ilaia

ADVANCES · IN · CHILEAN · ANTARCTIC · SCIENCE

N°3 – 2016

ISSN 0719-5036

CONTENTS

EDITORIAL

It is with great satisfaction that I present to you this third volume of ILAIA, INACH's only magazine produced exclusively in English.

In this edition we are very pleased to show some examples of the great strides we are making in the quality and scope of the Chilean Antarctic Science Program, which is the principal responsibility of our Institute.

We see Antarctica from the depths of its waters to the brilliance of its skies. In the seas we observe the ties of coexistence linking marine sponges with other organisms. On the horizon we assess the role of the Antarctic continent in the global energy balance. In this issue of ILAIA we cover many of the concerns of the world-wide international scientific community.

From the forever-relevant question of the Origin of the Continent to the worrying possibility of humans introducing diseases that may affect Antarctic wildlife, from the looming arrival of climate change to the Southern Ocean, to studying the Antarctic in winter, this issue covers the growth of the Chilean Antarctic Science Program.

We have also included two articles on international cooperation to reveal the recent work done in this area and the favorable changes taking place for having others working collaboratively with our program. We have grown in the scientific realm and every year we make major investments to improve the logistical network as well. This will soon extend from its key point in Punta Arenas as far as the distant Carvajal Station, on Marguerite Bay, along with several intermediary points.

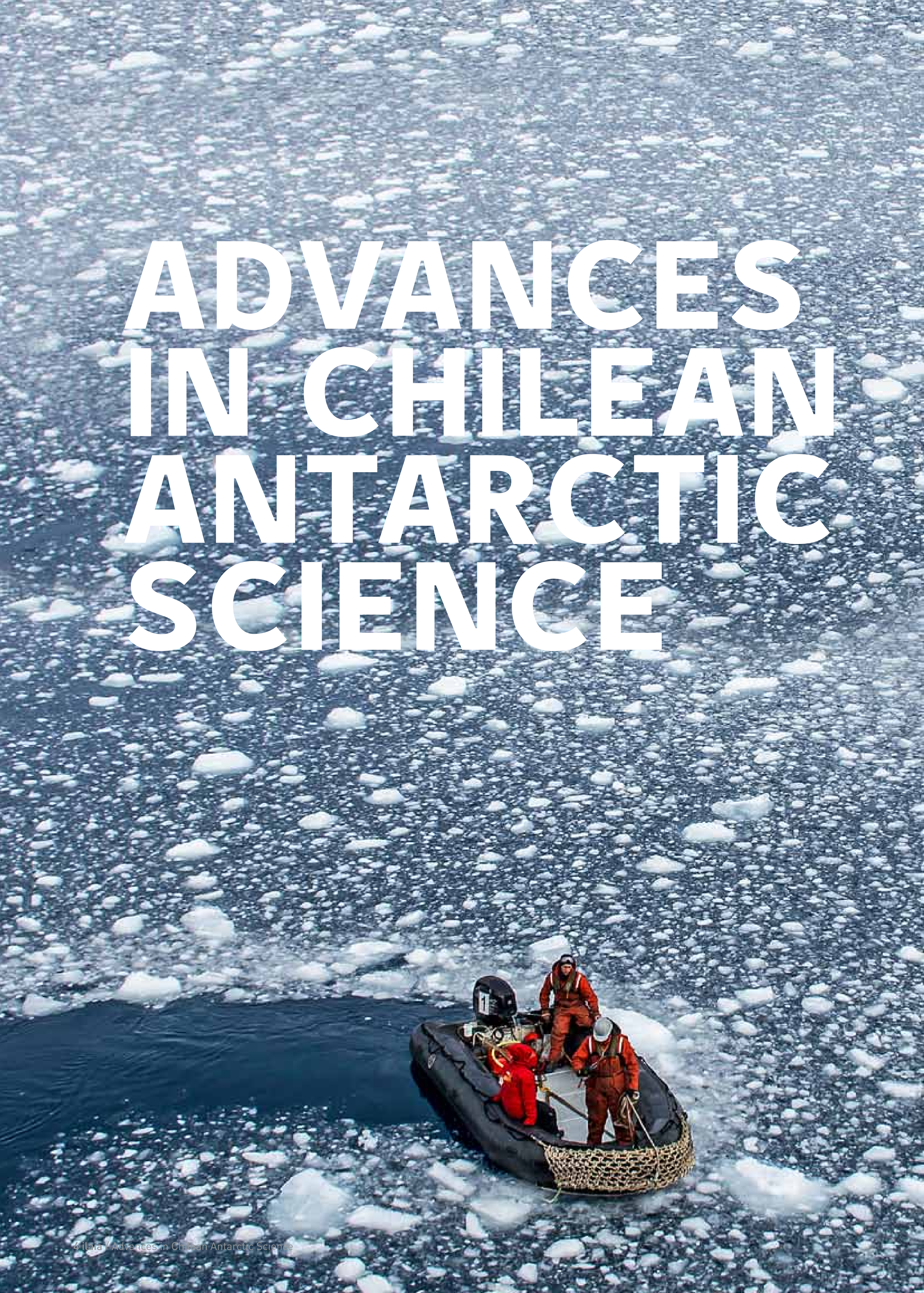
Our ship, the *Karpuj*, will become operational next summer, opening up a new world of possibilities for marine researchers. In addition, we are making great strides with the mega-project, the International Antarctic Center in Punta Arenas. For the two hubs already mentioned - science and logistics - we are adding another to focus on education and dissemination. In the coming months there will be an international call for the architectural design for the new center, and of course all are invited to participate.

The latest dynamic of our Antarctic program has allowed a rejuvenation of polar science, with more scientists added every year who will begin their careers with their sights set on the White Continent. To cover this point, the recent work of APECS-Chile is introduced by its directors in this issue of ILAIA.

Finally, we've included an article on the work of the sixteenth-century writer Alonso de Ercilla and his epic poem, "Famous Chilean Antarctic Region," which reminds us that our country has no choice but to follow its current path of participation in the strongest possible sort of international collaboration, for the purpose of revealing the secrets of this magnificent and vital continent to the future of humankind.

DR. JOSÉ RETAMALES ESPINOZA
Director
Chilean Antarctic Institute

ADVANCES IN CHILEAN ANTARCTIC SCIENCE




P. Ruiz

César Cárdenas
INACH
ccardenas@inach.cl

IN UNION THERE IS STRENGTH

COEXISTENCE BETWEEN ANTARCTIC SPONGES AND OTHER ORGANISMS FACING A CHANGING ENVIRONMENT

Marine sponges are important members of Antarctic benthic (botton-dwelling) communities, and as such they perform vital functional roles in the ecosystem. One of these sponges' critical roles involves their important associations with an endless number of other organisms, including fish and invertebrates, along with many microorganisms. FONDECYT has funded the project "Assessing the Utility of Antarctic Sponges for Studying Global Change: Individual to Community Level Responses." Preliminary results of this project suggest the existence of diverse and important associations between sponges and microorganisms. At the same time, results show an interesting relationship of coexistence between sponges and macroalgae, something contrary to patterns reported in many other studies that suggest competition for space between the two groups.

The Antarctic is changing, and for that reason it is essential that we increase our knowledge of the current distribution patterns of these important organisms to allow detection of future changes produced by global warming. This sort of information, together with the study of the physiological responses and the impacts of the sponges' biological association with other organisms, will allow us to detect eventual negative effects on these communities and on the Antarctic ecosystem as a whole.

1. South Bay was one of the first places studied at Doumer Island. The movements of icebergs and the reduction in light due to sea ice accumulation are factors that affect the abundance of sponges and the benthic community in general.

Sponges play important functional roles in marine ecosystems. One of the most relevant involves the interactions and associations they form with a large number of other organisms, including many invertebrates, fish, and microorganisms as well.

The Chilean National Science and Technology Foundation (FONDECYT) is financing project number 11150129, "Assessing the utility of Antarctic sponges for studying global climate change: individual to community level responses". This project will study the effects of global warming on Antarctic sponges not only as it affects a single species but also the impacts on the entire interrelated community, in order to better understand the effects of global warming on these species, their roles and their interactions with other components of the Antarctic ecosystem.

A large part of the research is focused on the competitive relationships between "macroalgae" or seaweeds, and sponges, which until now has been generally assumed to be negative between both species. The competition for space allows seaweed, with a faster growth rate, to typically displace the sponges, which exhibit much slower growth.

For many years it has been assumed that seaweeds are primarily responsible for distribution patterns of sponges in shallow waters. However, more recent research has revealed evidence that the distribution and abundance of sponges in the shallows are not determined just by competition with seaweeds and other organisms, but also due to interaction with other factors such as substrate inclination, light, and sedimentation. Evidence from the research in other latitudes indicates that in some cases there are positive relationships between these canopy-forming algae, and some species of sponges.

Marine sponges are recognized as key members of Antarctic communities, where they can be very abundant, particularly from 30 meters to considerable depths (areas less affected by the erosive effects of the movement of icebergs), where they form virtual gardens.

Sponge diversity in areas dominated by seaweeds are thought to be low. However, preliminary observations made by previous expeditions in Maxwell Bay (King George Island) and South Bay (Doumer Island) in 2009 and 2015 suggest a different situation. For this reason, one of the main objectives of the expedition carried out during January and February 2016, was to assess the distribution and abundance patterns for shallow-water Antarctic sponges in areas where seaweeds are usually dominant. This involved establishing a series of transects and collecting material in 10 and 20 meters depth in several locations near the "Yelcho" base at Doumer Island in the Palmer Archipelago.

The preliminary results based on what has been collected, and also calculations based on species richness estimates, confirm the previous observations: these suggest the existence of high sponge diversity in shallow waters with presence of canopy-forming algae, species capable of modifying their habitat with the fronds, resulting in virtual submarine forests. The number of species observed (greater than 15) is higher than what has been reported in seaweed communities in Arctic and sub-Antarctic shallow waters, and in some cases even greater than what is observed in temperate waters.

The results obtained so far suggest that sponge diversity is greater than previously believed. This alsoe confirms the hypothesis of a unique coexistence relationship between sponges and canopy-forming algae such as *Himantothallus grandifolius* and *Desmarestia* spp.

🛈 2. Last-minute adjustments of the sampling and photographic gear before a dive at Cape Kemp on Doumer Island. Photo by Nicolas Cabezas.

The next step is to experimentally investigate exactly how the kelp canopy promotes the growth of sponges, along with research into how these biological relationships may be affected by processes associated with climate change.

Together with the data showing the composition of the sponge groups, additional information was gathered on the composition and coverage of canopy-forming species, the abundance of predators (such as starfish) and some physical data (including substrate type and water column parameters such as temperature and luminosity). These last two will be obtained through small data-loggers left at the sampling sites, which will allow recording and storage of these daily readings for nearly a year.

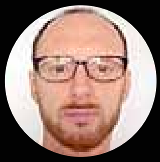
Sponges have important associations with microorganisms which provide significant benefits to the host, ranging from supplementary nutrition sources, enhanced structural rigidity, to protection from predators through the production of secondary metabolites.

However, in many cases the exact role of the dominant symbiotic groups is still not well defined. This situation is even less clear in Antarctic species since, in general, knowledge of the sponge-microorganism relationships to date has been based only on tropical or temperate species. Precisely for that reason, we plan to characterize the microbial communities associated with Antarctic sponges in a spatial and temporal survey to subsequently assess their stability in a hypothetical climate change scenario using laboratory experimentation. In this way, together with collecting material in several quadrants, we conducted a field experiment involving tagging individuals to study temporal paterns of the microorganisms associated with these sponges.

All of this information enhances our knowledge about the current distribution patterns of this important group of bottom-dwelling organisms. This information, together with the results our studies of the physiology and responses of the microbiome, may help in detection of potential changes. This is also important for identifying possible negative effects that global warming might bring to sponges and their functional roles, along with impacts on benthic communities and the Antarctic ecosystem as a whole.

🛈 3. Image of a photo-quadrat used to study spatial patterns of sponges and their relationships with seaweed and other organisms on rocky reefs in the Antarctic Peninsula.

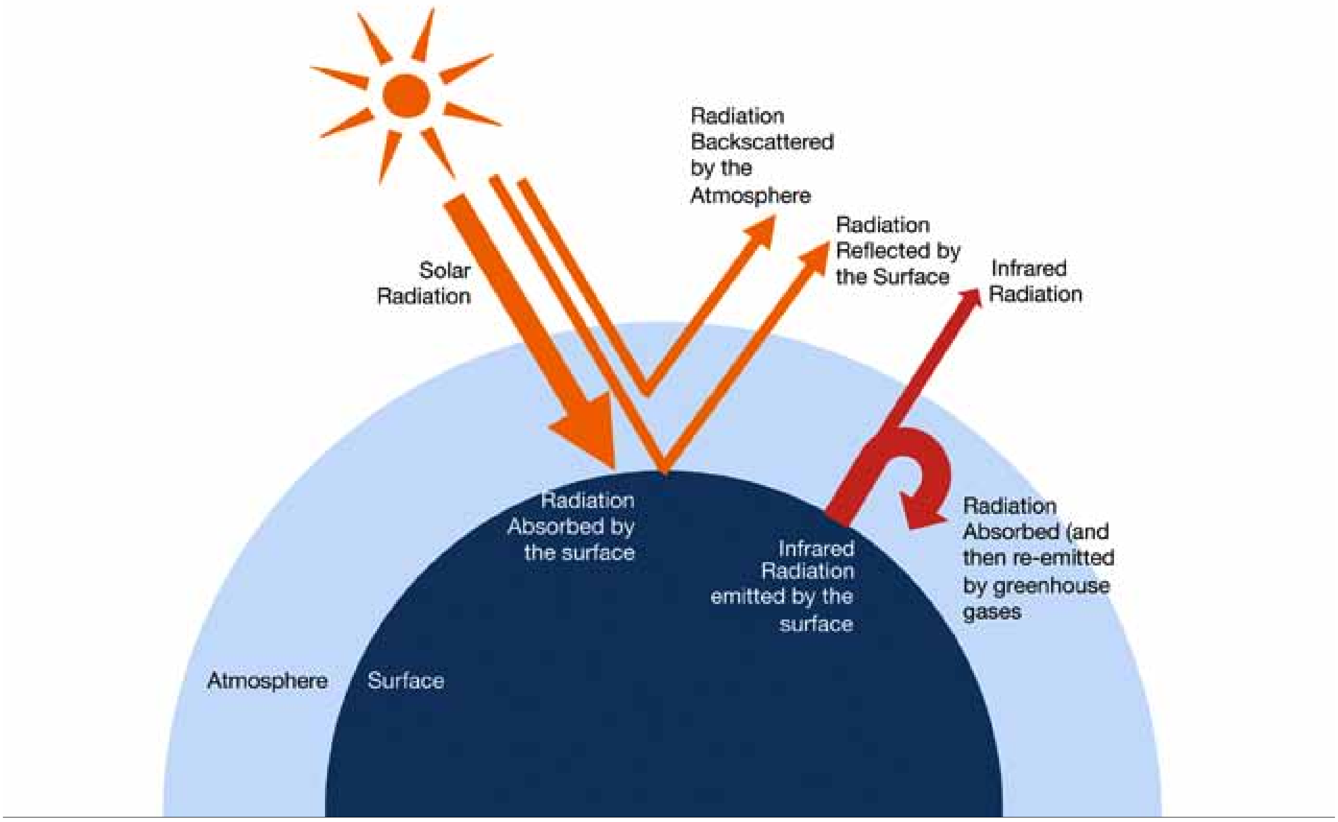
🛈 4. *Sphaerotylus antarcticus*, a species commonly found on rocky reefs of the Antarctic Peninsula.

Raúl R. Cordero[1], Alessandro Damiani[1] and Jorge Carrasco[2]
[1]University of Santiago de Chile, and [2]University of Magallanes
raul.cordero@usach.cl

HOW MUCH SUNLIGHT IS REFLECTED FROM THE WHITE CONTINENT?

Antarctica and its surrounding seas are covered by snow and ice, whose high reflectivity, or "albedo" gives the continent its unique white color but also plays a key role in the global balance of energy. Changes in Antarctic albedo can affect the climate on the entire planet. Taking this into account, the Chilean Antarctic Institute (INACH) and the Chilean National Science and Technology Foundation (FONDECYT) sponsored the "Reflectivity in Antarctica" project that conducted a detailed analysis of satellite-derived data from the NASA MEaSUREs series (1979-2012). This material has enabled us to determine that in summer the average albedo diminished at a rate of about ten percent per decade in the Amundsen Sea while it increased at a rate of about ten percent per decade in the Weddell Sea. These areas have also undergone changes in the concentration of sea ice, with losses in the Amundsen Sea and increases in the Weddell Sea. This suggests that the observed variations in the reflectivity in these extensive areas are the result of changes in sea ice. The magnitude of these phenomena requires additional efforts focused on their impacts on both regional and global climate.



🛈 Figure 1. The Earth's energy balance depends on the albedo (radiation reflected from the surface). Earth's average albedo is about 30% (although the fraction of energy that manages to escape to the space is significantly lower).

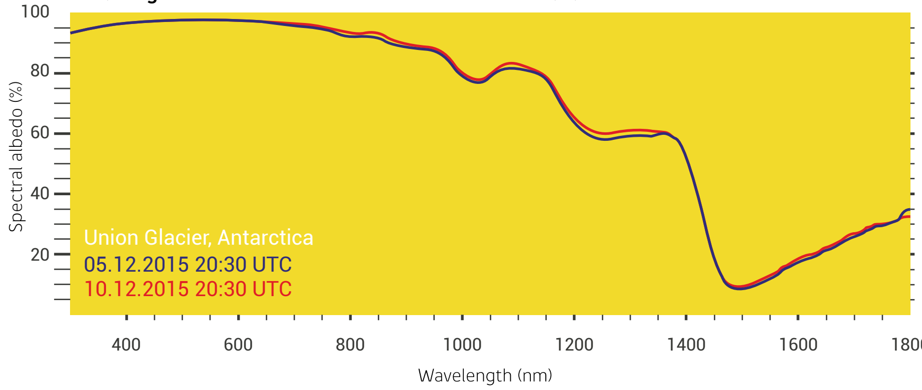
The earth's energy balance depends upon the amount of solar radiation absorbed by land, water bodies, and the atmosphere, as well as the radiation returned to space (back-scattered by the atmosphere or reflected from the surface) [Figure 1]. The greater the energy reflected by the surface, the less that is absorbed there. Consequently, the reflectivity or albedo of a surface plays an important role in the energy balance.

The term "albedo" comes from the Latin term for "whiteness" and is defined as the fraction of incidental radiation that is reflected from a surface. Albedo is particularly high for surfaces that are covered with snow or ice. Thus the albedo for Antarctica is extraordinarily high, particularly on the Antarctic plateau.

Figure 2 shows measurements taken at the Union glacier (latitude 79º S) as a part of the project "Reflectivity in Antarctica," funded by FONDECYT (grant 1151034) and by INACH. The measurements have demonstrated that the albedo in the ultraviolet (UV) range and the visible spectrum is greater than 0.90. In other words, more than 90 percent of the light that reaches the surface is reflected, while less than 10 percent of the impinging radiation is absorbed by the surface. The energy balance in this region differs from elsewhere. Indeed, the albedo for the visible spectrum is less than 10 percent in areas that are not covered with ice and snow, including the oceans.

Figure 3 shows the average of the daily values for Lambertian Equivalent Reflectivity (LER) in the UV range between December and February over the period 2005-2009. The LER values were generated using data from the NASA OMI satellite. The red shades in the figure show the higher albedo (particularly high on the Antarctic plateau) while the blue tones indicate lower albedo (such as the open sea areas with no sea ice).

🛈 Figure 2. Ground-based measurements of the spectral albedo at the Union glacier (December 2015). Note the extremely high snow reflectivity in the UV/VIS range (300-700 nm) range and the lower values in the near infrared (IR).



As figure 3 shows, the albedo is also high in the seas surrounding Antarctica, particularly where there are high concentrations of ice. This figure reveals that in the Amundsen Sea, the Ross Sea, and the Weddell Sea areas the albedo values are above 50 percent, which is in sharp contrast to the albedo values below 10 percent for open water without sea ice.

The formation of sea ice has the effect of increasing the high-albedo surfaces of Antarctica by thousands of square kilometers, which in turn augments the relative weight of the continent in the global energy balance. The consequences of changes in albedo in an area the size of Antarctica and its surrounding seas could have enormous global impacts affecting in turn the climate of the entire planet. Nevertheless, albedo changes even in smaller areas can have significant effects at a regional level. For that reason, monitoring the albedo in Antarctica, and detecting its changes, should be a priority.

Detecting changes is complex due to the

temporal variability of climate parameters, including albedo. Reflectivity involves seasonal variations in areas whose surface is covered by snow in winter but not always in summer (as, for example, at Fildes Bay, on King George Island). The albedo of the ocean surrounding Antarctica also presents important seasonal variations, with values being high when the concentration of sea ice is high and low when the sea ice levels diminish. As a result of seasonal variations, detection of change in trends requires data over long periods.

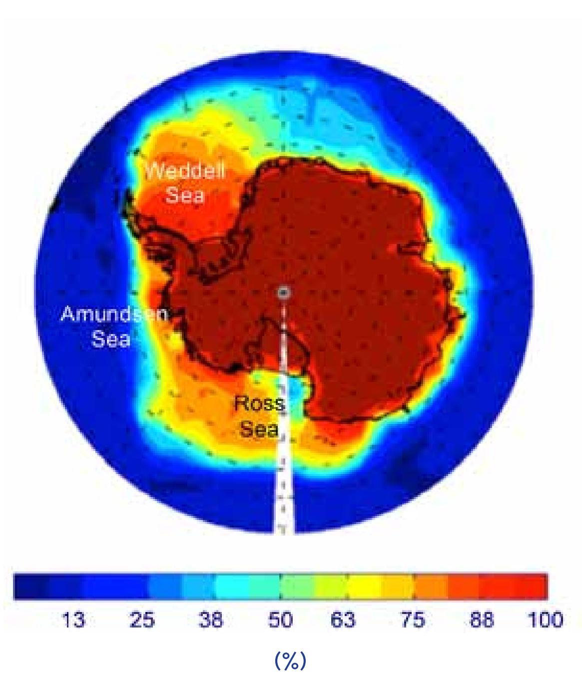
Figure 4 shows the percentages of change per decade in the average albedo for the month of March. The percentage of change is determined from daily surface reflectivity values in the UV range over the period 1980 to 2012, using observations from the NASA MEaSURE series. The red shades in this figure indicate increases in albedo (particularly evident in the Weddell Sea area) while the blue tones indicate decreasing albedo, with averages for the months of January and February showing similar tendencies. The average albedo for other months (October, November, and December) showed much less significant change.

As figure 4 shows, the Antarctic albedo is changing in the adjacent waters. In the Amundsen Sea, for example, the albedo for the month of March is decreasing by about 10 percent per decade. On the other hand, this reduction is in contrast to the increase in reflectivity in the Weddell Sea. In the latter, our results show that the March albedo is growing about 10 percent per decade. These changes in Antarctic albedo are related to alterations in sea ice.

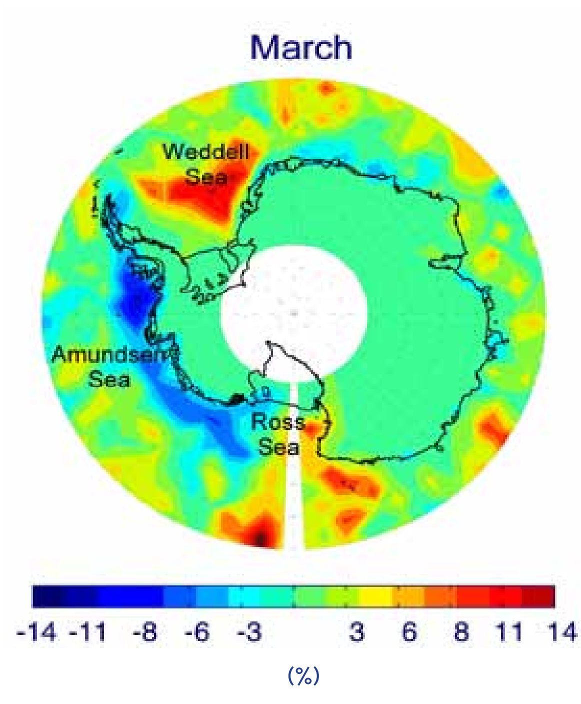
By using another set of data produced by NASA from readings taken by several satellites, we have analyzed the sea ice concentration trends over the period 1980 to 2012 in the seas surrounding Antarctica. Our results allow us to detect net reductions in sea ice in the Amundsen Sea and increases in the Weddell Sea. These changes in sea ice concentration show close correlation with changes detected in the albedo. This suggests that the variations observed in the reflectivity in wide areas of Antarctica are probably the result of modifications in the sea ice.

The increases in albedo in some areas (for example, the Amundsen Sea) have compensated for the reductions in others (such as the Weddell Sea). The average overall for Antarctica and the surrounding waters shows no significant change in reflectivity. However, the drastic changes in albedo detected in the Weddell Sea and the Amundsen Sea could bring about consequences affecting the regional climate and justify attention.

➊ Figure 3. Albedo (in percentages) during the austral summer, estimated from readings taken by the NASA OMI satellite. (Adapted from Damiani, Cordero, Carrasco, Watanabe, Kawamiya and Lagun, *Remote Sensing of Environment*, 2015).



➊ Figure 4. Change percentages per decade in the albedo for the month of March, calculated from the NASA MEaSUREs series. (Adapted from Damiani, Cordero, Carrasco, Watanabe, Kawamiya, and Lagun, *Remote Sensing of Environment*, 2015).





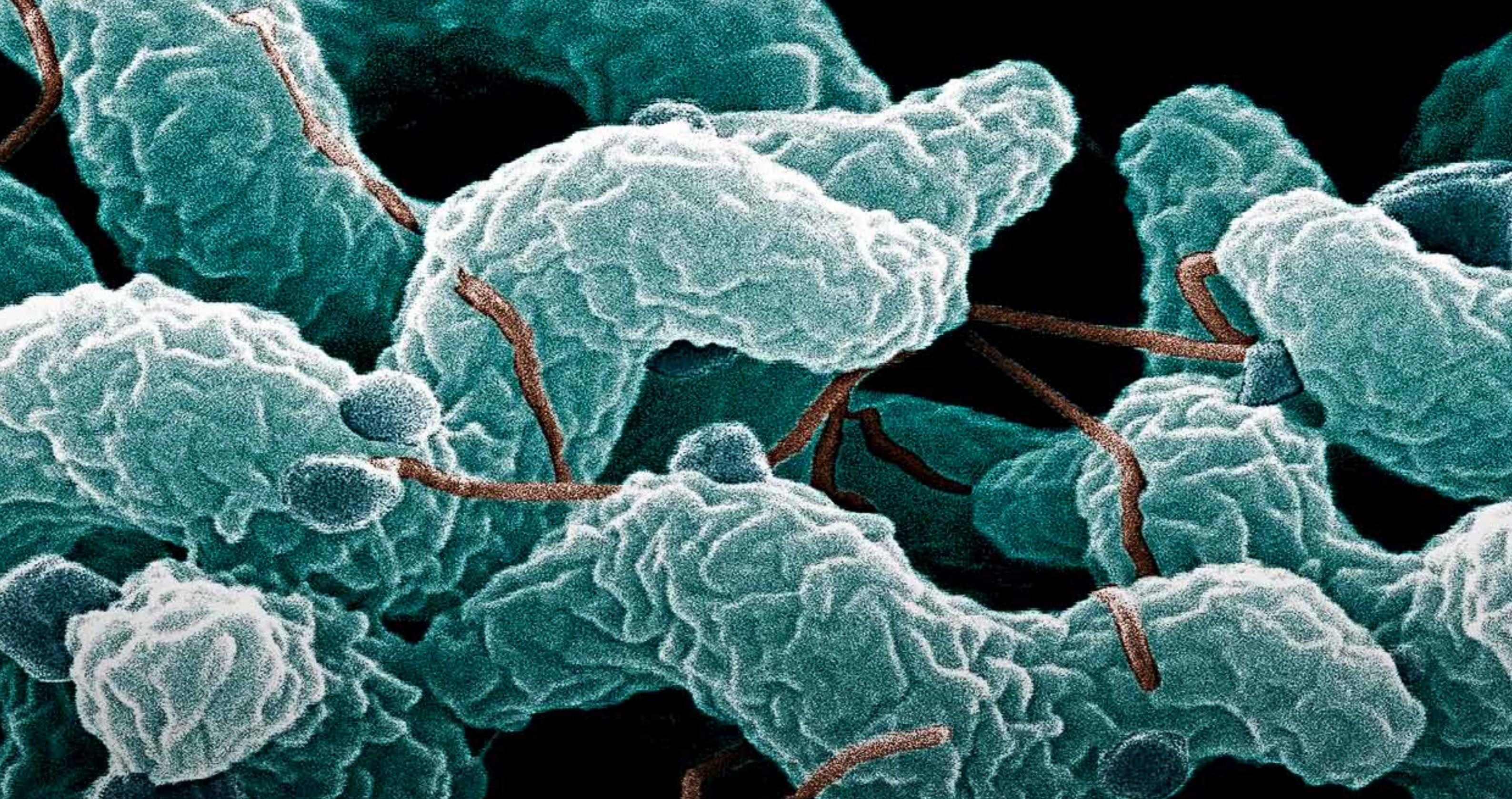
Daniel González-Acuña[1], Jorge Hernández[2,3] and Lucila Moreno[1]
[1]University of Concepción, Chile.
[2]Uppsala University (Kalmar, Sweden).
[3]Kalmar County Hospital (Kalmar, Sweden).
danigonz@udec.cl

BIRDS AND PATHOGENIC BACTERIA IN ANTARCTICA

HUMANS AS POSSIBLE VECTORS

In spite of its remote location, the Antarctic continent has no protection against an invasion of pathogenic microorganisms. As such, it is important to study infectious agents in wildlife as part of a long-term assessment of the viability of animal populations within the fragile Antarctic ecosystem. Bacteria in genus *Campylobacter* are found in a wide range of hosts and environments around the world, and are considered to be one of the most virulent and hazardous for human health. These bacteria often affect birds and have been recently reported in Antarctica where human activity is on the rise. For this reason it has been suggested that wild birds may play an important role as *Campylobacter* reservoirs and may be a potentially important element for spreading disease, since they serve as an intermediary in contacts between other wildlife and humans.

1. Area surrounding the "Gabriel González Videla" base at Paradise Bay, where the field work was performed (Photo by D. González).



2. Bacteria *Campylobacter* spp.

In this INACH-financed project we are collecting information surrounding the ecology of certain species of *Campylobacter* in Antarctica, according to hosts, locations, colony characteristics, and the physical condition of the host birds. So far, we have found 15 percent of the birds with positive indications of *Campylobacter*, primarily *Campylobacter lari*. Part of our research involves assembling data on the related origin and impacts of this strain. Human presence on the continent is expected to increase and for that reason our discoveries and data should prove useful in assessing the health management of the affected endemic Antarctic species.

There is a very real concern about the possibility of disease introduction into Antarctic wildlife, particularly due to the vulnerability of its fauna to invasive external agents. The arrival of new diseases could have devastating effects on native animals since these have been largely isolated and their immune systems are ill-equipped to deal with exposure to exotic pathogens. Climate evolution is another factor to consider in the potential introduction of new pathogens to Antarctica. Environments of increased temperatures and humidity could facilitate the growth of invasive species such as bacteria or other pathogens.

There is now increasing concern that climate change and human activities on the continent are bringing about a substantial degradation in the Antarctic environment. This is aggravated by the stresses induced by human activity, such as direct disturbance and exposure to pollutants and pathogens, which could reduce immunological effectiveness in native species, effectively increasing the virulence of the disease-producing organisms and setting off epidemics with high mortality among the native wildlife.

As the human population in Antarctica increases, its contact with native flora and fauna also grows, bringing about the potential for accidental introduction of disease. This is particularly true in areas with increasing numbers of visitors (tourists, researchers, and support personnel), primarily in the South Shetland Islands and the Antarctic Peninsula. Evidence is seen in many studies that show several pathogens in Antarctic bird species where none had previously been found on that continent.

For a better understanding of the dynamics of disease it is first necessary to gather information about environmental factors that influence the ecology of both the pathogens and the evolution of diseases, along with the implications related to protection. Immunological traits, environmental changes such as temperature and humidity, new contacts or interactions between humans and wild animals, new pathogens, reservoirs, vectors or hosts - these could increase in such a way as to create disastrous consequences for the preservation of these native species.

Pathogens in Antarctica have been the subject of some previous study, but not in a systematic manner. Most of these studies have been case descriptions, disregarding symptoms or evaluation of the condition of the species' population, since they have generally dealt with dead specimens, often those partly consumed by carrion-eaters.

A commonly found pathogen in the human digestive tract is the genus *Campylobacter*, which covers a broad range of hosts and environments throughout the world. This genus includes more than 30 species which are considered to be the most common causes of gastroenteritis on a global level, with *C. jejuni* being the most virulent for human health. These bacteria affect over 2.4 million people a year in the United States alone.

Campylobacter are thin, curved, gram-negative bacteria with high mobility. They measure from 0.5 to 8 μm in length with a transverse diameter ranging 0.2 to 0.5 μm, which means that they are much narrower than the majority of bacteria that are normally found in feces. They also exhibit very active movement due to the presence of an exposed flagellum at one or both ends of the organism. There are three species of bacteria that are important in animal and human health: *C. jejuni*, *C. coli*, and *C. lari*. They have been isolated in bodies of water and in a wide variety of animals, including cats, dogs, cattle, sheep, pigs, and birds, where they may be found as commensals or pathogens. These are considered sources of contamination for human life. These bacteria are found in hundreds of species of wild birds which serve as hosts in a wide range of latitudes throughout the world. Wild birds can act as vectors, spreading disease along their migratory pathways.

Some species of *Campylobacter* have been described recently in association with birds in Antarctica, demonstrating that such animals do play an important role as reservoirs of such bacteria on the White Continent. This is expected to be a significant epidemiological factor since the birds are considered natural reservoirs for these bacteria. Only the species *C. lari* has been observed in seagulls, while other *Campylobacter* have been isolated in chickens, cattle, pigs, dogs, cats, monkeys, sea lions, aquatic birds, and in the environment.

Biochemically, *Campylobacter* are oxidase- and catalase-positive, show nitrogen reduction characteristics, are Methyl Red- and Voges Proskauer-negative, and will not hydrolyze gelatin. The majority of the species are urea negative, with the exception of some strains of *C. lari*. Prolonged exposure to water makes these microorganisms more difficult or even impossible to culture. *Campylobacter jejuni*, *C. coli* and *C. lari* are thermophilic, allowing them to grow effectively between 42 and 43 ºC, while they will not develop below 25 ºC. In the environment, *Campylobacter* generally survive down to 4 ºC for several weeks. They are sensitive to desiccation, pasteurization, direct sunlight, acid conditions, and most disinfectants. Refrigeration temperatures have the effect of debilitation and reduction of the number of bacteria.

3. Researcher Jorge Hernández taking environmental fecal samples from Gentoo penguins in the area near the "Gabriel González Videla" base.

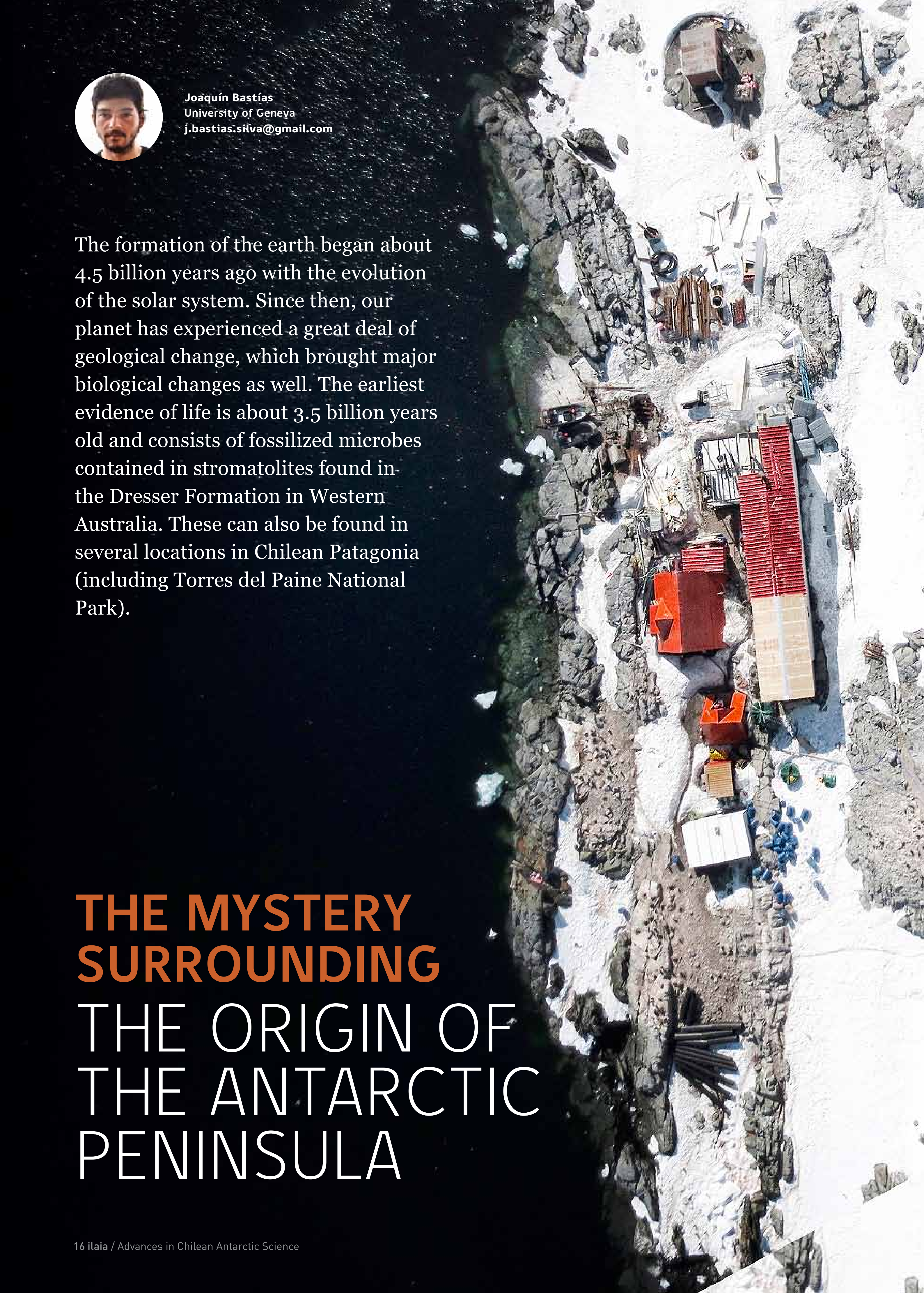
Human transmission of *Campylobacter* may be indirect, occurring through water or food that is contaminated, or through handling and/or consumption of meat that is raw or insufficiently cooked. Likewise, this transmission can take place from the consumption of unpasteurized milk, or from water or vegetables that are contaminated. It is well known that close contact between humans and animals involves a high risk of infection, and this is aggravated where environmental hygienic conditions are precarious or deficient.

Many studies have detected native Antarctic birds infected with *Campylobacter*. The project called "*Campylobacter* in Antarctica: varieties, origin, and effects on wildlife" was funded by INACH and is intended to demonstrate that the occurrence of pathogens in wild birds varies among geographic locations according to the anthropogenic influence affecting each area. If the growth of human presence in Antarctica influences the ecology of this pathogen, the prevalence of infection could increase in bird colonies, with greater dispersion on the continent as the result of human activity, which includes bases, huts, and tourism-related sites.

We are researching the capacity of the most common Antarctic birds (penguins, kelp gulls, skuas, and Antarctic doves) to be bacterial hosts, and to determine the associated species and genotypes that may be present.

We will compare the prevalence of the several *Campylobacter* species and genotypes with several ecological factors, including location and proximity to human presence, bird colony composition, and the physical condition of the birds. Through the use of multilocus typing in genotype sequencing, we will evaluate the epidemiological relationship between *Campylobacter* in Antarctic wildlife and samples from other sources. From these cultures we will be able to sequence the entire genome. This work has involved the collection of swabs from bird feces and body cavities from several Antarctic species (Gentoo penguins, Antarctic doves, kelp gulls, skuas, Antarctic terns) at several latitudes in this region. The samples were cultured in Nolton media and incubated at 37 degrees C for 48 hours. Up to this time *Campylobacter lari* have been observed while other similar species have not yet been identified. The birds with the highest prevalence of the bacteria were the Antarctic doves, skuas, and kelp gulls, whereas such presence in penguins is comparatively low. This suggests that the differences may be due to different eating habits of each bird species.

The results from this study will clarify distribution patterns for *Campylobacter* and help predict where these pathogens could affect the health of Antarctic wildlife. Antarctica will feel the effects of increasing human presence and for that reason, this project will be very useful in evaluating the effectiveness of health management efforts related to endemic Antarctic species.



Joaquín Bastías
University of Geneva
j.bastias.silva@gmail.com

The formation of the earth began about 4.5 billion years ago with the evolution of the solar system. Since then, our planet has experienced a great deal of geological change, which brought major biological changes as well. The earliest evidence of life is about 3.5 billion years old and consists of fossilized microbes contained in stromatolites found in the Dresser Formation in Western Australia. These can also be found in several locations in Chilean Patagonia (including Torres del Paine National Park).

THE MYSTERY SURROUNDING THE ORIGIN OF THE ANTARCTIC PENINSULA

1. View to the south of Cape Smith, Smith Island, South Shetland Islands.

At the beginning of the last century, the earth's age was unknown. This important question was answered after more than half a century of innovation in theory and instrumentation. In 1921, Walter Russell employed the principles of radioactivity decay to suggest that the age of the earth might be measured from the relative abundances of a radioactive parent element (uranium) and its transmutation or "daughter" product (lead). According to the theory derived from the rate of radioactive decay of certain isotopes, it is calculated that the earth was formed about 4.5 billion years ago during the accretion the solar nebula; that is, the gas and dust left over after the formation of the sun. Since then, our planet has been affected by enormous geological processes that have changed the shape and form of the earth's crust. Later, such powerful forces also brought about major biological changes as well.

So far, researchers have not found a way to directly determine the exact age of the earth, since the oldest rocks have been destroyed and their constituent materials have been recycled as a result of plate tectonic processes. The oldest rocks on the earth's surface (Acasta Gneisses) are located in northwestern Canada and are estimated to be about 4 billion years old.

The earliest undisputed evidence of life is located in the Pilbara region of Western Australia and dates from around 3.5 billion years ago. This consists of fossilized microbes contained in stromatolites found in the Dresser Formation Typically, when researchers have to work with such long periods of time, they have to approach the studies with various direct and indirect methods. Reviewing the earliest records of life, paleontologists have recognized at least five major extinction events, the most recent being the K-T mass extinction, sometimes called the "dinosaur extinction" because it occurred between the Cretaceous (K) and Tertiary (T) periods of geological time. This enormous puzzle has been partially reconstructed by the gathering and assembling of small pieces of information, which have been contributed by several studies over the years.

The Antarctic Peninsula is an important piece of this big puzzle. Considering that the oldest rocks reported in the region date from about 300 million years ago, it records at least three major mass extinctions.

In geological terms, two major processes have affected the Antarctic Peninsula: (1) its separation from Gondwana, and (2) its separation from Patagonia (South America). These two tectonic events were major engines for significant changes in biological diversity. The second event exemplifies the significance of these geological changes in the evolution of life. Indeed, the separation of the Antarctic Peninsula from Patagonia induced the opening of the Drake Passage, and with it, the beginning of the Antarctic Circumpolar Current. This current provides the conditions for high levels of phytoplankton, the basis for many of the life forms of the continent, including fish, seals, penguins, and albatrosses.

But not everything has been agreed upon and settled. In fact, the geological origin of the Antarctic Peninsula is still under debate. The scientific community continues to debate

Field work was conducted for two seasons (2015, 2016) in the Yelcho Station area (Doumer Island, Antarctic Peninsula) within the framework of the "Thermal Evolution of the Antarctic Peninsula" project, with the support of the Chilean Antarctic Institute (INACH). The results reveal that the rocks near Yelcho Station were formed within the range of 54 to 55 Ma (Ma = million years). This implies that, among other things, by the time the Andes range was actively forming in South America, the Antarctic Peninsula was also developing as a southerly continuation of Patagonia.

❶ 2. Taking samples at Yelcho Station, Antarctic Peninsula. Dr. Richard Spikings.

❶ 3. Field work at Yelcho Station, Antarctic Peninsula. Doctoral candidate Joaquín Bastías and Dr. Richard Spikings.

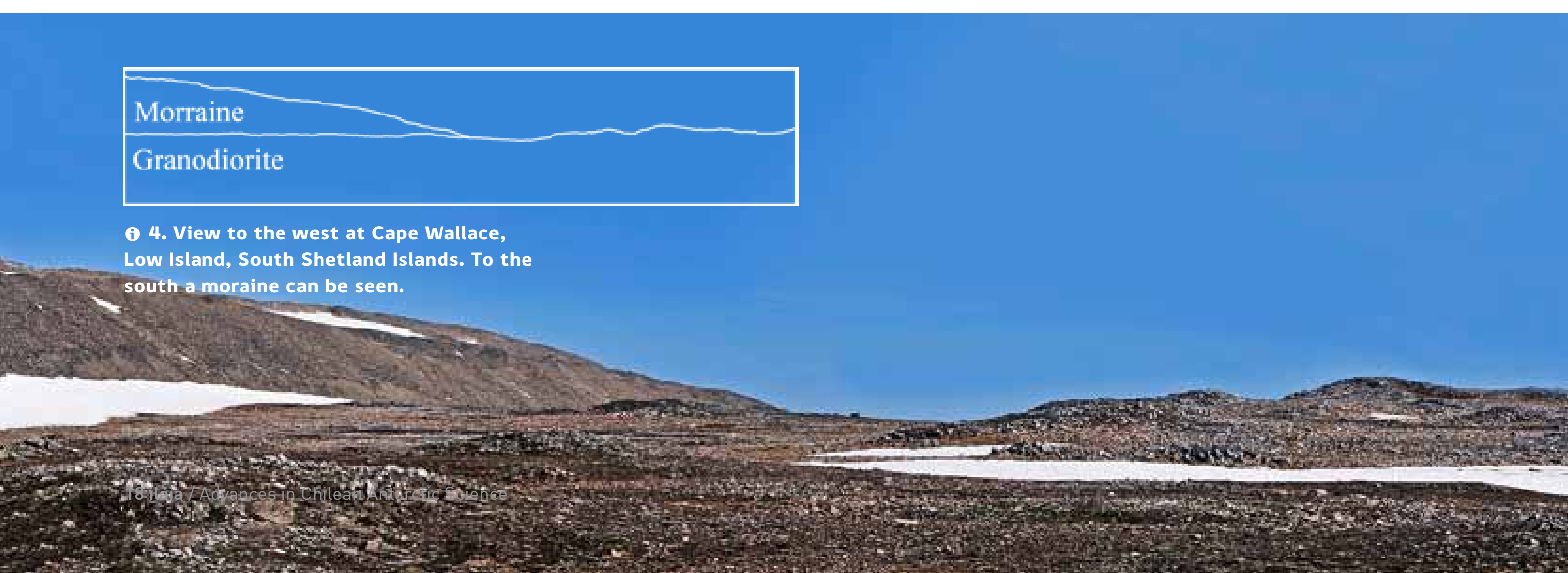
possible autochthonous (local) or allochthonous (distant or foreign) origins. Each option implies significant changes in the geological evolution, and consequently also in the biological evolution.

This question has not been easy to solve, given the natural conditions of the Antarctic region. Rock outcrops are comparatively scarce since about 98 percent of the continent is covered in ice. Access is also difficult, and the weather conditions are harsh. Nevertheless, researchers focus on the places where they have access, which are usually near established bases and the surrounding areas.

Field work was conducted for two seasons (2015, 2016) in the Yelcho Station area (Doumer Island, Antarctic Peninsula, 64º 53′ S, 64º 35′ W) within the framework of the project called "Thermal Evolution of the Antarctic Peninsula and the South Shetland Islands by Thermochronology: Implications for Climate Change," which has received the support of the Chilean Antarctic Institute (INACH) and is led by researchers from the University of Geneva and the Andrés Bello University.

The rocks of the Antarctic Peninsula hold important clues. The current project has estimated several U-Pb zircon geochronological ages. The ages obtained by the U-Pb (Uranium-Lead) isotopic system in zircon material indicates the age of the rock formation. The results reveal that the rocks in the Yelcho Station area were formed in the range of 54 to 55 Ma. This implies that, among other things, by the time the Andes range was actively forming in South America, the Antarctic Peninsula was also developing as a southerly continuation of Patagonia.

There are currently a number of geological and paleontological research projects attempting to solve the mystery of the age of the Antarctic Peninsula. Support for this research involves a significant effort by governments and institutions, particularly when considering the enormous amount of logistical assistance that is required. Continued research in this area is needed to gain a greater understanding of the origins of the Antarctic Peninsula.



❶ 4. View to the west at Cape Wallace, Low Island, South Shetland Islands. To the south a moraine can be seen.



Marcelo González[1], Luis Mercado[2] and Kurt Paschke[3]
[1]INACH, [2]Pontificia Universidad Católica de Valparaíso,
[3]Universidad Austral de Chile (Campus Puerto Montt)
mgonzalez@inach.cl

R. Quinán

THE LOOMING ARRIVAL OF CLIMATE CHANGE IN THE SOUTHERN OCEAN

Big changes in the environment are taking place on the Antarctic Peninsula. The most visible and spectacular for the general public are the large falling chunks of ice. However, within the waters there are also impacts which we don't easily observe. The water temperature is rising and its chemistry may be changing in ways that could affect the organisms with calcareous exoskeletons, as a result of acidification of the Southern Ocean. Two marine invertebrates that are key members of the Antarctic ecosystem, the Antarctic sea urchin and the giant isopod, have been the subjects of study to determine their physiological ability to successfully adapt to new environmental scenarios.

In our project, “Coping With Warming of the Southern Ocean: Invertebrates Responses to Thermal Stress Conditions,” (financed by FONDECYT) the results are not encouraging for these species since they reveal a low capacity for acclimatization, with slow and weak production of the molecules associated with these organisms’ defense against thermal stress.

The eyes of the international scientific community are all on the big changes that the Antarctic Peninsula has suffered, and continues to suffer. No longer are these changes at the level of studies of the ozone-hole or the breaking off of large masses of ice, but rather research into the effects that could come about from an increase in temperature or the possible effects of acidification of the Southern Ocean, or both, as these could impact key organisms in the Antarctic ecosystem.

Increases in the air or lake water temperature in the Antarctic Peninsula lead us to believe that this warning could affect the species of the Antarctic ecosystem ranging from krill to the higher mammals such as whales, key participants in the food chain.

Even though the ocean waters of the Antarctic are low (from -1.9 to 2.0 ºC), a small incremental change could affect the physiology of these organisms, such as the sea urchins, starfish (sea stars), or krill.

Figure 1. Part of the field work team in front of INACH’s Escudero Station (King George Island) where the study of sea urchins and isopods from Fildes Bay is being undertaken. From left to right: Kurt Paschke, Byron Morales, Andrea Martínez, and Marcelo González.

The difference between living in tropical and polar waters

One can think of these animals that live in an ocean with very low temperatures as having little capacity for movement, as a result of being “frozen,” if we compare them to species which live in more temperate or tropical environments.

In effect, if we apply cold to a tropical species, the result is a decrease in its biological activity. Something similar could occur if we increase the water temperature. For example, there is a type of Antarctic scallop which is accustomed to living in waters at 0 ºC, which cannot swim using its shell-halves (technically called “valves”) when the water temperature reaches 2 ºC.

During millions of years of evolution, Antarctic marine invertebrates have lived in very low temperatures, while developing a number of adaptations for many biological processes to operate at such temperatures. Nevertheless, these processes are between five and twelve times slower for species that live at temperatures of around 0 ºC, when compared to similar animals that live above 10 ºC.

The project titled “Coping with Warming of the Southern Ocean: Invertebrates Responses to Thermal Stress Conditions” (funded by FONDECYT) attempted to determine whether marine organisms such as the Antarctic sea urchin (*Sterechinus neumayeri*) or the giant isopod (*Glyptonotus antarcticus*), which live in very cold conditions, have the ability to adapt to temperature increases by means of stress response to thermal shock (Figure 1).

This classic response on the one hand is characterized by the production of a large quantity of heat shock proteins (HSP) which assist other protein in preserving their functionality when confronted with thermal shock. On the other hand, they produce antioxidants to counteract the production of harmful molecules such as those in reactive oxygen species (ROS) which are produced by the organism during the increased consumption of oxygen which takes place when under stress.

This thermal stress response mechanism in marine vertebrates allows them to better deal with new conditions in their ocean environment. A clear demonstration of the seasonal temperature increments in the Antarctic Peninsula ocean surface can be seen in recently measured levels above 2.9 ºC at the US Palmer Station at Anvers Island.

Our current knowledge indicates that Antarctic fish and some invertebrates lack this thermal stress response mechanism, while two Antarctic molluscs are capable of inducing these stress proteins. In the case of the two animals that we studied, both demonstrate the ability to produce these HSP as well as antioxidant proteins such as superoxide dismutase, catalase and peroxiredoxin, but more slowly and with a limited capacity for incrementing the concentration of these proteins in the tissues that were studied, compared to the animals that were not subject to thermal stress.
From the results of our project we have demonstrated that increasing temperature involves additional oxygen consumption in these organisms, which would indicate a low tolerance to thermal stress over short or long periods.

ℹ Figure 2. Example of a giant isopod, showing the prominent marsupium ("brood pouch").

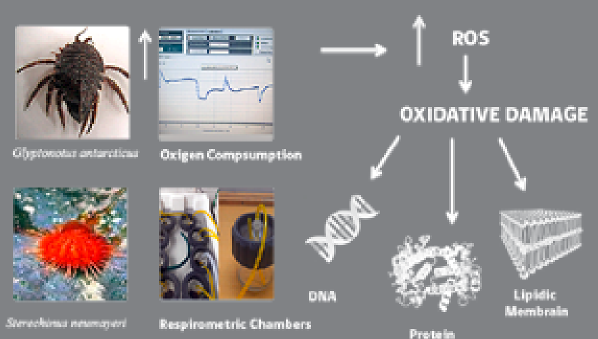
However, adult Antarctic isopod individuals appear to have a greater response capability than the Antarctic sea urchin, according to the observation of an increment in oxygen consumption in the isopod during the first hour, followed by a decrease. This suggests that this crustacean would be able to recover in the event of a moderate thermal stress event (Figure 2). Calculations were made of the Q10 index (indicator of the physiological rate of temperature sensitivity), with observed results for adult Antarctic isopods in values of 2.2, 2.4, and 2.5 for exposures of 1, 6, and 24 hours, respectively. These values are considered normal and correspond to reports in the literature of double or triple rates of metabolism in an organism when exposed to a increase of 10 °C.

It is particularly interesting to note the significant oxygen consumption increase in juvenile isopods released from a mother animal whose interior temperature is at 6 °C. The initial increase is equivalent to more than 600 percent of its metabolic rate as it acclimates and the Q10 suggests that this state of development would be particularly sensitive to an initial exposure of 6 °C.

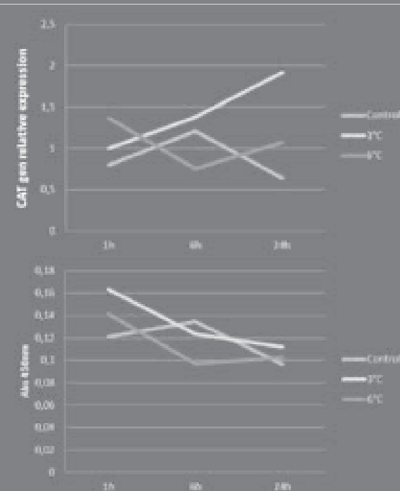
This increased oxygen consumption in juvenile isopods produces an important energy imbalance which calls for increasing their feeding rate, and this makes them more vulnerable to predators.

Furthermore, the significant increase in oxygen consumption during thermal stress will also result in the increase of ROS (reactive oxygen species) which under normal conditions these animals' own antioxidant enzymes act to eliminate or reduce.

ℹ Figure 3. Graphic showing the effect of temperature on the reactive oxygen species (ROS) and the damage that can result from an increase in the rate of oxygen consumption by the sea urchin and giant isopod. The animals were kept in respirometric chambers and then in a cold chamber to keep the seawater between 0 and 1 °C.



Nevertheless, our results show that these molecules are not increased significantly in either the sea urchin or the giant isopod and therefore the ROS levels produced by the increased temperature cannot be reduced by the organisms' own enzymes. As a result, the cells and tissues of these marine invertebrates would experience damage to their intercellular membranes and to the genetic material contained therein (Figure 3).



ℹ Figure 4. Catalase (CAT) expression of the Antarctic isopod. In the graphic above we see that temperatures of between 3 and 6 °C to which the isopods were subjected do not induce an increase in the catalase gene expression that duplicates the control value at 24 hours. The graphic below shows that the catalase measured as protein also does not increase in concentration with respect to control values and in fact shows a tendency to decrease over time.

We noted that the giant isopode responded in a slightly different way and apparently could more effectively reduce the associated ROS, since this animal is able to duplicate somewhat the expression levels of the superoxide dismutase at between 3 °C and 6 °C. However, the gene and protein expression of the catalase enzyme does not appear in this way during thermal stress, but instead reflects a tendency to be diminished (Figure 4).

Even though our data indicate a low capacity for these antioxidant enzymes, in the future we need to evaluate other non-enzyme antioxidants that these organisms may possess and at the same time assess the damage to cells and tissues produced by the ROS.

The effects of trying to respond quickly in the organisms' production of this type of stress proteins and antioxidants in an extreme cold environment might actually work against the production of these proteins, since it is known that this is a factor that interferes with the process and as a result yields lower stability in these protein. This would result in a less effective level of activity for these antioxidant enzymes for reducing the levels of oxidizing compounds.

Glossary

Q10 Index. The coefficient that describes the rate of change in chemical or biological processes produced for each increment of 10 °C. If the rate of a reaction doubles with an increase of 10 °C, the Q10 is 2. If it triples, the value is 3.

Oxygen consumption. The amount of oxygen consumed per cell, tissue, or organism and which provides a measurement of the amount of energy used under aerobic conditions.

Dr. Javier Arata
Dynamics of High Latitude Marine Ecosystems (IDEAL Research Center)
Universidad Austral de Chile
javier.arata@uach.cl

ANTARCTIC SCIENCE IN WINTER

SEEKING CLUES ABOUT LIFE IN THE COLD

Between August 3 and 30, 2015, the fourth US-Antarctic Marine Living Resources (AMLR) Program conducted studies to further develop knowledge of the spatial and temporal variability of the Antarctic krill (*Euphausia superba*) in the northern Antarctic Peninsula and South Shetland Islands. Dr. Javier Arata, who was then a staff member with the Chilean Antarctic Institute (INACH), participated in the campaign under special invitation.

1. Sea ice in the Bransfield Strait. Photo by Javier Arata

🛈 2. Antarctic krill (*Euphausia superba*). Photo by Javier Arata.

The invitation to participate in the fourth campaign of the US-Antarctic Marine Living Resources (AMLR) program provided an impressive experience. I was able to take part in a high-level scientific cruise that involved the rigorous working conditions we associate with the austral winter, in order to understand how the Antarctic krill are getting on during the challenging winter months.

It's true that many studies of these krill have been done during the summer season, but one of the critical periods of their survival takes place in winter, when research work is very difficult, and as a result there is a general shortfall in information about krill behavior during that season. In the winter, there is little to no daylight and so there is almost no growth in the algae that provide nourishment for the krill. At the same time, the seas are covered in ice. This effectively provides a new platform, below which layers of micro-algae form, and these serve as a sort of collateral food source for krill and other creatures during winter.

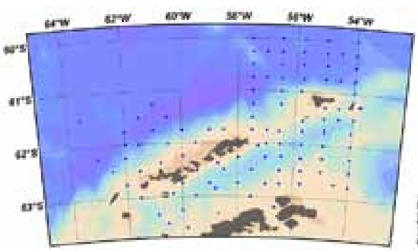
Contrary to what might be expected, there is a great deal of activity in Antarctica even in winter. During our cruise we spotted Antarctic fur seals (*Arctocephalus gazella*), crabeater seals (*Lobodon carcinophagus*), leopard seals (*Hydrurga leptonix*), elephant seals (*Mirounga leonina*) and even Minke whales (*Balaenoptera bonaerensis*), in addition to groups of Adélie and Gentoo penguins.

This expedition was organized by the US-AMLR Program and the National Oceanic and Atmospheric Administration (NOAA) and conducted by the US oceanic research icebreaker, the *Nathaniel B. Palmer*. On the cruise there were participating researchers from NOAA and several US universities, along with two colleagues from the Peruvian Oceanic Institute (Instituto del Mar del Perú -IMARPE). Another Chilean researcher, Paola Reinoso, from the Universidad Católica de Valparaíso, also took part and was in charge of sampling of seawater nutrients.

Life in Winter

The work on this cruise was focused on determining the abundance of krill in this region. For that purpose, samples were taken at pre-established stations every 15-20 nautical miles (27 to 36 km). At each station seawater samples were taken at various depths using a device called a Niskin bottle rosette. This is done to characterize the amount of food present (microalgae, nutrients). Zooplankton (small animals that live suspended in a water column) samples were taken using a net, at depths between the surface and 170 meters. Among the stations, soundings were taken using hydroacoustic (or "sonar") data which allow characterizing of the abundance and vertical (depth) distribution of fish and krill.

Once aboard, the zooplankton samples were classified according to species and abundance (the number of individuals of each species) by counting under a magnifying glass or microscope.



🛈 3. Work grid used on the fourth campaign of the US Antarctic Marine Living Resources program (blue dots).

Since the ship does not make rest stops, work is carried out in shifts of 12 hours each, some by day and some by night. In my own case, I worked primarily with the group that did the quantification of the presence of the various species of zooplankton.

Did you know that there are more than six species of krill in Antarctica? Well, the Antarctic krill is the largest and best known of all and it can reach 60 mm and weigh nearly 2 grams.

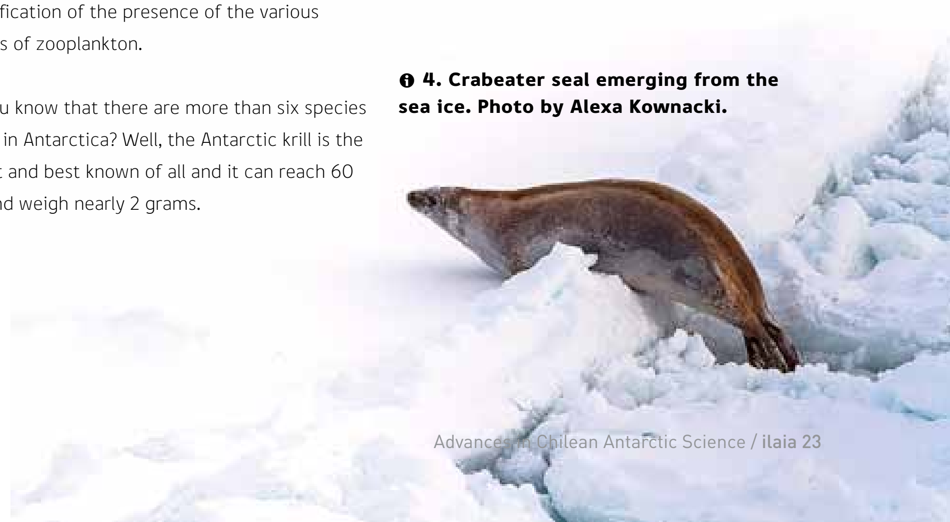
The other species are smaller (10-30 mm) but are interesting all the same. There is a marked difference in their distribution. Basically, when there is a lot of Antarctic krill, other species are almost absent. The smallest species tend to be more abundant in the open ocean, north of the South Shetland Islands. Besides krill, jellyfish and salps (mostly transparent, gelatinous chordates) are also found, along with gastropods with and without shells, amphipods, and copepods, which are another type of crustacean often found in the oceans.

We also captured several types of myctophids (lantern fish) due to the presence of photophores along the length of the body which shine in the darkness.

Doing Scientific Work at Minus Thirty

The part that I most enjoyed was helping to prepare and place the net into the water. We had days at -15 ºC, which felt like -30 ºC due to the wind-chill factor, thanks to a 30-knot breeze. We had to bundle ourselves completely, wear a helmet and gloves, and pull the fleece right up to our eyes in order to prepare the frame for the IKMT (Isaacs-Kidd Midwater Trawl) net, which would weigh about 60 kg, stretch the net which was about 8 meters long and always half frozen, and then maneuver it down from the stern into the water about 2 meters below.

🛈 4. Crabeater seal emerging from the sea ice. Photo by Alexa Kownacki.



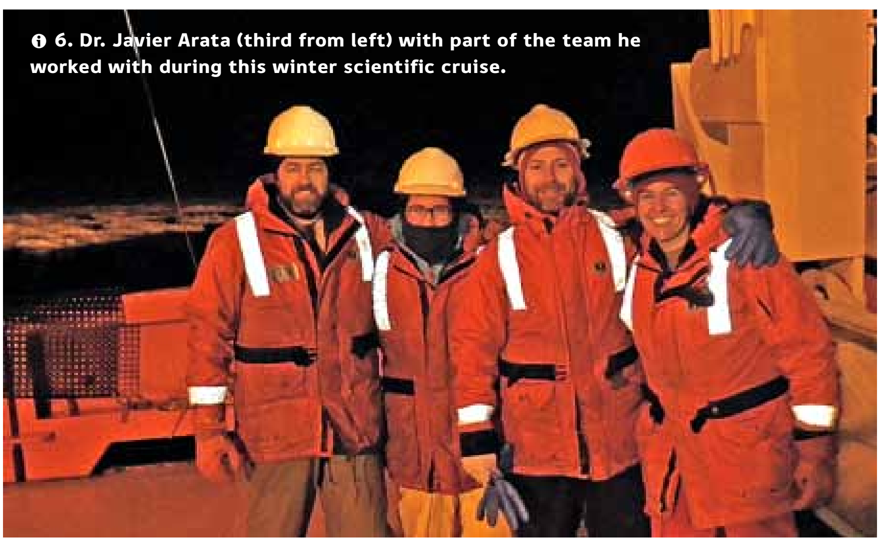

5. Deck team deploying the IKMT net. Photo by Alexa Kownacki.

The winch operator's work was crucial since he has to carefully lift and shift the net to the stern at the same time, but slowly. All this is while the ship is making way through the sea ice, opening a channel where we could deploy the net. After lowering and then raising the net, there was always some anxiousness in opening the capture container, which is a cylinder at the end of the net where everything that was caught would accumulate, to see which and how many species we had collected.

Besides identifying and counting zooplankton species, which was done during the night shift, I worked with the group that did sightings of birds and marine mammals, between dawn and noon.

Significance for Chile

Currently, Chile is attempting to position itself as a regional contender in Antarctic research. To that end it is modernizing its infrastructure on the White Continent. It is hoped within a few years that it will have a new icebreaker, this time with oceanographic capability which would allow world-class marine research, further out than the coastal strip to which we are restricted today. However, we have very little experience working in the Southern Ocean and under harsh Antarctic conditions. This experience allowed me to become familiar with work conditions, the details of the daily routines, and to see what worked and what didn't.


6. Dr. Javier Arata (third from left) with part of the team he worked with during this winter scientific cruise.

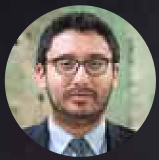
On the other hand, inasmuch as Antarctic krill is a key species in the Antarctic ecosystem, it's apparent that there is a lack of national research in this area. Thus one of my objectives on this cruise was to get to know the current methods for evaluating the state of the krill population, which is essential for the satisfactory management of this resource.

With this experience I hope to continue supporting the National Antarctic Science Program, now with better understanding about work practices on the high seas. Likewise I expect to assist in the design of the new icebreaker with its new scientific capabilities for Chile, now projected for the year 2020.

Our participation on this cruise was also a showpiece of cooperation between Chile and the United States in the area of Antarctic krill studies, with our sights on improving the current management of this resource under the auspices of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) . Both nations share similar interests and work in the South Shetland Islands.

The experience of sailing in the seas covered with ice has changed forever my vision of the ocean. This is another universe. There are no waves and rather than sailing, the ship crawls through the ice. You hear the soft groaning of the ice as it crumbles beneath the weight of the ship. The sea-ice is a large white beach where seals, sea lions, and penguins can climb out of the water and rest. And all this ice is variable, taking various forms: uncompacted or dense, a smooth surface or a rough pancake surface, thick or thin, with or without lakes. And every ice form attracts its own separate fauna.

The problem with the changing climate is that the thicker and more compact ice, that shelters the majority of the fauna, is diminishing. The thin ice which is not as compacted does not form as thick a layer of microalgae as does the denser ice and this results in a lower abundance of krill. Also, animals such as seals and sea lions prefer a solid ice platform for resting after feeding.



César Gamboa
Ministry of Foreign Affairs - Republic of Chile
cgamboa@minrel.gov.cl

ERCILLA'S "FAMOUS ANTARCTIC REGION"

Figure 1. Portrait of Alonso de Ercilla y Zúñiga, attributed to El Greco, showing the author of "The Araucana" with the laurels associated with a well-known and respected author.

According to Ercilla, Chile is located in the "Famous Antarctic Region." But how could such a phrase have been possible in the 16th century? Following a study of world geography as it was known in Ercilla's day, this work describes the concept of the world at that time and particularly the European view of the poles during that century. Likewise it is asserted that references to the "Antarctic Region" were common among writers of that time, as evidenced in the other works cited here.

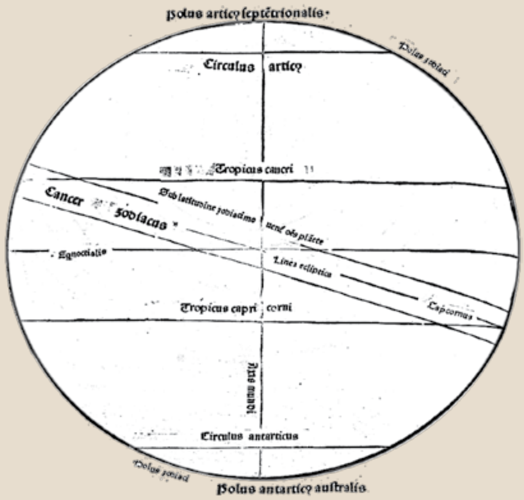


Figure 2. Diagram of the Imago Mundi (Image of the World) by Pierre d'Ailly, showing the division of the world according to the popular notions at the end of the Middle Ages. This book was published during the second half of the fifteenth century and was one of the works consulted by Christopher Columbus.

In one well-known passage of his magnum opus, Cervantes praised and immortalized the work of don Alonso de Ercilla y Zúñiga, published in three volumes appearing in 1569, 1578, and 1589 respectively. On the subject of "The Araucanian" and two other books ("The Austriada" and "The Montserrate") the prince of Spanish writers declared that these works were "the finest written in heroic verse in the Spanish language, competing with the most famous writings in Italian" and adding that these should be "kept as the crown jewels of Spain."[1] Such was the fame that Ercilla's epic poem achieved, written among "the vicissitudes and weariness of war, between battle and battle, during the breaks that followed the marches, during the forced leisure time in garrison" or rather, in difficult and troubled circumstances, with often improvised material.[2]

Taken as a whole, "The Araucanian" is much more than a literary work, since it has been demonstrated that the content is also historically valid and its geographic descriptions are consistent with those of the places mentioned, which in general were known to the author, who lived between 1533 and 1594. According to José Toribio Medina, "Ercilla alone portrayed the countryside and those around him in a manner that reveals the finest production of his talent and reflection of his justly immortal fame.[3] Nevertheless, this judgment of the sources of his material seems to understate the manner in which the poet observed and described the world according to the ideas and outlooks of his time, which witnessed the greatest expansion of the Spanish Empire.

Alonso de Ercilla had the good fortune of being born into a well-to-do family, as son of Fortún García de Ercilla, a famous jurist who was known to foreigners as "The Tactful Spaniard." His father died when the young Alonso was a little over a year old, though this had little impact on the considerable family fortune. The family's prestige explains why Alonso's mother, Leonor Zúñiga, had little trouble getting her son appointed as a page to the Hapsburg prince Phillip while Alonso was still a young child.

The circumstances surrounding the young Alonso's service to the future King Felipe II provided the young man with opportunities to travel to the major cities of Europe, where he met the important dignitaries of the age. Among these travels was one that was particularly important took him to London in July of 1554, when Ercilla was 21 years old. It was on that occasion that he accompanied the entourage of then-prince Felipe, who was about to marry Queen Mary I.

While Alonso was in London, word reached Europe of the murder of Pedro de Valdivia and the uprising by the Araucanians in Chile. Meanwhile, the competition for the position of governor there brought Jerónimo de Alderete to the English capital for the purpose of asking the prince regent for appointment as Captain-General of Chile. It was there that Alderete met the young Alonso de Ercilla, to whom he delighted in telling about "the beauties of these countries, the hardships of the conquest, the indomitable nature of the Chilean Indians, the great feats on the battlefield, the glory and wealth that invite the heroism and passion of the Castillians in their distant adventures".[4]

These tales instilled in Ercilla an immediate and deep enthusiasm, which led him to ask permission to go with Alderete, who had while still in London been designated the new governor of that distant and legendary province known as Chile, the land that Alonso would later describe in the powerful Spanish that characterized his work.

Chile's great length extends from north
to south along the new sea's coast,
from east to west its narrow width
measuring a hundred miles, at most;
below the Antarctic pole its height
equals twenty-seven degrees, continues
on to where the ocean and Chilean sea
blend their waters through a slender breast.

And these wide two seas, in their desire
to overreach their borders and join together,
beat upon the rocks and spread their waves,
but are hindered and cannot come near;
at this point at last they cleave the earth
and can merge here with one another.
Magallanes, my lord, was the man who first
opened up this passage he gave his name.[5]
[Translation by Dave Oliphant].

With these words, Ercilla did not in the slightest vary from the official documents of the age surrounding Chile. For example, in the Proceedings of the Santiago Council dated February 14, 1554, there is testimony that the jurisdiction of the Captain-General of Chile did extend as far as the Straits of Magellan.[6] In the first Royal Decree, delivered to Jerónimo de Alderete, it was also affirmed that the jurisdiction provided to Pedro de Valdivia extended to the Straits of Magellan. However, the second Decree, dated May 29, 1555, included a special mandate to go beyond the Straits and take possession of the land there:

> "…and because we wish to know about the land and populations that are beyond of the aforementioned Straits, and to understand what secrets may lie in that land, I order that from the provinces of Chile you send several ships to obtain information as to the nature of that land and its utility… and provide that possession is taken in our name of the lands and provinces that fall within the demarcation allocated to the Spanish crown. [7]

The degree of geographic knowledge that Jerónimo de Alderete demonstrates in his negotiations with the Spanish crown, together with the London contacts that Ercilla maintained, make it very probable that it was the experienced conquistador who provided the original sources of geographic insights for the later-famous Spanish poet. In fact, the description of Chile written by Ercilla appears to be quite consistent with the content of the royal decree that was issued in favor of governor Alderete, who was never able to serve in that position.

Whatever the case, the reference to the "Antarctic pole" in Ercilla's description was hardly a novelty in his time. For example, Martín Fernández de Enciso's "Suma de Geographia" ("Essential Geography"), which at the time was considered the official Spanish text on world geography, represented the earth divided by two "tropics" or circles, running from the Equator toward the poles.

> This view drawn from cosmology and geography was divided into five zones: the one called the equinoctial (from the word "equinox") divided the globe in the middle, in two parts. It was called "equinoctial" because the two divisions measured equally from the Equator to the Arctic and Antarctic poles...[8]

According to Fernández de Enciso, between the equinoctial (or Equator) and the poles there were regions, called "tropics," in the case of the northern hemisphere one was called the "estival" (summer) and the other the Arctic. In the southern hemisphere these "tropics" were called the "yemal" (hiemal in modern Spanish, meaning "winter") and the other the Antarctic. These regions were configured in the following manner:

> "...thus from the equinoctial to the Antarctic pole there are two zones called tropics, and one is called the Winter Tropic, and this is twenty-three and one-half degrees from the equinoctial, and in this tropic the sun arrives at the time of the first point of the Capricorn which is the twelfth of December, and from there starts to return toward the equinoctial; the other is called the Antarctic Tropic which is twenty-three and one-half degrees from the pole."[9]

If we consider that the location of Chile, according to Ercilla, is "beneath the Antarctic pole at a position of 27 degrees" and from there extends to the south, it was concluded that, according to the geographic coordinates of the day, the Captain-General's domain was within the "Antarctic Tropic" according to Fernández de Enciso's "Essential Geography" or the "famous Antarctic region" as Ercilla would describe it in his epic poem.

These geographic references were no inventions of the fifteenth or sixteenth centuries. On the contrary, it was during the Middle Ages that this concept had already been established, that the earth was divided into six parts, "by two circles, Arctic and Antarctic, and by two Tropics" as it was described by Pierre d'Ailly, one of the writers that Columbus had studied prior to his first voyage.[10] The poles were the mandatory reference in the works on cosmology that dealt with the composition of the earth. Moreover, though it cannot be established with certainty that Ercilla knew about Fernández de Enciso's work, neither can it be denied that the geographic coordinates used by both were identical.

In effect, toward the sixteenth century, representations of the earth already recognized the existence of the poles and used this in geographic references, making it possible to identify Chile as part of the Antarctic Zone. Then again, the chronicles of Pedro Mariño de Lovera described the Kingdom of Chile in the following words:

> "...although it is not beyond 25 to 42 degrees, which is the longitude of this kingdom from north to south, with all of this it has the closest relationship to the Antarctic pole by any measure, than anywhere else in the Americas, because the earth beyond that approaches said austral pole is either unpopulated or yet to be discovered; that which continues beyond the extent of the long Strait of Magellan..."[11]

Thus it is hardly unusual, in light of this paragraph, that Ercilla had written of Chile as the "fertile province, and identified within the famous Antarctic region,"[12] His reference was therefore predictable and wholly in keeping with his times. For this reason other echoes of Antarctica were felt in additional epic works of this age. Pedro de Oña referred to the "Antarctic hemisphere" in his "Arauco Domado" that appeared in Lima in 1596.[13] Juan de Miramontes y Zuazola wrote "Armas Antárticas", believed to have been prepared between 1608 and 1615, where he glorified conquistadors such as Francisco Pizarro and Diego de Almagro, calling them the "terror of the Antarctic regions."[14]

The Antarctic region attracted the attention of poets and warriors alike, each of them seduced by tales of the adventures, conquests, and discoveries that filled the annals of the Spanish Empire - an empire on which the sun always shone, and which embraced even the Southern Ocean with its eternal Antarctic ice.

Translator's note: Alonso de Ercilla y Zúñiga was a Spanish Basque poet (1533-1594) who wrote La Araucana ("The Araucanian"), one of the best-known epic poems of the Colonial period in Chile, based in large part on Ercilla's experience in the Spanish attempts to wrest control of a part of southern Chile from indigenous control.

NOTES

1. Miguel de Cervantes y Saavedra: El Ingenioso Hidalgo don Quijote de la Mancha. (New York: Appleton). 1903, Part I, Chap. VI.
2. Miguel Luis Amunátegui: Ensayos Biográficos. (4 volumes. Santiago: Imprenta Nacional). 1893-86, vol. IV, pp. 40-41.
3. José Toribio Medina: Historia de la literatura colonial de Chile. (3 volumes. Santiago: Printed by Librería del Mercurio). 1878, v. I, p. 5.
4. Diego Barros Arana: Historia General de Chile. (16 volumes. Santiago: Rafael Jover Editor & Imprenta Cervantes). 1884-1902, v. II, p. 83.
5. Alonso de Ercilla y Zúñiga: La Araucana. (Santiago: Casa de Moneda). 1983, Part I, Canto I, vv. 49-64.
6. Colección de Historiadores de Chile y Documentos relativos a la Historia Nacional. (49 volumes. Santiago: Imprenta del Ferrocarril). 1861-1942, v. I, pp. 394-99.
7. Miguel Luis Amunátegui: La cuestión de límites entre Chile y la República Argentina. (3 volumes. Santiago: Imprenta Nacional). 1879-80, v. I, pp. 322-23.
8. Martín Fernández de Enciso: Suma de Geographia. (Sevilla: Jacobo Cromberger). 1519, f.iiii v.
9. Ibid.
10. Pierre d'Ailly: Imago Mundi. (Louvain: J. de Paderborn). 1483, f. 6.
11. Pedro Mariño de Lovera: "Crónica del Reino de Chile". Viz., Colección de Historiadores de Chile y Documentos relativos a la Historia Nacional, v. VI, p. 19.
12. Alonso de Ercilla y Zúñiga: La Araucana, Part I, Canto I, vv. 41-42.
13. Pedro de Oña: Arauco Domado. (Santiago: Imprenta Universitaria). 1917, p. 46.
14. Juan de Miramontes y Zuazola: Armas Antárticas. (Caracas: Biblioteca Ayacucho). 1978, p. 23.

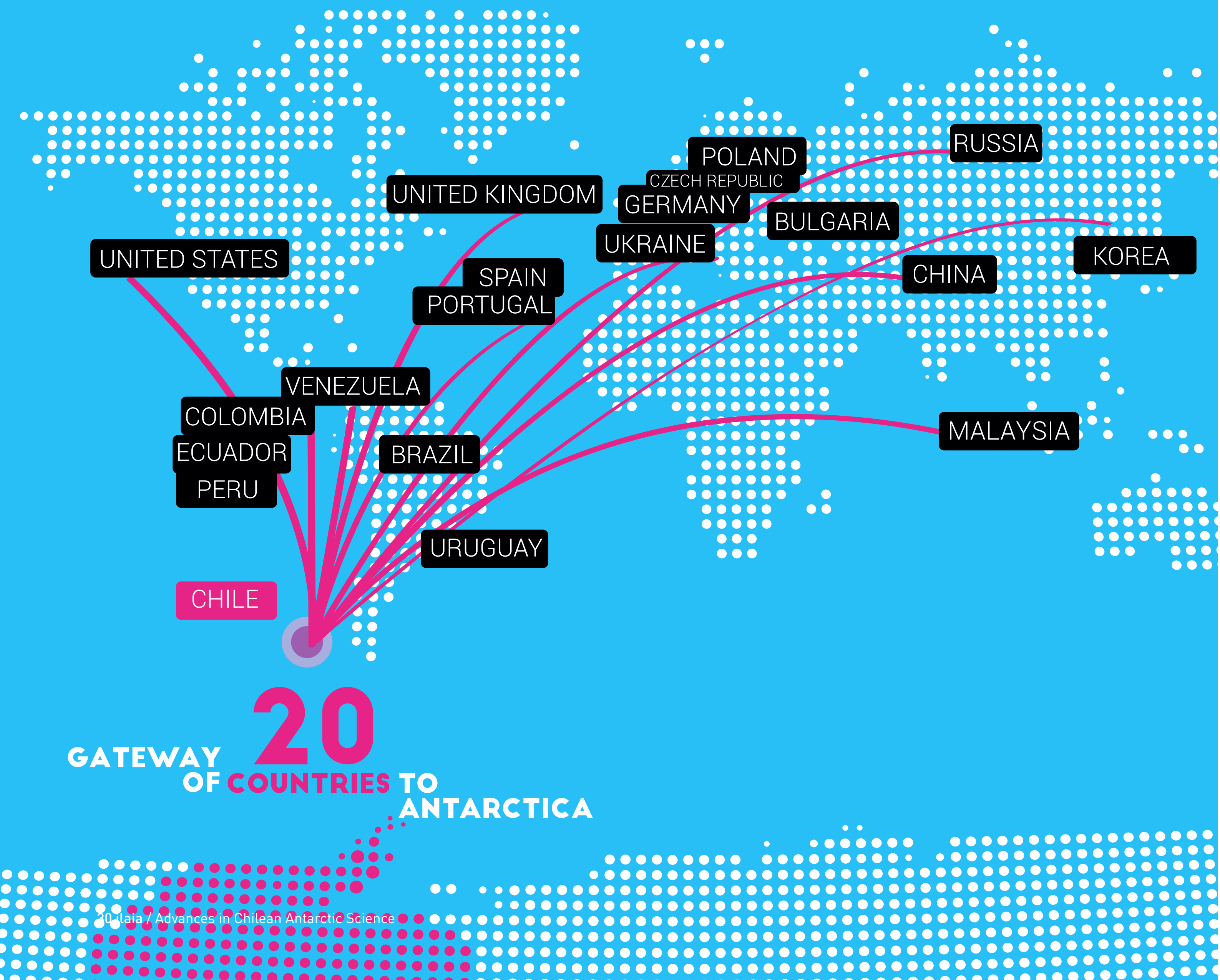

SANTIAGO
LONDRES 15.4?5 Km.
ISLA ELEFANTE 2.?76 Km.
IQUIQUE 6.652 Km.
TOKIO 14.736
NUEVA DELHI 14.239 Km.
BRASILIA 7.325 Km.
WASHINGTON D.C. 13.173 Km.
PUCÓN 4535 Km.
GRUPO DE AVIACION N°6
TOME 4825 K

INTERNATIONAL COLLABORATION

R. Quinán

José Retamales Espinoza
INACH
jretamales@inach.cl

PUNTA ARENAS WORLD CAPITAL FOR ANTARCTIC RESEARCH



Few places in the world are closer to Antarctica than the Chilean cities of Punta Arenas and Puerto Williams: two hours by air, or two days of sailing and you're right at King George Island, the part of the Antarctic Peninsula where the scientific work of no fewer than 22 countries is concentrated.

For most countries in the northern hemisphere, conducting studies on the Frozen Continent is notoriously difficult. Few are able to charter scientific vessels, or transport seawater with live organisms, or maintain laboratories and instrumentation at their bases. For that reason, Punta Arenas is striving to create an impressive new international science park to focus on world-class Antarctic and sub-Antarctic scientific research. Chile will thus be able to host these countries in its far south, as it is done at the large astronomical observatories in northern Chile.

At present, of the 53 nations that adhere to the Antarctic Treaty, 34 perform scientific work in Antarctica, and of those not all have permanent or even summer bases. Only 29, known as the Consultative Parties, maintain the 80 stations spread around the continent.

If strengthened, the Chilean Antarctic Science Program would be in an optimal position to support international cooperative science work, due to its proximity and logistical potential for assisting the countries with its activities based in this "South American Antarctica". Here is a summary of the situation for those countries:

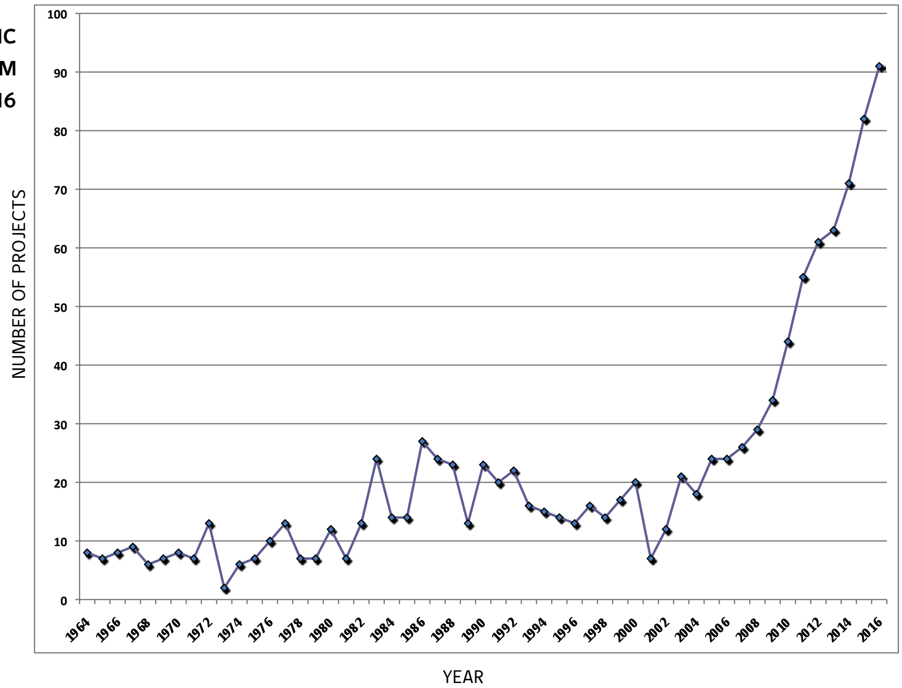
- Only 12 have permanent bases.
- Only 4 possess a ship with full scientific capabilities.
- Only 8 have logistical support vessels.

Our proximity to Antarctica offers great opportunities for conducting RDI (Research, Development, and Innovation) projects in a region that could be considered one of the greatest natural laboratories in the world. The continuing growth in international Antarctic scientific collaborations reflects the increasing interest and concern in the region.

The region where INACH is located is the one area of the planet most used by other nations to reach the White Continent. In addition to foreign participants, during the 2015-2016 season, there were more than 200 scientists from the Chilean Antarctic Program involved in scientific research.

Right now there is a strategy being implemented to organize a network of scientific and logistical platforms to operate from Punta Arenas to the Antarctic Peninsula, for the purpose of creating new opportunities for research. During the period from 2013 to 2015 several cooperative agreements were signed with countries that use Punta Arenas as their gateway to Antarctica.

CHILEAN ANTARCTIC SCIENCE PROGRAM 1964-2016



Keys to Growth and Bases for International Cooperation

INACH has been responsible for conducting the Chilean Antarctic Science Program (PROCIEN) for half a century. However, it has only been in recent years that it has turned over 100 % of its resources for scientific research in open competitions, conducted in English, and evaluated by international peer experts and demanding scientific quality standards in international peer-reviewed ISI journals.

Along with this, a normative framework for competition has been developed which helps include researchers who are in the early stages of their careers, along with agreements with Chilean national funding sources supporting basic and applied science work. This also incorporates international agencies together with National Antarctic Programs, which have created a working environment that includes methods for evaluating Chilean Antarctic science.

Researchers from 31 Chilean scientific institutions participate in PROCIEN. There are 91 Principal Investigators leading projects that could be small 1-2 year ones like a Master or PhD thesis or 10 years Research Centers getting as much as US$ 1.5 million/year. There are at least 7 calls for Antarctic science research per year in Chile. In one of them, the so-called Regular INACH Call, last year 36 scientific proposals arrived. This year we received 53. Unfortunately, available funds will only allow us to choose around 10 of them. Building new labs in the southern Antarctic Peninsula Chilean old stations and having small scientific research vessels will provide scientists with better facilities to do their work.

Let us consider for a moment the international publications (ISI - International Scientific Indexing) "Web of Knowledge" database, which measures certain parameters related to the production of contemporary periodicals, grouped according to an impact-factor index for each publication. During the 1990s, Chile produced fewer than five articles on Antarctica annually, while in 2015 this increased to nearly 50 (as detailed in the list in this issue of ILAIA). This increase of an order of magnitude within 15 years is significantly greater than the growth trend in national scientific work.

Another relevant factor surrounding the growth in PROCIEN involves increased international collaborations, with a greater number of nations participating in the Chilean Antarctic expeditions, something that is reflected in joint publications noted in the ISI. In 2015 there were 24 nationalities appearing in the screening of researchers, more than three times the 7 countries associated with Chilean Antarctic work in the year 2000.

A close look shows that during those 15 years, growth had been due in part to incentives in the

R. Quinán

funding mechanisms for Chilean Antarctic activities, which provide stimuli to attract the country's international counterparts. The existence of formal support and research pacts, access to top-of-the-line equipment, along with co-financing, all contribute to making research proposals all the more attractive.

As part of an effort underway for a long time, this year we have added some innovations that involve more international interaction. In the past we have added additional points to proposals that include cooperation with other countries in a "bottom up" manner. We have now added a "top-down" method for direct management of joint participation efforts with nations such as Brazil, South Korea, China and the UK. This brings about increased collaborative activity and helps to provide financing for the growth in our national scientific efforts.

The "Near" East

We should point out some examples of the trend towards growth in international collaboration in the joint activities conducted with several National Antarctic Programs.

Last summer season the top 7 countries having scientists participating in PROCIEN projects were USA (10 projects), Germany (9), UK (7), France (5), Spain (4), Brazil (4) and Canada (4). A Sino-Chilean expedition, with 10 Chinese scientists, lead by Professor Zhao Yue, sailed on the Aquiles in February 2016.

In December 2015, a workshop called "Scanning horizons for science collaboration in the Antarctic Peninsula" was organized at INACH headquarters. Chilean scientists and three Chinese polar scientists participate in the Workshop, from Shanghai Jiao Tong University, and Shandong University. The Chinese delegation took the opportunity to visit the head of the Magallanes region, Dr. Jorge Flies, at the Government Building.

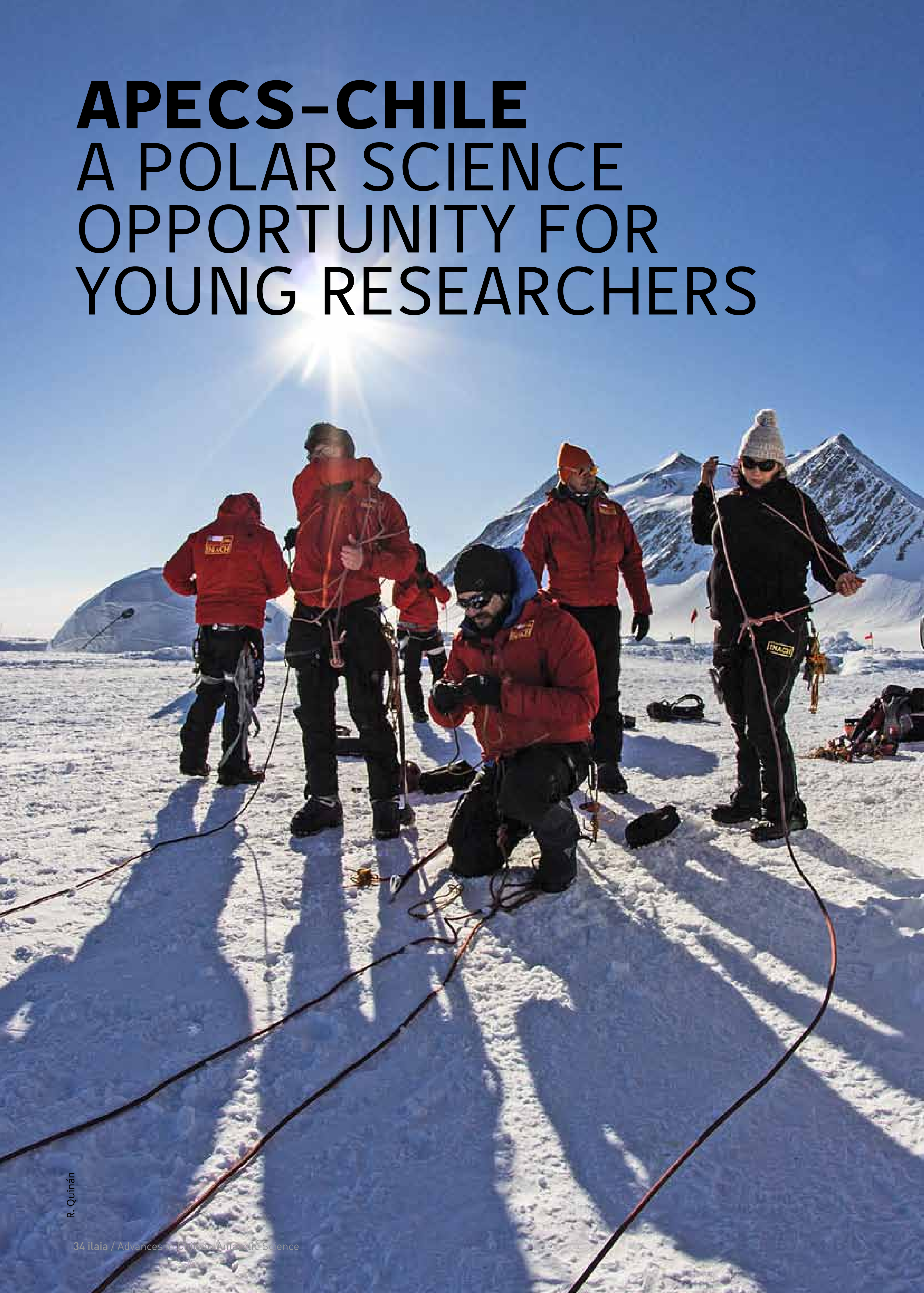
On February 26, 2016, at the INACH laboratory building, an "INACH-KOPRI Center for Antarctic Cooperation" was inaugurated. We hope this location will allow the Korean Polar Research Institute to better coordinate its activities in the city of Punta Arenas. Dr. Kim Yea-Dong, President of KOPRI, indicated that he hopes that "the inauguration of this new joint Chile-Korea center will help to increase levels of cooperation between our countries. We should be able to resolve the problems that concern humanity, such as climate change."

A "Workshop on Chile-Korea Antarctic Research Cooperation" was conducted at INACH the day before the inauguration ceremony. INACH and KOPRI signed a memorandum of understanding in 2012 and a letter of intent on April 23, 2015 for creating additional means for cooperation for combining efforts, capabilities, and resources for advancing science and technology, and to further the development of research and conservation on the Antarctic continent.

Chile has worked hard to boost its Antarctic program and we think we are at an opportune moment to develop new alliances. Welcome to Chile, and welcome to Magallanes. Welcome to the Antarctic that unites us all.


R. Quinán

APECS-CHILE
A POLAR SCIENCE OPPORTUNITY FOR YOUNG RESEARCHERS



R. Quinán

Claudia Maturana (president)[1], Joaquín Bastías (vice president)[2] and Sebastián Ruiz (secretary)[3].
[1]Institute of Ecology and Biodiversity, University of Chile.
[2]Earth Sciences Department, University of Geneva, Switzerland.
[3]Directorate of Antarctic Programs, University of Magallanes, Chile.
apecs.chile@gmail.com

The need for scientific work is growing more and more important in our society, though this is no easy task. But young scientists are being placed in programs where they can conduct studies or research.

One of the most important ways in which we conduct scientific work today is through collaborative networks which serve as support groups, employing researchers from several scientific disciplines who are attempting to solve problems through interdisciplinary means.

Nevertheless, all these efforts run into one main obstacle: funding. As a matter of background reference, the countries of the OECD (Organization for Economic Co-operation and Development) invest an average of 2.4 percent of their gross domestic product in research and development, while Chile (an OECD member) invests just 0.4 percent. Our principal funding hopes are centered on support through study grants, attendance at international seminars, or internships in foreign countries. These are important parts of our development as researchers and if we take into consideration the associated high costs of conducting actual scientific work, we have to resort to creativity to come up with the funding needed for our research.

As researchers (and as individuals, naturally) the modern world presents the urgent need to understand the impacts on biodiversity that result from human activity. Global warming has created undeniable repercussions throughout the world, with Antarctica being the most sensitive to these impacts. This continent has become a tremendous natural laboratory for the understanding of the processes and impacts of global warming.

But now the Association of Polar Early Career Scientists (APECS) has emerged. This is an international, interdisciplinary association of young researchers who are in the early stages of their scientific careers in polar region studies. Their mission is to broaden and improve the skills of these young scientists, supplying them with a network of contacts with experienced specialists in several areas. This also includes opportunities for professional and academic development through the creation and advertising of funding options for attending meetings and seminars. We believe that this contributes to the development of human capital as well as academic and professional collaboration on a global level.

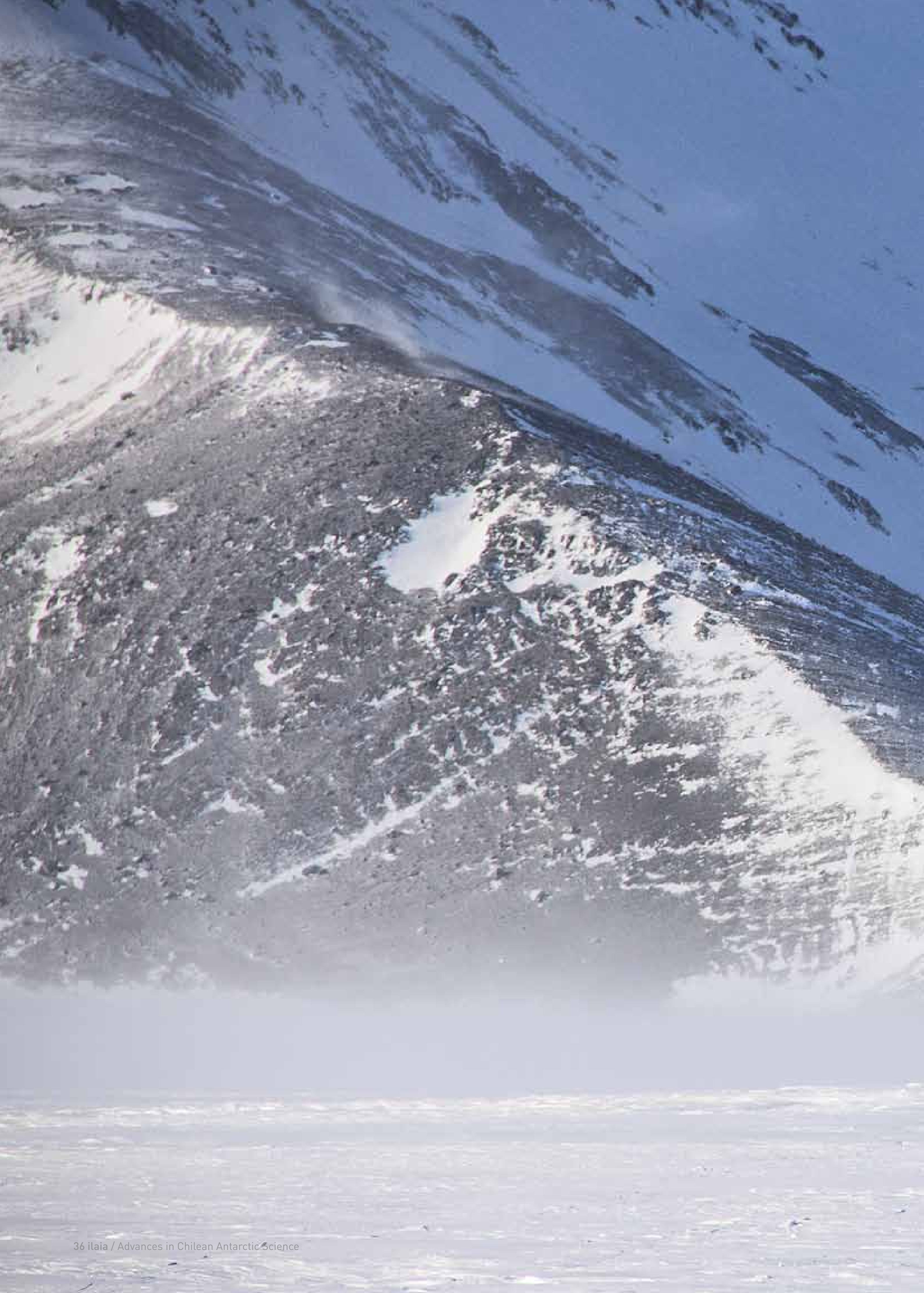
The national APECS-Chile committee brings together young people from all over Chile who have a growing interest in assembling and developing research work in several Antarctic subjects. As an organization we are aware of the need for the integration of a wide span of people involved in polar research, and for this we have ties with the Chilean Antarctic Institute (INACH) and the National Antarctic Research Committee. At the same time, we hope to extend scientific knowledge to society in general, and for that we are publicizing our research at educational establishments as a way of helping to create critical nature-oriented awareness related to the sciences.

Our principal objectives include 1) promoting an active integration of academic activities that are associated with Antarctic science, including meetings and seminars; 2) establish a collaborative network amoung young researchers; 3) promote publicity surrounding our scientific studies in educational establishments; 4) participate in educational seminars and science fairs; and 5) provide economic support for meetings and science seminars.

One of our accomplishments has been to provide lodging for our members to allow attendance at international seminars and participation in executive meetings in St Petersburg, Oslo, and Montreal for familiarization and guidance for directors of the organization. We have also obtained human resource assistance in initiatives for the Explora-CONICYT program including talks at schools and assessment of work at seminars and student fairs, along with being a part of the editorial committee for the Journal of Antarctic Affairs (the academic magazine of Agenda Antartica Foundation, a non-governmental organization). Lastly, we represented Chile at the international APECS council, becoming a point of reference for other South American countries.

Nevertheless, we still have many challenges in our future. One of these includes obtaining legal status that will let us obtain both public and private funding. We also hope to have the next APECS-Chile meeting with all our members to present ourselves to the national and other Latin American Antarctic science communities, to provide space for dialogue for our strategic plans for developing Antarctic scientific work.

Successfully meeting these objectives and strengthening APECS depends on closer relationships and the active participation of our members. To that end we are inviting students and young researchers to get involved in scientific endeavors beyond the laboratory. We need more supporters in the schools and greater assistance at science fairs and workshops, and increased participation in scientific organizations to explain who we are and how to help strengthen our organization, all for the ultimate goal of supporting the development of better polar science work within our country.



R. Quinán

LIST OF 2015 ANTARCTIC SCIENCE PUBLICATIONS (ISI)

	AUTHORS	TITLE	JOURNAL	VOLUME	NUMBER/ ISSUE
1	Leiva, Sergio Alvarado, Pamela Huang, Ying Wang, Jian Garrido, Ignacio	Diversity of pigmented Gram-positive bacteria associated with marine macroalgae from Antarctica	FEMS MICROBIOLOGY LETTERS	362	24
2	Billard, Emmanuelle Reyes, Jeanette Mansilla, Andres Faugeron, Sylvain Guillemin, Marie-Laure	Deep genetic divergence between austral populations of the red alga *Gigartina skottsbergii* reveals a cryptic species endemic to the Antarctic continent	POLAR BIOLOGY	38	12
3	Lamy, Frank Arz, Helge W. Kilianc, Rolf Lange, Carina B. Lembke-Jene, Lester Wengler, Marc Kaiser, Jerome Baeza-Urrea, Oscar Hall, Ian R. Harada, Naomi Tiedemann, Ralf	Glacial reduction and millennial-scale variations in Drake Passage throughflow	PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA	112	44
4	Huovinen, Pirjo Gomez, Ivan	UV sensitivity of vegetative and reproductive tissues of two Antarctic brown algae is related to differential allocation of phenolic substances	PHOTOCHEMISTRY AND PHOTOBIOLOGY	91	6
5	Isaksson, Jenny Christerson, Linus Blomqvist, Maria Wille, Michelle Alladio, Lucia A. Sachse, Konrad Olsen, Bjorn Gonzalez-Acuna, Daniel Herrmann, Bjorn	Chlamydiaceae-like bacterium, but no *Chlamydia psittaci*, in sea birds from Antarctica	POLAR BIOLOGY	38	11
6	Damiani, A. Cordero, R. R. Carrasco, J. Watanabe, S. Kawamiya, M. Lagun, V. E.	Changes in the UV Lambertian equivalent reflectivity in the Southern Ocean: Influence of sea ice and cloudiness	REMOTE SENSING OF ENVIRONMENT	169	
7	Chwedorzewska, K. J. Gielwanowska, I. Olech, M. Molina-Montenegro, M. A. Wodkiewicz, M. Galera, H.	*Poa annua L.* in the maritime Antarctic: an overview	POLAR RECORD	51	6
8	Fernandez, Leonardo D. Lara, Enrique Mitchell, Edward A. D.	Checklist, diversity and distribution of testate amoebae in Chile	EUROPEAN JOURNAL OF PROTISTOLOGY	51	5
9	Doetterl, Sebastian Stevens, Antoine Six, Johan Merckx, Roel Van Oost, Kristof Casanova Pinto, Manuel Casanova-Katny, Angelica Munoz, Cristina Boudin, Mathieu Zagal Venegas, Erick Boeckx, Pascal	Soil carbon storage controlled by interactions between geochemistry and climate	NATURE GEOSCIENCE	8	10
10	Alcaino, Jennifer Cifuentes, Victor Baeza, Marcelo	Physiological adaptations of yeasts living in cold environments and their potential applications	WORLD JOURNAL OF MICROBIOLOGY & BIOTECHNOLOGY	31	10 11
11	De la Iglesia, Rodrigo Diez, Beatriz Fonseca, Cassio A. Hajdu, Eduardo Trefault, Nicole	Characterization of bacterial, archaeal and eukaryote symbionts from Antarctic sponges reveals a high diversity at a three-domain level and a particular signature for this ecosystem	PLOS ONE	10	9
12	Valdivia, Nelson Jose Diaz, Maria Garrido, Ignacio Gomez, Ivan	Consistent richness-biomass relationship across environmental gradients in a marine macroalgal-dominated subtidal community on the Western Antarctic Peninsula	PLOS ONE	10	9
13	Acevedo, Jorge Carreno, Esteban Torres, Daniel Aguayo-Lobo, Anelio Letelier, Sergio	Cephalopod remains in scats of Weddell seals (*Leptonychotes weddellii*) at Cape Shirreff, South Shetland Islands, Antarctica	POLAR BIOLOGY	38	9

14	Jackson, W. Andrew Boehlke, J. K. Andraski, Brian J. Fahlquist, Lynne Bexfield, Laura Eckardt, Frank D. Gates, John B. Davila, Alfonso F. McKay, Christopher P. Rao, Balaji Sevanthi, Ritesh Rajagopalan, Srinath Estrada, Nubia Sturchio, Neil Hatzinger, Paul B. Anderson, Todd A. Orris, Greta Betancourt, Julio Stonestrom, David Latorre, Claudio Li, Yanhe Harvey, Gregory J.	Global patterns and environmental controls of perchlorate and nitrate co-occurrence in arid and semi-arid environments	GEOCHIMICA ET COSMOCHIMICA ACTA	164	-
15	Amaro, Eduardo Padeiro, Ana de Ferro, Andre Mao Mota, Ana Maria Leppe, Marcelo Verkulich, Sergey Hughes, Kevin A. Peter, Hans-Ulrich Canario, Joao	Assessing trace element contamination in Fildes Peninsula (King George Island) and Ardley Island, Antarctic	MARINE POLLUTION BULLETIN	97	1-2
16	Gomez, Ivan, Huovinen, Pirjo	Lack of physiological depth patterns in conspecifics of endemic Antarctic brown algae: a trade-off between UV stress tolerance and shade adaptation?	PLOS ONE	10	8
17	Palacios, Mauricio Cardenas, Cesar A. Newcombe, Emma M.	Rocky reefs seaweeds from Fildes and Collins Bays, King George Island, Antarctica	REVISTA DE BIOLOGIA MARINA Y OCEANOGRAFIA	50	2
18	Leyton, Arely Urrutia, Homero Miguel Vidal, Jose de la Fuente, Mery Alarcon, Manuel Aroca, German Gonzalez-Rocha, Gerardo Sossa, Katherine	Inhibitory activity of Antarctic bacteria *Pseudomonas* sp M19B on the biofilm formation of *Flavobacterium psychrophilum* 19749	REVISTA DE BIOLOGIA MARINA Y OCEANOGRAFIA	50	2
19	Jara-Carrasco, S. Gonzalez, M. Gonzalez-Acuna, D. Chiang, G. Celis, J. Espejo, W. Mattatall, P. Barra, R.	Potential immunohaematological effects of persistent organic pollutants on chinstrap penguin	ANTARCTIC SCIENCE	27	4
20	Tam, Heng Keat Wong, Clemente Michael Vui Ling Yong, Sheau Ting Blamey, Jenny Gonzalez, Marcelo	Multiple-antibiotic-resistant bacteria from the maritime Antarctic	POLAR BIOLOGY	38	8
21	Saucede, Thomas Diaz, Angie Pierrat, Benjamin Sellanes, Javier David, Bruno Feral, Jean-Pierre Poulin, Elie	The phylogenetic position and taxonomic status of *Sterechinus bernasconiae* Larrain, 1975 (Echinodermata, Echinoidea), an enigmatic Chilean sea urchin	POLAR BIOLOGY	38	8
22	Miranda-Urbina, Diego Portflitt-Toro, Matias Serratosa, Juan Luna-Jorquera, Guillermo	Vagrant Antarctic fur seal, *Arctocephalus gazella*, in northern Chile	POLAR BIOLOGY	38	8
23	Molina-Montenegro, MA Pertierra, LR Razeto-Barry, P Diaz, J Finot, VL Torres-Diaz, C	A recolonization record of the invasive *Poa annua* in Paradise Bay, Antarctic Peninsula: modeling of the potential spreading risk	POLAR BIOLOGY	38	7
24	Castillo, Paula Lacassie, Juan Pablo Augustsson, Carita Herve, Francisco	Petrography and geochemistry of the Carboniferous-Triassic Trinity Peninsula Group, West Antarctica: implications for provenance and tectonic setting	GEOLOGICAL MAGAZINE	152	4

25	Zuniga, Catalina Leiva, Diego Ramirez-Fernandez, Lia Caru, Margarita Yahr, Rebecca Orlando, Julieta	Phylogenetic Diversity of *Peltigera* Cyanolichens and Their Photobionts in Southern Chile and Antarctica	MICROBES AND ENVIRONMENTS	30	2
26	Stekolnikov, Alexandr A. Gonzalez-Acuna, Daniel	A review of Chilean chiggers (Acari: Trombiculidae), with the description of a new genus and ten new species	ZOOTAXA	3964	1
27	Rivera, Andres Uribe, Jose Zamora, Rodrigo Oberreuter, Jonathan	Subglacial Lake CECs: Discovery and in situ survey of a privileged research site in West Antarctica	GEOPHYSICAL RESEARCH LETTERS	42	10
28	Huene, Mathias Gonzalez-Wevar, Claudio Poulin, Elie Mansilla, Andres Fernandez, Daniel A. Barrera-Oro, Esteban	Low level of genetic divergence between *Harpagifer* fish species (Perciformes: Notothenioidei) suggests a Quaternary colonization of Patagonia from the Antarctic Peninsula	POLAR BIOLOGY	38	5
29	Hughes, Kevin A. Pertierra, Luis R. Molina-Montenegro, Marco A. Convey, Peter	Biological invasions in terrestrial Antarctica: what is the current status and can we respond?	BIODIVERSITY AND CONSERVATION	24	5
30	Rautenberger, Ralf Huovinen, Pirjo Gomez, Ivan	Effects of increased seawater temperature on UV tolerance of Antarctic marine macroalgae	MARINE BIOLOGY	162	5
31	Landais, A. Masson-Delmotte, V. Stenni, B. Selmo, E. Roche, D. M. Jouzel, J. Lambert, F. Guillevic, M. Bazin, L. Arzel, O. Vinther, B. Gkinis, V. Popp, T.	A review of the bipolar see-saw from synchronized and high resolution ice core water stable isotope records from Greenland and East Antarctica	QUATERNARY SCIENCE REVIEWS	114	-
32	Garay Vera, Cristian Leon Woeppke, Consuelo	The Cold War And Chilean Antarctic Policy, 1946-1952	REVISTA ESTUDIOS HEMISFERICOS Y POLARES	6	2
33	Figueroa, Luis Jimenez, Carlos Rodriguez, Jaime Areche, Carlos Chavez, Renato Henriquez, Marlene de la Cruz, Mercedes Diaz, Caridad Segade, Yuri Vaca, Inmaculada	3-Nitroasterric Acid Derivatives from an Antarctic Sponge-Derived *Pseudogymnoascus* sp Fungus	JOURNAL OF NATURAL PRODUCTS	78	4
34	Beaulieu, Michael Gonzalez-Acuna, Daniel Thierry, Anne-Mathilde Polito, Michael J.	Relationships between isotopic values and oxidative status: insights from populations of gentoo penguins	OECOLOGIA	177	4
35	Romanova, N. V. Pilipenko, V. A. Stepanova, M. V.	On the magnetic precursor of the Chilean earthquake of February 27, 2010	GEOMAGNETISM AND AERONOMY	55	2
36	Contreras, Gabriela Barahona, Salvador Sepulveda, Dionisia Baeza, Marcelo Cifuentes, Victor Alcaino, Jennifer	Identification and analysis of metabolite production with biotechnological potential in *Xanthophyllomyces dendrorhous* isolates	WORLD JOURNAL OF MICROBIOLOGY & BIOTECHNOLOGY	31	3
37	Dilly, G. F. Gaitan-Espitia, J. D. Hofmann, G. E.	Characterization of the Antarctic sea urchin (*Sterechinus neumayeri*) transcriptome and mitogenome: a molecular resource for phylogenetics, ecophysiology and global change biology	MOLECULAR ECOLOGY RESOURCES	15	2
38	Lubin, Dan Kahn, Brian H. Lazzara, Matthew A. Rowe, Penny Walden, Von P.	Variability in AIRS-retrieved cloud amount and thermodynamic phase over west versus east Antarctica influenced by the SAM	GEOPHYSICAL RESEARCH LETTERS	42	4

39	Bellio, Pierangelo Segatore, Bernardetta Mancini, Alisia Di Pietro, Letizia Bottoni, Carlo Sabatini, Alessia Brisdelli, Fabrizia Piovano, Marisa Nicoletti, Marcello Amicosante, Gianfranco Perilli, Mariagrazia Celenza, Giuseppe	Interaction between lichen secondary metabolites and antibiotics against clinical isolates methicillin-resistant *Staphylococcus aureus* strains	PHYTOMEDICINE	22	2
40	Segovia, Ricardo A. Armesto, Juan J.	The Gondwanan legacy in South American biogeography	JOURNAL OF BIOGEOGRAPHY	42	2
41	Nunez, Martin A. Dimarco, Romina D. Dickie, Ian A. Pauchard, Anibal	What can possibly go wrong? The risks of introducing soil microorganisms from Antarctica into South America	BOSQUE	36	3
42	Alvarado, Pamela Huang, Ying Wang, Jian Garrido, Ignacio Diaz, Maria J. Holtheuer, Jorge Leiva, Sergio	Phylogenetic diversity of epibiotic gram-positive bacteria isolated from Antarctic macroalgae	EUROPEAN JOURNAL OF PHYCOLOGY	50	1
43	Hernandez-Salas, Carlos R.	Distinguished Status Quo: The American Antarctic Quadrant after Submissions to the Commission on the Limits of the Continental Shelf	INTERNATIONAL JOURNAL OF MARINE AND COASTAL LAW	30	2
44	Parra, Loreto P. Espina, Giannina Devia, Javier Salazar, Oriana Andrews, Barbara Asenjo, Juan A.	Identification of lipase encoding genes from Antarctic seawater bacteria using degenerate primers: Expression of a cold-active lipase with high specific activity	ENZYME AND MICROBIAL TECHNOLOGY	68	-
45	Munoz, Patricio A. Correa-Llanten, Daniela N. Blamey, Jenny M.	Ionic Liquids Increase the Catalytic Efficiency of a Lipase (Lip1) From an Antarctic Thermophilic Bacterium	LIPIDS	50	1
46	Celis, Jose E. Barra, Ricardo Espejo, Winfred Gonzalez-Acuna, Daniel Jara, Solange	Trace Element Concentrations in Biotic Matrices of Gentoo Penguins (*Pygoscelis papua*) and Coastal Soils from Different Locations of the Antarctic Peninsula	WATER AIR AND SOIL POLLUTION	226	1
47	Maurel, Agnes Lund, Fernando Montagnat, Maurine	Propagation of elastic waves through textured polycrystals: application to ice	PROCEEDINGS OF THE ROYAL SOCIETY A-MATHEMATICAL PHYSICAL AND ENGINEERING SCIENCES	471	2177
48	Otero, Rodrigo A. Soto-Acuna, Sergio Salazar S., Christian Luis Oyarzun, Jose	New elasmosaurids (Sauropterygia, Plesiosauria) from the Late Cretaceous of the Magallanes Basin, Chilean Patagonia: Evidence of a faunal turnover during the Maastrichtian along the Weddellian Biogeographic Province	ANDEAN GEOLOGY	42	2
49	Cavagna, A. J., Fripiat, F. Elskens, M. Mangion, P. Chirurgien, L. Closset, I. Lasbleiz, M. Florez-Leiva, L. Cardinal, D. Leblanc, K. Fernandez, C. Lefevre, D. Oriol, L. Blain, S. Queguiner, B. Dehairs, F.	Production regime and associated N cycling in the vicinity of Kerguelen Island, Southern Ocean	BIOGEOSCIENCES	12	21

M. Leppe

CHILEAN ANTARCTIC SCIENCE PROGRAM

Line I.
The State of the Antarctic Ecosystem

I.8 Parasite fauna in Antarctic fishes

I.9 Microevolution of penguins

I.10 Evolutionary history of the Antarctic pearlwort

I.11 Viral and bacterial diversity in seawater and Antarctic fish species

I.12 A biophysical study of ichthyoplankton

I.13 DNA barcoding of Antarctic parasites

I.14 Photobionts of genus *Caloplaca*

I.15 Eukaryote microbial communities

I.16 New fungal species from Antarctic marine sponges

I.17 Foraging ecology in extreme environments

I.1 Phylogeography of Antarctic parasites

I.2 Diversification of the spiny plunderfish *Harpagifer*

I.3 Paleogeographic patterns v/s climate change

I.4 Macroalgal adaptive radiation

I.5 Biogeographic patterns and processes in mollusks

I.6 Metagenomics of microbial communities

I.7 Phylogeography and evolutionary history of *Neobuccinum eatoni*

Line II.
Antarctic Thresholds: Ecosystem Resilience and Adaptation

II.15 Climate adaptation in marine species

II.16 *Campylobacter* in Antarctica

II.17 Historic and recent colonizers

II.18 Active layer of frozen soils

II.2 Ecophysiology of snow algae

II.3 Freezing tolerance of Antarctic vascular plants

II.4 Responses of the Antarctic mosses to global warming

II.5 Response of soil enzymatic and microbial activity

II.6 Invertebrates responses to thermal stress conditions

II.10 Sponges and climate change

II.11 Photosynthetic responses to warming

II.12 Addressing global warming scenarios in freshwater ecosystems

II.13 Biological hot spots along the Antarctic Peninsula continental shelf

II.14 Endophytic fungi in *Deschampsia antarctica*

II.1 Antarctic plant ecophysiology

II.7 Impact of iceloss on coastal benthic ecosystems

II.8 Evolutionary history of *Colobanthus*

II.9 Antarctic microbial community in response to deglaciation

Line III.
Antarctic Climate Change

III.1 High latitude marine ecosystems dynamic

III.2 Influence of the solar activity on the polar environment

III.3 Iron and light on phytoplankton production

III.4 Glacier response to climate change in Chile

III.5 Climate reconstruction at the northern Antarctic Peninsula

III.6 Ozone and atmosphere-ocean system

OVERVIEW
CHILEAN ANTARCTIC SCIENCE

Line IV.

Physical and Earth Sciences

IV.8 Radiance distribution in the Antarctic Peninsula

IV.9 Thermal evolution of the Antarctic Peninsula

IV.10 Palaeoenvironment in Fildes Peninsula

IV.7 George VI Ice Shelf tributary glacier types

IV.1 Space plasmas

IV.2 Low clouds over the Antarctic Peninsula

IV.3 Reflectivity of Antarctica

IV.4 Ozone and solar radiation

IV.5 Seismic facies variability and sedimentation

IV.6 Warming, CO2 and leaf respiration of plants

Line V.

Antarctic Microbiology and Molecular Biology

V.4 Gram-positive bacteria associated with marine macroalgae

V.5 Yeasts in terrestrial habitats

V.6 Polyphenols isolated from lichens

V.7 Antifreeze proteins purified from microorganisms

V.8 Resistance genes from waste waters

V.9 Microbial consortiums with high acidogenic and methanogenic activity

V.10 Potential of actinobacteria

V.11 Microorganisms and nanoparticles

V.1 Enzyme with beta-galactosidase activity

V.2 Role of Antarctic root-endophytes in lettuce crops

V.3 Rhizosphere's bacteria and performance of *Colobanthus*

V.12 Bacterial diversity in soils

V.13 Study of cold-active enzymes

V.14 Nitrous oxide-reducing bacteria

V.15 Biosurfactants produced by bacteria

V.16 Nutraceutical metabolites in snow microalgae

V.17 Antimicrobial activity of Antarctic *Pseudomonas*

V.18 Psychrophilic bacteria isolated from Antarctic grass

V.19 Mercury resistance mechanisms in bacteria

V.20 Biochemical mechanisms of desiccation tolerance in moss

V.21 Reduction of tellurite and copper in bacteria

V.22 Tellurite resistance in bacteria

V.23 Depsides and depsidones from lichens

V.24 Laccase isolated from *Geobacillus*

V.25 Antibacterial effect of lichens

V.26 Cytotoxic activity of actinobacteria

V.27 Lichens and biofilm formation

V.28 *Rhodobacter* response to radiation

Line VI.

Antarctic Environment

VI.3 Persistent Organic Pollutants (POPs) in the aquatic food web

VI.4 Vitamin D and biomarkers

VI.5 Impacts of Antarctic bases on the aquatic ecosystems

VI.6 Methane cycling in lakes

VI.7 Xenobiotics in the South Shetlands

VI.9 Heavy metals and persistent organic pollutants on Antarctic fauna

VI.10 Drug residue in Southern Ocean

VI.11 HAPs in snow

VI.12 Environmental Antarctic Monitoring Center

VI.8 Melting Claims

VI.1 Paint schemes to protect structural steel constructions

VI.2 Soil communities and pollution

FINANCING SOURCES

- INACH FIELD PROJECTS
- INACH LAB PROJECTS
- INACH THESIS SUPPORT
- INACH SPECIAL PROJECTS
- PIA INACH
- CORFO-INNOVACHILE
- FONDECYT-INACH
- FONDEF-INACH
- INTERNATIONAL COLLABORATION
- FONDAP
- PAI-CONICYT

Line I

THE STATE OF THE ANTARCTIC ECOSYSTEM

Associated with the Scientific Committee on Antarctic Research (SCAR) program, "State of the Antarctic Ecosystem (AntEco)."

Biological diversity, or biodiversity, can be defined as the totality of all organisms within a system. Their collective interaction determines how ecosystems work and support the biosphere of our planet. In this respect, the focus of our research is on the past and present patterns of biodiversity for all environments in the Antarctic, sub-Antarctic and Southern Ocean regions, with the principal purpose of furthering knowledge about biodiversity, ranging from genes to ecosystems, along with gaining a better understanding of the biology of individual species. This knowledge can be applied to the preservation and management of Antarctic ecosystems.

The "State of the Antarctic Ecosystem" line of research is closely tied to international initiatives such as the Census of Antarctic Marine Life (CAML) and Chile's National Antarctic Program, which have been able to fill many of the gaps in knowledge about the condition of Antarctic ecosystems. In this way, the intricate biogeographical processes that lead to the similarities and differences among the southern (austral region) biota are being uncovered, though this has been possible only through broad interdisciplinary efforts. As a result, this PROCIEN line is attempting to gain further understanding of the evolutionary patterns behind the existence of unique communities in and around Antarctica, and to document the conditions and evolution as well as their conservation status.

Many Antarctic biological communities are still unknown and it is not surprising that scientific expeditions continue to discover new species. This had led to increasing the breadth of our knowledge of Antarctic biological diversity, while posing some very perplexing questions about their phylogeny, ecological roles, and population size - which may be related to future conservation needs.

There are more than 15 projects now in on this line of research, with studies ranging from microscale to ecosystem level, with the strongest emphasis on evolutionary and biogeographic details. This project involves a collaborative effort to answer key issues related to the 80 high-priority questions identified by SCAR for investigation during the next 20 years.

- I.1. Phylogeography, population genetic structure and connectivity of the Subantarctic crab *Halicarcinus planatus*, the first alien marine invertebrate discovered in Antarctica (2016-2020)
  Karin Gerard (UMAG)
  gerardkarin@yahoo.fr

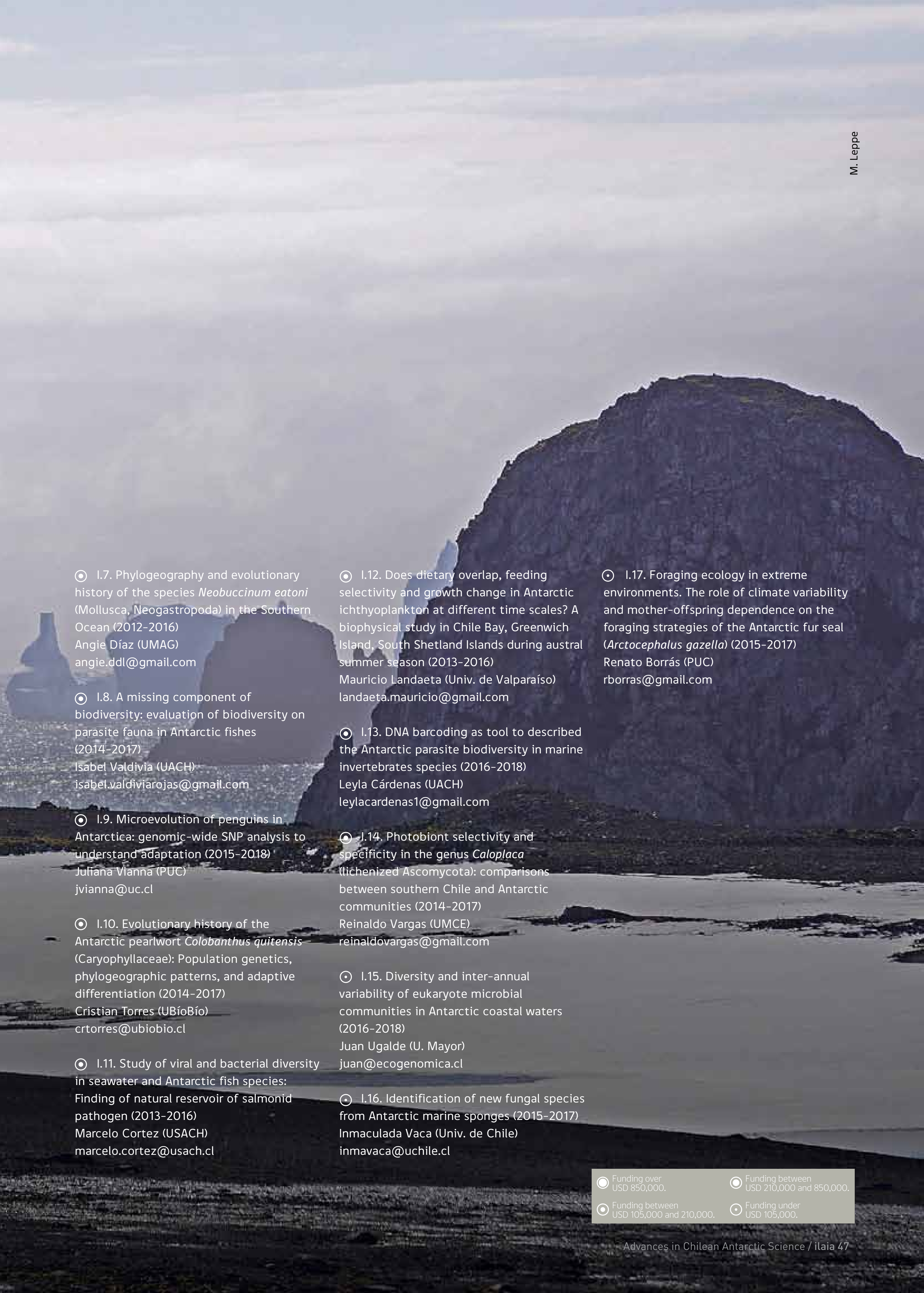
- I.2. Diversification of the spiny plunderfish *Harpagifer* in the Southern Ocean (2015-2018)
  Elie Poulin (Univ. de Chile)
  epoulin@uchile.cl

- I.3. Paleogeographic patterns v/s climate change in South America and the Antarctic Peninsula during the latest Cretaceous: a possible explanation for the origin of the Austral biota? (2015-2018)
  Marcelo Leppe (INACH)
  mleppe@inach.cl

- I.4. Macroalgal Adaptive Radiation: Potential Links to Ecological Niche Diversity in the Ecoregion of Magallanes and Chilean Antarctica (2014-2017)
  Andrés Mansilla (UMAG)
  andres.mansilla@umag.cl

- I.5. Historical and recent biogeographic patterns and processes in Southern Ocean marine mollusks with contrasting developmental modes (2014-2017)
  Claudio González (IEB)
  omeuno01@hotmail.com

- I.6. The metagenomes and metatranscriptomes of microbial communities at the Arctic and Antarctic Ocean surfaces: which metabolic processes and principal actors drive these ecosystems and how will climate change modify them? (2013-2016)
  Beatriz Fernández (Univ. de Chile)
  biotica@gmail.com



M. Leppe

I.7. Phylogeography and evolutionary history of the species *Neobuccinum eatoni* (Mollusca, Neogastropoda) in the Southern Ocean (2012-2016)
Angie Díaz (UMAG)
angie.ddl@gmail.com

I.8. A missing component of biodiversity: evaluation of biodiversity on parasite fauna in Antarctic fishes (2014-2017)
Isabel Valdivia (UACH)
isabel.valdiviarojas@gmail.com

I.9. Microevolution of penguins in Antarctica: genomic-wide SNP analysis to understand adaptation (2015-2018)
Juliana Vianna (PUC)
jvianna@uc.cl

I.10. Evolutionary history of the Antarctic pearlwort *Colobanthus quitensis* (Caryophyllaceae): Population genetics, phylogeographic patterns, and adaptive differentiation (2014-2017)
Cristian Torres (UBíoBío)
crtorres@ubiobio.cl

I.11. Study of viral and bacterial diversity in seawater and Antarctic fish species: Finding of natural reservoir of salmonid pathogen (2013-2016)
Marcelo Cortez (USACH)
marcelo.cortez@usach.cl

I.12. Does dietary overlap, feeding selectivity and growth change in Antarctic ichthyoplankton at different time scales? A biophysical study in Chile Bay, Greenwich Island, South Shetland Islands during austral summer season (2013-2016)
Mauricio Landaeta (Univ. de Valparaíso)
landaeta.mauricio@gmail.com

I.13. DNA barcoding as tool to described the Antarctic parasite biodiversity in marine invertebrates species (2016-2018)
Leyla Cárdenas (UACH)
leylacardenas1@gmail.com

I.14. Photobiont selectivity and specificity in the genus *Caloplaca* (lichenized Ascomycota): comparisons between southern Chile and Antarctic communities (2014-2017)
Reinaldo Vargas (UMCE)
reinaldovargas@gmail.com

I.15. Diversity and inter-annual variability of eukaryote microbial communities in Antarctic coastal waters (2016-2018)
Juan Ugalde (U. Mayor)
juan@ecogenomica.cl

I.16. Identification of new fungal species from Antarctic marine sponges (2015-2017)
Inmaculada Vaca (Univ. de Chile)
inmavaca@uchile.cl

I.17. Foraging ecology in extreme environments. The role of climate variability and mother-offspring dependence on the foraging strategies of the Antarctic fur seal (*Arctocephalus gazella*) (2015-2017)
Renato Borrás (PUC)
rborras@gmail.com

Funding over USD 850,000.
Funding between USD 210,000 and 850,000.
Funding between USD 105,000 and 210,000.
Funding under USD 105,000.

Line II

ANTARCTIC THRESHOLDS: ECOSYSTEM RESILIENCE AND ADAPTATION

Associated with the "Antarctic Thresholds: Ecosystem Resilience and Adaptation (AnT-ERA)" program, from the Scientific Committee on Antarctic Research (SCAR).

Stress factors in Antarctic ecosystems result from a number of aspects, including seasonal and inter-annual variability, long-term climate change, conditions involving low temperature, high levels of ultraviolet radiation, and scarcity of water. To these natural conditions we also acknowledge the stress factors related to human activities.

The unusual conditions found at various locations in Antarctica have shown differing levels of change. While some areas of the White Continent itself may not show evidence of this, the Antarctic Peninsula region has become one of the areas that has suffered the greatest temperature increases in the past fifty years. In the coming years we should expect to see cascading biological responses, ranging from a molecular level to alterations of entire communities, and involving key organisms in the Antarctic ecosystem.

The AnT-ERA program is intended to describe how Antarctic organisms have adapted to current conditions, and how they might respond in the future. It also hopes to identify which species will likely be winners and which will be losers under these new scenarios, and how this will affect the functioning of the communities and ecosystems.

This represents an opportunity for measuring and quantifying the effects of a warming climate, for impacts ranging from factors affecting individual species to the ecosystem, and helps in the understanding of current patterns and processes as well as for the detection of changes in the future.

This concept employs several projects, using a number of different approaches, to address the research questions, whether these deal with Antarctic plants, algae, invertebrates, mosses, or bacteria as the principal subjects in the studies. Antarctic algae, for example, have revealed their resistance to the effects of changing conditions in the Southern ocean, demonstrating that they have the metabolic prerequisites to adapt to such change. Likewise, Antarctic macroalgae would be resistant to short-term UV stress at current temperatures and under probable increases predicted within the context of climate change.

◉ II.1. Antarctic Plant Ecophysiology: Unraveling the biological consequences of climate change on plant populations of the Maritime Antarctic (2012-2016)
León Bravo (UFRO)
leon.bravo@ufrontera.cl

◉ II.2. Ecophysiology of Antarctic snow algae: adaptation mechanisms to a changing polar environment (2016-2019)
Iván Gómez (UACH)
igomezo@uach.cl

◉ II.3. How would experimental warming affect freezing tolerance of Antarctic vascular plants? (2015-2018)
León Bravo (UFRO)
leon.bravo@ufrontera.cl

◉ II.4. Metabolomic responses of the Antarctic mosses *Sanionia uncinata* and *Polytrichum alpinum* to global warming (2014-2017)
Gustavo Zúñiga (USACH)
gustavo.zuniga@usach.cl

◉ II.5. Response of soil enzymatic and microbial activity to global temperature increase in cold ecosystems of Patagonia and Antarctica (2014-2017)
Ángela Machuca (UdeC)
angmachu@udec.cl

◉ II.6. Coping with warming of Southern Ocean: invertebrates responses to thermal stress conditions (2013-2016)
Marcelo González (INACH)
mgonzalez@inach.cl

◉ II.7. A multi-disciplinary approach to understand the impact of ice loss and deglaciation on Antarctic coastal benthic ecosystems (2015-2018)
Antonio Brante (UCSC)
abrante@ucsc.cl

◉ II.8. Evolutionary history of *Colobanthus quitensis* and its associated microorganisms: implications for understanding present biogeographic patterns, adaptation to environmental change and interactions with glacial cycles (2015-2018)
Marco Molina (Univ. de Talca)
marco.molina@ceaza.cl

P. Ruiz

II.9. Shifts in marine Antarctic microbial community structure and function in response to deglaciation and sea ice meeting accelerated by climate change (2014-2017)
Beatriz Diez (PUC)
bdiez@bio.puc.cl

II.10. Assessing the utility of Antarctic sponges for studying global climate change: individual to community level responses (2015-2018)
César Cárdenas (INACH)
ccardenas@inach.cl

II.11. Photosintetic responses to warming as consequence of the climate change in populations of Antarctic plants from different latitudes in the Maritime Antarctic (2013-2016)
Patricia Sáez (UdeC)
patrisaezd@gmail.com

II.12. Addressing global warming scenarios in freshwater ecosystems using aquatic insects as model organisms in sub-Antarctic and Antarctic regions (2013-2016)
Tamara Contador (UMAG)
tamara.contador@yahoo.com

II.13. Physical controls of biological hot spots along the Antarctic Peninsula continental shelf: future status and current climate trends (2014-2017)
Andrea Piñones (CEAZA)
andrea.pinones@yale.edu

II.14. Effect of endophytic fungi on the ecophysiological performance and biochemical responses of *Deschampsia antarctica* under the current scenario and in one of simulated global climate change (2013-2016)
Rómulo Oses (CEAZA)
romulo.oses@ceaza.cl

II.15. Applying evolutionary principles to infer climate adaptation in marine species: using a genomic approach (2014-2017)
Juan Gaitán (UACH)
juadiegaitan@gmail.com

II.16. *Campylobacter* in Antarctica: diversity, origin and effects on wildlife (2014-2017)
Daniel González (UdeC)
danigonz@udec.cl

II.17. Historic and recent colonizers: genetic and phenotypic variability and phylogenetic relationships of *Colobanthus quitensis* and *Juncus bufonius* in the context of regional changes in Antarctica (2013-2016)
Marely Cuba (UdeC)
mcuba@udec.cl

II.18. Study of the active layer of frozen soils within the area of Düse Bay, Antarctic Peninsula (2015-2016)
Sebastián Ruiz (UMAG)
sruizp@outlook.com

Funding over USD 850,000.
Funding between USD 210,000 and 850,000.
Funding between USD 105,000 and 210,000.
Funding under USD 105,000.

Line III

ANTARCTIC CLIMATE CHANGE

Associated with the "Antarctic Climate Change in the 21st Century," and "Past Antarctic Ice Sheet Dynamics" programs, from the Scientific Committee on Antarctic Research (SCAR).

In dealing with the threat posed by climate change, it is clear that a large number of our society's challenges and opportunities will flow from two sources: the study of phenomena in Antarctica, and the impacts of global telecommunications.

The growing concern over climate change in recent years reinforces the urgent need to find answers to many key questions affecting Antarctica, so that the coming impacts can be assessed, along with a better understanding of the causes that bring these changes about.

At the same time, as a result of this search for answers relating to Antarctica, a steadily growing multidisciplinary approach has been developed, stimulating the advancement of science and at the same time, aiding in the formation of advanced human capital.

Within this context two SCAR scientific programs work toward these objectives:

1. Antarctic Climate Change in the 21st Century (AntClim21), an effort attempting to provide better regional predictions relating to key elements of the Antarctic atmosphere, the Southern Ocean, and the cryosphere over the next 20 to 200 years. The program also expects to provide improved understanding of the responses of physical systems and the biological factors derived from natural and anthropogenic forcing.

2. Past Antarctic Ice Sheet dynamics (PAIS), a program which is responsible for greater knowledge and understanding of the sensitivity of the ice sheets on East and West Antarctica and the Antarctic Peninsula, against a wide range of changing climatic and oceanic conditions. These include modeling the "greenhouse" climate of the past, which was warmer than the present environment, along with earlier periods of warming and ice retreat during the terminal phases of the most recent ice ages.

Several of the PROCIEN projects in this line of research reflect the efforts to enhance understanding of these processes and mechanisms of change, and to assess the associated trends. One approach attempts to reconstruct past climate conditions using recent high-resolution glacial and geochemical records obtained for the Laclavere ice plateau and surrounding areas near the Union glacier. This type of research involves enormous logistical challenges to provide for working in those extreme and remote environments. These projects involve the use of cutting-edge technologies to assist in solving key questions regarding the past, present and changing future in Antarctic climate parameters.

Special mention is in order for the project entitled "Research Center: High Latitude Marine Ecosystems Dynamic (IDEAL)," which receives 4.5 billion CLP (about US$6.7 million) in financing from CONICYT (900 million CLP each year for five years). This project focuses on two macro regions: southern Tierra del Fuego, and the Antarctic Peninsula, since both exhibit particular sensitivity to possible scenarios involving global warming and anthropogenic impacts. In turn, the project is organized in four research programs whose results will be connected through a modeling and synthesis group for expansion into a larger temporal and spatial context.

The first research program will study the connection between the Antarctic Peninsula and the southern region of Tierra del Fuego by looking into the Antarctic Circumpolar Current (ACC) which represents an insurmountable barrier for plankton and benthic (bottom-dwelling) fish, while generating local adaptation responses in the Antarctic and sub-Antarctic regions.

The second program deals with the modulation of biological interactions triggered in Antarctic and sub-Antarctic systems by environmental stress. The third program will address research into global impacts of climate change on various marine species, communities, and ecosystems. The last research program will cover the social dimension of the several socioeconomic system aspects of neighboring coastal communities (fishing, aquaculture, bio-fuels, climate control, nutrient cycles, recreation, tourism, research and education, esthetic benefits, and spiritual and cultural factors.

III.1. Research Center: High Latitude Marine Ecosystems Dynamic (2015-2020)
Humberto González (UACH)
humberto.gonzalez.estay@gmail.com

III.2. Influence of the solar activity on the polar environment (2014-2017)
Alessandro Damiani (USACH)
alessandro.damiani@usach.cl

III.3. Assessing the role of iron and light on phytoplankton production and air-seav CO_2 fluxes in a changing western Antarctic Peninsula (2015-2018)
Ernesto Molina (USACH)
emolina@bio.puc.cl

III.4. Understanding glacier response to climate change in Chile (2013-2016)
Shelley MacDonell (CEAZA)
shelley.macdonell@gmail.com

III.5. Recent high-resolution climate reconstruction at the northern Antarctic Peninsula - glacio-geochemical investigations at Plateau Laclavere ice cap (2012-2016)
Francisco Fernandoy (UNAB)
francisco.fernandoy@unab.cl

III.6. Ozone variability influence on the coupled atmosphere-ocean system (2014-2017)
Pedro Llanillo (USACH)
pedroquechua@hotmail.com

P. Ruiz

Funding over USD 850,000.
Funding between USD 210,000 and 850,000.
Funding between USD 105,000 and 210,000.
Funding under USD 105,000.

Line IV

PHYSICAL AND EARTH SCIENCES

Associated with the "Antarctic Astronomy and Astrophysics" and "Solid Earth Responses and Influences on Cryosphere Evolution" programs, by the Scientific Committee on Antarctic Research (SCAR).

More than anything else, it is the physical environment that has determined the nature of the existence of life in Antarctica, and has shaped its landscape. Understanding of the physical conditions is a major component in an appreciation of the present, as well as the future of the White Continent.

This research line integrates the branches of Antarctic science to create a holistic study of the continent and its surrounding ocean, as key parts of our planet down through history. This line is tied to the research conducted by two SCAR Standing Scientific groups: GeoSciences, and Physical Sciences. In addition, it is also linked to two of the SCAR Scientific Research Programs: Antarctic Astronomy and Astrophysics (AAA), and Solid Earth Response and influence on Cryospheric Evolution (SERCE) .

At a physical level, the processes occurring at the interfaces between the ice, the oceans, the land and the atmosphere -- all these are essential to provide us with the ability to describe and predict responses to climate change.

There are still uncertainties that call for continuing research to enhance our understanding of the dynamics of the Antarctic ice shelf, as well as the processes and changes involved in sea ice and ocean current circulation. There are still unresolved questions about atmospheric dynamics and chemistry, and the role of upper-atmospheric ozone as it affects the Antarctic climate.

We must also keep in mind that the elements of physical sciences research in Antarctica are based on the unique properties of the White Continent. Some of these special characteristics also support its use as a platform for astronomical observation and studies of the relationships between earth and the sun.

The 2016 PROCIEN projects covering this theme include two that we believe are particularly noteworthy. One is the study and interpretation of recent sedimentary processes to detect varying rates of sedimentation along the coast of the Antarctic Peninsula. The other is a new approach to study the influence of solar activity on the Antarctic environment, which compares satellite data estimates with new models of atmospheric chemistry in an effort to assess climate forcing.

R. Quinán

IV.1. Equilibrium and non-equilibrium processes in space plasmas and the solar-wind-magnetosphere-ionosphere interactions (2016-2020)
Marina Stepanova (USACH)
marina.stepanova@usach.cl

IV.2. Characterization of Low Clouds over the Antarctic Peninsula and the West Antarctic Ice Sheet (WAIS) (2016-2019)
Penny Rowe (USACH)
prowe@harbornet.com

IV.3. Reflectivity of Antarctica (2015-2018)
Raúl Cordero (USACH)
raul.cordero@usach.cl

IV.4. Multichannel espectroradiometer to monitor ozone and solar radiation in Antarctica (2014-2016)
Raúl Cordero (USACH)
raul.cordero@usach.cl

IV.5. Seismic facies variability and sedimentation processes in small bays and fjords of the Danco Coast, Antarctic Peninsula (2012-2016)
Cristián Rodrigo (UNAB)
cristian.rodrigo@unab.cl

IV.6. Effect of warming and increased CO2 concentration on thermal acclimation of leaf respiration of Antarctic plants (2014-2017)
Carolina Sanhueza (UdeC)
csanhuez@gmail.com

IV.7. Clustering of George VI Ice Shelf tributary glacier types (2014-2016)
Guido Staub (UdeC)
gstaub@udec.cl

IV.8. Ground-based Measurements of the Radiance Distribution in the Antarctic Peninsula (2015-2018)
Raúl Cordero (USACH)
raul.cordero@usach.cl

IV.9. Thermal evolution of the Antarctic Peninsula and the South Shetland Islands by thermochronology: implications to climate change (2014-2017)
Francisco Hervé (UNAB)
fherve@ing.uchile.cl

IV.10. Stratigraphy and palaeoenvironment of the lower strata of Fildes Peninsula Group (2015-2016)
Fernanda Carvajal (UNAB)
fer.carvajal.h@gmail.com

Funding over USD 850,000.
Funding between USD 210,000 and 850,000.
Funding between USD 105,000 and 210,000.
Funding under USD 105,000.

Line V

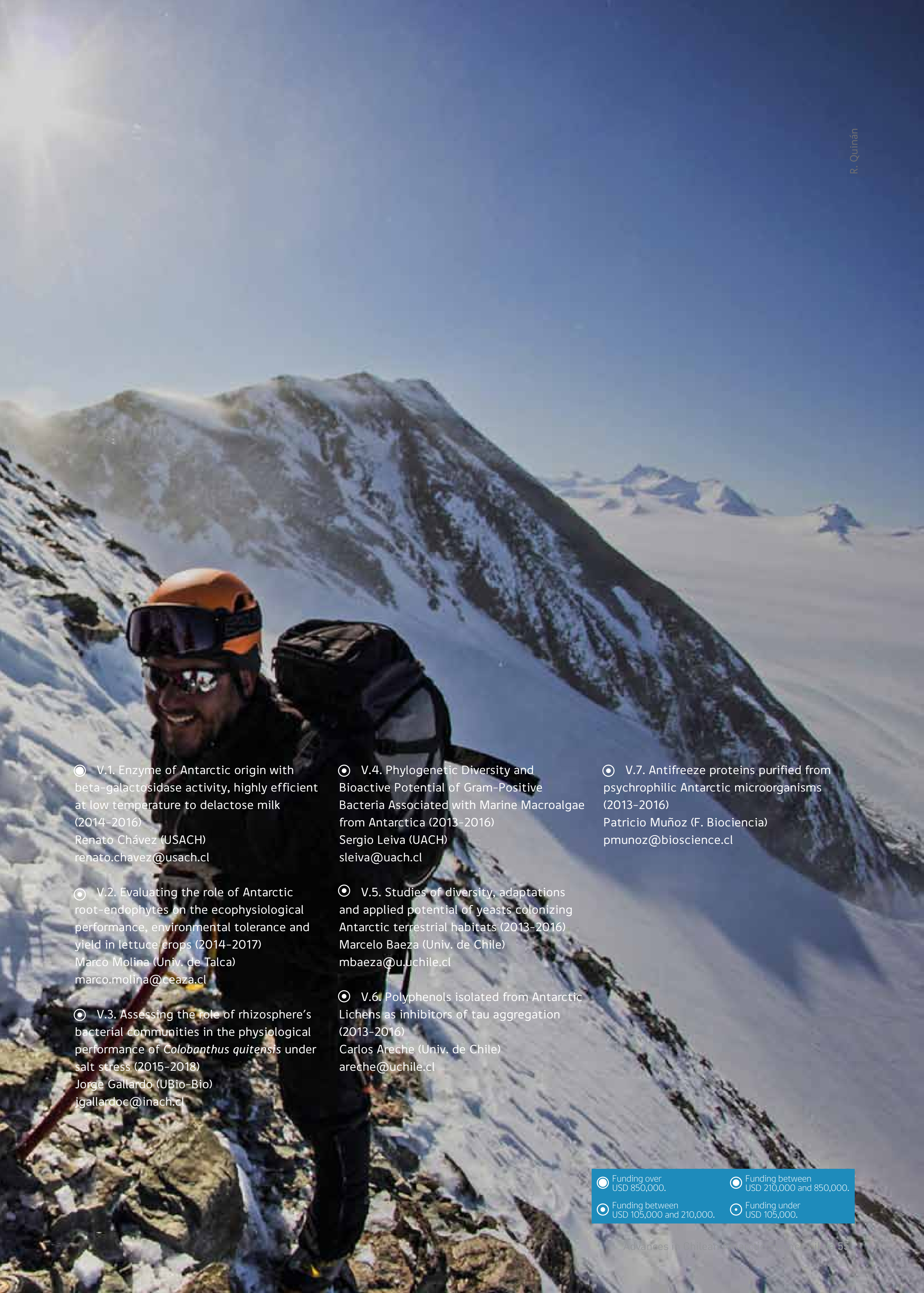
ANTARCTIC MICROBIOLOGY AND MOLECULAR BIOLOGY

Progress in molecular studies in Antarctica is coordinated with the national guidelines that are aimed at responding to specific needs through applied research. In recent decades, the Antarctic continent has become the focus for researchers who are interested in not only the study of adaptations of organisms to extreme Antarctic conditions, but are looking into possible applications.

After more than ten years of study, the stomachs of krill have provided insights and characterization of the first known enzymes that degrade proteins at low temperature. Many of the projects in this PROCIEN address the search for applications.

These include the characterization of antibacterial molecules produced by Antarctic bacteria, biotechnological applications of fluorescent nano-composites produced by bacteria, and even antineoplasic compounds from an Antarctic plant that could help fight cancer.

Yeasts, which are important in industrial processes such as bread making, can also be a source of new antioxidants. In the coming years, Chile should be able to not only increase the number of Antarctic scientific publications but also the number of related patents.



V.1. Enzyme of Antarctic origin with beta-galactosidase activity, highly efficient at low temperature to delactose milk (2014-2016)
Renato Chávez (USACH)
renato.chavez@usach.cl

V.2. Evaluating the role of Antarctic root-endophytes on the ecophysiological performance, environmental tolerance and yield in lettuce crops (2014-2017)
Marco Molina (Univ. de Talca)
marco.molina@ceaza.cl

V.3. Assessing the role of rhizosphere's bacterial communities in the physiological performance of *Colobanthus quitensis* under salt stress (2015-2018)
Jorge Gallardo (UBio-Bio)
jgallardoc@inach.cl

V.4. Phylogenetic Diversity and Bioactive Potential of Gram-Positive Bacteria Associated with Marine Macroalgae from Antarctica (2013-2016)
Sergio Leiva (UACH)
sleiva@uach.cl

V.5. Studies of diversity, adaptations and applied potential of yeasts colonizing Antarctic terrestrial habitats (2013-2016)
Marcelo Baeza (Univ. de Chile)
mbaeza@u.uchile.cl

V.6. Polyphenols isolated from Antarctic Lichens as inhibitors of tau aggregation (2013-2016)
Carlos Areche (Univ. de Chile)
areche@uchile.cl

V.7. Antifreeze proteins purified from psychrophilic Antarctic microorganisms (2013-2016)
Patricio Muñoz (F. Biociencia)
pmunoz@bioscience.cl

Funding over USD 850,000.
Funding between USD 210,000 and 850,000.
Funding between USD 105,000 and 210,000.
Funding under USD 105,000.

◉ V.8. Fildes Peninsula Resistome: Is there any contribution of antimicrobial resistance genes from waste waters? (2012-2015)
Helia Bello (UdeC)
hbello@udec.cl

◉ V.9. Selection and identification of microbial consortiums with high acidogenic and methanogenic activity from Antarctic sediments, for application to psychrophilic wastewater anaerobic digestion under temperate to cold climates (2013-2016)
Léa Cabrol (PUCV)
lea.cabrol@gmail.com

◉ V.10. Actinobacteria diversity in Antarctic ecosystems and assessment of the biotechnological potential of their secondary metabolites (2012-2016)
Leticia Barrientos (UFRO)
lbarrientos@ufro.cl

◉ V.11. Isolation of Antarctic microorganisms able to synthesize highly fluorescent semiconductor nanoparticles (Quantum Dots) for biotechnological applications (2011-2016)
José Pérez (UNAB)
jperezd@gmail.com

⊙ V.12. Bacterial diversity in soils of different animal settlements from Cape Shirreff, Antarctica (2015-2017)
Julieta Orlando (Univ. de Chile)
jorlando@u.uchile.cl

⊙ V.13. A xylanase from an Antarctic filamentous fungus as model for the study of cold-active enzymes (2015-2017)
Renato Chávez (USACH)
renato.chavez@usach.cl

⊙ V.14. Diversity and activity of nitrous oxide-reducing bacteria in Antarctic soils influenced by marine animal settlements (2015-2017)
Lía Ramírez (Univ. de Chile)
liaramirez88@gmail.com

⊙ V.15. Prospection and characterization of biosurfactants produced by Antarctic bacteria (2015-2017)
Claudio Lamilla (UFRO)
claudiolamilla@gmail.com

⊙ V.16. Nutraceutical metabolites and photosynthesis activity in Antarctic snow microalgae: Effects of temperature and UV radiation (2015-2017)
Claudio Rivas (UACH)
claudio.rivas@postgrado.uach.cl

⊙ V.17. Characterization, heterologous expression and improving antimicrobial activity of bacteriocins produced by Antarctic *Pseudomonas* (2013-2016)
María Soledad Pavlov (PUCV)
msoledad.pavlov@gmail.com

⊙ V.18. Characterization of psychrophilic bacteria isolated from *Deschampsia antarctica* phyllosphere and their potential protective effect against frost injury to plants (2013-2016)
Fernanda Cid (UFRO)
fernanda.cid.alda@gmail.com

⊙ V.19. Role of mercury resistance mechanisms in tellurite cross-resistance in psychrotolerant bacteria isolated from Antarctic Chilean territory (2015-2017)
Fernanda Rodríguez (USACH)
fernandarodriguez27@gmail.com

⊙ V.20. Biochemical Mechanisms of desiccation tolerance in the Antarctic moss *Sanionia uncinata* (2015-2017)
Marisol Pizarro (USACH)
marisol.pizarro@gmail.com

⊙ V.21. Study of the extracelular reduction of tellurite and copper in bacteria isolated from the Chilean Antarctic territory (2015-2017)
Mauricio Valdivia (USACH)
maur.valdivia@gmail.com

⊙ V.22. Identification and characterization of a new mechanism/strategy for tellurite resistance in tellurite-resistant bacteria isolated from Chilean Antarctic Territory (2013-2016)
Claudia Muñoz (USACH)
c.munoz.villagran@gmail.com

⊙ V.23. Depsides and depsidones from Antarctic lichens: Antioxidant activity and their possible effect as tau aggregation inhibitor (2015-2016)
Francisco Salgado (Univ. de Chile)
fsalgado@ug.uchile.cl

⊙ V.24. Purification and Characterization of a new Laccase isolated from the Antarctic thermophile *Geobacillus* sp. ID17 (2015-2016)
Joaquín Atalah (Univ. de Chile)
akhin.dw@gmail.com

⊙ V.25. Antibacterial effect of derivated compounds from Antarctic lichens against *Acinetobacter baumannii* (2015-2016)
Xabier Villanueva (UdeC)
xvillanuevamartinez@gmail.com

⊙ V.26. Evaluation of the cytotoxic activity of extracts isolated from Antarctic and Subantarctic actinobacteria, *Candida* sp., and from human cancer cell lines (2015-2016)
David Astudillo (Univ. de Valparaíso)
david.aab88@gmail.com

⊙ V.27. Effect of lichen compounds on biofilm formation and quorum sensing type I system of *Vibrio anguillarum* (2015-2016)
Claudia Torres (UdeC) ctorresb@udec.cl

⊙ V.28. *Rhodobacter* sp response to stress induced by UV radiation: Plateau vs. Antarctic (2015-2016)
Lenka Kurte (UCN)
lenka.kurte@live.cl

Funding over USD 850,000.
Funding between USD 210,000 and 850,000.
Funding between USD 105,000 and 210,000.
Funding under USD 105,000.

R. Quinán

Line VI

ANTARCTIC ENVIRONMENT

The Antarctic continent is characterized by an environment that features broad and complex interrelationships with the rest of the planet. Antarctica influences and is in turn influenced by what happens elsewhere on the earth.

Antarctica as an "island" continent? It is simply not so. Its cold ocean currents interact with much of the maritime environment of the rest of the world. The Humboldt current affects weather conditions throughout Chile. Furthermore, particles from distant volcanoes, trash from all the continents, and pollen and spores of various plant species, all find their way to Antarctica, transported by wind and currents from distant parts of the world, including South America, Africa, Asia, and Australia.

Antarctica's pristine environment, having very little human intervention, makes it susceptible to harm from increasing human activity. The search for more friendly anthropogenic interaction with this region calls for the development of new technologies adapted to the extreme polar conditions as well as a comprehensive political and regulatory framework for environmental monitoring that is kept up to date.

PROCIEN supports several initiatives in this line of research. Some projects are studying the impact of the Antarctic bases and stations on the freshwater bodies of the Fildes Peninsula, in order to obtain accurate data related to the effects of human occupation on the freshwater ecosystems in Antarctica. This research line also includes assessment of the effectiveness of the Antarctic Treaty, which has regulated activities on the White Continent since it came into force in 1961.

VI.1. Protocol to select paint schemes to protect structural steel against atmospheric corrosion in areas of Chile with high environmental corrosivity (2013-2016)
Rosa Vera (PUCV)
rvera@ucv.cl

VI.2. Anthropogenic pressure over the Antarctic microbial world: Stability of soil communities facing hydrocarbon pollution disturbance (2015-2018)
Sebastián Fuentes (PUC)
sebastian.fuentes.a@gmail.com

VI.3. Biomagnification and potential effects of Persistent Organic Pollutants (POPs) in the aquatic food web of the Antarctic Peninsula and Patagonia (2012-2016)
Gustavo Chiang (C-MERI)
gustavochiang@gmail.com

VI.4. Effects of Antarctic environment on vitamin D status and health risk biomarkers of its inhabitants (2016-2018)
Arturo Borzutzky (PUC)
drarturo@gmail.com

VI.5. An assessment of the impacts of Antarctic bases on the aquatic ecosystems of the Fildes Peninsula (2014-2017)
Roberto Urrutia (UdeC)
rurrutia@udec.cl

VI.6. Characterization of methane cycling in Antarctic and sub-Antarctic lakes (2015-2018)
Ma. Soledad Astorga (UMAG)
msoledad.astorga@umag.cl

VI.7. Environmental levels of xenobiotics in the South Shetlands islands, Antarctica (2015-2018)
Mónica Montory (UDEC)
mmontory@udec.cl

VI.8. Melting Claims: Antarctica as a challenge for theories of territorial and resource rights, and as a conceptual locus for rethinking the normative grounds of sovereignty claims over natural resources (2015-2016)
Alejandra Mancilla (INACH)
amancilla@inach.cl

VI.9. Assessment of heavy metals and persistent organic pollutants on Antarctic fauna from several locations of the Antarctic Peninsula (2015-2017)
José Celis (UdeC)
jcelis@udec.cl

VI.10. Determining the presence of drug residues in waters of the Southern Ocean (2015-2016)
Maccarena Marcotti (UST)
maccarena.marcotti.m@hotmail.es

VI.11. Development and optimization of an analytical methodology for determination of PAHs by solid phase microextraction using stir bar sorptive extraction (SBSE) for snow samples collected from the glacier La Paloma, Antarctic Peninsula (2015-2016)
Carmen Sánchez (UTFSM)
carmengloriasanchezb@gmail.com

VI.12. Environmental Antarctic Monitoring Center (2012-2016)
Claudio Gómez (UMAG)
claudio.gomez@umag.cl

Funding over USD 850,000.
Funding between USD 210,000 and 850,000.
Funding between USD 105,000 and 210,000.
Funding under USD 105,000.

Ilaia. Advances in Chilean Antarctic Science is an official publication of INACH. Its goals include dissemination of information on the Chilean Antarctic Science Program and related activities. *Ilaia* has a circulation of 1,000 copies, distributed free of charge to regional and national authorities, international Antarctic institutions, Chilean and foreign libraries, universities, and researchers. *Ilaia* is an annual publication. The opinions expressed here are those of the authors and do not necessarily reflect the positions of INACH. Total or partial reproduction is allowed with mention of the source.

"Ilaia" is a Yagan word that means "beyond the South."

DIRECTOR
José Retamales
EDITOR
Reiner Canales
(E-mail: rcanales@inach.cl)
EDITORIAL ADVISORY COMMITTEE
Edgardo Vega, Marcelo Leppe, Elías Barticevic, Verónica Vallejos
TRANSLATION
Robert Runyard
DESIGN
Pablo Ruiz
PRODUCTION
René Quinán
Hugo Aguilar (LPA)
Printed by La Prensa Austral,
Punta Arenas - Chile

instituto Antártico Chileno - INACH
Plaza Muñoz Gamero 1055, Punta Arenas, Chile
Phone (56-61) 2298100
E-mail: inach@inach.cl

Reg.Prop. Int. nº 224.246

BEYOND THE SOUTH

INACH
Ministerio de Relaciones Exteriores

Gobierno de Chile