XVI International Colloquium on Plant Ecophysiology

Parque Katalapi, Puerto Montt, Chile; January 18-20, 2023

We hope to contribute to generate a space for enthusiastic and relaxed talk, an atmosphere of relaxation to facilitate scientific discussion, sharing experiences and facilitate networking and contacts for graduate students and professors in the field of Plant Ecophysiology. Here we have compiled your scientific contributions to keep a record of your participation in the XVI International Colloquium on Plant Ecophysiology 2023 at Katalapi Park. This colloquium was created to share experiences with students

The organizing committee thanks the international participants who have tried to be with us and those who have contributed virtually from a distance. We also thank each of you for your interest, contribution to a constructive criticism and discussion and the time spent. The contribution of each one, finally makes the community progress and plant ecophysiology advance.

We appreciate the valuable contributions of the sponsors of the event:

Universidad de Concepción, Universidad de La Frontera, Instituto de Ecología y Biodiversidad, Programa Fondequip, ANID & Parque Katalapi.

Organizing Committee

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Links of interest:
www.antarcticplantscience.cl
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General Program

Time	Wednesday 18th	Thursday 19th	Friday 20th
8:00-9:00		Breakfast	Breakfast
9:00-9:45		Lecture 1 Adrienne Nicotra (ANU)	Lecture 3 Jeroni Galmés
9:45-13:00		Short Communications 1	Short Communications 3
9:45-10:00		Antonio Escandón	Alejandra Flores
10:00-10:15		Adrian Sanhueza	Valentina Vallejos
10:15-10:30		Benjamín castro	Fiorella Calderón
10:30-11:00		Coffee Break	Coffee Break
11:00-13:00		Mini-lectures 1	Mini-lectures 2
11:00-11:30		Enrique Ostria	Daniela Aros
11:30-12:00		Francesc Castanyer	Dariel López
12:00-12:30		Marely Cuba	Tomás Fuenzalida
13:00-14:30		Lunch	Lunch
15:00-15:45	GFS-300, WALZ training Katharina Siebke	Lecture 2 Jaume Flexas	Lecture 4 Ileana Echeverría
15:45-17:45	GFS-300, WALZ training	Symposium Soil-Plant	Departures
15:45-16:15		Francisco Matus	
16:15-16:45	Coffee Break	Coffee Break	
16:45-17:15	GFS-300, WALZ training	Ignacio Jofré	
17:15-17:45	GFS-300, WALZ training	Rodrigo Rodríguez	
17-45-18:30	GFS-300, WALZ training	Short Communications 2	
17:45-18:00	GFS-300, WALZ training	Karla Villena	
18:00-18:15	GFS-300, WALZ training	Javier Lopatín	
18:15-18:30		Catalina Castro	
18:30-18:45		Carolina Sanhueza	
19:00-20:00	Cata in Kata/Dinner	Dinner	

ABSTRACTS BOOKLET

LECTURES

Lecture 1:

What is (plant) thermal tolerance? And (how) does it matter in a warming world?

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Temperatures are rising and the thermal regimes of our ecosystems are changing rapidly, becoming warmer and more variable. Many of us are actively researching – the impacts of these changes by examining temperature and warming effects on a wide variety of organisms. Important questions revolve around what determines thermal tolerance or the thermal limits of a species distribution. Are they the same thing? And how best to measure or predict them? To assess the integrated response of organisms and communities to changing thermal regimes requires systems level perspectives that draw together impacts at different scales – e.g., cell vs organ vs organism within species; or plant vs pollinator vs pathogen at community scales. I will present work collaborators and I have been doing to better understand what plant thermal tolerance means, what drives it, and to explore how best to assess it, at seed, seedling, leaf, and whole plant scales. In the spirit of reconnecting, I'll aim to probe the crowd see how you're feeling, whether hot or cold, on whether we're approaching the subject of thermal tolerance in the right way.

Acknowledgments: This talk presents the work of a wonderful and large group of collaborators to whom I am extremely grateful, and is supported by the Australian Research Council.

Lecture 2:

Ecophysiological aspects of Western Himalayan plants

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In summer 2022, ecophysiological traits were determined in situ in native plants of the Himalayan Ladakh region (India), in an elevation gradient ranging from 4150 to 5315 m a.s.l. including steppe, alpine and subnival assemblies. Measured traits included leaf mass area (LMA) and desiccation tolerance (Falcon test), thermographic canopy temperature, and simultaneous gas exchange and chlorophyll fluorescence. The latter were determined for the first time above 5000 m a.s.l. proving that such measurements are feasible although tough. A trade-off between leaf desiccation tolerance and photosynthetic capacity (*A*) was observed, as already observed for diverse ecosystems.

Despite the very harsh conditions in the studied sites, it was shown that, at morning and midday, plants were able to keep canopy temperature well above ambient (up to >20ºC above air temperature), i.e. keeping conditions favorable to photosynthesis but also increasing leaf-to-air vapor pressure deficit, i.e. the atmospheric transpiration demand. Finally, it was shown that most of the studied species displayed very high *A*, yet relatively low photosynthetic water use efficiency. Due to the very low CO_2 partial pressures at high elevations, implying low CO_2 partial pressures in the sub-stomatal cavities of leaves (P_i), the apparent photosynthetic CO_2-use efficiency (i.e. the A/P_i ratio) proved to be very large in those species, tending to increase with elevation, suggesting large mesophyll conductance and/or Rubisco activity and efficiency. While preliminary, the results of the present field survey suggest that Western Himalayan plants are interesting candidates to study the ecophysiology of plants inhabiting very harsh environments at high elevations.

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Lecture 3:

Leaving the water, coming back in: wet and dry evolutionary trends in the CO_2 assimilation of land plants.

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The transition from aquatic to land-adapted photosynthesis in the Ordovician was a remarkable achievement in the evolution of plants. The terrestrialization of photosynthesis required the gradual acquisition of important anatomical, physiological and biochemical traits to enable efficient CO_2 capture and fixation during the colonization of the new terrestrial environments, subjected to novel and more variable stressors. Among these traits, increasing stomatal and leaf vein densities during the Cretaceous enabled seed plants to boost their photosynthetic capacity, and productivity, as compared to older Embryophyta groups, i.e. bryophytes, lycophytes and ferns. The enhanced capacity to assimilate CO_2 of angiosperms also required anatomical changes to facilitate the internal leaf transport of CO_2 towards the sites of carboxylation, mainly a thinner cell wall and a more efficient distribution of chloroplasts. While the evolution of stomata and leaf mesophyll during the radiation of land plants have been previously investigated, no information is available on how Rubisco traits co-evolved with the CO_2 diffusion components of photosynthesis. The reserve path, consisting in re-colonization of the aquatic environments by angiosperms, holds even more unknowns, including not only those regarding Rubisco's performance, but also those related with the diffusive components of photosynthesis. In the present talk, we will decipher the role of Rubisco in maximizing photosynthesis during the radiation of land plants and also during the re-colonization of the marine habitats. We will discover how carbon acquisition and assimilation mechanisms adapted to the new environments by a co-evolution between the Rubisco function and the delivery of CO_2 in the leaf mesophyll.

Acknowledgments: This work was financially supported by the Spanish Ministry of Sciences, Innovation and Universities, the Spanish State Research Agency and the European Regional Development Funds (project PGC2018-094621-B-I00).

Lecture 4:

Novel approaches to achieve efficient and safe plant nutrition.

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Nue (nutrient use efficiency) is a complicated agronomic trait because it involves the multiple interconnected steps of nutrient uptake, assimilation, transport and signaling. Nutrient intake efficiency is one of the NUE components. This parameter is positively affected if plant roots can position themselves in the place where nutrient-rich niches are found in the soil and, in turn, are equipped with efficient transporter proteins for uptake of these. This paper will present the study of the search for nitrogenous molecules, such as nitrate and amino acids, that constitute signals to attract roots to nutrient patches, as well as the molecular identification of some of the components of this signaling pathway. Also, the results obtained from an extensive phylogenomic analysis across land plants for nitrate transport proteins families are presented. In this study, we performed a microsynteny and orthology analysis on the NRT2 (nitrate transporter 2) gene family across 132 plants to decipher their evolutionary history. Significant differences in the number of sequences per taxonomic group and different genomic contexts that might have contributed to nitrogen acquisition by the plants were detected. The knowledge of the genomic context of nitrate transporter families in genotypes with contrasting habitats and domestication processes could make it possible to identify key genomic signatures of adaptation and domestication. Therefore, it can offer the potential to improve nutrient use efficiency and tolerance to adverse environmental conditions though naturally existing genetic variants.

Acknowledgments: Consejo Nacional de Ciencia y Tecnología (CONACYT) fellowship to ZRNM, FLG and FGL.

MINI LECTURES 1

It's getting hot in here: Responses of photosynthetic and water relation traits of two *Atriplex* species subjected to high temperature.

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Atriplex clivicola and *Atriplex deserticola* (Amaranthaceae) are native shrubs from the Atacama Desert. *A. clivicola* can be found from 0 to 700 m asl, and *A. deserticola* from 1500 up to 3000 m asl. Both species possess a C4 photosynthetic pathway and Krantz anatomy, which play a role in their adaptation to high temperature. Historical records and projections for the near future show increasing trends in air temperature and frequency of heat waves events in their habitats. Beyond sharing a C4 pathway, it is not

clear whether these species show similar or different responses to heat stress concerning leaf-level ecophysiological traits associated with photosynthesis and water relations. We studied ecophysiological traits (e.g., gas exchange, chlorophyll *a* fluorescence, water status) of *A. clivicola* and *A. deserticola* before and after a simulated heat wave (HW). Both species enhance their intrinsic water-use efficiency after HW, although apparently by different mechanisms. *A. clivicola*, which has a higher mass per leaf area (LMA) than *A. deserticola*, enhances water saving by closing stomata and maintaining RWC (%) and leaf Ψ_{md} potential at similar values to those measured before HW. After HW, *A. deserticola* shows an increase in A_{max} without evidence of significant changes in g_s. By contrast, *A. deserticola* shows a significant reduction in RWC and Ψ_{md} after RW. *A. deserticola* shows higher values of Chl*a* fluorescence and the I-P step from OJIP curves after HW. Thus, under heat stress, *A. clivicola* maximizes water saving, whilst *A. deserticola* enhances its photosynthetic performance. Their different ecophysiological responses could reflect functional adjustments to the local environmental conditions. More research is needed to better understand the specific response of C4 species to the effects of high temperature.
Acknowledgments: Proyecto Fondecyt Iniciación N°11201086.

Technological advances for plant science questions
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It is widely accepted that the oxygen isotope fractionation technique is the only effective method for studying the Alternative Oxidase (AOX) activity in terrestrial plants. However, the question immediately arises: how does AOX behave in algae or even in some human parasitic protozoa? In response to this, a technological solution is proposed for the use of the isotope fractionation technique in liquid media.
In the face of the existence of various landraces of Mediterranean tomatoes with a post-harvest shelf life of up to 10 months without apparent deterioration, several technological developments were designed to decipher the relationship between the long post-harvest shelf life and the respiration or water loss of the fruit and, in particular, the role of the cuticle to minimise fruit deterioration.
It is also known that some plants survive in areas whose thermal range pose severe limitations to photosynthetic organisms. A technological solution emerged to investigate those species most resistant to extreme temperatures.
These and others technological developments and designs, carried out to study various issues related with plant science, will be presented in this talk.
Acknowledgments: Spanish Ministry of Sciences, Innovation and Universities, the Spanish State Research Agency and the European Regional Development Funds (project PGC2018-093824-B-C41). SEQ-LIFE (PDR2020/59); Direcció General de Política Universitària i Recerca, Govern de les Illes Balears.

Antarctic vascular plant collection: challenges and advances
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Antarctica, considered a pristine system, is at the forefront of interest when we talk about the climate crisis. Only two vascular plants are native to Antarctica, although other no-native species have been reported as introduced. The use of these "model" species in understanding adaptation and resilience mechanisms, but also as a source of biotechnological applications and conservation is increasingly relevant. As part of environmental protection agreements and the International Antarctic Treaty, Specially Protected Areas and other *in situ* conservation and protection safeguards have been developed for genetic heritage in Antarctica. However, several investigations can be carried out from material conserved and protected *ex situ*. In our laboratory we have a collection of Antarctic plants, which for 12 years has been enriched with material from different sources, facilitating various investigations, scientific collaborations, and the formation of human capital. The collection is maintained from seeds obtained *ex situ*, or through vegetative propagation *in vitro* or in a common garden. We currently have 15 accessions and progress has been made in: propagation and conservation protocols, mainly in *C. quitensis*; elucidate mechanisms of tolerance to abiotic conditions in different populations; analysis of interactions between native and non-native species in the face of climate change; understanding the phylogeography in *C. quitensis* and its evolutionary history; and in biotechnological applications: development of mutants, induction of callogenesis and cell suspensions, genetic transformation, prospecting for secondary metabolites and abiotic elicitation of compounds of biological interest.
Acknowledgments: To the various sources that have financed projects in the laboratory, to national and international collaborators and students of the Engineering in Plant Biotechnology career at the Los Angeles Campus of the University of Concepción.

MINI LECTURES 2

Water as a key limitation for ferns.

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How plants colonized land depended on their ability to control water loss and transport. Because carbon is easy to acquire from the atmosphere, water is the most limiting resource. Therefore, for plants to colonize more arid habitats, they had to optimize their water use efficiency. Optimizing water use allow plants to reach not only extremely arid places such as deserts, but also habitats with little to no soil and hence no external water storage, for example, over rocks or tree branches, as shown by epiphytes. Ferns can be found in all the above-mentioned habitats, but they are far less common than angiosperms, especially in deserts, which could indicate their ability to use water efficiently. Still, few studies have focused on the physiology of ferns in relation to their environment, while angiosperms remain the most studied plants and have set the standard for most of what is known. In this talk, I will show how water plays a key role in the ecophysiology of ferns when compared to angiosperms.
Acknowledgment: SNF 310030_188498.

Asymmetric warming effect on cold deacclimation of *Deschampsia antarctica* (Poaceae)

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Asymmetric warming is characterized by a greater increase in minimum nocturnal than in maximum diurnal temperature. This phenomenon in Antarctica could lead to *Deschampsia antarctica* cold deacclimation. We hypothesize that *D. antarctica* freezing tolerance would be reduced mainly by nocturnal temperature increase rather than diurnal; mostly by the downregulation of transcription factors such as CBFs or their target genes with the upregulation of vegetative growth genes. Therefore, our objective was to determine the effect of diurnal and nocturnal warming on cold deacclimation of D. antarctica plants, under laboratory conditions. Fully cold-acclimated D. antarctica plants (0/8°C) were transferred to 4 treatments for 14 days: control (0/8°C), nocturnal warming (6/8°C), diurnal warming (0/14°C) and diurnal-nocturnal warming (6/14°C) in growth chambers. After 14 days of treatment: freezing tolerance (LT_{50}), ice nucleation temperature, freezing point and dehydrins levels and total soluble sugars were evaluated. Also, RNA-seq was performed and genes differential expression was bioinformatically analyzed. Treatments with nocturnal warming significantly reduced the LT_{50} > 7°C, and ice nucleation temperature and freezing point < 2°C, with respect to the control; dehydrins levels dropped below the detection limit also. While sucrose content was reduced in all warming treatment 38% at least. Nocturnal warming also downregulated CBF-like gene expression, UDP-glycosyltransferase and Sucrose synthase, and Dehydrins, and upregulated IAA-amino acid hydrolase, Plastocyanin and Triose phosphate/phosphate translocator, among others. Consequently, nocturnal warming has a greater effect on cold deacclimation process in *D. antarctica*, than a diurnal temperature increase. This may have important eco-physiological implications due to actual asymmetric warming evidence.

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Monitoring plant water status is a key goal in plant science; however, current methods used to monitor plant water status are expensive, laborious or hard to automate. During my PhD, I developed a simple method to monitor plant water status, called leaf squeeze-flow rheometry (LSFR). In this method, the leaf lamina is compressed between parallel plates, and the force and deformation are recorded over time. By adopting two measurement paradigms from material sciences, i.e., *stress relaxation* and *constant stress*, LSFR can be used to estimate the leaf turgidity and thickness, respectively. Using an average-cell model of leaf uniaxial compression, I postulate that LSFR can be used to measure additional leaf physical properties, such as the bulk elastic moduli,

hydraulic conductance, and bulk osmotic pressure. Potential applications of touch-based measurements in plants are discussed.

Acknowledgments: TIF was funded by the Becas Chile program by ANID, Scholarship 72180256. This study was funded using TIF's personal funds and supported by the Australian Research Council Discovery Project, Grant DP180102969.

SHORT COMMUNICATIONS 1

I would like to show you an *Embothrium coccineum* woody genet.

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Translocation of resources among ramets of clonal plants improves population persistence, colonization, and the physiological status. Plant clonality is a promising method vastly studied and applied in herbaceous plants. However, there are few studies focused on clonal trees, mainly because the lack of studies testing the effect of environmental heterogeneity, size and source-sink relationship within a woody genet. An important information required for the assessment of this method. The main objective of this research is to characterize the distribution and interconnections of *Embothrium coccineum* (Proteaceae) ramets in relation to the parental tree, the allometry of the individuals and the environmental variability in which they are found. In order to do this, an entire genet of *Embothrium coccineum* was identified, mapped, and measured. Our preliminary results shows that ramets occupy similar canopy openness (CO) than that of the forest, with most of them (55.2%) growing at similar CO than the origin of parent tree trunk (PTT). Ramets can be found between 1 and 13 meters from the PTT base, occurring most of them to the north-west. After ramet selection according to CO and size (2 levels each), those greater ramets inhabiting higher CO show higher total leaf area (LAT) and root distal to proximal ratio (DPR). LAT is positively and significantly correlated with CO, size and DPR. The greatest investment in biomass is seen in the larger ramets at higher CO.

Acknowledgments: We thanks to FONDECYT postdoctoral grant No. 3220691, FONDECYT Regular No. 1191118, and to Katalapi Park for providing facilities.

Tolerance and recovery capacity to water and salt stress of *Juncus balticus*, a dominant Salar de Atacama salt flat plant.

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In Andean salt flats (Salar), water deficit conditions and high salinity can negatively affect plants' fitness, inhibiting them. These conditions could be likely aggravated by industrial activity and climate change. To understand the vegetation Salar plant's cope mechanisms to this type of stress, we made an experiment of hydroponic growing of Juncus balticus, adding different concentrations of polyethylene glycol and NaCl that reach waters potentials of 0, -1, -1.5, -2 and -2.5 MPa, simulating rising intensities of water deficit and high salinity conditions. After two months under these conditions, half of the plants were subjected to a recovery stage, in which we maintained them in a nutrient solution at a water potential of 0 MPa. Our results show that below a water potential of -1.5 MPa, plant growth stops and below -2 MPa, plant survival drops below 50%. Aswell thus, the results were confirmed by another functional traits measurement performed. On the other hand, the study of recovery capacity reveals that *Juncus balticus* can restart its growth after the water stress period but not after a salt stress event.

Acknowledgments: Projects ANID BASAL FB210006 del IEB, PTE2121212 DID-ULS and Investigation program in hydroecology of the wetland at Salar de Atacama (SA 9500007981).

Physio-anatomical acclimation of understory tree species subjected to a precipitation exclusion in a southern south America temperate rain forest

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Trees are the longest-lived plants on earth. They can live from decades to even millennia. Trees are the keystones of the ecosystem that they inhabit, forests. They are involved in every aspect of forest functionality, from carbon stock to water transition and species refuge. However, forests and trees are threatened by global change. Reductions in precipitation and temperature increases expose forest ecosystems to novel climates that may affect composition, structure, and persistence. Anticipating this scenario and its effects, in this research, we evaluated the acclimation of understory tree species of the temperate rainforest of Chiloé submitted to an experimental precipitation reduction. We hypothesized that individuals submitted to a precipitation reduction would acclimate to more conservative physiology and anatomy than trees that obtain natural water input. Thus, eight species, and a total of 96 individuals, were assessed concerning foliar and hydraulic traits. At the branch level, we built the hydraulic vulnerability curves and estimated the P50 of each species. At the foliar level, we measured mass-to-area ratio, stomatal density, and δ13C. Vulnerability curves showed differences in P50 among species, although we found no differences in P50 between treatments for any species. Nevertheless, we found differences at the leaf level. LMA presented differences between treatments but not between single species. Two species had significantly more stomata in the reference treatment than in the exclusion. Finally, treatment and species possess more negative δ13C in the reference than in the exclusion treatment. Results are against our initial hypothesis, and we discuss them in light of these new outcomes.

Acknowledgmenst: Institute of Ecology and Biodiversity (Chile) through ANID project FB210006 and ANID Doctoral Scholarship 2018 for financing and support.

SOIL SYMPOSIUM

Freezing-thawing cycles affect organic matter decomposition in periglacial maritime Antarctic soils.

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King George Island in Antarctica is the fastest warming area in the southern hemisphere, however the impacts on soil organic matter (SOM) formation after glacial retreat remain unclear. Organic matter inputs are scarce in this area, as they are derived from lichens, mosses, bird feces, and minor input from two vascular plants species. Here, we examine impacts of freeze and thaw (FT) cycles on the priming effect (PE). We hypothesize that soil microorganisms preferentially use freeze-preserved SOM exposed after thawing as an important energy source, resulting in intense PE. Two soils with contrasting clay content were characterized by ATR-FTIR, and incubated with and without ^{13}C-glucose. CO_2 and ^{13}CO2 were recorded from soil: i) without FT cycles, ii) one FT cycle, and iii) three FT cycles (-18/12 °C). SOM showed low aromaticity stretching at 920 cm^{-1} and 1650 cm^{-1}. Glucose-derived CO_2 was maximal (26± 2.2 mg g^{-1} C) in the control soil without FT cycles and decreased to 8.6±0.1 mg g^{-1} C after three FT cycles. Glucose induced an intense positive PE for single cycle (41-64% of basal respiration) or no cycles (72-76%), but absent or negative PE after three FT cycles (-9.5-0.4%). Soil organic carbon (212 mg C kg^{-1}) was maximal with three cycles and decreased with increasing PE ($R^2 = 0.87$, $p <0.01$) on more processed materials after thawing. Frequent FT cycles due to global warming will increase positive PE, affecting the C sequestered during initial formation of maritime Antarctic soils.

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Manganese-oxidizing Antarctic bacteria (Mn-Oxb) release reactive oxygen species (ROS) as secondary Mn(ii) oxidation mechanisms to avoid toxicity.

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The Manganese (Mn) oxidation is performed through extracellular enzymatic activity by Mn-oxidizing bacteria (MnOxb) as the main weathering mechanism for Mn(III/IV) deposits during soil formation. In Antarctic territory, the soil development is defined as an extremely slow process due to low annual temperatures. However, it has been noted that the dynamics of the microbial communities can be altered as climate change intensifies, impacting on biogeochemical processes. The increase in soil temperature stimulates the production of microbial reactive oxygen species (ROS) as respiration by-product, those that have not been reported with beneficial roles for bacterial survival, instead, ROS from abiotic sources can attack from the organic matter to the soluble metals. We hypothesize that bacterial ROS oxidize Mn(II) to Mn(III/IV) as a secondary temperature-dependent mechanism for Mn oxidation and cell-defense. Fourteen MnOxb were isolated from Antarctic soils after the glacier retreat, and peroxidase (PO) activity, ROS (H_2O_2 and OH^-), and Mn (III/IV) production were evaluated for 120 h of incubation at 4°C, 15°C, and 30°C. The ROS contributions to Mn oxidation were evaluated in *Arthrobacter oxydans* under antioxidant and ROS-stimulated conditions. The Mn(III/IV) concentration increased with temperature, and positively correlated with ROS production. ROS scavenging with antioxidant depleted the Mn oxidation, and ROS-stimulant increased the Mn precipitation. High Mn(II) concentration caused a reduction in the membrane potential and bacterial viability, which resulted in Mn precipitation on the bacteria surface. In conclusion, bacterial ROS production serves as a complementary non-enzymatic temperature-dependent mechanism for Mn(II) oxidation as a response in warming environments.

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Antarctic soil microbiota transplant as a promising strategy to counteract water deficit stress in tomato plants.

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Climate change challenges modern agriculture to develop alternative and eco-friendly solutions to alleviate (a)biotic stresses. The use of soil microbiomes from extreme environments opens new avenues to discover novel microorganisms and microbial functions to protect plants. In this study we confirm the ability of a bioinoculant, generated by natural engineering, to promote host development under water stress. Microbiome engineering was mediated through three factors i) Antarctic soil donation, ii) water deficit and iii) multigenerational tomato host selection. We revealed that tomato plants growing in soils supplemented with Antarctic microbiota were tolerant to water deficit stress after 10 generations. Microbial community analysis using 16s rRNA amplicon sequencing data suggested that Candidatus Nitrocosmicus and Bacillus spp. were key taxa associated with the observed enhanced water deficit tolerance. We proposed that in situ microbiota engineering through the evolution of tridimensional factors (long-standing extreme climate adaption and host and stress selection) could represent a promising strategy for novel generation of microbial inoculants.

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SHORT COMMUNICATION 2

Fatty acids content of *Colobanthus quitensis* under experimental cold acclimation

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Colobanthus quitensis inhabit low temperature environments (Antarctica and high elevations in the Andes). Extreme temperature variation may cause damage to plant cell membranes. It has been reported that unsaturation of fatty acids (long-chain lipids) in plants is associated with drought and cold stress. The objective of this research is to identify the profile of fatty acids in the species *C. quitensis* and its association to freezing tolerance (LT_{50}) during a cold acclimation cycle. Plants were placed under two growth treatments: Cold acclimation: plants were placed in a cold chamber, with a temperature range of -5 to 2 ºC. Non-acclimated plants (control) were grown in a greenhouse with a temperature range of 16 to 20ºC. Leaf $LT_{50,}$ and fatty acids contents were measured. Cold-acclimated plants exhibited a LT_{50} of -13.9 ºC ± 2.6, and up to 112.1 µg/g fresh weight of total fatty acids. While in the non-acclimated plants, LT_{50} -8.0 ºC ± 0.1 and only 21.2 µg/g fresh weight of total fatty acids were observed. In the fatty acid profile: oleic, linoleic and myristic acid have higher contents in both treatments, however, cold-acclimated plants exhibited higher contents than nonacclimated ones (34.0, 17.8 and 11.4 µg/g fresh weight and 3.8, 3.2 1.7 µg/g fresh weight, oleic, linoleic and myristic acid respectively). There was no difference in the degree of unsaturation between the two experimental conditions. It is concluded that cold-acclimation induced an increase of fatty acid content in *C. quitensis*. Further studies are needed to clarify the role of this increment.

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Effect of vegetation on land-atmosphere Feedbacks in the Mediterranean zone of Chile.

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Climate change (CC) increases the frequency and duration of droughts and other extreme climatic events, severely affecting Mediterranean ecosystems. Plant communities with diverse responses to the environment are expected to be more resilient to extreme climate events. Understanding these feedbacks is essential for making high-resolution projections of ecosystem resilience under CC. However, the causal relationships between functional response diversity, i.e., the diversity of trait responses to water stress, and soil-atmosphere feedbacks remain largely unknown for Mediterranean ecosystems. This is a critical knowledge gap, affecting our ability to mitigate the impacts of CC on these ecosystems and the vital services they provide. This presentation presents the general outlines and preliminary results of the FONDECYT project SA77210031, which seeks to unveil how multiple facets of plant diversity interact with soil-atmosphere feedbacks in the Mediterranean ecosystems of Chile, which a decade-long mega-drought has strongly impacted. More specifically, we will i) evaluate the land-atmosphere feedbacks in Mediterranean vegetation; ii) identify functional components working as proxies of land-atmosphere feedbacks; and iii) generate methods for upscaling land-atmosphere feedbacks using remote sensing. We have been collecting biodiversity and trait measurements in the Mapocho watershed. Future work includes expanding the climate, diversity, and traits measurements to the Petorca and Cauquenes watersheds and the measurements of plant fluxes and Sun-Induced Fluorescence (SIF) using a WALZ GFS-3000FL IRGA system.
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Intergenerational resistance to nitrogen deficiency in *Chenopodium quinoa* Willd (Amaranthaceae) plants.

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Memory stress implies previous stress perceived by the plants increases the plant's ability to respond to future stresses. When the environmental stress responses can be inherited to offspring is called intergenerational and transgenerational memory. *Chenopodium quinoa* Willd (Amaranthaceae) is an annual alto-andina species with high N use efficiency. Considering the decrease of N availability for plants, it is important to understand if the tolerance to limited N would be inherited. Thus, our principal question was: Can the offspring of plants stressed by N-deficiency inherit a memory that allows them to improve their performance to low N content? "Mother" plants (F0) of *C. quinoa* were exposed to High and Low N (HN; LN) conditions. The descendant seeds (F1) were nutritionally characterized, together with their germination and growth capacity under HN and LN. F0-HN plants shown higher photosynthetic rates and yield than F0-LN. Although F1 descendants seed of both treatments presented similar size and weight, F1 descendent of F0-LN exhibited a higher germination rate. This was related to a greater storage of starch, soluble sugars and amino acids. F1 juvenile plants descendants

from F0-LN shown a higher aerial biomass, protein, and starch content in both HN and LN conditions compared to the descendants from F0-HN. From the data obtained, we suggest the presence of intergenerational memory in *C. quinoa*. This response could be crucial in their resistance to climatic changes.
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Increased CO_2 and nocturnal warming induce differential responses of respiration acclimation in Antarctic plants

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Projected rises in atmospheric CO_2 concentration and night-time temperatures may have important effects on plant carbon metabolism, affecting the respiration and photosynthesis of the only two vascular plant species inhabit the Antarctic Peninsula. We assessed the effect of CO_2 concentration (400 ppm and 750 ppm) and nocturnal warming (8/5°C vs. 8/8°C day/night) on gas exchange, non-structural carbohydrates, two respiratory-related enzymes and mitochondrial size and number of both species. The short-term sensitivity of leaf respiration, relative protein abundance, and mitochondrial traits were not responsive to either treatment in *Colobanthus quitensis*. Moreover, some acclimation to nocturnal warming at ambient CO_2 was observed in this species. The response of *Deschampsia antarctica* to experimental treatment was different, showing a significant respiration acclimation to temperature in the elevated CO_2 environment. The short-term change in thermal sensitivity indicates type I acclimation of respiration. Growth under elevated CO_2 and nocturnal warming resulting in a reduction in mitochondrial numbers and an increase in mitochondrial size in this species. The light-saturated photosynthesis at 400 ppm was significant reduced at elevated CO_2 and/or nocturnal warming in *C. quitensis*, while this parameter was not affected by either treatment in *D. antarctica*. Altogether, these responses led to an increase in the respiration-assimilation ratio in plant grown in elevated CO_2 in *C. quitensis*. On contrast, in *D. antarctica* the ability to maintain photosynthesis and mainly adjust its respiratory metabolism could allow this species to continue its successful colonization throughout the Antarctic Peninsula.
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SHORT COMMUNICATION 3

Is the rhizome hydraulic and nutritionally functional in a Hymenophyllaceae?

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The Hymenophyllaceae are epiphytic ferns with unique traits among vascular plants. Their fronds have only one layer of cells, they lack stomata and they are desiccation tolerant. Previous evidence suggests that rehydration may be faster through the leaves than through the rhizomes. The acquisition of nutrients in this family is unknown. We present results from a water + nitrogen isotope labelling experiment, aimed to determine their water and N source. Fronds and rhizomes from *Hymenophyllum tortuosum* were inmersed in 1 mg/L N solutions with contrasting isotope composition: H_2O + NH_4NO_3, D_2O + ^{15}N-NH_4NO_3, and D_2O + $NH_4{}^{15}N$-NO_3. In an atmosphere of 0 kPa VPD, the transport of water from submerged fronds to rhizomes not exposed, and submerged rhizomes to fronds not exposed is the same. Despite the fact that ^{15}N-NH_4NO_3 presented the greatest labelling in submerged organs, $NH_4{}^{15}N$-NO_3 presented the highest intensity of labelling in fronds and rhizomes not exposed. Our results indicated differential ability for uptake and transport of NH_4^+ and NO_3^-. The rhizome does contribute to the acquisition of water and nutrients.

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The effects of repeated freeze-thaw cycles on the hydraulic-photosynthetic performance of Antarctic vascular plants.

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Maintaining the integrity of the root-to-leaf water transport pathway is essential for sustaining photosynthetic gas exchange and growth. However, water in the xylem is

usually under tension, which increases face severe water stress conditions, such as freeze-thaw events. These events can be more damaging than only exposure to cold temperatures leading to decreased photosynthetic function, hydraulic dysfunction, and mortality. *Deschampsia antarctica* and *Colobanthus quitensis*, the only two vascular plant species able to colonize the snow-free areas of the Antarctic Peninsula, are often exposed to freezing and thawing events during the Antarctic summer. However, due to the already repeated regional climate change, it is expected that these events will increase, along with an increase in extreme temperatures, which could affect the photosynthetic and hydraulic processes of the Antarctic vascular species. We conducted a laboratory experiment to evaluate the effect of repeated freeze-thaw cycles (FTC) under different growth temperatures (5 °C and 15 °C). This showed that whole-plant hydraulic conductivity and photosynthetic performance decrease when the FTCs increase, mainly when they grow at 15°C. The first response can be assigned to a hydraulic failure caused by embolism, whereas the decline in photosynthesis may result from the reduction in diffusion pathways. These preliminary results suggest that Antarctic vascular plants may affect their ability to withstand weather uncertainty, especially sudden freezing events.

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Chlorophyll fluorescence in relation to N and K concentrations in *Beilschmiedia berteroana* seedlings during hardening phase.

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With the increment in temperatures and water deficit caused by climate change, water stress in plants in Mediterranean areas is aggressively increasing. Therefore, the evaluation of the physiological performance of plants against water deficit in response to the cultural practices in the nursery, becomes a fundamental aspect. Based on this, the aim of the study was to evaluate the effect of nitrogen (N) and potassium (K) applied during full growth, in concentrations of 100 and 300 mg L-1 each on the chlorophyll fluorescence in plants of Belloto del Sur (Beilschmiedia berteroana) subjected to water restriction (WR) during the hardening stage. During hardening (April-June), one batch of plants was kept at 50% moisture content (MC) of the tray (control), while the rest were brought to 20% MC for two cycles (73 days) in where fluorescence (Fv/Fm) was taken. Results demonstrated that K did not significantly affect fluorescence during WR. During the first WR cycle, fertilization with 300N obtained higher Fv/Fm values at the beginning of the cycle, nevertheless, 100N maintained its values for a longer period of restriction. In the second cycle, 100N managed to increase the Fv/Fm values of the fist cycle, and 300N decreased its maximum value, however, it maintained higher Fv/Fm for a longer period compared to the fist cycle. Nitrogen fertilization has a considerable impact on the responses of B. berteroana to WR events. It is essential to carry out more research that links the attributes of plants generated in the nursery with performance in the field.

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