Fyziologický výskum: dostupné metódy, princípy meraní a možnosti využitia

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Typy experimentov

Podmienky pokusu:

- kontrolované podmienky (rastové komory, klimatizované boxy)
- čiastočne kontrolované podmienky (skleník, ovplyvnenie zálievky…)
- vzorky odobrerané v lesnom poraste, rôzne podmienky simulované v laboratóriu
- prirodzené podmienky (lesné porasty bez zásahu + možnosť ovplyvniť podmienky)

Pokusy realizované v kontrolovaných podmienkach (klimatizované komory)

Klimatizované boxy (EKOCHL, AngelAntoni)

Pokusy realizované k kontrolovaných podmienkach (klimatizované miestnosti)

Miestnosť s umelým zdrojom žiarenia a klimatizačnou jednotkou

Pokusy realizované v sleníkoch, fóliovníkoch

Skleník s kontrolovanými podmienkami (Taliansko)

Fóliovník (Arborétum B. Hora)

Vzorky odoberané v lesnom poraste, podmienky sú manipulované v laboratóriu

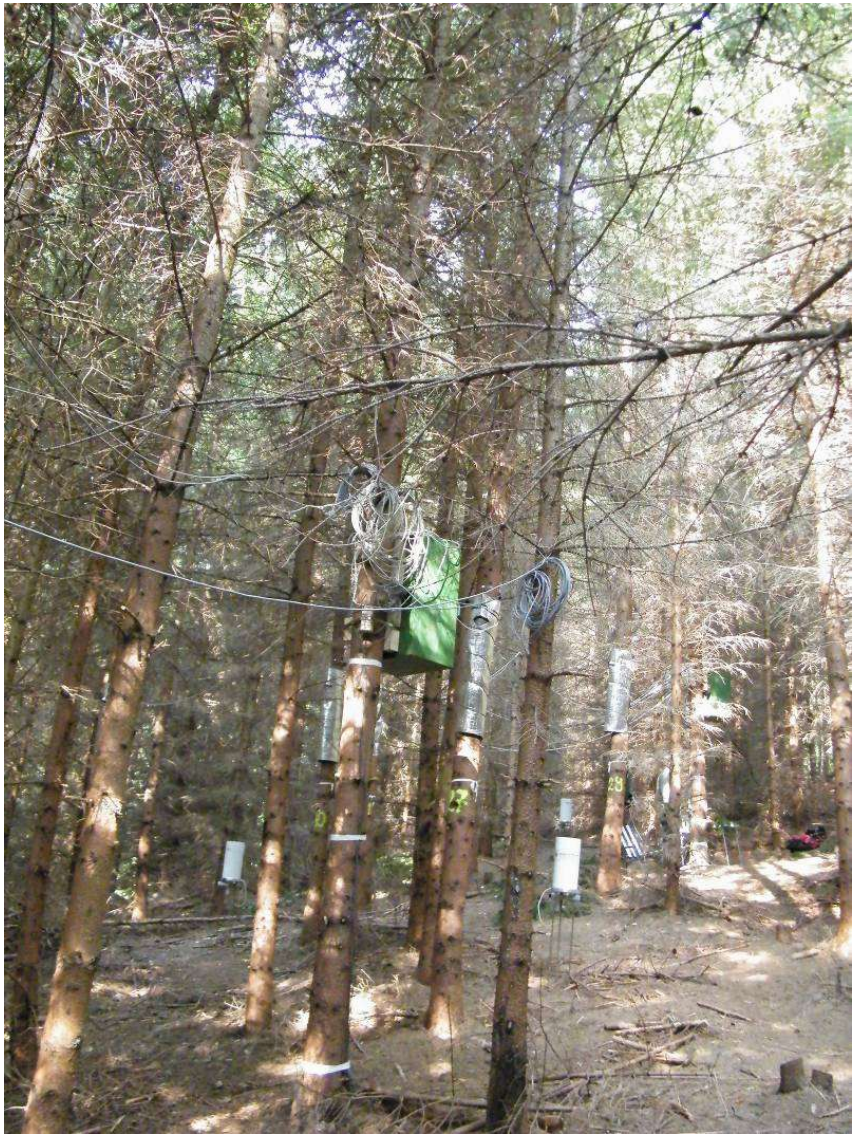
Vodný kúpeľ s bankami (WNE, Memert)

Pokusy realizované v terénnych podmienkach

Porast s obmedzenou možnosťou ovplyvnenia podmienok prostredia

Pokusy realizované v terénnych podmienkach

Zavlažovanie cez kvapkacie hadice



Pokusná plocha na Hriňovej

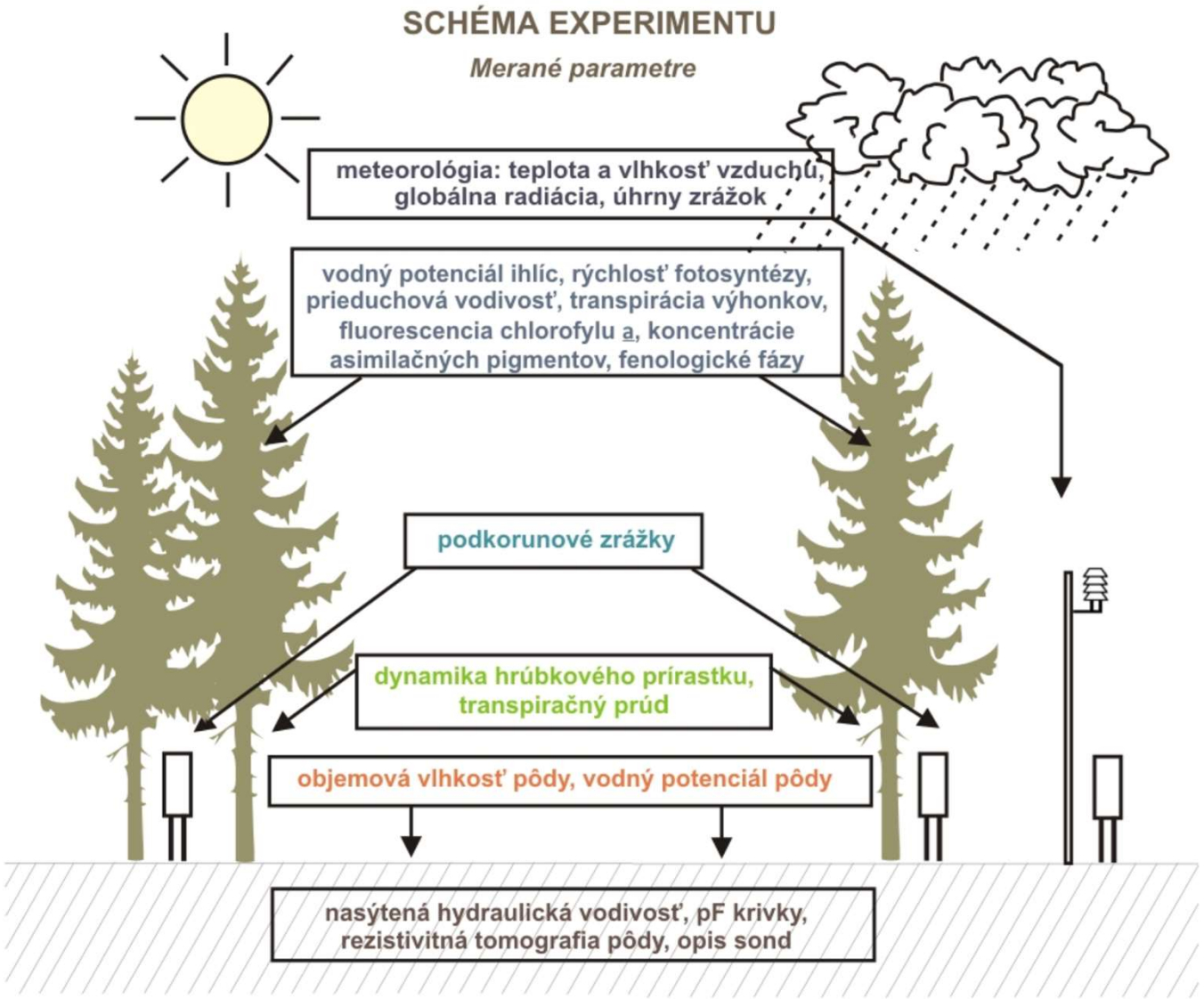
Podporné merania

Pokusy realizované v terénnych podmienkach

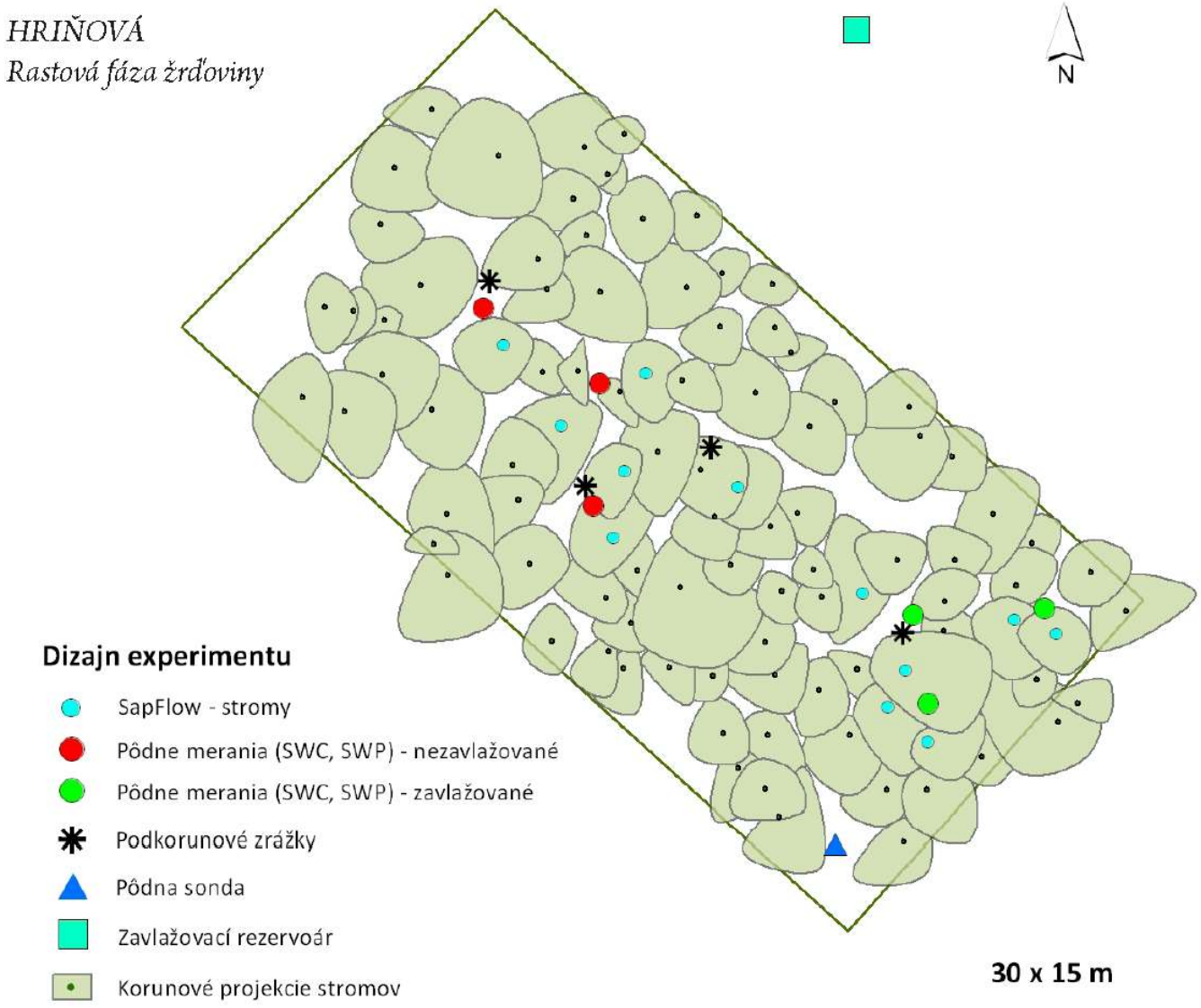
Odber rastlinného materiálu

Krúžok mladých elektrikárov

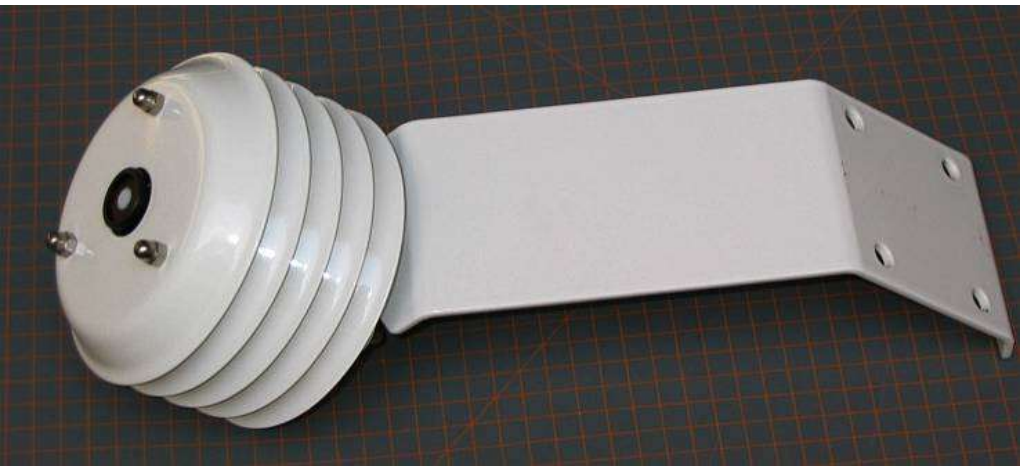
Parametre merané na našich výskumných plochách

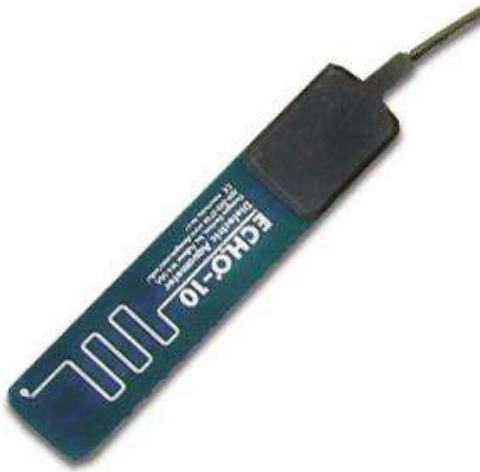


Dizajn pokusu a korunové projekcie stromov na výskumnej ploche (Field-map)



Meranie atmosférických a pôdnych podmienok

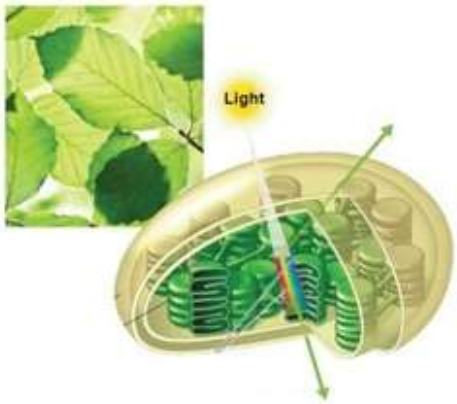


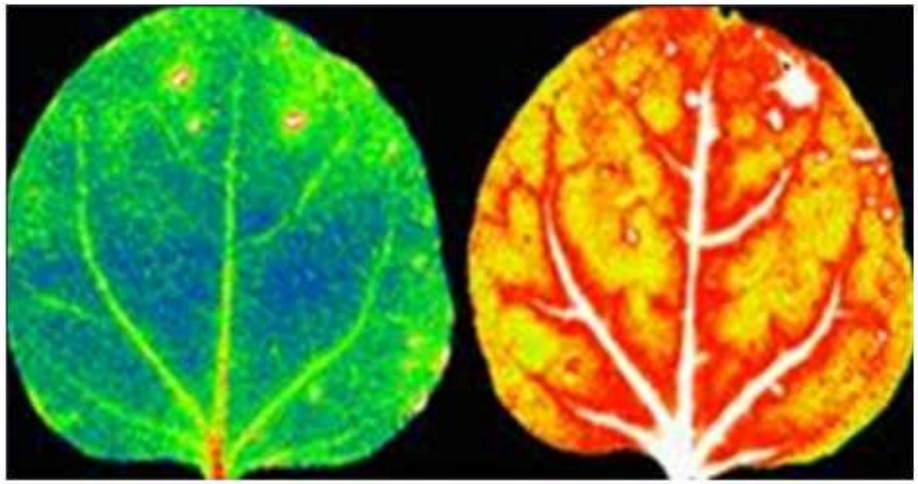


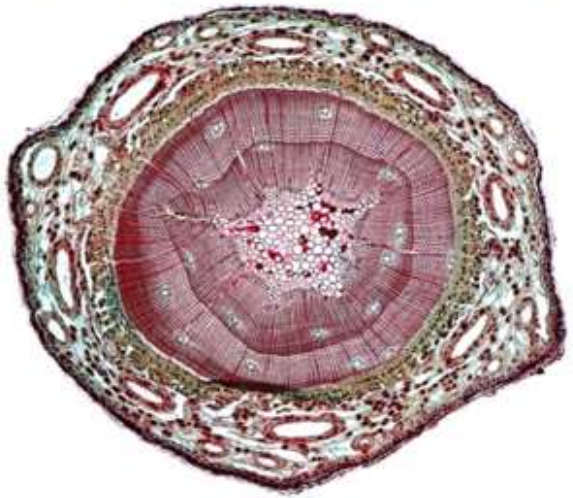
Meranie teploty, radiácie, vlhkosti vzduchu (%), zrážok

Meranie objemovej vlhkosti pôdy a vodného (sacieho) potenciálu pôdy

Fyziologické charakteristiky


Light





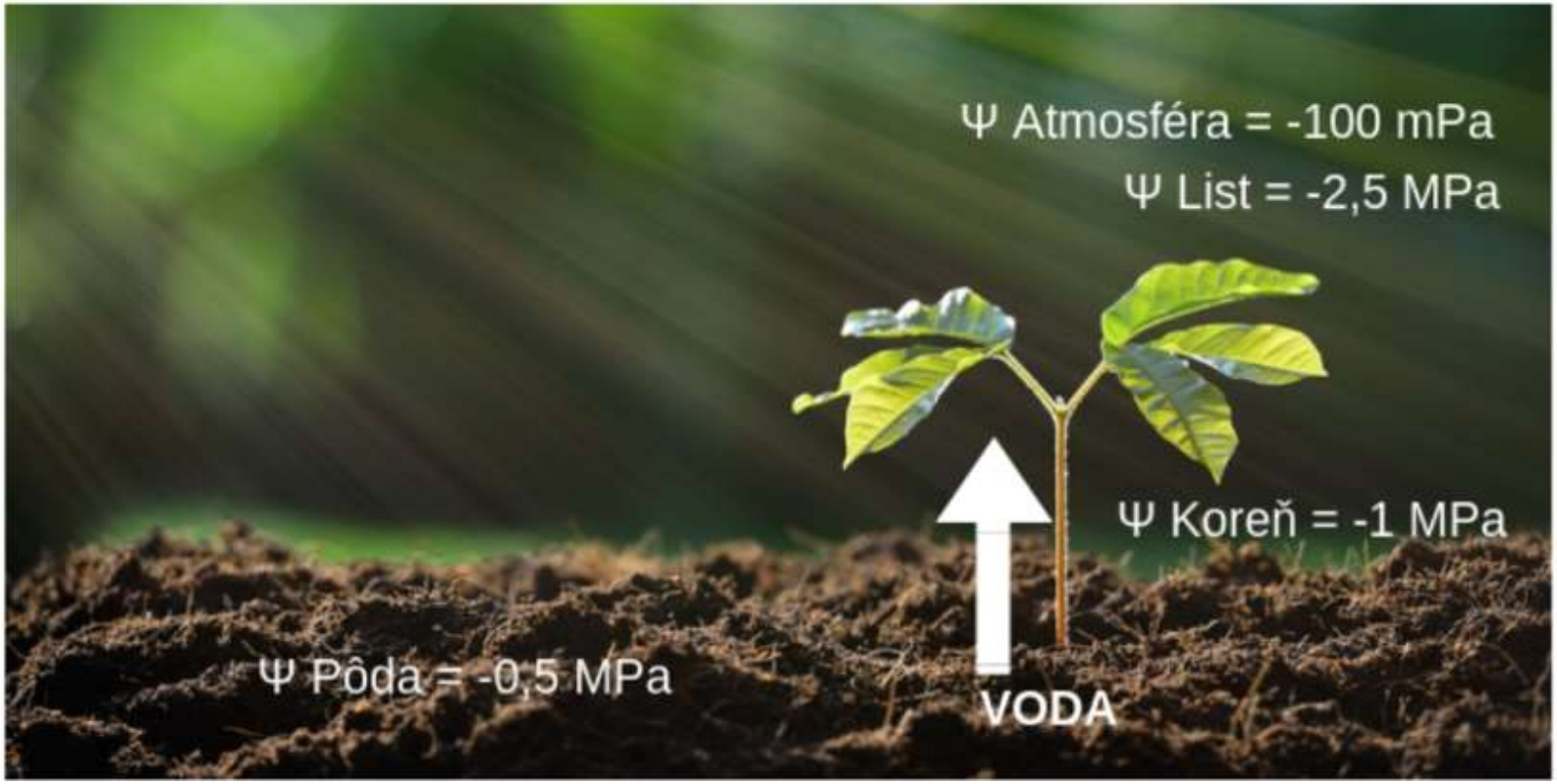
Vodný potenciál

Potenciálna energia vody

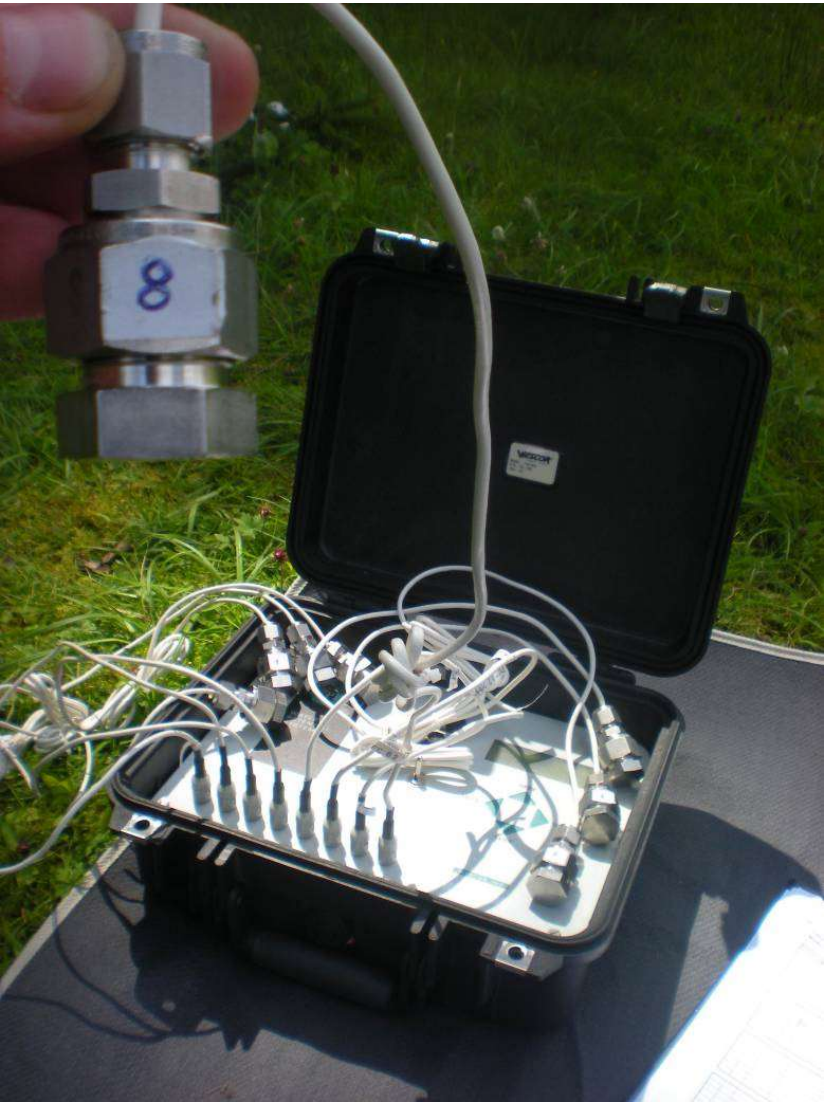
Ψ Čistá voda = 0MPa

Reguláciou vodného potenciálu dokáže rastlina meniť svoj vodný režim

Vodný potenciál má vždy negatívne hodnoty, čím nasýtenejšie prostredie osmoticky aktívnymi časticami tým nižšia hodnota vodného potenciálu

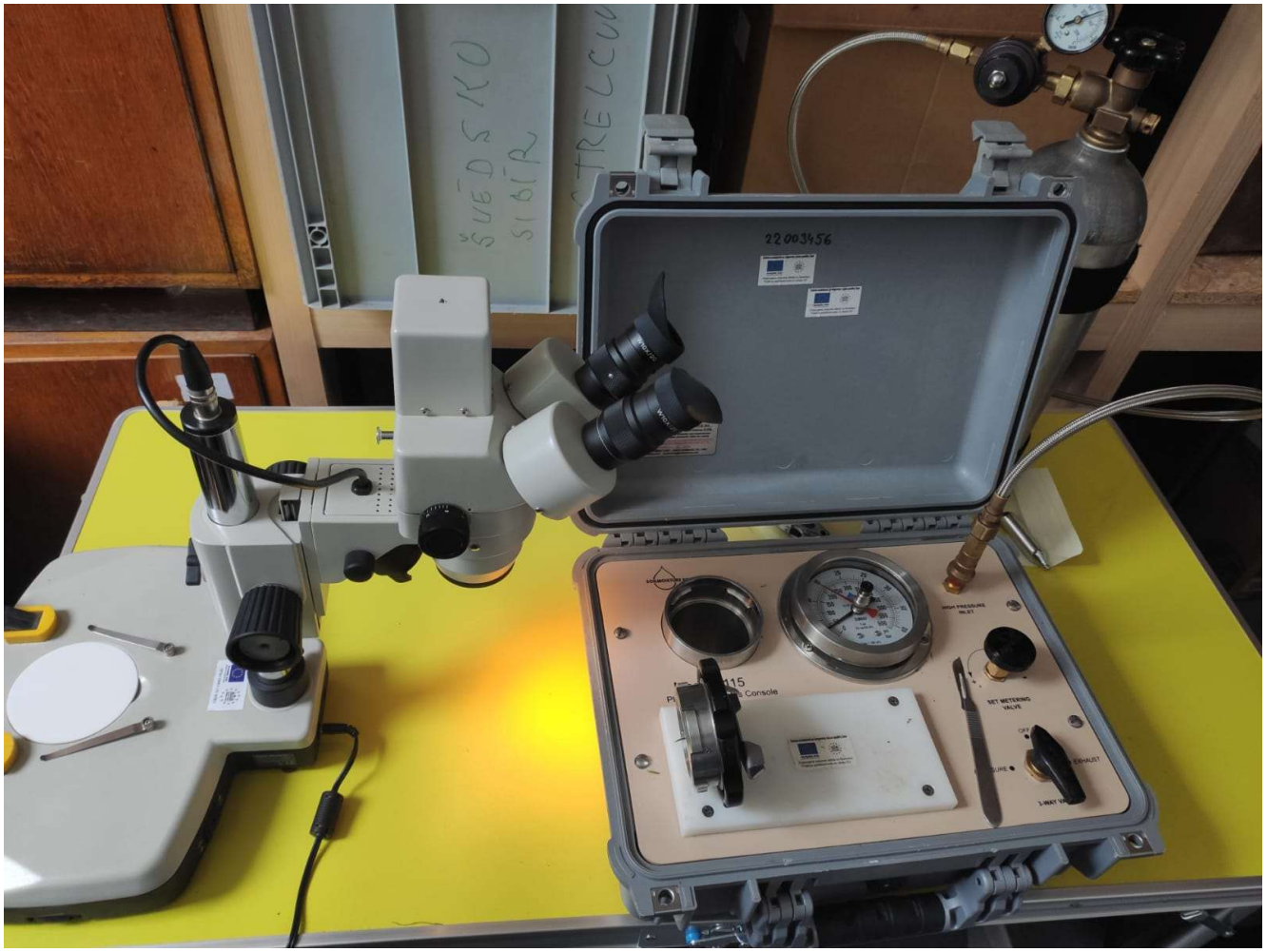


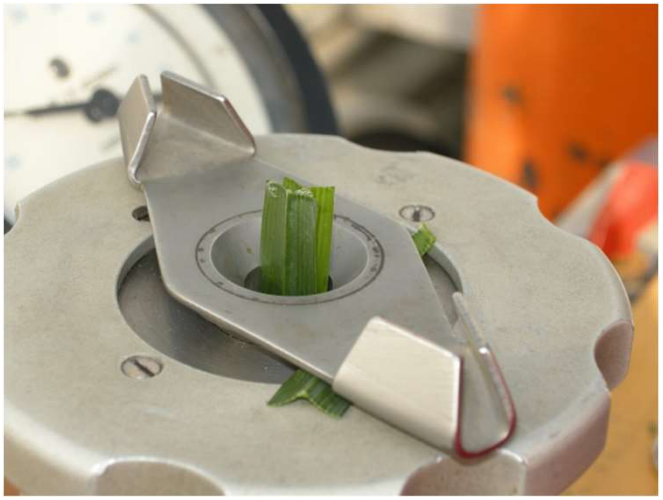
Meranie vodného potenciálu (listov a ihlíc)



Prístroj (PSY-PRO), neoplášťovaná komora

Termostabilná komora



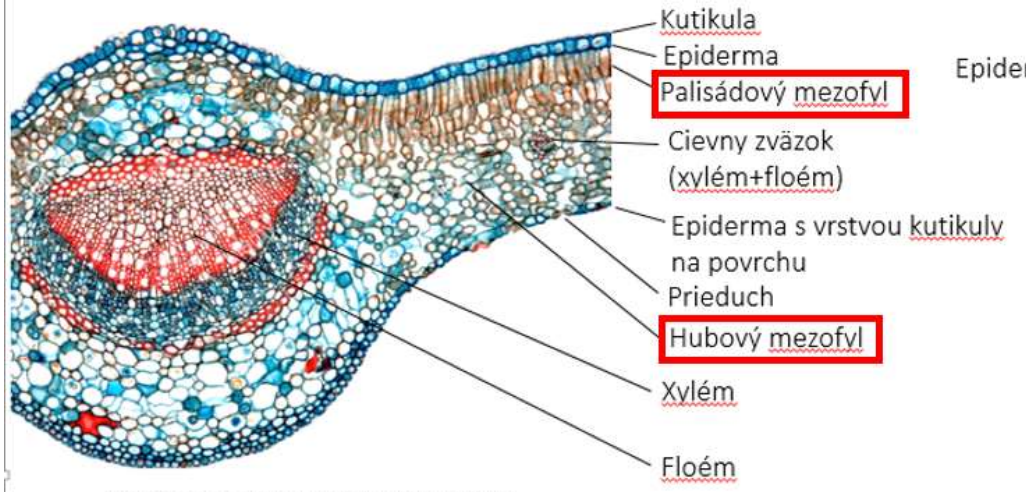


Tlaková scholandelova komora

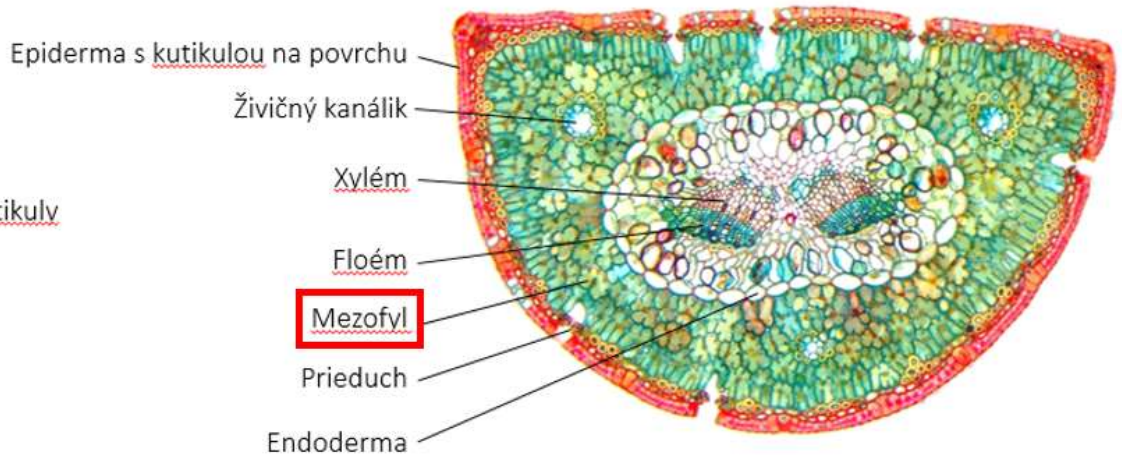
Meranie vodného potenciálu

Prieduchy a fotosyntéza/ respirácia / fotorespirácia

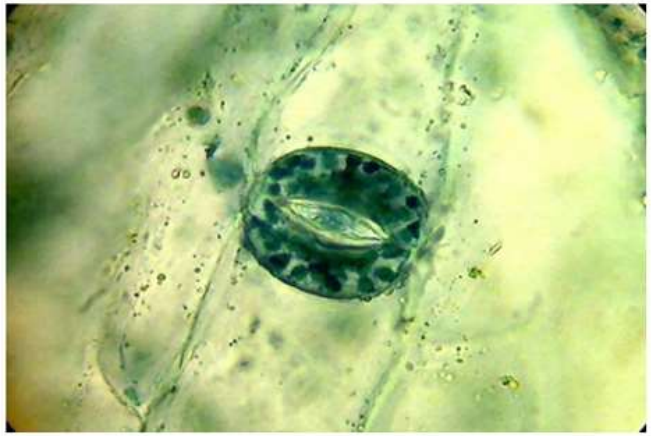
Anatómia na úrovni asimilačných orgánov



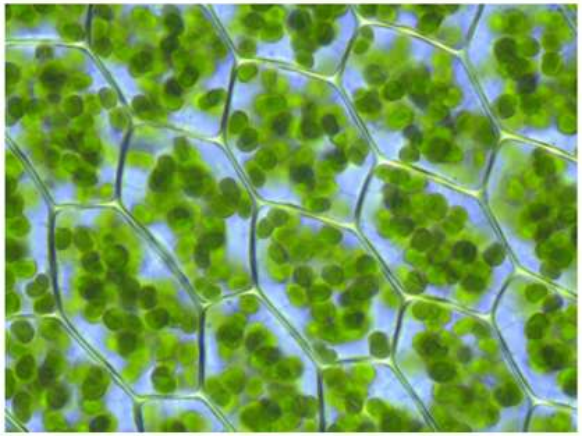
Priečny rez hlavnou žilnatinou listu



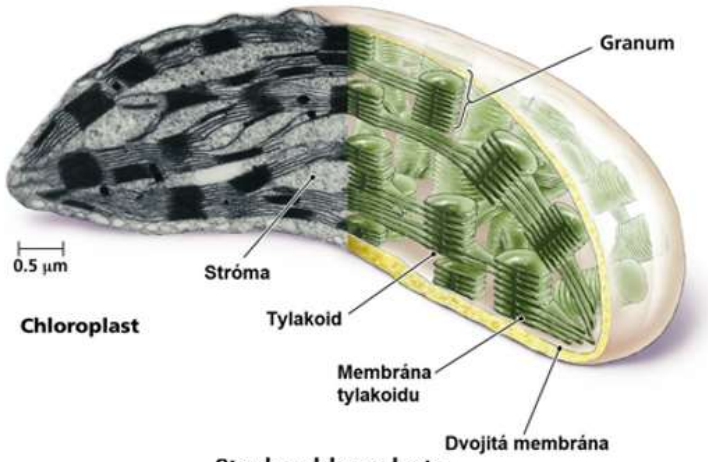
Priečny rez ihlicou



Prieduch tvorený dvoma zvieracími bunkami

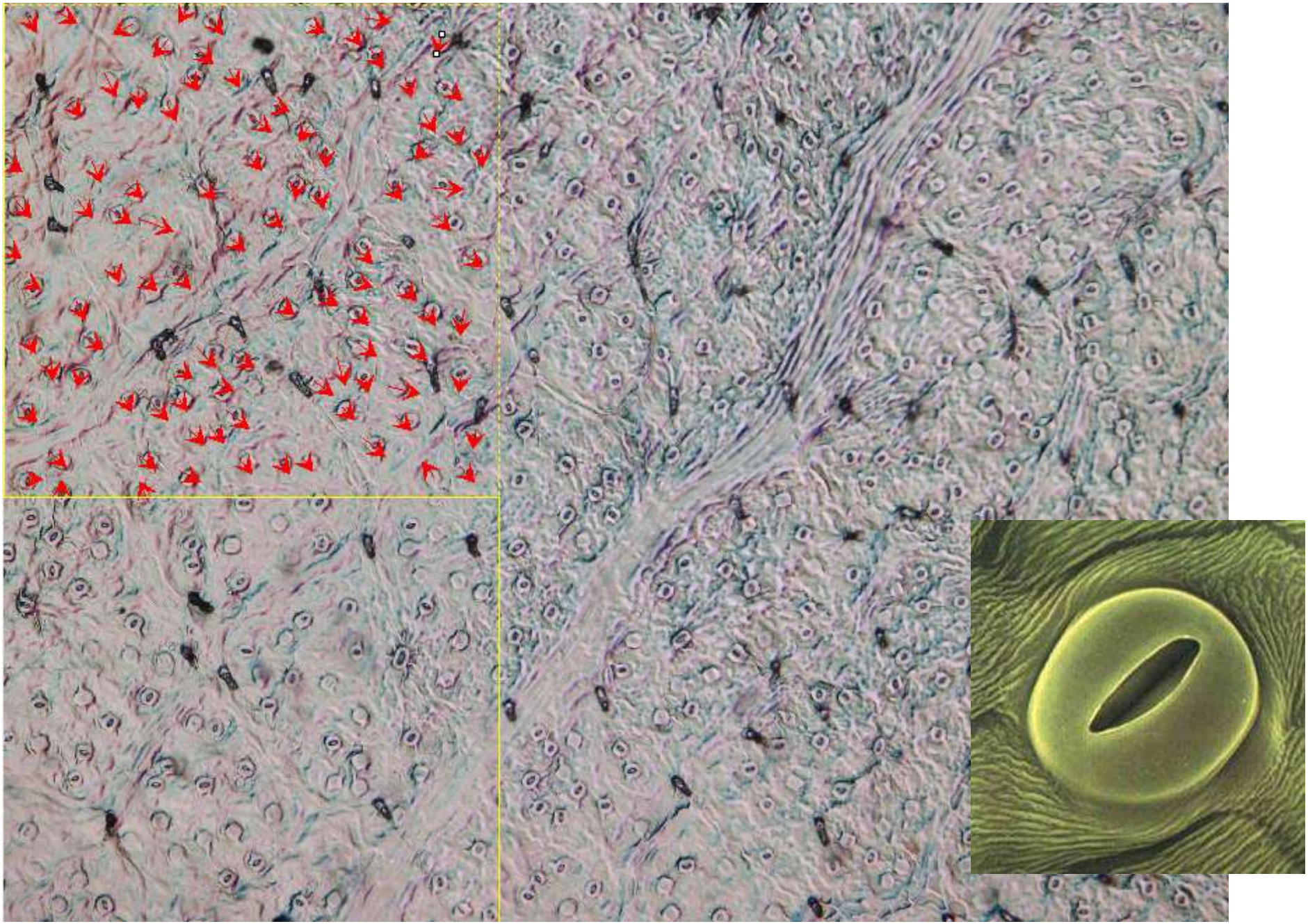


Bunky s chloroplastami

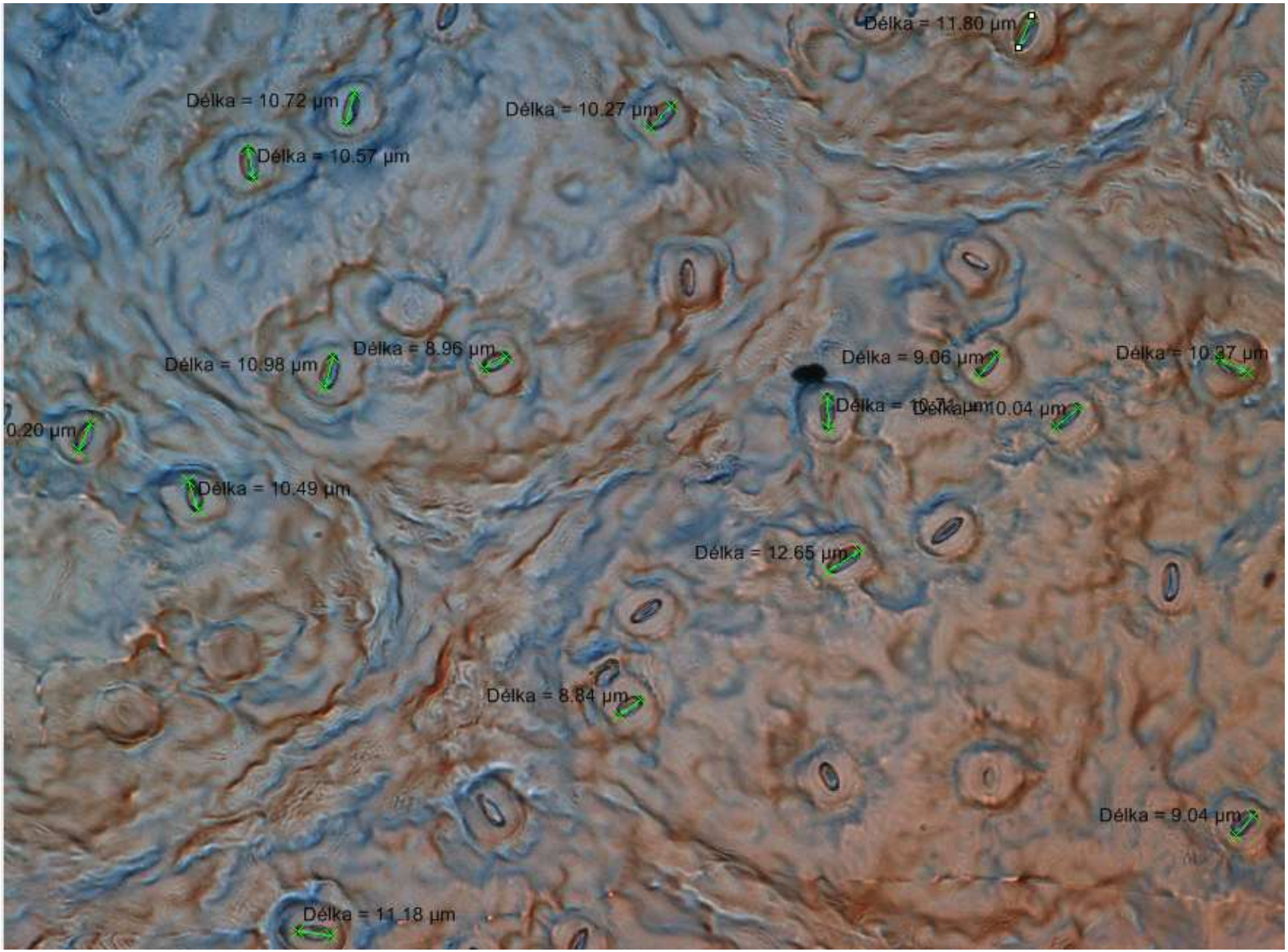


Stavba chloroplastu

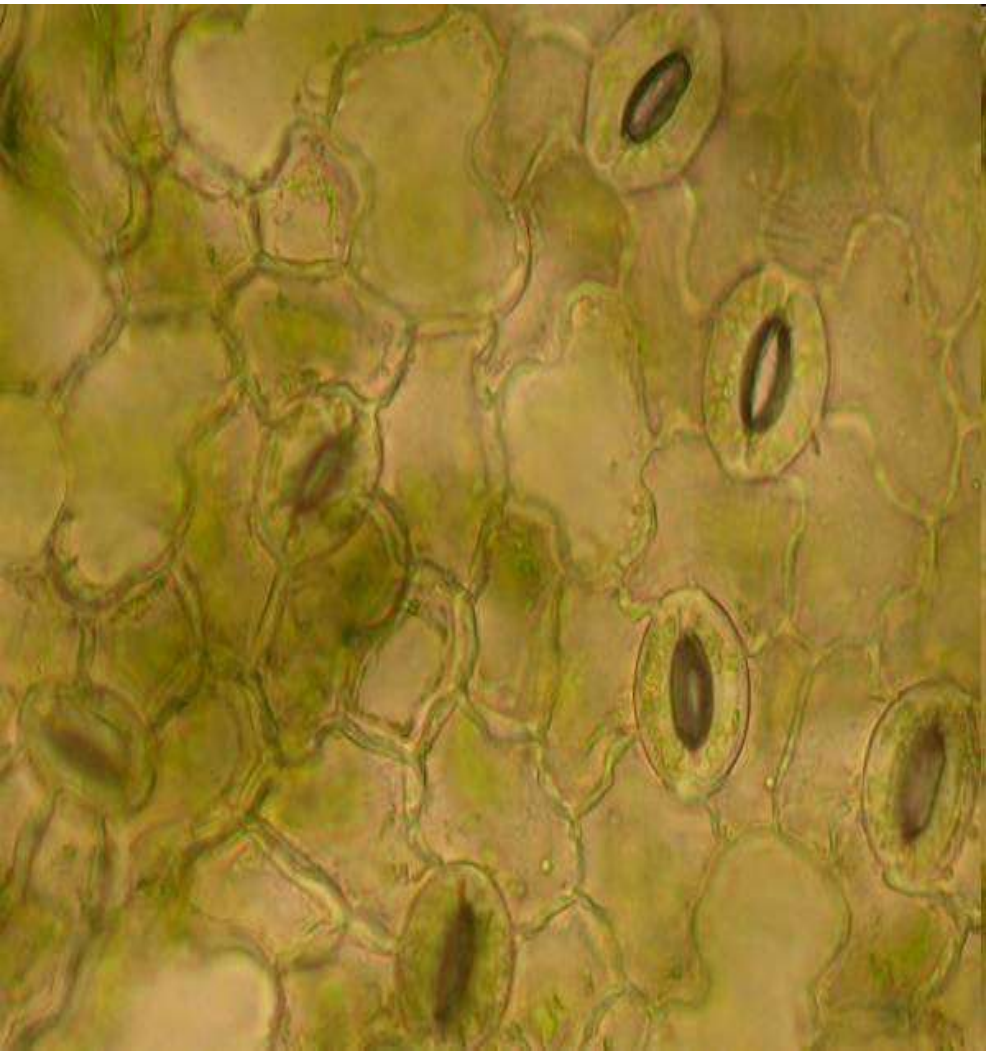
Zisťovanie počtu prieduchov



Meranie veľkosti prieduchov a prieduchovej štrbiny



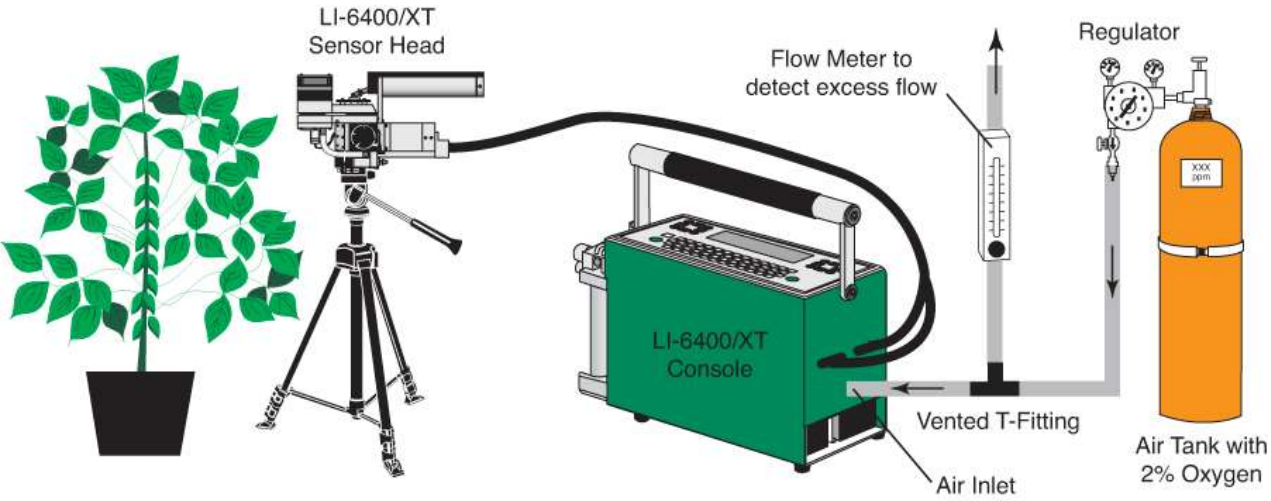
Porometer – meranie prieduchovej vodivosti



Prieduchy – „Pľúca rastlín“

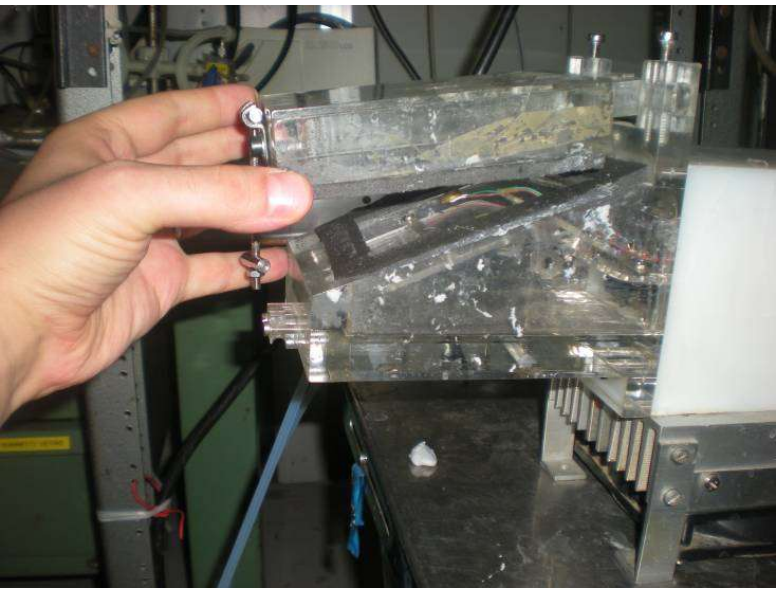
Porometer (AP4)

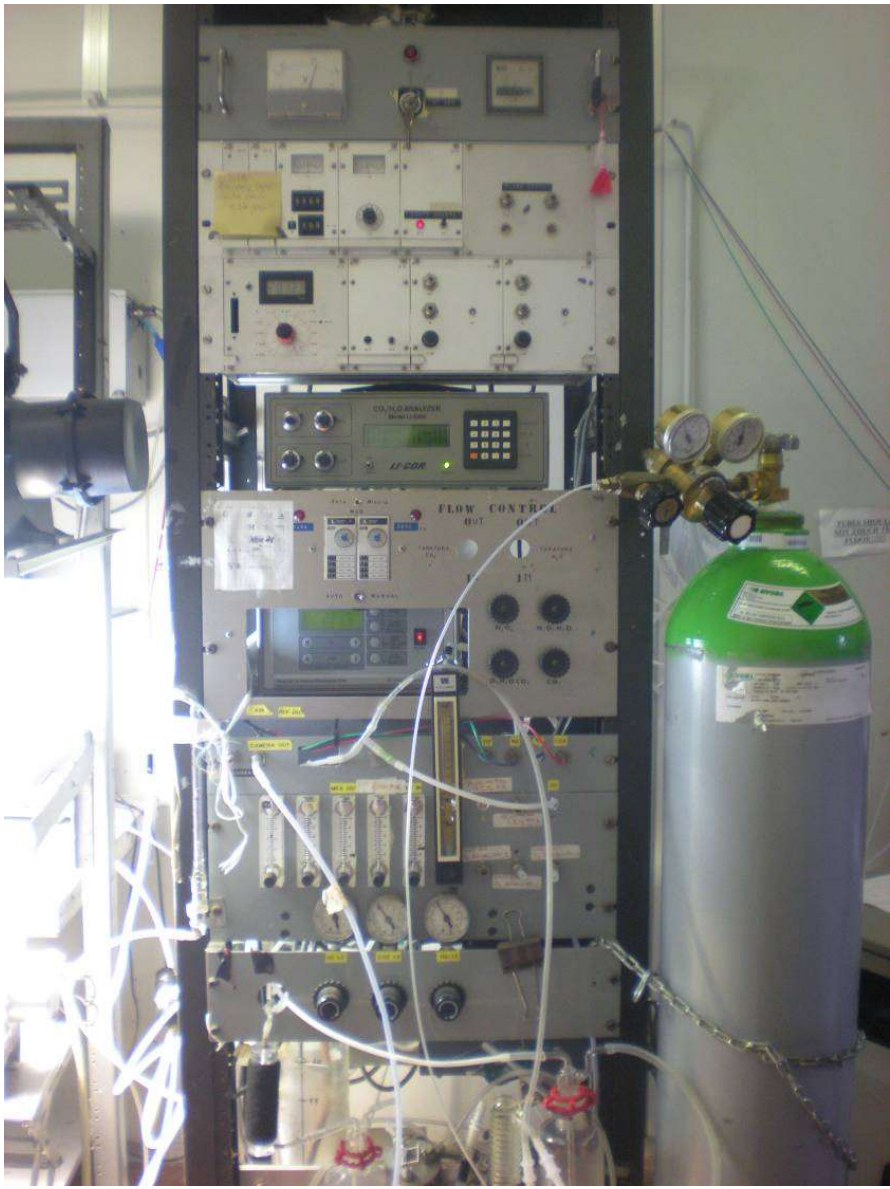
Gazometrický systém na meranie výmeny plynov



Gazometrický systém Li-cor 6400XT – meranie fotosyntézy, prieduchovej vodivosti, transpirácie

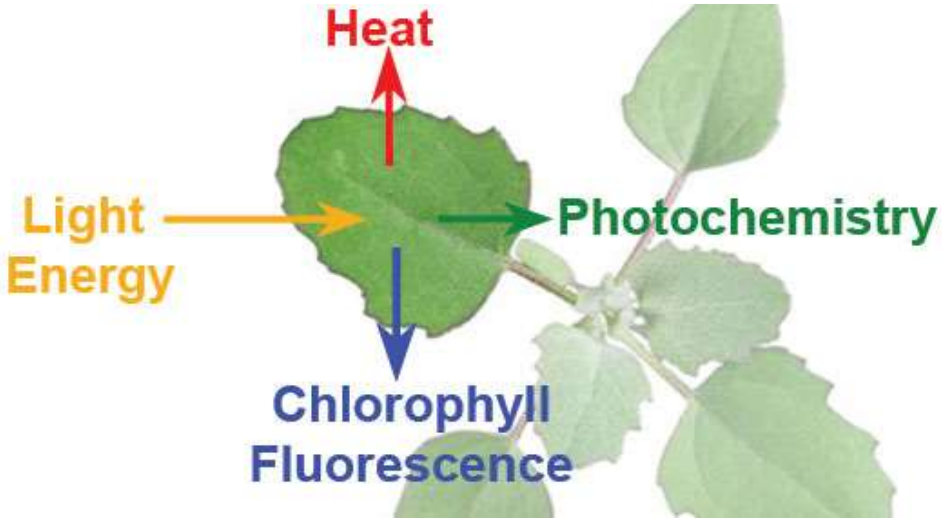
Gazometrický systém na meranie výmeny plynov

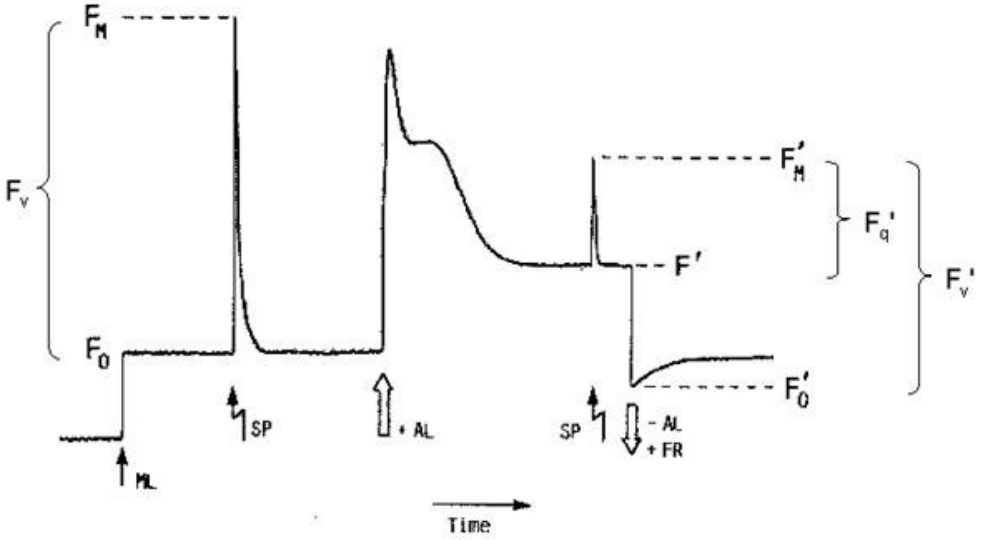




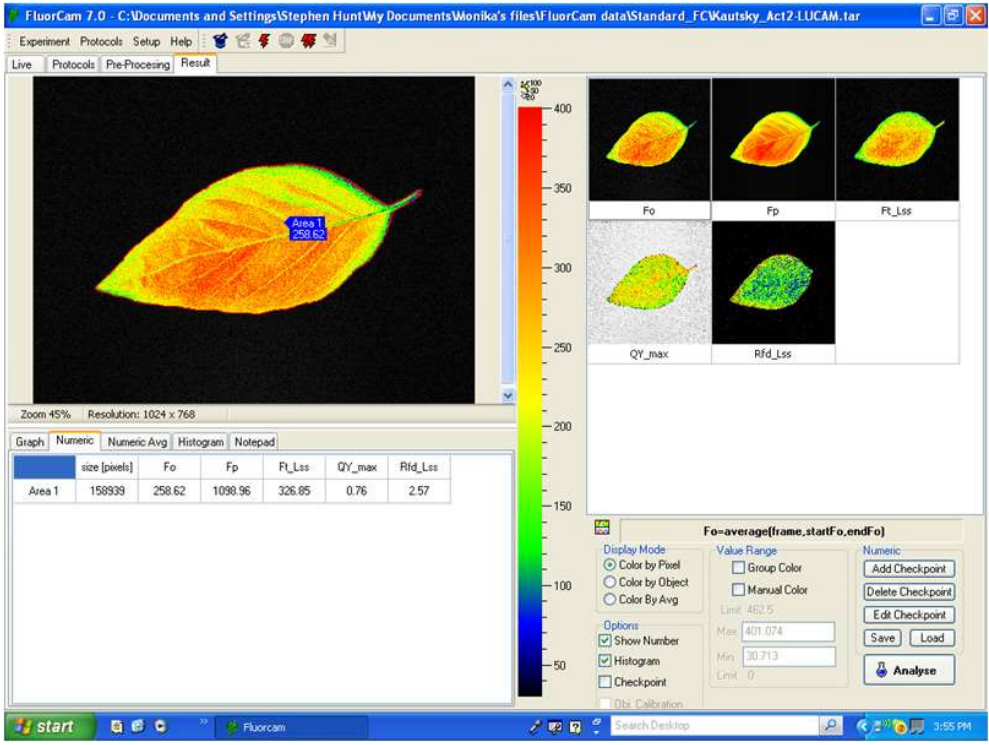
Gazometrický systém (Li-cor, Taliansko)

Meranie fluorescencie chlorofylu *a*





Princíp merania fluorescencie chlorofylu a – meranie fluorescenčného svetla neefektívne vyžiareného do prostredia



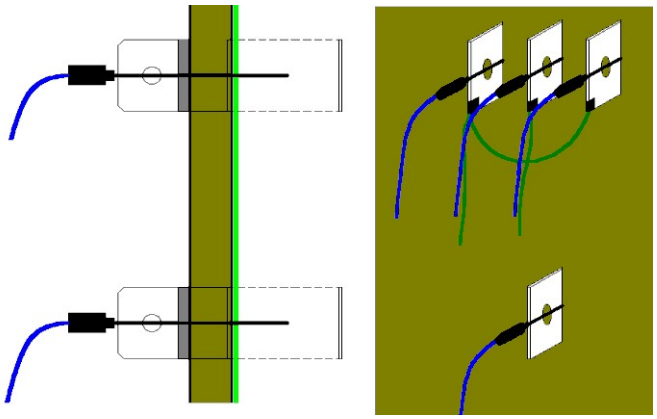
Výstup zobrazovacej fluorescenčnej kamery

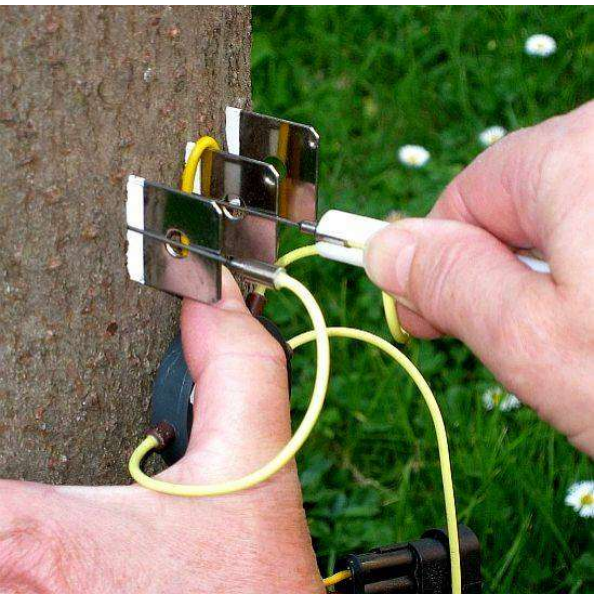
Meranie fluorescencie chlorofylu *a*

Fluorimetre na meranie rýchlej resp. pomalej fázy fluorescencie chlorofylu a

Transpirácia

Meranie transpirácie dospelých stromov





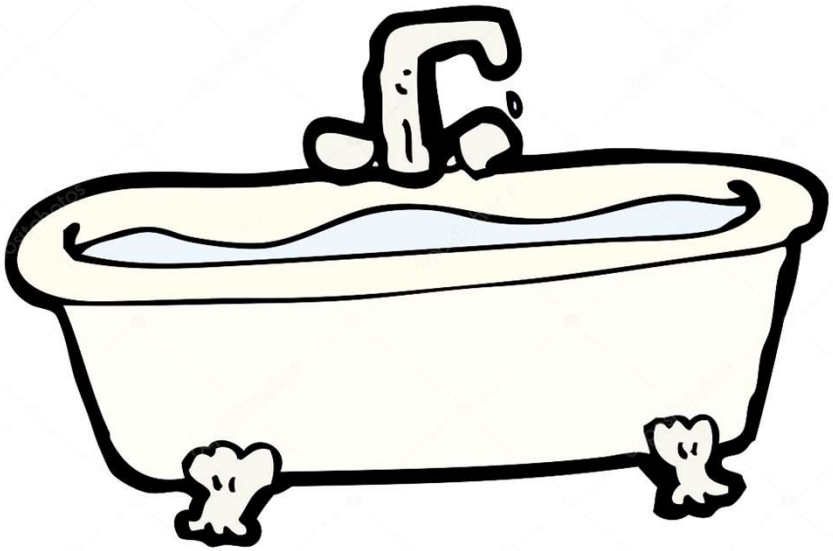
Metóda „tree-trunk heat balance“: sap flow-meter –Princípom je kvantifikácia množstva tepla unášaného cez vodivý xylém z celkového množstva tepla dodaného do tohoto priestoru

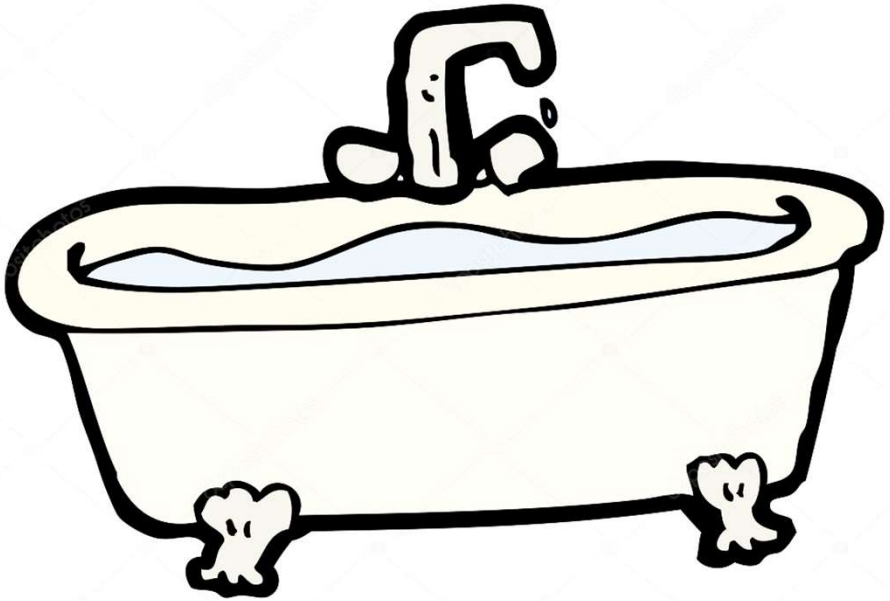
Meranie transpirácie mladých stromov a vetiev

Meranie toku vody kmeňom

Gravimetrické merania

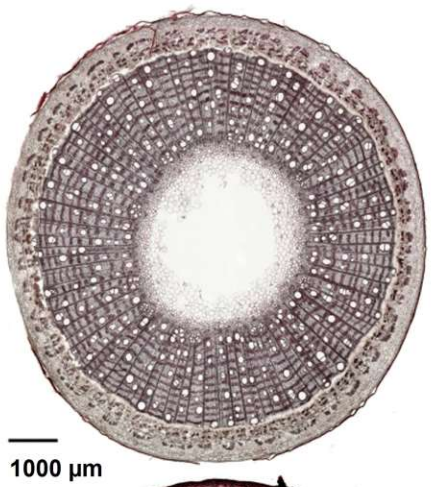
Koľko vody odparí počas jasného dňa dospelý strom?

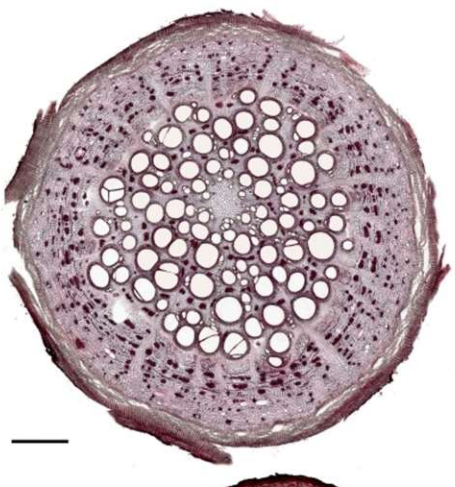


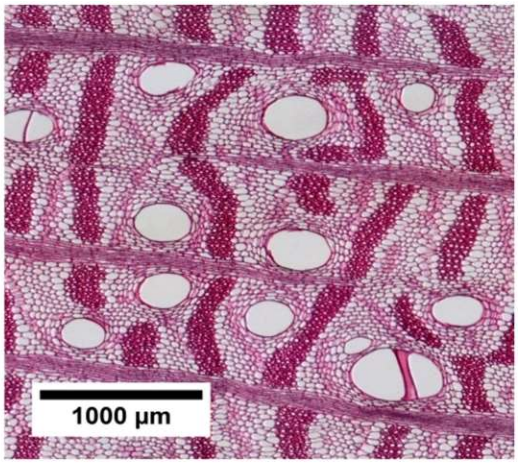


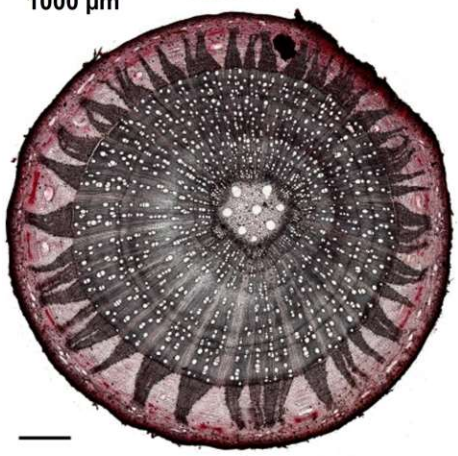
Anatómia a vlastnosti xylému

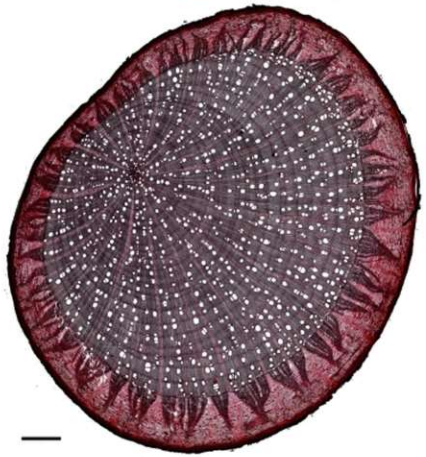
Vetva Koreň Kmeň

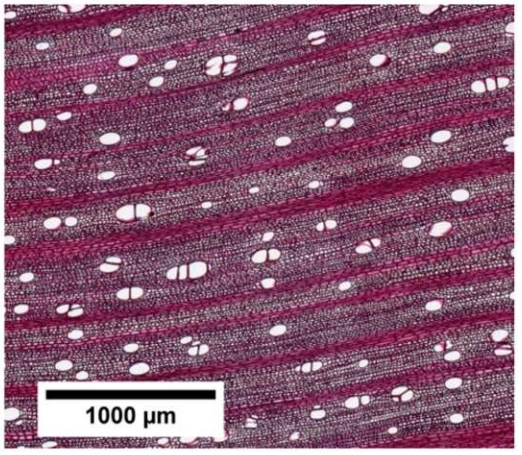


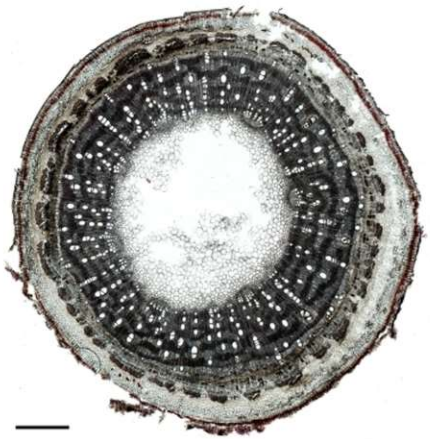


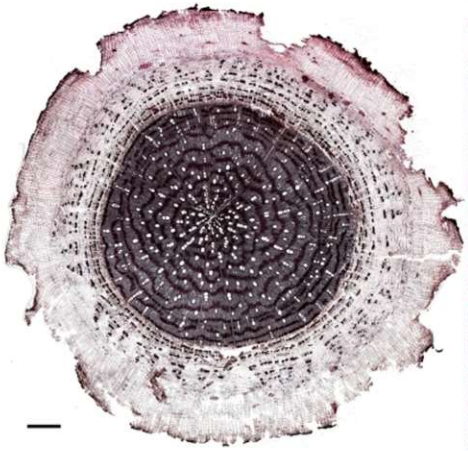


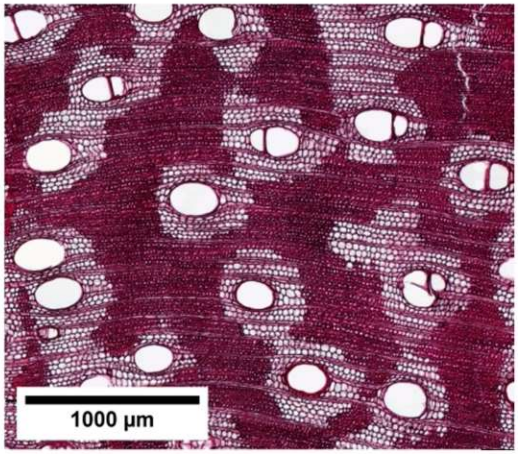




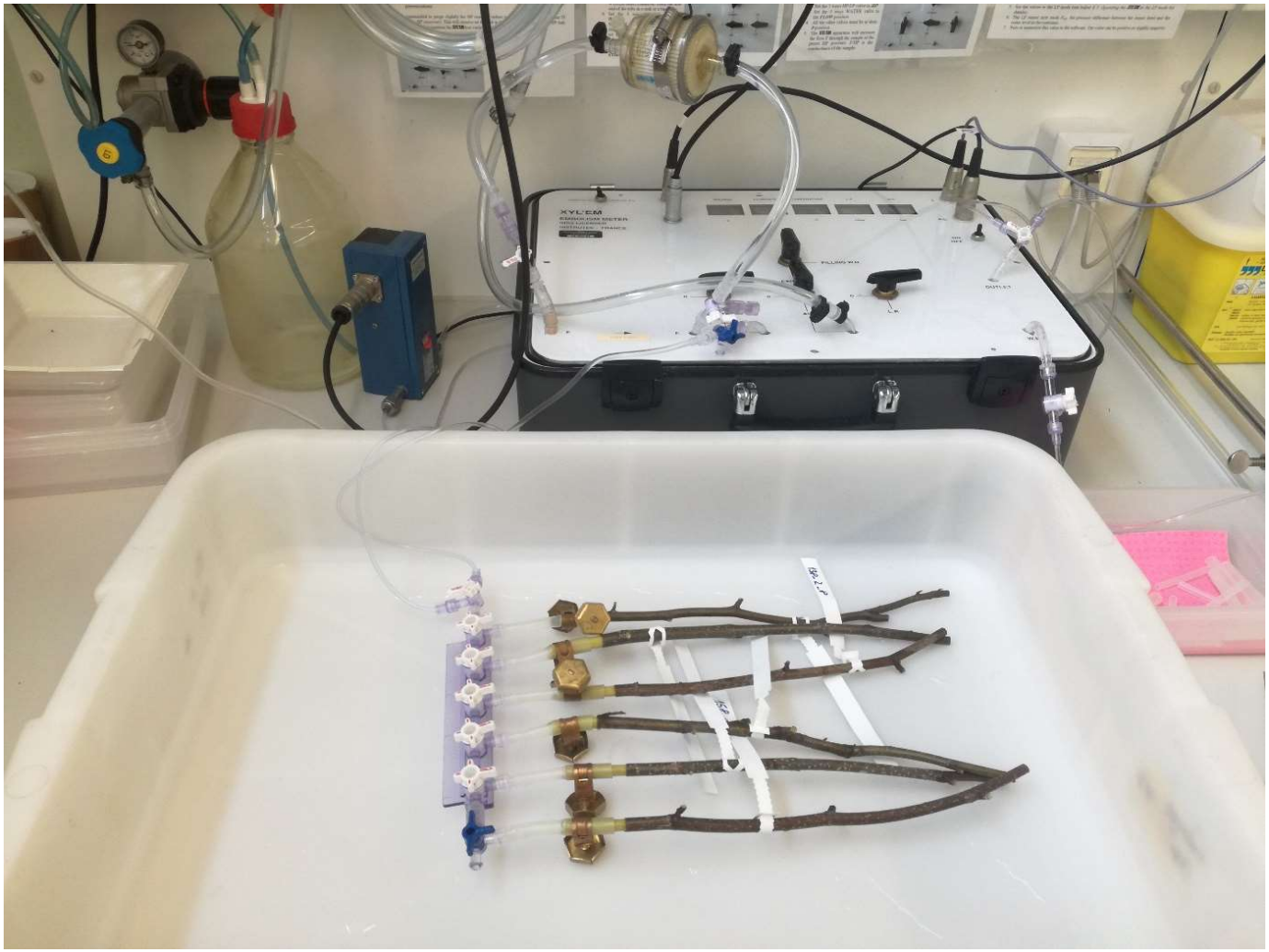




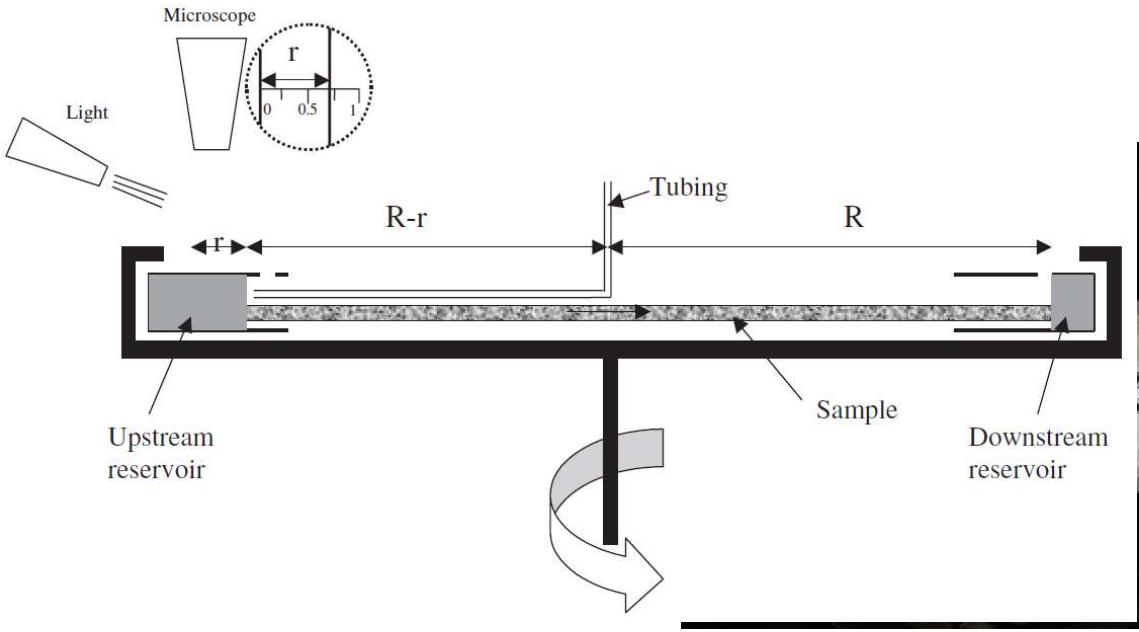




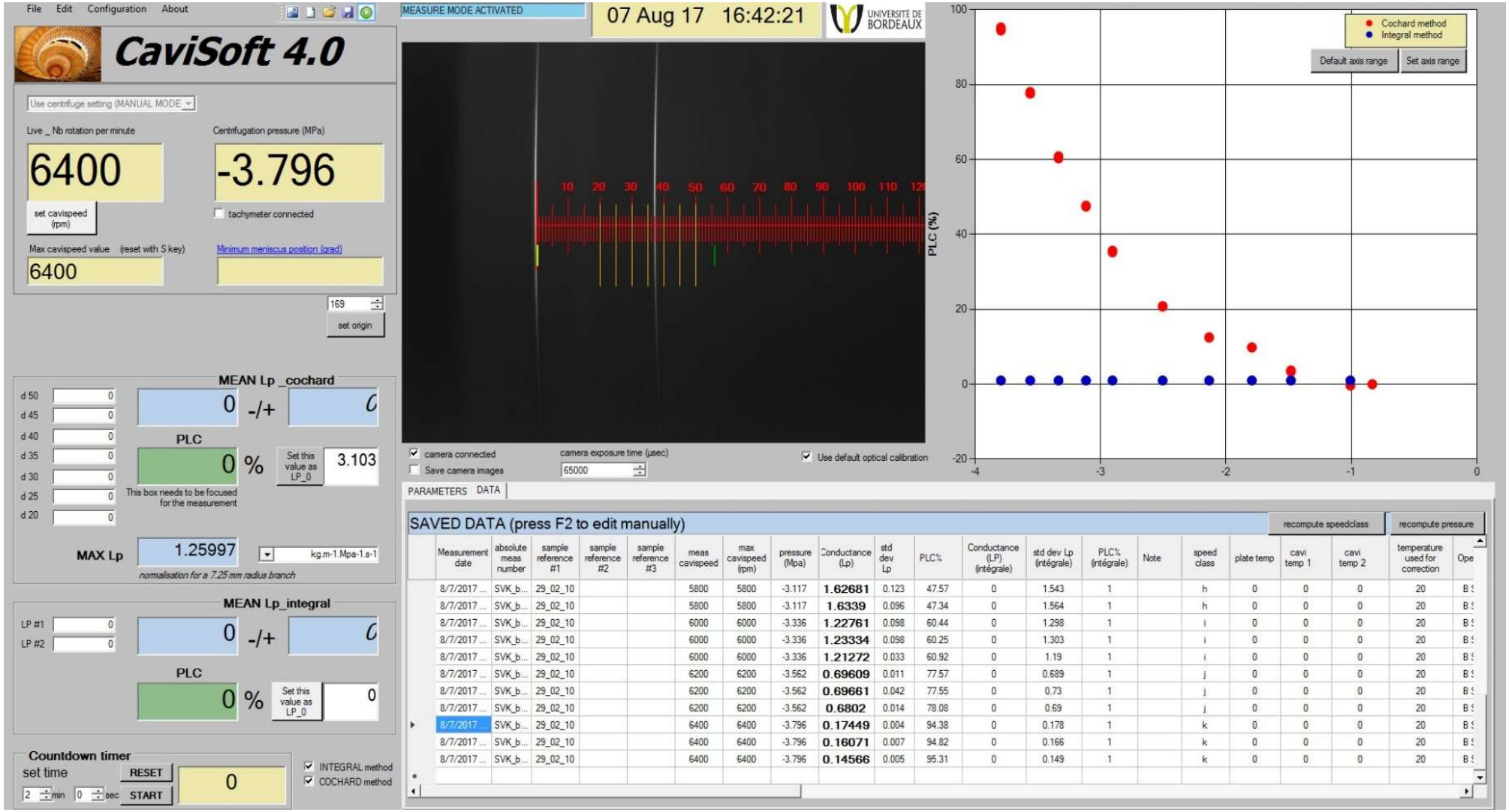
Measuring of hydraulic conductivity (Xyľem aparatus)



Measuring of xylem resistance to cavitation (Cavitron technique)

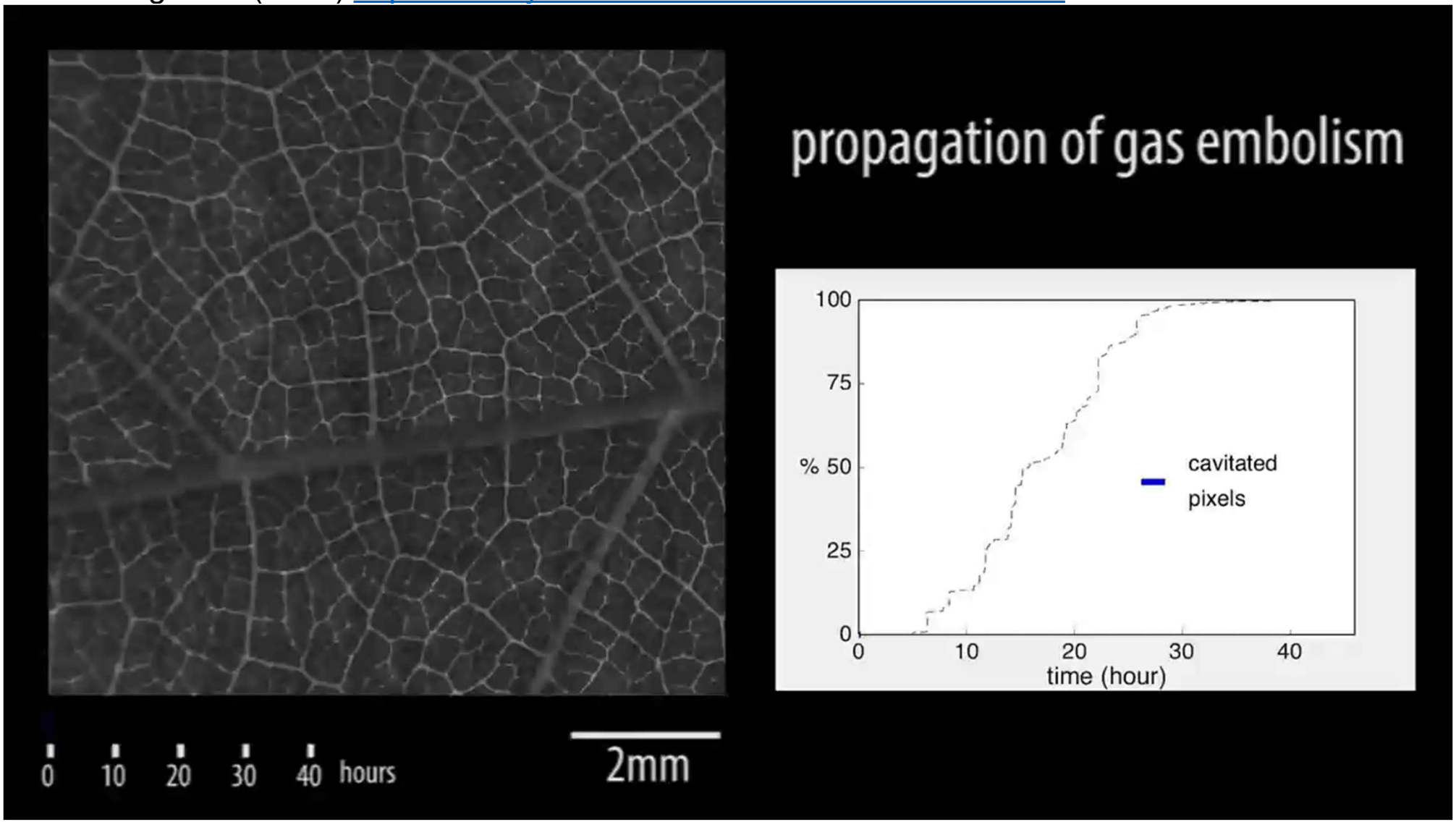


Cochard, Plant, Cell and Environment (2002)



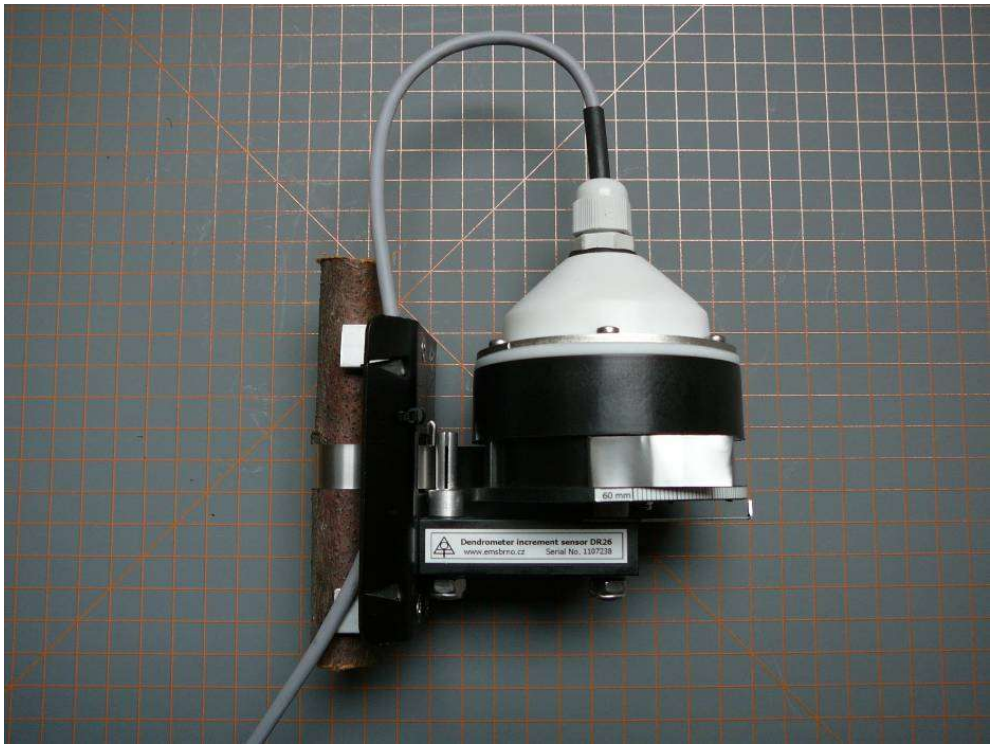
Measurement date	absolute meas number	sample reference #1	sample reference #2	sample reference #3	meas cavispeed	max cavispeed (rpm)	pressure (Mpa)	Conductance (Lp)	std dev Lp	PLC%	Conductance (LP) (intégrale)	std dev Lp (intégrale)	PLC% (intégrale)	Note	speed class	plate temp	cavi temp 1	cavi temp 2	temperature used for correction	Ope
8/7/2017 ...	SVK_b...	29_02_10			5800	5800	-3.117	**1.62681**	0.123	47.57	0	1.543	1		h	0	0	0	20	B
8/7/2017 ...	SVK_b...	29_02_10			5800	5800	-3.117	**1.6339**	0.096	47.34	0	1.564	1		h	0	0	0	20	B
8/7/2017 ...	SVK_b...	29_02_10			6000	6000	-3.336	**1.22761**	0.098	60.44	0	1.298	1		i	0	0	0	20	B
8/7/2017 ...	SVK_b...	29_02_10			6000	6000	-3.336	**1.23334**	0.098	60.25	0	1.303	1		i	0	0	0	20	B
8/7/2017 ...	SVK_b...	29_02_10			6000	6000	-3.336	**1.21272**	0.033	60.92	0	1.19	1		i	0	0	0	20	B
8/7/2017 ...	SVK_b...	29_02_10			6200	6200	-3.562	**0.69609**	0.011	77.57	0	0.689	1		j	0	0	0	20	B
8/7/2017 ...	SVK_b...	29_02_10			6200	6200	-3.562	**0.69661**	0.042	77.55	0	0.73	1		j	0	0	0	20	B
8/7/2017 ...	SVK_b...	29_02_10			6200	6200	-3.562	**0.6802**	0.014	78.08	0	0.69	1		j	0	0	0	20	B
8/7/2017	SVK_b...	29_02_10			6400	6400	-3.796	**0.17449**	0.004	94.38	0	0.178	1		k	0	0	0	20	B
8/7/2017 ...	SVK_b...	29_02_10			6400	6400	-3.796	**0.16071**	0.007	94.82	0	0.166	1		k	0	0	0	20	B
8/7/2017 ...	SVK_b...	29_02_10			6400	6400	-3.796	**0.14566**	0.005	95.31	0	0.149	1		k	0	0	0	20	B

Hochberg et al. (2016) https://www.youtube.com/watch?v=7-X8mmPFek0



A iné....

Meranie zmien obvodu kmeňa



Dendrometer DL26

Chemické analýzy

Spektrofotometer – napr. meranie koncentrácie pigmentov, aminokyseliny prolín cez meranie absorbancie

Vodný kúpeľ, homogenizátor vzoriek

Meranie obsahu chlorofylu

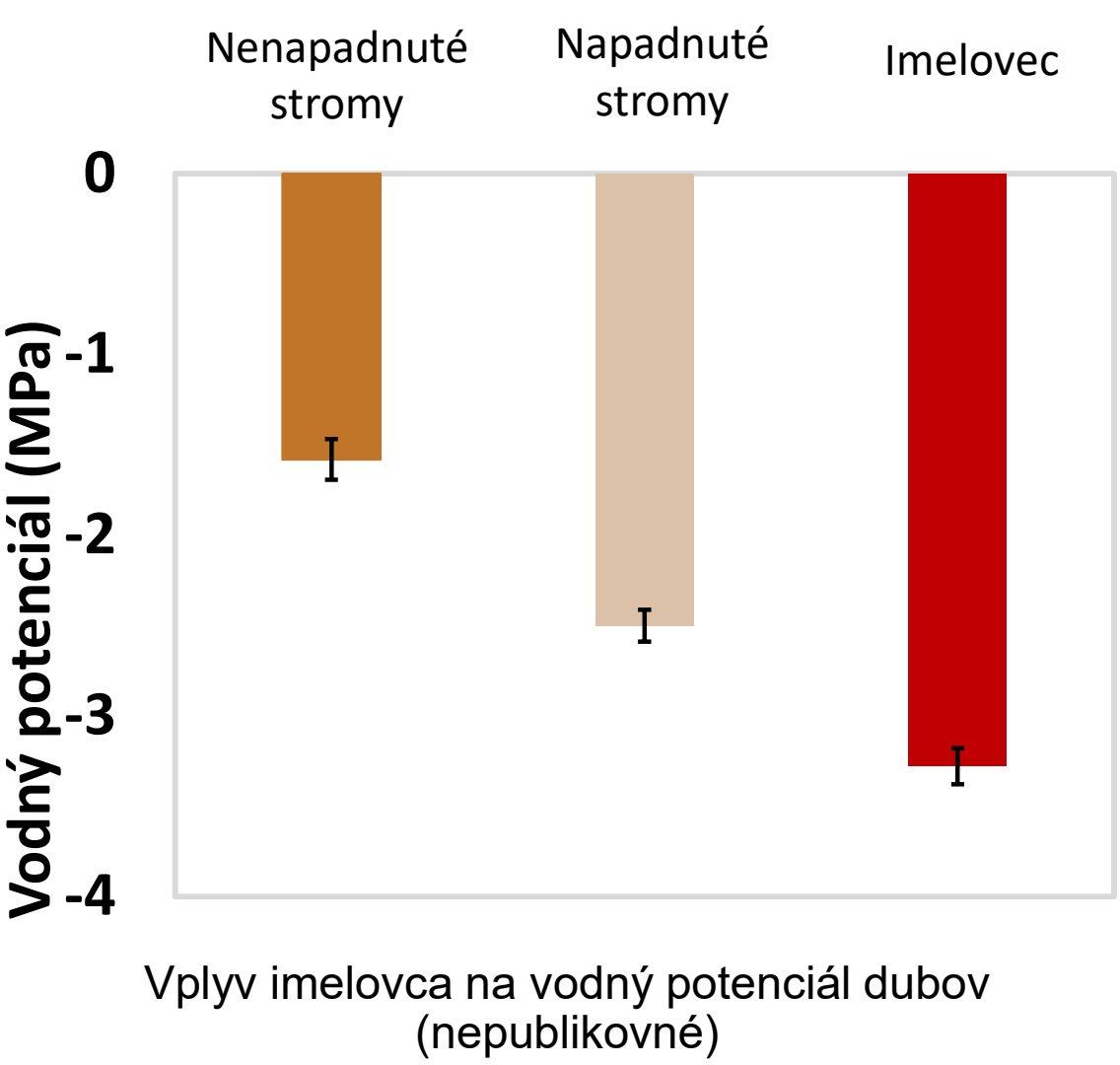
Chlorofylometer CL-01 (Hansatech)

Termokamera

Ťažká veda...

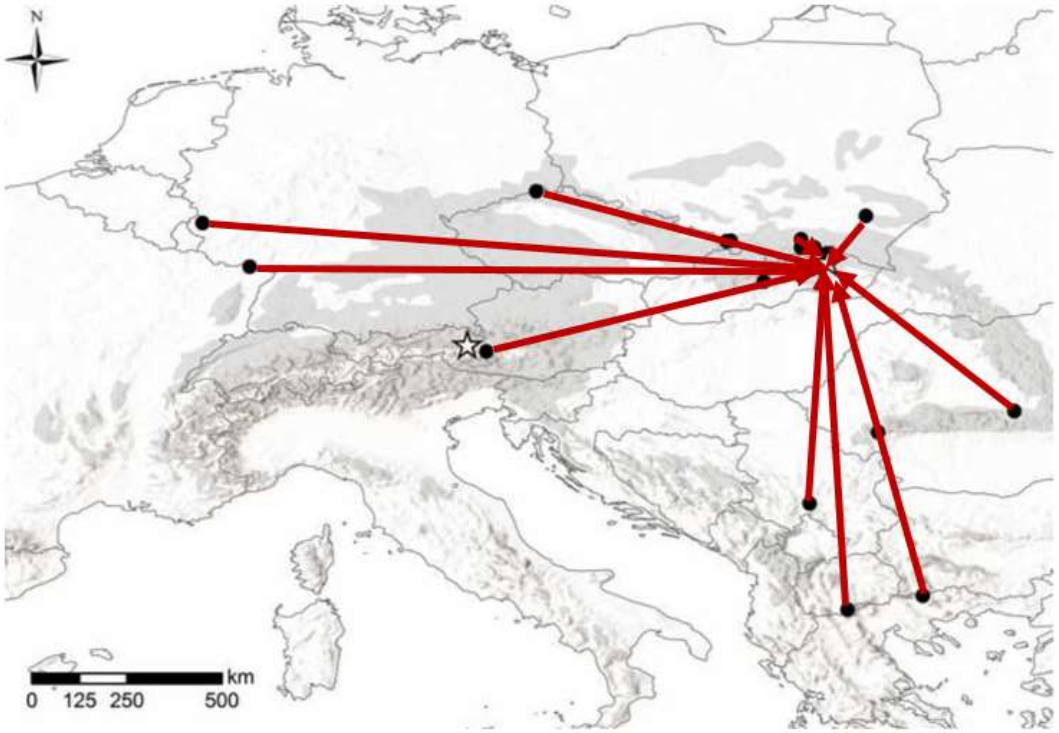
Výsledky a prečo to všetko?

- Odhad produkcie
- Sekvestrácia uhlíka
- Odhady rizika odumierania drevín
- Predikcia posunov v nadmorskej výške
- Skríning odolných genotypov resp. druhov
- Odhad významu adaptácie/aklimácie
- ....

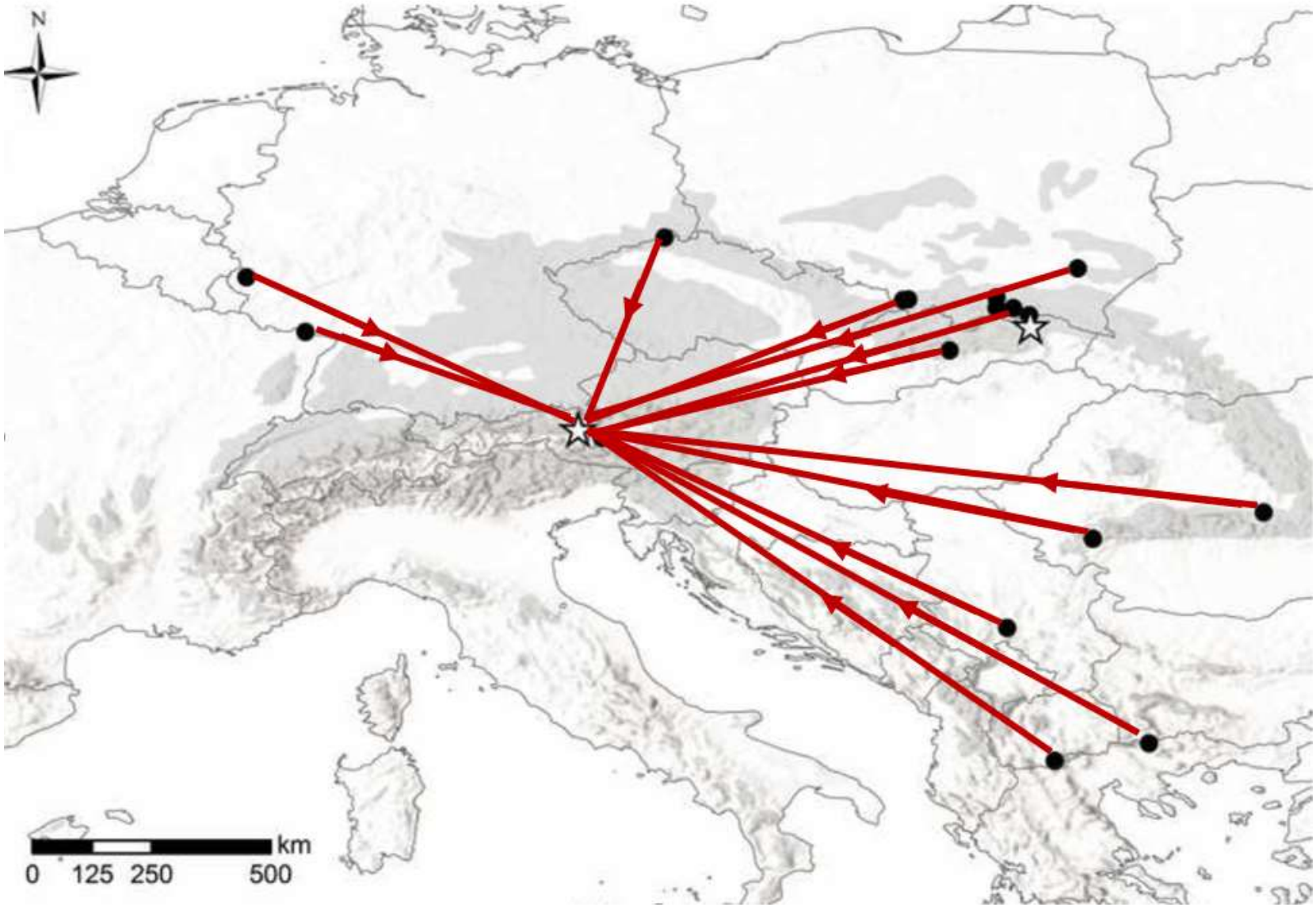


Vplyv imelovca na vodný potenciál dubov (nepublikovné)

Proveniečný výskum



block 3				block 2				block 1			
15 NL 5°48′ 52°17′	18 UK -2°00′ 51° 43′	06 FR 5°50′ 46° 48′	39 PL 19°10′ 49° 50′	55 SL 14°21′ 45° 44′	03 FR 3°06′ 49°15′	35 AT 14°06′ 47°43′	30 DE 12°25′ 52°03′	17 UK -3°25′ 57°40′	26 DE 10°40′ 53°39′	53 SI 14°23′ 45°38′	50 CZ 13°15′ 52° 4′
36 AT 14°51′ 47°32′	55 SL 14°21′ 45°44′	05 FR 1°09′ 48°22′	03 FR 3°06′ 49°15′	43 PL 22° 49′ 49°15′	28 DE 9°41′ 50°21′	15 NL 5°48′ 52°17′	26 DE 10°40′ 53°39′	31 DE 9°27′ 48°28′	21 DK 9°35′ 54°55′	67 PL 18°10′ 54°20′	12 LX 6°12′ 49°40′
40 PL 22°20′ 49°28′	64 CZ 14°00′ 50°00′	70 CZ 17°19′ 49°09′	26 DE 10°40′ 53°39′	62 FL 7°15′ 47°02′	06 FR 5°50′ 46°48′	64 CZ 14°00′ 50°00′	70 CZ 17°19′ 49°09′	35 AT 14°06′ 47°43′	06 FR 5°50′ 46°48′	40 PL 22°20′ 49°28′	43 PL 22°49 ′ 49°15 ′
57 BG 26° 08′ 42° 04′	62 FL 7°15′ 47°02′	23 SE 13° 12′ 55°34′	51 CZ 14°00′ 50°51′	23 SE 13°12′ 55°34′	40 PL 22°20′ 49°28′	50 CZ 13°15′ 50°34′	02 FR 0°46′ 49°32′	36 AT 14°51′ 47°32′	62 FL 7°15′ 47°02′	48 CZ 15°14′ 50°48′	30 DE 12°25′ 52°03′
48 CZ 15° 14 ′ 50° 48′	04 FR 2°35′ 44°09′	50 CZ 13°15′ 50°34′	30 DE 12°25′ 52°03′	39 PL 19°10′ 49°50′	57 BG 26°08′ 42°04′	31 DE 9°27′ 48°28′	21 DK 9°35′ 54°55′	03 FR 3°06′ 49°15′	64 CZ 14°00′ 50°00′	55 SL 14°21′ 45°44′	39 PL 19°10′ 49°50′
43 PL 22° 49 ′ 49°15 ′	12 LX 6°12′ 49°40′	31 DE 9°27′ 48°28′	02 FR 0°46′ 49°32′	36 AT 14°51′ 47°32′ ′	05 FR 1°09′ 48°22′ ′	53 SI 14°23′ 45°38′	14 NL 6°44′ 51°56 ′	18 UK -2°00′ 51°43′	02 FR 0°46′ 49°32′	14 NL 6°44′ 51°56′	23 SE 13°12′ 55°34′
67 PL 18°10′ 54°20′	28 DE 9°41′ 50°21′	13 BE 4°25′ 50°50′	21 DK 9°35′ 54°54′	67 PL 18°10′ 54°20′	13 BE 4°25′ 50°50′	51 CZ 14°00′ 50°51′	12 LX 6°12′ 49°40′	70 CZ 17°19′ 49°09′	57 BG 26°08′ 42°04′	04 FR 2°35′ 44°09′	13 BE 4°25′ 50°50′
53 SI 14°23′ 45°38′	14 NL 6°44′ 51°56′	17 UK -3°25′ 57°40′	35 AT 14°06′ 47°43′	17 UK -3°25′ 57°40′	04 FR 2°35′ 44°09′	48 CZ 15°14′ 50°48′	18 UK -2°00′ 51°43′	15 NL 5°48′ 52°17′	05 FR 1°09′ 48°22′	28 DE 9°41′ 50°21′	51 CZ 14°00′ 50°51′


N
km
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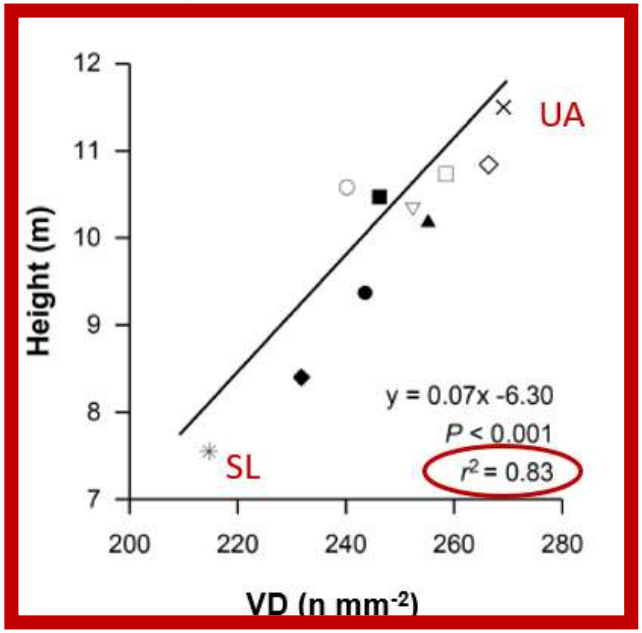
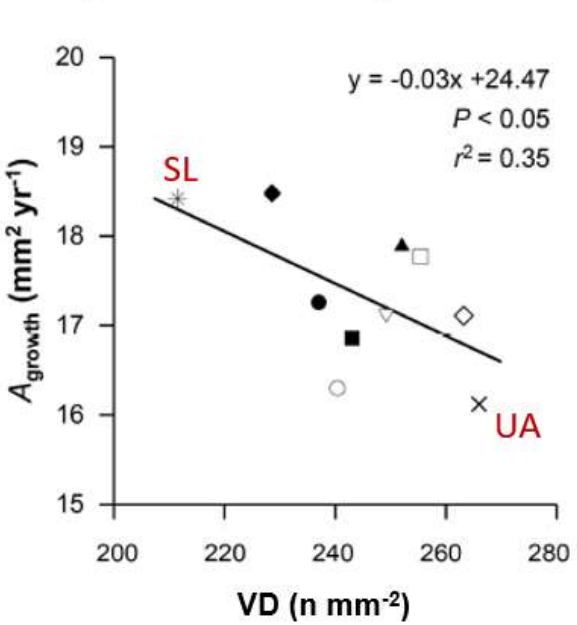
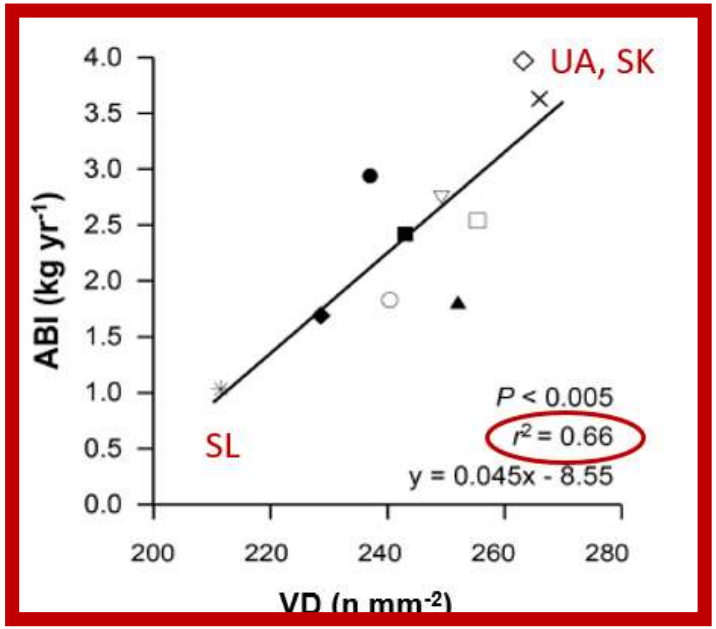
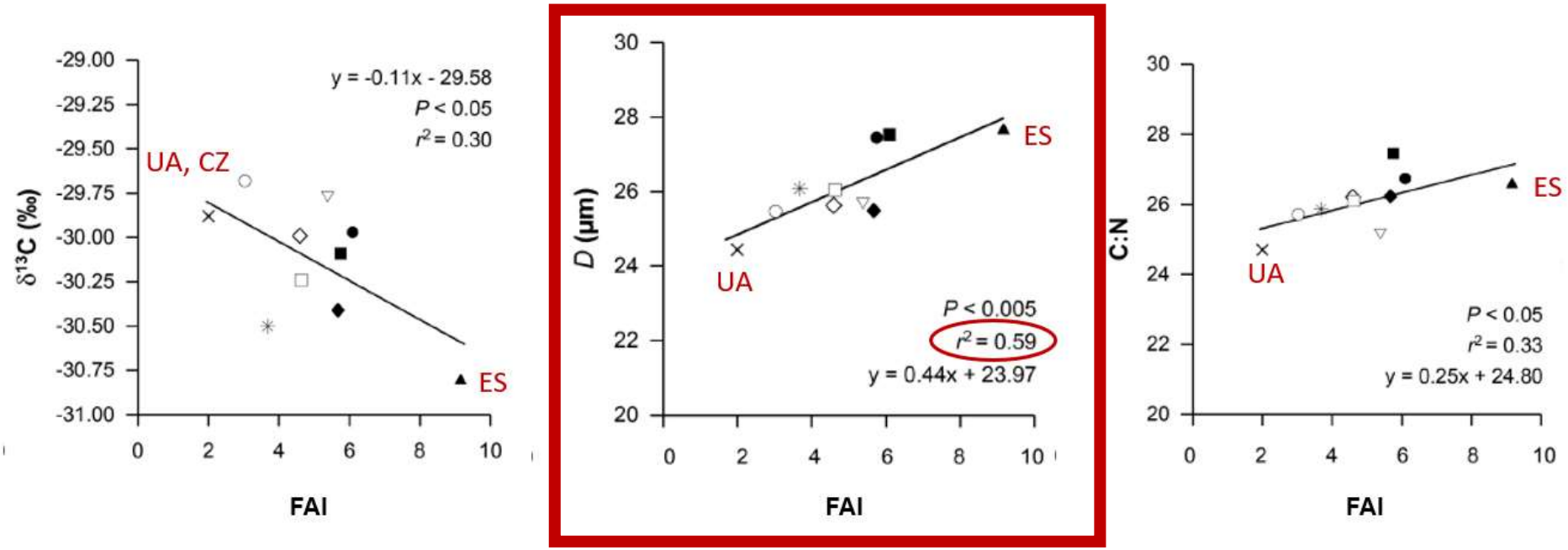
Relationship between vessel density and tree height, annual branch sapwood area increment, and aboveground biomass increment



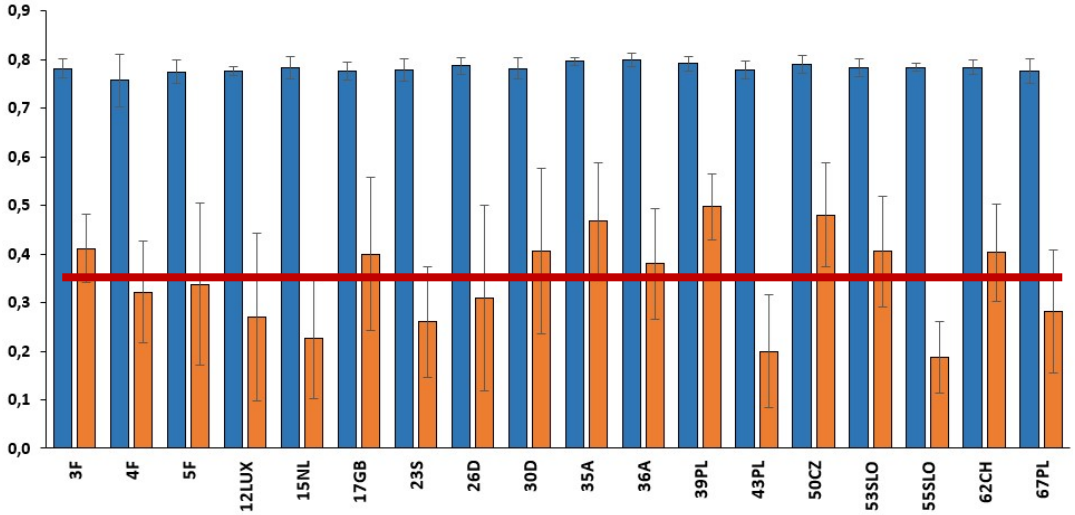




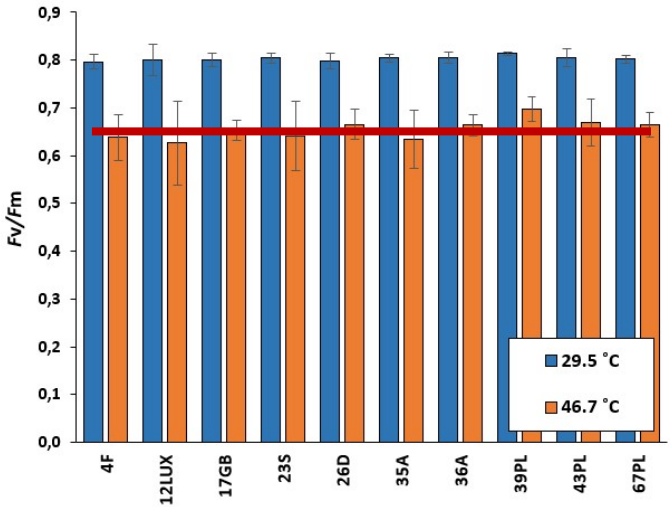
Relationship between the forest aridity index (FAI) at the place of origin and carbon isotope signature, vessel diameter, and carbon to nitrogen ratio



Chladnejšia plocha

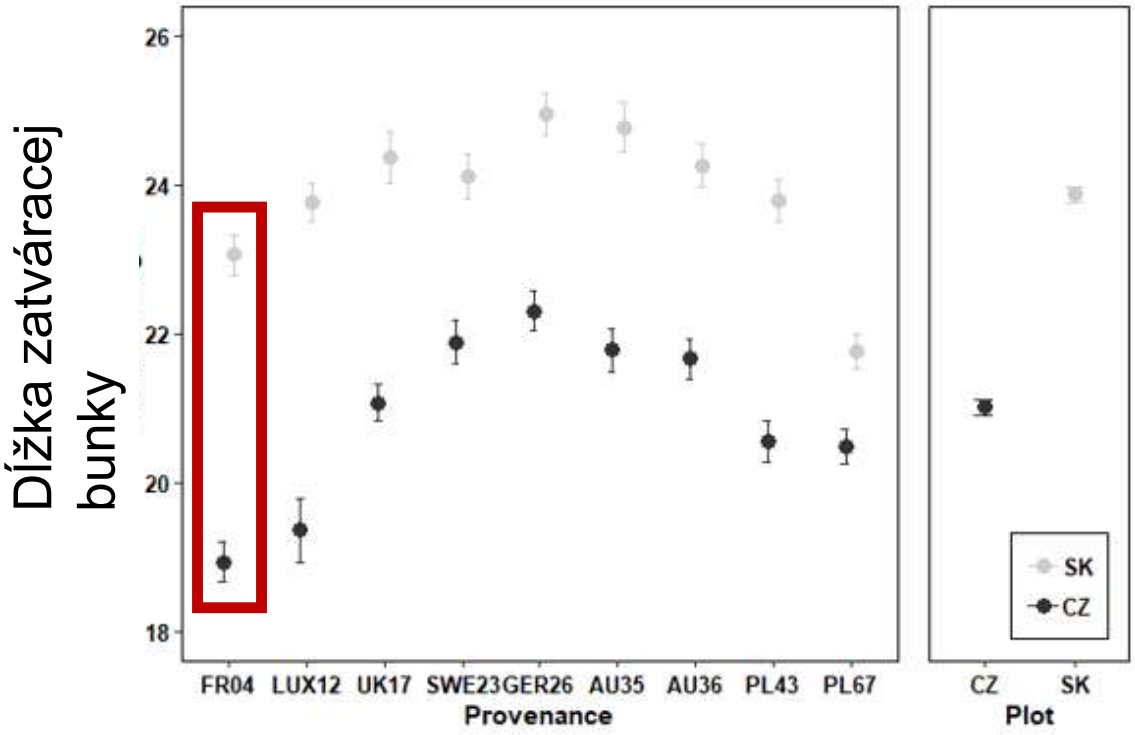


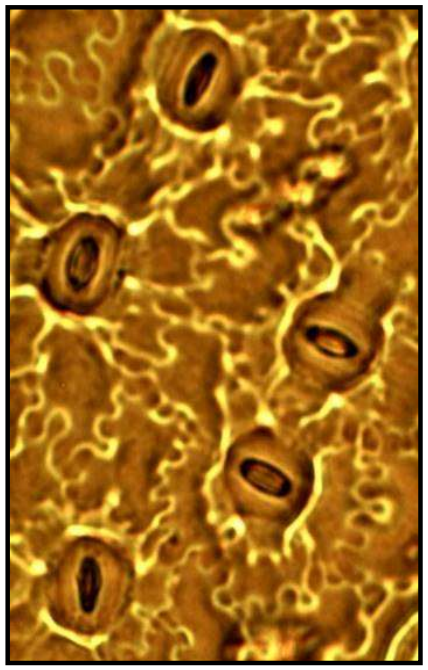
Teplejšia plocha



Priemerné hodnoty parametra *F*v/*F*m pre všetky testované proveniencie a pre obe plochy pri simulovaných teplotách 29.5 °C a 46.7 °C.

Veľkosť aj hustota prieduchov môžu byť rôzne v rôznom prostredí

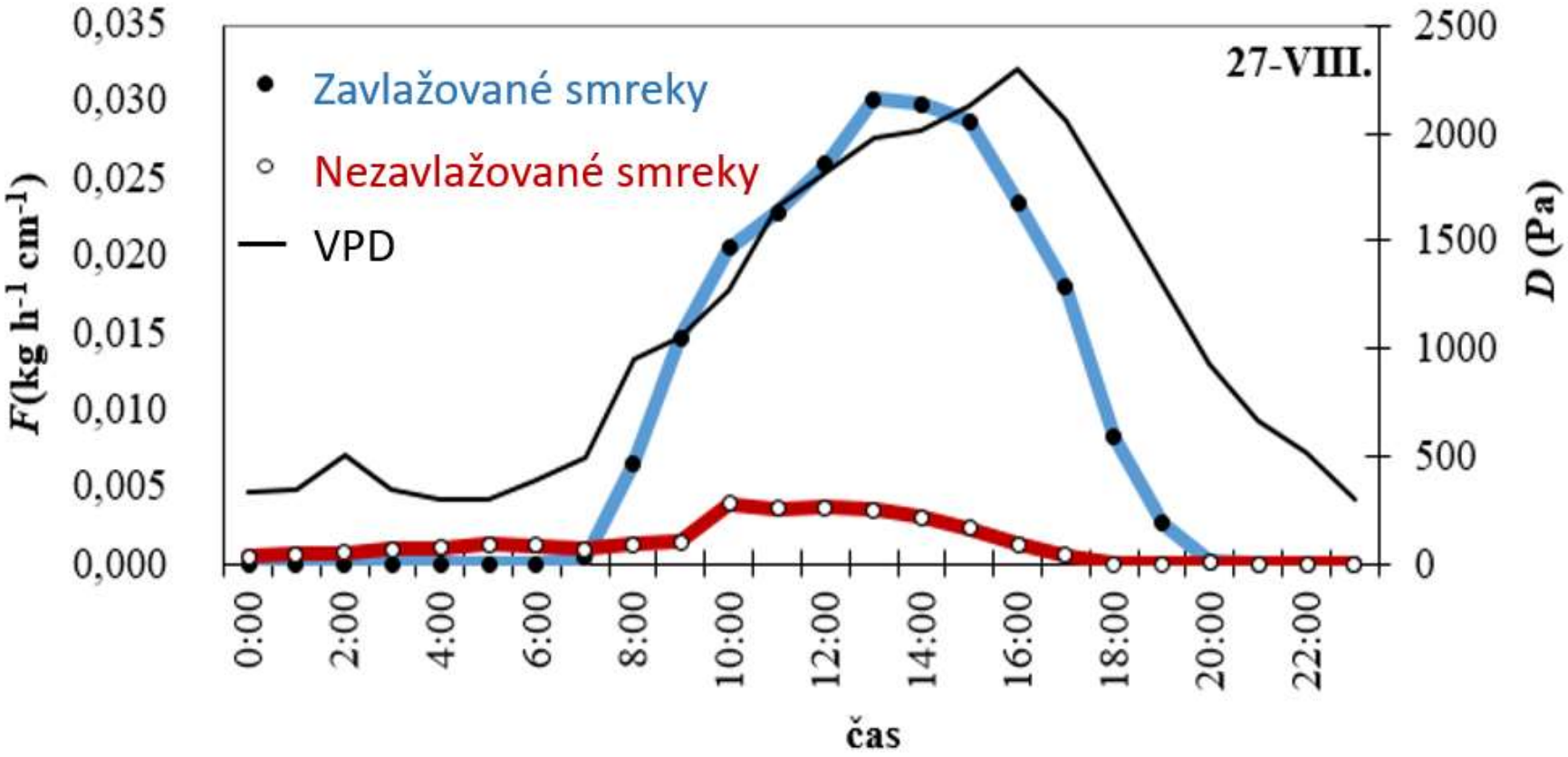




Proveniencie

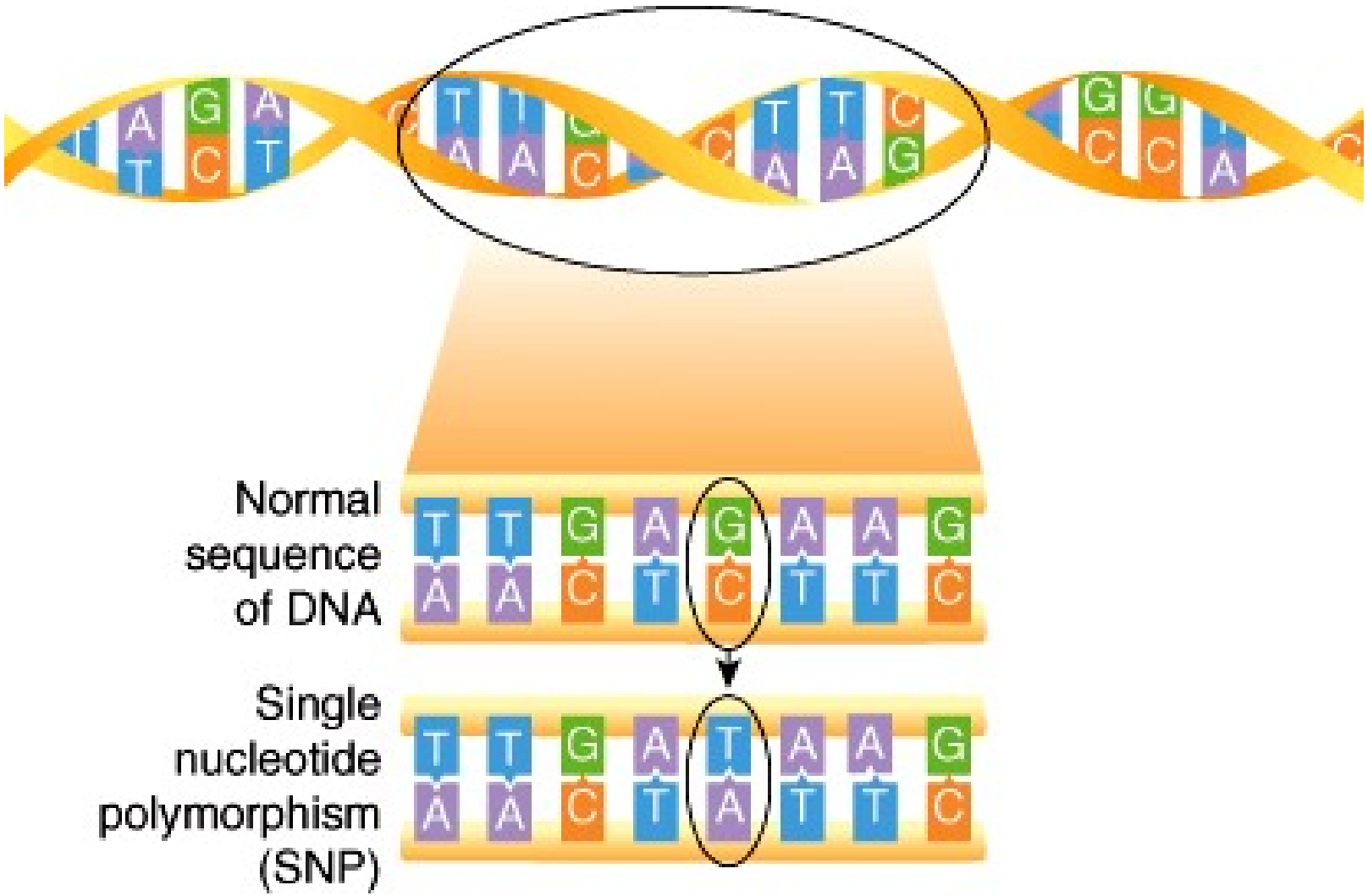
Plocha

Veľkosť zatváracej bunky (µm) pre buky rôzneho pôvodu rastúce v kontrastných podmienkach (nepublikované)



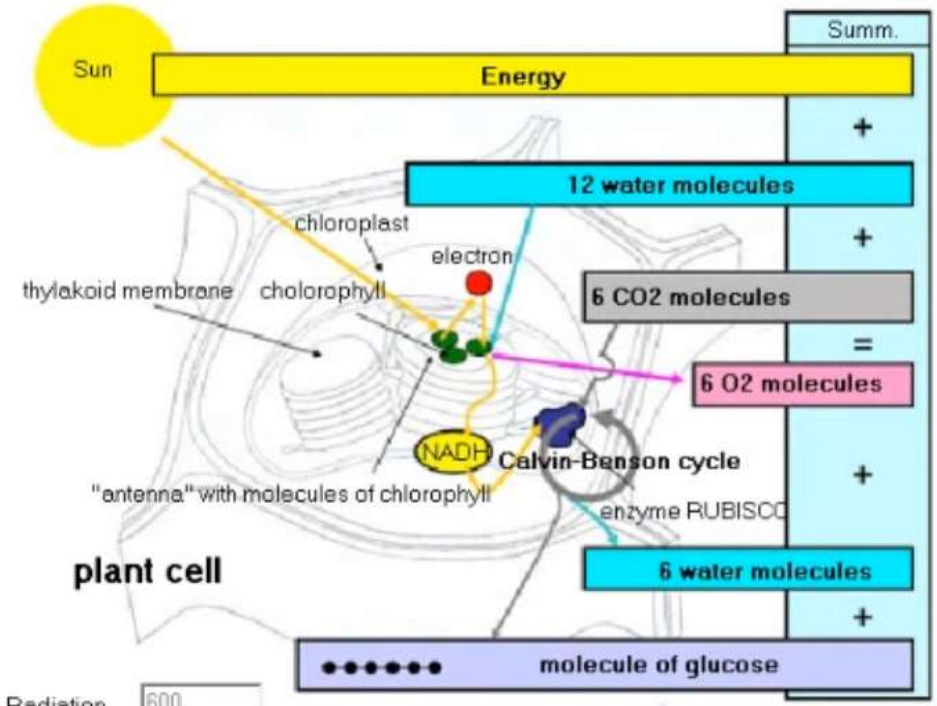
Denný chod transpirácie (F) pre zavlažené smreky (IR) a nezavlažené smreky (NIR) a deficitu tlaku vodných pár (VPD)

Kurjak et al., Euroean Journal of Forest Research (2012)


Normal sequence of DNA
Single nucleotide polymorphism (SNP)

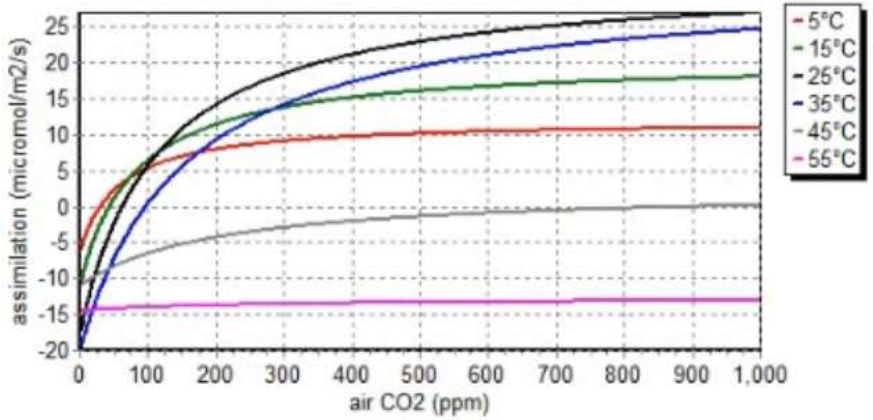
SIBYLA - Physiologist

Inputs | Pedotransfer functions | Hydrological balance | Stomatal conductance | Transpiration | Leaf energy balance | Photosynthesis | Respiration | Leaf phenology



Radiation 600

Assimilation rate limited by electron transport versus CO2



Maximum rate of RuBP carboxylation (mikromol/m2/s):	93.4
Maximum rate of RuBP oxygenation (mikromol/m2/s):	23.3
Michaelis-Menten constant for carboxylation (mikrobar):	472.7
Michaelis-Menten constatnt for oxygenation (milibar):	272.7
Rate of dark respiration (mikromol/m2/s):	1.43
CO2 compensation point in the absence of day respiration (mikrobar):	44.4
Light-saturated electron transport rate (mikromol/m2/s):	150.4
Optimal temperature (°C):	31
Optimal electron transport (mikromol/m2/s):	161.9
Photon flux density (mikromol/m2/s):	2394
Electron transport (mikromol/m2/s):	142
Balanced intercellular CO2 partial pressure (mikrobar):	364.3
Atmospheric CO2 partial pressure (mikrobar):	376.5
Intercellular CO2 partial pressure (mikrobar):	289.9

Assimilation rate limited by Rubisco (mikromol/m2/s):	19.1
Assimilation rate limited by electron transport (mikromol/m2/s):	21.6
Assimilation (mikromol/m2/s):	19.1

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Research Article
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Adaptive variation in physiological traits of beech provenances in Central Europe

Jana Kučerová [(1)],
Alena Konôpková [(2)],
Eva Pšidová [(1)],
Daniel Kurjak [(2)],
Gabriela Jamnická [(1)],
Kristina Slugenová [(1)],
Dušan Gömöry [(2)],
Lubica Ditmarová [(1)]

Current climate changes can led to a decline of local beech populations fully adapted to previous climate conditions. In this context, the issue of variation in adaptive traits becomes important. A field experiment with 18-year-old trees of *Fagus sylvatica* L. was conducted on provenance plot located in Tále (Central Slovakia), where physiological responses of five beech provenances originating from contrasting sites along an altitudinal gradient from 55 to 1100 m a.s.l. across the range of the natural beech distribution were studied. Stomatal characteristics, parameters of chlorophyll *a* fluorescence and gas exchange parameters were determined. Overall, we observed a significant increase in physiological performance at the leaf level with increasing altitude

frontiers in Plant Science
ORIGINAL RESEARCH
published: 15 June 2016
doi: 10.3389/fpls.2016.00791

Intraspecific Variation in Wood Anatomical, Hydraulic, and Foliar Traits in Ten European Beech Provenances Differing in Growth Yield

*Peter Hajek [1], Daniel Kurjak [2], Georg von Wühlisch [3], Sylvain Delzon [4] and Bernhard Schuldt [1]**

Trees
DOI 10.1007/s00468-017-1612-9

ORIGINAL ARTICLE

Differences in photochemistry and response to heat stress between silver fir (*Abies alba* Mill.) provenances

Alena Konôpková[1] · Daniel Kurjak[1] · Jaroslav Kmeť[1] · Raphael Klumpp[2] · Roman Longauer[3,4] · Ľubica Ditmarová[5] · Dušan Gömöry[1]

DOI: 10.1007/s11099-015-0101-x
PHOTOSYNTHETICA 53 (2): 187-194, 2015

Photosynthetic response of beech seedlings of different origin to water deficit

E. PŠIDOVÁ[*,+], Ľ. DITMAROVÁ[*], G. JAMNICKÁ[*], D. KURJAK[**,***], J. MAJEROVÁ[*], T. CZAJKOWSKI[#], and A. BOLTE[#]

https://www.youtube.com/watch?v=zxhgNmaCVAM

https://www.youtube.com/watch?v=YzpDN7laepo&t=48s

https://www.youtube.com/watch?v=uWL0EoZh09w&t=43s

https://www.youtube.com/watch?v=7-X8mmPFek0&t=13s