Round Table Session II

New methodologies and new integrated approaches for seagrass ecosystem research

Traditionally, research on Mediterranean seagrasses has been centered on specific aspects of plant biology (namely genetics, growth, phenology, physiology, and reproduction), meadow characteristics (e.g. spatial and bathymetric distribution, coverage and changes resulting from anthropogenic activities), and the ecology of associated biota. The results generated from such research have shown that Mediterranean seagrass meadows are highly productive and support a high diversity of associated species, some of which are of commercial importance. Therefore, as with other seagrass habitats in other parts of the world, Mediterranean seagrass meadows have high ecological and economic value, and efforts to conserve and manage them have increased in recent years. On the other hand, effective conservation and management depends on availability of knowledge at the 'ecosystem' level.

The ***new*** 'ecosystem' approach or BEF (biodiversity ecosystem function) approach requires integration of three domains: species-species interactions (the classic domain of community ecology), species interactions with the physical environment (the classic domain of ecosystem ecology) and evolutionary-ecological processes (the classic domain of population genetics combined with the emerging field of ecological genomics).

An understanding of BEF will require scaling up through several spatial scales, i.e., the quadrat and transect behind to some extent. In the case of Mediterranean seagrass habitat, information is lacking at both lower (micro) and upper (landscape) scales. For example, little is known on the ecology of a variety of small life forms (e.g. microbial and meiofauna) associated with Mediterranean seagrass meadows, while knowledge of seagrass landscape ecology for the region is lacking.

The role of genetics and ecological genomics will also open new doors in several important ways. First, describing population structure to include genetic and genotypic diversity (i.e., clonal diversity or lack thereof) at various spatial scales to understand population connectivity and small scale roles of sexual and asexual reproduction provides baseline information - a prerequisite to understanding population dynamics and to utilize scientific information to inform management for conservation and mitigation. Second, understanding genotype-phenotype interactions can be further addressed experimentally because of the easy of separating genotype x environment interactions through the use of clonal material. This modular, clonal feature of seagrasses opens up marvellous possibilities to assess function, performance and adaptation in the new integrated BEF context. Finally, understanding the genetic basis of adaptation is now on the horizon with ecogenomic approaches that utilize new classes of markers under selection for one or more "stress" factors, e.g., temperature, salinity, chemical defense; and genome scans/microarrays that are helping to unravel physiological control and response in nature. Some of the key question posed by Reusch (e.g.

Reusch & Hughes, 2006) and co-workers include: what is the effect of the aggregated genetic diversity among a collection of genotypes in an areas or population; does homozygosity retard resilience or translate to reduced population growth; and what is the genetic basis and population-level diversity of ecologically important traits?

Below are three highly recommended papers that highlight how BEF integration can actually take place:

McGill, B.J., Enquist, B.J., Ewiher, E. & Westoby, M. 2006. Rebuilding community ecology from functional traits. *Trends Ecol. Evol*. 21:178-185. [Linking community and ecosystem levels]

Duffy, J.E. 2006. Biodiversity and the functioning of seagrass ecosystems. *Mar. Ecol. Prog. Ser*. 311: 233-250. [issues around scaling up to the landscape and scaled down to the genotype, inference and evidence, testing principles related to diversity-stability]

Reusch T.B.H. & Hughes, A.R. 2006. The Emerging Role of Genetic Diversity for Ecosystem Functioning: Estuarine Macrophytes as Models. *Estuaries and Coasts* 29:170-175. [Genetics in an ecological, evolutionary and conservatin context]

This round table session aims to attract discussion on gaps in research on Mediterranean seagrass meadow in the new context of the new BEF at the ecosystem level, identify priority questions, identify specific methodologies and those researchers who know how to use them, and identify groups of researchers who can/could function as a team to address integrated questions.

Further notes:

Rethinking key questions about BEF that have been applied to terrestrial systems to seagrass systems (Duffy 2006 paper)
Scaling
High resolution GIS mapping combined with detailed current data
High resolution temperature loggers matched to satellite models

Developing a functional traits approach (McGill et al. 2006 paper)
Traits, e.g., basal metablois seed or egg size, nutrient concentrations and stochiometris, body mass, photosynthetic rated, leaf mass…
Environmental Gradients: why communities change in a systematic fashion across space.
Interactions milieu: frequency distributions
Performance currencies :

Developing an ecological genetics/genomics approach (Reusch & Hughes 2006 paper)
neutral marker surveys (e.g., microsatellites)
selective marker surveys (e.g., under development from genome and EST projects)
manipulative experiments (field and mesocosm) that manipulate species diversity and genetic diversity and environmental diversity in a factorial combination.

Some useful constructs to think about are show in the Table below. Most scientists work in one cell of the table. Think about ways that your own research could integrate horizontally and vertically.

	Top-Down is:	**Bottom-Up is:**	**Integration**
Evolutionary Biology	selection/genetic drift	genetic variation	speciation
Genetics/Genomics	the phenotype	the genotype	adaptation
Ecology	Grazing/predation/competition/ succession/maintenance of diversity	primary production, nutrient fluxes, food webs	BEF
seagrasses	life history, dispersal, demography		
all other organisms in the system			
Management			ecosystem level
Biodiversity	Ecosystem	genetic variation	all hierarchical levels