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REPORT OF WORKSHOP W7 "HUMAN PRESENCE AND CONTAMINATION IN ANTARCTICA"

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The interaction man/Antarctic environment can be studied from two points of view, different and complementary to each other:

1. **The impact of the Antarctic environment on human health and adaptation.**
2. **The impact of man on the Antarctic environment quality and the level of contamination.**

The proposed new research projects as part of W7, was drawn up on the basis of recent indications that SCAR obtained for the first time from a survey of researchers working in this sector (SCAR Horizon scan).

THE IMPACT OF THE ANTARCTIC ENVIRONMENT ON HUMAN HEALTH AND ADAPTATION

The human species is characterized by a remarkable capability to adapt to various environments. Human populations inhabited almost across the planet from the dry deserts to the ice shelves of the North. The only continent in which they failed to settle resident populations is Antarctica. The extreme weather conditions, solar radiation, limited presence of animal and vegetable life (confined in 1% of the Continent surface), and geographical isolation did not allow homesteading any human population. Due to their uniqueness, the members of exploratory and scientific expeditions, who since XIX century landed in Antarctica, have thus become the subject of medical and experimental interest. Such interest primarily concerns the adaptative capacities that individuals exhibit in order to meet the unusual requests of such an extreme environment.

Medical science is a small but important part of the scientific research programmes conducted in Antarctica. Areas that have been studied include aspects of cold and stress physiology, ultraviolet light effects, endocrine changes, alterations in immune function, chronobiology, psychology, microbiology, epidemiology and telemedicine.

Extreme conditions in Antarctica also constitute unique models for the study of pathophysiological phenomena widespread in the general population. Therefore, the findings obtained in Antarctica may also benefit the general population.

Moreover, the social conditions experienced by crewmembers of winter-over expeditions are considered as the closest simulation of space explorations. In particular, winter-over crewmembers experience a small group (10-14 participants per expedition), a confined environment, and isolation from the original social group. These conditions contributed to the definition of some Antarctica field stations (e.g. Concordia) as "White Mars". Many studies conducted at Concordia are considered as preparatory steps to space missions.

The issues on the discussion at the workshop on the biomedical researches are in accordance with the questions of the Horizon Scan, 2014 (n 80): "How will humans, diseases and pathogens change, impact and adapt to the extreme Antarctic?".

Immunology: There is much research demonstrating that thermal, nutritional and psychological stress all lead to decreased immune function resulting in increased risk of immune-related diseases. Stress responses may directly influence the immune system via endocrine mediators. Nonetheless, the immune system and other physiological processes may share gene transcriptional networks in which case transcriptional responses to abiotic stress, such as hypoxia, might also be important in mediating immune system effects. However, the impact on immune response under chronic hypoxic stress is largely unstudied. To better understand how immune system may be affected by unfavourable environmental conditions such as cold and high altitude hypoxia in Antarctica, we will investigate: i) whether acclimating to chronic hypoxia during the long-term isolation at Concordia alters the makeup of the peripheral immune system and/or the humoral and inflammatory responses; ii) which are the energetic costs of immune responses in terms of metabolic rate. This knowledge about interactions of stress and immunological pathways could greatly benefit ill patients who experience significant amounts of psychological and physical stress frequently complicated by tissue hypoxia in the fields of surgery, emergency and intensive care medicine.

Stress, physiology, psychology and behaviour: how stressful factors associated with isolated-confined-extreme environments regulate cognitive abilities (e.g. attention, memory, execution of tasks) and physiology (e.g. endocrine stress reactivity, neurotrophic factor). Role of social group in the regulation of individual performance: specifically, how group dynamics influence the ways in which an individual accomplishes a given task

Neurotoxicology (in close collaboration with "human presence and contamination"): Role of endocrine disruptors on physiology and behaviour. Investigate whether and how endocrine disruptors influence individual behaviour and stress physiology in experimental models.

Physiology: (Mal) adaptation to chronic hypoxia. Crews selection. Possible treatment on the field. Enormous relevant feed back on general population: cardiovascular and degenerative neurologic pathologies.

Altitude and reduced air density at Southern polar latitudes concur to create in Concordia Base a condition of hypoxia similar to that found at 3700m above sea level. Dwelling at this altitude induces remarkable acute and chronic physiopathological changes. Among these, the alterations in the blood gas carrying properties, characterized by the conflict between the need to oxygenate tissues, which induces alkalosis, and the need to preserve the blood acid-base status. Among chronic changes, the increase in erythropoietin and the blood haemoglobin levels, aimed at improving the oxygen transport to tissues at the expense of high blood viscosity and reduced iron body reserve. Such physiopathological changes may trigger the onset of pulmonary hypertension and iron starvation. It is also likely that the miRNA are altered with important implications in diagnostic of human diseases that involve hypoxia. Other physiological parameters that could be changed by this condition are the lipid and protein components at level of plasmatic fraction and blood cells. Finally, prolonged (months) hypoxia might induce ox-redox imbalance with several potentially lethal consequences as reduced level of endothelial-derived circulating progenitors, greater neuronal apoptosis with presumably irreversible neuronal injury, and diminished protection against ischemic cardiovascular injury.

Besides hypoxia. winter-over crewmembers experience a reduction of the habitual level of physical activity that can negatively affect their health status. The effects of this life-style change and the possible benefits induced by a physical training program (achievable in Concordia's gym) will be also assessed.

Further areas of interest of the biomedical research are:

- Telemedicine.
- Communications.
- Video Assisted Procedures.
- Robotic surgery.
- Medical personnel training.
- Different Medical Specialties.
- Medical procedure techniques.
- Evidence based medicine.
- Medical equipments/procedures: eg. blood analogues.
- Legal medicine issues.
- International cooperation/autonomous health system.

Moreover citizen science and governance: citizen science represents the effort of including the general public in scientific initiatives led by professional researchers. Within this framework, future projects shall aim at involving the general public in the scientific endeavours taking place in Antarctica. Specifically, it is possible to devise experimental apparatuses (e.g. environmental monitoring devices) in which individuals can be directly involved through constant monitoring or offering computing capabilities.

Moreover there have been identified possible biomedical research answers to two further questions of Scar Horizon 2014:

56. How will climate change affect the risk of spreading emerging infectious diseases in Antarctica?
77. How will the use of Antarctica for peaceful purposes and science be maintained as barriers to access change?

THE IMPACT OF MAN ON THE ANTARCTIC ENVIRONMENT QUALITY AND THE LEVEL OF CONTAMINATION

In the paper "Six priorities for Antarctic science" (NATURE, vol. 512, 23-25, 2014), Mahlon C. Kennicutt II, Steven L. Chown and colleagues outline the most pressing questions in southern polar research, and call for greater collaboration and environmental protection in the region. Environmental protection means, as key step, the recognition of the different sources of pollutants and other chemicals of environmental concern, and their quantification, through systematic monitoring of their presence in the various environmental components. Aspects of great importance are also studying the processes of transport and distribution across the major environmental interfaces (air/ice, ice/water, air/water, sediment/water.
In light of this premise, and also taking into account the skills acquired during the constant participation in the thirty expeditions to Antarctica already organized by the PNRA, the most important **scientific issues**, identified during the discussion at the workshop are as follows:

1. Chemical and dimensional characterization of atmospheric aerosol and identification of specific markers of the three primary sources (Long Range Atmospheric Transport, local human sources and other non-anthropic sources, such as volcanic eruptions and extensive forest fires). (SCAR Final questions no. 53 and 74).
2. Evaluation of the level of contamination and effects on the different components of the environment, with particular reference to the emerging pollutants. (SCAR Final questions no. 50, 52, 53 and 75.).
3. Study of chemical and photochemical reactions in the ice and snow, with particular reference to pollutants and other chemicals of environmental concern. (In response to the paper "Chemistry: ten things to need to know about ice and snow.", Nature, vol. 494, 27-29, 2013).
4. Study of the transfer processes of chemicals and micro-pollutants between different environmental compartments. (SCAR Final questions no: 48 and 53).
5. Effect of the extensive ice melting on the level of contamination in different environmental components. (SCAR, Final questions no. 23:53).
6. Use and implementation Bank of Environmental Antarctic Samples (BEAS), for retrospective studies. (SCAR Final questions no. 67 and 68)

Geographic areas.
Ross Sea, Northern Victoria Land, coastal areas, area around MZS, Dome C, the Antarctic Plateau, Antarctic peninsula. Lakes area at *(i)* Terra nova Bay; *(ii)* Edmonson Point; *(iii)* Inexpressible Island; *(iv)* Tarn Flat; *(v)* Vanda; *(vi)* Bonney, *(vii)* Hoare, *(viii)* Fryxell, *(ix)* Wilson, *(x)* Northern Victoria Land, *(xi)* Larseman Hills, *(xii)* Princess Elizabeth Land, East Antarctica; *(xiii)* King George Island, *(xiv)* Antarctic Peninsula., *(xiv)* Larsen and Reeves Glacier, *(xv)* Deception Island, *(xvi)* Livingstone Island, *(xv)* King George Island (Chile and Spain scientific base).

Methodologies and tools available.
1. Methodologies for the characterization of aerosols : primary natural markers of marine aerosol (amino acids); markers of biomass burning (methoxy phenol); identification of bio-aerosols by sugars, identification of metal sources associated with atmospheric particulate matter (elemental and isotopic analysis).
2. Methodologies for the chemical characterization of the sea surface microlayer.
3. Methodologies for the study of photochemical transformations of natural organic matter and anthropogenic contaminants within the cage of solvent present inside the ice matrix.
4. Conventional sampling of sea water, lake water, soil, sediment, air, snow, ice, organisms (marine invertebrates, fish, krill, birds and marine mammals), algae, lichens, mosses.
5. Use of both active and passive samplers for air sampling.
6. Use of the FIS-500 fractionation in-situ.
7. Use of the sampling device of sea-surface microlayer and sub-surface sea water (MUMS, Multi User Micro-layer Sampler)

International collaborations

1. Letter of endorsement (15 Sept 2015) required by Roger Fuoco (University of Pisa, Italy) to the Scientific Steering Committee of the Southern Ocean Observing System (SOOS) for the project "The presence of persistent organic pollutants (POPs) in the Southern Ocean: sources and trends (SOPOP).
2. Dr. PhD Susan Bengtson Nash, Griffith University, Nathan (Australia), Memorandum of Understanding.
3. Prof. Sungmin Hong, College of Natural Science, Inha University, Incheon 402-751 (Korea), Agreement for scientific collaboration.
4. Claude Bouthon, Honorary prof. at University Joseph Fourier, Grenoble (France), Agreement for scientific collaboration.
5. Dr. Marti Nadal, School of Medicine, IISPV, Universitat Rovira i Virgili, Catalonia (Spain), Agreement for scientific collaboration..
6. Prof. Thorsten Bartels-Rausch Paul Scherrer Institute (PSI) in Villigen in Switzerland.
7. Prof. Frank Vanhaecke, Department of Analytical Chemistry, Ghent University, Belgium.
8. Prof. Katrine Borga, Department of Biosciences, University of Oslo, Norway.
9. Dr. Jan Koschorreck, Federal Environment Agency (UBA), Germany.
10. Dr. Delphine Lanuzel, IMAS R. & E.Centres, University of Tasmania, Australia.
11. Prof. S. Jørgen Christiansen and Prof. Sophie Bourgeon, University of Tromso (Norway).
12. Julius Nielsen, University of Copenhagen (Denmark).
13. Rasmus Hedeholm, Greenland Institute of Natural Resources, Greenland.
14. Dr. Begona Jimenez, Instituto de Química Orgánica General, Consejo Superior de Investigaciones Científicas, Spain.
15. Dr. Karla Pozo, Universidad Católica Santisima Concepcion, Chile.
16. Prof C. Halsall, Lancaster Environment Centre.
17. Dr Massimo Gasparon, Department of Earth Sciences, University of Queensland, St Lucia, QLD 4072, Australia.
18. Dr. William J. Green, School of Interdisciplinary Studies, Miami University, Oxford, OH 45056, USA.
19. Dr. W. Berry Lyons, Byrd Polar Research Center, The Ohio State University, Columbus, Ohio 43210.
20. Dr Jenny Webster-Brown, University of Canterbury, Christchurch 8041, New Zealand.