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Editorial

After 28 years, Belgium is once again hosting the ATCM, the Antarctic Treaty Consultative Meeting. From 20 to 29 May 2013, some 350 representatives of the 50 signatory countries to the treaty, along with organisations acting as observers and selected experts will gather to discuss the various aspects of the treaty.

The Antarctic Treaty, signed in Washington on 1st December 1959 by 12 states including Belgium, is the foundation stone of the Antarctic Treaty System (ATS), which provides for the cooperative governance of the vast Antarctic continent and surrounding Southern Ocean. Since then, 38 other countries have signed the Treaty and the original text has been supplemented with the Madrid Protocol (1991), which introduced a ban on the exploitation of mineral resources and declared the entire area (7% of the Earth's surface) a natural reserve. The treaty has become a model of international cooperation.

This is the third time that the ATCM is being held in Brussels. The first was in June 1964, and the second, in October 1985. It was in fact on the occasion of this second gathering in Brussels that the Federal Science Policy Office launched its Research Programme on the Antarctic in order to provide ongoing support for Belgian research in Antarctica. Through the Polar Secretariat, our department also oversees the management and operations for the Princess Elisabeth Station that was opened in 2009.

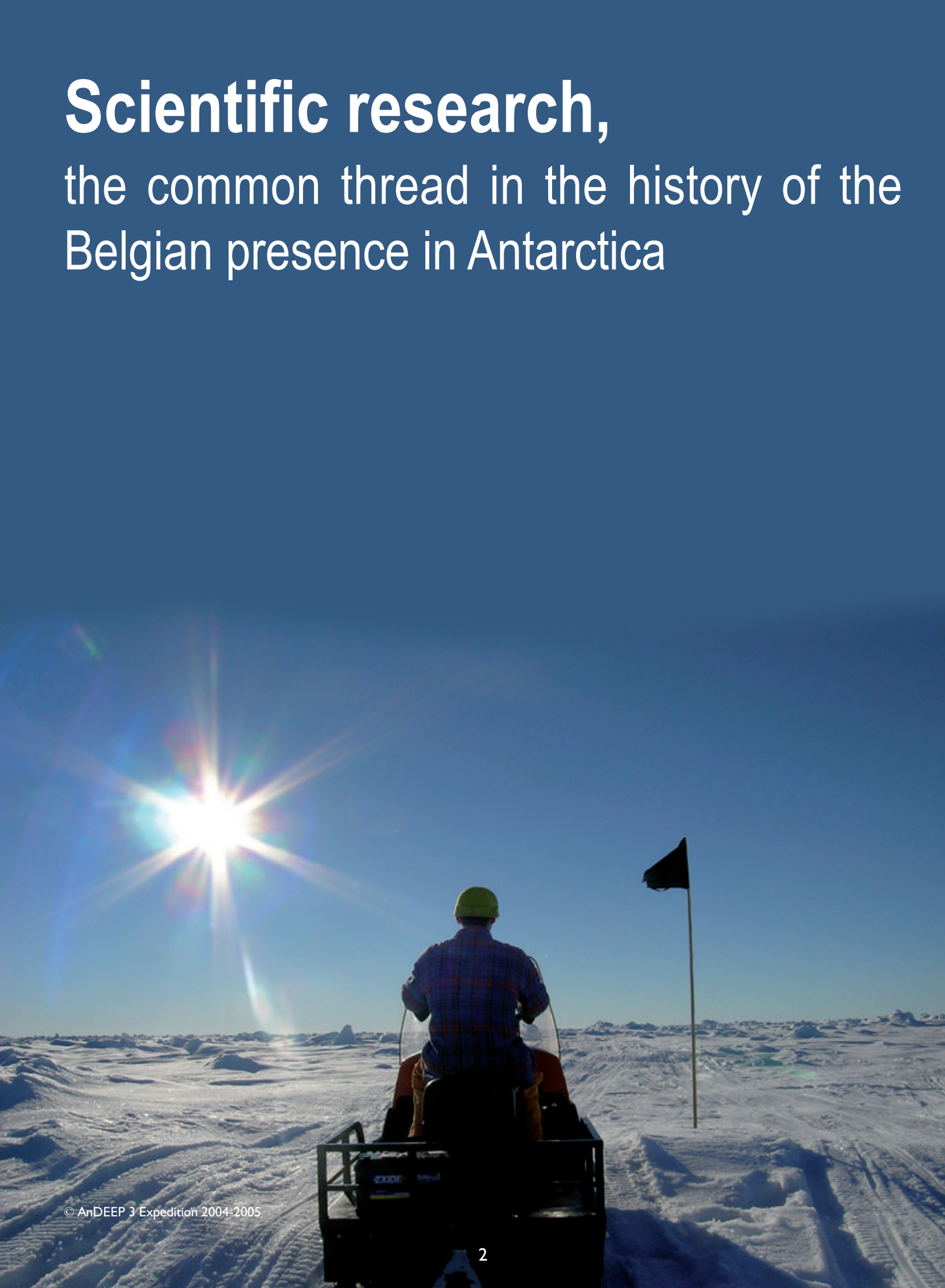
The follow-up of the ATS is carried out in close collaboration with our colleagues from the departments of Foreign Affairs and the Environment. Belgian diplomacy has made a substantial contribution to the success of the Treaty. For example, Belgium was among the 12 founder countries and, as one of the five countries that did not make any territorial claims, we played an important role in the drafting of the Treaty. Later, our country also contributed to establishing a far-reaching environmental protocol (the Madrid Protocol) in 1991. The Federal Department of the Environment is not only responsible for following up all environmental issues handled within the Committee for Environmental Protection (CEP), but is also in charge of granting environmental permits for all activities of Belgian citizens in Antarctica.

Hosting this important meeting in Belgium merits a special edition of *Science Connection*. This issue presents the background of the Antarctic Treaty and discusses its significance, as well as offering a snapshot of current Belgian research activities in Antarctica.
I hope you will find it interesting reading!

Dr. Philippe Mettens
Chairman of the Federal Science Policy Office

Scientific research,

the common thread in the history of the Belgian presence in Antarctica



The Belgica expedition organised by Adrien de Gerlache in 1897-99 took international observers completely by surprise. After all, at the time, Belgium had no established maritime or polar tradition. However, the young nation was undergoing a period of flourishing scientific and industrial activity and there was a spirit of expansionism. De Gerlache was supported and surrounded by a progressive milieu of academics and researchers in emerging scientific institutes and universities. The Belgica expedition is internationally recognised as the first completely scientific and international Antarctic expedition, which furthermore achieved the first successful winter stay in the Antarctic sea ice, thus paving the way for the exploration of Antarctica itself.

The establishment of the Roi Baudouin Base in Antarctica by Gaston de Gerlache, the son of the captain of the Belgica, took place on the occasion of the International Geophysical Year (IGY) of 1957-58. During this IGY, of which the secretariat was based in Brussels, 64 countries measured and quantified the Earth using the most modern tools available, encompassing the depths of the ocean as well as outer space. In fact it was the first major step towards understanding the 'Earth as a System'. All corners of the globe were surveyed, with a key position for Antarctica where 12 countries set up a network of 55 scientific stations, including the Belgian Roi Baudouin Base (1958-1966), systematically recording, for the first time, the entire range of geophysical phenomena such as aurora, cosmic rays, geomagnetism, glaciology, gravity, ionospheric physics, meteorology, oceanography, seismology and solar activity.

Fifty years after the IGY, by organising the 4th International Polar Year (IPY) 2007-2009, the international scientific community launched a new wave of observations in the polar regions. This time, environmental issues were the central theme, with a special focus on the problem of climate change and the role played by the ice cap and surrounding oceans. Studies on the reduced biodiversity and microbiological life in the most extreme conditions were also highlighted. Thanks to the construction of the Princess Elisabeth Station by the International Polar Foundation - commissioned by the Belgian State - Belgium now has a sustainable platform which is involved, on one hand, in the observation network for the study of these environmental issues whilst also, thanks to its use of sustainable technologies and energy sources, itself being a showcase of sustainable development.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It is no coincidence that scientific research in Antarctica forms the basis for a range of important international agreements, which govern peaceful coexistence, non-exploitation and the environmental protection of the region south of the 60th parallel. After all, scientific research is not only the goal of all the activities but also creates the conditions and provides the answers to enable peaceful and environmentally friendly collaboration in this region.

During the IGY 1957-59, the coordination of the scientific observations and the organisation of logistical operations, along with mutual assistance in a human-hostile environment, led to a unique international agreement, the 'Antarctic Treaty' (AT). In this way, the historically grown and largely overlapping territorial claims in Antarctica were put aside by freezing the existing claims on the one hand and by excluding potential new claims on the other. By also instituting a ban on military activities, and this remarkably enough at the peak of the Cold War, it was possible through a system of mutual inspection and exchange of observers, to declare Antarctica in its entirety a continent for 'Peace and Science'. In other words, science as a catalyst for a unique collaboration agreement.


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The geological research undertaken in the years following the IGY had identified potential sites for major ores and minerals and opened the door for the future mining of mineral resources in Antarctica. Needless to say that such an exploitation was difficult to reconcile with the ban on territorial claims. In 1991, after lengthy negotiations, the Madrid Protocol was established and added to the Antarctic Treaty. Relating to mineral resources in Antarctica, this Protocol prohibits any activity other than scientific research. Moreover, the parties are required to protect the Antarctic environment as a nature reserve. One of the means to achieve this is the requirement incorporated in the Protocol that an environmental impact report must be drawn up for all human activity. The functioning and compliance with this Protocol is discussed at the meeting of the Committee for Environmental Protection, CEP, which is part of the annual assembly of the Antarctic Treaty (Antarctic Treaty Consultative Meeting or ATCM). Designating an entire continent and its surrounding oceans (together forming some 7% of the Earth's surface) as a nature reserve is an environmental protective measure that is unprecedented in the history of mankind. Since then, this protocol has shifted the accent in the study and management of Antarctica largely to environmental aspects.

Since 1985, the Belgian Federal Scientific Policy Office has been the entity responsible for the financing and management of the 'Belgian Scientific Research Programme on the Antarctic'. Although this programme originally began as an independent entity, over the years it has been integrated into broader thematic programmes. Since 2012, Antarctic research is a part of the new framework programme BRAIN-be (Belgian Research Actions through Interdisciplinary Networks). The topics covered include: ecosystems, biodiversity, evolution, geosystems, universe, climate and data and collection management. The research projects are evaluated by an international panel of experts.

A typical characteristic of the Belgian research activities is their strong integration with international research networks. This can be explained in part by the fact that in the period from 1985-2009 Belgium did not possess its own research infrastructure in Antarctica and that our research teams thus joined expeditions from other countries in order to perform their studies. Since 2009 participation in the Belgian research campaigns at the Princess Elisabeth Station has been open to other countries. Consequently, the existing international collaboration is being further reinforced and expanded, all in accordance with the spirit of the Antarctic Treaty and in strict application of its principles.

In this context, the Research Programme also provides the possibility for the financial support of foreign partners.

The Polar Secretariat is the state structure created within the Federal Science Policy Office that manages the Princess Elisabeth Station, the emblem of the Belgian presence in Antarctica. The Polar Secretariat exists since May 2009 and is operational since March 2010. It is, in other words, a recent structure that is equivalent to other polar institutes around the world.

For more than a year now, it has been directed by Rachid Touzani. As a bio-engineer and passionately dedicated to the environment, science and innovation, his aim is to develop the Polar Secretariat, after the model of other countries active at the Poles, to actively contribute to gathering the knowledge that is essential for the existence of humanity.

The current role of the Polar Secretariat is to provide the financial, administrative and material management of the Princess Elisabeth Station and to ensure that potential partners in the activities and goals of the station - including the implementation and promotion of scientific activities at the station and the distribution of scientific expertise on Antarctic research and climate change - can be brought together. In order to do this, the Polar Secretariat has set up a strategic five-year plan for the development of the station and its tasks.

Each year, the Polar Secretariat dispatches scientists from Belgium and other countries to the Princess Elisabeth Station, to conduct research in diverse fields such as biology (BELDIVA), glaciology (ICECON), geology and geophysics (GIANT-LISSA), meteorites (SAMBA), and atmospheric sciences (HYDRANT, BELATMOS). These projects are financed by the Federal Science Policy Office.


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Many projects are the result of international collaboration. The SAMBA project, for example, was realised jointly with Japan, GIANT-LISSA with Luxembourg and ICECON with Luxembourg, Norway and Australia. The station is also used by other countries to perform their own research, in which case the Polar Secretariat provides them with logistical support.

The Polar Secretariat has entrusted the International Polar Foundation, as a logistical operator, with the upkeep and maintenance of the Station in the broadest sense, including the operational logistics and equipment within the framework of a public-private partnership. The specific nature of the Station and the extreme conditions of Antarctica make this job an ongoing challenge.

Sustainable management of Antarctica and the related ecosystems (terrestrial and marine) via the activities within the Antarctic Treaty system serves the common interests of all mankind. It is vital for the future that this unique continent be preserved as an irreplaceable research reference zone, for global changes to be studied (climate, ecosystems, biodiversity), and to continue to convince all of mankind of their collective responsibilities.

The authors

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More information

The Belgian Scientific Research Programme on the Antarctic:
www.belspo.be/antar

Antarctica

1959: peace, environment, international scientific cooperation
2013: the strategic challenges of the White Continent

The 36th Antarctic Treaty Consultative Meeting (ATCM) takes place in Brussels from 20 to 29 May 2013 at the Palais d'Egmont, with over 50 delegations and 350 participants expected to attend. The Federal Public Service Foreign Affairs is preparing and organising the conference in coordination with the Public Planning Service Science Policy and the Federal Public Service Health Food Chain Safety and Environment, which are providing assistance with both content and logistical preparation for the conference. The conference is therefore a model of cooperation between different Belgian federal public institutions.

For the Consultative Parties to the Antarctic Treaty signed in Washington on 1 December 1959, it is in the interests of all of humanity that the White Continent continues forever to be used exclusively for peaceful purposes and to not become the scene or object of international discord. All activity relating to mineral resources, other than scientific research, is prohibited by the Protocol on Environmental Protection to the Antarctic Treaty signed in Madrid in 1991.

More specifically, the Treaty 'freezes' the territorial claims of seven states: Chile, Argentina, Great Britain, Norway, Australia, New Zealand and France. However, these countries continue to dominate in the claimed sectors as if the areas belonged to them.

In West Antarctica, the sectors in the peninsula within Chilean, Argentinean and British Antarctic territory overlap in certain parts.

In East Antarctica, the territory is shared by four countries: Norway (Queen Maud Land), Australia (Australian Antarctic Territory), New Zealand (Ross Dependency) and France (Adélie Land).

All of the powers acknowledge that Antarctica is a huge reserve of natural resources.

At a time when, in the North, the Arctic is the subject of a veritable rush towards the riches it contains, some countries are applying increasing pressure to have the ban imposed by the Madrid Protocol lifted so that they can start drilling.

As long ago as 1908, traces of coal were already detected in the region. Explorations conducted since then have gradually uncovered the presence of many other minerals, to the extent that today, the inventory includes oil, methane, uranium, iron, copper, zinc, manganese, cobalt, molybdenum, and even gold and silver. Indications of mineralisation have been discovered on the periphery of the continent and at the top of mountains, on over 3% of the ice-free surface of the territory. The remaining 97% of the territory is covered in a thick layer of ice - 2 kilometres thick on average. Added to this are the huge banks of krill in the waters off the continent. These small cold-water shrimps are of interest to the agri-food industry and pharmaceutical research for anti-cholesterol medication, as well as due to the role played by krill in absorbing carbon dioxide and injecting it into the ocean.

Krill (or *Euphausiacea*) is the generic name of small shrimp of 1 to 2 cm long that live in cold waters. There are almost a hundred different species of krill. Adults live in large groups or shoals that sometimes cover hundreds of km^2, while the eggs and larvae can be found at a depth of up to 1000 m. The krill biomass is equal to 650 million tons, making the species one of the most abundant animal species on the planet.

The species of krill present in Antarctica is mainly *Euphausia superba*. Krill is the primary food source of numerous animals in Antarctica: whales and other cetaceans, penguins, seabirds, fish and large crustaceans. Krill is therefore fundamental to the food chain in Antarctica.

Krill is fished industrially in Antarctica. Thanks to its high calorific value and its high omega-3 content, krill is a great favourite in the nutritional supplement market, in cosmetic products and animal feed. Various authorities and NGOs have sounded the alarm bell. Krill, and the entire ecosystem that depends on it, is the victim of overfishing. Intense control of quotas and the closure of fishing zones are imperative. More than 200 000 tons are fished every year and this figure does not cease to increase. It is not only human activities that are threatening the krill. Its future is also compromised by global warming and the presence of toxic substances in the krill's habitat that it subsequently passes down the food chain.

The limitations on unrestrained exploration followed unrelentingly by commercial exploitation of the White Continent are currently not only legal but also technical in nature. This can be seen, for example, in Great Britain's recent cancellation of its drilling project under Lake Ellsworth, located at a depth of 3.4 km, which it was forced to call off with the scientists being unable to complete the planned operation. In February 2012, in a similar operation, Russia drilled down to a depth of over 3,000 m with a view to reaching Lake Vostok, situated almost 4,000 m under the ice.

The issue of bio-prospecting, i.e. scientific research with a promising economic component, is of major importance in the Antarctic Treaty System. Bio-prospecting has been carried out in Antarctica for a number of years. Such activity is permitted if it is carried out in compliance with the obligation to make the findings of any research freely available. This raises a number of delicate legal questions. Biological prospecting is a major economic and environmental issue, particularly in the pharmaceutical and medical sectors and certain branches of industry. It remains to be seen to what extent the use of the results of scientific discoveries by patents, for example, is compatible with the exchange of scientific data. Since 2002, this theme has come up again and again on the agenda of the ATCM. However, there is an urgent need to settle the issue as it involves commercial activity primarily carried out by the private sector in an extensive and widespread manner. This theme will be addressed at the ATCM XXXVI, which will be taking place in Brussels this year.

Belgium is taking a very active interest in this issue. Our country has previously funded an internet database of bio-prospecting activities and has also actively participated in the work of an intersessional contact group on the same theme. It is essential to ensure that the free exchange of scientific data is not compromised and to maintain consistency with the processes engaged under the Biodiversity Convention and the United Nations Convention on the Law of the Sea (UNCLOS). Any sharing of revenue must also benefit science and environmental protection.

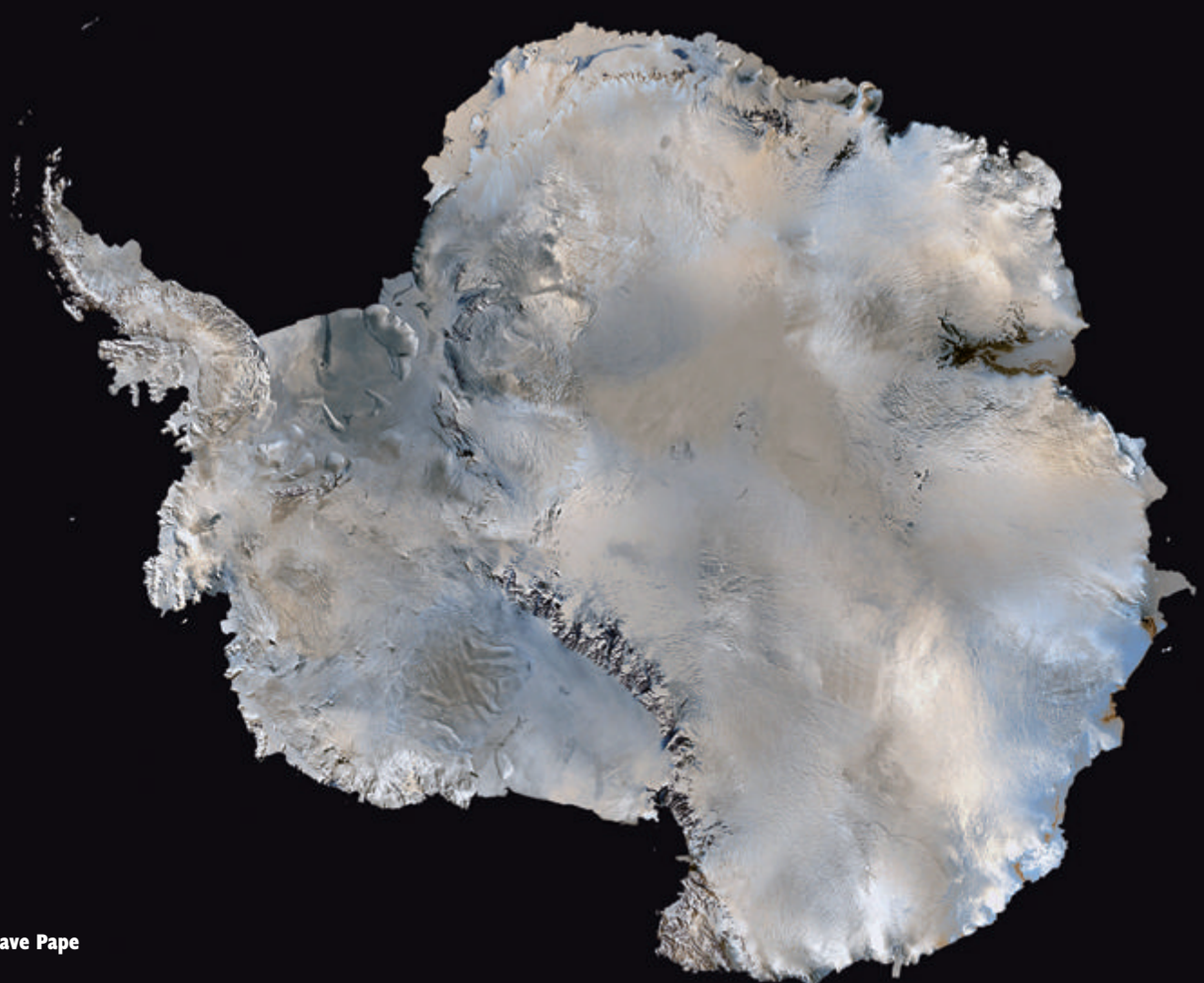
Access to genetic resources and sharing the benefits in Antarctica?

The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization has introduced a global governance system in terms of biodiversity. This protocol, which is an integral part of the Convention of Biological Diversity (CBD), provides a particularly unique legally restrictive framework. This protocol encourages the use of genetic resources and associated traditional knowledge while encouraging the sharing of the benefits resulting from their use. It thus significantly stimulates conservation activities and the sustainable use of biodiversity. Applicable to the genetic resources over which states have sovereign rights (Article 15, CBD), the Nagoya Protocol encourages the countries that supply genetic resources to clarify their policy in terms of access, thus helping to solve one of the most controversial issues in terms of environmental diplomacy: bioprospecting.

However, there are other instruments governing Access to Genetic Resources and Sharing of the Benefits (APA). Some apply to specific subcategories of genetic resources, while others tackle the problem of access to genetic resources situated in well-determined geographical areas.

However, in Antarctica, none of these 'traditional' legal instruments apply because the white continent is subject to an international legal system. The continent and the marine ecosystems surrounding it are governed by specific treaties and conventions which, although they take into account the notions of conservation and rational use, do not provide a comprehensive legal framework for the use of genetic and biological resources with a growing interest for research and its commercial exploitation.

It is therefore impossible to establish a link on the white continent similar to the one established by the Nagoya Protocol between sharing the benefits on the one hand and conservation and sustainable use on the other. However, this shortfall could well be overcome in the future since the parties to the Nagoya Protocol will have to examine, once the latter comes into force, the need and the terms of a global multilateral mechanism to share Antarctica's possible benefits.



Climate change, global warming, longstanding, but ever-increasing, tourism, as well as non-governmental activities in Antarctica are also themes of interest to the Parties and are addressed in the ATCMs.

Belgium will continue to defend the principle that the continent should be a land of peace, and that its unique ecosystem should be safeguarded, scientific research promoted and the environment protected.

Scientists in a cold sweat over impact of global climate change in Antarctica!

The 2007 'Fourth Assessment Report' of the Intergovernmental Panel on Climate Change (IPCC) represented an unquestionable milestone for international climate policy because it clearly removed any uncertainties about the causes of climate change (mankind), and global warming sceptics were put in their place once and for all. But it was also valuable because it expressed the consensus of some 2000 renowned climate experts worldwide on a very large number of findings, about which there can now no longer be any doubt in scientific circles.

This report also extensively discusses the warming of Antarctica and its impact. There is, for example, unanimous agreement that there has been a strong and significant temperature increase over the last 5 decades, although considerable regional differences are observed.

In the areas, which have had to face greater temperature increases, there has been a clear impact on the terrestrial and marine ecosystems. For example, sponges and their predators in shallow waters are thriving, whilst the krill populations, Adelie and Emperor penguins and Weddell seals are in decline, and meanwhile on land, two native flowering plant species are benefiting from the rising temperatures…

However, 2007 is already a long time ago. Since then numerous scientific studies have been published demonstrating that climate change is having an ever greater and more rapid impact. And although of all the continents, Antarctica appears to have been somewhat spared from global warming, there may be harmful long-term consequences, both directly – on the Antarctic ecosystems themselves – and indirectly, via feedback systems with impact on the climate.

In late 2013, the first part of the fifth IPCC-Assessment Report is due to be published with new findings and forecasts. One thing is absolutely sure: the bottom line of this new report will not be reassuring!

Our country recalls its historical role in the discoveries in Antarctica going all the way back to the 1897 expedition of Adrien de Gerlache de Gomery (1866 -1934) on the Belgica, the first to over-winter in Antarctica. His son Gaston led the Belgian expedition that established the King Baudoin base in 1957, during the International Geophysical Year (IGY 1957-1958).

As an original signatory of the Antarctic Treaty, Belgium is once again making a significant contribution to scientific research on site with the Princess Elisabeth Polar Research Station and is playing an active role in follow-up conferences to the Treaty. Belgium will use the occasion of the ATCM XXXVI to showcase its expertise in environmental technology, evidenced in the creation of the Princess Elisabeth Station, the first 'zero emission' Antarctic base. Several Parties have shown an interest in the concept in recent years, which has a promising future in Antarctica, with certain parties considering the construction of a station based on this model. Belgium is entirely willing to share the details with scientists of the other Parties to the Treaty in keeping with the spirit of cooperation of the Treaty.

As regards protection of the environment, the ATCM has adopted numerous measures aimed at broadening, completing and enhancing protection of the environment in Antarctica. Belgium would like to protect the ecosystems of the southern oceans to the greatest extent possible, where the CCAMLR (Convention for the Conservation of Antarctic Marine Living Resources, 1980) already serves as a model for other RFMOs (Regional Fisheries Management Organisations) within the context of the sustainable management of fish stocks.

The FPS Foreign Affairs will continue to play its role in the ATCMs to ensure that the spirit of the Antarctic Treaty System is respected by the other consultative parties and to prevent the development of a (very apparent) underlying current of geopolitical and economic interests, under the guise of 'promotion of scientific research'.

There are great expectations for the White Continent in many areas which are touched upon in the terms of current international undertakings in relation to Antarctica.

Alongside the natural economic potential identified globally, both in Antarctica and central Asia where the 'Great Game' of the 21st century is well advanced, the promises of diverse mineral wealth offered by Antarctica are the stuff of wonder. This huge wealth is beginning to arouse keen interest. Within the context of the increasing scarcity of raw materials, which has driven a rush towards exploration in all parts of the globe, the southern polar region constitutes a focus of new economic and geopolitical challenges on a truly global scale.

Many powers are investing politically in Antarctica in the hope of maintaining a major diplomatic voice with regard to policies on governance in Antarctica and internationally.

Antarctica and the protection of the environment

The Antarctic Treaty, signed in Washington D.C. on 1st December 1959, was the first of the great treaties to submit part of the planet to a specific international system. The area covered by this Treaty is defined as that which extends below the 60th parallel of the southern hemisphere. Antarctica is therefore both a continental zone and a marine zone.

As a consequence of the exclusive scientific rights, all military activity is banned. Another consequence of exclusive scientific use, which does not however fall under the scope of the Washington Treaty, is the prohibition – or at least the limitation – of the prospecting and exploitation of natural mineral or fossil resources. These types of activities were the subject of former negotiations which culminated in their complete ban by the Madrid Protocol of 1991, ratified by Belgium in 1996, which came into force in 1998.

1.The Madrid Protocol on Environmental Protection

During the 1980s, Belgium was one of the first countries to support the negotiation of a specific protocol aimed at protecting the environment in Antarctica. In 1989, the federal parliament modified the law of 12 January 1978 relating to the protection of the fauna and flora in Antarctica by adding an article banning any person of Belgian nationality and any Belgian legal entity from conducting any act aimed at prospecting, exploration or the exploitation of Antarctica's mineral resources. The Madrid Protocol is part of the Antarctic Treaty System, designating the continent as a '*natural reserve, devoted to peace and science*', banning any activities associated with Antarctica's mineral resources, except for the purpose of scientific research, and defining the conditions of any scientific or touristic activity in the region. In the annexes, it sets out the rules for the establishment and management of the protected areas[1] by the members, the assessment of impact on the environment[2], the conservation of the fauna and flora[3], the elimination and management of waste[4], the prevention of marine pollution[5] as well as the liability regime for damage caused to the environment

Until 2048, the Protocol can only be modified with the unanimous agreement of all parties at The Antarctic Treaty Consultative Meeting (ATCM). To implement these principles, the federal parliament adopted a law on these matters on 7 April 2005. In accordance with this law, the Federal Public Service Health, Food Chain Safety and Environment is responsible for Belgium's implementation of the Madrid Protocol.

2.The Committee for Environmental Protection

The Madrid Protocol created the Committee for Environmental Protection (CEP). This committee is an expert advisory body composed of 35 party states and 1 observer state, which gives opinions and formulates recommendations at the meeting of the Treaty's member states. The CEP will hold its 16th meeting in Brussels from 20 to 24 May 2013. The CEP's main areas of activity are environmental impact assessments (EIA), the designation of protected areas and the protection of biodiversity. Certain aspects of the protocol will be examined below.

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1. Cf. below ASPA and ASMA
2 and 3. Cf. below
4. Annex III of the Environment Protocol stipulates that 'the amount of wastes produced or disposed of in the Antarctic Treaty area shall be reduced as far as practicable'. It also identifies different types of waste that must be disposed of and sets out the rules for the storage and removal of waste. The introduction of certain products such as PCBs is prohibited in Antarctica. The annex also provides planning for waste management and the removal of waste from past activities.
5. The area covered by the Antarctic Treaty consists of 20 million km² of the Southern Ocean. These waters are designated as a 'special area' and special compulsory methods for the prevention of marine pollution must be adopted (International Agreement for the Prevention of Pollution from Ships). Annex IV of the Protocol on Environmental Protection prohibits the discharge of hydrocarbons, noxious liquid substances or waste into the area covered by the Antarctic Treaty.

2.1 *Biodiversity*

Antarctica has been relatively spared from human activities. The protection of the indigenous fauna and flora has thus been a major concern since exploration of the continent began. The Environment Protocol stipulates that the activities to be undertaken in Antarctica shall be planned and conducted so as to avoid 'further jeopardy to endangered or threatened species [plant or animal]'.

The Protocol sets out specific measures, including:

- the prohibition of taking (removing) and causing harmful interference, except with a permit[6];
- the prohibition of introducing non-native species (live poultry or other birds or dogs), except with a permit[7]; and
- the designation of specially protected species (Southern giant petrel, albatross or Ross seal).

Ross seal © NOAA Photo Library

Belgium is very active in this domain since it is the initiator of the www.biodiversity.aq website which has a freely accessible online database with all available data on biodiversity in Antarctica (see biodiversity.aq article).

CCAMLR (see CCAMLR box) focuses on the conservation and rational use of krill, fish and other marine resources living in the area covered by the convention.

2.2 *Protected Areas*

The CEP designated seventy-one Antarctic Specially Protected Areas (ASPA) and seven Antarctic Specially Managed Areas (ASMA). An ASPA aims to protect areas of outstanding environmental, scientific, historical, aesthetic or natural importance, and scientific research in progress or that is planned (for instance, Mount Harding, Adélie Land, etc.). An ASMA is an area where activities are conducted or will be in the future (for instance, the Larsemann Hills in East Antarctica, Deception Island, etc.).

An official list of historic sites and monuments (HSM) has also been in existence since 1972. Eighty-six sites are now considered as being of historical importance, for instance, Amundsen's tent used for his 1911 expedition, now buried under the snow and ice, the ruins of numerous bases, the memorial to the 257 victims of the Mount Erebus plane crash in 1979, the bust of Lenin on the site of the former Soviet base, etc.

The list of all the protected areas is available at the following address: *www.ats.aq/devPH/apa/ep_protected.aspx?lang=e*

2.3. *Environmental Permits*

In accordance with the law of 7 April 2005, the FPS Health, Food Chain Safety and Environment is also responsible for preparing the environmental permits required for any Belgians visiting Antarctica for touristic or scientific purposes. These permits are signed by the minister or secretary of the federal government responsible for the environment policy. Approximately five permits are issued every year.

In 2012, eight permits were granted. The permit issued at the beginning of November was for the BELARE 2012-2013 expedition at the Princess Elisabeth base. A permit was also granted for three cruises with tourists on board of a schooner under Belgian flag.

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6. These permits specify which activities are authorised. They are only issued (a) to supply specimens for study or scientifc information; (b) to supply specimens for museums, conservatories, botanical and zoological gardens or other institutions or uses of an educational or cultural nature. It is forbidden to take more mammals, birds or indigenous plants than is strictly necessary.
7. This includes only two exceptions: domestic plants and laboratory plants and animals, including viruses, bacteria, yeasts and fungi.

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2.4 The Marine Ecosystems in Antarctica

From a biological point of view, it is difficult to separate the terrestrial and marine parts of Antarctica. The marine mammals whose territory is protected by ASPA (*Antarctic Specially Protected Areas*) must be able to find sufficient food in the marine areas. This can be a problem if, for instance, these have been overfished.

On a political level, the international community decided to govern the continent of Antarctica through the Antarctic Treaty[8]. However, as regards Antarctica's marine life, another instrument, the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) was created in 1982.[9] CCAMLR is thus the reference organisation for the marine ecosystems.

CCAMLR is the acronym used for the Commission for the Conservation of Antarctic Marine Living Resources). This Commission was set up in 1982 following the signature of the Convention on the Conservation of Antarctic Marine Living Resources. The purpose of this Convention was to provide the Treaty's consultative parties with a multilateral response to the threats against the region's marine ecosystem owing to the increasing interest for commercial fishing of Antarctica's numerous resources, including krill.

Principles – CCAMLR applies an ecosystemic management approach. This approach does not exclude exploitation, but it makes it subject to the condition of sustainability and taking into account the effects of fishing on the other elements in the ecosystem. On the basis of the best scientific information available, the Commission has approved a series of conservation measures determining the use of Antarctic marine living resources. Therefore, this not only concerns the species that are the subject of commercial fishing, but also other species of fish, as well as seals and cetaceans.

Members – The Commission is comprised of 25 'initial' members including Belgium. The Commission is supported by a secretariat, situated in Hobart, Australia (Tasmania).

Protected Marine Areas

One of the ways in which CCAMLR intends to protect marine biodiversity and its unique ecosystem is by establishing marine protected areas (MPAs), an option that is explicitly provided for in the convention,[10] and consequently supported by the international community.

In 2002, at the World Summit on Sustainable Development (Johannesburg), States committed to establishing representative networks of marine protected areas by 2012. The international community repeated this promise at the 10th Conference of Parties to the Convention on Biological Diversity (Nagoya, 2010) – where the member States also committed to protecting 10% of the coastal and marine areas by 2020[11] – and at the Rio+20 Summit in Brazil in June 2012.

The toothfish (*Dissostichus* – known as the toothfish for obvious physiological reasons) is a large-sized fish that can grow up to 2 m long and weigh approximately 80 kg. It can live for more than 35 years. It is essentially demersal - i.e. it lives close to the bottom. The Southern Ocean toothfish is the subspecies found in Antarctica.

Threats – The toothfish is greatly appreciated for its firm white flesh and its gastronomic popularity is increasing. This success is recent since intensive commercial fishing only began in the 1990s. Considering its demersal life, the toothfish is often fished by bottom-trawling, which has a destructive effect on its habitat. Despite the fact that this form of fishing is now forbidden, the toothfish is regularly the subject of illegal fishing. Given its very slow reproductive cycle – often after dozens of years – the toothfish is particularly vulnerable to overfishing.

8. http://www.ats.aq/e/ats.htm
9. http://www.ccamlr.org/en
10. Article 9.2g, CCAMLR.
11. CBD Dec. X/29.
12. See, among others, CCAMLR-XXIII, § 4.13; CCAMLR XXIV, § 4.14; CCAMLR-XXIV, § 4.12; CCAMLR-XXVII, § 7.2 (i); CCAMLR-XXVIII, § 7.19; CCAMLR-XXVII, § 17.9.

CCAMLR did indeed fulfil its responsibilities and pursued this call in 2004 by adopting resolutions encouraging its various committees and workgroups to proceed with the study of the possibility of marine protected areas in Antarctica.[12] In particular, there was the adoption in 2011 of the general framework for establishing CCAMLR marine protected areas.

CCAMLR applies an ecosystemic approach, as well as the precautionary principle , thus making it one of the most progressive fishing management organisations, in particular for areas beyond national jurisdiction.

During its meeting in 2012, different proposals for the creation of a network of marine protected areas were put forward by the European Union, Australia, New Zealand and the United States, among others. However, the Member States of CCAMLR didn't manage to reach an agreement and were therefore unable to respect the 2012 deadline. This is why a CCAMLR extraordinary inter-sessional meeting will take place in July 2013 in Germany. The member States will thus have a final chance to take action in line with the expectations and prepare a proposal that could be unanimously adopted during CCAMLR's formal meeting in autumn 2013.

Opportunity for a side event at the ATCM

The establishment of marine protected areas in Antarctica is not only one of CCAMLR's hopes; it was also broached by the member States during the meetings of the Committee for Environmental Protection (CEP), which took place during the annual Antarctic Treaty Consultative Meetings (ATCM). The CEP identified the creation of marine protected areas as a priority[13] and co-organised workshops on the subject with CCAMLR. Furthermore, the majority of CCAMLR States are also Parties to the Antarctic Treaty and the areas aimed at by the two conventions are not only connected geographically, but actually interconnected. The links between the two entities are therefore obvious.

On 23 May 2013, Belgium will organise a side event at the ATCM with the NGO Antarctic Oceans Alliance[14], entitled 'Blue and White, Land and Sea'.

The aim is to reaffirm the environmental protection and conservation commitments included in the Antarctic Treaty and to highlight the synergy between the management of the terrestrial and marine components of the environment in Antarctica.

The side event is an opportunity for cooperation between the members of the Antarctic Treaty to encourage the establishment of a system of marine protected areas through a process that CCAMLR has already put into motion.

ATCM XXXVI hence offers States – the majority of which participate in the work of CCAMLR and CEP - a unique chance to consult each other on an informal basis. Moreover, the issue of marine protected areas will be the subject of a side event co-organised by Belgium on the sidelines of the ATCM.

The extent and the potential of ATCM XXXVI is therefore not limited to the terrestrial part of Antarctica; the meeting will also have an impact on the region's marine resources.

13. CEP IX Final report, §§ 94-101.
14. http://antarcticocean.org/

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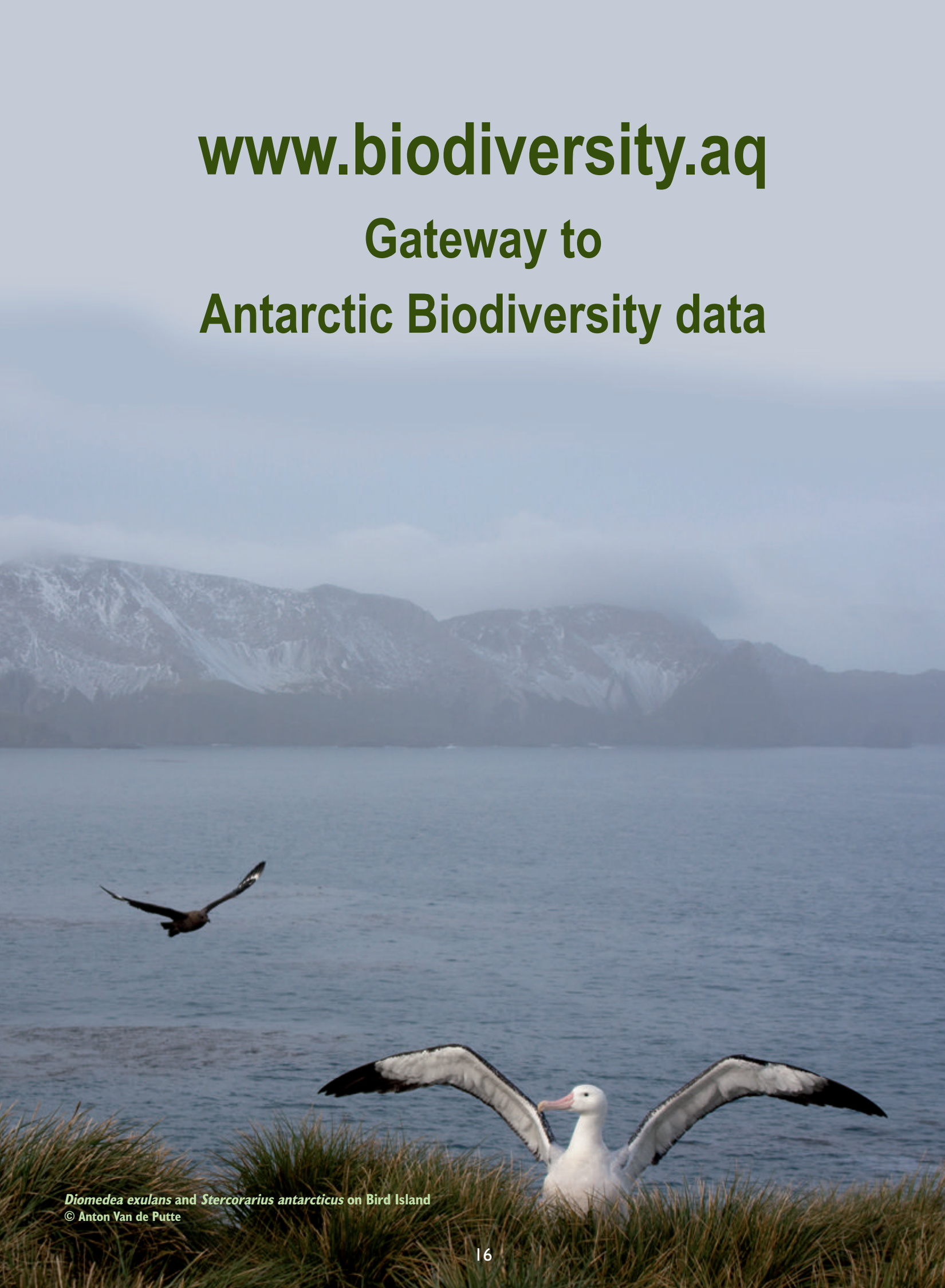
www.biodiversity.aq

Gateway to
Antarctic Biodiversity data



Diomedea exulans and *Stercorarius antarcticus* on Bird Island
© Anton Van de Putte

Whether you are looking for information on Antarctic organisms for scientific, conservation or management purposes or even just out of interest, your main gateway to such data is www.biodiverisity.aq . This online data portal provides free and open access to Antarctic primary biodiversity data from a network of data providers, but also has other interesting features.

The beginning

The roots of www.biodiversity.aq can be traced back to the International Polar Year (2007-2008), and more precisely the SCAR-MarBIN project (the *Mar*ine *B*iodiversity *I*nformation *N*etwork of SCAR, the Scientific committee on Antarctic Research). This Belspo-funded project by the Belgian Biodiversity Platform, started off in 2005 after Claude De Broyer (Royal Belgian Institute of Natural Sciences) noted that, although the Southern Ocean is extremely rich in biodiversity and numerous studies have already been conducted on it, this mass of scientific and technical information was very widely dispersed, fragmented and often not easily accessible.

Benefits of data publication

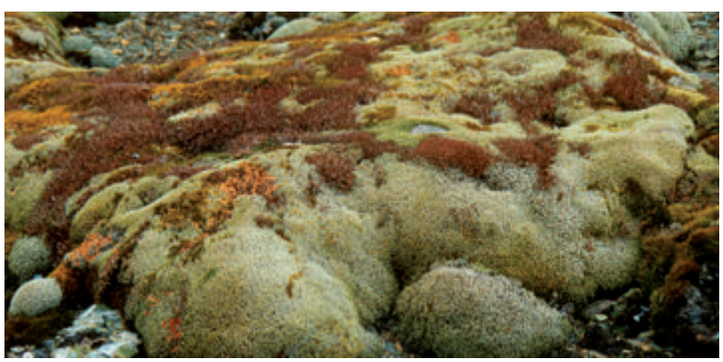
In order to efficiently conduct research to understand and protect terrestrial and marine ecosystems of the Southern Ocean and the Antarctic continent, it is vital to have an open, free and effective mechanism for exchanging information on Antarctic biodiversity. For a long time the Antarctic Scientific community has embraced the idea that primary biodiversity data should be made publicly available as soon as possible after it has been collected. This is in the spirit of article III. 1c of the Antarctic treaty, which states that 'scientific observations and results from Antarctica shall be exchanged and made freely available. While researchers do their utmost to publish the results of their work in scientific journals, such papers generally contain an analysis and interpretation of the data, but not the data itself. Access to original data (observations, measurements) is, however, extremely valuable for the scientific community: published data can be re-analysed to enable review of scientific views or hypothesis, or, after aggregation of several data sets, can be used in more comprehensive, large-scale analysis enabling study of processes at larger temporal or spatial scales. The publication of data sets through internet resources further prevents the loss of such primary data in case a researcher retires or changes career.

The biodiversity network

The initiative was therefore taken to aggregate all the data available from science explorations and from other sources such as ecosystem management and nature conservation. Where the original SCAR-MarBIN network focused on marine life in Antarctica, the new biodiversity.aq network builds on the success of SCAR-MarBIN and ensures its continuation by creating an overarching network that provides access to data from both the marine and the terrestrial realms. Biodiversity.aq not only aggregates data but it also feeds this information into global biodiversity initiatives such as the Ocean Biogeographic Information system (OBIS), which offers access to marine species datasets from around the world, and the Global Biodiversity Information Facility (GBIF). The new data platform (data.biodiversity.aq) aggregates Antarctic biodiversity data from various providers, such as the German PANGAEA and the Australian Antarctic Data Centre and offers a data hosting and publishing service to nations or research institutes that lack such facilities. As such all publicly available biodiversity data can be searched and retrieved through this data platform.

Data paper concept

An upcoming trend in science is that scientist produce data papers describing the dataset they use in their scientific work. Such a data paper is written in a structured form and published in a dedicated data journal while, of course, the data is published through an online repository. Such a data paper encourages researchers as it provides a citable journal publication that brings them scholarly credit, and brings the existences of the dataset to the attention of the academic community. The Global Biodiversity Information Facility (GBIF) and Pensoft publishers created a workflow to address this need: the Integrated Publishing Toolkit (IPT). Researchers can upload their dataset and a structured description of their data (this is called metadata). Such metadata is mainly meant for computer systems and databases and as such is not a format that is easily readable by humans. With the click of a button the IPT can generate a readable data paper that can be submitted to a growing number of data publishers. Biodiveristy.aq hosts such an IPT dedicated to Antarctic biodiversity data at ipt.biodiversity.aq. This allows all researchers to easily publish their data and make it available to future generations of scientists.



Mosses and lichens form a crytogamic fellfield vegetation on Bird Island © Pete Convey

***Phoebetria palpebrata* © Whoeler**

Salpa thompsoni
© Anton Van de Putte

Antarctic Field Guides

Within the structure of the biodiversity.aq portal there are specific subdomains that respond to various community needs, such as the Antarctic Field guides that provides an online species identification resource as well as links to dedicated projects such as the Biogeographic Atlas Of the Southern Ocean.

The Antarctic Field Guides is a collaborative tool offering free access to information that can help users identify Antarctic organisms. The Antarctic Field Guides allows users to build a tailor-made, customized guide, to be taken in the field or simply browsed. The pages are generated instantly from the contents of authoritative, quality controlled data resources (biodiversity.aq, RAMS, GBIF), and ensures users access to up-to-date information about the group of organisms they are interested in. High quality pictures and species description provided by experts allow identifying Antarctic Organisms. Any user can create their own personalised filed guide. This field guide can be stored online or saved as a PDF. As such it can be saved on a computer or printed on paper, allowing users access to good identification tools without having to carry a large library of books. Even if the primary focus is scientists, the Antarctic Field Guides can be used by anybody with an interest in Antarctic Biodiversity. Even tourists will be able to create personalized field guides of animals they wish to see in the frozen seas of the Southern Ocean.

Squid
© Anton Van de Putte

Squid
© Anton Van de Putte

Biogeographic atlas

Another project biodiversity.aq contributes to is the Biogeographic Atlas of the Southern Ocean edited by Claude De Broyer (RBINS) and Phillipe Koubbi (Université Paris). The most recent biogeographic overview of the Southern Ocean, the Antarctic Folio series, dates from the late sixties. Over the last couple of years, an international group of almost 100 researchers have been verifying and adding distribution data, studying the origin of the taxonomic groups, and explaining the distribution of species. Currently the printed version of this Atlas is in the final stages of completion and will be presented at the upcoming SCAR biology conference in Barcelona in July 2013, while the data on which the new atlas is based will be published through biodiversity.aq .

With all these new developments Biodiversity.aq is taking new steps in providing free and open access to Antarctic biodiversity data. The team is continuously answering to the evolving needs of the community and is currently working on integrating new types of data, such as molecular data or tracking data of marine mammals and birds, and is improving the functionalities offered through biodiversity.aq .

The authors

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Hendrik Segers is scientific coordinator of the Belgian Biodiversiy Platform.

***Hyperia macrocephala* © Anton Van de Putte**

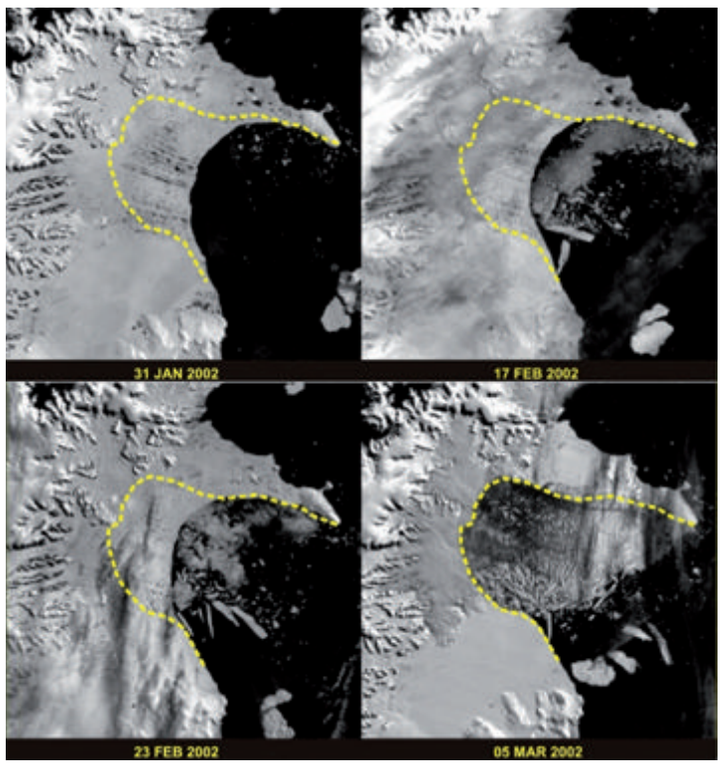
Belgian underwater robot explores the Antarctic seabed

In January-February 2010, three young researchers explored the seas around Antarctica with the UGent-underwater robot Genesis. During the 57-day expedition, Genesis explored 11 new areas of seabed. This Belgian exploratory mission was made possible by Belspo, within the framework of the HOLANT-project.

The blank areas on the world map have long been fully coloured in, and thanks to satellite information, you no longer even have to leave the comfort of your desk to view them. Simply scrolling around on Google Earth allows you to virtually visit the most beautiful places on Earth. Exploration is now possible without risk. Total unreachability, being completely cut off from the outside world? That too is a thing of the past.

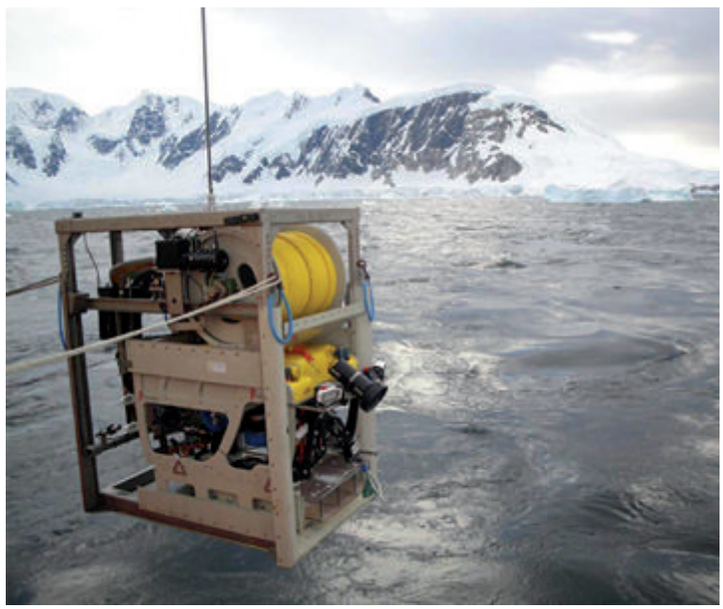
And yet… There are still undiscovered areas on the planet: Antarctica. It may no longer be a completely unexplored, virgin territory, but nevertheless… Ghent University was able to fill in a number of blanks thanks to the underwater robot ROV Genesis. The depths of the Antarctic Ocean are gradually revealing their secrets.

ROV stands for Remotely Operated (underwater) Vehicle. ROV Genesis is a Sub-Atlantic Cherokee type. This is a fairly compact underwater robot that is nevertheless able to perform a wide range of manoevres. ROV Genesis was recently transferred to the Flanders Marine Institute (*Vlaams Instituut voor de Zee* or VLIZ) which from now on will be responsible for this piece of high-tech equipment.



Evolution of the disintegration of the Larsen B ice shelf. © NASA

Location of the 11 regions explored with the ROV.



ROV Genesis is lowered overboard in Flandres Bay. © Lieven Naudts

A sunstar © Katrien Heirman

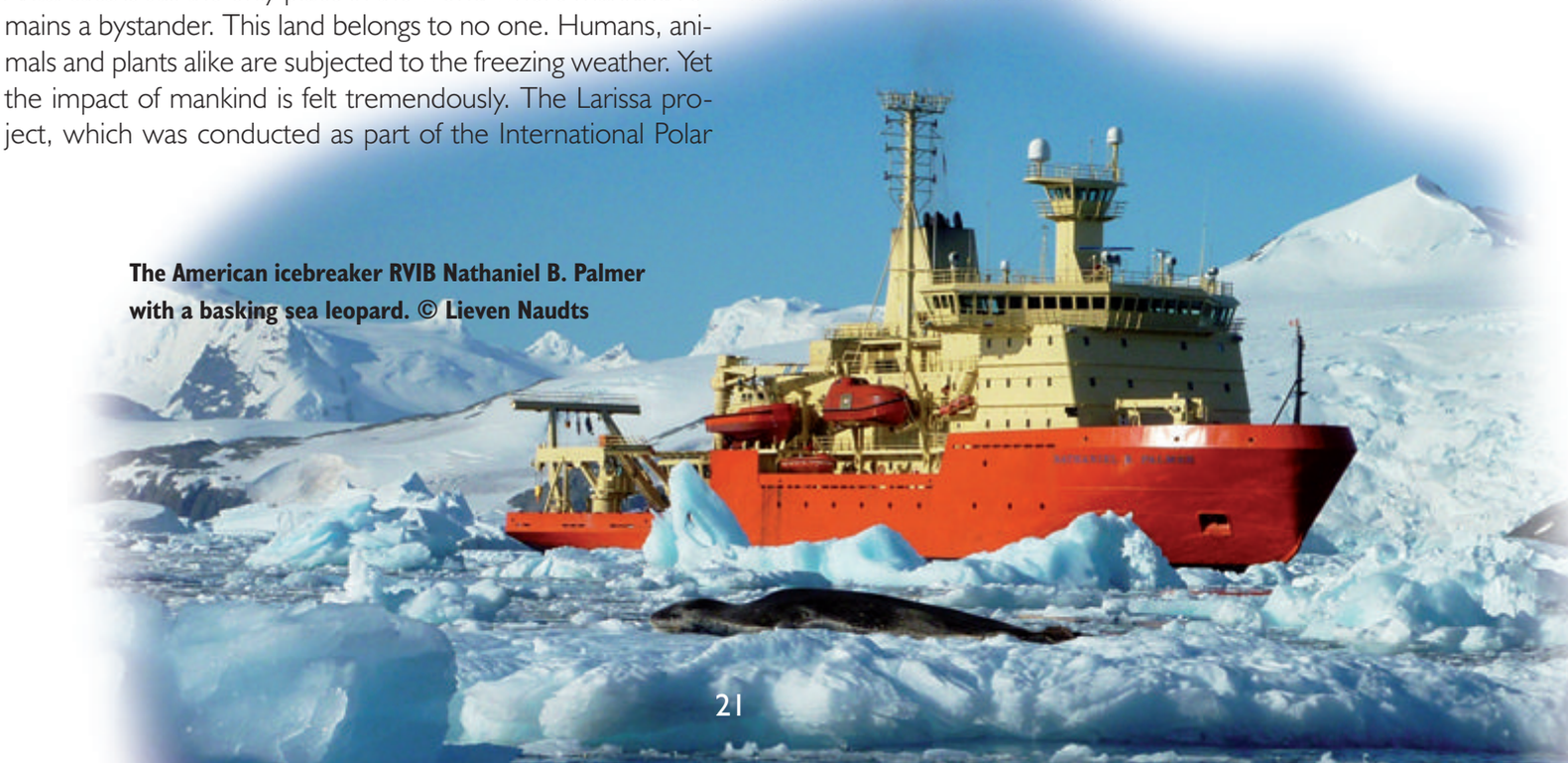
Dancing sea lilies © Katrien Heirman

Antarctica is still the only place in the world where mankind remains a bystander. This land belongs to no one. Humans, animals and plants alike are subjected to the freezing weather. Yet the impact of mankind is felt tremendously. The Larissa project, which was conducted as part of the International Polar Year (IPY), is designed to study, from various angles, the rapid and striking changes that have been taking place in recent years in the region of the **Larsen ice shelf on the** Antarctic Peninsula. In 2002, within a period of barely six weeks, part of this ice shelf broke into thousands of pieces and simply disintegrated entirely. The area in question was the Larsen B sector, with a surface area of 3250 km^2 (slightly larger than the Belgian province of West-Vlaanderen) and an average in thickness of 220 m. It is generally accepted that this is a direct consequence of global warming, which is having a heightened impact in this area of Antarctica. It is also accepted that this is only the beginning of the changes that the Antarctic ice shelves and ice cap will undergo in the decades to come… Studying the seabed in the Larsen B sector was the original aim of this expedition. However, the disappearance of the ice shelf caused the glaciers in this area to accelerate. Far more glacier ice, which is harder than sea ice, is now being pushed into the sea. This thick glacier ice prevented the scientists from achieving their originally intended goal and made the area difficult to access.

LARISSA stands for LARsen Ice Shelf System Antarctica. It is an international research project involving scientists from the United States, Belgium, Argentina, Ukraine and South Korea. The project covers three research topics:
- marine and quaternary geosciences
- cryosphere and oceans
- marine ecosystems

More information is available on www.hamilton.edu/expeditions/larissa or on the UGent-blog: www.poolwijs.ugent.be

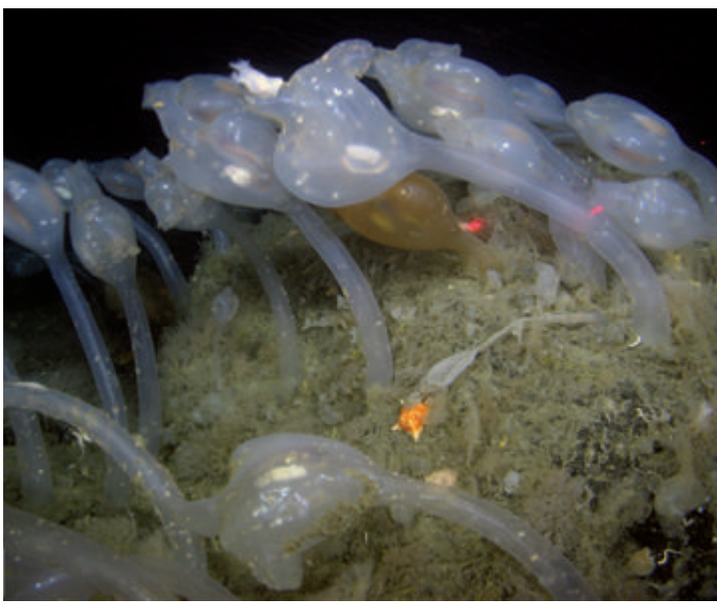
However, this obstacle did not stop the team from making other interesting discoveries. For 57 days, the Gent ROV explored 11 new areas of Antarctic seafloor using the American icebreaker RVIB Nathaniel B. Palmer as home base. Whilst the colour palette of Antarctica is ordinarily limited to white, grey and blue, beneath the cold seawater, a magnificent, multicoloured world was found to exist.



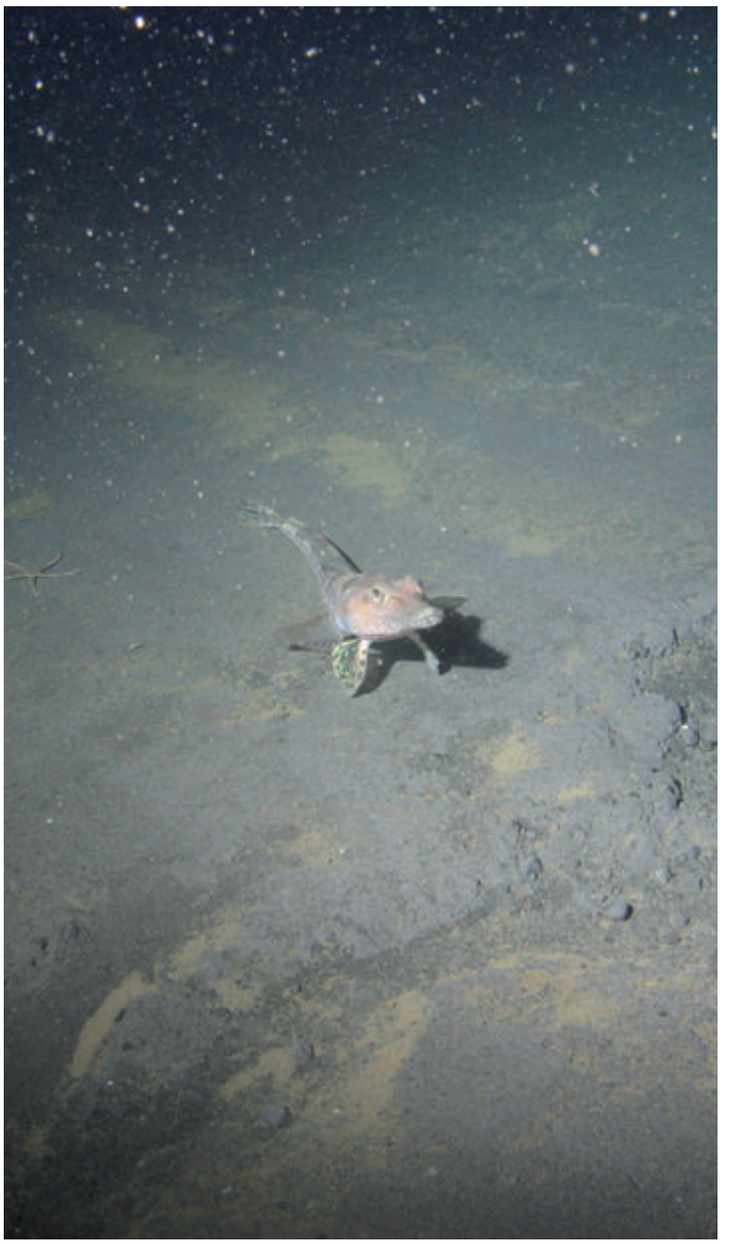
The American icebreaker RVIB Nathaniel B. Palmer with a basking sea leopard. © Lieven Naudts

The bottom of the cold Antarctic sea is teeming with life. Starfish, serpent stars, sea pigs and sea lilies all compete for a small patch of the seabed. Many of these organisms remain virtually unstudied and DNA-research should reveal whether they are known species or still undiscovered ones.

Antarctica is the scene of a struggle for survival, and although Antarctica is freezing cold, there is also fire. In fact there are volcanoes in Antarctica, both on land and under water. During a previous expedition, several scientists from the Larissa-team were able to chart an impressive underwater volcano. Their bathymetric study of the seabed suddenly revealed a volcano-like structure in the depths, which had never before been detected. However, at the time they did not have the equipment onboard to determine whether or not it was an active volcano. Thanks to the ROV however, it was now possible to find out. The descent into the depths had initially been obstructed by a gigantic iceberg apparently stuck on the volcano. In the end, the iceberg finally began to shift. The ROV started its exploration at the foot of the volcano and drifted slowly upwards. On its way to the top, the scientists observed that the flank of the volcano was completely covered with life. At the top, some 270 m under the surface of the water, however, the situation was utterly different. This volcano was definitely no longer active, yet life at the top was impossible nevertheless. Traces of icebergs were clearly visible. The giant blocks of ice scraped the top of the volcano bare and made it virtually impossible for organisms to take hold there, and only an occasional solitary fish was observed, startled by the ROV.



A densely populated volcano flank. © Katrien Heirman



A solitary fish on the denuded top of the submarine volcano. © Katrien Heirman

This was not the only location where the ROV encountered an extremely barren landscape. In the cold waters of the Palmer Deep in fact, the scientists made yet another surprising discovery. The Palmer Deep is located on the western side of the continental shelf of the Antarctic Peninsula. At a depth of some 1400 m, there was nothing but bare seabed to be seen. The colourful life so abundant elsewhere was completely absent.

Two large king crabs in a barren landscape.
© Katrien Heirman

The culprits proved to be huge king crabs. These invaders, which are normally only found at lower latitudes, have migrated in recent years along with the warming water, consuming everything in their path (Smith *et al*., 2012). For millions of years, the cold water had formed a natural barrier against these crabs, but warmer waters are now gradually penetrating the Antarctic seas and oceans. This is enabling new organisms to survive in Antarctica, disrupting the delicate ecological balance. The rise in the water temperature can be linked to climate change. In the past 50 years, the temperature of the water around the Antarctic Peninsula has increased by 1°C. These rising temperatures increase exponentially, each day.

Although Antarctica is still the most unspoiled territory on the planet, nowhere else on Earth is the impact of climate change so tangibly felt. What started with a study of vanishing ice shelves due to rising temperatures, ultimately ended with the discovery of a species of crab that had migrated all the way from the tip of South America to Antarctica due to warming seawater.

Scientists are virtually unanimous in concluding that these changes are happening more rapidly than we have been able to predict.

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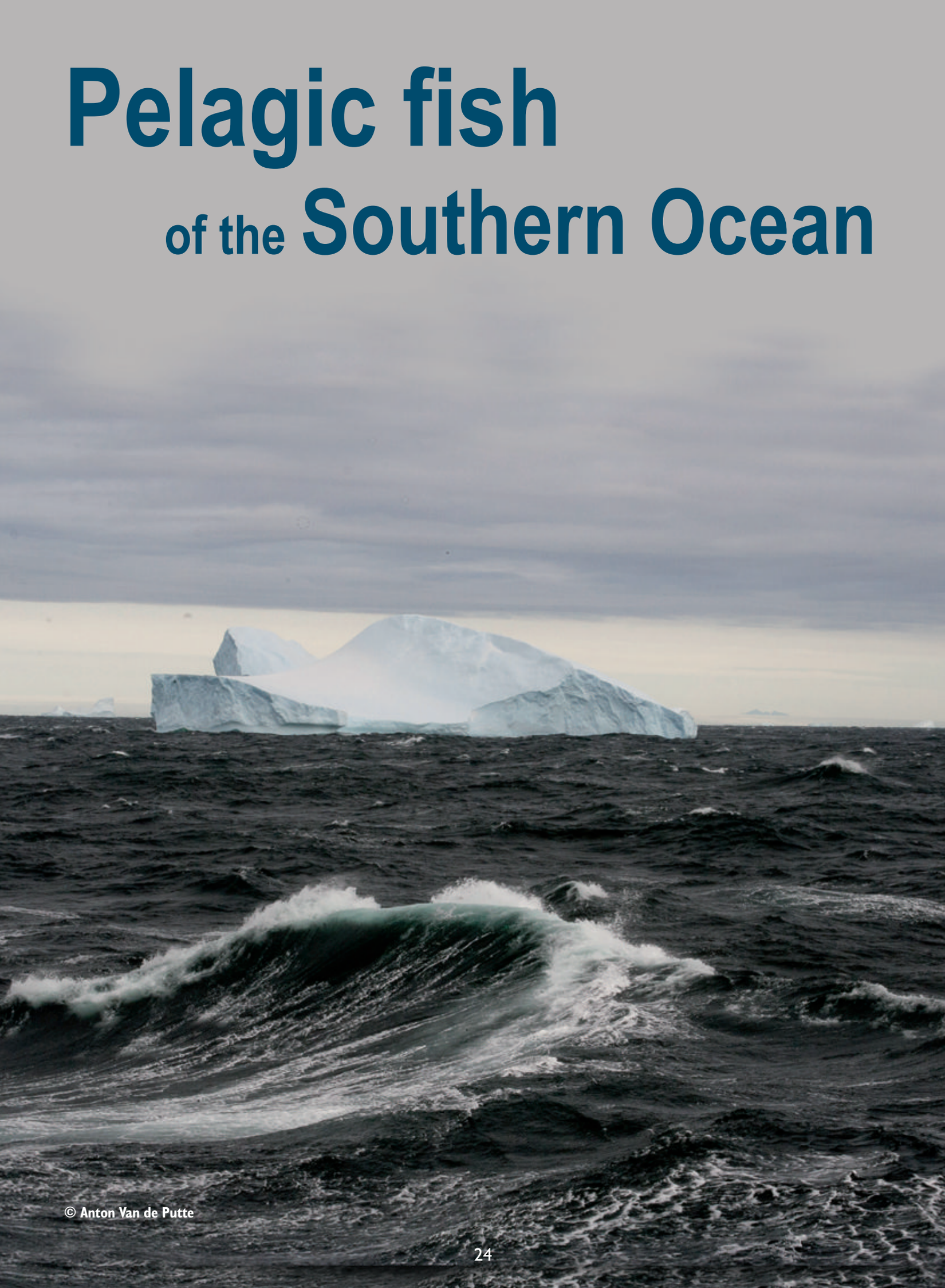
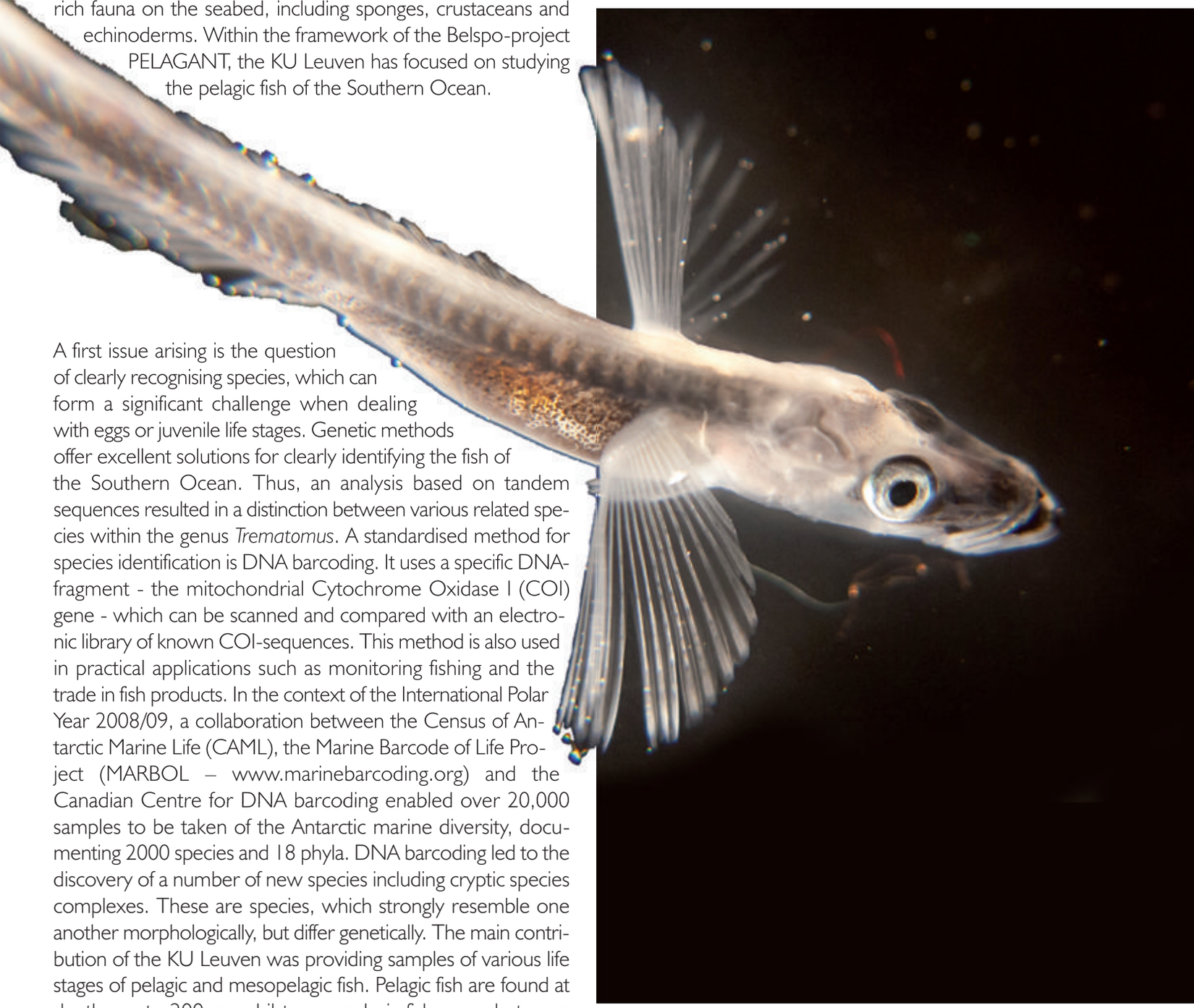
Pelagic fish of the Southern Ocean



The isolation of the Southern Ocean by the Antarctic Polar Front over the past 31 million years has led to a diverse fauna with a high degree of endemism, meaning that local species are not found anywhere else in the world. The cold temperatures of the ocean waters (reaching -2°C locally) have caused unique biological adaptations to occur such as the presence of anti-freeze glycopeptides and the absence of red blood cells in fish. Historical extinctions have shaped a depleted yet highly characteristic fish population, made up of some 300 species. The strikingly low number of predators has in turn given rise to a rich fauna on the seabed, including sponges, crustaceans and echinoderms. Within the framework of the Belspo-project PELAGANT, the KU Leuven has focused on studying the pelagic fish of the Southern Ocean.

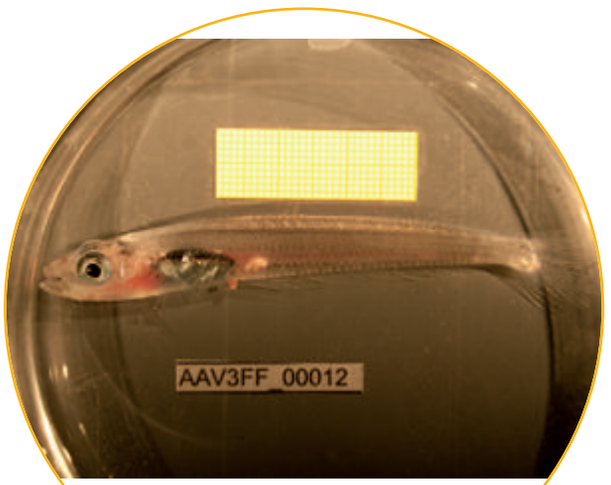
A first issue arising is the question of clearly recognising species, which can form a significant challenge when dealing with eggs or juvenile life stages. Genetic methods offer excellent solutions for clearly identifying the fish of the Southern Ocean. Thus, an analysis based on tandem sequences resulted in a distinction between various related species within the genus *Trematomus*. A standardised method for species identification is DNA barcoding. It uses a specific DNA-fragment - the mitochondrial Cytochrome Oxidase I (COI) gene - which can be scanned and compared with an electronic library of known COI-sequences. This method is also used in practical applications such as monitoring fishing and the trade in fish products. In the context of the International Polar Year 2008/09, a collaboration between the Census of Antarctic Marine Life (CAML), the Marine Barcode of Life Project (MARBOL – www.marinebarcoding.org) and the Canadian Centre for DNA barcoding enabled over 20,000 samples to be taken of the Antarctic marine diversity, documenting 2000 species and 18 phyla. DNA barcoding led to the discovery of a number of new species including cryptic species complexes. These are species, which strongly resemble one another morphologically, but differ genetically. The main contribution of the KU Leuven was providing samples of various life stages of pelagic and mesopelagic fish. Pelagic fish are found at depths up to 200 m, whilst mesopelagic fish occur between 200 and 1000 m.

The pelagic fish community displays a different composition in the coastal zone than in the open sea. The coastal zone is dominated by larval stages of Nototheniidae, a group of fish that is found virtually exclusively in the Antarctic Sea. By contrast, the open ocean is characterised by mesopelagic fish, which generally consist of species from families found throughout the entire world, but represented here by a couple of endemic species. Fish make up an important component of the ecosystem in the coastal areas as well as in the open ocean.

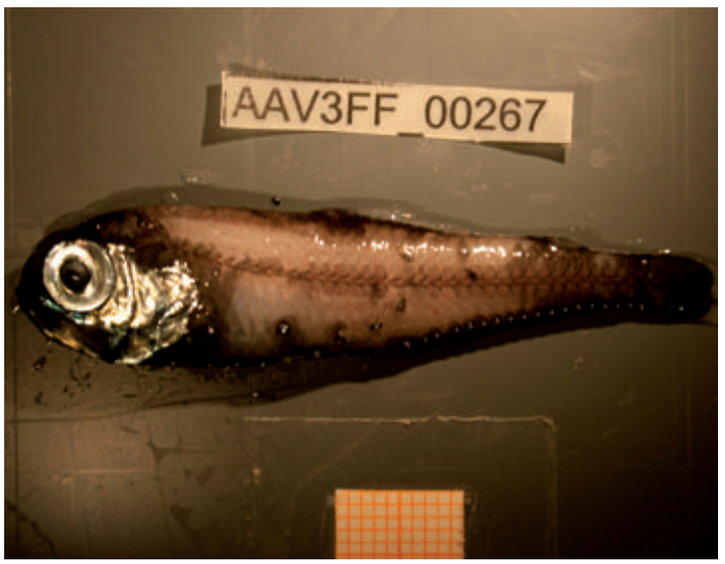


Nototheniidae
© Anton Van de Putte

Thus, the coastal-based pelagic Antarctic silverfish *Pleuragramma antarcticum* and the Antarctic lanternfish *Electrona antarctica*, which lives in the open sea, constitute an important part of the diet of apex predators such as whales, seals and penguins. Research into the diet and energy content of these fish sheds light on their role in the ecosystem. In most fish, fat and oils form an important source of energy. However *P. antarcticum* does something different with it: it uses fat reserves in special fat pouches to adjust its specific gravity in lieu of a swim bladder. Although it is generally accepted that different species have differing energy content, which has significant consequences for the functioning of the food web (fatter species are energy-rich), it should be taken into account that older animals have a higher energy-content than young ones. These new insights have contributed to an objective understanding of the structure and dynamics of the Antarctic food web, and therefore also of the impact of human intervention such as fishing and warming temperatures. In the future, they will help to draw up what are known as General Ecosystem Models.



Pleuragramma antarcticum
© Anton Van de Putte



Electrona antarctica
© Anton Van de Putte

Furthermore, genetic studies also help to understand the extent to which organisms have reacted to changes in the Antarctic ecosystem. The influence of Pleistocene cycles on the population dynamics over the past 2 million years is reflected in the patterns of genetic diversity. Thus, during periods of large ice masses, there is shrinkage of the coastal areas, which are the habitats for certain pelagic and demersal *Trematomus* fish species. Species that live in the water column and have a higher capacity for dispersal are generally better able to withstand such changes than species that live on the seabed. Productivity also changes, as does the food required to maintain populations, which in turn has an effect on the population dynamics. The current genetic diversity of lanternfishes and icefishes indicates a stable, high degree of diversity, which translates into large populations.

Icefish
© Anton Van de Putte

The genetic structure of these circumpolar species is weak, which might be explained by the homogenising effect of the circumpolar currents. On the other hand, specific biological characteristics and small-scale phenomena lead to species-specific local patterns. For example, there are indications that coastal species form more closed populations than those based in the open sea, a concept that corresponds to worldwide observations. On a regional scale, initial analyses indicate that the populations of the region of the Antarctic Peninsula are distinct from the rest of the Southern Ocean. As found in studies in the northern hemisphere, subtle population patterns were anticipated, which are attributable to adaptation to local conditions. Due to the current changes in the climate, however, it is this very adaptive capacity of Antarctic species that is under severe pressure. The ecosystem of the Southern Ocean is undergoing major changes due to the human impact. Thus, the collapse of the seal populations at the beginning of the previous century followed by - in sequence - large whales, small whales, certain fish and recently, krill, is putting severe pressure on the ecosystem and raising questions about the sustainability of its exploitation. Managing this will bring colossal challenges.

© Anton Van de Putte

Paradiplospinus gracilis
© Anton Van de Putte

Gymnodraco acuticeps
© Anton Van de Putte

The KU Leuven is contributing its biological expertise in nature conservation in two areas: the identification and tracking of fish and fish products, and the spatial planning for nature conservation ('Spatial Conservation Planning'). As mentioned, molecular techniques, known as DNA barcoding, are able to categorise fish and fish products with a high degree of reliability. Recent developments in molecular genetics now make it possible to also determine the origin of a fish or fish product. Although this is currently applicable to some ten economic species, in the future it will be expanded to cover a wider range of fish, and probably Antarctic species. Detailed spatial and temporal genetic information also allows two important parameters to be assessed, the effective population size and the connectivity of organisms. The effective population size is a way of measuring the number of individuals that are effectively contributing to producing offspring and is far smaller than the actual population count. Connectivity refers to the extent to which organisms make use of their environment throughout their lives. This information is crucial for determining the surface area, structure and spacing of managed zones so that fragmentation of the habitats of marine species can be avoided. Follow-up research has provided convincing proof that rest areas allow for the continued survival of populations, species, communities and ecosystems on an ecological and evolutionary scale.

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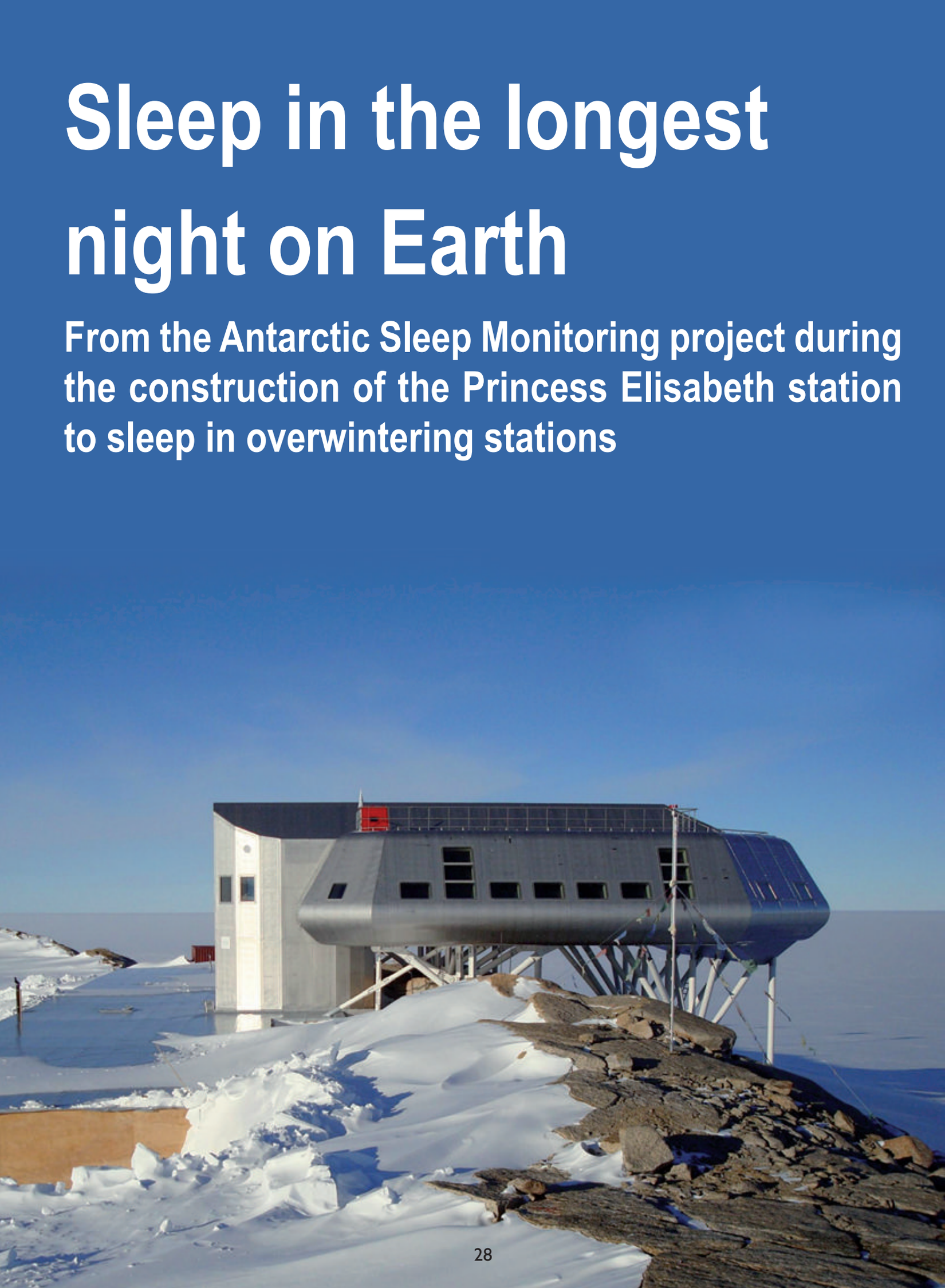
Sleep in the longest night on Earth

From the Antarctic Sleep Monitoring project during the construction of the Princess Elisabeth station to sleep in overwintering stations



Why study sleep in Antarctica?

Sleep complains are the most frequent noted complaints, both physiologically and psychologically, during Antarctic expeditions (Palinkas, 2000). The reasons for this are multiple, but the most important one is the lack of a normal photoperiod during almost half the year. Indeed, during the Antarctic summer, the polar day and the absence of night confuses our biological clock because of the absence of a 'light-off' signal, whereas during the Antarctic winter, the opposite is observed: the constant night and the lack of sunlight to entrain the biological clock causes shifts in our circadian rhythms, somehow like a long lasting jetlag.

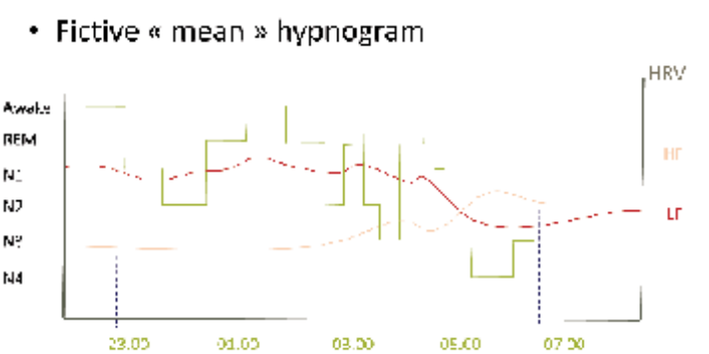
Two factors, characteristic to the Antarctic over-wintering, the prolonged absence of daylight and long-term confinement, are expected to influence sleep. The occurrence of sleep disturbances in winter months in Antarctic regions is indeed a consistent finding in literature. A study of Bhargava et al. (2000) indicated that subjective sleep problems, more specifically, difficulties in initiating sleep, were at the maximum in midwinter (June) in comparison with the beginning of winter (March), end of winter (September) and summer (December, January). In a large-scale questionnaire study of Palinkas et al. (2000) in 91 subjects spending winter at research stations in Antarctica, exposure to total darkness, as based on station latitude, was significantly associated with total hours of sleep, duration of the longest sleep event, time of sleep onset and quality of sleep. However, sleep parameters remained stable over the winter period going from March to October. While the presence of sleep problems during winter-over is mainly undisputed, in-depth studies on sleep physiology in Antarctica are rather limited. As a consequence, insight into the mechanisms leading to sleep disturbances in polar regions, is quite difficult. It has been suggested that restricted movement, less exertion and decreased fatigue may result in problems in initiating or maintaining sleep, but desynchronisation of the rhythm of important physiological systems from the sleep-wake rhythm can even be more important (Bhargava et al., 2000). Quality and timing of sleep is known to be determined mainly by three factors. First, process S or the homeostatic sleep drive is dependent upon the amount of wake or sleep before, but also by physical exercise, which increases the need for recovery. The longer one stays awake or the shorter the previous sleep period, the higher process S and the tendency to sleep. As we sleep, process S gradually goes down and the tendency to wake increases. Second, our biological clock, situated in the suprachiasmatic nucleus of the hypothalamus, controls the circadian component of our sleep-wake regulation system or process C, which is responsible for the diurnal variation in sleep tendency and alertness across the 24h period (Borbély, 1982). Finally, stress and arousal have a major impact on sleep-wake regulation, with higher levels of arousal leading to a decrease in sleep tendency (De Valck et al., 2003).

This disturbed sleep has potential far-reaching consequences in terms of well-being, health and operational security.

The Antarctic Sleep Monitoring project (ASMo)

Antarctica is what is called an analog environment for space related research: a setting where unique features of spaceflight can be studied to better understand the different effects of this 'multiple stressor' environment. A critical feature that Antarctica shares with space is the absence of 'Zeitgebers', external clues (like light) synchronizing our endogenous biological clock with the external time. This is linked to the fact that one of the main complaints on previous Antarctic expeditions is the reported sleep disruption, whether these are summer stays or overwintering. The ASMo (Antarctic sleep monitoring) project investigated sleep, sleep-wake regulation, circadian rhythms, physical activity, mood and attentional performance during two summer expeditions, the BELARE (Belgian Antarctic Research Expedition) campaigns 2007-2008 and 2008-2009 (Pattyn et al., 2009; 2011).

Over a time frame of two years, 30 subjects were investigated with actigraphy, polysomnography, attention testing and cortisol and melatonin monitoring. Data showed poor sleep efficiency and high sleep fragmentation and this was in concordance with participants' subjective evaluations. Furthermore, there was a strong correlation between sleep efficiency and active energy expenditure, which indicates that exercise is a potential non-pharmacological countermeasure for these sleep disturbances. In addition to high sleep fragmentation, both subjective and objective, a dramatic decrease in slow wave sleep (SWS) and an increase in REM sleep were evidenced. Furthermore, SWS occurred at the end of the night, rather than the beginning. Autonomic activation showed a concurrent variation, with a high proportion of low frequency heart rate variability, and a delayed occurrence of the high frequency component. Cortisol rhythmicity and serum levels were preserved, and secretion profiles were remarkably synchronized among participants. Melatonin secretion however, showed a severe phase delay, with no secretion onset as late as 24.00 and peak values around 06.00.



Results: Ultraradian rhythm

The results of this project thus showed a complete dissociation of cortisol and melatonin secretion profiles. The delayed and decreased SWS could be subtended by the phase delay in melatonin secretion. The modified autonomic regulation is related to the disturbed pattern of sleep stages. These findings suggest two distinct oscillators regulating cortisol and melatonin. Melatonin thus shows to be more sensitive to photoperiod, and cortisol to be more sensitive to social schedule. In terms of consequences of these disturbances, mood was remarkably preserved, with scores on the negative subscales of the POMS being lower than those of a control group, which we hypothesized to be due to the effect of the continuous bright light exposure. With regard to performance, severe attentional impairments were measured with the Psychomotor Vigilance Task, equivalent to results of 5 consecutive nights of partial sleep deprivation.

COGNIPOLE and ESCOM: the Neuropole project

Building further on the previously summarized results, we decided to target three aspects which had raised questions:

- Similar measurements during an overwintering campaign, to compare summer and winter values.
- The use of exercise as an intervention throughout an overwintering, to evaluate whether it would be efficiently used as a countermeasure.
- Further more in-depth investigation of cognitive performance, and more specifically targeting executive functions. This point was based on participants' feedback, indicating they felt less intellectually efficient during their stay. Executives functions are sometimes described as 'the higher cognitive functions': what allows us to multitask, to plan ahead, to ignore irrelevant information and select the relevant one in our environment, and the perception of time.

Based on these questions, we participated in two projects of the European Space Agency (ESA).

Indeed, the ESA funds Antarctic research at the French/Italian station Concordia, because of the similarities of the environment to a long-duration spaceflight. Indeed, for long-duration spaceflights, such as future exploration journeys, several features have to be taken into account for a successful preparation. The space environment includes many stressors that can impact health, both physiologically and psychologically. Usually, these are described according to four categories: environment, habitat, mission and social situation. Whereas environment and habitat are factors which require passive coping from astronauts (i.e. there are no direct leverages to modify those, and thus the only possibility is to modify how one deals with it), mission and social variables are highly dependent on management, personality factors and human interactions. Mission variables that can impact health and well-being are mainly about variations in workload: from very high and demanding to low and monotonous. The social situation is very specific to the space environment, with life for several months, if not years, with a small crew one has not chosen, and reduced communications to the Earth. For those familiar with the Antarctic environment, these stressors sound very well-known, for the Antarctic environment during winterover offers a remarkably similar setting.

Sebastian Falkenberg

The ESCOM project (The effect of exercise on sleep regulation, cognitive performance, mental health and mood) is a collaboration between the Flemish Institute for Technological Research (VITO), the German Sport University, the Royal Military Academy and the Vrije Universiteit Brussel. This project targets the effect of exercise as a potential countermeasure to the adverse effects experienced during overwintering. Experimental evidence indicates that physical exercise has a positive effect on brain functioning including cerebral blood flow, cognition, neurogenesis, neurotransmitter release and mood. Our previous research within the MARS105 study showed a positive effect of exercise on the isolation induced decrease in brain cortical function and mood. Recent evidence demonstrates rhythmic clock gene expression in tissues suggesting that functional clocks exist outside the central circadian pacemaker of the brain. The impact of different conditions (confinement, exercise, etc.) on circadian gene expression and the link with physiology and psychology is largely unknown. The application of gene expression analysis in combination with behavioural endpoints is initiated in the BEACON (Assessment of biomarkers for behavioral adaptation and health during isolated stay in Concordia) project during the overwintering 2009-2010. The present proposal aims at investigating the link between sleep, circadian rhythms and exercise, as well as the effects of an active exercise intervention on mood and performance in an Antarctica mission. This project will give an insight on the following points :

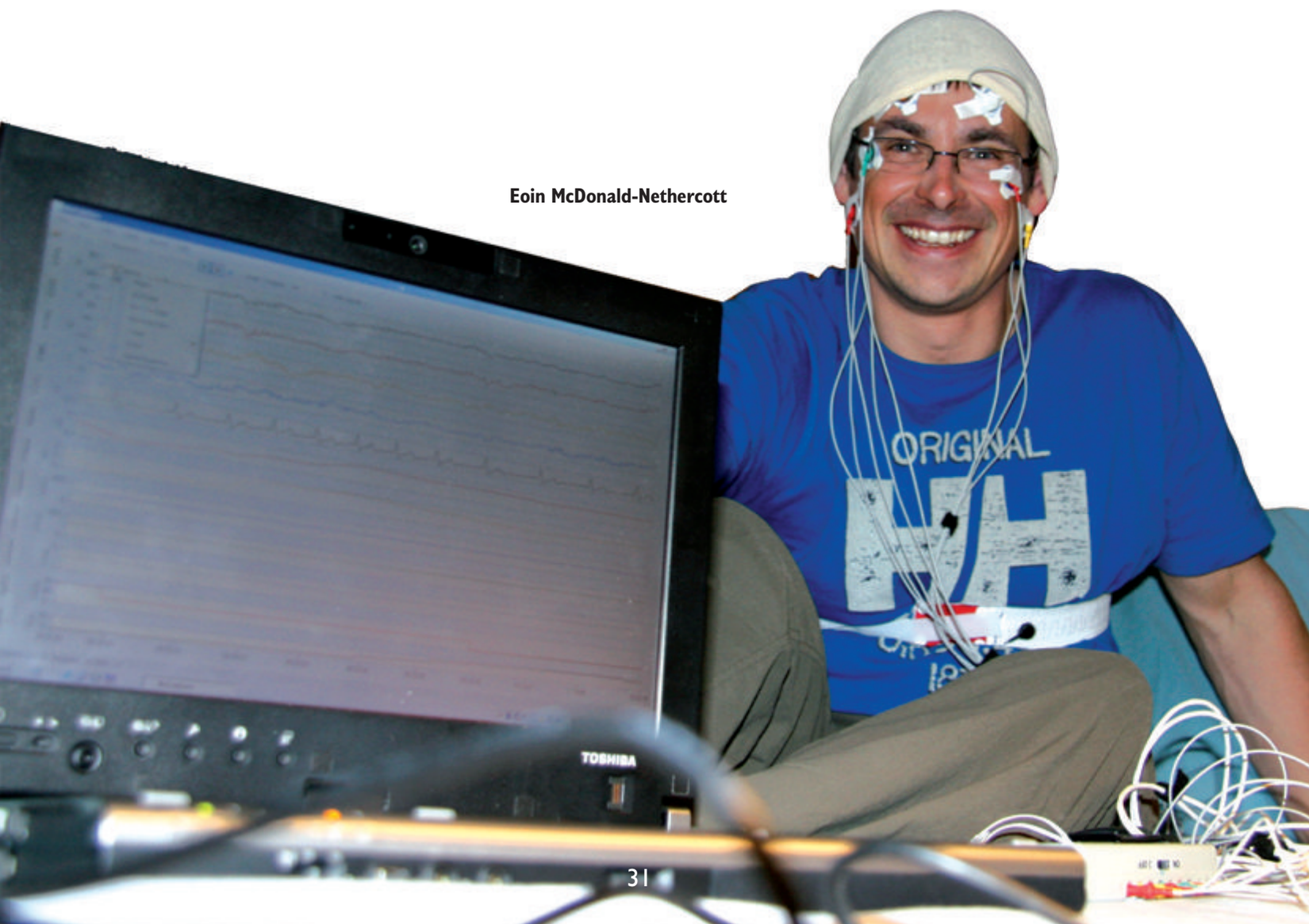
(1) Sleep-wake regulation is altered in both summer and winter periods, albeit through different mechanisms.

(2) Exercise has a positive effect on sleep quality, and is a candidate countermeasure for circadian desynchronisation.

(3) Exercise might counteract the potential disruption of cognitive performance and improve overall mood.

(4) Altered sleep-wake regulation can be measured using gene expression analysis in blood. The effects of exercise on sleep regulation and cognitive performance will also be reflected at a molecular level.

This study will be valuable for increasing health and well-being in extreme environments like space or Antarctica with an operational advantage. The results will also help to spread the outlasting positive effects of exercise in the general population.



Eoin McDonald-Nethercott

The COGNIPOLE project (Cognition mapping during an Antarctic overwintering) is a collaboration between the Hungarian Academy of Science, the University of Rome La Sapienza, the Royal Military Academy and the Vrije Universiteit Brussel. This project targets an in-depth mapping of cognitive functioning, both through different cognitive tasks, but also through the measurement of brain activity through EEG and Event Related Potentials. Indeed, a major determinant of performance is sleep and circadian rhytmicity. Reports on chronobiology research in the Antarctic suggest a desynchronisation between sleep and circadian rhythms, similar to jet lag, during the overwintering period. Results from our previous Antarctic experiment have shown dissociation between the rhythmic secretion of cortisol and melatonine, and performance on the psychomotor vigilance task was severely impaired. These findings suggest that, for attentional performance, the preserved circadian rhytmicity of cortisol, hence the normal functioning of the 'wake' system could not counteract the disturbed 'sleep' system, with the delayed melatonin secretion and slow wave sleep. Similarly to the findings on the interaction between mood and sleep quality – it has been shown that changes in mood during the austral winter were preceded by changes in sleep characteristics, and that mood changes affected sleep quality during an overwintering period (Palinkas et al., 2000) - we intend to study the effect of sleep quality on cognitive performance. Since previous research also showed that free-running circadian cycles led to different patterns of performance, the concurrent measure of sleep quality, circadian rhytmicity and performance could allow for a more detailed unravelling of existing interactions between potential disturbances of these systems. The COGNIPOLE project aims at identifying variations in cognitive performance during the overwintering period. This might be the measurement of decrements, but also of strategic shifts in cognitive control, that could have an adaptive function. The assessment of sleep quality and circadian rhytmicity will allow identifying whether previously described disturbances are replicated here, and how these relate to the quality of cognitive performance.

Both the COGNIPOLE and the ESCOM project (together termed NEUROPOLE) are still going on at the Concordia station. Thanks to the collaboration with the French Polar Institute (Institut Polaire Paul-Emile Victor), the COGNIPOLE study was also implemented at Dumont d'Urville (a French coastal station) to provide an additional measure in overwintering at sea-level, an important control condition in comparison with Concordia at an equivalent height of 3800 m.

To conclude, it is important to emphasize that such investigations are important, not only for the health and well-being of overwintering crews in Antarctica, nor for the prepartion of long durations spaceflights, but because this natural laboratory allows us to study extreme psychophysiological adaptation over time, thus enhancing our understanding of our human functioning.

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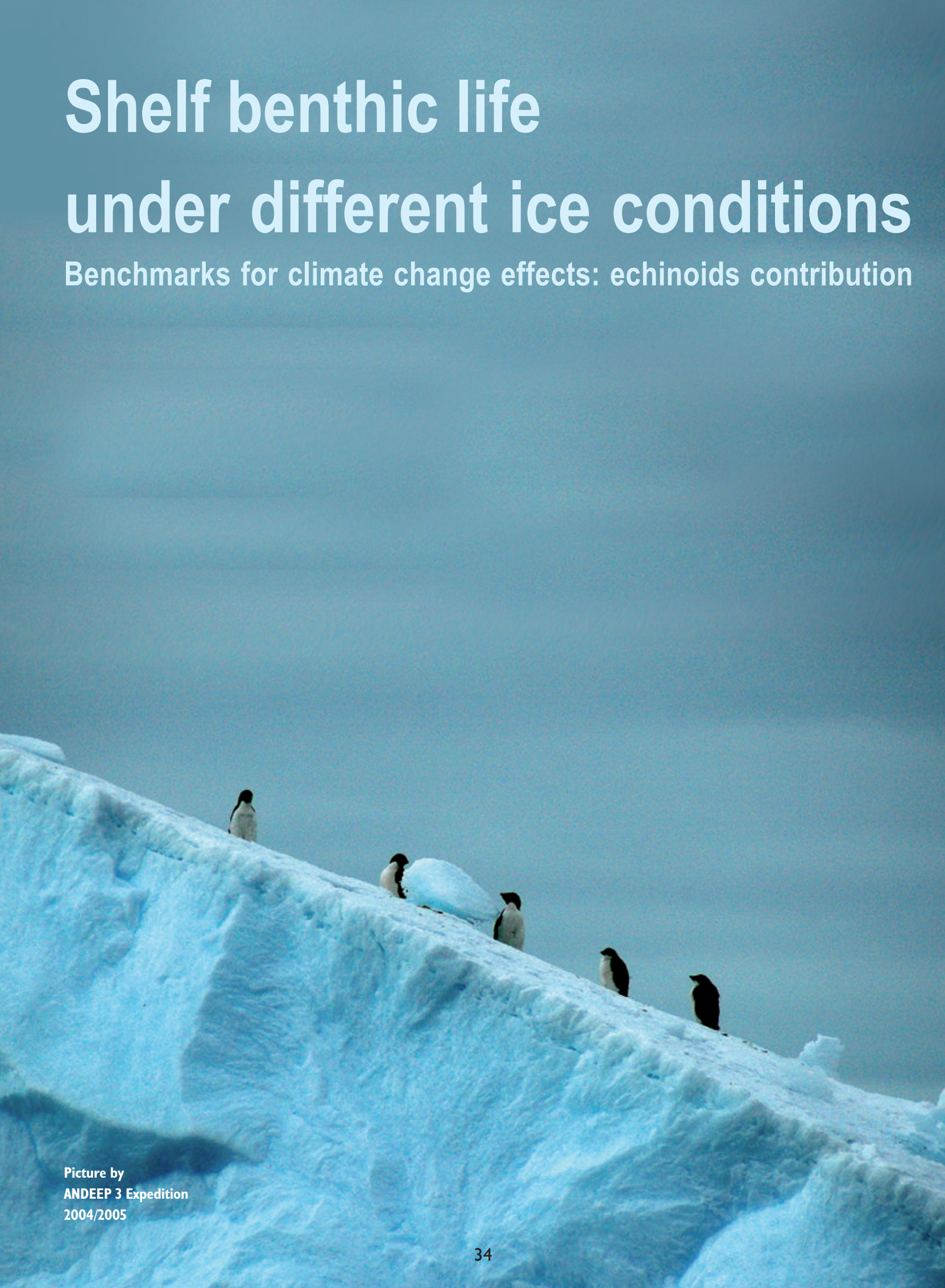
Shelf benthic life under different ice conditions

Benchmarks for climate change effects: echinoids contribution



Picture by
ANDEEP 3 Expedition
2004/2005

Regional climate change is observed in the Antarctic Peninsula since the late 1950's. The collapses of ice shelves like those of Larsen A (1998) and B (2002) East of the Peninsula are among the most visible climate-induced events. These highly disturbed sites together with areas undergoing 'natural' fluctuations in ice condition offer the opportunity to characterize colonizing processes expected to occur in a close future as a consequence of global change.

About 10% of known echinoid species occur south of the Polar Front, making the Southern Ocean an enriched 'spot' for echinoids as compared to the mean richness value of the world ocean. Antarctic echinoids are distributed into nine families and seven orders. They display various feeding strategies (omnivorous, deposit-feeders, carnivorous or phytophagous/algivorous) and reproduction modes (from broadcasters with planktotrophic larvae to brooders and direct developers). They belong to numerous ecological guilds, are recurrent members of benthic communities and are widely distributed throughout the Southern Ocean. They are therefore highly prone to participate to initial colonization and to ecological successions in disturbed areas.

Polarstern in the Weddell Sea (Expedition ANTXXIX/3 2013)

Echinoid (cidaroid) with brooded youngs (oral side).

Agassiz trawl - detailed view of a catch (Bransfield Strait)

Agassiz trawl back on the deck and emptying its contents.

Agassiz trawl - Scientists at work, sampling benthos.

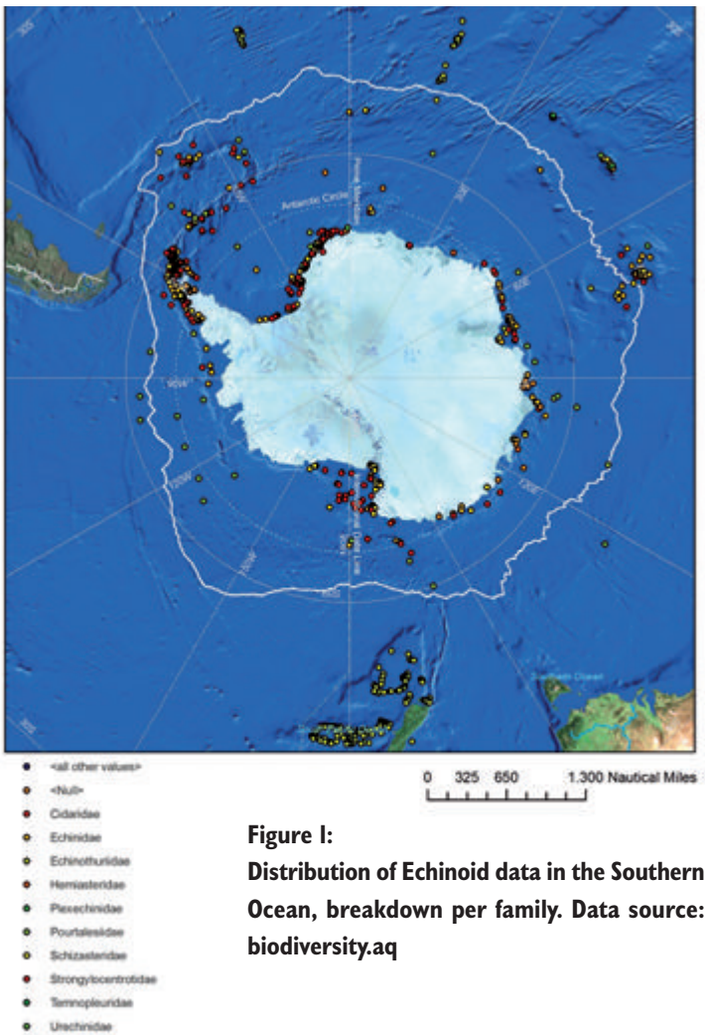


Figure I:
Distribution of Echinoid data in the Southern Ocean, breakdown per family. Data source: biodiversity.aq

The AWI expeditions ANTXXIII-8 in 2007 and ANTXXIX/3 in 2013, respectively exploring the shelf of Larsen A/B embayments and the shelf of the Antarctic Peninsula (SE to NW transects) offered the opportunity to get integrated environmental data together with benthos samples in areas undergoing different ice conditions. More particularly, ANT XXIII-8 provided an insight into colonizing processes occurring in previously 'barren' areas (after the collapses of ice shelves and subsequent scouring). This year, ANT XXIX/3 focused on how communities succeed along sea ice condition gradients. In Larsen A/B areas, three 'pioneer' echinoid species were recorded in 2007: *Sterechinus antarcticus, S. neumayeri* and *Notocidaris mortenseni*. Their reproduction mode and feeding behaviors support their colonizing aptitudes. The three species are broadcasters and were mostly feeding on sediments i.e. an 'unusual' food source as these species are rather opportunistic carnivores. Interestingly, these species were also shown to display local shift to carnivorous regime in stations north and west of the Peninsula, i.e., in stations undergoing more seasonal than permanent sea ice conditions. A similar shift was also observed for *Sterechinus* in the Ross Sea[1]. The ANT XXIX/3 expedition centered on the structure and functioning of benthic communities in response to food supply modulated by ice conditions and water masses. As pointed out by Norkko and collaborators[1]: 'The potential for receding sea ice associated with climate change highlights the need to develop a predictive understanding of how marine ecosystems will change with change of sea ice distribution and thickness. This requires a good understanding of ecosystem structure and function and how it relates to environmental drivers'. In that context, our work on echinoids mostly aims (1) to characterize their patterns of biodiversity and their contribution to local communities, (2) to point out their feeding and physiological flexibilities in response to sea ice conditions and thus to food availability. Point 1 will allow identifying species and their autoecology while completing also the echinoid database (biodiversity.aq[2]) (Figure 1). Point 2 will document how dominant echinoid species deal with contrasted food availabilities and explore their possible shifts in food regime across environmental gradients. The resulting impact on their metabolism and ability to control their acid-base balance will be assessed, an aspect of crucial importance in the context of ongoing ocean acidification in the Southern Ocean. The whole approach will provide an insight into their tolerance windows to these stressors.

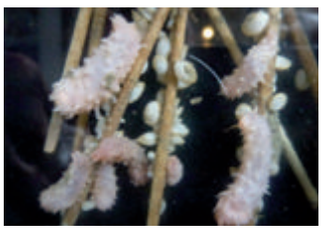


Figure 2:
Holothurians and bivalves living on the spines of a cidaroïd sea urchin. (Expedition: ANT XXIX/3; picture: Chantal De Ridder, ULB)

In addition, because their spines provide microhabitats for a wide range of sessile organisms, Cidaridae can be 'key' contributors to local biodiversity (Figure 2). This contribution was examined in Larsen A/B sites where the sessile fauna fixed on the spines of *N. mortenseni* displayed an 'unusual' diversity pattern as more than 80% of 'housed' taxa were shared with sessile communities present on stones of the sea bottom, indicating a lack of specificity. This strongly contrasts with patterns observed outside Larsen areas where sessile fauna fixed on cidaroids was rather specific. Specimens collected during the ANT XXIX/3 expedition will allow to compare the ectosymbiotic communities from stations with contrasted abiotic and biotic environment. Furthermore, this will allow to identify the relationships between ectosymbiotic and epibenthic communities, and to point out the contribution of ectosymbioses to local biodiversity.

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Bruno David (CNRS) and Thomas Saucède are researchers at the laboratory Biogéosciences of the Université de Bourgogne.

1 Norkko, A., S. F. Thrush, V. J. Cummings M. M. Gibbs, N. L. Andrew and J. Norkko, 2007. Trophic structure of coastal antarctic food webs associated with changes in sea ice and food supply. Ecology, 88(11): 2810–2820.
2 Danis B, Van de Putte A, Youdjou N, Segers H, 2013. The Antarctic Biodiversity Information Facility. World Wide Web publication, available online at http://www.biodiversity.aq

The human experience in Antarctica: recreating space on Earth

Mankind has always been fascinated by space. Thanks to observations and space missions, our knowledge of the extreme conditions outside the Earth's atmosphere is increasing. Currently, there is growing interest to send humans on interplanetary missions or back to the moon. However, it is important to envisage the health challenges that are associated with space travel. The Belgian Nuclear Research Centre SCK•CEN plays an important role in space research, including human space biology.

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Health risks of space travel: immune changes

To date, it is beyond doubt that a stay in space affects the human body. Besides exposure to increased radiation and reduced gravity, health problems can be caused by other stress factors including living in an isolated environment, heavy work load and disturbed sleep and eating patterns. These stressful conditions of physical and psychological nature are considered to have a major impact on human physiology and health performance. Among the physiological systems that are affected during space flight is the immune system. The immune system is a "distributed organ" of 4kg of total weight which is constituted of a network of cells, tissues, and organs that work altogether to protect the body against foreign substances or microorganisms. Weakened immunity may lead to chronic infection, autoimmune disease and the development of cancer. Several studies demonstrated that space flight-induced immunosuppression is therefore recognized as a major obstacle for long-term space missions. So far, the precise nature of this immune dysregulation is unknown and more research is needed to further understand the underlying mechanisms. In this regard, future space exploration will help to answer many critical questions. However, since the number of space flight experiments is limited, ground-based research platforms, such as the Antarctic Concordia station, can be used to recreate some aspects of the space conditions. These space analogues can partly elicit physiological responses similar to those experienced by the human body in space. Information obtained from this kind of experiments is useful to complement space flight investigations.

The Antarctic Concordia Research Station

The French-Italian Concordia research station is a unique and demanding environment: it is one of the coldest, darkest, and driest places on Earth. The station is built on an ice sheet at an altitude of 3200 m at a location called Dome C on the Antarctic plateau. The station is more than a thousand kilometers away from the coast and 600 km away from nearest human presence. Therefore, it is further away than the International Space Station (ISS) orbiting at around 400 km around the Earth. Due to the high altitude, oxygen levels are lower compared to sea level (12-13% instead of 20,9%). This condition of low oxygen is referred to as hypoxia. Moreover, the Earth's magnetic field is weaker near the South Pole thereby reducing the protection from cosmic radiation.

Map showing the geographic location of Dome C at Antarctica, where the Concordia station is situated.

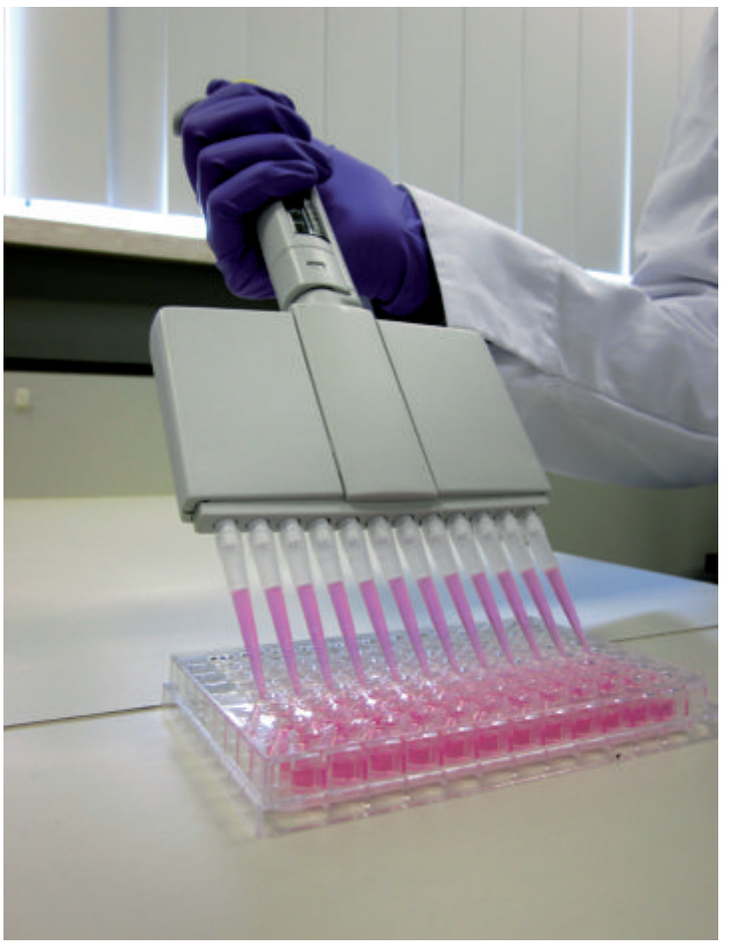
The Concordia base is one of the three all-year manned research stations on the Antarctic plateau. During the winter months the station is impossible to reach. The crew stays isolated from the outside world for a long period of time, completely dependent on their own resources. Moreover, during winter, no sunlight is seen for about three months.

In the context of space research, Concordia missions typically consist of prolonged stay (winter-over confinement, > 300 days) in this extreme environment. The living conditions are in many aspects similar to the environment onboard the ISS. In addition, the presence of hypoxia at the Concordia base can be useful also in the context of future manned explorations and habitats where lower levels of oxygen are anticipated to be advantageous to cope with technical and operational constraints, but also to mitigate to a certain degree the biological risk of radiation.

The Concordia Station © ESA

ESA CHOICE study

SCK•CEN is a member of a multidisciplinary Topical Team supported by the European Space Agency (ESA) and which deals with stress challenges and immunity in space. In collaboration with this ESA Topical Team SCK•CEN is involved in the CHOICE study 'Consequences of long-term Confinement and hypobaric hypoxia on Immunity in the Antarctic Concordia Environment'. The aim of the CHOICE study is to gain more insight into the immunological changes in individuals during the winter-over period. For this purpose, blood, saliva, and urine samples were collected from the crew before, during, and after winter-over confinement. High-throughput technologies available at SCK•CEN were used to precisely monitor immune changes in blood samples obtained from the crew members. Concentrations of several proteins that are known to be involved in immune responses were measured. In addition, molecular changes at the level of gene expression in white blood cells were analysed. Preliminary results demonstrate that a long-term confinement at Concordia station affects the cellular immune response of the volunteers. Molecular studies showed that there is a clear change in gene expression profiles over time. A more in-depth analysis of these identified genes and the possible pathways in which they are involved are currently being investigated. The obtained results can provide more insight into immune changes that are observed in astronauts during space flight.



Analysis of samples © SCK-CEN

In conclusion, ground-based research platforms, such as the Antarctic Concordia Research Station in which SCK•CEN is actively involved or maybe the Princess Elisabeth basis in the future, can help contributing in the determination of health risks associated with space conditions in human physiology, so that appropriate countermeasures may be developed prior to long-term space exploration.

For the CHOICE study blood samples were taken from the winter over crew. © SCK•CEN

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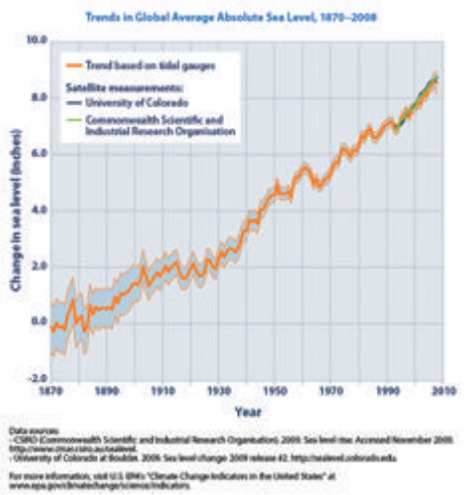
Ice2sea: Contribution of land ice to future sea-level rise

Why sea-level rise matters

Since 1993, scientists have used satellites to measure global sea-level rise with great precision. On average sea level has increased by more than 3 mm per year for the last two decades, a faster rate than estimated by tide gauges for the entire 20th century. Some recent studies suggest that a total sea-level rise of more than 1 metre by 2100 compared to the beginning of this century cannot be fully excluded.

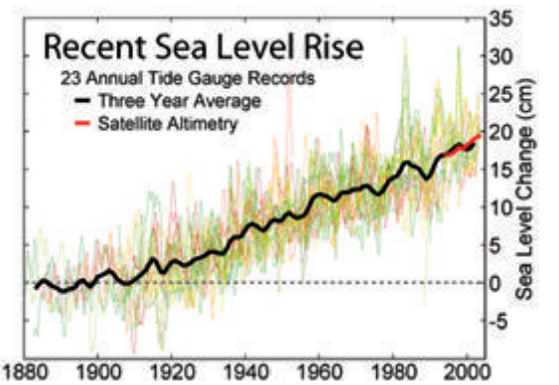


Trends in global average absolute sea level 1870-2008

Three main factors contribute to the observed sea-level rise, namely thermal expansion of the oceans, melting of mountain glaciers and ice caps, and mass loss of the ice sheets (Antarctica and Greenland). During the last decade, the first two terms account each for about one third of the total sea-level rise, while the ice sheets contribute about one fifth. The contribution from thermal expansion can be determined with most confidence. However, a large uncertainty remains concerning the contribution of the Antarctic and Greenland ice sheets, which contain more than 99% of the Earth's glacier ice.

© Prof. David Vaughan, British Antarctic Survey

Sea-level rise is a considerable threat all around the world as more than 40% of the total population lives within 150 km of the sea. It can be menacing for Europe in particular. Fifteen European Union (EU) countries have substantial coastlines that will be affected by global sea-level rise, leading to coastal inundation and erosion, destruction of natural sea defences, higher storm-surge flooding, changes in water quality, impacts on agriculture, etc. Therefore, understanding the magnitude of global sea-level rise during the twenty-first century (and beyond) is crucial. Developing policies to protect our coastlines and reduce the impact on lives and livelihoods of EU citizens demand the best projections of sea-level rise available.



Recent Sea Level Rise

The aftermath of IPCC AR4

The Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC), published in 2007, highlighted ice sheets as the largest uncertainty in projections of sea-level rise. In particular, the understanding of crucial ice-sheet dynamic effects was 'too limited to assess their likelihood or provide a best estimate of an upper bound for sea-level rise'. This hampered the overall projections of global mean sea-level rise in AR4.

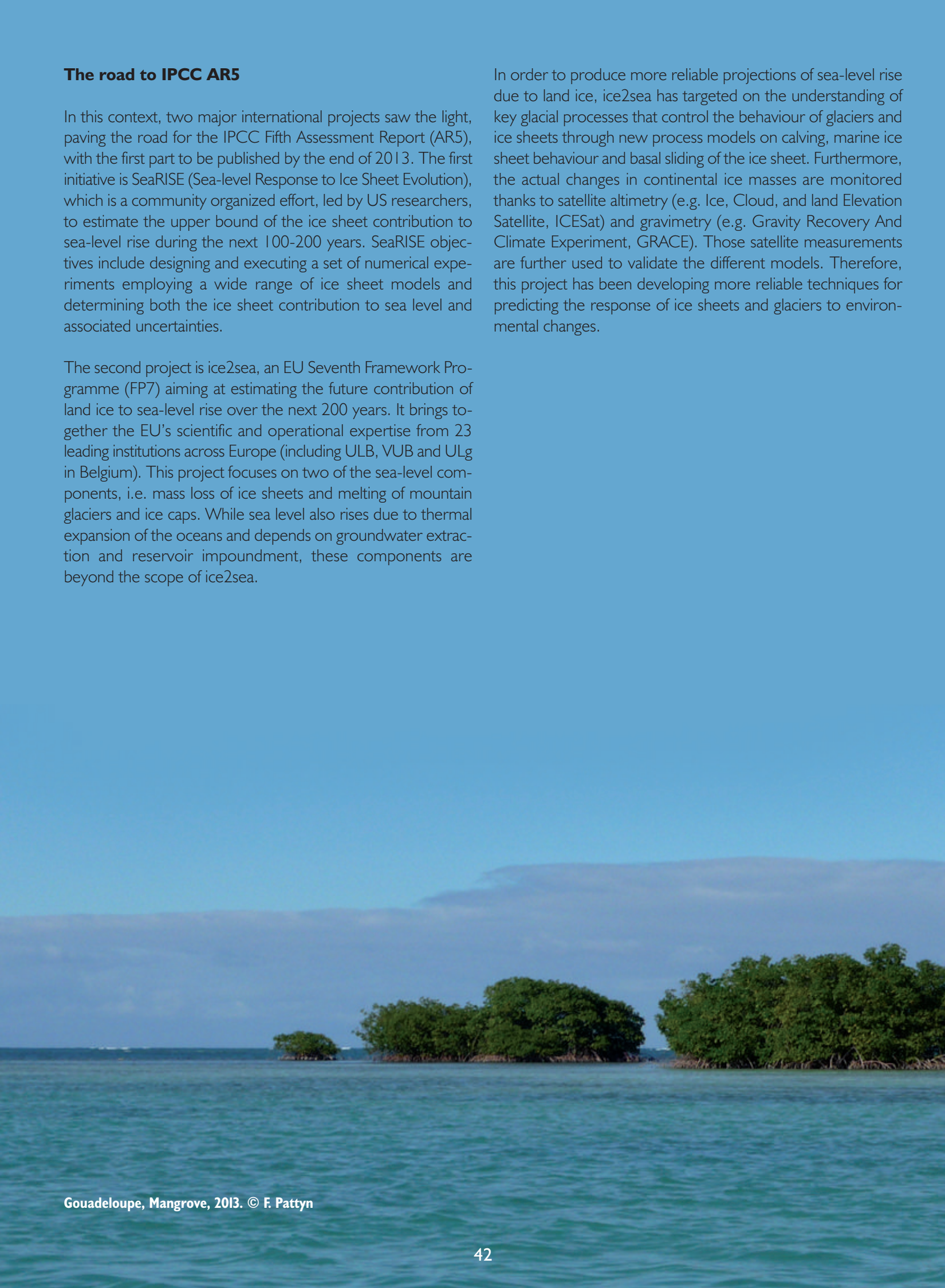
Nevertheless, there has been notable scientific progress since AR4 in the ability to estimate changes in the surface mass balance of the Greenland and Antarctic ice sheets by a number of independent techniques. Gravity measurements and laser altimetry from satellites now provide information on ice mass changes and surface elevation changes, as well as changes in the velocity of rapidly flowing ice streams. While it is now clear that the current mass balance of both large ice sheets is negative, uncertainties in the absolute numbers are still large and may amount to up to 100% for individual contributions such as those from ice streams or subsurface melting.

The road to IPCC AR5

In this context, two major international projects saw the light, paving the road for the IPCC Fifth Assessment Report (AR5), with the first part to be published by the end of 2013. The first initiative is SeaRISE (Sea-level Response to Ice Sheet Evolution), which is a community organized effort, led by US researchers, to estimate the upper bound of the ice sheet contribution to sea-level rise during the next 100-200 years. SeaRISE objectives include designing and executing a set of numerical experiments employing a wide range of ice sheet models and determining both the ice sheet contribution to sea level and associated uncertainties.

The second project is ice2sea, an EU Seventh Framework Programme (FP7) aiming at estimating the future contribution of land ice to sea-level rise over the next 200 years. It brings together the EU's scientific and operational expertise from 23 leading institutions across Europe (including ULB, VUB and ULg in Belgium). This project focuses on two of the sea-level components, i.e. mass loss of ice sheets and melting of mountain glaciers and ice caps. While sea level also rises due to thermal expansion of the oceans and depends on groundwater extraction and reservoir impoundment, these components are beyond the scope of ice2sea.

In order to produce more reliable projections of sea-level rise due to land ice, ice2sea has targeted on the understanding of key glacial processes that control the behaviour of glaciers and ice sheets through new process models on calving, marine ice sheet behaviour and basal sliding of the ice sheet. Furthermore, the actual changes in continental ice masses are monitored thanks to satellite altimetry (e.g. Ice, Cloud, and land Elevation Satellite, ICESat) and gravimetry (e.g. Gravity Recovery And Climate Experiment, GRACE). Those satellite measurements are further used to validate the different models. Therefore, this project has been developing more reliable techniques for predicting the response of ice sheets and glaciers to environmental changes.



Gouadeloupe, Mangrove, 2013. © F. Pattyn

Contribution of land ice to future sea-level rise

Several key findings have been reported by ice2sea researchers by now. One of these is that warm ocean currents are found to be the dominant cause of recent Antarctic ice sheet loss. By using ICESat satellite data to measure the changes in floating ice thickness, Pritchard *et al.* (2012) found that 20 of the 54 Antarctic floating ice shelves – most of which are located in West Antarctica – are thinning due to the penetration of warm water underneath. This leads to an acceleration of inland outlet glaciers, draining at present more ice into the sea and contributing to sea-level rise.

Besides, projections based on ocean models driven by future carbon emission scenarios have shown that a massive increase in melt in an unexpected part of Antarctica, the Filchner-Ronne Ice Shelf, during the second half of this century is likely (Hellmer *et al*., 2012). Its cause is a redirection of the coastal current into this ice shelf with water that is two degrees Celsius warmer than today. This is considerable as the projected ice loss at the base of the Filchner-Ronne Ice Shelf represents 80% of the present Antarctic surface mass balance. Such projections are a direct result of model improvement over the last couple of years.

Projections of the future of the Antarctic and Greenland ice sheets largely depend on an accurate evaluation of the present-day ice sheet imbalance, and each method that suits this purpose has its own advantages and deficiencies. The Ice Sheet Mass Balance Intercomparison Exercise (IMBIE) is a collaboration between 47 researchers from 26 laboratories who produced the most accurate assessment of current ice sheet loss to date (Shepherd *et al*., 2012). They showed that the Antarctic and Greenland ice sheets have contributed about one fifth (11 mm) of all sea-level rise since 1992, with two thirds of this ice loss coming from Greenland and one third from Antarctica. However, uncertainties as to whether the East Antarctic ice sheet is gaining or losing mass are still important.

Policymakers require scientists to make projections of maximum plausible sea-level rise, since their planning needs to take in account extreme events. Where the protection of coastal assets is the responsibility of local authorities, or even individuals, the emphasis may be on establishing a plan to deal with the most likely sea-level rise. For this reason ice2sea aims to communicate both the most likely and the maximum plausible sea-level rise projections, and give a range of certainty attached to each.

The authors

All authors are partners in the EU FP7 project ice2sea.
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Xavier Fettweis (Laboratoire de Climatologie, ULg, Liège) is a partner of the Work Package "High resolution atmosphere models".
Philippe Huybrechts (Earth System Sciences & Departement Geografie, VUB, Brussels) led large-scale modelling work on producing sea-level projections from the polar ice sheets during the 21st and 22nd centuries. More information on the programme can be found on www.ice2sea.eu. Phillipe Huybrechts is also review editor of the cryosphere chapter of IPCC AR5.

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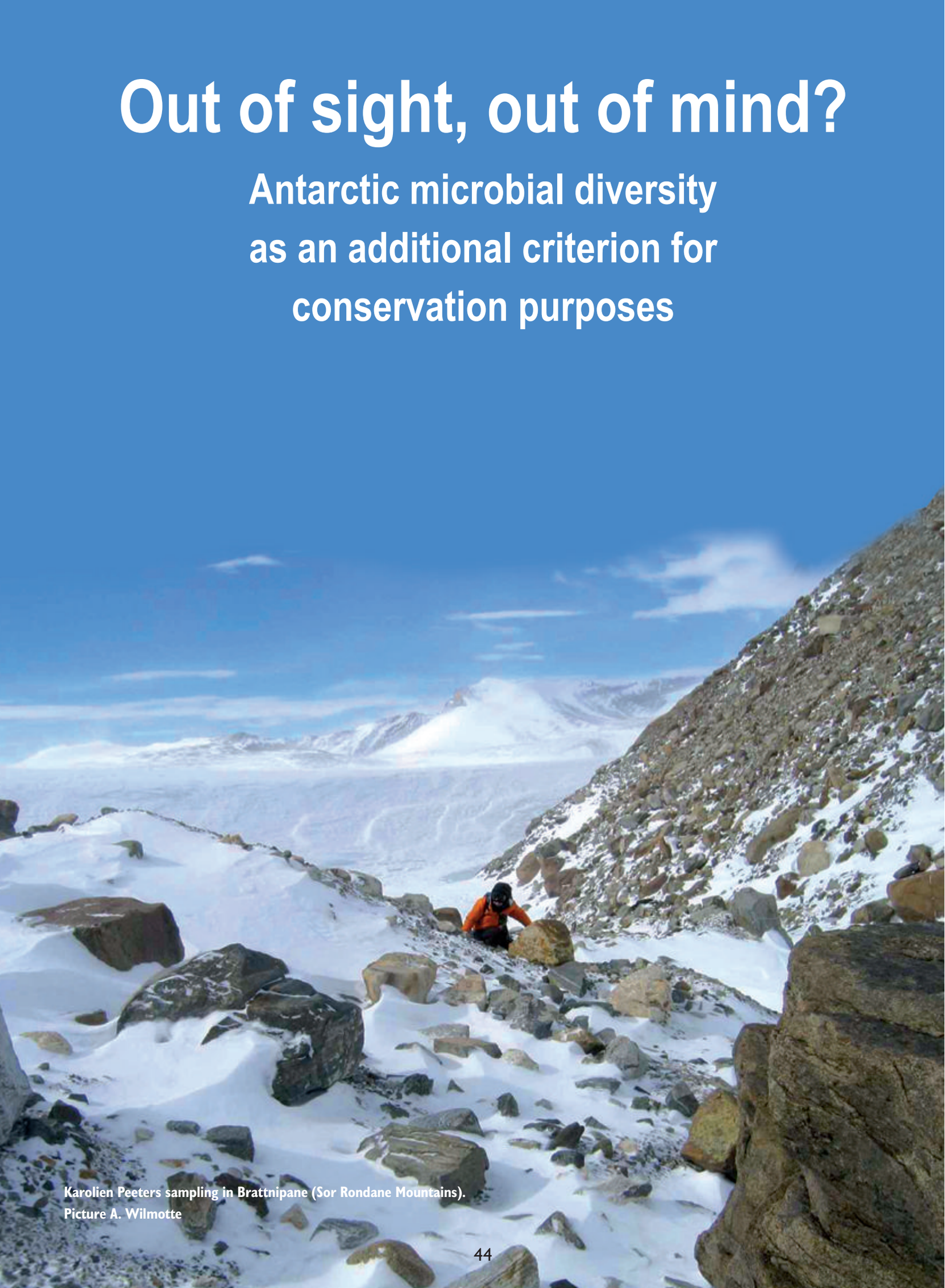
Antarctica, Dronning Maud Land ice/ocean 2012. © F. Pattyn

Out of sight, out of mind?

Antarctic microbial diversity as an additional criterion for conservation purposes



Karolien Peeters sampling in Brattnipane (Sor Rondane Mountains).
Picture A. Wilmotte

Introduction

Exploration of microbial biodiversity in Antarctic lakes and soils by Belgian research teams is revealing many new species, an unexpectedly high degree of endemism and strong influences of the glacial and tectonic history on the present-day distribution of microbes. These findings warrant more consideration of microbial diversity in conservation planning.

Microbial diversity and conservation

When the Protocol on Environmental Protection of the Antarctic Treaty was signed in 1991, knowledge on the biodiversity of small and microscopic organisms was much less extensive and molecular methods for biodiversity assessments

Microbial crust and black lichens on the Utsteinen nunatak. Picture A. Wilmotte

were still in their infancy. Therefore, the lists of taxa to protect do not include microbial species, though lichens, fungi and algae are listed under 'Plants' in Annex II. The network of ASPAs (Antarctic Specially Protected Areas) that is under construction by the Committee for Environmental Protection aims to protect 'outstanding environmental, scientific, historic, aesthetic or wilderness values, any combination of those values, or ongoing or planned scientific research' (www.ats.aq/e/ep_protected.htm).
Although it was recognized that microbes dominate biological activity in Antarctica, little was known about their taxonomic diversity and the age and geographic distribution of species.

Observation of endemic taxa in all studied microbial groups

During the Belspo projects ANTAR-IMPACT, BELDIVA and AMBIO, four Belgian teams studied the cultivable and uncultured diversity of cyanobacteria, heterotrophic bacteria, green algae and diatoms in Antarctic lakes and soils using state-of-the-art methods and the most recent taxonomic insights for species identification and delimitation.

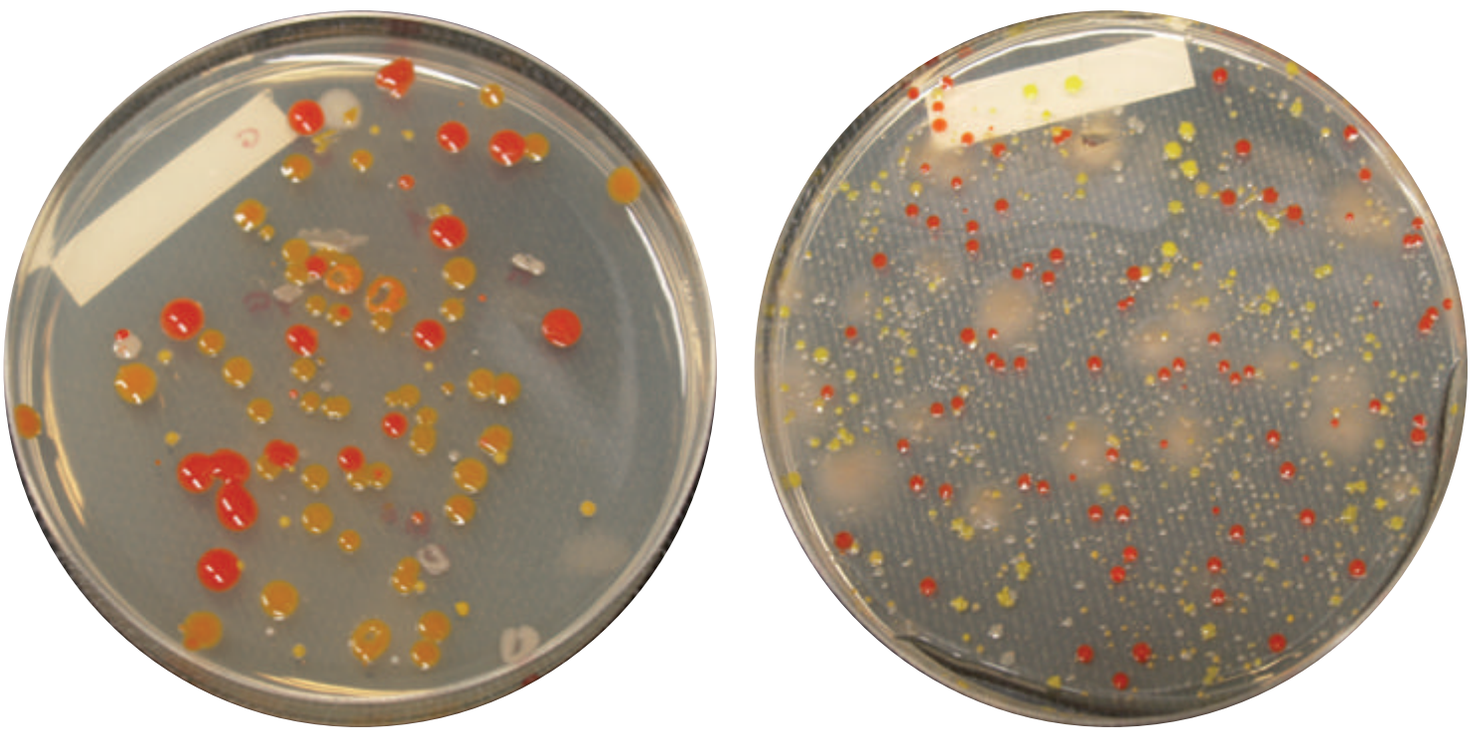
Diatom floras differ significantly between Continental Antarctica, Maritime Antarctica and the Sub-Antarctic islands. This strong bioregionalisation and high incidence of endemism can be partly explained by geographic variation in local environmental conditions but to a large extent also reflects the geographic isolation and the climatic and geological history of these regions. Some regions acted as glacial refugia during past ice ages and hold a relict flora, which is composed of a combination of Antarctic endemics (including several new species), taxa that inhabit alpine regions elsewhere and apparently cosmopolitan species complexes. However, molecular phylogenetic analyses revealed that these presumed cosmopolitan species comprise multiple species including a distinct Antarctic lineage which likely colonized the continent before the start of the Pleistocene ice ages.

Microbial mat fed by snowmelt in the Skarvsnes Peninsula, Lützow Holm bay, East-Antarctica. Picture W. Vyverman

In green algae, Small Subunit (SSU) ribosomal RNA sequences of cultivated freshwater microchlorophyte strains revealed a wide phylogenetic diversity of apparently endemic Antarctic lineages. The majority of the lineages have estimated ages between 17 and 84 Million years (Ma). These results point to several independent but rare colonisation events of the Antarctic continent and long-term survival of some lineages in glacial refugia. An analysis of the uncultured diversity using Denaturing Gradient Gel Electrophoresis (DGGE) of the SSU rRNA gene in microbial mats of over 40 continental Antarctic lakes revealed regional differences in the green algal flora, which are underlain by both local environmental conditions and historical events.

In bacteria, the isolation of about 3800 strains from just 9 samples revealed a large diversity of cultivable heterotrophic bacteria. 37 % of the strains seem to be restricted to Antarctica, and many were novel to science. There was only limited overlap between the bacterial strains obtained from each of the samples, suggesting a large spatial variation in species composition and high regional species diversity. We recovered representatives of five major phylogenetic groups (*Actinobacteria, Proteobacteria, Bacteroidetes, Firmicutes* and *Deinococcus-Thermus*) and several represented potentially new taxa. This suggests that in Antarctica, cosmopolitan taxa occur as well as taxa with limited dispersal, which potentially evolved in isolation.

In lakes of Eastern Antarctica, a study of the molecular diversity of cyanobacteria based on DGGE and SSU rRNA gene sequences for 50 microbial mats showed the presence of 35 Operational Taxonomic Units (OTUs, groups of SSU rRNA sequences with more than 98% similarity). 37% of the OTUs were restricted to the 'cold biosphere' (including Arctic and alpine regions) and 17% were potentially endemic to Antarctica. Most OTUs were present in several regions of Eastern Antarctica, which suggest frequent dispersal within the continent. In the terrestrial habitats, 157 samples of gravel, ice, microbial crusts, and rocks were collected in 10 different sites close to the Princess Elisabeth Station during three BELARE expeditions. Fifteen cyanobacterial morphotypes were observed by light microscopy. With DGGE based on SSU rRNA gene, 31 OTUs were obtained, including 10 OTUs potentially endemic in Antarctica and 6 OTUs only found in this region. This relatively high percentage of potential endemicity might be related to the fact that the Sør Rondane Mountains may have been a refugium during past glaciations.



Bacterial isolates with pigments that protect them, for example, against UV radiations. Picture K. Peeters

***Cyanothece aeruginosa* in a gravel sample on the Utsteinen nunatak. Picture Marie-José Mano**

A call for the inclusion of microbial taxa in conservation strategies and the designation of inviolate areas

In summary, the presence of endemic taxa in all groups studied and accumulating evidence that regional differences in microbial communities are related to past historic events, call for a better protection of Antarctic microbial communities. In particular, monitoring of microbial biodiversity would help to assess the impact of climate change and human activities, including the construction of new stations, field research, or tourism in these unique ecosystems. Therefore we argue that microbial biodiversity data should be considered as an additional criterion for the delineation of ASPAs. With further development of new sequencing technologies and –omics tools, assessing microbial diversity will become feasible and affordable at a scale and level comparable to monitoring programs of populations of birds, mammals, plants or multicellular organisms in general. In addition, the Annex V (Article 3) to the Madrid Protocol (www.ats.aq/documents/recatt/att004_e.pdf) foresees the possibility to include in the ASPAs, some 'areas kept inviolate from human interference so that future comparisons may be possible with localities that have been affected by human activities'. Clearly, such designations would also be of utmost importance to safeguard reference areas for future microbial diversity studies in a context of increasing anthropogenic pressure.

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Space rocks on Ice

SAMBA (Search for Antarctic Meteorites: Belgian Activities) is a Vrije Universiteit Brussel (VUB) and Université Libre de Bruxelles (ULB) project, financed by the Belgian Science Policy office (Belspo), in collaboration with the National Institute of Polar Research (NIPR) in Tokyo.

Starting in 2009, scientists of the VUB, ULB and NIPR carried out three meteorite recovery expeditions to the blue ice fields of Eastern Antarctica, in the region surrounding the Princess Elisabeth Station (PE). A total of 1278 new samples were found. These fragments are being studied to unravel the mysteries of the origin of the solar system and the formation of the first planets, some 4.5 billion years ago.

The importance of meteorites

Meteorites constitute the leftover building blocks of the Solar System. As such, they provide valuable clues on its origin and evolution as well as on the formation of the planets. The majority of meteorites comes from the main asteroid belt between Mars and Jupiter. Extremely rare ones were ejected from the deep crust of the Moon and Mars during large impact events. Meteorites are classified in groups corresponding to different evolution-phases of the Solar Nebula. The most primitive, the carbonaceous chondrites, together with the other chondrites, originated from the break-up of small size undifferentiated planetary bodies. The term undifferentiated implies that they have not evolved geologically since the formation of the solar system. The carbonaceous chondrites present almost the same chemical composition as the sun and result from the condensation of the solar nebula, almost without any fractionation or subsequent changes. The chondrules (former molten droplets with a round shape) and Ca – Al Inclusions (CAI) found in these meteorites were the first refractory phases to condense (> 1800 K) out of the Nebula. The radiometric dating of these CAI from the Acfer 059 meteorite using U/Pb isotope systematics places the origin of the Solar System at 4567.2 ± 0.6 Ma. Carbonaceous chondrites also contain complex organic compounds (ex. amino acids) and contribute to the understanding of the origin of life on Earth. The other groups of meteorites (iron, stony-iron and achondrites) originate from more differentiated or more evolved planetary bodies that have undergone several episodes of planetary evolution comparable to the formation of the core, mantle and crust on Earth, as well as episode(s) of shock metamorphism during collision events. Access to these samples from space offers a unique window to the mineralogy of the inaccessible deep Earth. The value of meteorites to document astronomical, solar system and planetary formation processes does not have to be further demonstrated. Meteorites have and continue to provide data on stellar evolution and nucleosynthesis, the chronology of the solar system, the formation of planets, cosmic rays bombardment, the deep crust of Mars and the Moon, the different types of asteroids and are often used to "calibrate" the instruments of the orbiters and landers used in planetary exploration (for example Spirit or Pathfinder).

Scientist collecting a meteorite on the blue ice field.

Meteorites in Antarctica

In 1969, for the first time a Japanese glaciology team discovered nine meteorites lying on the ice in the region of the Yamato Mountains in East Antarctica. Today, samples collected in Antarctica represent ~ 70 % of all known meteorites. Their study has greatly improved knowledge concerning the formation of the Solar system and the planets. Although extraterrestrial material falls evenly over the Earth, the ice fields of Antarctica concentrate rare and precious meteorites. Low temperature and extreme dryness at the South Pole preserve them from terrestrial weathering. A meteorite falling over Antarctica is quickly buried in snow, and sinks progressively deeper over the seasons to end up enclosed in ice as the snow crystallizes under pressure. Ice flows like a sluggish hydraulic system. The buried meteorites, entrained in the ice, move outward towards the edge of the continent, and unfortunately for the majority of them, ultimately end up in the ocean. However, when an obstacle, such as a mountain chain, stops or slows down the ice flow, the strong winds strip the superficial snow and slowly ablate the ice (figure 1). Over time, the meteorites trapped deeply inside the ice layers are brought back to the surface as the loss by ablation is replenished by upstream ice at depth. The patches of stagnant ice flow are referred to as meteorite stranding surfaces. With patience, a good eye and some luck, numerous meteorites can be collected in the blue ice fields of Antarctica.

Over the last thirty-five years, the USA and Japan have dominated the search for meteorites in Antarctica. Japanese expeditions mainly collect meteorites in the ice fields surrounding the Yamato Mountains in Eastern Antarctica, while the Americans focus on the other side of the continent working from the renowned McMurdo base. Nonetheless, the blue ice fields surrounding the Belgian station Princess Elisabeth and the Sør Rondane Mountains rank among the best in terms of meteorite abundance. Several rare and precious samples such as Martian and Lunar meteorites were recovered in Eastern Antarctica and have contributed to major advancements in planetary sciences. Increasing the number of recovered meteorites multiplies the chance of finding new and/or rare types that provide further opportunities to understand solar system evolution.

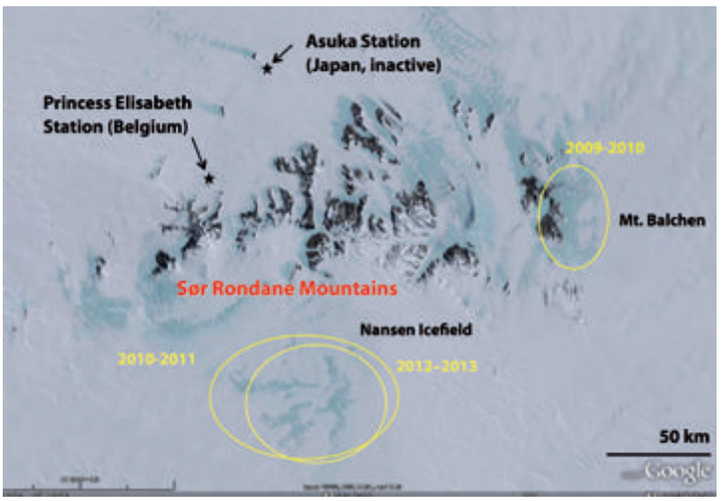

figure 2

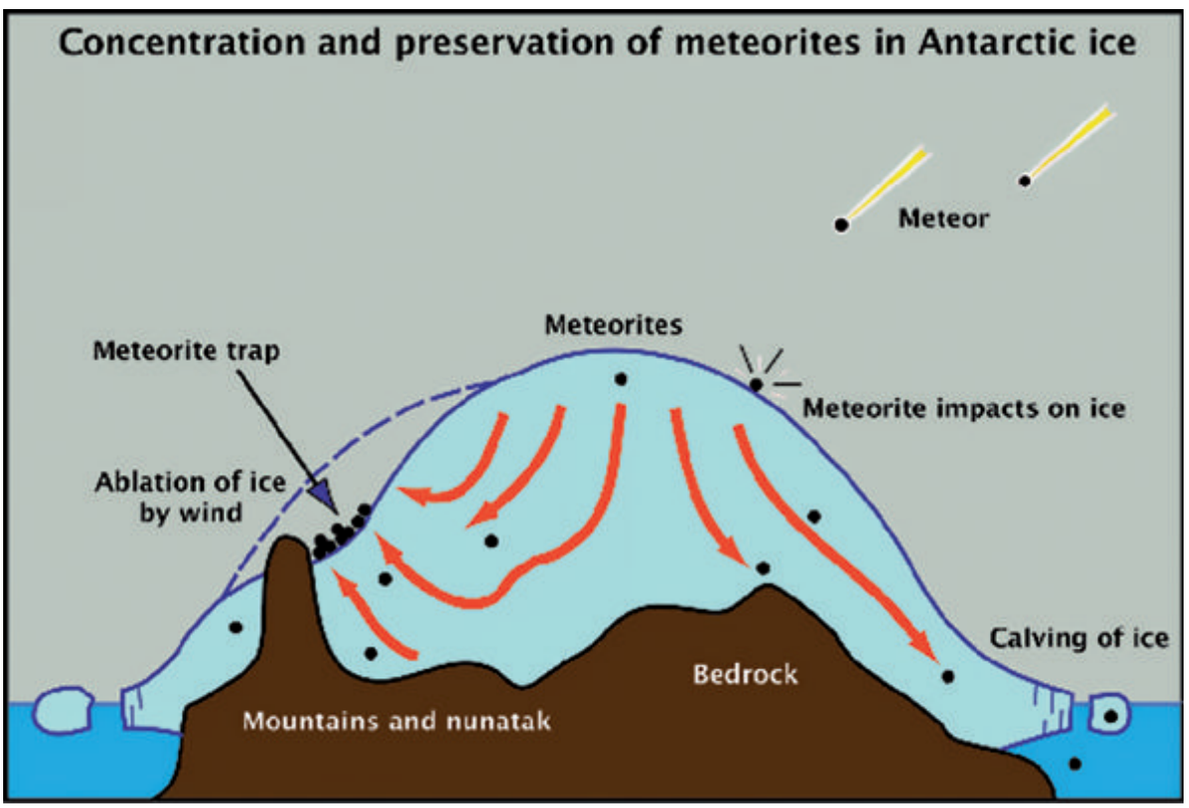

figure 1

Today, as the stranded meteorites are slowly but regularly being replenished by ice movement, many more samples remain to be found. The Princess Elisabeth station constitutes the perfect logistic base for such enterprise. The purpose of the SAMBA initiative is to recover these unique meteorites and bring them back to the laboratory for detailed studies. As it is a Belgian-Japanese joint venture, the recovered samples are shared equally between the two countries. After initial classification – that is the determination of the type of meteorite and its characterization in term of composition – the samples are made available for investigation by collaborating Belgian and Japanese researchers as well as to the rest of the international scientific community. For this purpose a curation facility has been set up at the Royal Belgian Institute of Natural Sciences (RBINS) in Brussels. It will work in parallel with the existing curation system at NIPR to allocate sample fragments to researchers from institutions worldwide based on a motivated request. Ultimately, through the curation of this collection of Antarctic samples, the RBINS should become a hub for meteorite research in Europe.

The meteorite search expeditions

In 2009, Dr. Steven Goderis (VUB) accompanied the Japanese expedition JARE 51 to the Balchen region, some 200 km from Princess Elisabeth. This expedition combined the study of the local geology with the recovery of meteorites. After a month on the famous Japanese icebreaker Shirase sailing from Perth (Australia), the ship arrived to Crown Bay where the spectacular unloading took place by use of helicopters. The team assisted in the construction of the convoy on ice shelf and left for the Balchenfjella area (~1600 m altitude) to the East of the Sør Rondane Mountains after only a few days. The highly successful meteorite searches under fortuitous weather circumstances led to the recovery of 635 meteorite fragments in the next 6 weeks. This grand total included several rare types, such as ureilites and irons.

The next year, an exploratory mission was organized to open the difficult route from Princess Elisabeth to the high altitude (2900 m) Nansen ice field located ~ 140 km to the south, on the south side of the Sør Rondane Mountains. The goal was to scout this region for its meteorite potential. This small expedition was composed of Steven Goderis, Vinciane Debaille (ULB) and Hiroshi Kaiden (NIPR). Because the number of participants was small, and because of adverse conditions, cold temperatures and very strong winds, the team collected less than 10 kg of samples (218 fragments) in the northwestern part of Nansen, but nevertheless they confirmed the strong potential of the Nansen ice field in terms of meteorite collection.

In 2012-2013, a much larger expedition was put together to return to the southern and eastern parts of the Nansen ice field, under the leadership of Vinciane Debaille. It counted 8 scientists, 5 Belgian scientists from ULB and VUB and three Japanese, two from NIPR and one from Tokyo University. This time, the team spent 6 weeks on the plateau, collecting 425 meteorites including a unique sample weighing ~ 18 kg, the largest meteorite recovered in East Antarctica over the last 25 years. This expedition was a clear success as more than 75 kg of meteorite were recovered.

Close up of a large meteorite on ice.

Group posing in front of the largest meteorite recovered during the 2012-2013 expedition, it weights 18 kg.

How to find meteorites?

Skidoos are most commonly used to search the vast ice fields for meteorites as these black rocks stand out on the white ice. In some other locations, for example near a moraine field, searches can also be done on foot. With the skidoos, a team covers 15 to 30 km per day, which takes 4 to 6 hours, depending on the weather conditions. Generally, they adopt a V-shape formation, with the field guide in front to spot crevasses or any other potential risk. There is between 20 to 50 m between each driver, depending of the visibility and the potential dangers of the field. Terrestrial rocks are rare in the blue ice fields, and if necessary meteorites can be distinguished by the presence of a fusion crust, formed by heating during their rapid passage through the atmosphere. When a meteorite is spotted, GPS positions and pictures with a scale are taken of the meteorites. The new sample is then carefully put in a plastic bag without being touched by hands to avoid any biological contamination, labelled, and all available data are recorded in a logbook. Everybody then retakes his/her place in the V-shape, with the meteorite carefully tucked away in a bag.

The recovered meteorites are first sent to Japan frozen. At the NIPR, they undergo defrosting according to a specific procedure. For long these meteorites were protected from weathering by snow and ice, and it must be avoided that water percolates and penetrates into the rock during the thawing process. Consequently, the latter occurs under vacuum, so the ice becomes vapor, instead of H_2O liquid. This way, the meteorite remains dry, pristine and uncontaminated; ready to undergo all kinds of research experiments in the laboratory to unscramble its message about the birth of the solar system and the planet.

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V-shaped search formation used for meteorite search.

'Integrative taxonomy' as a fundamental discipline in polar environments

The global biodiversity crisis

Currently, species are undergoing a rate of extinction that is a thousand times higher than the estimation made based on fossil archives, and this could worsen by a factor of ten in the near future. Moreover, any loss of biodiversity has an impact on the functioning of ecosystems, their stability, their ability to resist change, the services they can render, and human well-being in general.

Faced with this worldwide biodiversity crisis and the threats associated with global climate change, the improvement of our knowledge of biodiversity is an absolute priority, in particular in polar environments where many organisms can only withstand a narrow margin of variation in environmental factors and are therefore particularly vulnerable.

Integrative taxonomy

The knowledge of biodiversity is based on species and therefore taxonomy, the biological discipline that identifies, describes, names and classifies species. The 'species' category is the fundamental unit, whether it is used to estimate the extent and structure of biodiversity, draw up observed or predicted biodiversity maps, identify 'hotspots' of species richness and endemism, or to define protected areas.

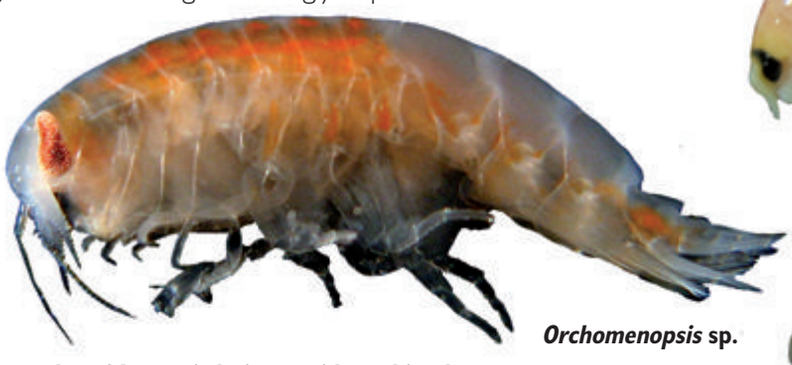
Currently, rather than considering a new species as a new natural fact, taxonomists approach it as a true scientific hypothesis, whose delineation is supported by data from different fields of research. In this so-called 'integrative' taxonomic approach, new methods and data – especially molecular (DNA) – are becoming increasingly important.

In the last few years, DNA sequencing, and especially the growing use of molecular barcodes, have helped to improve the discovery of new species and reveal a considerable and unexpected amount of cryptic diversity. These discoveries have major repercussions on the assessment of biodiversity, conservation and the nomenclature of the groups studied.

Combined with the classic morphological approach, the molecular approach has also enabled the reactivation of several evolutionary and historical issues associated with the biodiversity of the Southern Ocean and its deep surrounding waters. Amphipod crustaceans, a group that the Institut royal des Sciences naturelles de Belgique (IRSNB) has been studying for a long time, illustrate these different aspects.

Cryptic species and biodiversity

Within the group of Peracarida crustaceans, amphipods represent the group with the highest number of species (919) in the Southern Ocean, 545 of which are strictly Antarctic (i.e. present in the region delimited by the continental coastline and the polar front) and 417 of which are endemic, corresponding to a rate of endemism of approximately 76%. The use of DNA barcodes has made it possible to refine the delimitation of species within several groups of Antarctic amphipods and to modify our perception of their biodiversity. Hence, some species of Antarctic lysianassoid amphipods (fig. 1), assumed to have an Antarctic circumpolar distribution and present at all depths (eurybathic species), are in fact complexes of cryptic species with a restricted distribution.



***Orchomenopsis* sp.**

Abyssorchomene rossi.

Fig. 1 Examples of Antarctic lysianassoid amphipods. (Photos: H. Robert, C. d'Udekem d'Acoz; IRSNB).

The lyssianasid *Eurythenes gryllus*, a giant abyssal amphipod usually considered a species with a cosmopolitan and eurybathic distribution, provides an interesting example of bathymetric segregation, i.e. associated with the depth of the ocean (Havermans et al., 2013) (fig. 2). An integrative taxonomic approach, combining genetic, morphological and phylogeographic analyses, recently showed that *E. gryllus* is, in fact, a complex of several species, with a distinct bathymetric distribution, suggesting, moreover, the existence of a universal phylogeographic barrier of tolerance to barometric pressure. The majority of species identified within the *E. gryllus* complex seems to be restricted to a single oceanic region. Only the species the closest to the morphological type that served for the description of *E. gryllus* is present in the bathyal zone of the Arctic and Southern oceans. This bipolar distribution is demonstrated for the first time in deep-water benthic macroinvertebrates.

These studies, begun on a particular group of amphipods, are continuing on several other groups, some of which are iconic elements of Antarctica's fauna (fig. 3). All confirm a fundamentally similar scenario, i.e. a mix of widely distributed species and others with more restricted distribution, the majority of which are endemic in the Antarctic region or the Southern Ocean, with sometimes a large proportion of cryptic diversity and a specific richness that is always highly underestimated, the knowledge of which remains very fragmentary in terms of cover of the biogeographical regions, bathymetric zones, habitats and eco-functional groups.

Fig. 2 *Eurythenes gryllus*, a complex of giant abyssal species
(Photo: H. Robert, IRSNB).

Modelling of the distribution of biodiversity, global climate change and conservation

An important part of current research in polar environments, carried out in particular by the IRSNB, relates to the development of biodiversity distribution models (fig. 4). These models should allow us to better understand how the distribution of the Southern Ocean's benthic fauna is structured on a large scale, and how it could evolve in response to global climate change. Although the evolving aspect of these models gives them a great deal of flexibility, they remain fundamentally dependent on the results provided by taxonomy.

Besides the fact that the integrative taxonomic approach allows us to call into question certain paradigms that are linked to the distribution of species, the identification of complexes of cryptic species has a major impact on conservation. While, before being recognised as such, the complexes of cryptic species had a wide geographic distribution, the biological species identified in these complexes often have a more restricted distribution, making them all the more vulnerable and subject to extinction. The discovery of these previously unknown pockets of endemism and diversity has therefore inevitably repercussions on the identification of zones requiring protection measures.

To sum up, the recent development of new concepts and approaches has allowed a so-called 'integrative' taxonomy to better understand and protect biodiversity. Because it constitutes the foundations on which a whole series of derived disciplines have been built, such as ecology and conservation science, taxonomy remains a fundamental discipline on which the credibility of biological research in polar environments rests.

The author

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Echiniphimedia hogdsoni

Epimeria rubriequies

Eusirus giganteus

Liljeborgia sp.

Fig. 4 Illustration of different groups of amphipods studied at the IRSNB. (Photos: H. Robert, IRSNB).

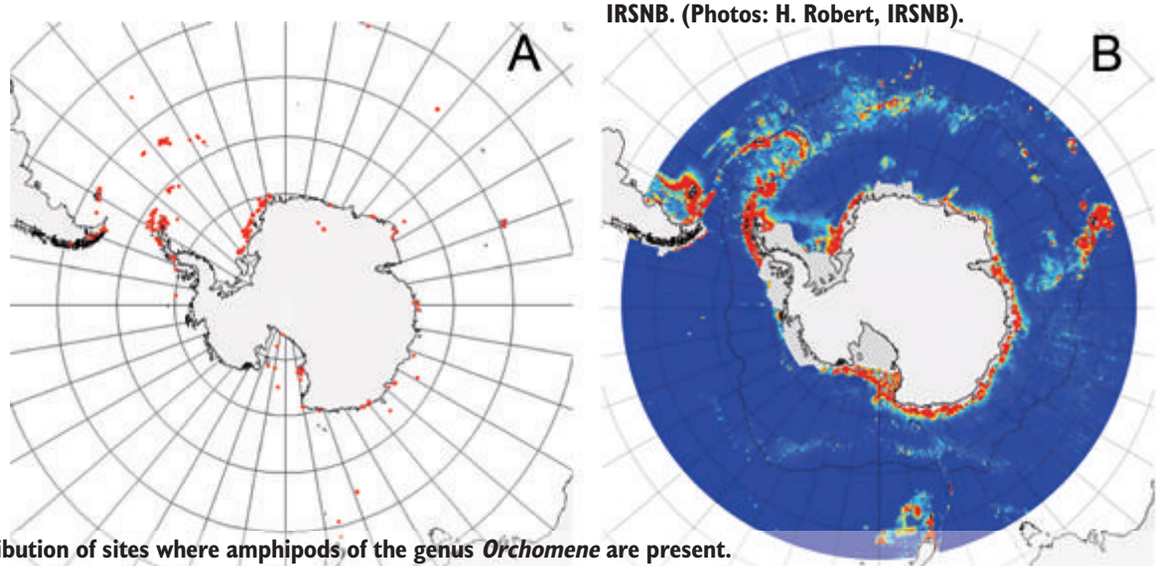

Fig. 4 A. Distribution of sites where amphipods of the genus *Orchomene* are present.
B. Map of habitat suitability (probability of occurrence) for for amphipods of the genus *Orchomene*, generated by maximum entropy modelling (MaxEnt method); gradient of colours: red = highly suitable habitats, blue = not suitable habitats.
(Plates: B. Pierrat, Université de Bourgogne, France).

APECS BeNeLux

United we stand, divided we fall

The Association of Polar Early Career Scientists, APECS, is an international and interdisciplinary organization for undergraduate students, graduate students, postdoctoral researchers, early faculty members, educators and anyone with interest in the polar regions and wider cryosphere. APECS aims to stimulate research collaborations and develop effective future leaders in polar research, education and outreach. To achieve those aims, APECS facilitates networking to share ideas and experiences and to develop new research directions and collaborations; provides opportunities for professional career development; promotes education and outreach as an integral component of polar research and stimulates future researchers. Currently, APECS has almost 4000 members in 76 countries worldwide. On a day-to-day base, it is led by the director and Executive Committee. They are furthermore supported by a 26-headed Council and guided by senior scientists from the Advisory Committee.

The APECS Belgium core group

Antarctica Day on 1st December 2011 © Ines Tavernier

Several committees have been established at a national level. APECS Belgium, founded on December 1st 2011, in the spirit of 'Antarctica Day' and building on the formerly established Youth Steering Committee, is one of them. Each year, several activities take place on Antarctica Day worldwide to commemorate the signing of the Antarctic Treaty by twelve nations on December 1st 1959. Belgian researchers met, a keynote presentation about the Antarctic Treaty was given by environmental lawyer Hendrik Schoukens (Ghent University), short poster presentations were given and a core group of APECS Belgium was formed. Young researchers got to know each other and each other's research and were able to talk under a more informal atmosphere. From then on, the core group consisting of Anton Van de Putte (biodiversity.aq), Ines Tavernier, Dagmar Obbels, Francesca Pasotti, Freija Hauquier, Hendrik Schoukens (Ghent University), Marie Dierckx, Denis Callens, Morgane Philippe (Université Libre de Bruxelles), Marie-Jose Mano, and Pedro De Carvalho Maalouf (Université de Liège) regularly meets at the Belgian Science Policy office to discuss any upcoming events. Last year, the group visited the New Belgica Project (Boom, Belgium). This social project, led by Eddy Steur, is providing carpenter training for long-term unemployed people, by building a form-replica of the Belgica, the research vessel of Adrien de Gerlache that sailed to and overwintered in the Antarctic at the end of the 19th century. The team of Adrien de Gerlache was the first to make a full annual cycle of scientific observations in Antarctica. After the scientific expedition, the Belgica was used for other purposes and finally sunk in front of the coast of Norway during the second world war, under unclear circumstances. The form-replica which will be built in compliance with modern maritime standards, will also have an educational component as it will sail around the world, and inform people about climate change and the historic role of pioneers such as Adrien de Gerlache.

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The BeNeLux group

And one leads to the other. The accidental meeting of representatives of Belgium (Ines Tavernier), The Netherlands (Frigga Kruse) and Luxembourg (Tania Gibéryen) at the International Polar Year conference in Montréal, Canada (April 2012), gave rise to the idea to establish APECS BeNeLux. The main thought that gave rise to this idea was: why shouldn't young polar scientists from nearby countries work more closely together? United we stand, divided we fall. This resulted in the first (bi)annually APECS BeNeLux symposium in Ghent, on 11 and 12 October 2012, organized by the APECS Belgium core group. For this symposium, we invited (inter)national keynote speakers: dr. Frank Pattyn (glaciologist and ice-sheet modeler at the Université Libre de Bruxelles), dr. Renuka Badhe (Executive officer from the Scientific Committee on Antarctic Research - SCAR), dr. Pete Convey (terrestrial ecologist at the British Antarctic Survey - BAS) and dr. José Xavier (marine biologist at the University of Coimbra, Portugal and the British Antarctic Survey). Besides the keynote speakers, 12 young researchers presented their work. One of these presentations was given by Wim Van Buggenhout, a high school teacher, who talked about his different projects to inspire students and get them enthusiastic about science, global climate and the poles. After all, a stronger connection between scientists and teachers is vital to encourage and motivate students, the next generation of scientists. On the second day of the symposium, four workshops were given: presentation skills, non-academic careers, talking to the media, and proposal writing. These skills you normally do not acquire at the university and were presented by the keynote speakers along with additional invited experts: journalists Manu Sinjan and Jos Van Hemelrijck and David Cox and Martine Vanderstraeten from the Belgian Science Policy Office. To break the ice between young scientists and senior researchers, successful social activities were organized at the conference venue and in the historic city centre of Ghent.

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Now that Belgium is hosting the Antarctic Treaty Consultative Meeting (ATCM) in Brussels between 20 and 29 May 2013, APECS Belgium feels that it is time to get public attention for the poles, their protection, the historic role of Belgium in scientific research on Antarctica, the importance of current research and global climate change. To this end, we are planning an event in the weekend of 25 and 26 May 2013 composed of a science fair (experiments), lectures and documentaries open to everyone who is interested in our polar regions. APECS Belgium is in charge of the logistics and organizational part of the event and counts on its contacts and partners to ensure the experiments throughout the weekend, targeting families, students and teachers. Several lectures, both on the Arctic and Antarctic will be given on various topics, suitable for various age groups. By doing so, we hope to also attract politicians attending the ATCM. This event is acknowledged and supported by SCAR (Scientific Committee on Antarctic Research), IASC (International Arctic Scientific Committee), The Belgian Antarctic Archives, New Belgica Project, APECS international, and the Belgian Science Policy Office. With this action, young Belgian researchers hope to transfer some of their enthusiasm about the poles to a wider public and arise consciousness about the environmental changes that are happening there at a large speed.

Visit of the New Belgica wharf.
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The authors

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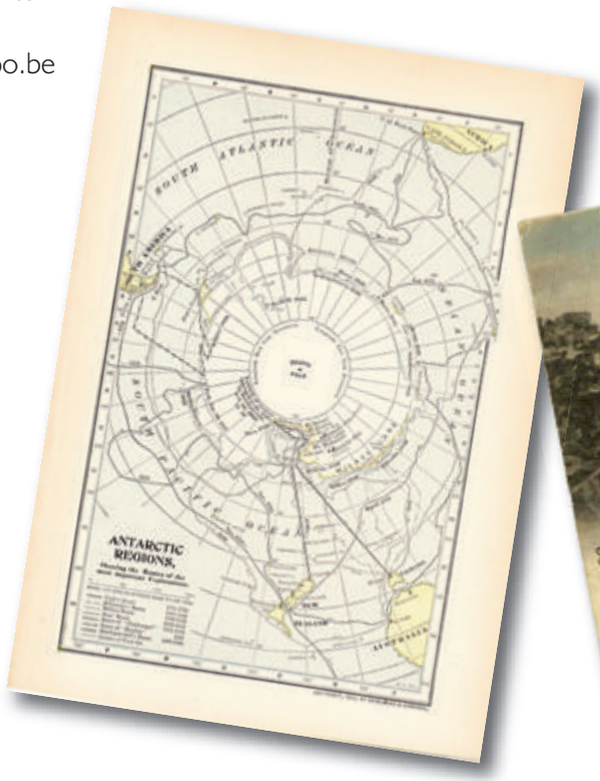

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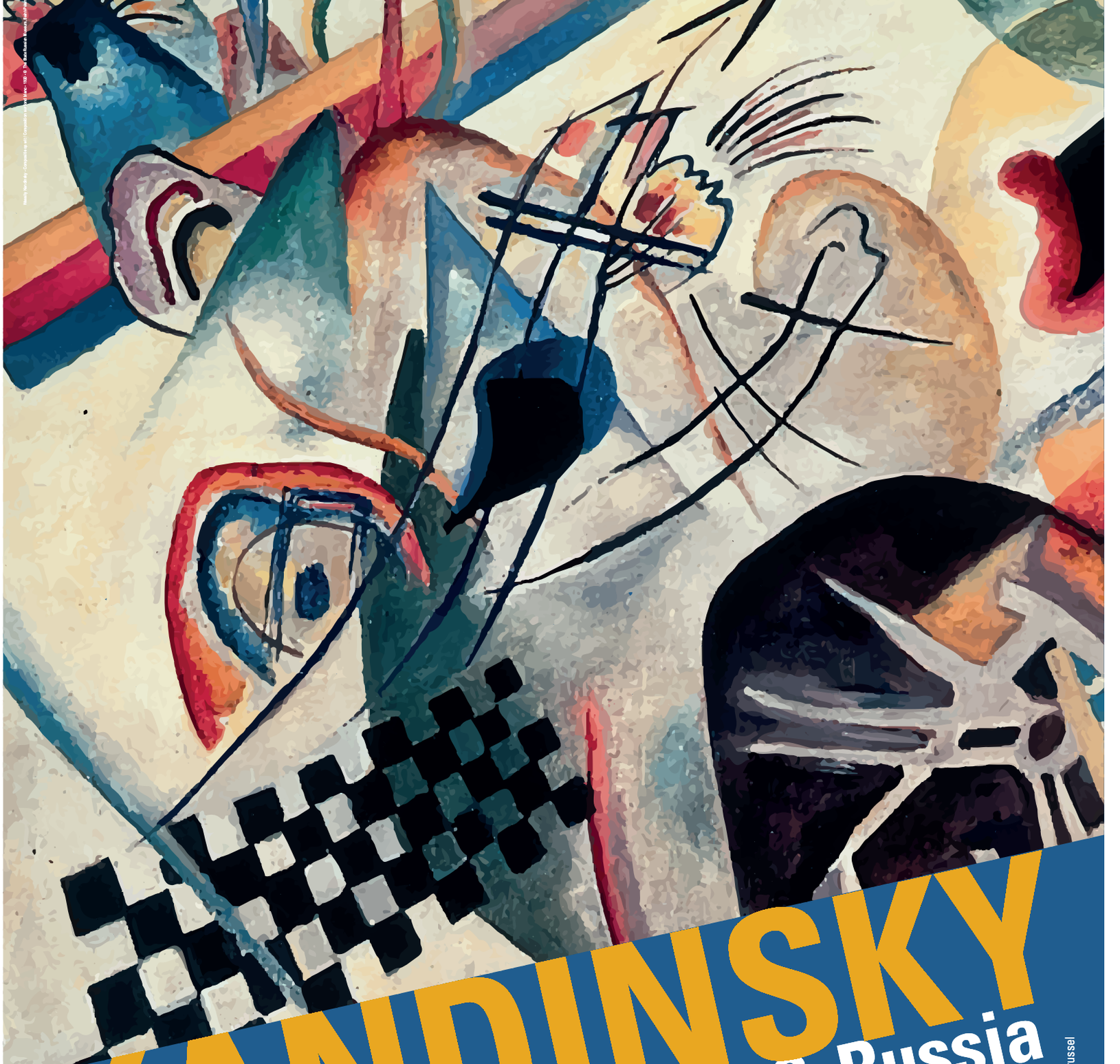

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