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Contribution to the Theme Section 'Marine biodiversity: current understanding and future research'

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Introduction

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ABSTRACT: Human activity extensively, and often irreversibly, alters marine biodiversity and ecosystems on a global scale. Notwithstanding a substantial research effort on the ecosystem consequences of altered biodiversity, it is vital that the marine community summarise and communicate its knowledge to policy makers. This Theme Section celebrates the establishment of the World Conference on Marine Biodiversity as a vehicle for integrating marine biodiversity science and co-ordinating future research efforts.

KEY WORDS: Biodiversity · Ecosystem functioning · Ecosystem processes · Macroecology · Spatial scale · Statistical partitioning

The status of global biodiversity fundamentally determines levels of ecosystem functioning and, ultimately, human well-being (see Naeem et al. 2009). Yet, the synergistic effects of multiple causes of biodiversity loss that is linked to human activities are causing serious threats to the functioning and viability of marine ecosystems (Halpern et al. 2008, Rockström et al. 2009). In Europe, the general consensus that marine systems are at significant risk led to the development of the Marine Biodiversity and Ecosystem Functioning Network of Excellence (MarBEF; www.marbef.org/) and the establishment of the first World Conference on Marine Biodiversity, held in Valencia, Spain during November 2008 (for reviews, see Webb 2009, Miloslavich & Klein 2009). At this meeting, a consensus on the current position of marine biodiversity research was agreed upon, based on contributions involving >1000 marine scientists and formulated as the Valencia Declaration (Box 1).

This Theme Section celebrates the establishment of this conference as the vehicle for integrating marine biodiversity science and co-ordinating future research efforts. It starts with contributions which document the spatial and temporal extent of particular species (de Voogd et al. 2009, Guidi-Guilvard et al. 2009, Danovaro et al. 2009), reminding us that little is known about the distribution of many species and highlighting the need for maintaining taxonomic expertise. Kochzius et al. (2009) uses comparative analyses of the genetic population structure of a starfish and its associated parasite in order to establish which evolutionary and ecological processes led to the realised distribution of these and other species across the Indo-Malay Archipelago. Next, Christie et al. (2009) use data compiled from a number of sources to examine the role of macrophytes as habitat for other fauna and highlight how the presence of some species are important for the persistence of others. The documentation of change in species distributions in existing (Blight et al. 2009) and future (Hawkins et al. 2009) environments is essential for understanding how climate change affects marine communities, as are experimental manipulations of model communities in the laboratory and field for establishing the importance of biodiversity for ecosystem functioning (Salo et al. 2009). These concepts are extended to account for the role of other components of natural systems that influence ecosystem properties: Godbold & Solan (2009) use statistical partitioning to distinguish the relative importance of biodiversity and environmental variables along a gradient of organic enrichment for an important ecosystem process, whilst Josefson (2009) uses similar methodology to examine how diversity and environmental parameters change across spatial scales that extend to the km level. Finally, Webb et al. (2009) introduce the use of a macroecological framework for understanding how local and regional scale processes interact and how species traits may influence large scale patterns in diversity.

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Box 1. The Valencia Declaration: a plea for the protection of marine biodiversity (MarBEF; www.marbef.org/worldconference/docs/The_Valencia_Declaration_20081115.pdf)

Recognising the fundamental importance of marine biodiversity to human well-being,

Concerned that the convergence of global environmental pressures pose critical threats to the sustainability of marine biodiversity in the oceans,

Acknowledging efforts by many agencies to give increased attention to marine biodiversity, but aware that the current pace of efforts to protect marine biodiversity is insufficient,

We, the community of scientists engaged in research relevant to marine biodiversity and ecosystem functioning and ocean management gathered in the City of Arts and Sciences of Valencia, Spain at the World Conference on Marine Biodiversity, November 2008 agree, on the basis of the overwhelming scientific evidence presented, that:

- Marine biodiversity and ecosystems are essential to the functioning of our biosphere and hence to human well-being.
- The pace and scale of anthropogenic changes occurring in the oceans and the impact of these changes on marine biodiversity and ecosystems are cause for grave concern.
- When effectively designed, managed and enforced, marine protected areas can deliver many ecological and socio-economic benefits as well as building the resilience of marine ecosystems in the face of increasing global pressures
- Emerging human activities, such as geo-engineering of the oceans to mitigate climate change, may deliver negative impacts to marine ecosystems.
- Research efforts to explore marine biodiversity and assess its status are insufficient, lagging well behind similar effort on terrestrial biodiversity.
- To be effective, networks of marine protected areas must be ecologically coherent and should be embedded in integrated ocean management frameworks that address the range of human activities and impacts both within and beyond the protected areas.
- Deep sea ecosystems differ significantly from coastal ones such that the dynamics of most deep-sea fish stocks are so fragile and slow to recover that they should be approached with an exceptionally high degree of precaution.

We urge that:

- Integrated ocean management be put in place covering human activities impacting on marine biodiversity and ecosystems both within and beyond national jurisdiction.
- Ecologically coherent networks of marine protected areas be developed at an urgent and accelerated pace based on existing scientific data and understanding.
- Participative management structures be developed, where they do not exist, engaging those involved in the exploitation of marine living resources with the goal of sustainable use of marine biodiversity.
- Research efforts to explore and better understand marine biodiversity be enhanced and promoted to provide the knowledge base necessary to underpin an adaptive management process.
- Mechanisms be established to enhance cooperation between scientists, governments and relevant organizations to identify and protect ecologically and biologically significant areas based on the scientific criteria adopted by the Parties to the Convention on Biological Diversity for the open ocean and deep seas.
- Deep-sea fisheries be authorised only where evidence has been gathered to conclusively demonstrate that a stock can be sustainably exploited in full compliance with FAO Technical Guidelines for deep-sea fishing in the high seas.
- The United Nations General Assembly builds on the Law of the Sea and the Convention of Biological Diversity to achieve an international governance regime for the effective stewardship of marine areas beyond national jurisdiction and the fair and equitable use of living resources for the benefit of human kind.

Looking to the future, it is clear that impending environmental problems, often of considerable magnitude and complexity, require a portfolio of information from a variety of disciplines (Benton et al. 2007). It is also essential, however, that the marine community communicates knowledge as it accrues, even when it is incomplete or the advice is uncertain (Solan et al. 2009). For a variety of cultural reasons (Raffaelli et al. 2005), discussions with policy makers and the public have been dominated by terrestrial ecologists; the influence of the marine scientific community on environmental policy is comparatively poor (Hendriks et al. 2006). A commitment to an intergovernmental science-policy platform on biodiversity and ecosystem services (http://ipbes.net/) is yet to be fully embraced by scientists and policymakers alike (Loreau et al. 2006, Mooney & Mace 2009), but such a consultation is necessary to ensure that efforts to sustain biodiversity do not continue to fall short of targets (Walpole et al. 2009) and that marine systems are appropriately protected. An immediate challenge for the marine community is to provide a policy-relevant consensus of opinion that is based on the latest portfolio of evidence, which recognises and incorporates levels of uncertainty. The 2nd World Conference on Marine Biodiversity (www.abdn.ac.uk/marine-biodiversity/), scheduled for September 2011, provides the next opportunity and platform to do so.

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