Template for new SCAR Scientific Research Programmes

1. Name of the Proposed SRP: State of the Antarctic Ecosystem (AntEco)

2. Name(s) of the lead proponent(s) (including affiliations and contact information):

Professor Don A Cowan, Director, Genomics Research Centre, University of Pretoria, Hatfield, Pretoria, South Africa (representing the entire PPG)
Ph: +27 82 8799117
E-mail: don.cowan@up.ac.za

3. Sponsoring SSG(s):   Life Sciences

4. Estimated SCAR funding required over the total programme lifetime (in US$):

$128, 000 over 8 years = $16, 000 per year

5. Abstract (250 words or less)

Biological diversity is the sum of all those organisms that determine how ecosystems function, and underpins the life-support system of our planet. This programme has been designed to focus on past and present patterns of biodiversity across terrestrial, limnological, glacial and marine environments within the Antarctic, sub-Antarctic and Southern Ocean regions, to provide the scientific knowledge on biodiversity, including genetic diversity, species diversity and ecosystem diversity that, coupled with increased knowledge of species biology, can be used for the conservation and management of Antarctic ecosystems.

Under the framework of EBA, initiatives such as CAML, SCAR-MarBIN and ANTABIF have demonstrated how internationally coordinated research and standardized techniques can rapidly advance knowledge of the state of Antarctic ecosystems. These have improved our understanding of key elements of Antarctic biodiversity, its linkage with global biodiversity and aspects of its phylogenetic and biogeographic history, and have further highlighted the importance of cross-disciplinary links with the oceanographic, glaciological and climate communities in particular.

The new challenges are to further the knowledge on current biodiversity and patterns therein, to distinguish the impact of present processes from historical signals, and use this knowledge to develop scenarios of its future state through interdisciplinary approaches. To do so we will promote the use of both established and innovative technologies, on scales from the latest molecular analyses to remote sensing, that will provide the means for synthesis and integration across the entire region over physical and temporal scales and at resolutions that until now have not been possible.

a. Introduction - scientific objectives and statement of task

The **AntEco** program aims to promote, stimulate and coordinate international interdisciplinary research relevant to Antarctic ecosystems. The over-arching theme is to promote the use bioinformatics and ecoinformatics approaches to understand spatial patterns in Antarctic biodiversity from genes to ecosystems, to determine how these patterns have evolved through time, and to identify the implications for conservation management, including mitigation of forecast threats, in a time of rapid environmental change. The objectives are succinctly encompassed by the phrase: 'surveys, sequences, systematics and synthesis'.

Key scientific questions:

> ➢ How has Antarctic biodiversity evolved in response to past environmental change and what does this tell us about its capacity to respond to future change?
> ➢ What are the systematic and environmental geographic features of Antarctic biodiversity, and what mechanisms underpin the current distribution and abundance of biodiversity?
> ➢ Given the evolved geographic distribution of diversity and forecast threats, what conservation actions are required for mitigation of, and adaptation to, change?

The programme is divided into three interlinked themes: a) Evolved patterns, b) Spatial patterns, and c) Governance, mitigation and adaptation. A high priority will be placed on providing biological information for, and increasing linkages across, the SCAR standing scientific groups, in particular with relevant areas of oceanography, glaciology, soil science, permafrost, geochemistry, geosciences, and climatology, particularly through links with programme AntClim21. It will also involve important synergies with the physiological limits and tipping points identified by 'AnT-ERA' and interface with other future SCAR programmes (see Appendix 2 – The next generation of SCAR research programs). The integrated information will be made available through SC-ATS to the Antarctic Treaty System.

b. Background - foundational knowledge

In the face of global climate change, one of the biggest questions facing humanity is what will happen to global biodiversity in the near future. Gaining an improved understanding of the effect of past climate change and tectonic events on speciation, extinction and rates of evolution will help us to predict the effect that future changes will have on Antarctic biodiversity. Antarctica's unique marine and terrestrial biota, together with its thermal isolation and reasonably well-defined climatic, tectonic and glacial history make it an ideal test case in which to study the origins, evolution and maintenance of biodiversity.

Major climatic and geological events in Antarctica's history are likely to have precipitated extinctions in Antarctic taxa, giving rise to vacant niches and providing opportunities for speciation. Such events may have also facilitated the colonisation of other areas (e.g. the deep sea) from a suggested centre of origin in Antarctica. Relatively minor climatic and geological events in Antarctica's recent history have also resulted in shifts in species distribution, species succession and establishment that will continue to have an impact on biodiversity.

Understanding recent past events (since the Late Pleistocene) is key to our ability to produce models and projections of near-future possible scenarios. Linking climate record

with the genetic structure of extant populations is a major challenge which is waiting to be addressed by the scientific community using the innovative technologies which are now available.

Despite numerous studies on the biogeography of the 'Antarctic' region, there is little consensus on fine scale patterns of biodiversity, particularly in the terrestrial realm (Chown and Convey 2007). Obtaining such a view about how the various regions of Antarctica and the surrounding islands relate to each other in terms of their biodiversity has taken on renewed urgency as a consequence of conservation threats and requirements in the region. These are threefold. First, although the continent and oceans south of 60°S are designated as areas for peace and science there is increasing concern about the effects of climate change, invasion, and other forms of disturbance (Ayres et al. 2008; Tin et al. 2009). Thus, there is increasing emphasis on Antarctic Specially Protected Areas and how they are performing to conserve the biodiversity of Antarctica given these threats. Second, the sub-Antarctic islands are subject to similar changes, and understanding which islands are most significant from a conservation perspective is of considerable significance (Shaw et al. 2010). Finally, because the extent of movement between areas in the Antarctic involved in both science and tourism activities is increasing, the likelihood of transfer of propagules among islands or between ice-free areas in the Antarctic is also growing (Lee and Chown 2007; Hughes and Convey 2010; Cowan et al. 2011; Chown et al. 2012). Understanding the relationships among areas both from a species and population perspective is therefore vital.

Genetic techniques are now often used provide more definitive answers regarding the provenance and historical distribution of species (e.g. Rogers 2007). Only a few recent genetic studies have provided further evidence of terrestrial organism dispersal into Antarctica after the last glacial maximum, with the majority rather providing support for vicariant speciation as the most important factor driving the diversity and distribution of Antarctic terrestrial biota (Stevens et al. 2006; Convey et al. 2008). There is a growing recognition that many Antarctic species have actually survived in small isolated populations for perhaps millions of years (Convey et al. 2009). In addition to this increasing body of molecular data that suggests that some of the Antarctic species may have survived in 'refugia' during glacial cycles, it is also becoming clear that, in general, the extant distribution of shelf species is the result of recent recolonizations. Understanding the recent past (since the Late Pleistocene) is key to our ability to produce models and projections of near-future possible scenarios.

This program aims to integrate patterns and processes resulting from historical climate change and understanding of contemporary ecosystem function in order to form a predictive framework for understanding the impacts of future climate change on the Antarctic and Southern Ocean biota, and to inform best future management practice.

Evolved patterns: The Antarctic and Southern Ocean biota provide an ideal test case with which to characterise the effect of climatic and tectonic change on molecular evolutionary processes and biodiversity. The climatic, tectonic and glacial history of Antarctica is reasonably well defined (Clarke & Crame, 2003) and is understood to be integral in shaping Antarctic biota. For example, events such as the opening of the Drake Passage, leading to thermal isolation of the continent, marked and sudden temperature changes and orbitally-forced glacial cycles have all been suggested as important in shaping the present day Antarctic marine biota (Clarke & Crame, 1992). Furthermore, the opening of the Drake Passage and the subsequent establishment of deep-water connections between the

Southern Ocean and the rest of the major ocean basins of the world has been suggested to have facilitated recolonization of deep sea areas after extinction events due to deep ocean oxygen depletion (Rogers 2000; Little & Vrijenhoek, 2003; Strugnell et al., 2008). The resulting influences of these events and processes should leave discernible signatures in the molecular information systems of Antarctic organisms.

On land and in lakes, there has been a paradigm shift in the general understanding of the antiquity, endemism and regionalisation of the contemporary biota, many elements of which have survived and evolved on the continent through multiple Miocene, Pliocene and Pleistocene glacial cycles. The requirement for refugia has implications for our understanding of the glaciological and geological evolution of the continent and its ice sheets. Studies of changes in biodiversity across the most recent glacial interglacial cycle have shown that the present day biota contains a mixture of often cryptic species that result from isolation in glacial refugia and post-glacial colonists, and have identified species that are sensitive to quite minor changes in the physical environment.

Our knowledge of the diversity of Antarctic marine and terrestrial biota has greatly increased recently with the availability of new databases, (e.g. SCAR-MarBIN, ANTABIF, RiSCC/EBA), syntheses (e.g. Convey et al. 2008, 2009; Vyverman et al. 2010) and the development and application of molecular sequencing techniques (e.g. Smith et al., 2006; Wilson et al., 2009; González-Wevar et al., 2010). These studies confirm some unexpectedly high levels of taxonomic diversity (e.g., Smith et al., 2006), and previously unsuspected levels of cryptic speciation, and the presence of a number of species rich clades (e.g. peracarid crustaceans, trematomid fish, nudibranchs, pycnogonids, octopus). Other studies have found widespread distributions of a single taxon (e.g. Raupach et al., 2010). Nonetheless, large data gaps still occur, especially for marine invertebrate taxa, and must be considered in study design.

Together these findings have focused attention on the timing, nature and potential causes of diversification leading to species-rich clades, reinvigorated debate on whether polar regions should be regarded as evolutionary sources or sinks (Goldberg et al. 2005; Strugnell et al., 2008; Strugnell et al., 2011), and highlighted the environmental factors that are most likely to shape future biodiversity.

Spatial variation: Antarctica and the Southern Ocean contains ecosystems across the full range of complexity, from the most simple ecosystems of the inland frigid deserts and nunataks to some of the most complex marine benthic ecosystems known. This provides an ideal/unique resource with which to explore fundamental rules of ecosystem assembly structure and function.

There remain very large gaps in our knowledge of even some fundamental aspects of Antarctic terrestrial and marine biology. These include such aspects as ecosystem structure and function and the true diversity of biota including microbial species. These gaps inhibit higher levels of understanding, such as the exact inter-relationship between organism and microclimate, the structures and functions of biological assemblages and the true nature of chemical cycling, without which understanding of ecosystem responses to climate change cannot be advanced.

Genetic data can provide more definitive answers regarding the diversity and distribution of species (e.g. Rogers 2007). Regional biodiversity surveys such as recently undertaken by the NZTABS program (which include modern molecular phylogenetic analyses) are excellent models for more extensive analyses. Only a few recent genetic studies have provided

evidence of organism dispersal into Antarctica after the last glacial maximum with the majority providing support for vicariant speciation as the most important factor driving the diversity and distribution of Antarctic biota.

Governance, mitigation and adaptation: The Antarctic Treaty System seeks to protect Antarctic biodiversity across the terrestrial and marine biomes. Considerable progress has been made in identifying areas of important and vulnerable marine biodiversity through initiatives like CAML, and with the support of organisations like CCAMLR these are starting to be recognised by the creation of Marine Protected Areas. Links such as between **AntEco** (as a biodiversity information provider and analyst) and CCAMLR are going to be critical in the on-going management of important marine and terrestrial areas. Data from a range of sources (including bird and seal population and tracking data, information from organisations like ACAP and potentially fisheries information from CCAMLR) can be used to assist in the identification of important marine biodiversity areas and potentially feed in to the Marine Protected Area (MPA) assessment procedures.

c. Scientific approach and rationale

The Antarctic is experiencing unprecedented (at least in recent geological history) rapid change and it is now critically important to assess the state of the ecosystem so that we can measure current change, predict future trajectories of change and inform best practice in environmental management and stewardship in the Antarctic. By using a combination of surveys, systematics, sequences and synthesis we hope to clarify the evolutionary and ecological drivers of spatial variation in diversity and apply this information to identify and mitigate threats.

There are two principal factors supporting the timeliness of this proposal.

The Antarctic continent is under growing threat from various impacts, which could fundamentally change elements of its biology. The dramatic changes in climatic conditions, particularly in Western Antarctica and the Antarctic Peninsula, have the capacity to induce massive long-term changes in biological communities. The consequences of these changes can only be understood by elucidating how historical changes have affected communities in the past, and by obtaining present day baseline data.

In addition, the rapid rise in human impact on small but important areas of the continent, resulting from the ever-growing activities of national operators and the ecotourism industry, represents a real threat. Physical impacts, disturbance, chemical contamination and the input of macroscopic and microscopic propagules all represent perturbations of sensitive Antarctic ecosystems and communities. Research programs designed to assess, monitor and quantify such processes are vital as tools for establishing viable management and control strategies.

Technical developments in molecular biology over the past few decades have greatly facilitated the investigation (and accurate understanding) of species origins/history/ trajectories and diversity. The key to addressing these issues is to use integrated and cross-disciplinary approaches - for example, remote sensing, spatial analyses, and computer modelling in conjunction with bio- and eco-informatics.

With the very recent expansion of high throughput 'next' generation DNA sequence analysis, the opportunities to comprehensively assess species diversity and community structure are

unparalleled. These technical opportunities also coincide with analytical advances and a perception of genetic diversity as a resource, not only for the expansion of biotechnology, but also for understanding fundamental aspects of species interactions and organismal adaptation.

In the marine realm there has been significant increase in biodiversity knowledge through initiatives like CAML, although for most of the Southern Ocean and its benthic environments the scale at which data are available is far from satisfactory and continues to limit analyses. Consequently, databases like SCAR-MarBIN are becoming useful tools in assessing biodiversity and identifying areas that are vulnerable or unique. However, nothing similar has been undertaken for the terrestrial realm except at small, localised scales. Preliminary analyses undertaken by SCAR have shown that there are no biodiversity records for a significant proportion of ice-free Antarctica (Terauds and Chown 2010). Such gaps could be addressed in a number of ways including concerted and targeted field surveys (in a similar manner to CAML) and the incorporation of existing data into the terrestrial equivalent of SCAR-MarBIN – the SCAR Antarctic Biodiversity Database. The refinement and development of appropriate spatial frameworks with which to categorise and assess biodiversity on the Antarctic continent is a key element of any on-going conservation management of the region. Given the recent completion of the preliminary SCAR analyses of the Environmental Domains, it is timely for **AntEco** to facilitate and co-ordinate the progression of this research. These frameworks can then be used with Antarctic biodiversity data and also with characteristics of Antarctic biodiversity (i.e., dispersal mechanisms, genetic variability, rarity, vulnerability etc.) to assess the current set of protected areas and inform the choice any new protected areas that are required.

d. Experimental section and methodologies

The essence of this program is informatics (and the technologies which generate the data on which informatics is based). Utilising existing and emerging technologies in molecular research, spatial analyses and meta-analyses will allow us to better understand biodiversity patterns and processes in Antarctica. The threats to biodiversity now and in the future will also be a major product of these analyses and by linking these data with outputs from AnT-ERA and AntClim21 a comprehensive model of Antarctic biodiversity protection can be created.

This programme will be addressed by:

➢ Elucidating the molecular evolutionary history of Antarctic and Southern Ocean biota using the latest multigene phylogenetic reconstruction methods (e.g. Heled and Drummond, 2010). Synthesis across taxa will enable broad scale patterns to be detected and shed light on potential past refugia during glacial maxima. Taking advantage of the latest developments in Bayesian comparative methods (e.g., Knowles, 2009; Huang et al. 2011) will allow integration of paleontological and molecular data to produce bounded estimates of genetic divergence times, species diversification rates, and patterns of concerted responses by multiple taxa (communities) to shared geophysical drivers of environmental change. These will be linked to improved models of physical histories to infer the environmental drivers of past evolutionary change.

- Determining late Quaternary and Holocene changes in biodiversity of the marine, lacustrine and terrestrial biota using established methods (Hodgson et al. 2009) and identifying which environmental factors are significantly related to these changes.
- Establishing and developing new cross-disciplinary links (through international workshops) between members of the molecular evolution, glaciological, oceanographic, climatological and climate modelling communities, to facilitate these ambitious integrated approaches to reconstructing the evolutionary and biodiversity history of Antarctica.
- Implementing cutting edge historical seascape and landscape genetics techniques (e.g. Galindo et al. 2010) in conjunction with simulation studies, to quantify the past connectivity of the Southern Ocean and Antarctic biodiversity to the global biosphere.
- Analyzing past changes in biodiversity in groups that leave morphological or biogeochemical remains in sediments and taking advantage of these historical specimens for use in ancient DNA and biomolecular archaeological studies to elucidate past genetic diversity and palaeoenvironments.

- Organising interdisciplinary workshops to identify emerging evolutionary patterns and to facilitate interpretation of extant taxon distributions (held within these databases) in the light of the historical evolutionary patterns and also to identify current and future threats to biodiversity.

- Using state of the art software (e.g. GIS, multivariate statistical approaches) to analyse and synthesise large and complex data sets, taking advantage of SCAR's georeferenced community datasets (e.g. SCAR-MarBin, ANTABIF). Continued engagement of these initiatives will be promoted to store, collate and make this data accessible to the broader Antarctic community. Develop the successful approach of CAML and initiate co-ordinated holistic sampling approaches involving standardised gears for biodiversity census which include recording of environmental parameters, and populate existing georeferenced databases (e.g., SCAR- MarBIN, ANTABIF, SCAR Antarctic Biodiversity Database, Barcode of Life Database) with these data to make them internationally available.

- Apply cutting edge remote sensing and other technological innovations (such as the use of digital elevation models) to detect biotic changes (both spatially and temporally) and also provide additional parameters to increase environmental model resolution. Use these techniques to build up a model of environmental proxies for biodiversity.

- Employ mathematical modelling and simulation techniques utilising the improved census (direct and remotely sensed) and molecular data and higher resolution environmental data to investigate potential impacts under a range of environmental scenarios to facilitate our understanding of the threats to biodiversity.

- Implement established and 3rd generation sequencing techniques for exploring microevolutionary processes in order to better understand species and population structure and diversity, population history, molecular adaptation and to provide a baseline for monitoring of future population change.

- Develop autecological studies which enhance our understanding of individual species' functional roles within community and ecosystem structure.

- Establish protocols for a genetic monitoring program to detect the range shifts, demographic expansions and contractions, and changes in genetic structure and

diversity that may result from environmental changes. This will provide guidance in establishing protocols for environmental protection.

➤ Populate appropriate spatial frameworks with up to date and comprehensive biodiversity data to identify patterns in biodiversity with particularly attention to biodiversity hotspots and areas of unique biodiversity.

➤ Undertake modelling and prediction of biodiversity-environment interactions, pattern analyses and bioregionalization.

This research follows on seamlessly from the recent biodiversity analyses undertaken by SCAR and will feed directly into the process of testing the distribution, extent and representative nature of existing Antarctic Specially Protected Areas (ASPAs). A new assessment of current biodiversity will also allow us to test how well the existing portfolio of ASPAs satisfies the principles and intent of the Madrid Protocol. Additionally these analyses will facilitate the development and testing of physical/environmental surrogates for sites of high biodiversity and geodiversity values, which has been identified as another important aspect of protected area assessment, particularly in data sparse environments. However, it is explicitly noted that there is a real need for improved co-ordination of activities and standardization of methodologies within the relevant international scientific communities.

e. Management and Reporting

The program **AntEco** is composed of field analyses, laboratory experimental programs and modelling approaches. The implementation and the adaptation of single components depend on the cooperation between specialists since the **AntEco** remit incorporates numerous sub-disciplines, habitats and groups of organisms.

The most effective approach to coordinate and enhance the objectives and outcomes of **AntEco** is communication between dispersed research groups. Coordination and communication should be effectively managed by the formation of a Steering Committee, where the committee participants effectively represent all sectors of the **AntEco** field. The wider management of this program will be most effectively achieved through a coordinated series of workshops and conferences. The principal vehicle for these meetings will be the existing SCAR conference structure (SCAR Open Science Conferences and SCAR Biology Symposia), but such meetings should be supplemented with more focussed workshops as necessary.

The Steering Committee and the Program managers will actively encourage post-graduate student opportunities, (e.g., Antarctic Science Bursaries, Gateway Antarctic funding, etc.). Importance will be placed on building multidisciplinary links and ensuring capacity building so that all parties (including those less resourced) can utilise the resources available most effectively.

f. Milestones, outcomes, and results (including metrics of performance)

The following can be considered as performance criteria:

➤ Relevant meetings, symposia, workshops etc. organised and implemented.
  o The coordination role of this program will be largely implemented through international meetings; such meetings may be held under the auspices of the

        relevant parent organisations or by more specialised sub-groupings with field-specific interests.
- ➢ Number of participating laboratories and organisations.
  - o The expectations of a successful program would include participation of laboratories across many or all of the Antarctic-active nations, covering all aspects of the physical and biological fields relevant to the **AntEco** concept.
- ➢ Aggregated staff and student numbers involved in **AntEco**-relates programs.

  - o The performance and productivity of any research program is intimately linked to the personnel involved. Quantification of research staff numbers and level provides and effective measure of performance and success in achieving **AntEco** objectives.
- ➢ Funding related to **AntEco** objectives leveraged from national and international grant bodies.

- ➢ As the role of the **AntEco** program is to motivate and steer research relevant to the **AntEco** objectives, virtually all substantive activities will inevitably be supported by national agencies.

- ➢ Evidence of cross-boundary and cross-national collaborations.
- ➢ Relevant outputs (research student graduates, publications; advisory documents etc.).

The following are quantifiable (and appropriate) deliverables from the program.

- ➢ Potential cross linkages between SRPs (AntClim21, **AntEco**, AnT-ERA) – papers authored by scientists across SRPs/disciplines/nationalities/etc.

- ➢ Publications in peer-reviewed journals (research publications and reviews)

- ➢ Preparation of relevant strategy and advisory documents

- ➢ Population of relevant databases with spatially significant population datasets

- ➢ Presentations at appropriate scholarly meetings, workshops and conferences

- ➢ Training and graduation of post graduate students (MSc and PhD)

- ➢ Presentations at public (non-scientific) forums

- ➢ Establishment of new public interaction sites (web pages etc.)

- ➢ Relevant media activities

Coordinators of the **AntEco** program will be expected to assemble relevant output data as part of the requisite reporting structure.

Using the criteria identified above, the following general biennial milestones for the 8-year duration of the project can be identified:

Activity	Period of program (yrs.)			
	1-2	3-4	5-6	7-8
AntEco-related symposia/workshops	✓	✓	✓	✓

Participation of multiple international laboratories	✓	✓✓	✓✓✓	✓✓✓
Evidence of cross-disciplinary activities	✓	✓✓	✓✓✓	✓✓✓
Leveraging of research funding	✓	✓✓	✓✓✓	✓✓✓
Published research outputs		✓	✓✓	✓✓✓
Evidence of student training and development		✓	✓✓	✓✓✓
Synthesis document - Final State of the Antarctic Ecosystem report				✓✓✓

g. Data management plan

AntEco research will typically generate very large datasets, particularly those programs which utilise modern –omic technologies. In some instances phylogenetic and metagenomic data sets will be linked to micro- and macro-environmental (non-biological) data. The most appropriate mechanisms for data management will be the use of existing and accepted national and international conventions and established infrastructures, e.g., ANTABIF, Polar Information Commons, NCIMB and GenBank. Such data systems are typically designed for the storage and open access of large datasets, and most provide user-friendly portals for international researchers. However, it will be necessary, particularly with the exponential growth of data volumes, for **AntEco** to establish and maintain a meta-information structure to assist researches to access the relevant datasets.

h. Capacity building, education and training plan

The fundamental nature of Antarctic research is to maintain a very strong training and capacity building element. All Antarctic research activities, whether government or University, which fall within the **AntEco** remit will be expected to incorporate, and to report on, the post-graduate training elements of the research. In doing so, the progressive training of new generations of Antarctic scientists is maintained. The incorporation of developing researchers into the SCAR community may be actively promoted by various interventions, possibly including:

> ➢ The construction of an **AntEco** web-site which caters specifically for younger scientists. Such a website could serve multiple purposes, including as the portal for **AntEco** metadata (see g. above), a site for technology and methodology interchange, and as an information hub for funding opportunities, job and career development opportunities, and much more.

> ➢ A program of travel bursaries to post-graduate researchers to facilitate their attendance at the SCAR Open Science Conference and specialist meetings as well as **AntEco** workshops

> ➢ The inclusion of 'early career' (APECS) representative(s) on the **AntEco** Steering Committee and subsidiary group and workshop committees

i. References

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Short biosketch and homepage URL for SRP proposal coordinator

Don Cowan was educated in New Zealand at the University of Waikato and completed a period of Post-Doctoral study there before moving to University College London as a Lecturer in 1985. After 16 years in London, he accepted the position at Professor of Microbiology in the Department of Biotechnology at the University of the Western Cape, Cape Town, South Africa, where he is currently a Senior Professor and Director of the Institute Microbial Biotechnology and Metagenomics. He has recently accepted the post as Director of the new Centre for Genomics Research at the University of Pretoria, RSA.

Don Cowan is also Adjunct Professor at the University of Waikato (NZ), was elected as a Fellow of the Royal Society of South Africa in 2007, as a Member of the Academy of Sciences of South Africa in 2008, and as an Honorary Fellow of the Royal Society of New Zealand in 2009. He was awarded the UWC Vice-Rector's Award for Research Excellence in 2008 and the South African Society for Microbiology Silver Medal in 2009. He is currently President of the Royal Society of South Africa. For more information, see **http://imbm.co.za/**

Don Cowan has published over 200 research papers, review articles and book chapters.

I. Justification for SCAR sponsorship (why does SCAR support add value?)

Understanding the 'State of the Antarctic Ecosystem' is a huge challenge. It is widely accepted that current knowledge on species diversity, species interactions and trophic structuring, interactions between biological and non-biological systems etc. remains limited. Despite the magnitude of the objective, progress in achieving a better understanding of the Antarctic Ecosystem will best be obtained using a coordinated multi-disciplinary approach. SCAR, as the international structure most closely involved in all aspects of Antarctic research, is ideally placed to stimulate, through research initiates such as **AntEco**, this research objective.

II. International involvement and partnerships

AntEco activities may reasonably be expected to interface very closely with new SCAR-sponsored programs (AnT-ERA, PAIS, AntClim21) and with existing core and peripheral SCAR programs (e.g., the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) and the "Integrating Climate and Ecosystem Dynamics" (ICED) programme). **AntEco** research will also provide valuable inputs to a range of international databases (SCAR- MarBIN, ANTABIF, SCAR Antarctic Biodiversity Database, Barcode of Life Database).

At the research level, **AntEco** activities (workshops, etc.) can be expected to stimulate, through the normal pathways of collaborations, partnerships between international research groups. Such collaborations will naturally evolve through mutual interests, complementary and unique skills, coordinated logistics, and other synergistic drivers of research linkages.

III. Budget justification (other potential sources of funds)

All research (field and laboratory) activities falling within the remit of the **AntEco** program will be funded through National Antarctic and other funding programmes. The role of **AntEco** is therefore to stimulate, motivate, coordinate and disseminate. SCAR funding, through its support for the activities of the proposed Steering Committee (including workshops etc.) will effectively leverage an international Antarctic research budget which will be several orders of magnitude greater.

IV. For a list of contributors to this proposal, see Appendix 1.

Appendix 1. Authors of the AntEco SRP proposal

Aleks Terauds, Australian Antarctic Division, AU

Angelika Brandt, University of Hamburg, DE

David Barnes, British Antarctic Survey, UK

Dominic Hodgson, British Antarctic Survey, UK

Don Cowan, formerly University of the Western Cape, now University of Pretoria, SA (coordinator)

Elie Poulin, University of Santiago, CL

Huw Griffiths, British Antarctic Survey, UK

Ian Hogg, University of Waikato, NZ

Jan Strugnell, La Trobe University, AU

Louise Allcock, National University of Ireland, UK

Louise Newman, formerly PAGES IPO, now SOOS, AU

Mark Hindell, University of Tasmania, AU

Nerida Wilson, Australian Museum

Nicoletta Cannone, University of Subria, IT

Pete Convey, British Antarctic Survey, UK

Piero Luporini, Unicam, IT

Rod Seppelt, Australian Antarctic Division, AU

Stefano Schiaparelli, UNIGE, IT

Steven Chown, Centre for Invasion Biology, University of Stellenbosch, SA

Win Vymerman, University of Ghent, BE

Appendix 2. Interactions between AntEco and other SCAR Research Programs

The next Generation of SCAR Research Programmes

Ant-ERA

<u>Recent and future biological processes</u>
under climate change

AAA*

Astronomy;
astrophysics

atmosphere

AntClim
21

Predictions:
ocean

adaptation

Ecosystems

SERCE

Ice mass change

<u>biodiversity patterns</u>

system evolution,
governance, mitigation

Paleoecology;
refugia

Climate;
Cryosphere;
Sea level

Ice sheet
dynamics

AntEco

PAIS

Past climate

* Approved 2010