GENERAL INFORMATION

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MATERIALS & METHODS

study area	6b
time period	May-July 2012
goal	This exploratory study has two objectives: (i) investigating the feasibility of the potometric technique in remote areas with no electricity and (ii) validating the accuracy of potometric sap flow field readings through comparison with field-generated sap flow data from a calibrated sap flow sensor.
set-up	- *Hedera helix* on a beech and an oak tree (30 m tall), stem diameter ranged from 9.5-13 mm: two sap flow sensors o control o potometer experiment - continuous cut potometric approach versus SGA10 Dynamax Inc., Huston, TX sap flow sensor
data collection	Meteorological data (measuring tower) - precipitation (Delta-T-Device tipping bucket rain gauge, model type RG1 with a resolution of about 0.2 mm) - photosynthetic active radiation (Delta-T-Device PAR quantum sensor PQS2) - relative humidity (Vaisala HMP143 series relative humidity transmitter) Sensor calibration (laboratory, 2 days) - every five minutes: cumulative weight of tap water flowing through a *Hedera helix* stem segment collected in a beaker placed on a Sartorius Basic weighing balance of 1 mg accuracy - sap flow sensor installed on the *Hedera helix* stem segment on a perpendicular axis with width 1.02 cm and length 1.12 cm Experiment - external thermocouple to capture air temperature in the vicinity of the two sensors - two sap flow sensors (the automated datalogger was programmed to take an average every five minutes of data logged every 20 seconds) - potometer: five-minute interval water addition to replenish water taken up by the plant; water uptake was determined by noting the volume of water remaining in the 50 ml graduated measuring cylinder after adding water into the flat bottomed flask - each experiment lasted 2 days and was done on 3 trees - path taken by sap in the ivy plant: Gurr Certistain® VWR International Ltd., England safranine O red organic dye on a single stem at the end of the experiment

remarks	Both the spring and summer of 2012 were marked by unpredicted sun episodes punctuated with rainy spells, strong wind and massive cloud cover. As a result, data was collected on partly rainy, windy, sunny and cloudy days.

ABSTRACT

The whole tree potometer was explored in order to ascertain its feasibility to quantify water use in climbing plants (lianas) under uncontrolled field conditions. The liana species English Ivy (*Hedera helix* L.) was used in the study. The exploration involved the use of a continuous cut potometric approach on ivy which rose up to nearly 30 m on host trees; oak (*Quercus robur* L.) and European beech (*Fagus sylvatica* L.). This study allowed potometric estimates of ivy water use to be accurately quantified through comparison with sap flow estimates from the SGA10 Dynamax Inc., Huston, TX sap flow sensor, used as a benchmark for accuracy. This research proved that indeed the potometer was a good method to quantify sap flows in ivies. This was due to its remarkable performance under varied environmental conditions. The potometric approach also allowed night time sap flow of the ivy to be quantified. *Hedera helix* wood anatomy stained using dye during potometric trials revealed that the ivy used its entire xylem section to transport water. This meant that not all types of modern day sap flow sensors can precisely determine ivy water use without some form of correction. The error that resulted when potometric and sensor flow rates were compared was 16%. Nonetheless, the findings of the study indicate that the potometric approach is promising and should be further explored.

RESULTS

The water uptake from the "no re-cut" potometric experiment significantly dropped due to water stress induced by the healing of the wound caused by cutting.

There was a clear relationship between the sensor and potometer data for sap flows of 10-100 g h^{-1}. For flows larger than 100 g h^{-1}, there was considerable deviation between the two techniques. The potometer might have underestimated the sap flow, or sap flow overestimates possibly occurred due to a lack of thermal equilibrium between the xylem fluid and the temperature of the sensor on the stem surface. *Hedera helix* used its entire xylem area to conduct sap. Although the model only explained 69 % of the potometer measurement deviations (with regard to the sensor measurements), the slope between the measurement values of the two techniques indicated an error of only 16%.

Hedera helix transpired less on sunny days (14 g h^{-1}) compared to overcast days (20 g h^{-1}). Low flows correspond to a maximum PAR of 1600 µmol m^{-2} s^{-1} and RH of 30-40%. High flows occurred at maximum PAR of 1600-1800 µmol m^{-2} s^{-1} and RH of 60-80%. *Hedera helix* thus uses overcast weather conditions with moderately high RH to photosynthesize as less water is lost in these conditions. The water-use efficiency of *Hedera helix* was high. The night time sap flow noted might have been due to rehydration.

CONCLUSONS

The potometer was a good method to quantify sap flow in ivy, because of its remarkable performance under varied environmental conditions and the possibility to quantify night-time sap flow. The ivy used its entire xylem section to transport water, which indicates that not all types of current sap flow sensors can precisely determine ivy water use without some form of correction. The potometric approach is promising and should be further explored.