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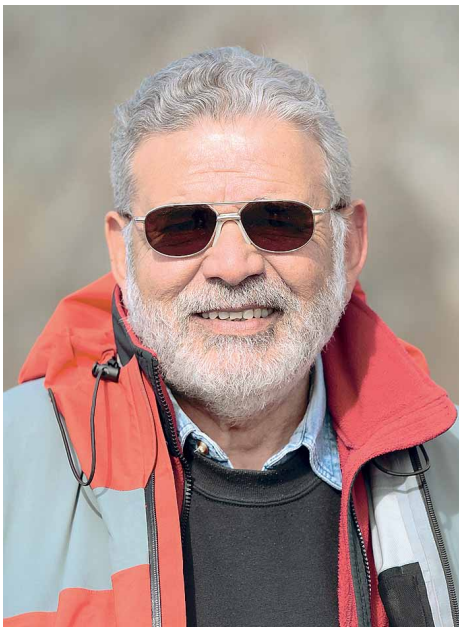


Dr. José Retamales Espinoza
Director
Chilean Antarctic Institute (Instituto Antártico Chileno - INACH)

Foreword

1963 was the charter year for the Chilean Antarctic Institute (INACH), when its first roles were assigned by our Ministry of Foreign Affairs, formalizing Chile's commitments and concerns, and recognizing the nation's historical connection with Antarctica as well as the framework of the Antarctic Treaty.

Likewise, ten years have passed since INACH was transferred to Punta Arenas. Moving away from Santiago was not easy. Many doubts and resistance had to be overcome. We believe that during these years it has been shown it is truly possible to perform successful management of a national agency (verified by indicators that are discussed in this publication) from our outpost location so distant from the national capital, yet so close to the region that gives meaning to its purpose: the Chilean Antarctic Territory.

It is important to note that the conditions needed to guarantee a robust and competitive scientific program are now in place. The available funding for an open scientific proposals competitive program has increased. There is also a broader availability of funds, along with a bigger number of projects. We have seen an expansion in the Chilean Antarctic scientific community, which now includes undergraduate and post-graduate students, young as well as experienced researchers, interdisciplinary teams, groups composed by researchers from different universities, and both Chilean and international participants.

*This issue of PROCIEN 2013 brings you several recent developments. The line of research that has grown the most is that which deals with Adaptations to the Antarctic Environment. There are twenty projects studying the strategies of organisms to survive the cold, the dryness, the high salinity, the atmospheric radiation, and other factors that characterize the polar climate. Scientific interest has focused on studying these biological adaptations and the possible applications that could come from this research. Results have uncovered certain enzymes that can break down fats in waste from the food industry, and biofertilizers that can stimulate growth in commercially valuable plants. Antarctic hairgrass (*Deschampsia antarctica*) extracts have shown activity potentially useful in fighting cancerous cells.*

Relationships between South America and Antarctica, Climate Change, Biodiversity, and Environment make up other lines of research under the PROCIEN banner. It is important to point out the many areas covered under this program, along with the number of researchers and scientific institutions that participate in Antarctic research in Chile, the substantial support supplied by FONDECYT, by PIA (Program for Associated Research), FONDEF, and CONICYT as a whole, together with the projects supported by CORFO-INNOVACHILE. All of them together, combined with the logistical support and direct project funding provided by INACH, make up the strongest national Antarctic scientific research program since the creation of the Chilean Antarctic Institute fifty years ago.

Line I. Relationships between South America and Antarctica

F. TRUEBA/EFE

The projects in this line of research are uncovering a pattern of similarities in the rocks, fossils, and living organisms of two continental land masses that are now separated: South America, and Antarctica. Using a scale of tens of millions of years, it is possible to trace the origins of the southern continental biota all the way to the end of the Age of Dinosaurs. On a more precise scale, a close linkage has been demonstrated for invertebrates and algae from the two regions up until just a few million years ago, when the land connection no longer existed between South America and Antarctica.

1. Seen here is the Antarctic limpet (*Nacella concinna*), one of the dominant species in the rocky intertidal system on the Antarctic Peninsula. In this image it is feeding on macro-algae foliage. Dr. Claudio González is studying the demographic history of this limpet, taking into account the glacial Quaternary period, to reconstruct the phylogenetic relationship between the variants of *Nacella* in the Antarctic and those of the sub-Antarctic Marion Island in the southern Indian Ocean.

Evolution and origins of the austral biota

In recent years important scientific advances have highlighted the significant role of Antarctica in modeling the biota of the southernmost end of the hemisphere. A complex chronological sequence had been reconstructed to cover the natural history of this area, including both geochemical and sedimentary "fingerprints" reflecting the physical connection between Patagonia and the Antarctic Peninsula. This sequence also shows the entry into Patagonia of the first arboreal elements in what has become the Valdivian Forest, and the final separation of groups of marine invertebrates, considerably later than the formation of the Antarctic Circumpolar Current. This model also shows the shaping effect of changes over long periods of time, resulting from the glacial cycles of the Pleistocene and Holocene.

Closer scrutiny of these issues has been the work of several scientific disciplines, including geology, paleontology, biogeography, evolution, molecular biology, and classification. The results have global significance, meaning that young Chilean researchers are finding themselves in the forefront of some of the most important aspects of international Antarctic science.

One outcome of these scientific studies during the last decade has been to identify and highlight the scientific value of a large number of locations with high national and international interest in the fields of biology, geology, and paleontology, as a way of uncovering the complex natural history of southern Chile and Antarctica. The objective is to transform this scientific knowledge into the basis for a new level of tourism in areas of special paleontological interest, with a modern and innovative approach that combines science and tourism.

◉ I.1. Addressing biogeographic and phylogeographic scenarios regarding origin and persistence of macroalgal floral diversity in sub-Antarctic and Antarctic regions using taxonomic, ecophysiological and molecular approaches (2011-2014)
Contact: Andrés MANSILLA (U. de Magallanes)
andres.mansilla@umag.cl

◉ I.2. Factors involved in a cyano-lichen association: availability, specificity and selectivity (2010-2013)
Contact: Julieta ORLANDO (U. de Chile)
jorlando@u.uchile.cl

◉ I.3. Invertebrates and paleoflora of the Early Cretaceous ichthyosaurs site at Torres del Paine National Park, southernmost Chile (2011-2013)
Contact: Marcelo LEPPE y Wolfgang STINNESBECK (INACH - U. Heidelberg)
mleppe@inach.cl

⊙ I.4. Assessment of historical and recent climatic change over Antarctic penguin adaptation (2011-2013)
Contact: Juliana VIANNA (P. U. Católica de Chile)
jvianna@uc.cl

⊙ I.5. Inverse Bergmann's and Cope's rules and the evolutionary dwarfism in Antarctic and Magellanic molluscs (2011-2013)
Contact: Marcelo RIVADENEIRA (CEAZA)
marcelo.rivadeneira@ceaza.cl

Geological evolution of the southern continental land masses

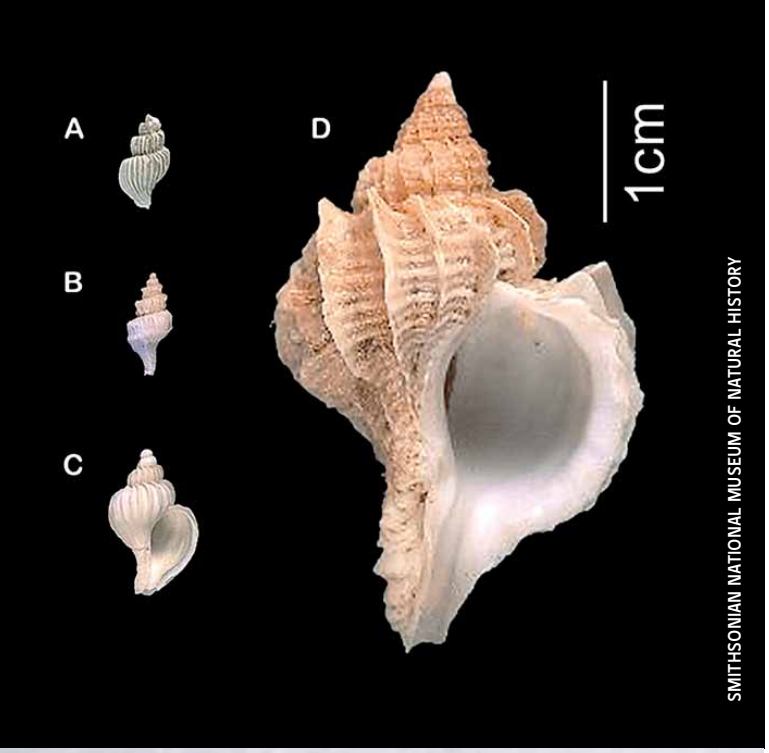
One project funded by the CONICYT Associative Research Program (PIA, in Spanish) and INACH hypothesized that the Antarctic peninsula was attached to the western edge of Patagonia until 200 million years ago (Early Mesozoic) and later migrated to its current location, propelled initially by the forces leading to the opening of the Weddell Sea and the subsequent expansion of the ocean bottom in the Scotia Sea.

Very old rocks - up to 540 million years old - and some that reflect their creation during the Permian (250 million years ago) have supplied considerable information and important background data for determining geological relationships. The Permian rocks had experienced a common metamorphosis, supporting a proof that Antarctica and Patagonia had probably been joined prior to the Permian. A new project is now looking into a comparison of the development of two basins, the Magellan and the Larsen, in Patagonia and the Antarctic, respectively.

◉ I.6. Geological and paleontological evolution of the Magellan and Larsen Basins during the Mesozoic and Cenozoic: source areas and possible similarities (2010-2013)
Contact: Teresa TORRES (U. de Chile)
terexylon@gmail.com


D. SCHORIES

◉ 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.



Phylogenetic studies in marine invertebrates

A group of biologists are planning to use selected organisms as a living marker of the recent and remote pasts, looking into the ultimate element common to evolutionary processes: DNA. Thanks to these genomic and phylogenomic studies it has been possible to determine complex evolutionary relationships between the fauna of Antarctica and those of far-away sub-Antarctic islands around Australia, South Africa, and Chile.

◉ I.7. Phylogeography and evolutionary history of the species *Neobuccinum eatoni* (Mollusca, Neogastropoda) in the Southern Ocean (2012-2015)
Contact: Angie DÍAZ (U. de Magallanes)
angie.ddl@gmail.com

◉ I.8. Comparative genomic sequencing in marine patelogastropods species (*Nacella*, Schumacher, 1817) inhabiting rocky shores from Central Chile to Antarctic Peninsula (2010-2013)
Contact: Leyla CÁRDENAS (U. Austral de Chile)
leylacardenas1@gmail.com

⊙ I.9. Phylogeography, demographic inference, post-glacial patterns and recolonization routes of the Antarctic limpet *Nacella (Patinigera) concinna* (Strebel, 1908) (2011-2013)
Contact: Claudio GONZÁLEZ (IEB)
omeuno01@hotmail.com

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2. Dr. Marcelo Rivadeneira, at the Arid Zone Advanced Studies Center (CEAZA, at the Universidad Católica del Norte) is researching one of the most surprising and unusual features of Antarctic marine biodiversity: the presence of both gigantic and dwarf life forms. In the image here we see examples of dwarfism in Antarctic gastropods of genus *Trophon*. The species *Trophon minutus* (a), *Trophon drygalskii* (b) and *Trophon longstaffi* (c), found in Antarctica, reach less than 1 cm in length. This is in contrast to the species *Trophon geversianus* (d), found in southern continental Chile and Argentina, which may reach 11 cm.

3. Dr. Andrés Mansilla (Universidad de Magallanes) is collecting seaweed samples in the icy polar waters as part of a study to learn about, among other things, the origins of the species in the extreme south (from Chiloé to Antarctica). This research involves study of the seaweed for potential medicinal properties, for food, and for possible sustainable commercial exploitation.

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Line II. Adaptation mechanisms in Antarctic organisms

Deception Island.

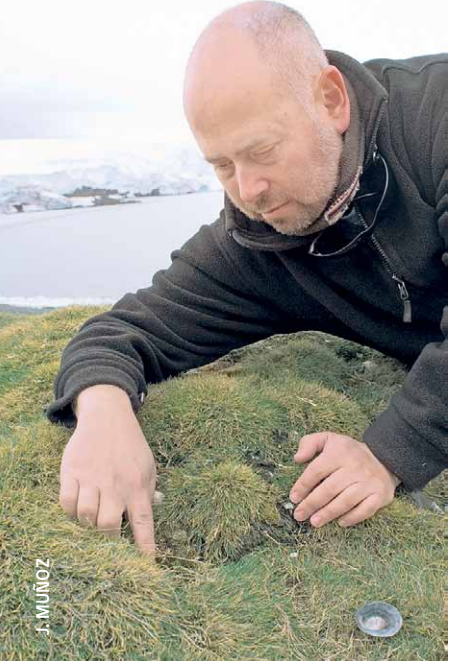
The extreme climatic conditions of Antarctica require that the organisms that live on that continent develop strategies to survive low temperatures, extremely dry conditions, high salinity, and intense ultraviolet radiation, at times enduring several of these environmental conditions at the same time.

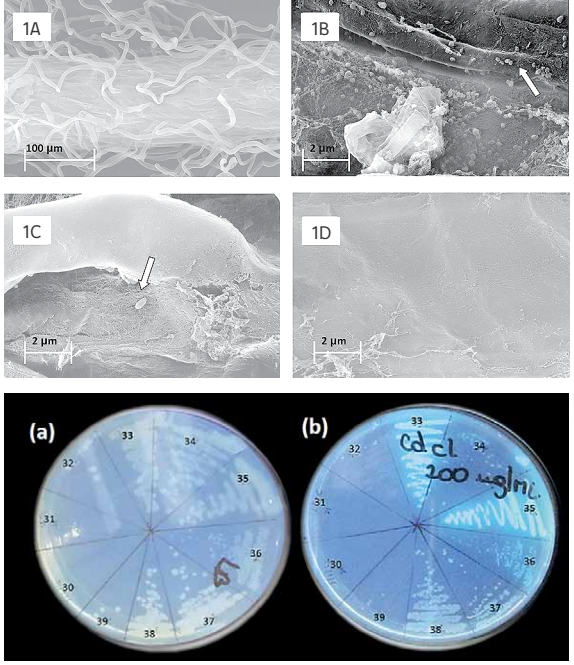
This is how many of our researchers became interested in understanding the biological adaptations at various molecular or physiological levels that have made life possible in Antarctica. But in addition, several projects take an interest in seeking out possible uses or applications that this knowledge might lead to. For example, in the last five years there have been patents for several inventions related to the expressions of proteins that show stability and functioning at low temperatures, preventing cell damage due to oxidative stress. It has also been shown that lipaze type enzymes can act to degrade liquid waste materials with high fat content that come from the food processing industry, or biofertilizers originating from the roots of a vascular plant that grows naturally in Antarctica: *Deschampsia antarctica*, which can enhance the growth of roots in plants with commercial interest. In fact, one of the patents resulting from research performed in Chile with the same plant has proven to have active ingredients for use against carcinogenic cells.

As we can see with these examples, the study of Antarctic plants, bacteria, yeasts, and fungi has succeeded in strengthening this line of research and expanding it for the benefit of improved scientific investigation that Chile is undertaking on the continent.

The microbiology work associated with the National Antarctic Science Program has gathered unusual momentum in these past years, with development of the first project for Antarctic laboratory infrastructure funded by the CORFO INNOVA program. Since then, the projects that study microorganisms have earned a predominant place in PROCIEN, starting with 12.5 percent of all projects in 2006 and increasing to 40 percent in 2011. In the past six years there have been 31 projects in microbiology research, corresponding to 29 percent of all new projects undertaken by Chile during this period (105 projects).

Finally, the projects that are included for this year deal with subjects relating to the study of the yeast *Xanthophyllomyces dendrorhous*, which in previous research has shown a high production of carotenoid pigments when compared to other yeasts, and from which there will now be analysis of metabolytes with biotechnological promise. Other projects in this area of possible applications belong to microorganism genomic studies associated with sponges and cnidarians, employing new DNA sequencing technologies, along with studies of actinobacteria diversity or the enzyme action mechanisms of thermophylic lipazes produced by a bacteria that grows in 70 degree Celsius waters found at Deception Island.





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1. Dr. Manuel Gidekel has studied at length one of only two vascular plants that are able to live on the White Continent: *Deschampsia antarctica*. One of his projects involves isolating those microorganisms capable of living at low temperatures (bacteria and fungus) which are associated with rhizosphere of *Deschampsia antarctica* in order to cultivate them in vitro. The compound image here shows an electron microscope view of a root from *D. antarctica*, colonized by *Pseudomona antarctica*, a strain known for biofertilizer activity. 1A: morphology of *Deschampsia* root-hairs. 1B: surface of root-hairs colonized by *P. antarctica* two months after innoculaton. 1C: surface of the roots of plants colonized by *P. antarctica* two months after innoculation. 1D: root surface of a plant that was not innoculated (free of bacteria).

2. Nanotechnology from Antarctica: That is the work of Dr. José Manuel Pérez (Universidad de Chile), isolating bacteria capable of producing fluorescent nanoparticicles. The figure shows Antarctic bacteria strains. Image A shows bacteria in a standard culture medium, while image B reveals the same bacteria, but grown under conditions that favor fluorescent nanoparticles. Here we see fluorescence in two bacteria strains (shown as numbers 33 and 35).

Adaptation and functionality

Several of the projects in this section study the physiological adaptations to low temperature possessed by marine invertebrates and plants.

The general objectives of these projects are:
- Create a platform to facilitate the study of Antarctic organisms
- Uncover the effects of freezing, UV radiation, hydric stress, and wind on vascular plants; and the expression and modulation of biomolecules in situ.
- The study of relevant biological chemicals produced by Antarctic lichens and mosses, as these interact with and affect the structures of the cellular membrane.
- To isolate psychrophilic microorganisms (bacteria and fungi) associated with vascular plants, to grow them in vitro.

◉ II.1. Antimicrobial peptides of Antarctic bacteria. Synthesis and optimization for control of pathogenic bacteria in foods (2012-2014)
Contact: Sergio MARSHALL y Marcelo GONZÁLEZ (P. U. Católica de Valparaíso - INACH) smarshal@ucv.cl

◉ II.2. New antineoplastic molecule from *Deschampsia antarctica* Desv. (2012-2015)
Contact: Manuel GIDEKEL (Uxmal S. A.)
mgidekel@gmail.com

◉ II.3. Antibacterial activity of Antarctic lichens against multiresistant pathogenic bacteria (2012-2014)
Contact: Gerardo GONZÁLEZ (U. de Concepción)
ggonzal@udec.cl

◉ II.4. Functional metagenomics of whole microbial communities associated with Antarctic marine invertebrates: diversity and bioactive compounds synthetic capabilities (2012-2015)
Contact: Nicole TREFAULT (U. Mayor)
ntrefault@gmail.com

⊙ II.5. Using natural compounds from Antarctic actinomycetes to increase food safety in processing and refrigerated plants (2012-2014)
Contact: Paris LAVÍN (INACH)
plavin@inach.cl

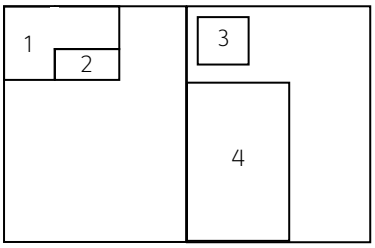
◉ II.6. Bioactive compounds obtained from new fungi isolated from Antarctic marine sponges (2009-2013)
Contact: Inmaculada VACA (U. de Chile)
inmavaca@uchile.cl

⊙ II.7. Secondary metabolites from marine organisms (2009-2013)
Contact: Aurelio SAN MARTÍN (U. de Chile)
aurelio@uchile.cl

◉ II.8. Isolation of Antarctic microorganisms able to synthesize highly fluorescent semiconductor nanoparticles (Quantum Dots) for biotechnological applications (2011-2014)
Contact: José PÉREZ (U. de Chile)
jperezd@gmail.com

⊙ II.9. Analysis and enhancement of the production of metabolites of biotechnological interest in Antarctic *Xanthophyllomyces dendrorhous* yeast strains (2012-2015)
Contact: Jennifer ALCAÍNO (U. de Chile)
jalcainog@u.uchile.cl

⊙ II.10. Enantioselectivity of thermophilic Antarctic lipases in nonaqueous systems (2012-2015)
Contact: Jenny BLAMEY (F. Biociencia)
jblamey@bioscience.cl



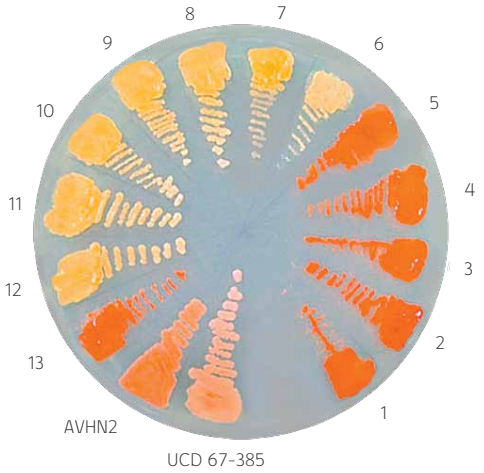
⊙ II.11. Actinobacteria diversity in Antarctic ecosystems and assessment of the biotechnological potential of their secondary metabolites (2012-2015)
Contact: Leticia BARRIENTOS (UFRO)
lbarrientos@ufro.cl

⊙ II.12. Purification and characterization of a thermostable nitrilase from hyperthermophile or thermophilic Antarctic microorganism (2011-2013)
Contact: Geraldine DENNETT (U. de Santiago de Chile) g.dennett@gmail.com

⊙ II.13. Characterization of the intestinal bacteria of the Patagonian toothfish (*Dissostichus eleginoides*) (2012-2013)
Contact: Rocío URTUBIA (U. de Magallanes)
rocio.urtubia@gmail.com

⊙ II.14. Diversity of cyanobacteria in the Antarctic Peninsula (2012-2013)
Contact: Marcelo GONZÁLEZ (INACH)
mgonzalez@inach.cl

◉ II.15. 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)
Contact: Léa CABROL (P. U. Católica de Valparaíso)
lea.cabrol@gmail.com



3. *Xanthophyllomyces dendrorhous* is the name of a yeast with considerable biotechnology interest due to its ability to produce the carotenoid astaxanthin, a pigment used in pisciculture, to give salmon its characteristic color. A PROCIEN project is investigating this yeast in Antarctica, with results revealing that some strains produce up to five time more astaxanthin than other wild yeasts isolated in other parts of the world, such as the south of Chile and Japan. In the image, isolated *X. dendrorhous* yeasts from Antarctica (numbers 1-13) and those from the Biobío region of Chile (AVHN2) and Japan (UCD 67-385).

4. Dr. Jenny Blamey at Deception Island, one of the places that has attracted attention for biological studies due to the particular conditions there that allow the existence of extremophile organisms.


J. MUÑOZ

Biochemical responses to stress conditions

Several projects are focusing on the study of biochemical responses of organisms to stresses encountered in an environment of extreme conditions, and particularly high levels of UV radiation.

◉ II.16. Coping with warming of the Southern Ocean: invertebrate responses to thermal stress conditions (2013-2016)
Contact: Marcelo GONZÁLEZ (INACH)
mgonzalez@inach.cl

⊙ II.17. Evolutionary adaptations of voltage dependent potassium channels in an Antarctic organism (2012-2015)
Contact: Patricio ROJAS (U. de Santiago de Chile)
patricio.rojas.m@usach.cl

⊙ II.18. Effect of radiation (PAR and UV-B) and temperature in the expression of genes involved in the fructans biosynthesis in *Deschampsia antarctica* Desv. (2010-2013)
Contact: Ariel PARDO (U. de Santiago de Chile)
ariel.pardo.ramirez@gmail.com

⊙ II.19. Proteomic and metabolomic analysis of UV-B radiation tolerance on *Deschampsia antarctica* Desv. ex vitro (2012-2014)
Contact: Hans KOHLER (U. de Santiago de Chile)
hans.kohler@usach.cl

⊙ II.20. Evaluation of the effect of Antarctic bacterial supernatant in the survival of zebrafish larvae (*Danio rerio*) challenged with *Flavobacterium* spp (2012-2013)
Contact: Ana RABANAL (U. de Concepción)
anamariarabanal@udec.cl

◉ Funding over USD 850.000.
◉ Funding between USD 210.000 and 850.000.
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⊙ Funding under USD 105.000.

Line III. Abundance and diversity in Antarctic organisms

Life on the Antarctic continent develops primarily in the ocean. The environment suitable for terrestrial organisms is very limited, being principally along the continental coasts and on the islands. Nevertheless there are environments explored only very little, and vulnerable in the face of a changing world. One interesting case is presented for study of the impacts of exotic species introduced into Antarctica through physical vectors (wind and ocean currents), animals (animals (organisms with migratory cycles) and humans. Several PROCIEN projects focus on understanding of the diversity on a population and community level in these environments, along with their vulnerability and stability.

In the ocean there are descriptions for communities that make up plankton (fito- and zoo-plankton), benthic communities (seaweed, protozoans, sponges, crustaceans, ophiuroids , molluscs, and fish) and nekton (fish, birds, and mammals). The first element in this chain is the object of study in four projects that will research the bacterial plankton at a community level.

In the past there existed a general principle which assumed that Antarctic organisms were extremely abundant, but with a relatively low level of diversity when compared with the marine organisms of tropical waters. This assumption has changed radically in recent years. On the sea bottom environments in particular, the number of known organisms has increased by an order of magnitude. In much the same way, microbiological discoveries in land and lake environments have been flourishing in ways previously unimaginable.

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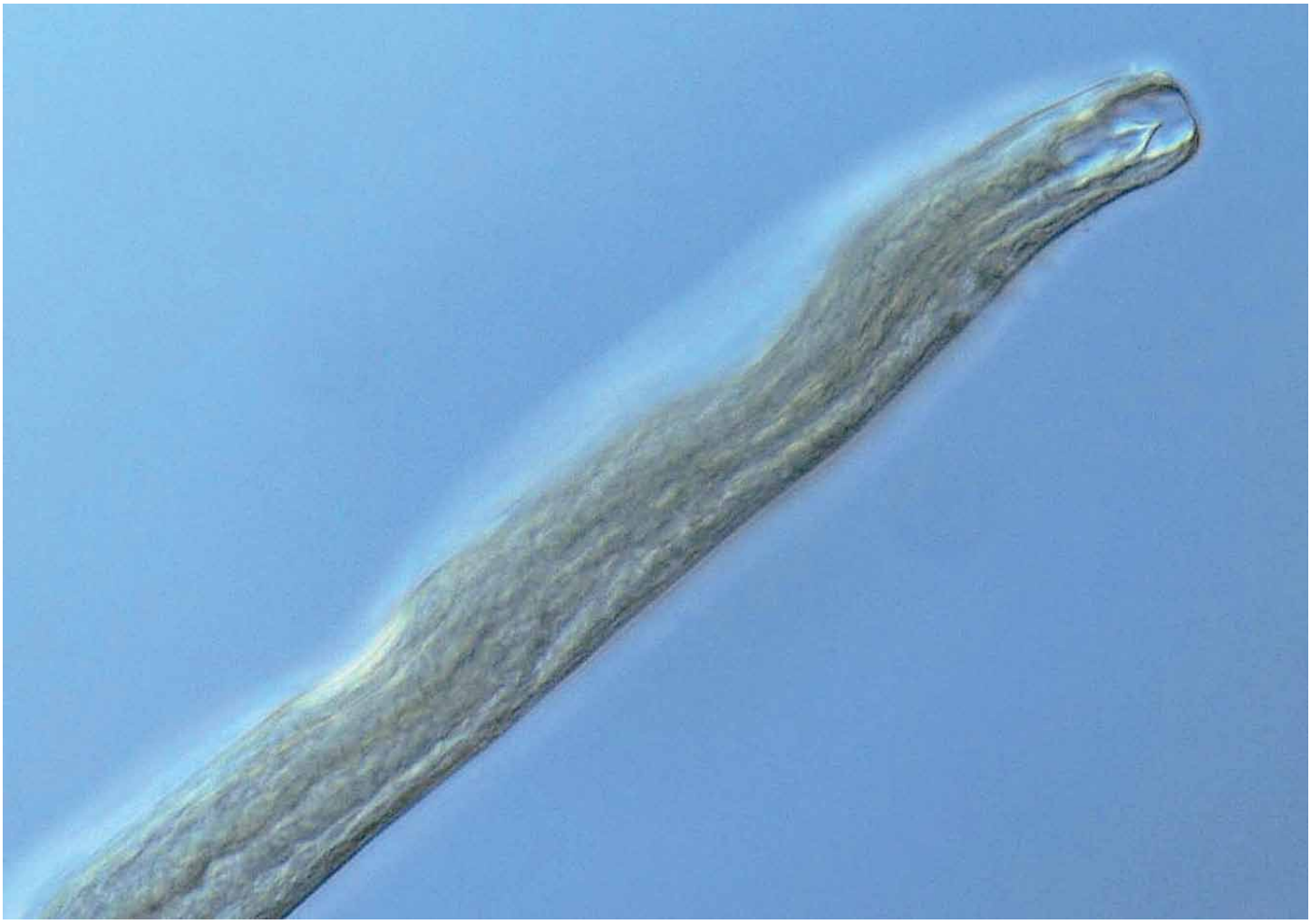

Community-level ecological studies

Ecological studies of communities have differing foci, and one of these involves the characterization of diversity, distribution, and activity of the diazotrophic bacteria found in thermal sources that are distributed along the Chilean Andes range and in Antarctica. This is in addition to seeking better understanding of the marine diazotrophs in the polar regions as part of the identification of new species and genetic material of ecological significance.

The main objective of the project called "High Latitude Meiofaunal Macro-ecology and Diversity Assessed using both Morphological and Molecular Techniques" is to quantify the diversity of the large animals on continental Antarctic beaches and to study their relationships with continental plant life, using morphological and molecular analysis. In this image we see a juvenile nematode from the family Oncholaimidae, found on Elefantera Beach on King George Island.

◉ III.1. DIAZOSPRING: Ecology of diazotrophic cyanobacteria in hot springs along a latitudinal gradient from the Atacama Desert to Antarctica (2011-2014)
Contact: Beatriz DÍEZ (P. U. Católica de Chile) bdiez@bio.puc.cl

◉ III.2. DIAZOPOLARSEA: Marine diazotrophy in the Southern Ocean (2011-2014)
Contact: Beatriz DÍEZ (P. U. Católica de Chile) bdiez@bio.puc.cl

◉ III.3. Diversity and ecology of communities of photosynthetic planktonic eukaryotes in Antarctic coastal waters: a comparison between austral summer and winter (2010-2013)
Contact: Rodrigo DE LA IGLESIA (P. U. Católica de Chile) sirkonio@gmail.com

⊙ III.4. Marine bacterial community structure in polar systems (2012-2013)
Contact: Cynthia SANHUEZA (U. de Chile) ctsanhueza@gmail.com

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◉ Funding between USD 210.000 and 850.000.
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⊙ Funding under USD 105.000.

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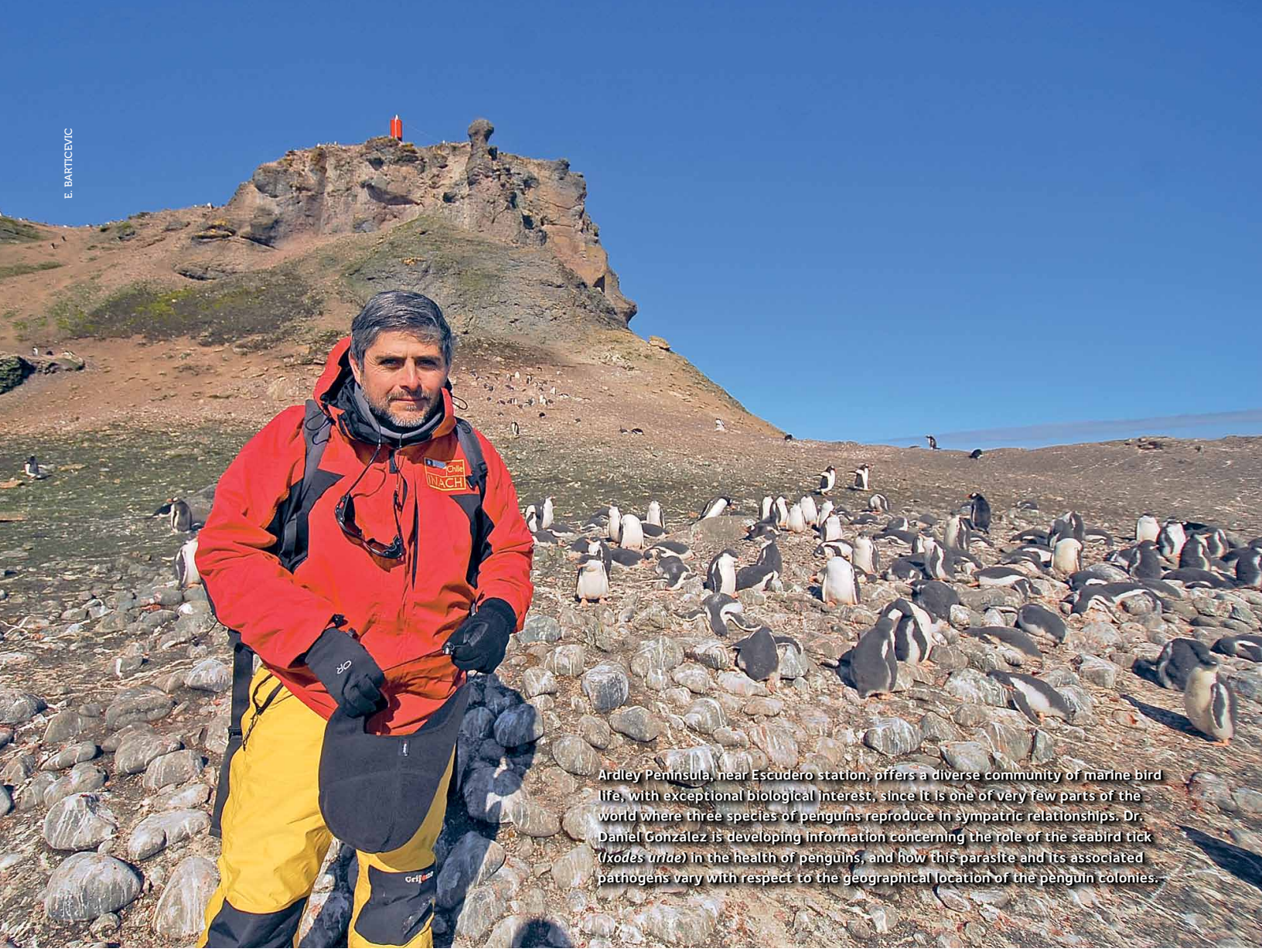
		V.5 ENVIRONMENTAL MONITORING CENTER V.8 WEATHER OBSERVATIONS V.9 NEUTRON MONITORING
	IV.6 GLOBAL IMPACT ON MACROALGAE IV.9 UV RADIATION AND ENDEMIC SPECIES IV.10 ECOPHYSIOLOGY OF ANTARCTIC PLANTS	
		V.1 ATMOSPHERIC CORROSIVITY MAP
III.1 DIAZOSPRING III.8 BIO-OPTICAL MODELING III.9 FRESH WATER AND PRIMARY PRODUCTIVITY	IV.1 CLIMATE CHANGE AND UV RADIATION IV.2 CLIMATE RECONSTRUCTION IV.3 SEISMIC FACIES AND SEDIMENTATION IV.11 PLANT-MOSS INTERACTIONS	V.6 MAGNESTOSPHERE DYNAMICS
	IV.8 THERMAL STRESS IN ECHINODERMS	



Ardley Peninsula, near Escudero station, offers a diverse community of marine bird life, with exceptional biological interest, since it is one of very few parts of the world where three species of penguins reproduce in sympatric relationships. Dr. Daniel González is developing information concerning the role of the seabird tick (*Ixodes uriae*) in the health of penguins, and how this parasite and its associated pathogens vary with respect to the geographical location of the penguin colonies.

Population-level ecological studies

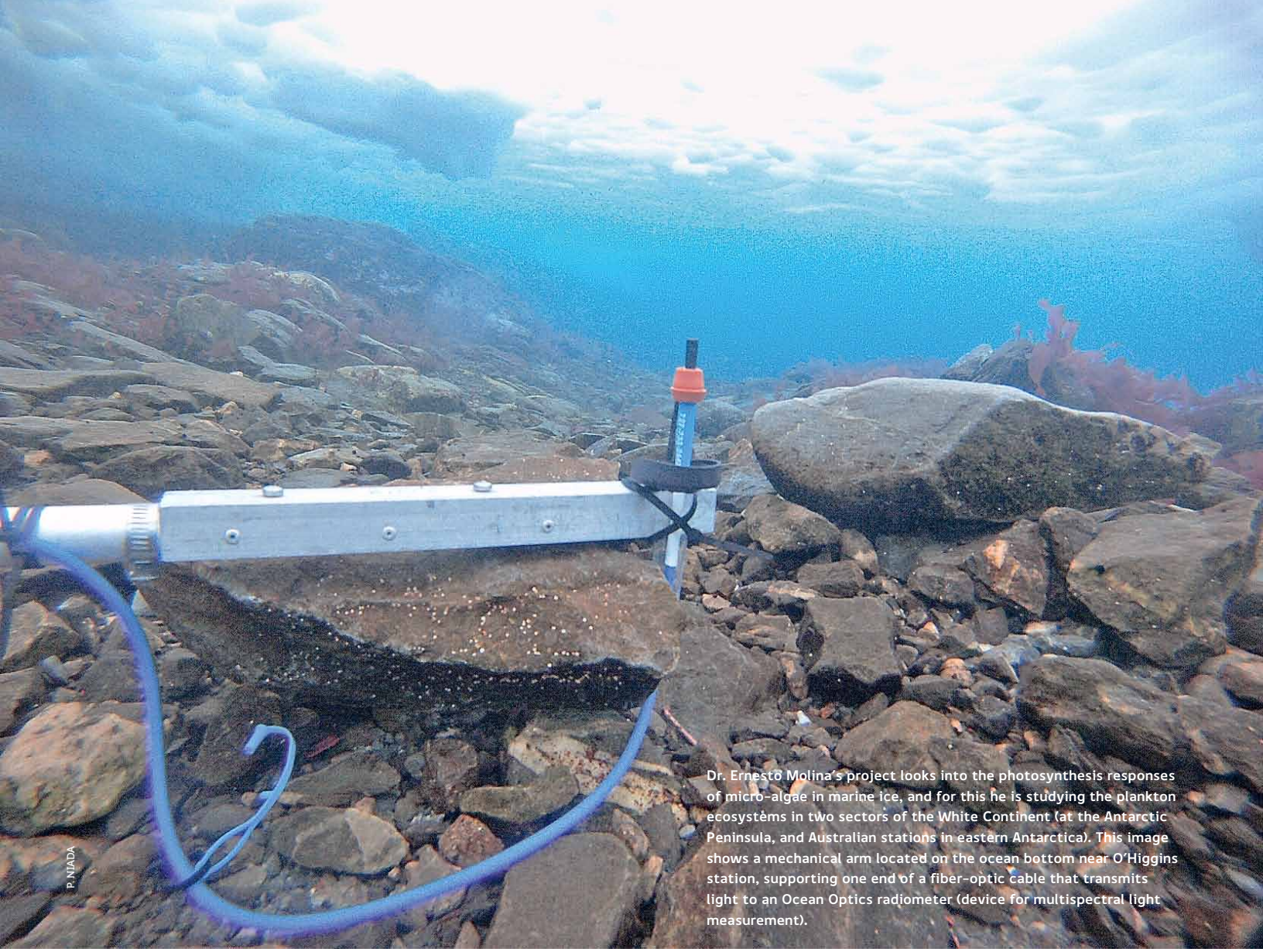
At a species-level, the use of various molecular tools is supplying a valuable insight into the genetic diversity of several organisms, whose distribution and abundance are directly affected by numerous physical and biological parameters which vary according to global changes.

◉ 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.

◉ III.5. The common seabird tick *Ixodes uriae* (White, 1852) as vector of pathogenic virus, bacteria and protozoa to penguins of the Antarctic environment (2010-2013)
Contact: Daniel GONZÁLEZ (U. de Concepción)
danigonz@udec.cl

◉ III.6. Biodiversity of Southern Ocean Seaweed: first local and regional insights using a molecular-assisted alpha taxonomy approach (2012-2015)
Contact: Marie Laure GUILLEMIN (U. Austral de Chile)
marielaure.guillemin@gmail.com

⊙ III.7. Metapopulation research of Antarctic penguins (genus: *Pygoscelis*): Assessing population genetic structure and sex-biased deviation in a molecular approach (2012-2013)
Contact: Paulina VALENZUELA
(P. U. Católica de Chile) pbvalenzuela@uc.cl



P. NIADA

Dr. Ernesto Molina's project looks into the photosynthesis responses of micro-algae in marine ice, and for this he is studying the plankton ecosystems in two sectors of the White Continent (at the Antarctic Peninsula, and Australian stations in eastern Antarctica). This image shows a mechanical arm located on the ocean bottom near O'Higgins station, supporting one end of a fiber-optic cable that transmits light to an Ocean Optics radiometer (device for multispectral light measurement).

Interactions on a physical level

Some of the projects in this line concentrate on the study of relationships which certain organisms have with their physical surroundings. There is research into the role of biological soil crusts formed by varying contributions of communities of lichens, mosses, liverworts, and algae. In this case the soil is formed from accumulations of nitrogen, phosphorus, and organic material from non-ornithological communities or also so-called nitrophobic material. Another project is determining the abundance and composition, both taxonomic and and functional, of eukaryotic phytoplankton in Antarctic coastal waters, and its variations between winter and summer, just as a project from the University of Los Lagos is characterizing nematodes and tardigrades associated with Antarctic intertidal microhabitats, using morphological and molecular techniques, comparing the results with those from the Magellanic region in South America.

◉ III.8. Bio-optical modeling of Antarctic sea-ice algal growth (2012-2014)
Contact: Ernesto MOLINA (P. U. Católica de Chile) emolina@bio.puc.cl

◉ III.9. Influence of freshwater flow on primary productivity, biogenic silica content and nutrients in southern Patagonia and the Antarctic Peninsula (2012-2014)
Contact: Claudia ARACENA (U. Austral de Chile) claudiaaracenap@gmail.com

◉ III.10. High latitude meiofaunal macro-ecology and diversity assessed using both morphological and molecular techniques (2011-2014)
Contact: Matthew LEE (U. de Los Lagos) matt.meio.lee@gmail.com

◉ III.11. The role of soil biological crusts as sources of nitrogen in non-ornithogenic soils of South Shetland Islands, Antarctic Peninsula (2011-2014)
Contact: Cecilia PÉREZ (IEB) cperez@bio.puc.cl

Line IV. Global warming and climate evolution

Changes in the cryosphere and impacts of terrestrial and marine ecosystems

Without doubt we find ourselves today under the influences of climate change that affects parts of the planet unevenly. Recent reports highlight contrasts such as reduced marine ice in the Arctic while at the same time modest increases in Antarctic ice during the past three decades, as one proof of this. Many questions are raised: What is responsible for these differences? How do these changes impact marine and terrestrial organisms? How do we go about obtaining information to reduce the uncertainty in projections for the coming decades? An endless number of other questions justify our redoubling of efforts to go forward with seeking knowledge on these matters that are of such great significance to humanity.

J. PLANA

With respect to the basis of the observed trends, which are connected to a rapid and recent regional atmospheric warming and recorded with instruments, there is evidence that the Antarctic Peninsula is a unique region, being one of the 'hotspots' of the Earth that is warming significantly. This represents an opportunity for our country, given the proximity to the study location where these changes are taking place in so intense a manner. But it is also a threat, since the changes to a system which is so close to continental Chile could signal an early warning about environmental disturbances that could propagate on a global scale.

Within PROCIEN there are several projects that are seeking new evidence for conclusions that will support further understanding of this phenomenon, and to explain the many interactions that may come from this.

Physical variables: earth, sea, and atmosphere

The research into the state of glacier systems – clear indicators of the impact of atmospheric and ocean warming – is being carried out by means of several projects. One is to study specific issues associated with snow chemistry and its relationship with aerosols and climate change. Another, with the same level of funding, will determine the rates of change in tidewater glacier front detachment. Two other projects involve study at small bays on the coast of Danco Island, considering recent historical climate as evidenced in ice cores at the northern end of the Antarctic Peninsula.

Effects on marine organisms

In other areas, the interaction between climate change and biodiversity, and the impacts of global change on the physiology of certain organisms, is undergoing research through another series of projects. This work is to describe and quantify the perturbations on macrofauna and macroalgae that are tied to dynamic changes in the movement of icebergs and on primary production due to growing intensity of UV radiation.

Effects on terrestrial organisms

The study of plant ecophysiology, which is another project in this line, is seeking new answers related to the consequences of climate change affecting terrestrial flora. These effects are associated with physiological performance, including nutrient absorption, changes in metabolism, and carbon balance. Another initiative is looking into understanding the importance of mosses in the establishment of native plants in Antarctica, and trying to characterize the future role for this interaction, using experimentation that employs passive warming at various locations at the South Shetland Islands.


E. BARTICEVIC


E. BARTICEVIC

- 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.

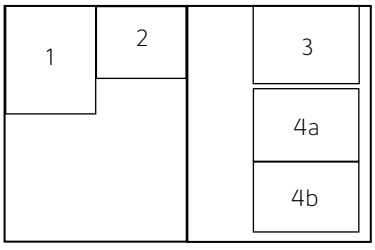
- IV.1. On climate change related effects on surface UV radiation in Antarctica: development of a ground-based UV reconstruction model (2010-2013)
  Contact: Alessandro DAMIANI (U. de Santiago de Chile) adamiani024@gmail.com

- IV.2. Recent high-resolution climate reconstruction for the northern Antarctic Peninsula (2012-2015)
  Contact: Francisco FERNANDOY (U. Nacional Andrés Bello) francisco.fernandoy@unab.cl

- IV.3. Seismic facies variability and sedimentation processes in small bays and fjords of the Danco Coast, Antarctic Peninsula (2012-2015)
  Contact: Cristián RODRIGO (INACH) crodrigo@inach.cl

- IV.4. Para-ICE: towards a better understanding of Ice Calving Events (2013-2015)
  Contact: Christophe KINNARD (CEAZA) christophe.kinnard@ceaza.cl

- IV.5. Chemical fingerprint characterization of Antarctic aerosols and snow at the Laclavère Plateau: Assessment of the impact on glacier retreat and its relationship with global warming (2013-2016)
  Contact: Francisco CERECEDA (U. Técnica Federico Santa María) francisco.cereceda@usm.cl



1. Dr. Cristián Rodrigo's research focuses on the analysis of tidewater glacier environments in order to establish geological and oceanographic correlations that will lead to understanding evolving climate change on the Antarctic Peninsula.

2. Dr. Angélica Casanova is studying the effects of warming on Antarctic mosses and their interactions with native plants. In the photo we see a passive warming experiment using OTC (open top chamber) cameras on the Fildes Peninsula.

3. The project for Dr. León Bravo (in the photo, during field work at Jenny Island in Marguerite Bay) involves assembling an international research group specializing in vegetal ecophysiology, to then study and report on plant responses to temperature and carbon dioxide increases, for the purpose of establishing biological baselines for plant populations in the current Antarctic maritime climate change environment.

4. Dr. Eduardo Quiroga's project is characterizing changes in the diversity of macrofauna on the bottom of the Weddell Sea, in an array of locations disturbed and not disturbed by the movement of icebergs. Figure 4A shows a three-dimensional view of the Weddell sea-bottom, which is dominated by a dense population of stemmed sponges (*Stylocordyla* sp.) and soft corals (Pennatulacea). Below those is a mantle of hundreds of colonies of bryozoans, ascidians, and in the distance, a swimming crinoid. In figure 4B we see an area at the bottom of the Weddell Sea following erosion caused by an iceberg.

Effects on marine organisms

◉ IV.6. Impact of global change on the physiology of Antarctic seaweeds: Consequences for coastal processes in scenarios of temperature shifts and enhanced UV radiation (2012-2015)
Contact: Iván GÓMEZ (U. Austral de Chile) igomezo@uach.cl

⦿ IV.7. Macrofauna community responses to iceberg disturbances on the eastern Weddell Shelf (Antarctica): experimental trawling net simulation of ice scours effects on benthic trophic structure (2010-2013)
Contact: Eduardo QUIROGA (P. U. Católica de Valparaíso) eduardo.quiroga@ucv.cl

⊙ IV.8. Comparing the response to heat stress in tropical and Antarctic echinoderms (2012-2013)
Contact: Marcelo GONZÁLEZ (INACH) mgonzalez@inach.cl


E. BARTCEV/C

Effects on terrestrial organisms

◉ IV.9. Surface spectral UV radiation and UV-linked effects on endemic species (2010-2013)
Contact: Raúl CORDERO (U. de Santiago de Chile) raul.cordero@usach.cl

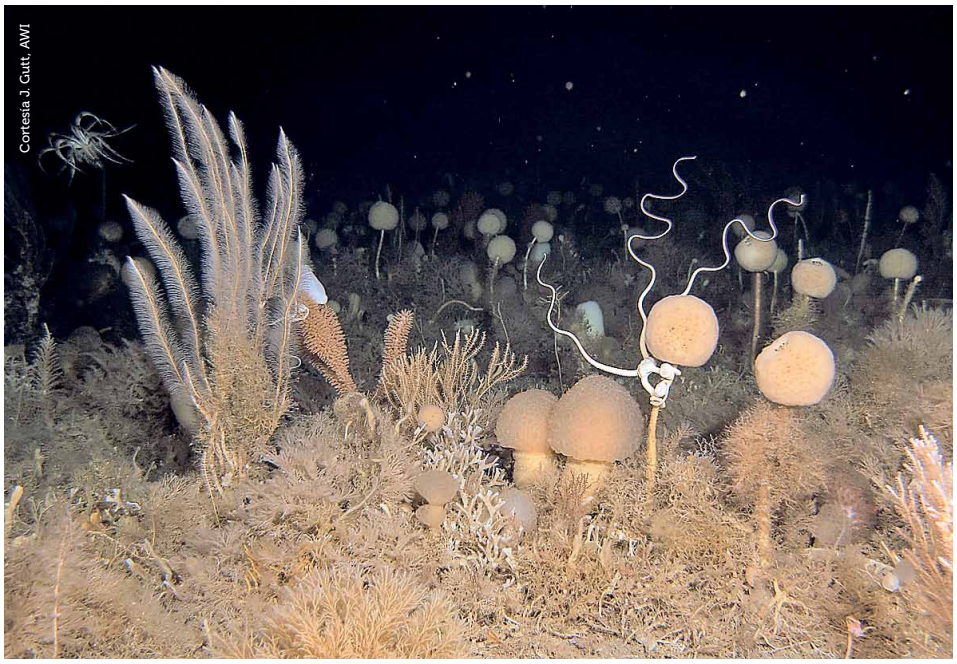
◉ IV.10. Antarctic Plant Ecophysiology: Unraveling the biological consequences of climate change on plant populations of the Maritime Antarctic (2012-2015)
Contact: León BRAVO (U. de La Frontera) labravo@gmail.com

◉ IV.11. Assessing the importance of moss carpets for the establishment of native plants in the Antarctic under a global change scenario (2012-2015)
Contact: Angélica CASANOVA (U. de Concepción) angecasanova@gmail.com

⦿ IV.12. Biological weathering in a soil chronosequence of glacier retreat in the Fildes Peninsula (Antarctica) (2011-2014)
Contact: Roberto GODOY (U. Austral de Chile) rgodoy@uach.cl

⊙ IV.13. Role of fungal endophytes on the ecophysiological performance of Antarctic vascular plants under a global climate change scenario (2011-2013)
Contact: Rómulo OSES (CEAZA) romulo.oses@inia.cl

⊙ IV.14. Morphological and molecular characterization of foliar fungal parasites in *Deschampsia antarctica* plants exposed to climate warming in situ at the Fildes Peninsula (2012-2013)
Contact: Sebastián MORALES (U. de Concepción) sebasmorales@udec.cl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Cortesía J. Gutt. AWI

Line V. Environment and other initiatives

In addition to the projects in the first four lines, there are several others pertaining to additional areas of polar research, which are supported by INACH and which relate principally the Antarctic environment.

J. PLANA

Organic compounds and environmental monitoring

Several projects focus on the effects of anthropogenic contamination in Antarctica, identification of their key parameters, including persistent organic compounds and their potential risks to the Antarctic environment.

Space and atmospheric monitoring

Antarctic presents an exceptional location for atmospheric and space studies, due to its particular features that include isolation and lack of precipitation (the "icy desert") and its unique status as a polar zone.

◉ V.1. Construction of atmospheric corrosiveness maps to metals and alloys of major technological interest for Chile (2010-2013)
Contact: Rosa VERA (P. U. Católica de Valparaíso) rvera@ucv.cl

◉ V.2. Biomagnification and potential effects of Persistent Organic Pollutants (POPs) in the aquatic food chain of the Antarctic Peninsula and Patagonia (2012-2015)
Contact: Gustavo CHIANG (U. de Concepción) gustavochiang@gmail.com

◉ V.3. Fildes Peninsula Resistome: Is there any contribution of antimicrobial resistance genes from waste waters? (2012-2015)
Contact: Helia BELLO (U. de Concepción) hbello@udec.cl

⊙ V.4. Heavy metals in Adeliae, Antarctic, and Gentoo penguin colony soils on the Fildes Peninsula (2012-2013)
Contact: Alessandra PERFETTI (U. de Concepción) aleperfetti@udec.cl

⊙ V.5. Antarctic Environmental Monitoring Center (2012-2014)
Contact: Claudio GÓMEZ (U. de Magallanes) claudio.gomez@umag.cl

◉ V.6. Turbulence in space plasmas and its impact on magnetospheric dynamics and space weather (2011-2015)
Contact: Marina STEPANOVA (U. de Santiago de Chile) marina.stepanova@usach.cl

⊙ V.7. Initial steps in identifying an optimal astronomical observation site in western Antarctica (2011-2013)
Contact: Patricio ROJO (U. de Chile) projo@oan.cl

⊙ V.8. Meteorological observation program for the basic global network of synoptic stations Eduardo Frei, Bernardo O'Higgins and Arturo Prat (permanent)
Contact: Jorge CARRASCO (DGAC) jorge.carrasco@meteochile.cl

⊙ V.9. Neutron Monitor MN-64 for the Antarctic Territory (-2013)
Contact: Enrique CORDARO (U. de Chile) ecordaro@dfi.uchile.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.

Chile, an Antarctic nation

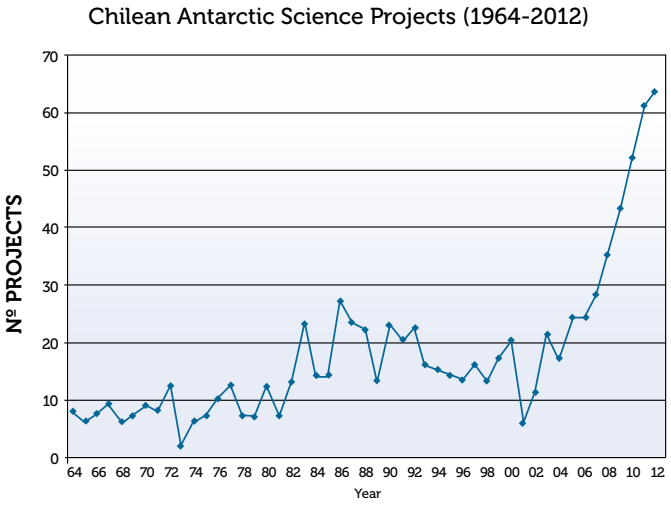
O'Higgins station is located on the Antarctic Peninsula, and includes a complete laboratory and capacity for 8 researchers.

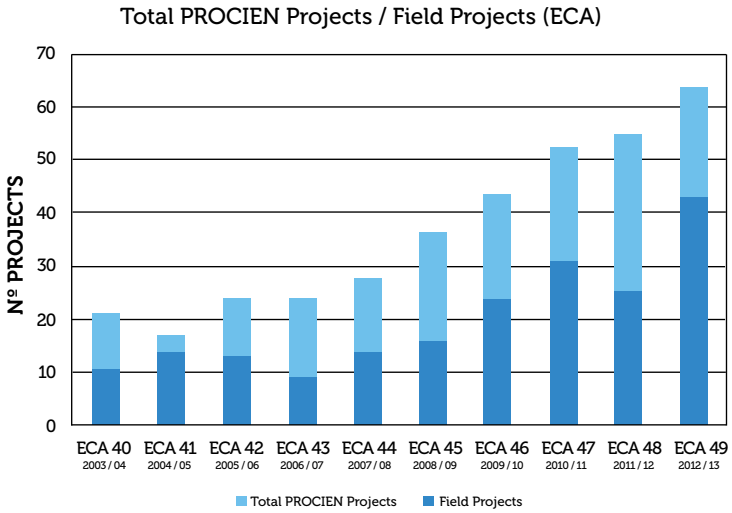
The icebreaker *Óscar Viel* provides transportation for researchers and cargo to several parts of Antarctica, supplying vital support for Chilean national polar science efforts.

The impressive capabilities of the Hercules C-130 provide an air bridge between Chile and Antarctica during much of the year.

Management of the Chilean Antarctic Science Program

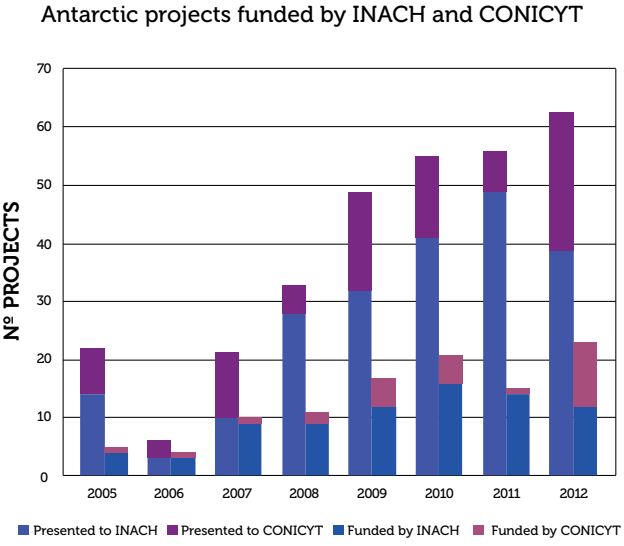
Evolution of the PROCIEN

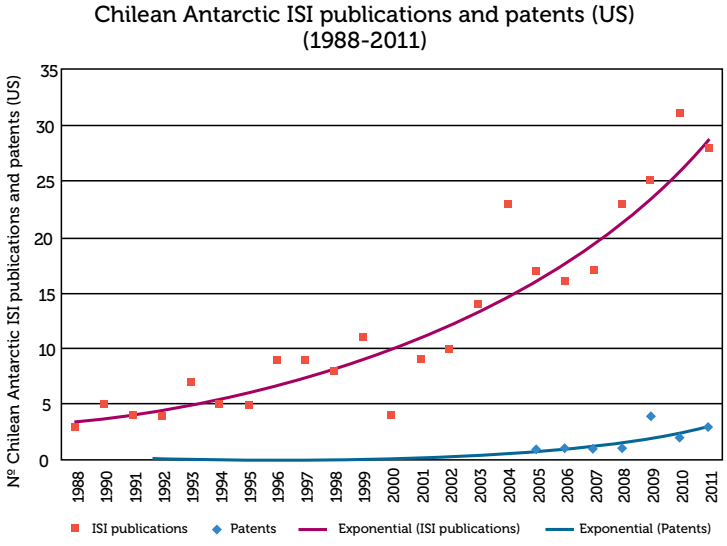




The PROCIEN, thanks to increased funding and additional funding bases, has tripled the number of science projects in the last six years. PROCIEN made possible the projects for the Chilean Antarctic Scientific Expedition (ECA) which was organized by INACH. The number of these projects has increased, with a corresponding growth in knowledge of the Chilean Antarctic Territory, in terrestrial as well as marine aspects.

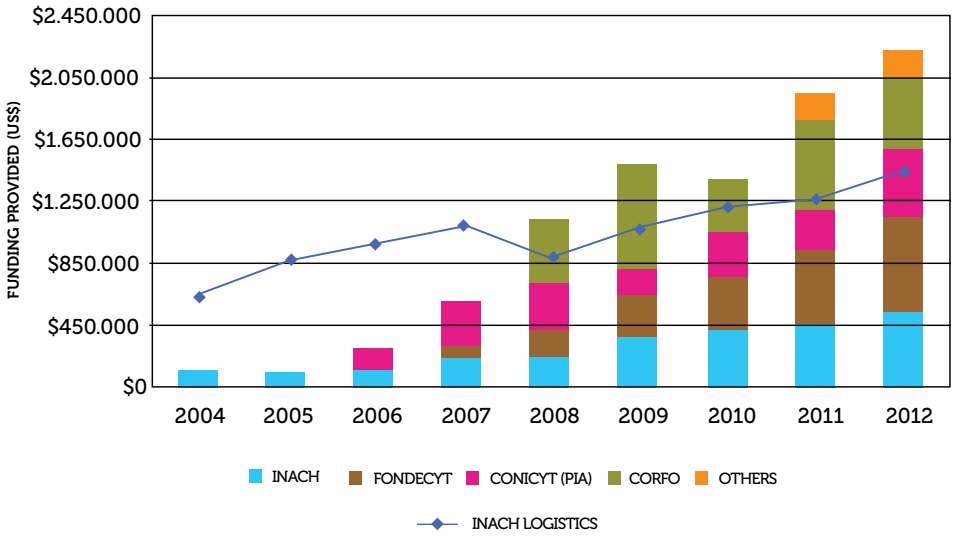
Chilean proposals and publications covering Antarctic science





The figure at the left shows how the number of projects presented to and approved by CONICYT has tripled during the period 2005-2012. This increase is particularly significant in the case of those projects that were presented and ultimately financed by INACH. The relationship between the proposals presented and those accepted (approximately one in three) sustains a healthy degree of competitiveness, which has driven a high level of quality in the projects selected. At the same time, researchers have noted the possibility of following a career in Antarctic science, including current polar work for post-doctorate researchers. Other indicators showing the history of growth of the Chilean Antarctic Science Program include the increasing numbers of ISI publications, and the patents of Chilean Antarctic researchers registered in the United States.

Financing for the Chilean Antarctic Science Program



One of the principal achievements of the PROCIEN has been the increase in funding allocated by all the agencies that finance science and technology in Chile, with allocations further stimulated by the presentations of new proposals. Beginning with USD 850.000 in 2004, this amount reached nearly USD 4 million for 2012, plus the value of the logistical support offered by INACH to all researchers in their work at several locations around the Chilean Antarctic Territory. These figures speak to the ability to sustain the trend in high-quality research projects in new areas of scientific endeavor, and the continuation of a program that is of vital importance to Chile.

The "Profesor Julio Escudero" station is located on King George Island (latitude 62° 12' 57" S and longitude 58° 57' 35" W) and is the most complete scientific station of Chile in Antarctica. Its 1,682 m^2 built provide accommodation for 36 persons, between scientists and logistic personnel, and can shelter up to 60 persons during emergencies. Recently inaugurated facilities include a complete building dedicated to science labs, including a microbiology and genetics lab, a wet lab and divers room for the support of marine sciences, a reading and conference room and a renovated area for leisure activities.

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