

Workshop 7

Human presence and contamination in Antarctica



Workshop 7

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Scientific bases



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Leonid Ivanovich Rogozov

Russian: Леонид Иванович Рогозов,
14 March 1934 – 21 September 2000)

was a Soviet General Practitioner who took part in the sixth Soviet Antarctic Expedition in 1960–1961. He was the only doctor stationed at the Novolanzarevskaya Station and, while there, developed appendicitis, which meant he had to perform an appendicectomy on himself, a famous case of self-surgery.



Rogozov V, Bermel N, Auto-appendectomy in the Antarctic: case report. *BMJ*, 2009; 339:b4965, Dec 2009

“A job like any other, a life like any other”

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Human presence and contamination in Antarctica

Edward Leichester Atkinson

(South Upperwind Island, Nov, 23rd, 1881–
Mediterranean Sea, Feb, 20th, 1929)

English surgeon and explorer.

1908 joins Royal Navy. 1910 party of the Terra Nova Expedition of Robert Falcon Scott in Antarctica. Will be Atkinson to lead the rescue expedition of remain party from South Pole and to find the tent with the body of the death Scott, Henry Robertson Bowers and Edward Adrian Wilson.

Atkinson is at the center of controversies about the managing of the sledge dogs to help the Scott party on their way back and about suspect signs of scurvy in the Scott group.

During the first world war he participates to the Gallipoli battle.

To Atkinson is dedicated the Atkinson Cliffs in the Victoria Queen Land in Antarctica.



Workshop 7

Human presence and contamination in Antarctica

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Workshop 7

Human presence and contamination in Antarctica

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Workshop 7

Human presence and contamination in Antarctica

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Workshop 7

Human presence and contamination in Antarctica

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Workshop 7

Human presence and contamination in Antarctica

Horizon Scan, 2014 : 80 most important scientific questions on direction of Antarctica Science.

BIOMEDICAL RESEARCHES:

80. How will humans, diseases and pathogens change, impact and adapt to the extreme Antarctic.

56. How will climate change affect the risk of spreading emerging infectious diseases in Antarctica?
(Cross-cuts "Human")

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Human presence and contamination in Antarctica

Horizon Scan, 2014: 80 most important scientific questions on direction of Antarctica Science.

BIOMEDICAL RESEARCHES:

- Legal medicine issues
- International cooperation/autonomous health system

77. How will the use of Antarctica for peaceful purposes and science be maintained as barriers to access change?

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Biomedical research:

- Human adaptation**
- Physiology**
- Psychology**
- Immunology**
- Nutrition**
- Telemedicine**
- Medical personnel training**
- Medical procedure techniques**
- Medical equipments**
- Legal medicine issues**

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Peculiarity of biomedical researches:

- statistical data value: time.
- consensus
- invasiveness
- privacy



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■ Environments ICE:

Isolated Confined Extreme

Concordia Station.

Many stressor characteristics of long duration deep space missions.

Extreme isolation and confinement, a useful analogue platform for research relevant to space medicine.

During the winter the crew are:

- without possibility of evacuation or deliveries for 9 months
- for a prolonged period in total darkness,
- at altitude almost equivalent to 4000m at the equator.



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■ Environments ICE:

Isolated Confined Extreme

Concordia Station.

The physiological and psychological strains on the crew are marked. Concordia station is particularly useful for the study of

chronic hypobaric hypoxia,
stress secondary to confinement and isolation,
circadian rhythm,
sleep disruption,
individual and group psychology,
telemedicine,
astrobiology.

Concordia station has been proposed as the one of the highest fidelity real-life Earth-based analogues for long duration deep space missions.

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From the past to the future:

HUMAN ADAPTATION TO LIFE IN ANTARCTICA

QUE WILSON*
Medical Officer of the Norwegian Arctic Expedition 1910-12 to Queen Maud Land, Antarctica (1911-12)

Introduction

The Antarctic is a geographically and ecologically well defined area and is unique in many respects. It is the only land mass that has had no inhabitants up to the time of this century, and it still has no settled population. Man in a permanent and a short time visit. Only a few men have spent more than three years of their life on this continent, which was first sighted in 1820 by FABIAN G. BELLINGSCHEW, two days before EDWARD BRANFORD discovered Cockburn Land. BRANFORD was the first to chart a portion of the Antarctic mainland. The Antarctic Peninsula (Graham Land) was also seen by NATHERAL PALMER at this time.

The first man to set foot on the Antarctic continent had been two New Zealanders, CAPTAIN LAMARCK RUKER-ROSE and GABRIEL ROBERTSON, who together jumped ashore from a small boat in the struggle to be the first one. This landing was made in 1808 at Cape Adare (71°15' S). ROBERTSON* was also the first to make a planned wintering on the continent with nine other men in 1808-1809 at Cape Adare, although an expedition under GABRIEL ROBERTSON had wintered on board the ship "Belgica" a year earlier. The vessel had been trapped for just six and four to six (75%) in the Bellingschev Sea. Thus the age of man on the Antarctic continent began less than 70 years ago, but much the same situations and problems that was met in this region had previously been encountered by explorers in the Arctic for many hundreds of years.

Although the climate environment seems most undesirable to human life, it does not present a serious obstacle to civilized man with his present knowledge. He is fast learning how to overcome the difficulties and to new establishing himself more permanently on the continent. The aspects of man living in the Antarctic have changed considerably since he first arrived at this distant and desolate place, which is difficult to approach. Great advances in science and extremely increased technological resources have made possible an invasion of this area to an extent that could not have been foreseen by the most imaginative of early explorers. But this

CONTROVERSIES IN ANTARCTIC RESEARCH

Antarctic Medicine

Disability in Long, Cold Weather

During the last part of the long, cold Antarctic winter, the number of people who were disabled by the effects of the problem was significant. It is difficult to control the situation. The Antarctic environment is unique in many respects. It is the only land mass that has had no inhabitants up to the time of this century, and it still has no settled population. Man in a permanent and a short time visit. Only a few men have spent more than three years of their life on this continent, which was first sighted in 1820 by FABIAN G. BELLINGSCHEW, two days before EDWARD BRANFORD discovered Cockburn Land. BRANFORD was the first to chart a portion of the Antarctic mainland. The Antarctic Peninsula (Graham Land) was also seen by NATHERAL PALMER at this time.

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physiological reaction, the ability to resist fatigue and mental reactions by the day or night, and the number of people who were disabled by the effects of the problem was significant. It is difficult to control the situation. The Antarctic environment is unique in many respects. It is the only land mass that has had no inhabitants up to the time of this century, and it still has no settled population. Man in a permanent and a short time visit. Only a few men have spent more than three years of their life on this continent, which was first sighted in 1820 by FABIAN G. BELLINGSCHEW, two days before EDWARD BRANFORD discovered Cockburn Land. BRANFORD was the first to chart a portion of the Antarctic mainland. The Antarctic Peninsula (Graham Land) was also seen by NATHERAL PALMER at this time.

Health Care in Antarctica

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Medical Contamination

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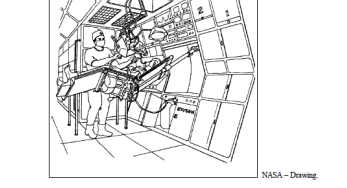
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MARKSTECHCARE
NECESSARY BIOMEDICAL TECHNOLOGIES FOR CREW HEALTH CONTROL DURING LONG-DURATION INTERPLANETARY MANNED MISSIONS

FINAL REPORT

ESA Contract ESTEC No. 16423/02/NL/LeH



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Workshop 7 Human presence and contamination in Antarctica

From the past to the future:

LONG TERM MEDICAL SURVEY



Concordia Station in Antarctica
 This activity was approved by the Aurora Board of Participants within the Work Plan 2005-2006 and should be initiated by the end of 2005.

To prepare for a human mission to Mars, it is essential to learn more on the physiology and psychology of human beings when subjected to confinement and extreme environments.

The winter-over crews that will stay about eight months at the Concordia Station (Antarctica) for performing maintenance and scientific work offer a suitable analogue situation to what could be an exploration stay on Mars. Collecting physiological and psychological data will provide extremely valuable information on not only adaptation to extreme environments but also on how to select the best psycho-physiological profiles.

To support that activity, ESA has decided to team up with the Concordia partners in order to study the behaviour and medical parameters of the Concordia crew. Under that agreement, ESA will supply and support a system used to monitor the life and well-being (fitness) parameters of the Concordia Station crews. The data will be available for the medical doctor on site, and recorded data will be transferred to Europe for further processing by scientists.

A competitive study has already been placed for a definition phase of the LIMS system (sensors, data processing and archiving). It is essential to supply all the Concordia winter-over crews with a LIMS system for them to record a set of physiological (and later on psycho-physiological) data. Ideally a prototype should be shipped to the Station end 2005 for refinement of protocols and data transmission check out. The present activity is dedicated to the detailed design study and realisation of the prototypes of the operational LIMS system.

Based on the outcome of the definition phase study, the aim of the activity is to perform a phase B study with realisation of a fully functional prototype of the LIMS including sensors, data processing software, hardware and data management system (database).

The prototype is intended to be used on human beings, to test the wireless data transmission and demonstrate it can operate for two subjects at the same time. As the prototype will be used on human beings, it is foreseen to have it fully safety-tested according to the applicable medical standards.

The prototypes should be highly representative of the final version of the LIMS and should also demonstrate all the data processing capabilities, such as extraction of parameters, MMI capabilities and instant access to non-nominal data.

The LIMS prototypes will have to undergo safety assessment to clear them for use on humans. Later the prototypes will be validated by experts for all physiological parameters. After validation, it is intended to test the LIMS prototypes operationally in situ at Concordia, in order to collect additional data for further optimisation and prepare for the operational LIMS systems.

Notes: The priority for development is the LIMS sensors, hardware and data processing software. Depending on the effort actually required to build those, the development of the data management system (database) may be scaled down but a system for safety saving, retrieving, distributing and exporting the data will be developed.

Start or actual duration	Expected or actual duration	Status	Prime contractor
18/01/2006	18/01/2006	IBD	IBD

Last update: 17 May 2006

Evaluation of the Airborne Bacterial Population in the Periodically Confined Antarctic Base Concordia

Rob Van Soest¹, Francis De Boer¹, Ru Cui¹, Fabia La Colla¹, Mikko Miettinen², Stephen Hobbie³, Van Thorpe⁴, Yaelia Lavi⁵

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Abstract The environmental airborne bacterial population in relation to human confinement was investigated over a period of 1 year in the Concordia Research Station, which is located on the Eastern Antarctic plateau. The unique location of the station makes it suitable for different research streams such as physiology, astrophysics, volcanology, meteorology, etc. Furthermore, it is used as a test bed for long-duration spaceflights to study the physiological and developmental responses to isolated environments. A total of 50 samples were collected at eight different locations in the station or regular intervals. The airborne bacterial concentration was for 90% of the samples lower than 100 CFU/m³ (colony forming units per cubic meter) and 0.01 CFU/m³ was the lowest bacterial concentration measured.

Keywords Microbiological contamination • Human health • Airborne bacteria • Antarctic • Isolated environment • Confinement • Air quality • Human presence • Antarctica

Introduction Microbiological contamination of various built environments has become a global concern. Airborne and respiratory microbial species represent a significant risk to human health in general and those who are living and working in confinement represent unique stresses that could affect health and performance [1]. Bacterial contamination, other factors including disruption of sleep-wake cycles, high workload, stress, and fatigue could also affect crew health and performance [2]. Bacterial contamination, other factors including disruption of sleep-wake cycles, high workload, stress, and fatigue could also affect crew health and performance [2]. Bacterial contamination, other factors including disruption of sleep-wake cycles, high workload, stress, and fatigue could also affect crew health and performance [2].

Snow crystals observations at Dome C, Antarctica

A. Cagnati¹, R. Donsillati², E. Saviotti³, R. Udiati⁴

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Introduction Significant observations on the snow deposition with the conventional method have been carried out near the Concordia Station at Dome C, on the Antarctic eastern plateau, during the summer and the winter of 2005. Snow deposition constitutes a factor of primary importance in the evaluation of the surface energy balance of the Antarctic ice sheet. Knowledge of ice crystals is also important for the surface energy storage.

Method Approximately 800 m from the base, a wood, 30 m high, steel support, has been installed to collect the snow deposition. A millimetric crystal grid in black plastic material has been fixed on the steel ladder. On 19 July, observations on the amount of the deposition and on the changes and the shape of snow particles have been made with a special lens in the power and hoodless, which results pictures have been taken with a digital camera.

Crystal typologies and related phenomena

Crystal type	Frequency	Typical size (μm)	Typical shape
Hexagonal plate	High	10-20	Hexagonal plate
Hexagonal column	Medium	10-20	Hexagonal column
Hexagonal dendrite	Low	10-20	Hexagonal dendrite

Observations summary

	Jan	Feb	Mar	Apr	May	Jun
Temperature (°C)	-18	-15	-12	-10	-8	-6
Humidity (%)	95	98	99	99	99	99
Wind speed (m/s)	10	12	15	18	20	22
Wind direction	SW	SW	SW	SW	SW	SW
Cloud cover	10	15	20	25	30	35
Relative humidity	95	98	99	99	99	99
Relative humidity deficit	10	12	15	18	20	22

Meteorological conditions

At temperature: Line graph showing temperature fluctuations between -18°C and -6°C from Jan to Jun.

Wind speed: Line graph showing wind speed fluctuations between 10 m/s and 22 m/s from Jan to Jun.

Topical Team Assisted Surgery for Human Space Exploration

Coordinator: Prof. Dr. Ing. P. POIGNET

Contributors: Dr. E. Donbre (LRMAM), Dr. N. Farnsey (KU Leuven), Prof. J. Vander Sloten (KU Leuven), Dr. R. Konetschke (DLR), Dr. R. Dacanelli (Concordia MD), Dr. D. Martu (MD), Dr. H. Delagrèze (NRGA), A. Sylvain (DGA)

ESA Technical Officer : A. Rauge

Topical Team – ESTEC Contract 21009/07/NL/17

Acknowledgment: J.F. Clervoy (ESA) and B. Coent (MEDES) for their contributions to the discussion

September 2012

Workshop 7

Human presence and contamination in Antarctica

CSNA



ESA




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Human presence and contamination in Antarctica

Currently on the field:

Crew Cohesion Dynamics and related Neurostructural, Cognitive, and Physiologic Changes During a 1-year Antarctic Winter-Over Mission



Bernd Johannes, PhD
Mathias Basner, MD, PhD, MSc
German Aerospace Center (DLR), Cologne
University of Pennsylvania, Philadelphia, USA

Concordia Workshop
ESTEC, 7/17/2014

AO-13-Concordia-15
Long-term daylight deprivation during Antarctic winter – impact on sensitivity changes in the eye and circadian sleep-wake rhythms



Coordinator: Dr. Mirjam Münch¹
Science Team: Prof. Dr. Aki Kawasaki², PD Dr. Dieter Kunz¹
Dr. Erik Bes¹


¹Charité University Medicine Berlin, Institute of Physiology, Group Sleep Research & Clinical Chronobiology, Berlin (Germany)
²University of Lausanne, Hôpital Ophtalmique Jules Gonin, Lausanne (Switzerland)

AO-13-Concordia-15, Investigator Meeting, Noordwijk (NL) July 16-27, 2014


Effects of Confinement, Isolation and Hypobaric Hypoxia on Blood Pressure Regulation during Overwintering in Antarctica

The effects of Confinement and Isolation on Blood pressure regulation in Antarctica (CIBA)

AO-11-Concordia



Knowledge for Tomorrow



Psychological Status Monitoring by Content Analysis and Acoustic-Phonetic Analysis of Crew Talks and Video Diaries (CAPA)


PI: prof. Peter Suedfeld

Language:

- Crew-members make a **video-diary** and **read aloud** a short text once a week.
- **Social conversations** at the dinner table (crew meetings) recorded occasionally. (once a week?, only after winter crew is left alone?)

Computerised Analysis:
We analyze the data for changes in psychological content and articulation with advanced computer algorithms.


Follow-up of COALA:
Algorithms, classifiers etc will be used „blind“
Free social conversations added



Concordia DWG for WO 2015

Exploration of the microbial diversity within the vicinity of the Concordia Antarctic Station: a guided study on the distribution of environmental and human-associated microorganisms with the attempt to isolate novel extremophiles for future astrobiological investigations (Short Title: **BacFinder**)

Petra Rettberg as representative for the BacFinder project
STC Ralf Moeller
German Aerospace Center (DLR e.V.), Institute of Aerospace Medicine, Radiation Biology Department, Research Group 'Astrobiology', Köln, Germany



Knowledge for Tomorrow



Workshop 7

Human presence and contamination in Antarctica

Currently on the field:



PdR 2013/AC1.02
Scientific Coordinator: Dr. Simone PORCELLI

ESTEC, 17th July 2014

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BIOMEDICAL RESEARCHES:

emerging issues:

“concordance”

“citizen science”

Human adaptation

- Immunology
- Psychology
- Neurotoxicology (endocrine disruptors)
- Physiology

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BIOMEDICAL RESEARCHES:

Immunology:

Stress affects immune functions resulting in increased risk of immune-related diseases.

Salivary IgA levels are potential biomarkers to evaluate the effects of environmental stress.

IgA is the predominant antibody present in mucosal fluids distinguished into IgA₁ and IgA₂ subclasses.

We propose to evaluate the effects of environmental stress at Concordia station by:

- Periodically monitoring IgA₁ and IgA₂ levels in comparison with IgM and IgG levels both in blood serum and saliva
- Quantifying IgA⁺-B cells
- Evaluating the expression level of the polymeric Ig Receptor involved in the transcytosis of secretory IgA

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BIOMEDICAL RESEARCHES:

Stress, physiology, psychology and behaviour:

- **Stressful factors regulating cognition (e.g. attention, memory, execution of tasks)**
- **Role of social group (e.g. how the group influences individual performance)**
- **Individual adaptation to ICE (Isolated, Confined and Extreme) environment**

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BIOMEDICAL RESEARCHES:

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.

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BIOMEDICAL RESEARCHES:

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.

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BIOMEDICAL RESEARCHES:

-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

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Literature was formerly an art and finance a trade;
today it is the reverse”

Joseph Roux (1834-1905)





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MANY THANKS FOR YOUR ATTENTION.