

Recent advances in medical research



THIRTY YEARS AGO AUSTRALIAN ANTARCTIC DIVISION (AAD) medical practitioners commenced the first immunological studies on the Australian National Antarctic Research Expeditions (ANARE). In the intervening years many research projects have been performed^{1,2,3} in collaborative studies between AAD and international and national universities and agencies.

One such recent collaboration, under the leadership of Professor William Shearer of Baylor College of Medicine, Houston, Texas, USA, saw doctors from AAD collect thousands of specimens of blood, cells, urine, and saliva from volunteers at all ANARE stations during winter 1999 for later processing at that institute, the University of Texas MD Anderson Cancer Center, Houston and the University of Washington, Seattle. Support for the study came from AAD and NASA through the National Space Biomedical Research Institute (NSBRI).

The eight-month total physical isolation at Casey was employed as an analogue for longer duration space flight and the T cell-dependent neo-antigen ϕ X 174 bacteriophage was used to determine if this isolation would alter human antibody responses. Macquarie Island subjects were used as a control group.

Bacteriophage ϕ X 174 is a virus which infects bacteria but which does not replicate or cause illness in humans. It can induce antibody responses in humans and over the past 30 years has been used to identify abnormalities in the primary (IgM) and secondary (IgG) antibody responses in immunodeficient and immunosuppressed patients.

All the subjects at Casey cleared the bacteriophage normally by one week after primary immunization and all had normal primary and secondary antibody responses, including immunologic memory amplification and a switch from IgM to IgG antibody production. The data did not support the hypothesis that *de novo* antibody responses of subjects become defective during conditions



Testing expeditioners in the cold room at the AAD's Kingston headquarters before they head south. GLENN JACOBSON

of winter in Antarctica⁴. This is an important finding for Antarctic expeditions as, although no disease could be associated with altered immune changes in ANARE groups in the past,^{5,6} such immune changes may have important long-term health implications.

Mucosal immunity studies were conducted at all ANARE continental stations in 1992 to address the concern that immuno-suppression may occur in expedition staff and be associated with the anecdotal observation of an increased incidence of infections in staff when winter isolation is broken. The study just published⁷ revealed significant changes in salivary immunoglobulin values over the period in Antarctica, with similar patterns at all three Australian stations. Immunoglobulin levels (IgA and IgM) were lower in the first four months in Antarctica, with increases to maximum values after midwinter, before returning to mean levels when isolation was broken and new expeditioners arrived. The pattern suggests that stressors due to isolation may play a role in alterations of mucosal immunity.

Further work is proceeding at all stations in 2001 on the role of environmental stressors (cold) in altered

immune responses as well as into cold adaptation. This was made possible by the signing of a Cooperative Research and Development Agreement in April 2000 between the AAD and the United States Army Research Institute of Environmental Medicine (USARIEM) for long-term collaborative research into areas such as thermal physiology, cold climate clothing, stress and adaptation, predictive modelling, and the role of environmental stressors in altered immune responses.

The first studies under this new Agreement were performed in September/October 2000 in Hobart, when shortly before sailing south, 35 volunteers from the 2001 ANARE were exposed in a cold room at 5°C for 120 minutes while dressed only in underwear and a light paper smock (see photograph above). Deep core temperature of each was collected via a radio temperature pill and stored in a small data logger. Skin temperatures were measured with thermistors attached to the chest, arms, and thighs and connected to a continuous monitoring system. Rate of oxygen uptake was determined every 20 minutes during the 120 minutes cold stress test and samples of blood were taken for assay of factors such as catecholamines, vasopressin, anti-diuretic hormone, immunoglobulins, neuropeptides and melatonin.

The purposes of this protocol are:

- 1) to quantify shivering thermogenesis associated with deep core temperature and specific skin temperatures during a standardised cold stress test, prior to and following an Antarctic expedition;
- 2) to confirm if there is a reduction in specific cytokines during prolonged Antarctic exposure.

A major goal is to document whether such changes have a direct association with depressed thermoregulatory responses following prolonged Antarctic exposure; 3) to develop specific algorithms applicable for the cold acclimatised state that can be used to validate cold stress prediction models.

The results of the pre-departure phase of this study have already been accepted for presentation at the International Thermal Physiology Symposium in Wollongong in September 2001.

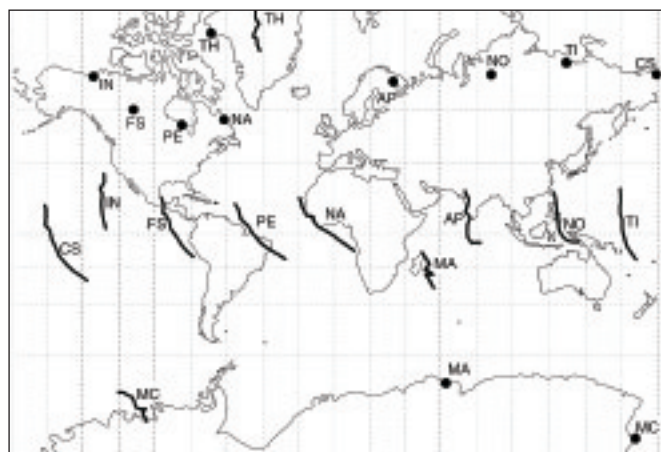
Monthly blood collections are currently in progress at all four stations, and a repeat of the cold room stress test will be conducted on the volunteers when they return to Australia in early 2002.

References:

1. Lugg DJ. ANARE Medical Research: what did happen to all those specimens, Doc? In: Proceedings of the ANARE Jubilee Science Symposium, Hobart, July 1997. In Press.
2. Lugg DJ, Shepanek M. Space analogue studies in Antarctica. *Acta Astronautica* 1999; 44: 693-699.
3. Muller HK, Lugg DJ, Quinn D. Cell mediated immunity in Antarctic personnel: 1984-1992. *Immunol Cell Biol* 1995; 73: 316-320.
4. Shearer WT, Lugg DJ, Rosenblat HM, Nickolls PM, Sharp RM, Reuben JM, Ochs HD. Antibody responses to bacteriophage ϕ X 174 in humans exposed to the Antarctic winter-over model of space flight. *J Allergy Clin Immunol* 2001; 107: 160-164.
5. Tingate TR, Lugg DJ, Muller HK, Stowe RT, Pierson DL. Antarctic isolation: immune and viral studies. *Immunol Cell Biol* 1997; 75: 275-283.
6. Mehta SK, Pierson DL, Cooley HN, Dubow R, Lugg DJ. Epstein-Barr reactivation associated with diminished cell-mediated immunity in Antarctic expeditioners. *J Med Virol* 2000; 61: 235-240.
7. Gleeson M, Francis JL, Lugg DJ, Clancy RL, Ayton JM, Reynolds JA, McConnell CA. A year in Antarctica: mucosal immunity at three Australian stations. *Immunol Cell Biol* 2000; 78: 616-622.

*D. J. Lugg and P. Sullivan,
Polar Medicine, AAD*

Space Ship Earth: monitoring space weather



The location (filled circles) and viewing directions (heavy lines) of the Space Ship Earth network of neutron monitors.

The stations are: Apatity (AP), Cape Schmidt (CS), Fort Smith (FS), Inuvik (IN), Mawson (MA), McMurdo (MC), Nain (NA), Norilsk (NO), Peawanuck (PE), Thule (TH) and Tixie Bay (TI).

SPACE SHIP EARTH IS THE BRANCHCHILD OF PROF JOHN Bieber of the Bartol Research Institute, University of Delaware. The Earth is travelling through space in the inner part of the solar system and is the perfect platform for making measurements of the high-energy radiation environment of the region. Thus the name of the collaborative program. The consortium comprises Prof John Bieber and Prof Paul Evenson from Bartol, Dr Evgenia Eroshenko and Dr Anatoly Belov from IZMIRAN (Institute of Terrestrial Magnetism, Ionosphere and Radiowave Propagation) in Russia and Dr Marc Duldig from the Australian Antarctic Division. A network of polar neutron monitors will give real or near-real time measurements of the high-energy radiation environment surrounding the Earth. The polar monitors have been carefully selected to give narrow longitudinal bands of view at equatorial latitudes with a further two monitors viewing in polar directions (see figure). The Mawson and Inuvik monitors are crucial elements of the system because they have the narrowest longitude spread. They

will characterise event arrivals more tightly than the rest of the network. Data will feed directly to Bartol for analysis and forwarding to industry and governments. The near-real time 3-D monitoring of the radiation will greatly benefit spacecraft operators and will be one input to now-casting of space weather. It is hoped that studies with this unique linked system will lead to improved prediction of space weather and the space radiation environment. Of particular interest will be the rare 'Ground Level Enhancement', blasts of particle radiation arriving from the Sun. These can produce increases of several hundred percent at ground level but are much

larger above the protective layers of the atmosphere. The higher dose but lower energy radiation arrives some 20 minutes or so later allowing predictions to be provided to relevant space authorities. Also of interest will be Forbush decreases that occur with geomagnetic storms. These decreases show evidence of precursors a day or more in advance and may be of value in space weather prediction. The Mawson cosmic ray observatory will be enlarged over the 2001-02 season and additional detectors installed the following summer in readiness for this exciting new program.

Marc Duldig, Cosmic Ray Physics Program Leader, AAD



Australian Antarctic Science Grants for 2001-2002

Senator the Hon. Robert Hill has approved the following Australian Antarctic Science Grants for 2001-2002. Funds totalling \$653, 159 (GST inclusive) were allocated among 49 projects from researchers based at 18 institutions.

Institution	Chief Investigator	Project Title	Amount of Grant
Australian National University [ACT]	SKOTNICKI, Dr Mary	Conservation of plant biodiversity in Antarctica - a genetic approach	\$18,810
	SKOTNICKI, Dr Mary	Investigation of virus biodiversity in Antarctic terrestrial plants	\$7,700
	TREGONING, Dr Paul	Crustal rebound in the Lambert Glacier area	\$15,400
			<i>[\$41,910]</i>
James Cook University [QLD]	JONES, Dr Graham	Factors affecting DMS in the seasonal ice zone	\$22,000
			<i>[\$22,000]</i>
La Trobe University [VIC]	ESSEX, Dr Elizabeth	Mapping the GPS total electron content and scintillation activity at southern higher latitudes during high sunspot numbers	\$18,150
	DYSON, Professor Peter	Upper atmosphere dynamics and thermodynamics	\$11,000
	DYSON, Professor Peter	Investigations of Space Weather and the Mesosphere using the TIGER Radar	\$22,000
	GOLDSWORTHY, Dr Simon	The conservation of fur seals in the antarctic marine ecosystem	\$27,423
			<i>[\$78,573]</i>
Macquarie University [NSW]	GORE, Dr Damian	Palaeoenvironments of the Antarctic coast, from 50E to 120E	\$11,000
	GORE, Dr Damian	Glacial history of the Frammes Mountains, East Antarctica	\$17,215
			<i>[\$28,215]</i>
Southern Cross University [NSW]	SLADE, Dr Rob	Isolation and characterisation of arboviruses in seals and birds	\$10,670
			<i>[\$10,670]</i>
Tasmanian Parks & Wildlife Service [TAS]	GALES, Dr Rosemary	Status and conservation of albatrosses on Macquarie Island	\$22,000
			<i>[\$22,000]</i>
University of Adelaide [SA]	VINCENT, Dr Bob	Dynamical coupling in the Antarctic middle atmosphere	\$17,050
			<i>[\$17,050]</i>
University of Canberra [ACT]	PEARSON, Professor Colin	Deterioration studies, archaeological investigations and structural assessments of Mawson's Huts (Cape Denison)	\$2,200
			<i>[\$2,200]</i>
University of Melbourne [VIC]	BYE, Dr John	Modelling the formation and subduction of subantarctic mode water in the South Australian Basin	\$16,500
	SIMMONDS, Assoc Prof Ian	Recent changes in the semiannual oscillation in the sub-Antarctic and their connections with cyclone variability	\$18,700

	SIMMONDS, Assoc Prof Ian	The nature of the Antarctic Circumpolar Wave and its connections with Australian rainfall variability	\$22,000
	STEVENS, Professor Geoff	Development and application of particle separator technology for the removal of contaminated particulates from water in Antarctica	\$7,700
	WARD, Dr Simon	The distribution and abundance of nesting sites of flying seabirds in eastern Prydz Bay	\$9,900
	WILSON, Assoc Prof Chris	Proterozoic and Palaeozoic evolution of the Rauer Group	\$3,575
	WILSON, Assoc Prof Chris	Structure and dynamics of the Sorsdal Glacier	\$16,500
			[94,875]
University of Newcastle [NSW]	FRASER, Professor Brian	Observations of ULF space plasma waves in Antarctica	\$22,000
	FRASER, Professor Brian	A Southern Hemisphere imaging riometer experiment (SHIRE)	\$19,848
			[\$41,848.40]
University of New England [NSW]	SMITH, Dr Steve	Spatial and temporal variation in the recruitment of benthic macroinvertebrates to artificial substrata	\$5,423
			[\$5,423]
University of New South Wales [NSW]	BURTON, Dr Michael	The automated astrophysical site testing observatory	\$10,890
			[\$10,890]
University of Queensland [QLD]	BERGSTROM, Dr Dana	Regional Sensitivity to Climate Change in Antarctic Terrestrial Ecosystems [RiSCC]: the periantarctic region	\$18,167
			[\$18,166.50]
University of Sydney [NSW]	CLARKE, Dr Geoff	The strength of the lower continental crust; evidence from Stillwell Hills-Oygarden Group coastline	\$9,350
	DEEN, Ms Tara	Tomographic inversion of seismic data over holocene drift deposits from the George V Continental shelf, East Antarctica	\$3,300
AMMRC	ROGERS, Dr Tracey	Leopard Seal Program	\$15,400
			[\$28,050]
University of Tasmania [TAS]	BOWMAN, Dr John	Bacterial hydrocarbon degradation and impacts of hydrocarbon pollutants on microbial communities within Antarctic coastal sediments	\$7,480
	COLEMAN, Professor Richard	Amery Ice Shelf Dynamics from GPS	\$20,900
	COLEMAN, Professor Richard	GLAS Validation on the Amery Ice Shelf	\$11,752
	DAVIDSON, Dr Garry	Tectonic, magmatic and hydrothermal evolution of ocean floor spreading at Macquarie Island	\$8,580
	JACKSON, Dr George	Squid in the antarctic and subantarctic, their biology and ecology	\$4,180
	KAMENETSKY, Dr Dima	The distribution of volatile and metallic elements in the Macquarie Island glasses and melt inclusions: Implications for fractional crystallisation and degassing during seafloor basaltic magmatism	\$8,800
	KIERNAN, Dr Kevin	Geomorphological evolution of Heard Island	\$7,150
	McMINN, Assoc Prof Andrew	Ecology and local impacts on near shore marine benthic algal mats	\$18,322
	McMINN, Assoc Prof Andrew	Sea ice primary production off eastern Antarctica	\$22,000
	NUNEZ, Dr Manuel	UV climate over the Southern Ocean south of Australia, and its biological impact	\$9,900
	QUILTY, Professor Pat	Evolution of East Antarctic marine environment during the Neogene	\$4,268
	REID, Dr James	A comparison of sea-ice thickness measurements made using ship-mounted and airborne electromagnetic induction devices	\$6,380
	ROBERTS, Dr Donna	High Resolution palaeoclimate analysis of the Windmill Islands: the last 200 years	\$1,320
	WILLIAMS, Dr Ray	Near-coastal distributions of icebergs, derived from SAR and Landsat MSS data using semi-automated image analysis techniques	\$9,900
			[\$140,932]
University of Western Australia [WA]	KENNEDY, Dr Andrew	Impact of global environmental change on the terrestrial biogeography of Antarctica	\$20,891
	SHELLAM, Professor Geoff	Investigations of bacterial, viral and parasitic infections in Antarctic and the development of a standardised monitoring scheme	\$16,995
	SHELLAM, Professor Geoff	South polar skuas as vectors of disease	\$8,800
			[\$46,686.20]
University of Wollongong [NSW]	DAVIS, Dr Andy	Effects of UV radiation on community establishment: a global perspective	\$14,586
	ROBINSON, Dr Sharon	Assessing UV-B induced DNA damage in Antarctic plants: is desiccation a compounding factor?	\$21,934
			[\$36,520]
Western Australian Museum [WA]	GODFREY, Dr Ian	Research in natural freeze-drying technology for the preservation of historic Antarctic buildings	\$7,150
			[\$7,150]
Total			\$653,159