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Viewpoint

On the relevance of meiobenthic research for policy-makers

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ABSTRACT

The need for scientific advice to manage the aquatic environment in an ecosystem context has never been greater. Many assessments of ecosystem state and change use inadequate data on non-conspicuous, non-target organisms. These include meiofauna, a diverse group of small-sized organisms (<1 mm) that live in a range of terrestrial and aquatic environments. Meiobenthic research published between 2007 and 2011 has failed to underpin ecosystem management and conservation practices. This is partly because of the belief amongst decision-makers and the public that microscopic organisms beyond our normal range of perception are ecologically unimportant. Methodological limitations related to the taxonomic identification of small-sized organisms and the narrow scope of many contemporary meiofauna studies are also to blame. This article explores ways in which meiobenthologists can improve the impact and uptake of their research.

1. Introduction

I begin this article with a statement from Sheppard (2006): "As marine scientists we need to increase our own emphasis and pressure on behalf of the majority of species which do not have any appeal whatsoever, which are not attractive and which, for the most part, are not even seen, yet which are crucial elements of our biosphere." Although this statement was made in the context of biodiversity science, it is highly applicable to meiobenthic research.

Meiofauna separates a discrete group of small-sized organisms (<1 mm) whose morphology, physiology and life history characteristics have evolved to exploit a range of terrestrial and aquatic environments. Meiofauna are most commonly encountered in sedimentary environments but they can also be found on hard substrates, living on algae or on sessile invertebrates (e.g. barnacles, mussel beds etc.). Some meiofauna species are ancestrally miniature and were most likely involved in the earliest stages of the diversification of metazoan life. Others have secondarily evolved miniature morphologies from macroscopic ancestors (Rundell and Leander, 2010). With most of the known animal phyla represented, this is phyletically the most diverse fauna on the planet, yet its diversity and biology are surprisingly understudied and poorly known relative to more familiar larger fauna. The continuous reproduction of meiofauna results in the constant presence of juvenile individuals, facilitating rapid colonisation of available habitat. Overall, this renders meiofauna less vulnerable to disturbances than larger fauna, where a disturbance event during the recruitment period might destroy the population until the next recruitment (Vanaverbeke et al., 2002).

Meiofauna assemblages have been widely used to determine the effects of both natural and man-induced perturbations in aquatic ecosystems (review by Coull and Chandler, 1992). The small size of meiofauna, coupled with their often high abundance and diversity allows intensive repeated sampling, with minor disruption to the sampling site because the sample size required is small. Their small size also makes meiofauna amenable to experimental manipulation (for recent examples see Braeckman et al., 2011; Brinke et al., 2011; review by Fleeger and Carman, 2011). Additionally, many of the more intensively studied meiofauna species (e.g. nematodes) have short life-cycles (1–3 months) and therefore offer potential for showing rapid responses to environmental change and experimental treatments (Warwick et al., 1988).

The meiofauna have an important role in the functioning of benthic ecosystem. They contribute significantly to the diet of many other animals (Gee, 1989; Coull, 1990) and facilitate mineralization of organic material (Coull, 1999; Riera and Hubas, 2003). Thus the state of meiofauna assemblages may reflect the overall health of the marine benthos (Kennedy and Jacoby, 1999; Schratzberger et al., 2000).

Over the past decade, there has been an increasing emphasis on the need for new scientific knowledge to inform policy and management decisions. Many studies focusing on environmental challenges point to the urgent need for improved understanding of the functioning of marine systems and to more effective communication of scientific findings to decision-makers and the public (Lubchenco, 1998). "Meiofauna are not impressively large or tasty, and they are not even dangerous–they are simply small". This perception, shared by many from the science, policy and public arenas

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alike, has been greatly affecting general concern for and interest in meiobenthic research (Giere, 2009). How successful are meiobenthologists as producers of scientific knowledge at making it accessible to the users of this knowledge, i.e. policy-makers and ultimately the public? The attempt to answer this question, at least in part, motivated me to write this viewpoint article.

I reflect briefly on the role of meiobenthic research in meeting the challenges created by a changing world. Much of what I write applies to research in general and meiobenthic research in particular. I then move on to illustrate how discrete pools of scientific knowledge of meiofauna can be potentially used to inform policy and, at the same time, contribute to the fundamental understanding of marine ecosystems. In doing so I use examples from peer-reviewed literature on aquatic meiofauna published between 2007 and 2011.

2. The changing world

Worldwide, there are increasing pressures on marine ecosystems. The growth of the human population and the growth of the amount of natural resources used are altering the environment in unprecedented ways (Lubchenco, 1998). Environmental and social changes challenge scientists to meet new scientific obligations and policy-makers to develop strategies to protect, conserve and manage the marine environment. Society requires more comprehensive information, understanding and technologies to move toward a more sustainable biosphere. For science these requirements translate into new fundamental and applied research, faster and more effective transmission of new and exciting knowledge to decision-makers and better communication of this knowledge to the public (Lubchenco, 1998).

Investment in science is, and has been, predicated upon the expectation of a return of knowledge and technology to society. Investment in science has brought benefits in the past and is expected to bring benefits in the future (Lubchenco, 1998), although direct benefits are often difficult to quantify (Macilwain, 2010). The expectations on science have not changed but the needs of society have. Until about 50 years ago, the physical sciences were the most influential in shaping public policy. Since then, however, the biological sciences have overtaken the physical sciences. Mounting public concerns over the quality of the environment have led to an increasing reliance on the biological sciences to uncover and solve environmental problems (Pouyat, 1999). The current and growing extent of human dominance on the planet will require new kinds of knowledge and applications from science; knowledge to reduce the rate at which we alter ecosystems, knowledge to understand ecosystems and how they interact with the numerous components of human-caused change and knowledge to manage ecosystems (Lubchenco, 1998).

For many habitats, we have a reasonably good conceptual knowledge of the way in which environmental characteristics influence the biota and a relatively good conceptual and semi-quantitative knowledge of the biological interactions. We have good models of disturbance and excellent quantitative analysis techniques which have increased our knowledge of temporal and spatial variability. Even in areas that benefit from a good knowledge base and scientific consensus, there sometimes seems to be a data overload but information paucity, meaning that scientific information collected is only partly relevant to address the current needs or that scientific knowledge has not been translated effectively into information, or both.

As Lawton (2007) pointed out, there is probably a faulty model in many of our minds of how science is translated into policy namely: firstly to identify a problem, secondly do science or review literature and finally formulate policy. Policy-making is an ongoing process. Although the details vary, it commonly entails an iterative cycle, involving not only science but also a shifting range of social, political, legal, cultural, economic and environmental concerns (Fig. 1).

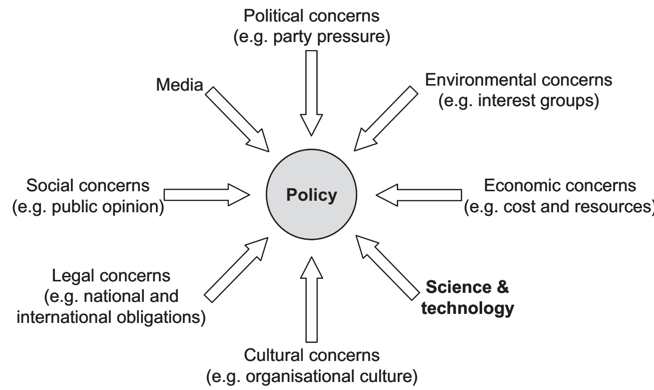

Fig. 1. Factors feeding into the policy-making process.

In order to be effective, those communicating science (e.g. scientists) need to be mindful of the crowded evidence and opinion space into which they are providing scientific information (Bielak et al., 2008). Decision-makers, on the other hand, need to maximize the quality of their evidence so that it can be asserted in a manner that will compete in the decision-making environment (Larcombe et al., 2008; Juntti et al., 2009).

3. Meiobenthic research: from dilemma to opportunity

How can we as scientists in general and meiobenthologists in particular ensure that our science does not get marginalized? First and foremost, our science needs to remain relevant to the major questions articulated by decision-makers. These generally revolve around significance: Why is the issue in question important? Are there legal directives that suggest that it must be considered? Increasing public attention generally elevates the importance to decision-makers, i.e. "(...) policy-makers listen more to the voters than to the scientists" (Choi et al., 2005). Varied perception of significance and/or importance is a crucial aspect to consider (Juntti et al., 2009). This is often related to the viewpoint i.e. that of a scientist versus an environmental manager versus the general public and this perception is confounded with scale. Being not visible to the naked human eye, meiofauna has very little resonance with the public and hence with decision-makers.

The scientific desire to fundamentally understand the system, including the bottom-up processes often conflicts with the policy-maker's concerns for the high level (top-down) responses, and hence their focus on the charismatic species such as birds, fishes and mammals (de Jonge et al., 2006). In the past, most marine environmental surveys paid little attention to the bottom-up processes even though the components with the largest material fluxes, including meiofauna, are at the bottom of marine food webs. Given the natural dynamics and the implicit requirements for many international directives (Table 1), however, bottom-up processes need to be included as part of assessing the status of marine ecosystems with a view to manage these in a holistic and sustainable manner (de Jonge et al., 2006). Over the next few decades, therefore, environmental management is likely to focus on the quality of both ecosystem structure and function (Borja et al., 2008) as well as physical and chemical conditions, including those resulting from human activities (Borja et al., 2011). This is particularly relevant when considering how best to manage the sustainable use of, and impacts on, the benthic habitat which