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SESSION 30

ENVIRONMENTAL FACTORS DRIVING DIVERSITY AND COMPOSITION OF FOSSIL AND LIVING ANTARCTIC COMMUNITIES

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Giant pseudo-toothed birds in the Eocene of Seymour Island, Antarctica

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The James Ross Basin, at the northern tip of the Antarctic Peninsula, contains a unique Cretaceous-Tertiary sedimentary succession. The Paleogene sequence exposed in Marambio/Seymour Island has resulted highly fossiliferous, and among vertebrates, birds are one of the best represented groups. Fossil avifauna includes penguins, albatrosses, petrels, falcons, ratites, and pelagornitids, besides other doubtful records. Pelagornithidae, also known as pseudo- or bony-toothed birds, constitutes a peculiar group of extinct seabirds that lived in all continents between the latest Paleocene and early Pleistocene. We recently found a mandible belonging to a Pelagornithidae in the Submeseta II Allomember (Bartonian, middle Eocene) of the Submeseta Formation in Seymour Island. They were among the largest flying birds and are characterized by the presence of interspersed osseous pseudo-teeth of different size in the beak, and extremely light bones with a highly specialized structure adapted for pelagic soaring. The Antarctic record of pseudo-toothed birds is fragmentary and exclusively represented by isolated elements. Even so, it was possible to establish the presence of two different morpho-types based on sizes. The smaller corresponds to specimens of 3.5–4.5 m wingspan, whereas the larger were huge birds of 5–6 m wingspan. The new fossil is represented by a large dentary with latero-medially compressed denticles of three different sizes and a wide neurovascular sulcus that longitudinally runs along its lateral surface. It belonged to the second morpho-type of pelagornithids that lived in Antarctica during middle-late Eocene and reached the largest known sizes around the world.

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Signs of volcanic eruptions in an Antarctic marine benthic invertebrate

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The ability of some aquatic invertebrates to take up and accumulate trace elements has recently provided interesting results. The analysis of accumulated metal concentrations has numerous applications in the fields of biomonitoring programmes, but they can also be interesting for monitoring active volcanic areas and reconstructing past eruptive events. In this study, we analyzed the Antarctic limpet "Nacella concinna" (Strebel 1908), the most conspicuous benthic macroinvertebrate of the intertidal zone of the Antarctic Peninsula and adjacent islands. Samples were collected in Port Foster, a sea-flooded bay located in the interior of Deception Island, one of the most active volcanoes in Antarctica. The historical volcanic activity and the recent eruptions (1967, 1969, and 1970), together with the unrest episodes of 1992, 1999, and 2014–2015, categorize Deception Island as a very active volcano. The objective of this study is to evaluate whether Mg/Ca and Sr/Ca ratios measured in the shell's annual bands of the limpet "N. concinna" are reliable proxies for environmental variations, especially for those caused by volcanic activity. The combination of images obtained with optical and electronic microscope, including cathodoluminescence, allowed us to visualize and count the growth bands of the shell, and thus to determine, together with their size, the age of the limpets. We conclude that the Mg/Ca and Sr/Ca elemental ratios are not temperature-dependent, but other variables may instead influence them, and the shells do not register the volcanic activity on Deception Island.

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Habitat severity structures soil communities and aboveground-belowground linkages across a latitudinal gradient on the Antarctica Peninsula

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The Antarctic Peninsula is experiencing rapid environmental changes, making it susceptible to alterations in species diversity and distribution. However, we lack a firm understanding of soil biodiversity, including its relationship with the aboveground community and environmental parameters, some of which are rapidly changing. This strongly limits our ability to predict the consequences of environmental change for soil communities. To determine the nature and strength of aboveground-belowground linkages in influencing the soil community across the AP, we sampled soil communities at 10 sites (from 60-75°S) beneath key aboveground habitats (moss, grass, lichen, algae, and bare soil). We compared bacterial, fungal, and invertebrate diversity and abundance to soil chemistry and climatic conditions to determine the relationships between soil communities and their physical and chemical environment. While latitude, precipitation, temperature, or soil chemistry alone were not directly related to the soil community, we found that community composition and abundance varied along a "habitat severity" gradient, a composite variable that ranges from more favourable conditions of warmer temperatures with moderate precipitation and high-nutrient but low-pH soils, to sites that were either wetter or drier, often cooler, and low in nutrients. Notably, the aboveground community was more important for structuring soil communities at sites in the mid-range of habitat severity than the extremely severe or relatively less severe sites. The use of such key variables can potentially help us identify "hotspots" of soil biodiversity in order to focus conservation efforts.

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Microbial communities as indicators of anthropogenic impact in Antarctic lakes

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Fildes Peninsula (King George Island, Antarctica Peninsula) is among the Antarctic regions with the highest intensity of human activity, including six permanent scientific stations. Consequently, alterations to the environment have been noted, for example due to transportation and oil pollution. Monitoring programs in general have only been in place since the agreement of the Protocol on Environmental Protection in 1998. There is thus a lack of data concerning the region's natural state before the increased human presence. Our objective was to assess trajectories over the past century in the microbial communities of seven lakes on Fildes Peninsula. Five of these lakes are located near stations, while two control lakes are distant from the stations. We hypothesized that microbial communities in lakes near the stations are different due to the effects of human activities. Pigment diversity in water and sediments was analyzed by HPLC and modern and ancient bacterial diversity by molecular techniques. Our results show that seasonality had an effect on phytoplankton composition and biomass in modern samples due to environmental variation (in conductivity, temperature, pH and dissolved oxygen). We explored a possible increase in the delivery of anthropogenic contaminants during summer, when lakes are ice-free, as an explanation for differences in phytoplankton community composition and biomass. There were significant differences in pigment composition between sediment samples and the overlying water, confirming that lake surface sediments integrate several years of deposition. Sedimentary diversity of microorganisms and geochemical data are archives reflecting changes in past environmental conditions.

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Rates of Molecular Evolution in Antarctic and Temperate Nematodes

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Relative to nematodes from temperate climates, Antarctic nematodes have very short windows of time for growth and reproduction each year. This allows little opportunity for mutations to accumulate in the population. Thus, we expect the rates of molecular evolution to be slower than related sister taxa, since nematodes in warmer regions complete more generations in the same period of time. We used time calibrated molecular clocks generated from previous studies on phylogenetic divergence times in Panagrolaimidae to more accurately estimate rates of evolution of Antarctic nematodes and estimate dates of divergence. We also explored patterns of ice sheet advancement and retreat to test hypotheses of species divergence in response to glacial dynamics. We discuss our results in the context of mechanisms by which the Antarctic nematodes generate and maintain genetic variation and the implications of these mechanisms on their ability to respond to climate-driven changes.

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The use of next generation High Throughput Sequencing in accessing plant diversity in the South Shetlands islands

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The use of HTS has recently become a powerful tool for accessing large amounts of data, especially useful for environmental samples. Even being well established for microorganisms, its use for plants has been less applied with few studies focusing on this subject, in Antarctica its use of HTS for plant DNA is virtually non-existent. Recently our group decided to try HTS techniques in DNA metabarcoding for plant DNA present in the air, soil and snow communities on Deception and Livingstone islands. Our preliminary data suggested the presence of levels about 6x times higher of plant (Viridiplantae) diversity than previously surveyed using traditional morphological methods. Our data also suggest the presence of some invasive plants that may have been brought by humans in some very delicate ecosystems like Deception Island. In this talk we will show results for DNA metabarcoding in both islands and will discuss its use and caveats.

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Dynamics of an intense diatom bloom in the northern Antarctic Peninsula, February 2016

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Diatoms are considered the main base of the Southern Ocean food web as they are responsible for more than 85% of its annual primary production and play a crucial role in the Antarctic trophic structure and in the biogeochemical cycles. Within this context, an intense diatom bloom reaching >45 mg m–3 of chlorophyll a was registered in the northern Antarctic Peninsula (NAP) during a late summer study in February 2016. Given that nutrient concentrations and grazing activities were not identified here as limiting factors on the bloom development, the aim of this study was to evaluate the effect of water column structure (stability and upper mixed layer depth) on the phytoplankton biomass and composition in the NAP. The diatom bloom, mainly composed by the large centric Odontella weissflogii (mostly >70 µm in length), was associated with a local ocean carbon dioxide uptake that reached values greater than –60 mmol m–2 day–1. We hypothesize that the presence of a vertically large water column stability barrier, just below the pycnocline, was the main driver allowing for the development of the intense diatom bloom, particularly in the Gerlache Strait. Contrarily, a shift from diatoms to dinoflagellates (mainly Gymnodiniales <20µm) was observed associated with conditions of a highly stable thin layer. The results suggest that a large fraction of this intense diatom bloom is in fast sinking process, associated with low grazing pressure, showing a crucial role of diatoms for the efficiency of the biological carbon pump in this region.

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Defining composition and other variability of substrate: a continent-wide dataset of Antarctic rock exposures is now available (GeoMAP v.202008)

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A geological GIS dataset describing exposed bedrock and surficial geology of Antarctica has been constructed by the SCAR GeoMAP Action Group. Work started from a continent-scale, low density, attribute-poor dataset that was added to and improved through multiple iterations during 2015-2020. It involved capturing existing geological map data, refining its spatial reliability, then improving representation of glacial sequences and geomorphology. Around 83,000 polygons are unified for use at 1:250000 scale, but locally have areas with higher spatial precision, founded on a mixed chronostratigraphic- and lithostratigraphic-based classification. Feature classification and description rock and moraine polygons employs international GeoSciML data protocols to provide attribute-rich and queriable data; including bibliographic links to source maps and literature.

A new version (v.202008) will be released at the Hobart Open Science Conference, that follows a beta version made available in 2019 for comments and peer review. GeoMAP is available for webview or download (see www.scar.org/ssg/geosciences/geomap). The initiative was aimed towards continent-wide perspectives and for cross-discipline use, describing 'known geology' of rock and bare sediment exposures rather than 'interpreted' sub-ice features. Because it provides a continent-wide definition of substrate nature and composition, it should be ideal as a contextual layer for biological and ecological analysis or in models exploring environmental factors that drive diversity of Antarctic communities and their ecology.

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Coastal fjords reveal temporal patterns of lower salinity by glacial meltwater input along the western Antarctic Peninsula

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The nearshore waters of the western Antarctic Peninsula (WAP) are a region experiencing some of the fastest rates of warming, with over 87% of the marine terminating glaciers in retreat. Glacial meltwater enters the coastal ocean through fjords and embayments, altering the physical and chemical nature of the marine environment. Freshwater input can change salinity, temperature, nutrient availability, overall light availability, as well as provide greater stratification layer, favorable to phytoplankton growth. The resulting influx may influence the succession patterns of these primary producers on a seasonal or inter-annual basis. Variability in freshwater presence may favor different phytoplankton assemblages (e.g., favoring nanoflagellates over diatoms) and shift the overall seasonal timing of phytoplankton blooms. An understanding of the meltwater patterns along the WAP may help to elucidate spatial and temporal patterns seen in phytoplankton community composition and production.

In this study, sampling for conductivity, temperature, pressure, and turbidity in nearshore wasters between 62S and 65S was conducted through a citizen science project – FjordPhyto – in collaboration with the International Association of Antarctica Tour Operators vessels (IAATO). The presence of meltwater within various fjords along the western Antarctic Peninsula was analyzed, testing the hypothesis that meltwater would be observed earliest in the summer season within fjords along the northern Antarctic Peninsula, with meltwater occurrence extending southward as the season progresses. This analysis provides a preliminary glance at the variability in meltwater distribution patterns amongst fjords along the peninsula from November to March.

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Composition and diversity of microbial communities in subglacial lakes beneath Siple Coast ice streams

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Subglacial environments at the base of the Whillans and Mercer ice streams consist of water-saturated sediments and hydraulically-active lakes that effect ice dynamics. Direct access to two subglacial lakes [Whillans Subglacial Lake (SLW) and Mercer Subglacial Lake (SLM)] in this region demonstrated that active microbial communities inhabit their water columns and sediments. Higher dissolved oxygen and lower dissolved organic carbon concentrations were observed in SLM water column when compared to SLW, indicating biogeochemical differences between the lakes. Positive net water column metabolic production of reduced carbon in SLW and negative net production in SLM support this contention. The structure and composition of microbial communities in these lakes were analyzed using benthic sediment and filtered water column samples. Amplification and sequencing of the small subunit (SSU) rRNA gene indicated the majority of taxa are bacteria and archaea; however, eukaryotic SSU rRNA sequences related to unicellular ciliate protists and flagellates were detected in surficial sediments of SLM. The community structures inferred from SSU rRNA gene analysis reveals that the SLW water column was richer than SLM (1,808 vs. 619 amplicon sequence variants, respectively) and each shared more common taxa with those observed in the surficial sediments, than with each other. Sediment communities within each lake were taxonomically distinct, but shared several hundred taxa as well as similar metabolic potentials, specifically the oxidation of reduced sulfur/iron compounds and methane. One possible explanation for the greater similarities between the sediment communities is a historical linkage to ice sheet retreat and past marine incursions.

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Exploring the boundaries of microbial habitability in soil

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Microorganisms are the most ubiquitous forms of life on Earth and active microbes can be found in even the most challenging environments. As a result, it is often assumed that microbes should, over time, come to inhabit every terrestrial surface on Earth. Is this paradigm wrong? Are there terrestrial surfaces that are uninhabited? Previous work has hinted that uninhabited soil environments, without any detectable microbial activity, might exist in Antarctica. To explore this potential limit of habitability, we used a range of approaches, including cultivation dependent methods, cultivation independent genetic sequencing, and metabolic assays to explore patterns of microbial activity in Antarctic surface soils. By testing >200 soils collected along transects defined by environmental and geochemical gradients across the Shackleton Glacier Valley, we sought to confirm whether uninhabited surface soils do exist in Antarctica, and to determine what environmental factors may be limiting microbial activity. While many soils contained diverse microbial communities, we could not detect any active microbes in approximately 20% of the collected samples. Together our results suggest that microbial recruitment and survival may be limited by the unique combination of cold, dry, salty conditions experienced at inland, higher elevation sites throughout the Transantarctic Mountain. Additionally, the prevalence of fungi at many of the most challenging sites suggests that fungi may in fact be better adapted to some of the most challenging soil environments on Earth than Bacteria and Archaea.

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New ichnospecies of the medusiform burrows Gyrophyllites from the Eocene of Marambio (Seymour) Island, Antarctica

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Ichnofossils are structures produced by the activity of organisms, which modified the depositional fabric of the sedimentary rocks. Burrows, borings, and traces ichnogenera were recognized for the Eocene outcrops of Seymour Island. Here we describe the first record of Gyrophyllites usually interpreted as the result of worm-like organisms that mined the unconsolidated sediment in search for food. More than a hundred of specimens with an average diameter of 40 mm were collected from surficial levels of the Submeseta Allomember II of the Submeseta Formation that crops out in the locality DPV 13/84 of Bartonian age. They were found associated with Planolites, penguins and fish bones, in a flat sandstone surface of less than 50 mm thickness. Most of them were preserved as epirelief, although a minor number of specimens were found as complete relief, enclosed in ellipsoid concretions. They preserve a different number of non-overlapping concave petaloid lobes radiating from a shaft. Some of the specimens are preserved as a radial structure with six oval to subcircular deep lobes. In others, the petaloids are less excavated and defined, increasing the number of lobes up to nine. A third type are kidney-like structures in outline with five or less lobes. Despite these new specimens differ from all known Gyrophyllites ichnospecies, the main resemblance is with G. cristinae (Ordovician from Argentina), interpreted as the result of the colonization of a storm bed by worm-like organisms, favored by an increase of sea-floor oxygenation and the supply of fresh organic detritus.

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Teeth, legs, and ears: new evidence to fill the Paleogene record of land mammals from West Antarctica

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The current absence of terrestrial mammals in Antarctica contrast with the information from their fossil record, which indicate that this continent, played an outstanding role in mammalian evolution. Paleobiogeographical proxies suggest that West Antarctica probably functioned as an origin center for Australosphenida during the Jurassic. Also as a dispersal corridor during the Late Cretaceous?/earliest Paleogene, from Australia to South America for monotremes, and from South America to Australia for marsupials. In contrast, Antarctica was a sieve for placentals. We report here new land-mammal specimens from different levels and localities of the Eocene La Meseta and Submeseta formations in Marambio/Seymour Island: 1) A medial portion of a petrosal bone from Acantilados II Allomember at the locality IAA 1/13. 2) A mesiodistal half of a lower first premolar from the lower coquina bed of Cucullaea I Allomember at the site IAA 2/16. 3) Two teeth from the naticid bed of the Cucullaea I Allomember at the classic locality IAA 1/90. One is a fragmentary tooth with an enamel thinner than in sparnotheriodontids and astrapotherians from the same stratigraphic level. The other is a complete incisiviform of an herbivorous mammal of half the size to the incisive of Notiolofos arquinotiensis. 4) Several fragments of an upper tooth, also from the naticid beds were found in IAA 1/95. 5) A tibia from Submeseta II Allomember represents the first terrestrial mammal record in the locality DPV 13/84. These findings suggest that Eocene diversity in Antarctica was higher than previous interpretations from the fossil record.

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Who fills the gaps? Microbial communities colonising newly created aquatic habitat in the Antarctic Dry Valleys converge rapidly with pre-existing assemblages

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A commonly cited risk to Antarctic terrestrial communities from changing climate is that newly created habitat offers opportunities for enhanced species turnover. Here we investigate this paradigm by using the recent rapid rise of water level in the a perennially ice-covered Lake Vanda, Southern Victoria Land (77.52o S, 161.67o E), which is steadily creating new lake habitat. Two boundaries are steadily moving up: the soil-lake interface, and the lower ice-water boundary; and we focus on the consequences of this shift for the structure of benthic microbial mat communities, major primary producers in the system.
We used 16S rRNA gene sequence analysis to characterise microbial communities from the lake edge to 30 m depth. Replicate samples from around the seasonally unfrozen lake edge showed spatially variable bacterial communities in the most recently flooded soils, whereas within the first 2 m spatial variability declined and mat communities rapidly converged. This convergence happened within only five years of inundation. Under perennial ice cover, community composition could be related to gradients in irradiance within partially disconnected water layers characterized by distinct water chemistry. We suggest that, while creation of new substrate in Antarctic aquatic habitats initially provides an opportunity for colonisation by organisms uncommon to lake communities, at present environmental filtering is powerful enough to deliver quickly a predictable “signature” community. Only if habitat creation is accompanied by a change in environmental conditions can we expect to see persistent community shifts.

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Who cares more about chemical defences in the red seaweed Plocamium cartilagineum – the seaweed or its only grazer?

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Inter- and intraspecific interactions between organisms can either be a form of communication, environmental sensing, or defence and are often mediated by chemicals such as secondary metabolites. Sessile marine organisms such as macroalgae commonly produce chemical defences against grazers, pathogens, as well as biofoulers. Plocamium cartilagineum is a finely branched red understory alga that is common in Antarctic macroalgal forests. It supports a very high abundance of amphipods of which most are not able to feed on the heavily chemically defended P. cartilagineum except for Paradexamine fissicauda. Different P. cartilagineum individuals produce differing mixtures of halogenated secondary metabolites which are referred to as chemogroups. Around Palmer Station between 2016 and 2018 a total of 16 different chemogroups were identified. A subset of these chemogroups were used to identify whether the feeding rate of P. fissicauda differs between individuals that vary in secondary metabolite production. The same subset was used to assess differences in growth rate and reproductive output of P. fissicauda when held on a chemogroup-specific diet. These data determined whether there is a fitness cost associated with feeding on particular chemogroups and whether secondary metabolite variation impacts the grazer's feeding rate.

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Connectivity of the subtidal red seaweed Plocamium cartilagineum and how it effects the distribution of defensive secondary metabolites

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Inter- and intraspecific interactions between organisms can be a form of communication, environmental sensing, or defence, and are often mediated by chemicals like secondary metabolites. Sessile marine organisms, such as macroalgae, commonly produce chemical defences against grazers, pathogens, and biofoulers. Plocamium cartilagineum is a finely branched red understory alga that is common in Antarctic macroalgal forests. It supports a high abundance of amphipods of which most are not able to feed on their host as it is heavily chemically defended, with the exception of Paradexamine fissicauda. Different P. cartilagineum individuals produce differing mixtures of halogenated secondary metabolites which are referred to as chemogroups. Around Palmer Station, from 2016 to 2018, a total of 16 different chemogroups were identified which fit well into two haplotypes identified by the cox1 and rbcL genes. These data also suggest that chemogroups are to some extent site specific and that their occurrence has some correlation with depth. In order to determine the mechanisms driving the geographic patterns of secondary metabolites in P. cartilagineum, a variety of different approaches were taken. Transplant experiments revealed that the environment does not play a strong role in chemogroup production. Using microsatellites, preliminary analyses of multilocus genotypes have revealed that underlying patterns of genetic differentiation likely play a strong role in chemodiversity patterns, elaborating and expanding on the patterns based on single gene sequencing. Thus, findings indicate that patterns of gene flow, rather than the environment, play a larger role in the geographic distribution of chemogroups.

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Biostratigraphical and paleoecological analysis of Campanian–Maastrichtian of northern James Ross Island, Antarctic Peninsula, based on foraminifera and geochemistry data

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This study proposes a biostratigraphical and paleoenvironmental characterization of the Campanian–Maastrichtian deposits from James Ross Basin, Antarctic Peninsula, carried out in the region of The Naze, based on the analysis of foraminifera assemblages and Hg and TOC concentrations. A total of 30 benthic foraminifera taxa were identified, with 29 agglutinated ones and a single one calcareous. An association of opportunistic agglutinated foraminifers' taxa predominates in a stressful environment of neritic to upper bathyal paleobatimetry, which is in agreement with the global sea-level trend for this interval. The chronostratigraphic positioning of the interval was established by the recognition of the Gaudryina healyi Zone, corresponding to the Campanian-Maastrichtian. Campanian–Maastrichtian boundary was inferred based on the last occurrence of Trochammina ribstonensis and the first occurrence of Spiroplectammina spectabilis. Hg/TOC negative incursions at the C/M boundary suggest smaller burial or runoff in agreement with environmental conditions described as the Campanian-–Maastrichtian Boundary Event (CMBE).

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Taphonomic aspects of Late Cretaceous paleoflora from Nelson Island, South Shetlands, Antarctic Peninsula

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Paleontological studies particularly focusing on taphonomy on Nelson Island in the South Shetland Islands, are rather scarce. Here we presented the preliminary taxonomic survey and taphonomic aspects obtained during field work of the PALEOANTAR project carried out in the 2019-2020 austral summer. Specimens were collected in three fossil sites, two representing new localities (P2 and P3) at the RIP Point. P1a consist of interlayered laminae tuffaceous sandstones and siltstones with leaf impressions. Among the leaves collected Nothophagus sp., Papuacedrus sp., Dicotylophyllum elegans and undetermined ferns. The upper layer (P1b) was marked by tuffaceous sandstones with carbonized logs over 70 cm long. The elements were preferentially Northeastern oriented. The level P1c was lateral to P1b and exhibited bituminous coal lens. P1d was 30 meters above P1b and it exhibited wood fragments and possible leaf prints in tuffaceous sandstones and chloritized tuffites. P2 and P3 comprises layer of agglomerates with carbonized wood with quartz veins inside the matrix-supported conglomerate (P2) and agglomerate sheets (P3). These features are correlated to lacustrine environment for P1a and P1c. P1b, P1d, P2 and P3 could represent a change to a high energy lava flow, which could have carbonized the threes and pulverized any leaf present in this paleoenvironment. The Rip Point Flora have suggested that the environment experienced a wet meso-microthermic temperate climate with a relatively dry season similar to the conditions described for the Cretaceous Santa Marta Formation on James Ross Island, or the prevailing Mediterranean climate of Chile today.

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Wildfires in the Campanian of James Ross Island: a new macro-charcoal record for the Antarctic Peninsula

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The Cretaceous is widely regarded as a “high-fire” period in Earth’s history and extensive wildfires directly affected plant communities. These fires were frequent and widespread during this period, reaching both low and high latitudes. The James Ross Sub-Basin, especially the Santa Marta Formation bears significant palaeobotanical records from the Antarctic Peninsula, but - to our knowledge - no evidence of palaeo-wildfires were reported so far. Samples of macro-charcoal were collected in James Ross Island by the PALEOANTAR Project team during the fieldwork of the XXXV Brazilian Antarctic Operation (austral summer 2015/2016) and analysed. The material comes from the Lachman Crags Member (Santa Marta Formation) in the northeastern part of the island. It presents macroscopic features of charcoal (≥ 2.0 mm, black color and streak, silky luster). Under SEM, well-preserved homogenized cell walls can be observed. Charcoal is a direct evidence for palaeo-wildfires and the presence of homogenized cell walls confirm that the studied material was charred. In longitudinal section, tracheids show rare uniseriate or biseriate alternate pitting consisting of uniseriate pits. Rare uniseriate rays, formed by 4–7 cells with 150–187 µm height are preserved. Cross-field pitting seems to be cupressoid to taxodioid, but this feature can be easily disturbed during charring and can therefore not be used reliably for taxonomic purposes regarding woody charcoal. However, all observed characteristics point to a gymnosperm origin for these samples. The new evidence contributes to the construction of a Cretaceous palaeo-wildfire scenario in Gondwana, especially in the Antarctic Peninsula.

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Short note on the Cretaceous vertebrate fauna collected by the PALEOANTAR project in the James Ross and Vega islands, Antarctic Peninsula

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The record of fossil vertebrates in the Antarctic continent is rather scarce due to the difficult working conditions. Field work carried out by the PALEOANTAR project in the Antarctic Peninsula for several years has yielded a large number of fossils, including remains of Cretaceous vertebrates. The collecting effort has been concentrated in two islands: James Ross and Vega. Among the most important specimens recovered from James Ross is a sequence of vertebrae, propodial and autopodial elements from the base of the Lachman Crags Member (Santonian) of the Santa Marta Formation, which at the time of discovery was the oldest marine reptile recovered from Antarctica. This material further indicates a higher diversity of plesiosaur groups in the Antarctic Peninsula. Recently the Lachman Crags Member also furnished an isolated element identified as a portion of a pterodactyloid wing phalanx, the first record of this group of flying reptile in this region. Other vertebrate remains come from the upper deposits of the Santa Marta Formation and consist of isolated teeth and vertebrae of plesiosaurs, mosasaurs and sharks (e.g., Hexanchiformes, Synechodontiformes). Preliminary osteohistological analysis on fragmentary bony material revealed the presence of ankylosaurian dinosaurs. From the Vega Island, the most important specimen recovered so far is an incomplete diaphysis of a wing metacarpal IV lacking articulations of a pterodactyloid pterosaur (wingspan 4-5m) from the Snow Hill Island Formation (Maastrichtian), showing that large flying reptiles were present in this region. Systematic collecting efforts will increase the diversity the paleovertebrate fauna in the Antarctic Peninsula.

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On the employment of osteohistologic analysis on fragmentary fossil reptile bones for taxonomic purposes: an example from the James Ross Island (Antarctic Peninsula)

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Fossil vertebrates in Antarctica are scarce, mostly consisting of fragmentary material that lack anatomical features that allows taxonomic identification. However, some vertebrate groups present unique osteohistological patterns, which can result in their identification even in small fragments. To explore this possibility, a few incomplete bones collected by the PALEOANTAR project were sectioned. Among the specimens are two small elements with a crest-shaped base and top. In the first (CAV-A5), the cortical region is diagenetically worn. The medullary region is fibrolamellar, with abundant osteocyte lacunae, resorption cavities and intense reticular vascularization. There were also well-demarcated structural fibers throughout the entire primary tissue. In the second (AK-316), the secondary remodeling was intense, full of fibers and areas for the insertion of new structural fibers. There are large numbers of LAGs along the lamellar bone, and the osteons are oriented in a circular and elongated shape. The presence of structural fibers is a unique feature of Ankylosauria due to the high replacements of their primary tissue early in ontogeny. Calcium was released to ossify protective osteodermal structures in juveniles or sub-adult stages, causing an additional remodeling for the increased mechanical load. Structural fibers observed in the remodeled bone may be indicative of mechanical resistance in the Haversian tissue. The osteohistological features present in both specimens are compatible with ankylosaurid osteoderms, known by one species in this region. Although still preliminary, this study has shown that osteohistological studies can be used as an efficient tool for taxonomic identifications of fragmentary elements from Antarctica.

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Short note on shell beds (coquinas) from the northern part of the James Ross Island (Cretaceous), Antarctic Peninsula

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During the austral summer of 2015/16, the PALEOANTAR project performed fieldwork at the northern part of the James Ross Island, exploring deposits of the Lachman Crags Member, lower portion of the Santa Marta Formation (Marambio Group). Two distinct shell beds (coquinas) where identified and named based on the locality they were found as the Passo São José Shell Bed (PSJSB) and the Muro do Castelo Shell Bed (MDCSB), respectively. Based on the fossil content and the depositional structures, it can be inferred that both were formed under shallow marine conditions, with the PSJSB being deposited in a relatively deeper environment than the MDCSB. The PSJSB has an average thickness of 35 cm, with gastropods as the predominant bioclast, whose packaging is considered dense/loose. It can be classified as a calcarenite of allochemical origin. Texturally, it is a poorly sorted bioesparite, with sub-angular grains and lack mud in the matrix. This suggests a high energy depositional environment. The MDCSB is stratigraphically positioned above the PSJSB and has an irregular thickness, varying laterally from 10 cm to 48 cm. It is also classified as an allochemical calcoarenite, has a reddish color and a greater variety of bioclasts, predominantly bivalves. It presents loose packaging and levels of conglomerates. The great thickness of individual shells observed in both coquinas indicates an environment rich in nutrients and with high water temperatures, facilitating the production of CaCO3 by the organisms.

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Diversity of cyanobacteria and microalgae in coastal terrestrial ecosystems, Lützow-Holm Bay, East Antarctica

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Photosynthetic cyanobacteria and microalgae are adapted to various extreme environments (cold, dry and/or ultra-oligotrophic conditions). Continental Antarctica is an extreme environment because of its high latitude, harsh climate and ice cover. The Antarctic terrestrial ecosystem has low biological diversity. However, ice-free regions, which include only 3% area have relatively rich ecosystems dominated by cyanobacteria, microalgae, lichens, and mosses. Understanding the diversities of photosynthetic microorganisms in these environments is important because they are primary producers and their spatial distribution and diversity are changing at present. The coastal area around Syowa station (69°00’ S, 39°35’ E) in Lützow-Holm Bay, East Antarctica, contains many ice-free regions. In these regions, Japanese Antarctic Research Expedition has investigated the terrestrial ecosystems from ecological, taxonomic and physiologic points of views. Here, we conducted a sampling campaign in Langhovde (50 samples), Skarvsnes (52), Skallen (26), Ongul Island (6), Inhovde (10), Padda Island (4) and Amundsen Bay (15), during the Antarctic austral summer in 2018-2019 (163 samples). The samples were collected from different habitats: lakes, shallow wetlands ponds - streams, biological soil crusts, snow, seashores, etc. Then, cyanobacteria and microalgae diversity were identified by light microscopy together with a description of the most important environmental parameters. Samples were sorted into different groups for more detailed taxonomical and ecological analyses. In this presentation, we introduce a diversity map of photosynthetic organisms in the studied area of the East Antarctic. This research is supported by JARE-60 2018/19 and contributes to the long-term biological diversity monitoring of Antarctic terrestrial ecosystem.

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Long-term spatially-replicated data show no cost to a benefactor species in a facilitative plant-plant interaction in the sub-Antarctic

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Facilitation is defined as an interaction where one species (the benefactor) positively impacts another species (the beneficiary). However, the feedback effects of beneficiaries on benefactors are infrequently considered and are typically only documented using short-term datasets. However, a long-term repeated measures approach documenting changes in benefactor performance in relation to beneficiary cover and composition could potentially be used to more robustly examine the impact of bidirectional plant-plant interactions. Here, I use two dominant species: Azorella selago, a cushion plant species and facilitator, and a perennial grass species, Agrostis magellanica, on sub-Antarctic Marion Island as a model system, comparing individual plants over a 13-year period. I hypothesized that A. selago size and vitality would be negatively affected by A. magellanica cover, and that A. magellanica cover would be positively related to A. selago dead stem cover. I observed three main findings: 1) A. magellanica had no long-term effect on A. selago size and vitality; however, 2) the feedback effect of A. magellanica varied depending on the type of approach used and the performance measure examined, and 3) A. selago dead stem cover was not related to A. magellanica cover. Therefore, for the first time using a long-term dataset, I show that the cost of facilitation to a benefactor species may be negligible, in contrast to the majority of short-term studies. Long-term datasets may, therefore, be more practical, and possibly more robust, for assessing beneficiary feedback effects than snapshot approaches in systems where benefactors are slow-growing.

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Examining the complexity within a key plant-plant interaction: Inter-specific facilitation mediates the outcome of intra-specific interactions in the sub-Antarctic

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Where inter-specific facilitation favours the establishment of high densities of a beneficiary species, strong intra-specific competition may subsequently impede beneficiary performance and may ultimately reduce beneficiary fitness. Consequently, the negative influence of intra-specific competition could potentially outweigh the positive influence of inter-specific facilitation. Here we examine the impact of an inter-specific interaction on the outcome of intra-specific interactions (measured as beneficiary reproductive effort) within the context of plant-plant facilitation. We used the cushion-forming Azorella selago and the beneficiary grass species Agrostis magellanica on sub-Antarctic Marion Island as a model system. Experimentally reducing Agrostis density had no effect on Agrostis performance. However, the effect of Azorella on Agrostis (i.e. the inter-specific interaction) was positive, and increasingly so under more severe conditions. Moreover, observational data showed that high Agrostis densities may favour conspecific performance, because Agrostis reproduction was positively related to conspecific density, both on and away from Azorella. Finally, the effect of Agrostis density on Agrostis performance was dependent on whether the grass was growing on or away from Azorella, suggesting that the inter-specific interaction mediates the outcome of the intra-specific interaction. This research, therefore, highlights that facilitation, both within and between plant species, could matter more than intra-specific competition in some systems. More broadly, these results suggest that both positive inter- and intra-specific biotic interactions should be considered when predicting species responses to changing environmental conditions.

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Impact of Iron and Cobalamin on Phytoplankton Composition and Dimethylsulfoniopropionate Concentrations in the Amundsen and Ross Seas

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Recent studies have reported both the existence of vast groundwater systems beneath the ice sheets of Antarctica and that increased transport of warming seawater beneath coastal Antarctic glaciers has increased basal melting of the glaciers. One consequence of these findings is that coastal Antarctic seas could receive increasing non-aeolian iron inputs that could impact microbial community composition and dimethylsulfoniopropionate (DMSP) biogeochemistry. Moreover, changes in microbial community composition could alter the availability of bacterially-derived vitamin B12 (cobalamin) to B12 auxotropic phytoplankton. Previous fieldwork in the Ross Sea region has shown that both iron and cobalamin influence phytoplankton growth, taxonomic composition and DMSP levels, and can do so interactively. To further investigate the impact of iron and cobalamin on DMSP biogeochemistry, a series of six shipboard experiments involving both diatom- and Phaeocystis-dominated phytoplankton communities was conducted in the Amundsen and Ross Seas during the austral summer of 2017-18. The results of the experiments show a complex spatial pattern of responses with additions of iron alone, cobalamin alone or in tandem triggering changes in the phytoplankton community composition and DMSP concentrations. In some instances, cobalamin additions caused increases in the relative abundance of diatoms and prasinophytes irrespective of iron additions. Conversely, on occasion, iron additions resulted in an increase in cryptophyte abundance and a shift towards increasingly diatom-dominated phytoplankton communities. With respect to DMSP cycling, the most notable change was increases in dissolved DMSP, possibly reflecting changes away from Phaeocystis dominance and decreases in particulate DMSP to DMS conversion via Phaeocystis-bound DMSP lyases.

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Can we assess mesoplankton biomass of the Southern Ocean from satellites?

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The Southern Ocean is in the focus of numerous studies devoted to carbon–climate Earth system models, fishery and nature protection activities. Oceanic zooplankton is a significant contributor to carbon cycles and the main food source for fishery objects and protected whales. We present algorithms linking mesoplankton biomass (B) with surface chlorophyll concentration (Chl) and further assess integral B values for the whole Southern Ocean. We sampled three strata within the layer 0-300 m at 43 stations along the Greenwich Meridian between 34.44º S and 56.90º S. Two approaches were used to average Chl: site approach (rectangles around each sampling site) and jet approach (Chl averaged over nine rectangles bounded by eight dynamic jets; the rectangles were shifted 10° upstream). Overall, B was most strongly associated with an antecedent Chl signals. The most robust regressions linked B integrated over the whole 0-300 m layer to (1) Chl averaged three-month prior to survey and over rectangles 2º x 10º and or (2) Chl monthly averaged over rectangles shifted 10º upstream Antarctic Circumpolar Current 1-2 months prior to survey. Assessment of integral B based on found regressions gave the value of 2.49- 3.38 Gt for the whole Southern Ocean, high latitudes of the Atlantic are one order of magnitude richer in B than low latitudes between 40º N and 40º S. The presented tool may be of interest for a wide range of biologists and oceanographers; we also anticipate its benefit for carbon–climate Earth system models.

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A hierarchy of environmental factors driving composition of plankton assemblages in the Southern Ocean

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Material (43 stations, 129 samples, 163 identified taxa) was taken with a Judey net along the SR02 international transect in December 2009 synchronously with hydrological survey. At each station we sampled three strata separated by vertical gradients of temperature and salinity. We analyzed impact of major environmentals (hydrological factors, depth, surface chlorophyll, light) on structure of plankton assemblages. Novelties this study are (1) a use of surface chlorophyll as an analyzed environmental, (2) an implementation of a modern model of the Antarctic circumpolar Current (ACC) structure including hydrological fronts and dynamic jets, (3) a retrieval of the hierarchy of environmentals, individual fronts, and jets. Abundances of dominant species and total plankton abundances were distributed relatively homogenously across the ACC with maximal values in the upper mixed layer; north and south of the ACC abundances decreased. In terms of the impact on plankton assemblages, we retrieved the following hierarchy of environmentals (in descending order): hydrological factors, depth, surface productivity, light condition. Deeper insight into hydrological zonation showed a greater impact of hydrological fronts than dynamic jets. Among hydrological fronts, the Subtropical Front was the most important and followed (in descending order) by the Polar Front, the Subantarctic Front, and the Southern Boundary. Local influence of gyres and meanders on plankton assemblages was comparable to that of hydrological fronts.

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Summer phytoplankton community variability in nearshore waters of the Western Antarctic Peninsula

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The western Antarctic Peninsula (WAP) is one of the most productive regions in Antarctica. The nearshore waters, within fjords between 62-67 ºS harbor large Antarctic krill stocks that represent the main food source for higher trophic levels and, consequently overlap with breeding and feeding locations for penguin, seal and whale populations. This food web is supported by high primary productivity, however, phytoplankton studies in these waters are scarce. For this study, samples were collected during austral summers 2016-2019 from November to March, through a citizen science project – FjordPhyto – in collaboration with the International Association of Antarctica Tour Operators vessels (IAATO). Microscopy counts from six areas between 64 and 65ºS were analyzed (Cierva Cove, Wilhelmina Bay, Cuverville Island, Danco Island, Neko Harbor and Paradise Bay). Species identification and enumeration were performed by light and scanning electron microscopy and carbon biomass was estimated by cell-volume conversion. Phytoplankton abundance and carbon biomass varied up to 10 orders of magnitude. In general, phytoplankton was scarce during November, peaked during December and January (up to 9.5 × 106 cells L−1 and 1,597 µgC L−1) and decreased during February through March. Preliminary results suggest that diatoms were not predominant, while blooms of cryptophytes and prasinophytes were recurrently observed. Moreover, an intense dinoflagellate bloom was first recorded in the WAP. Most of these bloom-forming nanoflagellates do not coincide with Antarctic species. This study highlights the nearshore waters of the Danco/Graham coast as areas of high accumulation of phytoplankton biomass during austral summer.

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Phytoplankton assemblages in an Antarctic fjord: composition, diversity and productivity

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The Western Antarctic Peninsula (WAP) hosts the largest amount of glacio-marine fjords in Antarctica, which distribute meltwater to the ocean. These environments, that are sensitive to climate warming, are expected to be dominated by flagellates, in particular cryptophytes. We studied the spatial and temporal variability of specific phytoplankton composition and assessed the primary production (PP) during spring and autumn in Andvord Bay, a fjord located in central WAP and connected to the Gerlache Strait. Three main phytoplankton assemblages, that differ in their biomass, PP, and spatial and temporal distribution, were identified based on the relative biomass of the different taxa: (1) an assemblage dominated by cryptophytes, with biomass (59.2 ± 28.2 µgC L-1) and PP (1,428.4 ± 1,200.1 mgC m-2 d-1), present in the inner part of the fjord during spring; (2) an assemblage dominated by diatoms, mainly Odontella weissflogii, with biomass (40.1 ± 17.2 µgC L-1), and PP (2,529.8 ± 1,314 mgC m-2 d-1), present in the mouth of the fjord and adjacent waters of the Gerlache Strait during spring; and (3) an assemblage dominated by heterotrophic dinoflagellates, with biomass (3.5 ± 3.5 µgC L-1) and PP (160.7 ± 152.1 mgC m-2 d-1), present in the fjord and the Gerlache Strait during autumn and infrequently during spring. This study supports the notion that WAP fjord phytoplankton assemblages can be dominated by cryptophytes; however, diatoms control productivity, independent of their numerical abundance.

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Wind as a driver of fine-scale variation in plant communities

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Studies of species distributions typically focus on temperature and precipitation as climatic drivers. However, other climatic factors may also play a role in determining individual species distributions and community-level characteristics. Wind is an underexplored aspect of climate and, while the effects of extreme wind events are relatively well understood, the influence of habitual wind conditions is poorly appreciated. Here we investigate the role of wind as a driver of fine-scale variation in plant communities, using the sub-Antarctic as a study system. Data was collected in 1440 quadrats on Marion Island, measuring multiple abiotic conditions (e.g. pH, soil moisture, temperature) and plant community characteristics (species richness, vegetation cover and species composition). Using four different statistical models (GLM, GBM, GAM and GEE), we tested whether the addition of wind variables increased the accuracy of species richness, cover and composition predictions. Wind exposed areas had lower vascular plant cover than sheltered areas. Additionally, wind had a significant effect on species composition, but not on species richness. This suggests that wind-tolerant species replace those that cannot survive stronger wind conditions, thereby maintaining a similar species richness across the wind gradient. There is a growing availability of wind data at coarse scales, but these results suggest that variation in winds at fine-scales requires greater attention during ecological studies. Given the current changes in global wind patterns, it is potentially important to understand how wind affects species and communities in order to predict how vegetation will respond to future changes in climate.

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Food Web Structure and Community Composition of 13 Lakes and Ponds Across the Antarctic Peninsula

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Antarctic Peninsula has been rapidly warming and consequently terrestrial aquatic ecosystems change in abundance and surface cover as well as ecosystem structure and function. Therefore, comparative studies of aquatic ecosystems across large latitudinal gradients is to be useful for better understanding the changes in these ecosystems as well as for more reliable predictions under changing climate. We have sampled thirteen lakes and ponds across the Antarctic Peninsula during Turkish Antarctic Expeditions in 2018 and 2019 seasons. The lakes and ponds are located in Ardley, Robert, Livingstone, Galindez and Horseshoe Islands covering a latitudinal gradient over 800 km. We conducted snap-shot samplings for water chemistry (nutrients and trace metals), biota (pigments, plankton, epiphytic diatoms and macroinvertebrates) and stable isotopes (N15, C13). The pigment compositions were assessed using HPLC. Epiphytic diatoms were identified and counted using light and electron scanning microscopy. These lakes had a large variation in nutrient concentrations (0.04 - 55.09 micM PO4 and 0.11 - 39.55 micM NO3 + NO2) and conductivity (30-735 micS). The composition of pigments in the water column and epiphytic diatoms had also a significant variation across the lakes. These changes were predominantly associated with salinity and conductivity gradients across the lakes. Overall, the patterns mostly reflected the transport from the sea mediated through the activities of animals (seals and penguins).

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Diatom stratigraphy of a periglacial lake in Robert Island, Antarctic Peninsula

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Understanding past changes in climate and environment as well as their effects on the biota and ecosystems is crucial for effective prediction of future climate change and management of fragile ecosystems. Lakes of the Antarctic Peninsula are facing dramatic changes and paleoecological studies enable us to better understand and quantify these changes. For the study presented here, a lake sediment core of 20 cm length from the Robert Island (59°40'6.10"W 62°23'4.77"S) in the Antarctic Peninsula was analyzed. To assess the community shifts, sediment core was sliced into 2 cm intervals and permanent diatoms slides were prepared and counted up to 400 frustules for each interval. Species identifications were completed via light microscopy and scanning electron microscopy. We observed that most dominant species in the sediment samples are from Planothidium, Psammothidium and Nitzschia genera. Planothidium australe constituted 14% of the diatoms in the top 0-2 cms of the sediment core and Planothidium reneii constituted 18% of the diatoms in the top 18-20 cms of the sediment core. Planothidium spp are known to be common in small alkaline freshwater lakes of the region, indicating the high pH levels throughout the lake history covered by the analyzed sediment core. The change in the diatom communities and biogeochemical characteristics of the sediment core will be presented to infer the recent past of the lake and its catchment.

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The interplay of bacterioplankton and phytoplankton communities in the course of summer phytoplankton bloom in Argentine islands region

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The long-term marine monitoring program was launched at Ukrainian Vernadsky Antarctic Station to study the state of marine foodweb, in particular the interplay of phytoplankton and bacterioplankton communities in the course of phytoplankton bloom. The samples were collected at 2 depths - surface and deep chlorophyll maximum (DCM) at 6 stations near Galindez island, under the differential influence of meltwater run-off, during summer bloom in February 2019. Bacillariophyceae (60%) and Dinophyceae (24%) dominated phytoplankton community. The representatives of Bacillariophyceae were the most abundant at DCM comprising 73% compared to 17% at surface, at the contrast Prymnesiophyceae constituted 40% at the surface and 10% at DCM. Both surface and DCM bacterioplankton communities were characterized by the dominance of Rhodobacteraceae (65% and 44% respectively), Nitrincolaceae (10% and 21%) and Flavobacteriaceae (14% and 12%) known to be the first responders to algal bloom and benefiting from phytoplankton exudates. At the genus level Sulfitobacter, previously shown to be associated with diatoms, were the most abundant at both surface (60%) and DCM (40%). Significant proportion of bacterioplankton community functional repertoire included MetaCyc pathways involved in phytoplankton exudates' breakdown (secondary metabolite degradation, amine and polyamine degradation, carboxylate and carbohydrate degradation, sulfur and nitrogen compound metabolism). The results obtained indicate the complex interplay existing between phytoplankton and bacterioplankton in the course of phytoplankton bloom and highlight the importance of further investigation in this field, as it is one the primary factors influencing the nutrient flux and shaping the foodweb.

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A new neopterygian fish from the Late Jurassic Ameghino (=Nordenskjöld) Formation

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A new Jurassic neopterygian fish is presented on the basis of an almost complete specimen from the early Tithonian (Late Jurassic) Ameghino (=Nordenskjöld) Formation in the Argentine Antarctic Sector (Antarctic Peninsula). The specimen was recovered during the 2019/2020 Antarctic Summer field. Analysis of the new material suggests this is a new species of Dapediiformes –deep-bodied neopterygian fishes–. Dapediids as a whole are yet poorly sampled in formal phylogenetic analyses but to date, they are considered as stem-holostean fishes or the sister group of ginglymodians [Semionotiformes + Lepisosteiformes]. Moreover, the establishment of apomorphic characters for the members of the group is difficult. The specimen presented herein shares some similarities with the genus Dapedium (e.g., ellipsoidal to circular body outline, a seam-like dorsal fin, pectoral fin placed high in the body, roughly rectangular scales with a smooth caudal margin, skull bones heavily ornamented with tubercles). Besides its importance as the first Dapediiformes described from Gondwana continents, this specimen adds information relative to the anatomy of this fish group, their diversity, ecology, and paleobiogeography. Furthermore, the study of this fossil will increase the understanding of dapediids anatomy and phylogenetic relationships among neopterygians.

1096

Antarctic Middle-Late Mesozoic marine fossil-bearing units: new reports and future perspectives from Argentine paleontological explorations

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Scientific activity in the Argentine Antarctic Sector has been conducted by the Instituto Antártico Argentino (IAA) since 1951. The Vertebrate Paleontology Research Group (VPRG) comprises several disciplines within the study of vertebrates and incorporates researchers and technicians from different Argentinian institutions. The main objectives of this group are the prospection, collection, and study of fossil vertebrates recovered during the Antarctic Summer field season. The Jurassic in Antarctica is still little explored, even though it represents a key moment for understanding the evolutionary history of certain fish groups. In light of the Jurassic outcrops occurring in Antarctica since 2015 the VPRG, has been exploring some areas with a strong focus on the recovery of fossil fishes. Jurassic marine fishes were known from the Ameghino Formation (=Nordenskjöld) and the Hauberg Mountains Formation. Our preliminary results show that the taxonomic diversity of fishes from the Ameghino Formation is greater than what had been previously reported. Additionally, abundant bromalites with fish remains content have been recovered, as well as other vertebrates and invertebrates previously undescribed at the formation. The studies of the fish material and bromalites might provide information on anatomy, taxonomy, phylogeny, paleoecology, paleobiology and morphological disparity of the taxa. These data are useful to improve the understanding of the Jurassic gap in the evolutionary history of the major clades of fishes in the Southern Hemisphere.

1104

Geology and palaeontology of the Marine Maastrichtian of the James Ross Basin, Antarctica: New multi proxy approach

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During the last summer 2020 field trip carried out under the Argentine Antarctic Program (IAA-DNA), new geological and palaeontological data of the Maastrichtian López de Bertodano Formation (Upper Cretaceous), James Ross Basin was recovered. This transgressive/regressive sequence is well exposed in the Sandwich Bluff Member of Vega Island and in the southern part of Seymour (Marambio) Island. The aim of this study is to compare both areas, in order to evaluate in detail their potential palaeoecological differences. We elaborate detail sedimentological logs and exhume new fossil material of vertebrates, invertebrates and plants. Fossil vertebrates belong to neognathae birds, chondrichthyes and osteichthyes fishes and marine reptiles. In comparison with Seymour Island fossil vertebrates at Sandwich Bluff Member were found isolated or incomplete, and the fossil association of marine reptiles is characterized by less abundance of mosasaurs vs plesiosaurs. The invertebrate fauna is less abundant and diverse. Few isolated bivalves were recovered and the presence of abundant and well preserved leaves and logs suggest a stressful environment. Vega fossil assemblages indicate marginal near-shore environments under tidal-influence characterized by an impoverished of invertebrate. In terms of diversity and taphonomy, the fossil record of marine reptiles in this area could be indicating that they would not have actively inhabited these environments, and that the incomplete remains found correspond to fragments of skeletons dragged towards the coast. The sedimentological data shows that upper beds of the Sandwich Bluff Member consist of siltstone to fine-grained sandstone deposits.

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Myco- and photobiont associations in crustose lichens in the McMurdo Dry Valleys (Antarctica) reveal high differentiation along an elevational gradient

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The climate conditions of the McMurdo Dry Valleys (MDV, 78° S) are characterized by low temperatures and low precipitation. The annual mean temperatures at the valley bottoms range from -30 °C to -15 °C and decrease with elevation. Precipitation occurs mostly in form of snow. Liquid water is rare and represents the primary limitation to biological activity. Snow delivered off the polar plateau by drainage winds, dew and humidity provided by clouds and fog are important water sources for rock inhibiting lichens. In addition, the combination of the extremely low humidity and drying caused by foehn winds, confined to lower areas of the valleys, with colder and moister air at higher altitudes creates improved water availability with elevations.

We investigated the diversity and interaction specificity of myco-/photobiont associations of a total of 232 crustose lichen specimens, collected along an elevational gradient (171-959 m a.s.l.) within the MDV. Elevation, positively associated with water availability, turned out to be the key factor explaining most of the distribution patterns of the mycobionts. Pairwise comparisons showed Lecidea cancriformisand Rhizoplaca macleanii to be significantly more common at higher, and Carbonea vorticosa and Lecidea polypycnidophora at lower, elevations. Lichen photobionts were dominated by the globally distributed Trebouxia OTU Tr_A02 which occurred at all habitats. Network specialization resulting from mycobiont-photobiont bipartite network structure varied with elevation and associated abiotic factors.

Along an elevational gradient, the spatial distribution, diversity and genetic variability of the lichen symbionts appear to be mainly influenced by improved water relations at higher altitudes.

918

Understanding the microbiome diversity through a combination of remote sensing and close-range field observation techniques in the Sør Rondane Mountains, East Antarctica

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The sparse ice-free regions of Antarctica are the coldest arid deserts on Earth. Yet, ice-free soils harbor substantial and diverse microbial communities that can vary significantly between the regions and the micro-climatic conditions. The factors responsible for driving the microbial diversity and community structure in inland nunataks of East Antarctica, like the Sør Rondane Mountains, are still poorly understood. Within the BELSPO MICROBIAN project, three sampling campaigns took place in a 70 km radius around the Belgian Princess Elisabeth Station during the Austral summers of 2018, 2019 and 2020, resulting in the biggest sampling effort for microbial analysis in the region. Samples ranged from different kind of barren bedrock to substrates covered by biofilms and well-developed biological soil crusts consisting of lichens, mosses and cyanobacterial/microalgal mats. In this study, long-term microenvironmental monitoring data show that temperature and soil humidity regimes vary with the elevation, slope, aspect, wind exposure and daily irradiance regimes of the surveyed nunataks. Bacterial and eukaryotic diversity were assessed by amplicon sequencing targeting 16S and 18S regions of the rRNA genes with the Illumina MiSeq platform (2x300 bp). Preliminary multivariate analysis indicate that habitat characteristics derived from remote sensing and data loggers give important insights about the distribution of bacteria, cyanobacteria and eukaryotes in these unique environments. Further analyses are ongoing on chemical characterization of the soils and on potential biotic interactions to better understand the terrestrial microbial ecology of Antarctic ice-free regions.

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Fatty acid trophic transfer from Antarctic algae to the benthic amphipod Gondogeneia antarctica

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The shallow coastal benthos (between 5- 40 m) of the Western Antarctic Peninsula supports dense macroalgal forests, often dominated by large chemically defended brown macroalgae. Macroalgae provide cover for abundant amphipod communities that include carnivores, omnivores, and herbivores, which primarily consume diatoms and other chemically undefended macroalgae. Some of these chemically defended macroalgae become more palatable within a few weeks of death and the contribution of these dead macroalgae to amphipod diets is unknown. The trophic dynamics between amphipods and macroalgae are difficult to observe directly, making the use of biomarkers such as fatty acids ideal if controlled feeding assays are used to quantify how amphipods incorporate the fatty acid signatures of their algal diets into their tissues. We performed a feeding trial with Gondogeneia antarctica to generate a fatty acid 'resource library' of known diets which we compared with the fatty acids of G. antarctica collected in the wild. We maintained G. antarctica on one of four possible algal diets, representing a palatable macroalga (Palmaria decipiens), benthic diatoms, or one of the two freeze-killed chemically defended macroalgae (Desmarestia anceps or Himantothallus grandifolius). After nine weeks, amphipod fatty acid signatures reflected their diet treatments with those amphipods maintained on diatoms having fatty acid profiles most similar to wild amphipods, suggesting that diatoms make up the majority but not the entirety of the diets of G. antarctica in situ.

1638

Exploring the Streptophyta at Deception island (Antarctica, South Shetlands) using metabarcoding of environmental soil DNA

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Antarctica vegetation is composed by only two native angiosperms and about 142 bryophyte species. The Deception Island shows about 50% of all moss diversity of Antarctica and 18 species that doesn't occur anywhere else in the continent. Environmental DNA or eDNA metabarcoding has the potential to detect and classify genetic molecules of species present in environmental samples such as sediment, water, soil, air, and feces. This tool was used by the first time in Antarctica to detect plant DNA in soil to reveal taxa non detectable through traditional surveys. In this study we aimed to use NGS to investigate community's diversity of Streptophyta (Viridiplantae) present in soil samples in two different sites in Deception Island, one inside of a protected area (Crater Lake) and one outside (Whalers Bay). A total of 39 taxa were found in the soil. Crater Lake samples presented seven Bryophyta, one Marchantiophyta, one Monilophyta and 14 Magnoliophyta; in Whalers Bay, we found five Bryophyta, two Monilophyta and 22 Magnoliophyta. The more abundant species was Imbribryum blandum, never cited to Antarctica before, occurring as South as the subantarctic Campbell Island, followed by Sanionia uncianata, the most common moss species in Antarctica. However, we found 32 species not previously cited to Antarctica, most of them (29) vascular plants. The protected area showed 25% less taxa than non protected area in Deception of total the taxa. This could be an indication that protected areas are less disturbed by human activities and potential introduction of non native plant DNA.

1329

Diversity, biogeography and potential parasite-host interactions of aquatic fungi in (sub-)polar lakes

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Towards the poles, freshwater biota are increasingly dominated by microorganisms, many of which perform critical ecosystem functions. In addition, Antarctic freshwater foodwebs are regarded as truncated, because many clades, such as large metazoan grazers, are absent while microbial heterotrophs are important components. Nevertheless, little is known about the biogeographic distribution or the trophic status of many of these heterotrophic microeukaryotes.

We studied the biodiversity of microbial eukaryotes, focusing on fungi in (Sub)Antarctic lake benthos using high-throughput sequencing of the ITS region and 18S rRNA gene and compared the patterns with similar data from the Arctic to study their biogeography. Our results show that polar lakes harbour a diverse pool of fungi, dominated by Cryptomycota and Chytridiomycota, as well as yeast-like Ascomycota and Basidiomycota and a relatively large proportion of unknown diversity. Additionally, several taxa were restricted to the Southern Hemisphere. Local OTU-richness in the Southern Hemisphere lakes was significantly lower than in the Arctic, and fungal communities were considerably differentiated between the biogeographical regions. Co-occurrence network inferences revealed that Chytridiomycota and Cryptomycota OTUs were significantly overrepresented, and their abundances were strongly and positively correlated with OTUs belonging to Bacillariophyta, Chrysophyceae-Synurophyceae and Dinoflagellata, suggesting that these taxa may serve as potential hosts. Combined, we show that poorly understood or unknown taxonomic groups among the Cryptomycota and Chytridiomycota account for a large proportion of polar and subpolar aquatic fungal diversity. Our results suggest that these predominantly parasitic groups may have an underestimated role in the carbon and nutrient cycling of polar lakes.

1309

Beta-diversity of an Antarctic rocky subtidal community is associated with glacier meltdown processes

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The Western Antarctic Peninsula (WAP) shows one of the fastest responses to climate change on Earth. Glacier meltdown—leading to increased seawater turbidity and decreased temperature and salinity—is one of the largest environmental responses with larger implications of anthropogenic impacts in the WAP. The consequences of this process for fundamental attributes of biodiversity, such as beta-diversity, are still not well understood. Here, we assess the beta-diversity of a species-rich marine subtidal macrobenthic community (consumers and primary producers) across two abiotic environmental gradients defined by the distance from a glacier (several km) and depth (down to 20 m) in Fildes Bay, King George Island. The analysis of spatially extensive records of seawater turbidity, high-frequency temperature and salinity data, and suction dredge samples of macrobenthic organisms revealed non-linear and functional group-dependent associations between beta-diversity, glacier influence, and depth. Species richness and Shannon's diversity of consumers significantly decreased in the nearby of glacier relative to reference sites. The number of consumer species also increased with depth across the bay. Moreover, the spatial variation in community structure of consumers and primary producers depended on both glacier distance and depth. These results suggest that glacier melting can have significant effects on diversity and community structure. Therefore, the observed acceleration of glacier meltdown may have major consequences for local biodiversity in this ecosystem.

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The influence of the Polar Front on vertical mesoplankton migrations: a case study from the Drake Passage

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Diurnal and seasonal vertical migrations of zooplankton represent a widespread phenomenon occurring both in marine and freshwater environments. However, they are believed to be absent or insignificant during summer in subpolar and polar areas such as the Southern Ocean. This viewpoint has been accepted in numerous studies of vertical distribution of net mesoplankton. However, the data obtained from various hydrological zones are often put in a common data pool, so trends within each of these zones can be masked. The hydrological fronts greatly influence plankton composition and its spatial and temporal distribution. Here we test the hypothesis that hydrological fronts do influence the patterns of diurnal vertical migrations of mesoplankton. We analyzed diurnal dynamics of abundance, biomass and diversity of mesoplankton at differnet depths sampled in four cruises in the Drake Passage during spring and summer in 2008-2011. During all these cruises we observed a prominent Polar Front (PF), which provided statistically representative division of stations on both sides of it. We analyzed material of 85 day-and-night stations and found that diurnal and seasonal migrations significantly differ south and north of the PF. We present and analyze observed differences in diurnal and seasonal dynamics of the community integral parameters (abundance, biomass, diversity) and individual dominant taxa.

1365

The nitrate-to-dissolved-iron ratio in West Antarctica coastal waters

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Diatoms experience iron stress at high nitrate-to-dissolved-iron ratios in high-nutrient low-chlorophyll (HNLC) ocean provinces. In Antarctic coastal waters, dissolved iron enrichment is found near ice shelves, at the sea-ice edge, during spring blooms, or at oceanic fronts. We expect these regions or events to be enriched in diatoms. In West Antarctica, dissolved iron has been identified as the limiting growth factor for phytoplankton growth. The literature reports concentrations varying by 2 orders of magnitude while the nitrate-to-dissolved-iron ratio varies by 3 orders of magnitude. This ratio is mainly controlled by the dissolved iron concentration. Waters with lowest ratios are found in the western Antarctic Peninsula coastal and shelf waters, a region known for abundant and diverse diatom species. In contrast, waters in the Amundsen and Ross Seas have the highest ratios, regions where Phaeocystis antarctica blooms abound. Based on detailed sampling in Antarctic fjords, we were able to estimate pseudo-uptake rates for diatoms and flagellates in the field which indicate that diatom growth increases the nitrate-to-dissolved-iron ratio by efficiently stripping iron from surface waters. However, as diatom carbon (biomass) increases during bloom development, the dissolved iron-to-carbon (dFe:C) pseudo-uptake ratio decreases. Our study indicates that not only dissolved iron concentration but also the ratio of nitrate-to-dissolved-iron are important parameters that control diatom abundance, and hence high rates of primary production and an efficient carbon transfer through the Antarctic food webs.

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Diversity and ecological role of cyanobacterial benthic microbial mats in five lakes, Lützow-Holm Bay, East Antarctica

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Cyanobacteria in bottom benthic mats of five lakes in Lützow-Holm Bay, East Antarctica, were investigated by a multi-facet approach. Morphological (cell biovolume - three groups of cyanobacteria were determined according to their cell morphology: unicellular, filamentous, and heterocystous cyanobacteria) and molecular methods (NGS amplicon sequencing of cyanobacterial 16S rRNA) were combined with a characterization of their ecological role (nitrogenase activity). Five samples were collected from five lakes (Bosatsu-ike, Hotoke-ike, Nyorai-ike, Naga-ike, Skallen-ike), spanning a range of different ecological environments in the deglaciated areas of Skarvnes and Skallen. We evaluated the influence of lake characteristics on the cyanobacterial benthic mats' diversity and ecophysiological activity. In addition to cyanobacteria, eukaryotic microalgae (diatoms, coccoid, filamentous algae – Chlorophyta and Charophyta) were also distinguished. This research is supported by JARE-60 (Japanese Antarctic Research Expedition) 2018/19 and contributes to the long term monitoring of Antarctic lakes.

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How have Shackleton Glacier's soil fauna responded to deglaciation since the Last Glacial Maximum?

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Connections between the structure of soil communities and the role that geological legacies play in shaping them help us understand their response to environmental changes. The Transantarctic Mountains region experienced massive environmental changes associated with glacial recession since the Last Glacial Maximum (LGM), yet we have few clues as to how biotic communities responded. We recently surveyed the soil invertebrate fauna from above and below LGM elevations along two transects of the Shackleton Glacier (~9 features, two locations per feature) and investigated if habitat suitability, taxonomic diversity and community structure follow predictable patterns with distance from the LGM trim line. Our transects provide a gradient of surface ages that should reflect extinction and recolonization events across highly heterogeneous soil habitats. Our results indicate that soil fauna abundance and habitat suitability declined with increasing distance from the ice shelf (p abundance<0.001; p habitat<0.0001) and the nearest glacier (p abundance<0.01; p habitat<0.001). Soil fauna community structure was also affected by distance from both ice shelf (F=3.59, df=1, p=0.002, r2=0.40) and glacier (F=4.82, df=1, p=0.001, r2=0.53), with the omnivorous nematode genus Eudorylaimus relating to shorter distances from ice shelf (<10-20 km) and glacier (<200-400 m) if compared to rotifers, tardigrades, and other nematodes (Scottnema and Plectus), indicating higher trophic complexity in younger exposed soils. We conclude that distance from present ice surfaces (as a proxy for surface exposure time) is negatively related to habitat suitability, with decreases in soil fauna abundance and simplified community structure with increasing distance from present ice surfaces.

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Does size matter? Hydrology and habitat in “medium”-sized lakes and ponds, Antarctica

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The classification of Antarctic terrestrial lake and pond systems is based predominantly on size and morphology, as this influences the volume of liquid water, its chemistry and the habitat provided for aquatic life. However, the research underpinning this classification pertains mainly to small ponds, which freeze and thaw each year, and large perennially ice-covered lakes. There is currently little information on what might be termed “medium” sized-water bodies, and how the interactions of topography and temperature influence their evolution. In January 2019, medium-sized water bodies in a valley off the northwest margin of the Koettlitz Glacier, were investigated; Ward Lake (950m diameter), Burt Lake (735m) and Keyhole Lake (376 m). All were relatively shallow (<4m) with a predominantly frozen water column at the centre, but only Burt Lake was frozen solid, without liquid water or cyanobacterial mat development. Ward and Keyhole lakes had horizons of water-laden, candled ice within solid lake ice, moat and mat development and a thin layer of liquid brine at the very base of the lake ice. These observations indicated that the presence of active or intermittent inflow and outflow systems, and consequent changes in lake level over time, influence biological productivity to a greater degree than pond volume, surface area or depth.

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Pond ice gases as a record of ecosystem metabolic change during freezing

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Gases interred in Antarctic ice sheets have yielded critical information on long-term temporal changes in atmospheric gases. Gases trapped in the seasonal ice formed in Antarctic ponds and lakes, may likewise preserve a record of temporal changes in the metabolism of a pond's ecosystem during seasonal freezing; a record which is almost impossible to measure directly. Two 65cm ice cores collected from frozen ponds (JA & P70) at Bratina Island, on the McMurdo Ice Shelf, have been analysed using gas chromatography, after melting sections of ice core in a vacuum. Oxygen and nitrogen dominated the trapped gases at all depths in the core, with the proportion of oxygen dropping from 0.37 to <0.1 mole/mole of dry gas in the final stages of freezing (at the base of the ice core). In contrast, carbon dioxide increased with depth, from < 0.0004 in surface ice, to 0.35 mole/mole dry gas at the base of the JA core, and methane increased with depth only in P70, achieving a maximum of 3.5 mmole/mole dry gas. Other detectable trace gases; nitrous oxide, carbon monoxide, carbonyl sulphide, hydrocarbons, did not show consistent trends with ice core depth. When compared with temporal trends in water chemistry and primary productivity in these ponds, it is apparent that ice gas composition has faithfully reflected and recorded major shifts in metabolic processes during freezing.

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Adelie Penguin Habitat Requirements in relation to Geology and Geomorphology: Further developing the species-environment relationship

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The Adelie penguin is one of the most extensively studied avian species in the world. With this long history of research, the Adelie penguin has emerged as a key indicator species for climate change, assisting in identifying changes in the surrounding Antarctic landscape. With environmental conditions changing due to the growing pressures of climate change, it is important to understand the key drivers influencing Adelie penguin habitat requirements at a temporal and spatial scale. Although many aspects of Adelie habitat requirements have been extensively researched, there is still little known about their species-environment relationship in relation to geological and geomorphological requirements. Without this key information, predicting future habitat availability is challenging.
This project will primarily focus on Adelie populations distributed throughout the Windmill Islands. Using satellite imagery, aerial photos and ground-based data, significant geological and geomorphological aspects of the environment will be identified. This will be developed and contrasted against presence-absence data supplied from the Australian Antarctic Division. By compiling these data sets, potential patterns may be revealed that further our understanding of Adelie penguin habitat requirements and how this has changed with environmental conditions over time.

This project aims to further our knowledge on the key drivers that influence Adelie penguin habitat requirements. The results may assist in making projections of future habitat availability and predicting other possible impacts of climate change on Adelie penguin populations.

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The evolution of benthic invertebrate community ecology in the Cenozoic of Antarctica

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Assessing changes in the ecology of fossil communities, and how this affected the evolution of marine life, gives insight into how modern communities will react to environmental change. Modern Antarctic benthic invertebrate marine communities are described as archaic and retrograde, dominated by epifaunal suspension feeding organisms. Previous studies suggested this evolved in the Eocene, with cooling decreasing durophagous predation. However, some evidence does not corroborate this hypothesis. The Cretaceous-Paleogene mass extinction did not cause a distinct change in Antarctic benthic community ecology. However, other global signals, for example a shift in dominance between bivalves and gastropods, occur in the Paleocene. During the Eocene, there was a radiation of many taxa. Stalked crinoids, the main evidence for the original hypothesis that Antarctic community structure arising at this time, are present. However, we have linked this to asynchronous timing of the Marine Mesozoic Revolution in the Southern Hemisphere. Evidence of the first glaciations in the west Antarctica comes from King George Island (South Shetland Islands). The Polonez Cove and Cape Melville Formations preserve marine sedimentary sequences from the Oligocene and Miocene. Dropstones, diamictites and striated rocks confirm deposition in a glacial environment. Both preserve abundant fossils, representing Antarctica's first glacial sea floor communities. However, the youngest unit, does not preserve an invertebrate community with the modern Antarctic ecological structure. It is dominated by infaunal bivalves, with a significant proportion of durophagous decapods. We hypothesise that the evolution of the modern benthic invertebrate community structure occurred more recently than previously thought.

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Past cyanobacterial biodiversity in polar regions

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Looking to the past, the FNRS project HERBA aims to study the past diversity and biogeography of cyanobacteria in polar regions by investigating herbaria specimens from the Smithsonian Institution (Washington, DC, USA). First results, obtained with 454 pyrosequencing of the 16S rRNA gene V3-V4 segment, showed that it was possible to retrieve the sequences of Antarctic samples taken in 1948-9 from Ross Island, in 1940 from Deception Island and in 1964 from Victoria Land. DNA could be amplified in all cases and 55 OTUs (97.5% similarity) were detected. Sequences of Nostoc sp., Microcoleus sp., Phormidesmis priestleyi, Leptolyngbya sp., and Timaviella sp. were retrieved and compared with present-day sequences. This study gives access to the cyanobacterial community composition in a period where anthropogenic and climatic pressures were still low in the remote polar regions and will allow to detect possible changes in biogeographic patterns or shifts of genotypes towards more generalist ones.

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MICROBIAN : Microbial diversity in the Sør Rondane Mountains in a context of climate change

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The Sør Rondane Mountains (SRM) represent a c. 900 km² large
mountain range, encompassing a large range of terrestrial habitats differing in geology and soil characteristics, exposure time and microclimatic conditions. The objectives of the BelSPO project MICROBIAN are to (i) use a combination of remote sensing (Digital Elevation Model) and close-range field observation techniques to map physical habitat characteristics and the presence/extent of biological crust communities in the region of the Princess Elisabeth Station Antarctica (PEA), (ii) generate a comprehensive inventory of the taxonomic and functional diversity of microbial communities in these habitats by amplicon sequencing of the 16S and 18S rRNA genes and metagenomics, (iii) use mesocosm field experiments (Open Top Chambers and snow fences) to mimic the possible effects of future climate change on the taxonomic diversity of these microbial ecosystems, and (iv) conduct field experiments to inform policy-makers in view of decision making regarding environmental protection and prevention measures to reduce the introduction and spread of non-native species and to avoid cross-contamination between sites. The proposed research will provide a proof of concept to use high resolution satellite images for identifying regions of particular biological interest in East Antarctica and more broadly make a significant contribution to understanding Antarctic terrestrial microbial ecology.

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Effect of environmental parameters on diversity, community composition, and functional guilds and growth forms distribution of fungi in Victoria Land soils

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Ice-free areas of Victoria Land are patchily distributed, mainly restricted to coastal regions, mountain peaks and to McMurdo Dry Valleys. Exposed soils concentrate most of the terrestrial biota and are important oases supporting unique edaphic communities, that more than in other continents, are made up of microorganisms, playing key roles in soil ecology and sustainability. Despite the well-known role of fungi in soil ecosystems in recycling C sources and their high resistance to desiccation and UV radiations, their role in Antarctic soils received little focus until now. Through ITS1 rDNA metabarcoding, we characterized the fungal communities of 65 soil samples from 9 different localities in coastal sites of Northern Victoria Land and inland sites of Southern Victoria Land. We obtained 896 OTUs, among which 495 were assigned to functional guilds, that were dominated by lichenized and saprotrophic fungi. When possible, we identified the growth form (filamentous, yeast or meristematic) for OTUs with high identity with known fungal genera and families. Diversity, community composition and distribution of different functional guilds and growth forms were related to the geographical distance of sampling sites and to different edaphic parameters (soil texture, pH, moisture, C, N, available P, cation exchange capacity and exchangeable cations Na+, K+, Mg2+ and Ca2+), in order to: i) give insights into soil/fungi dynamics from costal to inland areas of Victoria Land in relation to the extreme environment to which they are adapted and ii) define the main drivers of their distribution.

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