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Person Responsible:	Graham Hosie

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SCAR SRP 'Evolution and Biodiversity in the Antarctic'

Final Report

Executive Summary

Title: SCAR SRP 'Evolution and Biodiversity in the Antarctic'

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Relevant URLs or references to other reports: www.eba.aq

Introduction/ Background: EBA is the last of the previous portfolio of SCAR SRPs to complete its cycle, ACE and AGSC winding up in 2012. Over that cycle it was the only SCAR programme representing the interests of the very large and diverse biological sciences research community with interests in Antarctica. With the development and adoption of two new biological SRPs by Delegates in 2012, the leaders of EBA agreed to wind up the programme a year earlier than planned originally, not requesting funds for 2013, although extending the time period for use of its existing 2012 funds, not least to take advantage of the 2013 SCAR Biology Symposium (Barcelona) as a timely and high profile 'wind up' event for the programme. Work under the auspices of EBA is divided into five 'workpackages', each working in both the marine and terrestrial environments of Antarctica.

Important Issues or Factors: Since the Programme's last Report to Delegates, it has continued to be very active in its primary coordination role, and in science areas previously noted to Delegates; in particular the programme has contributed to the development of robust scientific advice central to informing the CEP and hence ATCM on issues relating to human impacts on the ecosystems of Antarctica, and conservation planning and governance issues. In its final year of active operation the programme members and leaders (1) deliver a themed mini-symposium documenting the 'state of the art' and major future challenges in the programme's science fields at the 2012 SCAR OSC; (2) completed the delivery of planned research workshops or meetings in the remainder of 2012; (3) played an active and central role in the transition to successor SCAR biological and cross-disciplinary research programmes; and (4) used remaining EBA funds as seed money to contribute to specific workshops in this transitional period, in particular to a series of workshops setting the ground for the proposed ANTOS (Antarctic Nearshore and Terrestrial Observing System) activity, contributing to a joint workshop with AnT-ERA on "omics", and contributing with SSG-LS to an international penguin biology workshop strongly slanted towards the early career scientist community.

Recommendations/Actions and Justification: To note and approve of EBA actions and progress to the end of its formal life cycle.

Expected Benefits/Outcomes: Continued significant publication output (both content and numbers), outreach delivery, advice to stakeholders, enhancement of SCAR profile. Although these direct functions will now be taken over by the new biological SRPs, EBA outputs will clearly continue to enter the public domain, while the legacy of the programme is also the foundation it provides for the new SRPs

Partners: Various outputs involve interactions with CEP, COMNAP, SCAR Expert and Action Groups, IPCC

Budget Implications: No further budgetary or other approval is required for EBA itself.

Evolution and Biodiversity in the Antarctic: The Response of Life to Change (EBA)

1. *Rationale*

Evolution and Biodiversity in the Antarctic: the Response of Life to Change (EBA) was endorsed by SCAR and became operational from January 2006.

The overall aim of the EBA programme is to understand the evolution and diversity of life in the Antarctic, to determine how these have influenced the properties and dynamics of present Antarctic and Southern Ocean ecosystems, and to make predictions on how organisms and communities will respond to current and future environmental change.

This programme involves an explicit integration of work on marine, terrestrial and limnetic ecosystems. The science in this programme thus extends over an entire biome on Earth. By comparing the outcome of parallel evolutionary processes over the range of Antarctic environments, fundamental insights can be obtained into evolution and the ways in which life responds to change, from the molecular to the whole organism level and ultimately to biome level. Most national programmes individually cannot attempt a study on such a bold scale, whereas the collaborative spirit of the Antarctic science community provides a mechanism for achieving outstanding scientific success.

EBA has established five linked Work Packages to cover the intended areas of research:

- Work Package 1: Evolutionary history of Antarctic organisms
- Work Package 2: Evolutionary adaptation to the Antarctic environment
- Work Package 3: Patterns of gene flow and consequences for population dynamics: Isolation as a driving force
- Work Package 4: Patterns and diversity of organisms, ecosystems and habitats in the Antarctic, and controlling processes
- Work Package 5: Impact of past, current and predicted future environmental change on biodiversity and ecosystem function

2. *Overview of Progress*

Information regarding the outputs and inputs specifically concerning the EBA programme and its undertakings are provided in the summary format requested by SCAR below. These highlight the high level, diversity and connectivity of research that contributes to EBA, and also emphasise that EBA has continued 'business as normal' since its previous report to Delegates, as would be expected of a programme in its final phase.

3. *Major Tasks and Timeframe*

Note that the level of detail provided in the original EBA implementation plan developed in 2004/5 is predictably limited for the final years of the programme. Included here are significant workshops and meeting that have had high relevance to EBA in 2012/13.

Year	Task outlined in 2005 Implementation Timeline, or subsequently developed	Comments
2012	PuP: Planet under Pressure, Elsevier Conference, London, UK IPY, Montreal APECS Brazil South America-Antarctica linkages meeting SCAR Open Science Conference (Portland)	Significant EBA presence and contribution Significant EBA presence and contribution EBA sponsorship and participation PC Co-Chair of International Scientific Organising Committee.

	Society for Experimental Biology main meeting (Austria July 2012) CCAMBIO workshop (Belgium, organiser A. Wilmotte)	EBA mini-symposium, lead organiser J. Gutt EBA sponsored session on 'Physiology of Environmental Gradients' EBA sponsored – workshop on application of next generation sequencing in Antarctic microbial and diversity research
2013	SCAR Biology Symposium – wrap-up of results and last year of program Three ANTOS planning workshops (Barcelona, Australia, South America; to encourage maximum participation) “Omics” workshop (with Ant-ERA) International Penguin Conference (Bristol,UK) (following an approach to SCAR Office, and with SSG-LS)	Formal end of programme financing by SCAR at end 2012. Contribution from carry-over funding Ditto Ditto

4. Deliverables

The EBA Implementation plan (2005) outlined that the main output from the EBA programme would be a significant step forward in our understanding of the Antarctic biota and its evolution. There would also be important contributions to fundamental understanding in a number of disciplines. Specific outputs have included the following (as demonstrated in the following sections):

- Primary literature publications and books
- Conference proceedings and publications from workshops
- Programme reports
- Website
- Input to databases
- Advisory reports to ATCM and others (e.g., CEP, CCAMLR, COMNAP)
- Input to, and feedback from, international programmes
- Synergies with other SCAR programmes (e.g., ACE, AGCS, SALE)
- Trained PhD graduates and post-doctoral research fellows
- Capacity development of students and members from developing Antarctic nations
- Outreach via National Programmes and in coordination with proposed SCAR Outreach Committee
- Approximately 40 projects identified under the EBA Banner (listed in previous Report, and not repeated here)

5. EBA Committee

Name	Role	Gender	Country	Term From
Prof Peter Convey	<i>Co-Chair</i>	Male	United Kingdom	2005
Prof Guido di Prisco	<i>Co-Chair</i>	Male	Italy	2005
Jose Xavier	<i>Co-secretary</i>	Male	Portugal/UK	2010
Meghana Rajanahally	<i>Co-secretary, APECS representative</i>	Female	NZ/India	2010
Dr Dana Bergstrom	Member	Female	Australia	2005
Prof Angelika Brandt	Member	Female	Germany	2005
Dr Marc Lebouvier	<i>Member (conservation matters)</i>	Male	France	2005
Dr Kathy Conlan	<i>CO LSSSG (ex officio)</i>	Female	Canada	2008
Dr Michael Stoddart	<i>Census of Antarctic Marine Life</i>	Male	Australia	2005
Dr Brigitte Ebbe	Work Package 1 leader	Female	Germany	2005
Dr Dominic A. Hodgson	Work Package 1 leader	Male	United Kingdom	2005
Dr Katrin Linse	Work Package 1 leader	Female	United	2009

			Kingdom	
Prof Takeshi Naganuma	Work Package 2 leader	Male	Japan	2005
Dr Elie Poulin	Work Package 3 leader	Male	Chile	March 2008
Dr Ian D. Hogg	Work Package 3 leader	Male	New Zealand	2005
Dr Satoshi Imura	Work Package 4 leader	Male	Japan	2005
Dr Lúcia de Siqueira Campos	Work Package 4 leader	Female	Brazil	Sept 2008
Dr Julian Gutt	Work Package 5 leader	Male	Germany	2005
Dr David Renault	Work Package 5 leader	Male	France	March 2008

6. Outputs

a. Key achievements

- I. *Publications:* As previously reported, at least 280 peer reviewed papers were published by groups contributing to EBA between 2008 and 2009, further to the minimum of ~280 previously reported from 2006/7. These include several journal ‘special issues’, and a major editorial and author contribution to the ACCE report, to the subsequent annual update papers to the ATCM, and to the more detailed update published in *Polar Record* in 2013. Further special issues and other similar or major outputs published in 2012 and to date in 2013 are listed in section 6c below. In recent consultation with the EBA community, we have attempted a collation of EBA-related publication outputs over the period 2010-present, but accept this is clearly incomplete, and that outputs will continue to accumulate. They indicate at the very least a sustained pattern of output over the life of the programme, across a very wide range of ranking journals. A source file listing these outputs will be placed on to the EBA website in due course.

Year	2010	2011	2012	2013
Papers published (collation by MAR, Apr 2013, most 2013 outputs yet to be reported)	~195	~210	~260	~35

- II. *Workshop Sponsorship:* As the role of EBA has developed several workshops have been sponsored to encourage communication among scientists particularly to foster new ideas and cross-discipline discussions. Appendix 1 lists the various workshops that EBA has sponsored or has been involved in since the previous Report in 2012 (workshops prior to that were listed in previous reports, and are not repeated).
- III. *EBA Website:* The EBA website (www.eba.aq) was launched in July 2007 to help promote the cause of EBA and bring to the fore the various groups that contribute to EBA. It receives many thousands of unique visitors each year, and over 100,000 hits. The EBA website (and other SRPs that have come to an end) should be archived to provide legacy information of previous SRPs.
- IV. *EBA Newsletter:* The EBA Newsletter gives recent news of the various parts of EBA. Started in March 2008, two newsletters have been compiled and circulated each year. The final newsletter issue was circulated in March 2013 and is available on the EBA website.
- V. *Links with the Antarctic Master Directory:* An EBA portal exists in the Antarctic Master Directory where information about Antarctic data is stored. This enables us to easily search for all types of data that contribute to EBA outcomes. SCADM have not appointed a new representative to the EBA committee following the resignation of S. Gordon from this role in 2010 after a change in employment.

Bruno Danis has requested GCMD to add the identifier ‘ANTABIF’ to the AMD for use with the proposed amalgamation of the marine and terrestrial databases (see d. Project Databases) into one portal at www.biodiversity.aq. ANTABIF stands for Antarctic Biodiversity Information Facility. Existing metadata records will be marked with this identifier for retrieval in the new portal. Responsibility for ANTABIF has now been handed to Anton van der Putte.

b. Contributions to IPY Programmes:

Besides being a SCAR programme, EBA was also endorsed by the IPY Committee (Project # 137, coordinated by Guido di Prisco). All of the EBA-IPY projects contributed to the EBA SRP and several other projects that contribute to EBA were themselves IPY endorsed projects (e.g. CAML, SCAR-MarBIN, Aliens, TARANTELLA, ICED). With the completion of the IPY period, we are now in a period of data analysis, presentation and publication, exemplified by the strength of EBA and component IPY programme contributions to the 2010 and 2012 IPY meetings in Oslo and Montreal. G. di Prisco and C. Verde have coordinated two Springer volumes on marine biology research outcomes of the IPY (see section 6c).

c. Publications in peer reviewed literature

As highlighted, EBA as it stands does not publish, however the many projects and programmes that contribute to EBA do. Individual publications from these groups have not been compiled since the last Report. Note that many publications are co-written by members of more than one project.

A selection of important publications (special issues, other volumes, highlights) supported by or with large EBA member contributions published in 2012 or to date in 2013 are listed below:

- Bell, E. (ed.) 2012. *Life at Extremes*. CABI Publishing, Wallingford,
- Chan Y., Van Nostrand J.D., Zhou J., Pointing, S.B. & Farrell, R.L. 2013. Functional ecology of an Antarctic Dry Valleys landscape. *Proc Natl Acad Sci USA*, in press.
- Chown, S.L., Huiskes, A.H.L., Gremmen, N.J.M., Lee, J.E., Terauds, A., Crosbie, K., Frenot, Y., Hughes, K. A., Imura, S., Kiefer, K., Lebouvier, M., Raymond, B., Tsujimotoi, M., Ware, C., Van de Vijver, B., & Bergstrom, D.M. 2012. Continent-wide risk assessment for the establishment of nonindigenous species in Antarctica. *Proceedings of the National Academy of Sciences: 109*, 4938-4943.
- Chown, S.L., Lee, J.E., Hughes, K.A., Barnes, J., Barrett, P.J., Bergstrom, D.M., Convey, P., Cowan, D.A., Crosbie, K., Dyer, G., Frenot, Y., Grant, S.M., Herr, D., Kennicutt, M.C., Lamers, M., Murray, A., Possingham, H.P., Reid, K., Riddle, M., Ryan, P.G., Sanson, L., Shaw, J.D., Sparrow, M.D., Summerhayes, C., Terauds, A. & Wall, D.H. Challenges to the future conservation of the Antarctic. *Science* 337, 158-159.
- Convey, P., Chown, S.L., Clarke, A., Barnes, D.K.A., Cummings, V., Ducklow, H., Frati, F., Green, T.G.A., Gordon, S., Griffiths, H., Howard-Williams, C., Huiskes, A.H.L., Laybourn-Parry, J., Lyons, B., McMinn, A., Peck, L.S., Quesada, A., Schiaparelli, S. & Wall, D. 2013. Spatial structure and patterns in Antarctic biodiversity. *Ecological Monographs*, in press.
- Coppola, D., Giordano, D., Tinajero-Trejo, M., di Prisco, G., Ascenzi, P., Poole, R.K., Verde, C. (2013) Antarctic bacterial hemoglobin and its role in the protection against nitrogen reactive species. *Biochim Biophys Acta* Feb 19. doi: 10.1016/j.bbapap.2013.02.018
- Giordano, D., Boron, I., Abbruzzetti, S., Van Leuven, W., Nicoletti, F.P., Forti, F., Bruno, S., Cheng, C.-H.C., Moens, L., di Prisco, G., Nadra, A.D., Estrin, D., Smulevich, G., Dewilde, S., Viappiani, C. & Verde, C. 2012. Biophysical characterisation of neuroglobin of the icefish, a natural knockout for hemoglobin and myoglobin. Comparison with human neuroglobin. *PLoS ONE* 7(12):e44508. doi: 10.1371/journal.pone.0044508
- Gutt, J., Zurell, D., Bracegridle, T.J., Cheung, W., Clark, M.S., Convey, P., Danis, B., David, B., De Broyer, C., di Prisco, G., Griffiths, H., Laffont, R., Peck, L.S., Pierrat, B., Riddle, M.J., Saucedo, T., Turner, J., Verde, C., Wang, Z. & Grimm, V. 2012. The use of correlative and dynamic species distribution modelling for ecological predictions in the Antarctic: a cross-disciplinary concept. *Polar Research* 31, 11091, <http://dx.doi.org/10.3402/polar.v31i0.11091>
- Hermant, M., Prinzing, A., Vernon, P., Convey, P. & Hennion, F. 2013. Endemic species have highly integrated phenotypes, environmental distributions and phenotype/environment relationships. *Journal of Biogeography* doi:10.1111/jbi.12095.
- Hughes, K.A. & Convey, P. 2012. Determining the native/non-native status of newly discovered terrestrial and freshwater species in Antarctica – current knowledge, methodology and management action. *Journal of Environmental Management* 93, 52-66.
- Kaiser, S., Brandão, S.N., Brix, S., Barnes, D.K.A., Bowden, D., Ingels, J., Leese, F., Linse, K., Schiaparelli, S., Arango, C., Bax, N., Blazewicz-Paszkowycz, M., Brandt, A., Catarino, A.I., Danis

- B., David, B.,13, De Ridder, C., Dubois, P., Ellingsen, K.E., Glover, A., Griffiths, H.J., Gutt, J., Halanych, K., Havermans, C., Held, C., Janussen, D., Lörz, A.-N., Pearce, D., Pierrat, B., Riehl, T., Rose, A., Sands, C.J., Soler i Membrives, A., Schüller, M., Strugnell, J., Vanreusel, A., Veit-Köhler, G., Wilson, N., Yasuhara, M. 2013. Pattern, process and vulnerability of Southern Ocean benthos - a decadal leap in knowledge and understanding. *Marine Biology* DOI 10.1007/s00227-013-2232-6.
- Lewis, G., Aitken, S., Dang, P., Hik, D., Kulkarni, T., Coulson, S.J., Jonsdottir, I.S., Barry, T., Gill, M., Convey, P. & di Prisco, G. (eds.) 2012. The Impacts of Climate Change on Circumpolar Biodiversity. *Biodiversity* 13 (special issue).
- di Prisco, G., Convey, P., Gutt, J., Cowan, D., Conlan, K. & Verde, C. 2012. Understanding and protecting the world's biodiversity: the role and legacy of the SCAR programme Evolution and Biodiversity in the Antarctic" *Mar Gen* 8:3-8
- di Prisco, G. & Verde, C. (eds.) 2012. *From Pole to Pole, Adaptation and Evolution in Marine Environments – The Impacts of Global Change on Biodiversity, Volume 1. A book series on environmental research during IPY*. Springer, pp 1-222
- Rogers, A.D., Johnston, N.M., Murphy, E. & Clarke, A. (eds.) 2012. *Antarctica: An Extreme Environment in a Changing World*. Blackwell, Oxford.
- Simões, J.C., Garcia, C.A.E., Evangelista, H., Campos, L.S., Mata, M.M. & Bremer, U.F. (2012). *Antártica e as Mudanças Globais*. Blucher, Rio de Janeiro.
- Terauds, A., Chown, S.L., Morgan, F., Peat, H.J., Watts, D., Keys, H., Convey, P. & Bergstrom, D.M. 2012. Conservation biogeography of the Antarctic. *Diversity and Distributions* 18, 726-741.
- Tin, T., Liggett, D., Maher, P. & Lamers, M. (eds.). In press. *The Future of Antarctica: Human impacts, strategic planning and values for conservation*. Springer.
- Turner, J. Barrant, N.E., Bracegirdle, T.J., Convey, P., Hodgson, D., Jarvis, M., Jenkins, A., Marshall, G., Meredith, M.P., Roscoe, H., Shanklin, J., French, J., Goosse, H., Guglielmin, M., Gutt, J., Jacobs, S., Kennicutt, M.C. II, Masson-Delmotte, V., Mayewski, P., Navarro, F., Robinson, S., Scambos, T., Sparrow, M., Speer, K., Summerhayes, C. & Klepikov, A. 2013. Antarctic Climate Change and the Environment – An Update. *Polar Record* doi:10.1017/S0032247413000296.
- Verde, C., Convey, P. & di Prisco, G. (eds.) 2012. Special Issue: Molecular and Genetic Advances to Understanding Evolution and Biodiversity in the Polar Regions *Marine Genomics* 8, pp 1-66
- Verde, C., Giordano, D., di Prisco, G. & Andersen, Ø. 2012. The hemoglobins of polar fish: evolutionary and physiological significance of multiplicity in Arctic fish. *Biodiversity* 13:228-233
- Verde, C. & di Prisco, G. (eds.) 2012. *From Pole to Pole, Adaptation and Evolution in Marine Environments – The Impacts of Global Change on Biodiversity, Volume 2. A book series on environmental research during IPY*. Springer, pp 1-239

Note that particularly significant EBA-related publications have been picked up effectively by the media arms of author parent organizations.

d. Project Databases

Biodiversity Database

The Australian Antarctic Data Centre (AADC) continues to host and maintain a Biodiversity Database (<http://data.aad.gov.au/aadc/biodiversity/>) which contains data on Antarctic and sub-Antarctic flora and fauna. This started through EBA's predecessor, RiSCC, and is EBA's main database. This database contains as many collections of data that we are aware of in the public domain (see <http://data.aad.gov.au/aadc/biodiversity/collections.cfm>). The samples and/or observations from each collection are classified into one of three possible habitat domains - terrestrial, limnetic or marine (see table below).

There are also other databases that are coordinated by several of the individual projects/programmes that contribute to EBA. See: SCAR-MarBIN, MERGE, SO-CPR.

As previously noted, the Royal Belgium Institute of Natural Sciences funded a two year project called ANTABIF, as a follow on from SCAR-MarBIN project, on building a regional biodiversity portal for the Antarctic and sub-Antarctic. This is now in existence and is available at www.biodiversity.aq. This project

utilises as far as possible data standards, components and tools developed at GBIF. It is also proposed to augment the existing database with an authoritative terrestrial and limnetic taxa catalogue to complement the existing Register of Antarctic Marine Species (RAMS). A suitable acronym for this product is suggested to be Register of Antarctic Freshwater and Terrestrial Species (RAFTS).

The contents of the existing terrestrial database were central to a jointly funded EBA and SC-ATS analysis of terrestrial biodiversity patterns across Antarctica, also including links with the Environmental Domains Analysis V2 from New Zealand. This analysis has previously been reported to SCAR, and is central to plans for future advice to CEP and ATS parties relating to conservation planning and management in Antarctica. The work was formally published in 2012 (Terauds et al., 2012 – see 6c above), and formed part of a considerable emphasis on biodiversity, conservation planning and governance at the 2012 Portland OSC, and specifically to the Mini Symposium (Antarctic Conservation Challenges in a Century of Changes) led and organised by Dr N. Gilbert.

7. *Inputs*

a. Meetings and workshops

Since the previous Report, several meetings and workshops have been, and are planned to be, sponsored by EBA, and many have been linked to EBA. These can be found in Appendix 1.

b. Links to other SCAR SRPs or SCAR Action or Expert Groups

The Southern Ocean Continuous Plankton Recorder Survey (SO-CPR Survey) has identified itself as a project that contributes to EBA and this is currently an LS-SSG Action Group.

Links have been made with ACE and AGCS through the SCAR inter-programme leaders group, the editorial committee and authorship of the ACCE report and its subsequent updates, through the creation of a new Expert Group on ACCE, and the Action Group on the Prediction of Change in the Biological and Physical Environments of Antarctica (now wound up).

Along with SSG-LS, EBA members have been very closely involved in the development of the two new SCAR biological SRP proposals. These proposals provide a very firm and exciting foundation for the involvement of a wide cross-section of the international biological research community in Antarctic biological research over the next 5-8 years. EBA members have also been directly and positively engaged in the development of the new physical science research proposal ‘AntClim21’.

A number of EBA members are also involved in direct contributions to IPCC5.

Appendix 1: Workshops/Meetings Supported by EBA or linked to EBA since 2012

Title	Venue	Date	Report/Supported Personnel	Attendees/Supported
2012				
PuP (Planet under Pressure)	London, UK	March 2012	EBA/SCAR keynote lecture	Multinational participation.
IPY	Montreal, Canada	April 2012	EBA/SCAR lecture	Multinational participation.
APECS Brazil South America-Antarctica linkages meeting	Rio Grande, Brazil	May 2012	EBA/SCAR keynote. Brazil programme large contributor to EBA. Also relevant Argentinian, Chilean and Uruguayan personnel present	Multinational participation.
SCAR OSC	Portland, USA	July 2012	EBA mini-symposium. Various EBA related sessions	
Society for Experimental Biology main meeting	Salzburg, Austria	July 2012	EBA-sponsored session on environmental gradients	Speakers supported from various European countries, USA , Australia
CCAMBIO workshop	Liege, Belgium	October 2012	Workshop on application of next generation sequencing technologies in Antarctic microbiology	EBA sponsored. Speakers supported from Europe and North America (in person and by weblink), proceedings live online.
2013				
SCAR Biology Symposium – wrap-up of results and last year of programme	Barcelona, Spain	July 2013	Wrap-up of results and last year of programme	Formal end of programme financing by SCAR at end 2012
Three ANTOS planning workshops (Barcelona, Australia, South America; to encourage maximum participation)		2013	Contribution from carry-over funding	
“Omics” workshop (with Ant-ERA)		2013	ditto	
International Penguin Conference		September 2013	ditto	