "Patterns in the spectral composition of sunlight and biologically meaningful spectral photon ratios as affected by atmospheric factors". In: *Agricultural and Forest Meteorology* 291, p. 108041. DOI: [10.1016/j.agrformet.2020.108041](https://doi.org/10.1016/j.agrformet.2020.108041).