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Guest editorial

Probing the depths

When scientists from HMS *Challenger* dredged animals from over 5km depth, they finally laid to rest the azoic hypothesis of Edward Forbes, that life could not exist in cold dark depths of the ocean, and thereby opened the doors to true deep-sea biology. The past decade has witnessed a further sea change in our view of marine diversity, if I may be permitted the pun, a change driven to a large extent by improved knowledge from Antarctica. For many years we viewed the tropics as the engines of diversity; species arose in warm clear seas, especially those associated with coral reefs, and spread slowly to populate the harsher high latitudes. Early studies of the isopod fauna had also suggested that at least some organisms living on the continental shelf of Antarctica may have originated in the deep sea. After a period of intense work, much of it under the auspices of the SCAR EASIZ (Ecology of the Antarctic Sea Ice Zone) and more recently the EVOLANTA (Evolution in Antarctica) programmes, we can now modify both hypotheses, with powerful implications for our understanding of global marine diversity. The marine invertebrate fauna of the Antarctic continental shelf is now better described than might be thought, and the total fauna may well exceed 17000 taxa. Interestingly, there are very few places in the world with comparable data, but we can say that the fauna has had a long history of evolution in situ and is not simply a last refuge for taxa that originated elsewhere

Basic systematic work may be unpopular with funding agencies, but without it we cannot make the broad generalisations needed by the community and demanded by politicians. Such work is particularly important in the deep sea, and it is in the deep waters around Antarctica that we are currently witnessing our most rapid growth of knowledge of marine diversity, primarily as a result of the ANDEEP cruises. The original idea that deep sea organisms are preadapted to Antarctic conditions has been upset by the recognition that conditions in the deep sea are largely dictated by high latitude oceanography. But the combination of traditional systematics with modern molecular techniques is indicating that some taxa have moved down from the shelf into deep water, as well as others moving the other way. Work from Antarctica is rewriting our view of the relationship between the faunas of the deep sea and the continental shelf.

One of the most important insights has been the recognition that many groups of organisms have radiated in Antarctica. The classic case is the notothenioid fish, so well recognised now that they are now a textbook example. Here the radiation was identified by traditional systematics techniques, but molecular tools have provided important support, in some cases changing the details, and allowed us to date the radiation, albeit imprecisely as yet. Similar techniques have identified other important radiations, including lipariid fish in deeper water, amphipods, isopods, pycnogonids and some groups of predatory gastropods.

We would like to be able to date these radiations from fossils, but here we are impeded by the relative paucity of suitable exposures, particularly at climatically important times in the Cenozoic. We do, however, have a rapidly developing picture of the tectonic context and associated climatic changes. This makes Antarctica a unique laboratory for setting evolutionary changes in their environmental context. The papers in this issue demonstrate that evolutionary studies are alive and well in Antarctic science. Work in the deep waters may be expensive and time-consuming, but without plumbing these depths we will miss vital clues to our global understanding of how life on earth evolved. Yet again Antarctica, remote but highly relevant, is providing key insights into fundamental processes.

ANDREW CLARKE

Note from the Editors

We would like to bring to your attention the following changes in the way the journal operates:

1. When submitting a new paper the authors **must** include an electronic version - a pdf is preferred but we will accept any commonly available package. Papers will not be processed without this elctronic version.

2. Wesites. A citation to websites should be inserted in an appropriate place in the text [e.g. SCAR 1993, http://www.nerc-bas.ac.uk/public/magic/add.html]. They are not listed in the Reference section as the longterm availability of the information has yet to be proven.

3. From the end of this year we will no longer be offering authors free offprints. Instead, we will send authors a print and proof quality pdf of the published paper. Authors still wishing to purchase hard copies of the paper will be able to do so if they are ordered in advance of publication.

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Introduction to the Meeting

I am very glad to be here as an old member of this community, thus having the chance of meeting once again with many colleagues and friends from all over the world.

The recent constitution by SCAR of the EVOLANTA Programme followed a rather unusually long procedure. Its development from the very beginning started in 1989, when SCAR sponsored a first meeting of an *ad hoc* international committee composed mainly of marine biologists and geneticists. The meeting was hosted by the Department of Biology in the University of Padua (Italy). The purpose was to explore the opportunity to launch a research project on the genetics of Antarctic marine organisms and its evolutionary implications. While, at the time of that first meeting, a significant amount of biological information was available for some species, the data at hand were sparse. More genetic information was badly needed in order to provide assistance in resolving problems as diverse as stock delimitation in fisheries, the molecular basis of adaptation to very low temperatures and rates of evolutionary divergence in the special conditions found in the area, such as those caused by the Antarctic Convergence. The opportunity was discussed that the information gathered in these studies should, of course, be integrated with that gathered y oceanographers, ecologists, physiologists, and others.

At the time of the first Padua meeting a significant evolutionary approach had already been started in the late 70s of the last century, but mainly developed during the 80s thanks to the possibility offered to many scientists to participate in expeditions and cruises to Antarctica. Moreover, research progress in the same period concerned the introduction of molecular techniques in Biochemistry and Physiology, thus providing the background for an explosive multiplication of this kind of studies.

The first meeting at Padua was followed by two workshops otganized by the University of Curitiba (Brazil), by others in Padua and in Kent (UK) and by less formal reunions on the occasion of SCAR Biology Symposia.

The interest in the broader topic, Adaptive Evolution, to be dealt with at the present Workshop, developed quite late in the Antarctic environment, despite the fact that the process of evolution provides the central, unifying concept in Biology. Although important studies in the past had been conducted on the basis of taxonomical, palaeontological and physiological investigations, other studies utilizing new conceptual and methodological tools were started only about twenty years ago. They concerned primarily aspects of physiological and biochemical adaptation but no approach was yet available for elucidating adaptive mechanisms in terms of population genetics. Such limitations were imposed by the difficulty of finding animal or plant species which could be reared and crossed in the laboratory. Moreover, this possibility was reduced because the great majority of Antarctic species live in the sea, an environment whose inhabitants are, or at least were, poorly suited for cross-breeding experiments.

The introduction of new techniques, such as genetic analysis based on allozyme electrophoresis, made it possible to fill the gap. Opportunities of this kind were increased through the development and utilization of the modern techniques of molecular biology.

In the meeting starting today, a number of contributions are centred on classic topics, as, for instance, abundance, diversity and community patterns; number of species in the Antarctic shelf; aspects of comparative morphology; speciation and dispersal of Antarctic species, with a focus on adaptive radiation of Notothenioid fishes; strategies of behaviour. But the bulk consists of some research developments of biochemistry, physiology and genetics, where the approach is mainly molecular. Interesting developments concern topics such as immunoglobulin at the gene and protein levels; the evolution of haemoglobins; protein metabolism and proteomic networks in cold adaptation; adaptive evolution in Ciliates, globin gene loss; biochemical composition of membranes

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in marine bacteria; molecular cytognetics.

An interesting and very modern topic to be included concerns the genomic approach to Antarctic marine organisms. This is nowadays of fundamental importance for biomedical research and is being increasingly applied to biology in general. This new approach allows the rapid study of thousands of genes and in biological research the genomic approach will allow investigation of how DNA sequence confers function. Comparison of sequences in species at different evolutionary levels will permit the elucidation of the physiological role of 'conserved sequences'. Moreover, quantitative evaluation of proteins at the cellular level will lead to the development of modern proteomics.

The year 2003 marked the fiftieth anniversary of the discovery of DNA structure and function, a critical development for progress in the field of life sciences. Many contributions in our meeting reflect, also in our field, the fundamental role played by this discovery.

As a whole, studies on evolutionary adaptations in Antarctica have to be conducted not simply in terms of life sciences but in the framework of an interdisciplinary approach. Some years ago a great oceanographer, George Deacon, stressed the opportunity of carrying on in Antarctic marine transition areas research involving more than a single discipline. This should be rewarding since, for instance, the interplay between physics and biology might help to solve several problems of great scientific relevance.A number of ecological, physical, geological, climatological factors, to mention only a few, play a fundamental joint role in governing 'Adaptive Evolution' and leading to its more obvious consequence, Biodiversity. The studies of Evolution in Antarctica will offer us great opportunities for many years to come.

Bruno Battaglia