

## EVOLUTION AND BIODIVERSITY IN THE ANTARCTIC (EBA)

### 2008 Annual Report

EBA aims 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. EBA integrates work on marine, terrestrial and limnetic ecosystems. 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 the biome level. Most national programmes individually cannot attempt a study on such a bold scale. EBA's role, as a non-science-funding umbrella or facilitator, is primarily one of connection, and encouragement of various research initiatives being undertaken towards the goals of EBA by a large number of projects, programmes and individuals covering very diverse areas of biology. To facilitate its work, EBA has established five Work Packages to cover its main areas of research (see below).

#### **Progress:**

##### Projects under EBA

EBA is both a SCAR and an IPY programme. Several other important coordinating projects that contribute to EBA are themselves IPY endorsed projects such as CAML (Census of Antarctic Marine Life), MarBIN (Marine Biodiversity Information Network), Aliens, TARANTELLA, MERGE, the Latitudinal Gradient Project, and ICED (Integrating Climate and Ecosystem Dynamics in the Southern Ocean). Of these, CAML, MarBIN and ICED are either SCAR activities or sponsored by SCAR. They are part of the list of some 40 national and international programmes contributing to EBA.

##### EBA Publications

EBA's success is reflected in part in publications emerging from its scientific community, and in excess of 150 EBA – related publications are expected to have been published, in 2008 including:

- Convey, P. et al. 2008. Antarctic terrestrial life - challenging the history of the frozen continent? *Biol rev.* 83: 103-117. doi:10.1111/j.1469-185X.2008.00034.x
- Dettai A, di Prisco G, Lecointre G, Parisi E, Verde C. 2008. Inferring evolution of fish proteins: the globin case study *Meth Enzymol* Vol 436, Chapter 30, pp 539-570.
- Negrisola E, Bargelloni L, Patarnello T, Ozouf-Costaz C, Pisano E, di Prisco G, Verde C. 2008. Comparative and evolutionary genomics of globin genes in fish. *Meth Enzymol* Vol 436, Chapter 29, pp 511-538.
- Petit, J. (ed.) (64 co-editors and contributing authors). *The Beacons of Europe Impacts of climate change on the biodiversity of European Union overseas entities*. International Union for the Conservation of Nature.

- Vincent, W. F and Laybourn-Parry, J. (eds). 2008. Polar lakes and rivers: limnology of Arctic and Antarctic aquatic ecosystems. Oxford University Press. 9780199213894
- Verde, C., Giordano, D., di Prisco, G. 2008. The adaptation of polar fishes to climatic changes: Structure, function and phylogeny of haemoglobin. *IUBMB Life* **60**, 9-40

And further upcoming publications of note:

- Pugh, P.J.A. & Convey, P. 2009. Surviving out in the cold: Antarctic endemic invertebrates and their refugia. *J. Biogeog.* **35**, 2176-2186.
- Tin, T., Fleming, Z., Hughes, K.A., Ainley, D., Convey, P., Moreno, C., Pfeiffer, S., Scott, J., & Snape, I. (In press). Impacts of local human activities on the Antarctic environment: a review. *Antarctic Science*.
- Parnikoza, I., Convey, P., Dykyy, I., Trakhimets, V., Milinevsky, G., Tyschenko, O., Inozemtseva, D. & Kozeretska, I. (Accepted subject to revision). Current status of the Antarctic herb tundra formation in the central Argentine Islands. *Global Change Biology*.
- Second Special Edition of *Antarctic Science* with at least 20 publications relating to the Latitudinal Gradient Project from groups working in Victoria Land and along the Antarctic Peninsula.
- Cheng, C.-H., di Prisco, G., Verde, C. 2009. The “icefish paradox”. Which is the task of neuroglobin in Antarctic hemoglobin-less icefish? *IUBMB Life* (in press)
- Cheng, C.-H., di Prisco, G., Verde, C. 2009. Cold-adapted Antarctic fish: the discovery of neuroglobin in red-blooded and hemoglobin-less Notothenioidae. *Gene* (in press)
- Special Issue of *Marine Genomics* addressing the EBA-sponsored workshop of 2008 in Naples. It will contain 12-13 publications.
- Special Issue of *Polar Science* addressing MERGE-related work and arising from contributions to the 2007 Salekhard and 2008 Banff meetings.
- Special Issue of *Polar Science* arising from the 2009 SCAR Biology Symposium, expected to contain about 50 publications.

An inaugural EBA Newsletter was distributed in March 2008 followed by a second issue in October 2008 giving recent news of the various parts of EBA. These were circulated on the EBA listserver and hard copies distributed at the SCAR OSC in St Petersburg.

### Workshops

EBA facilitates collaboration through workshops and conferences that maximize international and multidisciplinary involvement; in 2008 these included:

A MERGE workshop (**Microbiological and Ecological Responses to Global Environmental Changes in Polar Regions**) held within the Polar and Alpine Microbiology Conference (Banff, Canada). A publication from NIPR Japan (Polar Science) is being planned as an outcome of the meeting, and three international keynote speakers were sponsored using EBA funding from Korea, India and the USA.

**Integrating Climate and Ecosystem Dynamics in the Southern Ocean (ICED)**, established to address scientific challenges arising due to climate and human-driven change, held its first modelling workshop in April. Thirty international participants attended, including physical oceanographers, biogeochemists and ecologists. Three of the participants were supported by EBA. The workshop characterised Southern Ocean food webs across trophic levels and geographical areas, towards developing end-to-end models. Modelling approaches to bring together different scales and processes were reviewed. Gaps in knowledge were identified, as was the importance of exploring regional and trophic complexities. An important workshop outcome was a community now focused on Southern Ocean ecosystem modelling, with emphasis on cross-disciplinary aspects.

The workshop “**The polar and alpine environments: molecular and evolutionary adaptations in prokaryotic and eukaryotic organisms**”, Naples, Italy (May 29<sup>th</sup>-30<sup>th</sup>), was sponsored by EBA, with 20 speakers from 6 countries. The sessions were: 1. Structure, function and evolution of cold-adapted protein; 2. Evolutionary biology of polar organisms; 3. Physiological and genomic adaptations to cold environments; 4. Microbial ecology and biodiversity. 13 Manuscripts will be assembled in a special issue of *Marine Genomics*.

**Coordination Action for Research Activities in Life in Extreme Environments (CAREX; [www.carex-eu.org](http://www.carex-eu.org))** held its inaugural meeting on 18 March at the British Antarctic Survey with 42 European and North American experts attending. A second workshop of this group, with approximately 70 participants, was held in Spain in early December. CAREX aims at identifying and consolidating the European scientific community involved in research on life in extreme environments around common research priorities and interactive communication tools, and supports research interests across microbes, plants and animals evolving in diverse marine, polar, and terrestrial extreme environments as well as in outer space. This meeting provided the opportunity to present the project's structure, approach, objectives and actions in detail and to get valuable feedbacks from the participants. Presentations included several on Polar Environments, given by Guido di Prisco, Peter Convey and Cinzia Verde, which also highlighted the relevance of EBA to the CAREX objectives.

A **SCAR MarBIN** workshop was held in November 2008, and a report from this meeting is currently awaited.

EBA sponsored an ‘invited participant’ workshop on ‘**Antarctic Gradients**’, held at the British Antarctic Survey in May 2008. 16 participants from 7 countries were involved, with the aim of examining how the concepts and results of the Latitudinal Gradient Project in Victoria Land could be extended to, and compared with, other parts of Antarctica, in particular but not only the Antarctic Peninsula and Scotia arc. From this workshop a major review is in preparation for submission to Ecological Monographs later in 2009, and an open workshop was also held linked with the SCAR OSC in St Petersburg.

The **SCAR OSC** in St Petersburg was a major event attracting participation from many hundreds of Antarctic and Arctic biologists. The marine and terrestrial biology sessions received by far the largest number of abstract submissions and presentations

of the many sessions on offer, with further important biological presentations in several other sessions, illustrating the size and vibrancy of the Antarctic biological research community. It might also be reasonable with hindsight to conclude from the levels of submission to, and participation in, the various different sessions offered at the meeting that the 'demand' from the different scientific research communities was not that well matched by the actual sessions 'offered' at the meeting, something that should be borne in mind by the International Steering Committee of the next OSC.

Highlights from the different Work Packages include the following:

*WP 1: Evolutionary history of Antarctic organisms:* Key recent papers by EBA participants (Convey & Stevens 2007, *Science*; Convey et al. *Biological Reviews*, 2008), have led to considerable research activity and increasing interactions with the SCAR glaciological and geological communities. Further publications have been produced by EBA participants (e.g. Pugh & Convey 2009 *J. Biogeog.*) and a large cross-disciplinary review has recently been submitted to *Quaternary Science Reviews*. Members of this and other EBA work packages are contributing to the SCAR 'Antarctic Climate Change and the Environment' (ACCE) report.

*WP2: Evolutionary adaptation to the Antarctic environment:* Microorganisms in terrestrial habitats including lakes and ponds are studied to understand their evolutionary adaptation to Antarctic conditions. The IPY-MERGE project is making a key contribution. Several MERGE expeditions and projects are underway, including ones run by Poland, UK, Japan, Spain, Malaysia, Belgium and Brazil. Organisms studied include fungi, methanogens, cyanobacteria, bacteria and microalgal protists (particularly diatoms and green algae). MERGE is bipolar and includes Arctic projects.

Genes and proteins in polar fish, invertebrates and bacteria offer the opportunity to study thermal adaptation at the molecular level. The results of these studies have been further developed by some EBA participants (e.g. Verde, di Prisco et al. *Meth Enzymol*, *J Am Chem Soc*, *IUBMB Life*, *Current Protein & Peptide Sci*) and summarised in a number of refereed publications on international journals with international Editorial Boards, and book chapters, and have been the object of over 10 lectures in international and national venues. Several cross-disciplinary invited reviews have been recently submitted to *Biol Rev*, *Marine Genomics* and *J Fish Biol*. The recent discovery of the neuroglobin gene in the brain of icefishes opens the question "what is the role of Ngb in fishes lacking hemoglobin as oxygen carrier, as well as in many cases myoglobin" ?

*WP 3: Patterns of gene flow and consequences for population dynamics: isolation as a driving force:* There has been ongoing work on this topic in the Ross Sea Sector. Among terrestrial organisms the work targets rotifers, tardigrades, nematodes, terrestrial arthropods (springtails and mites), lichens and mosses. In the marine realm, New Zealand's RV *Tangaroa* collecting fish and invertebrate samples at several sites in the Southern Ocean as part of an IPY- CAML voyage. Studies are planned on patterns of gene flow in populations of amphipod crustaceans. This is an area of very active research at present, involving participants from a range of national programmes

contributing to EBA (notably, New Zealand, Australia, UK, Belgium, Germany, Italy, Malaysia, Japan).

*WP 4: Patterns and diversity of organisms, ecosystems and habitats in the Antarctic, and controlling processes:* Much of the faunal work under this heading is being undertaken under the Census of Antarctic Marine Life (CAML) programme, which contributes to EBA (see CAML details, below). Various studies have shown that Antarctic benthic systems are not as stable as once thought, but that they are exposed to dynamic conditions and respond to environmental changes. We are trying to find out how, and what parameters limit the resilience of such systems. In shallow water, along the Western Antarctic Peninsula, studies are focusing on the response of assemblages or key species to disturbance by sea-ice and geographical shift. Deeper offshore communities are locally and regionally shaped by iceberg scouring, which can alter biodiversity. Other studies try to correlate biological and physical processes in the water column and sea-ice with higher trophic levels such as fish and benthos. Some assemblages show significant pelago-benthic coupling. Recent studies show that algae, krill and salps, which play a key ecological role as food for predators, respond sensitively to atmospheric and oceanic changes. Efforts continue to clarify the tolerance of assemblages to changes in food supply. Gradients are being investigated (e.g. from shallow to deep waters, or along latitudes) to detect ecological controls and changes over time. The ultimate objective is to predict the evolution of marine Antarctic ecosystems. A range of publications under this heading have been produced over the last year (e.g. Brandt et al. 2008 *Nature*; Griffiths et al. 2009 *J. Biogeog.*; Smale et al. 2008 *MEPS*).

*WP 5: Impact of past, current and predicted future environmental change on biodiversity and ecosystem function.* This topic includes addressing ecological questions and theories related to the consequences of climate change and biological invasions in the subantarctic islands. Dispersal of invasive species is being investigated, their spatial dynamics are being monitored and rates of dispersal modeled. The vulnerability of endemic biota to biological invasions is being assessed, as is the effect of climate change on the invasive species. EBA members have been active along with members of the SCAR ATS committee in integrating data on terrestrial biological diversity in Antarctica, with the twin aims of generating a working paper for the ATCM, and a status review for the scientific literature, which is intended for submission during 2009. A newly created combination of national operator and NGO scientists have also recently published a review of direct human impacts on the Antarctic environment, in the context of examining the effectiveness of the Environmental Protocol (Tin et al. 2009 *Antarctic Science*). EBA members are contributing to the new SCAR Action Group on Prediction of Changes in the Physical and Biological Environments of the Antarctic.

#### Data Management

In part the success of EBA rests on the extent to which biological data can be maintained, archived and exchanged. For the most part this is achieved through the Australian Antarctic Data Centre, which hosts and maintains a Biodiversity Database (<http://data.aad.gov.au/aadc/biodiversity/>) that contains data on Antarctic and sub-Antarctic flora and fauna. The database started through EBA's predecessor, RiSCC, and is now EBA's main database, containing all of the collections of data that we are

aware of in the public domain (see <http://data.aad.gov.au/aadc/biodiversity/collections.cfm>).

EBA also relies on other databases that are coordinated by several of the individual projects and programmes that contribute to EBA, such as SCAR-MarBIN, MERGE, and the Southern Ocean Continuous Plankton Recorder Programme (SO-CPR). EBA has set up a portal within the Antarctic Master Directory, which allows access to metadata that contribute to EBA's aims. To view the portal – go to:

<http://gcmd.nasa.gov/KeywordSearch/Home.do?Portal=eba&MetadataType=0>

There is currently concern over the security of future funding for SCAR MarBIN, which has until now been largely received from Belgium, but will in future require funding from other sources. Failure of national operators to secure the future of SCAR MarBIN will have a considerable negative impact on the Antarctic marine biological research community.

#### **Future meetings with significant EBA input:**

1. Xth SCAR International Biology Symposium Sapporo, Japan 26 - 31 July 2009 – with 1 or 2 EBA dedicated workshops;
2. Sub-Antarctic Forum, Hobart, April 2009
3. MISA 4, Kuala Lumpur, April 2009
4. EBA-sponsored workshop, Italy: “Genomics, Proteomics and High Technologies in Polar Biology” 2009
5. SCAR OSC Buenos Aires, 2010.