

International Polar Year Proposal

EXPOSE: Exploration of polar seamounts (AD Rogers, British Antarctic Survey)

Introduction

EXPOSE is an exploratory project that aims to exploit the international nature of IPY to undertake, for the first time, a comprehensive assessment of the biodiversity and biology of seamounts in polar waters. Mountains on the land are well known for hosting endemic communities of plants and animals because of special environmental conditions and their isolation from other mountain ranges. The estimated 100,000 seamounts in the world's oceans¹ also represent an unusual variety of rare habitats and host a specialised and highly endemic fauna^{2,3}. It is also now recognised that seamounts play an important role in ocean biology as "oases" of life⁴. They exert a strong influence on physical oceanography and local productivity and are foci for feeding and reproduction of many species of cephalopods, fish, birds and cetaceans^{2,4}. However, because of the large concentrations of commercially valuable species associated with seamounts they are targeted by both trawl and long-line fisheries². These both impact target species and severely damage the rich communities of corals, sponges and other organisms that are found on seamounts⁵. Our knowledge of the biodiversity of seamount communities, at a global level, is extremely poor. However, given the high diversity and endemism of seamounts studied to date and the number of these features worldwide it is likely that they host a significant proportion of the world's marine biodiversity. Very few polar seamounts have been explored by scientists, though a number have been subject to commercial fishing. EXPOSE will make a major contribution to knowledge on polar biodiversity but it will also allow scientists to study patterns of species diversity and distribution on seamounts. This will provide, for the first time, a scientific basis for a global management strategy for seamounts and their biological communities.

Project hypotheses

1. Seamounts are host to faunas with a high level of endemism. The level of endemism is dependant on a variety of factors including distance to the continental shelf, size of the feature and its summit depth and the physical oceanographic setting in which the seamount lies.
2. The similarity of seamount faunas is correlated to the physical distance separating them so that seamounts occurring in a cluster or chain will have a similar diversity and species composition.
3. Seamounts exert a strong influence on the pelagic ecosystem around them and are significant at the regional scale for populations of large marine predators.
4. Seamounts are significant in evolutionary terms as centres for the origination of new species, as refugia from climatic perturbations, and as stepping stones for the dispersal of animals across ocean basins.

Methods and Approaches

IPY will be utilised to draw together an international team of marine biologists, geologists and oceanographers and palaeo-oceanographers to study seamounts in the polar regions. The aim will be to carry out interdisciplinary cruise campaigns that target seamounts (such as the De Gerlache, Balleny, Islas Orcadas Seamounts and those around the Scotia Arc) within different sectors of the Southern and Arctic Oceans and regional seas.

Biology: Biological studies will include both benthic and pelagic elements. Benthic sampling will by necessity be carried out using ROV technology as trawling or dredging generally has an extremely detrimental impact on the communities of animals living on the seabed. ROVs that maybe considered for use include the U.K. ISIS facility, Canadian ROPOS, U.S. JASON. Video transects and biological samples will be taken from target seamounts using ROVs. Baited traps will also be deployed to sample mobile scavengers. Physical measurements and observations will also be carried out using benthic landers and moorings. Pelagic studies will include acoustic surveys coupled with pelagic trawling using RMT or MOCNESS-type opening and closing nets. These will be carried out both over the seamounts and at successive distances away in order to quantify the extent of influence of these features on pelagic communities. Observations will also take place of seabirds and cetaceans throughout cruises and satellite tagging may also be used to determine whether major predators preferentially forage around seamounts. Conventional taxonomic approaches and genetic population and evolutionary studies will form a part of the EXPOSE programme.

Oceanography: CTD casts, moorings and undulating ocean recorders will be used to analyse the structure of the water column around seamounts. These will determine whether currents are enhanced around seamounts and in particular whether up-welling occurs associated with Taylor column formation (trapped eddy of water). Analysis of whether seamounts enhance productivity through up-welling of nutrient-rich waters will be carried out by chlorophyll measurements, remote sensing and other methods. Moorings may be used to gather long-term oceanographic data on current movements over seamounts, particle flux and other data.

Paleo-oceanography / Geology: Cores will be taken from sediments on seamounts where they occur in order to examine records of climate change in the vicinity of seamounts. This data will be useful for deriving a climatic history of the seamount itself and of the wider geographic region. Geological studies will be aimed at analysis of the origin of seamounts, their age and the influence of specific rock and sediment types on the biological communities of seamounts.

Outcomes

This study will produce a significant increase in our understanding of polar marine biodiversity and as such will make a valuable contribution to the Census of Marine Life Programme. More importantly it will also help to determine how biodiversity is distributed on seamounts. Conservation management approaches to these habitats will be markedly different if a single seamount hosts species not found anywhere else or if all the seamounts in a region host the same suite of species. This will feed in to current international efforts aimed at conserving seamount biodiversity (see recent papers arising from the 7th Conference of Parties for the Convention of Biodiversity). The multi-disciplinary nature of this study will allow a better quantification of the influence of seamounts on the physical and biological features of the water column and will enable modellers to assess the role, if any, that seamounts play in productivity and carbon cycling in the oceans. The evolutionary significance of seamounts will also be assessed through a multidisciplinary approach combining palaeo-oceanography, geology, taxonomy and molecular phylogenetics. High definition video and digital cameras on the ROVs will also provide a valuable public education tool through this project.

References

1. Wessel P (2001) *J. Geophys Res.* 106 (B9): 19431 – 19441. 2. Rogers AD (1994) *Adv. Mar. Biol.* 30: 305 – 350. 3. Richer de Forges et al. (2000) *Nature* 405: 944 – 947. 4. Worm et al. (2003) *Proc. Natl. Acad. Sci. USA* 100 (17): 9884 – 9888. Rogers AD (1999) *Int. Rev. Hydrobiol.* 84: 315 – 406.