SCAR 2020

Antarctic Science – Global Connections

SCAR OPEN SCIENCE CONFERENCE 2020

SESSION 29

SUB-ANTARCTIC ISLANDS – SENTINELS OF CHANGE

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ABSTRACTS SUBMITTED TO THE (CANCELLED) SCAR 2020 OSC IN HOBART

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Ecological consequences of a single introduced species to the Antarctic: the invasive midge Eretmoptera murphyi on Signy Island

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The nutrient-poor soils of Antarctica are sensitive to change. Ongoing increase in anthropogenically assisted non-native species introductions means that understanding the impact of such species on these soil systems is urgent, and essential for developing future risk assessments and management actions. Through comparative baseline characterisation of vegetation, microbes, soil biochemistry, substrate composition and micro-arthropod abundance, this study explores the impacts that have resulted from the 1960s introduction of the invasive chironomid midge Eretmoptera murphyi to Signy Island in maritime Antarctica. The key finding is that where E. murphyi occurs there has been an increase in inorganic nitrogen availability within the nutrient-poor soils. Concentration of available nitrate is increased three- to five-fold relative to uncolonised soils, and that the soil ecosystem may be impacted through changes in the C:N ratio which can influence decomposition rates and the mircoarthropod community. We also measured the levels of inorganic nitrogen in soils influenced by native marine vertebrate aggregations and found the increase in nitrate availability associated with E. murphyi to be similar to that from seals. We suggest that these changes will only have greater impacts over time, potentially benefitting currently limited vascular plant populations and altering plant and invertebrate communities.

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Petrel responses to invasive species eradication on Macquarie Island

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In a changing climate pest management on islands at high latitudes takes on added importance to provide blank canvases for species that must shift their ranges. Already among the most threatened groups of birds globally owing to the impacts of invasive alien species on their breeding islands, petrels are also latitudinally range-restricted, suggesting their ranges may need to shift in the face of ongoing climate change. Understanding the responses of recovering, recolonising or newly colonising species to pest management will help clarify the extent to which petrels may be adaptable or resilient to future climate perturbations. We report the results of a three-year study to quantify short-term post-eradication responses of burrowing petrels on Australia's Macquarie Island, a Tasmanian State Reserve and World Heritage Site. The island received major conservation investment for the management of invasive predators including cats in the late 20th Century and concluding with the eradication of rabbits, rats and mice in 2011-2014. Blue Petrels, Grey Petrels, White-headed Petrels and Antarctic Prions were either extirpated or heavily impacted in terms of population size, range and breeding productivity in the 1970s. Whole-island surveys and repeat monitoring for all four species show all are present and increasing with higher breeding productivity compared with their 1970s baselines. We also recorded presence or confirmed breeding for a number of other species that are apparently recolonising or colonising for the first time.

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Lack of nocturnal warming explains the effect of in situ warming by OTC on freezing

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Antarctic vascular plants are freezing tolerant, with LT50 of -22.8°C for D. antarctica (Da) and -15.3°C for C. quitensis (Cq). The accelerated warming (3.5°C in the last century) and heat waves experienced by Maritime Antarctica, specially during summer, could cause plant cold de-acclimation making them vulnerable to stochastic frosts during the growing season. This work describes the effect of experimental in situ and laboratory warming on freezing resistance in Da and Cq. The results of in situ warming experiments using open top chambers (OTC) installed near Arctowski Station showed that after two seasons of OTC exposure, LT50 increased slightly, 2°C in Cq, at two studied sites and 2.8°C at one of the 3 studied sites for Da. A contrasting situation was observed after four growing seasons in OTCs, while Cq showed a 2°C lower LT50 in plants grown in the OTC than untreated plants, Da showed no significant differences between treatments. Therefore, this suggest that warming 3 to 4°C above average temperature would not make these plants significantly more vulnerable to freezing. This was consistent with similar antifreeze activity observed in leaf apoplastic extracts of Da grown in OTC and in open areas. These results could be associated with the fact that OTC being a passive heating system does not exert night warming. Laboratory studies in which these two species were subjected to simulated day and night warming confirm this hypothesis. Preliminary results from nocturnal in situ warming systems will be discussed

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Microplastic in Marine, Nearshore Waters of South Georgia: A study of background environmental levels of microplastic contamination which organisms are exposed to.

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Microplastics, ubiquitous in the global ocean, have even been found in remote polar environments- including Arctic snowfall and Antarctic subtidal sediment. Levels in the Southern Ocean were shown to be 100,000 times higher than predictions in some areas. The documented presence of microplastics in two resident penguin species suggests that ecologically important lower trophic levels, such as krill, and commercially important fish species, which South Georgia waters support, are also vulnerable.
This study is the first comprehensive survey of microplastics in the nearshore waters of South Georgia. Surface water samples were collected at 1km intervals around the accessible shoreline of the Thatcher Peninsula, including directly adjacent from the outflow pipes of the research station, King Edward Point (KEP). Over 50 suspected anthropogenic particles and fibres from 11 sites were confirmed to be plastic through Fournier Transmission- Infrared (FT-IR) Spectroscopy. Microplastics were present in every sample and ranged in size from 0.05mm-3mm. Preliminary results suggest that microplastic concentrations do not vary with increasing distance from KEP. In addition, two samples were collected directly from outflow pipes at KEP and Grytviken in order to determine the level of local input from anthropogenic wastewater systems. Water samples from long-term plankton monitoring sites at Rosita Harbour and Cumberland East Bay (CEB), confirm the contamination level which the keystone species, such as Euphasia superba, are exposed to in the region.
10 microplastics were found in a sample from Gull Lake, isolated from oceanographic influence, suggesting a different potential pathway for microplastic contamination: atmospheric transport.

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Sentinels of change: Can we use lichen life-history traits to predict the future of the Antarctic tundra?

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Terrestrial habitats in the Antarctic Peninsula's tundra biome are dominated by lichens and bryophytes. In order for them to maintain their role as key drivers in this pristine habitat with rapid temperature shifts, a high physiological plasticity is on demand. Previous works were based on the assumption that the width of the ecological response amplitude was linked to biogeographical distribution pattern of a species. Endemic species with narrow distribution range were considered to be highly specialised to the local climate resulting in a narrow ecological response amplitude. Generalist species, distributed across wider ranges, experience more diverse climates and therefore have wider ecological response amplitudes and physiological plasticity. Accordingly, with the climate becoming more variable in the region, we expect endemic, specialised species reach their critical stress temperature earlier than generalists, which could ultimately result in a species homogenisation with unknown effect on ecosystem services in future scenarios.
This study examines the response of photosynthesis and respiration to acute changes in temperatures for three Antarctic lichen species with different distribution patterns. While our measurements of gross photosynthesis, the total amount of fixed carbon, clearly indicate 20 degrees C as the temperature where all species experience a net carbon loss, the interpretation for the response amplitude width is not straightforward. The endemic species Usnea aurantiaco-atra shows very similar responses to the cosmopolitan species Stereocaulon alpinum indicating that other factors than acute temperature changes affect lichen viability on Livingston Island. Consequences of our results are highlighted and future research perspectives are discussed

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Biological invasions in South Africa's offshore sub-Antarctic territories

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The sub-Antarctic Prince Edward Islands (PEIs) constitute South Africa's most remote territory. Despite this, they have not been spared the fate of alien invasions. Here, we review what is known about invasions to the PEIs for terrestrial taxa (vertebrates, invertebrates, plants and microbes), freshwater taxa and marine taxa. Prince Edward Island, which has no permanent human settlement and is visited only infrequently, has significantly fewer alien species than Marion Island. the house mouse (Mus musculus), which occurs on Marion Island, can be considered the most detrimental invader to the islands; it impacts on plants, insects and seabirds, which results in changes to ecosystem functioning. The impacts of other terrestrial invaders are less well understood. At present, no invasive freshwater or marine taxa are known from the PEIs. Invasion threats to the PEIs are changing, and the amelioration of the climate of the islands may increase invasion threats to both terrestrial and marine habitats. Lessons for the sub-Antarctic region will be highlighted.

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How global change can influence the presence of the vegetation in the past and the future in Patagonia and Antarctica: An example of mosses and other species

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Southern-Patagonia has shown a great change in its weather patterns in recent years. Precipitation and winds have increased, as well as the average annual temperature. Through the analysis of the genetic diversity and structure of populations and modeling of ancestral niches, we have studied some species such as Rubus geoides, Sanionia uncinata, and other mosses species. The study was developed from the northern part of the Magallanes region in Chile from Torres del Paine to the southern Tierra del Fuego, and for mosses, it also includes some parts of maritime Antarctica. In general, the total genetic diversity for all the species was relatively low; the genetic differences among populations were moderate. Mixed ancestry in some populations, private alleles in specific sites and gene flow from specific populations were observed. Based on the observed genetic structure, results suggest the influence of reproductive biology as well as the dispersal of this species in relation to climatic aspects since the last glacial maximum. It could be also recognized the presence of a refuge. The dispersion pattern and ancestry tests suggest the importance of conserving sites whose individuals show the ability to settle in areas free of ice because they could be at risk due to the global change.

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High-frequency monitoring of stream water physicochemistry on

sub-Antarctic Marion Island

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Concentrations of major ions in stream water from the Soft Plume River on sub-Antarctic Marion Island were measured. During the annual relief voyage, samples were collected daily over a 16-day period (21 April–6 May 2015) from three sites along the stream to better understand temporal and spatial variability of stream water chemistry on the island. The chemical composition of the stream is dominated by the sea salts Na+ and Cl−. Mean solute concentrations for Na+ and Cl− are 7 ± 0.58 and 12.5 ± 0.84 mg/L, respectively. The mean molar Na:Cl ratio for all samples is 0.86 ± 0.05, with a range from 0.71 to 0.99 (n = 47), and there is a strong, significant positive correlation between Na+ and Cl− concentrations ($r = 0.80$; $p < 0.001$). These values are consistent with previous studies from Marion Island and other sub-Antarctic islands. Temporal variation in ion concentrations was small. The largest detected change was a decrease in most solute concentrations that coincided with two precipitation events. This decrease was largest at the highest altitude and the shallowest site, suggesting that there was more rainfall at this location. These findings confirm the dominance of the surrounding ocean as the main source of the island's stream water chemistry and illustrate spatiotemporal patterns that provide an insight into mechanisms affecting their composition on sub-Antarctic Marion Island.

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A key to the Collembola of the Antarctic and sub-Antarctic Islands

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On sub-Antarctic islands, where species diversity is low, Collembola (springtails) are particularly important as they make up the majority of terrestrial fauna. As springtails are ubiquitous and important in sub-Antarctic ecosystems, with the number of species relatively low compared to other continental areas globally, they have been relatively well surveyed. Despite this long record of springtail collection and identification from the region, some sub-Antarctic islands have no existing keys for springtail fauna, whilst others are out-of-date. Furthermore, improved observation tools and access to genetic confirmation of species have provided new clarity on species identification. Importantly, continued introductions of novel species to sub-Antarctic islands alongside human activities have resulted in expanding established and invasive non-native springtail fauna. It is important that these new species are described and reported in updated keys to inform future identification, island conservation management and biosecurity. Understanding the indigenous diversity and the threat posed by non-indigenous springtails is essential for understanding the efficacy of current sub-Antarctic and Antarctic protected areas and their likely future value. Based on recent and long-term sampling, we discuss our up-to-date taxonomic keys and biogeographical notes for the Collembola of mainland Antarctica and several sub-Antarctic islands. In addition, we also discuss the distribution of species, non-native species and new records found.

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Diversity of the microbial communities in the rhizosphere of the endemic cushion plant from Kerguelen Islands Lyallia kerguelensis

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The sub-Antarctic islands are subject to a rapid climate change with already visible impacts on their vegetation. The Kerguelen province hosts a high richness in endemic plant species, all perennial and often long-lived, meaning these species may be particularly at risk. Here we focus on L. kerguelensis a long-lived cushion plant species strictly endemic to Kerguelen Islands. This species can be considered as keystone species, providing habitat for soil microorganisms within its rhizosphere. Conversely, the microbial communities hosted could be composed of endemic taxa that may have and may still play a role in the adaptation of this endemic plant to harsh environments and to climate change. Recently, necrotic parts were observed in L. kerguelensis cushions, which might be related to water stress since a relationship between necrosis rate and soil sodium concentration was observed. We hypothesized that the rhizomicrobiome, depending on its taxonomic composition, might influence positively or negatively plant necrosis.

Thus, our objectives were to i) determine if L. kerguelensis hosts a specific rhizomicrobiome and ii) study the potential involvement of this rhizomicrobiome in the plant vigor, by analyzing the relationship between microbial community and necrotic rate. Using metabarcoding, we analyzed bacterial and fungal communities in the rhizosphere of L. kerguelensis presenting various necrotic rates and sampled across an environmental gradient. Preliminary results suggest that fungal communities are site-specific contrary to bacteria and a relationship was observed between the relative abundance of some specific phyla and the necrotic rate. Deeper analyses are currently running to confirm these results.

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Growth and necrosis dynamics in the endemic cushion plant, Lyallia kerguelensis, across environmental conditions in Kerguelen Islands

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Kerguelen Islands, like other sub-Antarctic islands are subject to a rapid climate change consisting in enhanced mean annual temperature and decrease in rainfall. The Kerguelen province stands out as hosting a high richness in endemic plant species, all perennial and often long-lived, meaning that these species may be particularly endangered. Among them is a cushion plant strictly endemic to Kerguelen, Lyallia kerguelensis (Montiaceae). Its distribution on Kerguelen is sparse and restricted to fellfields and even “wind deserts” where the climate is particularly harsh. Furthermore, necrotic parts have been described in cushions since 1990 and may be related to water stress. Given its high patrimonial value, we aim to evaluate the response capacity of L. kerguelensis to climate change. We followed the dynamics of necrosis in plants from various populations monitored at 5 year time steps as part of the “Lyallia kerguelensis Observatory”. Populations were subject to different regional climates and local environments. Morphological traits such as vigorous and necrotic surface areas were measured by data imaging acquisition. We (i) studied changes in cushion morphology across time to determine a necrosis threshold above which the cushion fate would be death, then (ii) investigated the intra- and interpopulation dynamics of growth and necrosis in relationship to local climate and environment. The results provide a hint for the temporal scale of morphological and necrotic changes. L. kerguelensis will be a model case for the response capacity of long-lived and possibly relict endemic plant species from past eras and climates to climate change.

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Show us your beaks and we tell you what you eat: Different ecology in sympatric Antarctic benthic octopods under a climate change context

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Sympatry can lead to higher competition under climate change and other environmental pressures, particularly in South Georgia region, where the two most common octopod species, Adelieledone polymorpha and Pareledone turqueti, occur side by side. As both species' beaks are commonly found in predator's stomachs and its ecology is still poorly known due to their elusive behaviour, we studied their feeding ecology through a multidisciplinary approach combining stable isotope signatures ($\delta^{13}C$ and $\delta^{15}N$), total mercury (T-Hg) analysis and biomaterials' engineering techniques (Scanning Electron Microscopy, X-Ray Diffraction, micro-Computerized Tomography and Nanoindentation Test). An isotopic niche overlap of 95.6% was recorded for the juvenile stages of both octopod species, dropping to 19.2% in adult stages. Both species inhabit benthic ecosystems around South Georgia throughout their lifecycles ($\delta^{13}C$: −19.210 ± 1.870‰, mean ± SD for both species) but explore partially different trophic niches during adult stages ($\delta^{15}N$: 7.010 ± 0.400‰, in A. polymorpha, and 7.840 ± 0.650‰, in P. turqueti). The beaks of A. polymorpha are less dense and significantly less stiff than P. turqueti beaks. The T-Hg concentrations in the flesh of P. turqueti where higher relative to A. polymorpha (0.434 ± 0.128 μg·g-1 and 0.322 ± 0.088 μg·g-1, respectively). Overall, both octopod species exhibit similar habitats but partially different trophic niches, related to different morphology/function of the beaks. Moreover, both species presented T-Hg concentrations similar to the ones found in northern hemisphere octopod species and may increase under the present climate change context.

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Mitogenome responses to fine-scale habitat selection in three Marion Island springtail species: does the mitogenome facilitate local adaptations?

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Mitochondria are commonly referred to as the powerhouse of cells. Although mitochondria were often referred to as neutral, mitogenomes encode for proteins involved in the oxidative phosphorylation process, which provides aerobic organisms with their primary source of energy. The mitogenome is now frequently used to address fundamental ecological and evolutionary questions. In short, the functional content of mitogenomes defines evolutionary dynamics that facilitate organismal adaptations to specific environmental conditions. Springtails (Collembola) are emerging model organisms to investigate adaptive responses to environmental changes. Our study is the first to reveal the functional content of the mitogenomes of three springtail species (Isotomurus maculatus, Cryptopygus antarcticus travei, and Tullbergia bisetosa) that inhabit three different ecological niches within the soil (i.e. epigeic (surface-dwelling), hemidaphic (litter surface) or euedaphic (litter depth)). The complete mitogenome of the three species was assembled de novo and the gene boundaries were manually annotated. Comparative studies of the functional content of the mitogenomes in three study species identified candidate loci that are closely linked to springtail habitat selection. This result confirms that functional variations, in core thermal and respiratory metabolic pathways within mitochondria, play a critical role in niche specificity reported for these species.

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Warming effects in photoprotection and photo-oxidative stress markers in the two unique Antarctic vascular plants

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The Antarctic Peninsula has experienced a rapid warming in the last decades. How antarctic vascular plants (Deschampsia antarctica and Colobanthus quitensis) are responding to this accelerated warming is important to predict their success in the future warming scenario. Since redox status imbalance could be trigger under rises temperatures, we experimentally warmed a patch of Antarctic tundra using open top chambers (OTC) and evaluated its effects in a set of photoprotection and oxidative stress markers in plants growing in OTC compared to Open Areas (OA) in a natural population of the Maritime Antarctic during the growing season. In both conditions plants were able to acclimate and showed absence of photoinhibition. D. antarctica plants decreased lipid membrane damage and abscisic acid contents, as well as xanthophylls and anthocyanins in OTC compared to OA, thus suggesting a decreased activation of protective mechanisms in response to warmer temperatures. C. quitensis also showed a lower activation of their photoprotection mechanisms in OTC. Our results showed an absence of oxidative damage under rises temperatures in both species, at least under these conditions studied.
It is concluded that Antarctic vascular species are currently activating acclimation mechanisms to the prevailing warming effects and will be able to prevent, at least to some extent, photoinhibition to the photosynthetic apparatus under a climate change scenario.

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Characteristics of cryoconite holes on Ecology Glacier (maritime Antarctic)

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The most biologically diverse, active, and productive glacial communities are those associated with cryoconite holes. They form when supraglacial sediment (cryoconite) along with microorganisms absorb more solar radiation than the surrounding ice and melt into the ice. Most of the organisms in cryoconite holes are unique and highly adapted to cope with extreme cold, frequent cycles of melting and freezing, flushing of nutrients, and high UV radiation. Despite recent great interest in glacier ecosystems in the continental Antarctic, little is known about their maritime counterparts. Our study presents descriptive data on cryoconite sediments and cryoconite holes on Ecology Glacier (King George Island). Specifically, it identifies diversity and composition of microbial eukaryotes (algae, invertebrates) and prokaryotes, characterizes abiotic conditions, and describes the extent of biotic/abiotic interactions. Seventeen species of algae and cyanobacteria with biomass of 0.79 to 5.37 µg/cm³ have been found in sediments. Biomass of Bacillariophyceae was significantly higher than that of Chlorophyta and cyanobacteria. We found three species of rotifers and a glacier dwelling Acari (Nanorchestres sp.). The presence of cryophilic organisms and organic matter on glaciers may lead to a build-up of radionuclide levels on glaciers, investigated artificial radionuclides included ^{137}Cs, ^{238}Pu, ^{239}+^{240}Pu and ^{241}Am. Values of activity ratios in cryoconite holes suggest their yearly biological recycling, also on Ecology Glacier for more than 70 years. Overall, cryoconite holes on Ecology Glacier present unique habitats that could serve as monitoring tools to track climate-driven changes in supraglacial ecosystems in Maritime Antarctic.

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Following morphological diversity of Antarctic water bears – description of a new Dactylobiotus sp. nov. with varying egg-shell morphology and morphometry

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The challenging environments of Antarctica are represented by depauperate biodiversity, in which tardigrades (water bears) have become one of the dominant invertebrate groups. Living in various habitats, tardigrades play major roles as consumers and decomposers in the trophic networks of Antarctic terrestrial and freshwater environments; yet we still know little about their biodiversity. Tardigrades have a five segmented body and four pairs of lobopodous limbs with claws. Since tardigrades have a limited suite of taxonomic characters, eggshell morphology is considered an important trait for those groups that lay ornamented eggs. Although intraspecific variation in egg morphology is reported in some tardigrade species, it is unclear what causes morphological variation in egg morphology. KOPRI ecology team collected some tardigrade species from Lake Critical Zone Observatory (CZO) of King George Island during 2014-2015 season expedition. Among the collected several species, one species have been cultured in the laboratory rearing system. A new species Dactylobiotus sp. nov. from King George Island is distinguished from others in having morphometrically different buccal-pharyngeal apparatus and claw morphology. Culturing of Dactylobiotus sp. reveals a significant variation in the egg-shell morphology, which is recognized by differences in the number and size of the processes. Since all eggs were laid in the same stable laboratory condition, such variation is considered to be caused by epigenetic effects, and not be subject to different environmental or seasonality. These results shed new light on the identification of common tardigrade species in the maritime Antarctic.

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Evaluation of surface ablation of the Schiaparelli Glacier in response to local meteorological events using electronic Ablation Station and AWS Data

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The ablation and energy balance of the Schiaparelli Glacier were investigated for 412 days, 2017/2018. Schiaparelli glacier (Cordillera Darwin, Chile), a valley glacier with a mean annual temperature of 4.87 ºC, and 8-12 m a^{-1} of superficial melting in the ablation zone. We set a network of sensors with two automatic weather stations(AWS) and 2 electronic Ablation Stations (eAS). Ablation averaged 1.5 cm day-1, but showed seasonal variation. Radiation provided most of the glacier's melting energy, with convective flows contributing most of the rest. The results are related to local atmospheric circulation patterns. Different weather situations generate different energy estimates, with solar radiation being more important in all seasons and relatively significant convective flows in the summer and autumn seasons.

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Effect of temperature on Sanionia uncinata physiology

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The temperature on earth is rising affecting every level of life especially plants. Plants are essential for many processes like photosynthesis, water cycles, and nitrogen cycles among others. During the last years, the number of hot days in Antarctica has increased. This year the maximum temperature was recorded on Marambio station (Seymour Island) reaching an air temperature 20.75 °C, but there are other antarctic island that are experiencing a warming.
Coppermine peninsula, ASPA 112 (62°24'S; 59°30'W) is located in Robert Island, South Shetlands is an area protected because their vegetation like Deschampsia antarctica and mosses like Bryum sp; Chorisodontium aciphyllum, Bartramia patens, Syntrichia sp, Polytrichum alpinum and Sanionia uncinata among others. Since the 90 decade we have records of soil temperature, in 1995 we found that in a hot day soil could reach a maximum of 18 °C, but in 2018 we observed that temperature in the soil were plants grows reach 24.0 °C in 2019 was 29.5 and 2020 the maximum was of 30.4 °C.
When environmental conditions change, for example temperature, the plant physiology also changes with the purpose of maintain their homeostasis. S. uncinata an antarctic moss is tolerant to desiccation but there are no studies of the response to high temperatures. The objective of this work is contributing to the understanding of the physiology of S. uncinata under high temperatures in field conditions. Our results show that the antioxidant machinery of S. uncinata, specially CAT y POD to control reactive species oxygen and membrane lipoperoxidation.

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Past performance of the macrolichen Usnea aurantiaco-atra gives insights into its future behaviour in a climate warming scenario

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Usnea aurantiaco-atra is one of the most widespread and prominent macroclichens in ice-free areas of maritime Antarctica and, therefore, a key species for predicting the effects of climate change. In this experiment we linked both long-term field activity monitoring by chlorophyll a fluorescence and climate at different scales to CO2 exchange analysis in order to predict the productivity and the lichen activity at a daily level in a climate change scenario. Both field measurements and macroclimate conditions were linked with CO2 exchange analysis in order to predict the productivity and the lichen activity at a daily level in a climate change scenario. . The analysis was carried out using the longest long-term activity dataset ever published (from 2009 to 2014) in Antarctica Both predictions were carried out using generalized additive models (GAMs) and the Global Circulation Model MIROC5 of the CMIP5. Increasing temperature in the Representative Concentration Pathways (RCPs) 4.5 and 8.5 whilst maintaining present solar radiation and precipitation levels show a clear rise in productivity although lichen activity percentage remained at similar rates to nowadays. Broadly, it appears that climate change (temperature increase) would not negatively affect Antarctic-sub Antarctic species like U. aurantiaco-atra, because it is, at present, mainly photosynthetically active under suboptimal conditions as its optimum temperature is higher than the usual climate in maritime Antarctica.

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Keeping up with the neighbours: Disentangling the potential response to warming of cosmopolitan and endemic cryptogams of the maritime Antarctic

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The cryptogamic tundra in maritime Antarctica is composed of lichens and mosses of diverse phylogeographic origins. Around half of the total cryptogamic flora is made up of species that are either endemic or cosmopolitan, yet these two groups are at opposite poles of a phylogeographic classification. For cosmopolitan species the maritime Antarctic is a small part of their global distribution whereas, for the endemic species, it is their only location. The two groups have evolved under dissimilar geographic and environmental conditions and might be expected to show different adaptive potential having been selected to meet different limiting factors. For instance, in a warming scenario, it might be expected that cosmopolitan species will have adaptive advantages compared to endemics. To test this hypothesis, we investigated the response of net photosynthesis to light intensity and temperature for some of the most abundant species of lichen (Himantormia lugubris, Sphaerophorus globosus) and mosses (Andrea gainii, Sanionia uncinata) belonging to both phylogeographic categories. We used standard CO2-exchange techniques under fully controlled measurement conditions to generate response curves of net photosynthesis to light and temperature and, from these, determined the respective optima. Samples were used directly after removal from their growth sites. In addition, we recorded the microclimatic conditions when they were active in their natural habitats on Livingston Island (South Shetland Islands) using dataloggers and chlorophyll fluorescence monitoring. Although growing well under present environmental conditions, cosmopolitan species showed a strong positive response to warmer temperatures that was not detected in the endemics.

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From a local observing system of climate change to wider sub-Antarctic challenges

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Climate change has been documented in the sub-Antarctic islands along the last decades and its multiple effects are expected to deeply affect the functioning of terrestrial and marine ecosystems. This holds true for coastal marine habitats in which many species have limited regulatory abilities. Characterizing the impact of climate change on marine life implies that abiotic and biotic components of the environment be continuously recorded and monitored to interpret ecological changes, predict their potential impacts on marine life, and set up relevant conservation strategies. To this end, a long-term observing system of nearshore marine habitats was implemented in the Kerguelen Islands under the umbrella of the LTSER-France network (Zone Atelier Antarctique - ZATA) and the support of the French Polar Institute. Implemented in partnership with the National Nature Reserve of the French Southern Lands, main objectives are to establish a base line for assessing the impact of climate change on coastal marine ecosystems of the Kerguelen islands by ecological and genetic monitoring at reference sites. Using experimental and field data, ecological models are being developped to predict the response of species and populations to environmental changes around the Kerguelen Islands and beyond, in the sub-Antartic islands and the entire Southern Ocean. On-going phylogeographic studies also aim at analyzing population and species connectivity in the sub-Antarctic regions, a fundamental element for conservation actions. This can only be achieved through a dense collaborative network of national and international, complementary partners.

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Reconstructing past climate and sea ice using ice cores from the sub-Antarctic islands.

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The Antarctic and sub-Antarctic islands are uniquely located to capture changes in the globally significant circumpolar westerly winds and the Antarctic circumpolar current, key to the mixing and ventilation of the world's deep oceans. The glaciers on a number of these islands potentially contain an inimitable record of past climate, atmospheric circulation, westerly winds and pollution from this data sparse region. Here we present initial results from five new shallow (14-24 m) ice cores collected as part of the Antarctic Circumnavigation Expedition (ACE), including two Antarctic coastal domes and the first ever records from Bouvet Island, Peter 1st Island and the Balleny Islands. We present the density profiles and melt layer histories, together with ground penetrating radar, to establish the potential preservation of annual layers in the ice core records. We demonstrate their suitability to reconstruct past climate and present novel proxies for reconstructing past sea ice extent.

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The influence of landscape, climate, and history on spatial genetic patterns in keystone plants (Azorella) on sub-Antarctic islands

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The distribution of genetic variation in species is governed by factors that act differently across spatial scales. To tease these apart, it is useful to study simple ecosystems such as those on sub-Antarctic oceanic islands. We characterized spatial genetic patterns in two keystone plant species, Azorella selago on sub-Antarctic Marion Island and Azorella macquariensis on sub-Antarctic Macquarie Island. Although both islands experience a similar climate and have a similar vegetation structure, they differ significantly in topography and geological history. We generated data for 1,149 individuals from 123 sites across Marion Island and 372 individuals from 42 sites across Macquarie Island. We tested for spatial patterns in genetic diversity, and clines in different directional bearings. We also examined genetic differentiation within islands, isolation-by-distance with and without accounting for direction, and signals of demographic change. Marion Island has a distinct northwest–southeast divide, with lower genetic diversity and more sites with a signal of population expansion in the northwest. We attribute this to asymmetric seed dispersal by the dominant northwesterly winds. No apparent spatial pattern, but greater genetic diversity and differentiation between sites, was found on Macquarie Island, which may be due to the narrow length of the island in the direction of the dominant winds and longer population persistence permitted by the lack of extensive glaciation on the island. Together, our results clearly illustrate the implications of island shape and geography, and the importance of direction-dependent drivers, in shaping spatial genetic structure.

ISBN: 978-0-948277-59-7

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