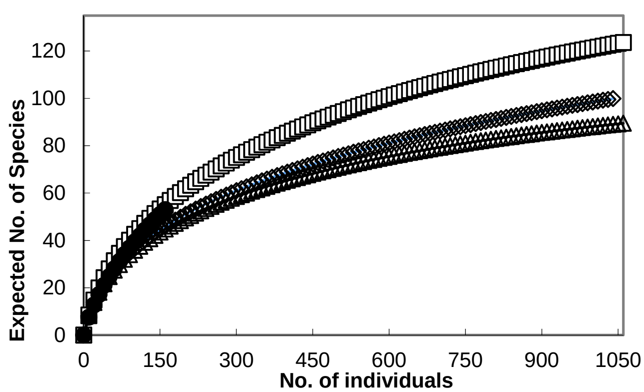
The Known Unknowns…

Gordon L J Paterson
Department of Life Sciences, Natural History Museum, London SW7 5BD, UK

Abstract

The deep sea remains our least explored and also our largest environment on the planet. Determining the environmental impact of mineral extraction depends on the information and data available. A considerable level of knowledge will be required to assess and manage sustainably exploitation of resources found in the deep sea. Yet there are fundamental gaps in our understanding of the deep-sea ecosystem; in particular our comprehension of the patterns of distribution of the organisms, which inhabit the various deep-sea habitats currently being explored as potential sites for mineral extraction. Understanding the biogeography of deep-sea biota, the spatial distribution of life, is an essential first step in assessing the risks that extraction will pose. Knowing the distribution of an organism is at the heart of assessing the likelihood that human activities will ultimately lead to its extinction.

Determining the patterns of distribution of the biota at various spatial scales, from local to area to region, requires that it is possible to be able to identify species accurately and consistently. A robust and accessible taxonomy is required. In the deep sea providing this has been, and remains, a challenge. The reasons for this are both scientific and cultural. Scientific, in that the deep-sea remains an under-explored area. The deep abyss is the largest habitat on the planet. The exploration phase of this ecosystem is still underway. New discoveries continue to be made. The species accumulation curves for most of the study areas show steep rises. We are far from identifying, let alone describing the hundreds, perhaps thousands, of species which are to be found in regions such as the Clarion Clipperton Fracture Zone.



Rarefaction curves for three sites in the CCFZ. Although the rate of accumulation is slowing it requires considerable sampling effort to achieve this

The cultural reasons stem from the way scientific research is undertaken. All projects are question driven. Funding focuses on producing targeted results addressing small and particular aspects of the system. Funding to undertake the basic taxonomic analyses is limited and as a result many of the species discovered are never formally classified. There is a taxonomic logjam, which now is threatening our ability to assess the risks to deep-sea fauna from mining.

Yet there is the opportunity to meet such challenges. The renewed focus on the CCFZ provides the impetus for the taxonomic community to become engaged in assessing the biodiversity patterns in areas of economic interest. Time is short so it is important that there is collaboration between all the parties, that the most appropriate technologies are being used and that there are efficient systems for the co-ordination and sharing of information. It is no longer enough that each contractor or research team works only toward their own aims.

Two examples provide background and reason for the need to undertake co-ordinated taxonomic and biogeographic research.
The first example is an analysis of what current data tell us about the distribution of macrofauna across the CCFZ. Three data sets, in this example polychaete worms, were available to assess biogeographic patterns both from an east to west direction and also from a south to north. In assessing the impact of mining, the key question is whether the impact will result in an irreversible change, in particular will there be the extinction of species. Species distributions fall into two basic patterns–nestedness and turnover. Nestedness suggests that the species in one area are a subset of the regional species pool. In an area such as the CCFZ, where there are know environmental gradients, it would mean that the fauna in one area is a subset of that found in another area. In effect species are widespread throughout the CCFZ and the risk of global extinction is low.
The alternative situation is where the fauna shows patterns of species turnover. In this situation the fauna changes at increasing distances across the region such that the fauna at one site may be very different to that of a site at the other end of the region. In this case understanding the spatial scale where the fauna turns over significantly is going to be critical. This is because the risk of extinction is greater when there is faunal turnover.
In the analyses, the presence and absence of polychaete species at various spatial scales across the CCFZ were assessed. The results indicated that while there were several species which occurred across the whole region, much of the rest of the fauna showed signs that it changed, turned over, at scales of 1000 kms. This means that the fauna at one end of the CCFZ is not the same as at the other. The risk of global extinction could be real.
However, there are a number of important caveats to these findings. The dataset is remarkably small; the number of samples, the spatial coverage and the taxonomic resolution are really insufficient. But these are all the data that are available. So collaborative effort is needed to increase the resolution.
The second example involves rarity, an emergent property of high diversity systems. Rare species are those with restricted distributions. These are the species most at risk from mining. But the issue in the abyssal ecosystem is whether such species are actually rare or whether they are undersampled. It has been argued that such species are so infrequent that they are irrelevant to the ecosystem. But research in other high diversity environments suggests that rare species do have important ecosystem function roles. To address this issue again needs collaboration and critically good taxonomy to be able to determine the actual distribution of such species.
A gap analyses of the CCFZ concentrates on whether currently there are the data and the taxonomic resources to try to address these biogeographic issues. An assessment was made by the EU MIDAS project of the adequacy of current levels of taxonomic resources, sampling and biogeographic data. Despite over 40 years of exploration significant gaps remain. There are few taxonomic works, keys or analyses for this region. Collections of specimens from current and previous programmes exist, but are scattered and there is little information available about them. Molecular data are limited and collecting genetic samples is not widespread. The results of exploration are not widely available, the data are not always comparable and there is not infrastructure in place to exchange and enhance the data being collected.
Time is running out and if the information needed is not provided soon then there is the very real danger that mineral extraction will cause irreversible damage and the loss of species. But there is the opportunity to harness the resources available and, by binging all the actors together, to target and provide resources to address the gaps in our knowledge.