PANEL REPORT BY THE MODERATOR

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Our environment is exhibiting changes at an unprecedented rate. Some of these changes involve ecosystem shifts with serious consequences for ecosystems and society. It is thus imperative that we develop a series of indicators to detect significant changes that are easy to measure and representative across scales. This panel consisted of six presentations followed by a debate on multi-disciplinary, international programs and initiatives and on scientific tools to detect significant physical, hydrological and biological signals of climate change and ecosystem shifts.

Dov Rosen presented the CIESM/IOC MedGLOSS Programme, conceived to provide data on absolute and relative sea level change using an array of field stations. Between 2001 and 2006 sea level rise in the Mediterranean was about 4mm per year, and the projected sea level rise may be higher than previously thought, as suggested by new data on the fast melting of Arctic ice. Another program, MedAlert, will measure sea level on a series of stations along the North African shores. The main objective of this program will be to act as an early warning system for tsunamis: the Mediterranean has suffered 10% of the world's tsunamis since 1901, and 25% of tsunamis in recorded history. The new warning system will be of paramount importance for preparing local communities to such events.

Isabelle Taupier-Letage highlighted the importance of continuous measurements to further understand oceanographic features that occur at mesoscales, such as eddies. Mesoscale eddies form everywhere in the Mediterranean, and they have an important role in determining the productivity of open waters, which in turn influences the distribution of marine mammals, pelagic fishes and thus fisheries. The CIESM Programme TRANSMED aims at using ships of opportunity such as ferries to collect data on basic variables (e.g., temperature, salinity, rainfall) along regular routes. A pilot study conducted on two transects between Marseille and Algier, and Marseille and Tunis illustrated the scale of a mesoscale eddie north of Algeria. I. Taupier-Letage discussed the need for observation networks across the Mediterranean, including moorings, ships of opportunity, gliders, and Argos profilers. She emphasized the need for a closer interaction between oceanographers and meteorologists to provide more accurate predictions of changes.

Many ecologists are concerned with precision and carry out small scale studies, because detailed measurements at extensive spatial scales are often impractical. Since experimental ecology focuses mostly on the microscale and since satellites deal with macro-scales only, intermediate scales are often neglected. Ferdinando Boero presented some "macrodescriptors" that would act as warning signals at scales larger than most traditional scientific studies. These macrodescriptors are highly informative of the state of an ecosystem, and are detectable even by casual observers. For instance, most tourists are able to observe jellyfish or algal blooms. The value of these observations lies in numbers: single observations are considered anecdotes, but hundreds of consistent observations become reliable information. The macrodescriptors are aimed at macroscopic events such as ecosystem shifts, including the shifts from fish to jellyfish, algal forests to barrens, and temperate to tropical biota. Macrodescriptors include gelatinous plankton blooms, red tides, mucilages, seagrass leaves and shells washed on the shore, vertical distribution of gorgonians, sea urchin barrens, arrival of alien species, and disappearance of native species.

Enric Sala synthesized the dramatic shift that Mediterranean coastal marine ecosystems have suffered, and proposed a minimum set of indicators of human impacts. Major drivers of change of Mediterranean coastal ecosystems are overfishing and fishing down food webs, destruction of habitats, pollution, microbialisation of the water column, invasive species, and global warming. These stressors act in synergy and have homogenized and accelerated the turnover of the ecosystem. On rocky coasts, this means a shift from dominance of large vertebrates and native algal forests to impoverished fish assemblages dominated by planktivores and turf or barren benthic communities. The change has been general, across habitats, and is typically understood as a reversal of ecological succession that is associated with an increase of the turnover rate of the community. Ecological theory can be used to develop easy-to-measure indicators of human impact, such as proxies of the turnover rate. For example, on rocky coasts good indicators of impact and ecosystem health are total vertebrate biomass, and biomass of native algal canopy. Such indicators, however, cannot be applied in the south shore, where most of the coastline consists of soft-sediments.

The Mediterranean Sea now harbours more than 500 introduced species, many of which have become invasive. Bella Galil stressed the importance of using invasive species as a warning of global change. Alien species are more likely to occur in environments that are already degraded by human activities, and could thus be used as indicators of biological integrity. Global warming is an added factor that changes the conditions and probably facilitates invasions, hence the value of CIESM surveys of invasive species across the Mediterranean.

Adi Kellerman discussed the views and activities of ICES with regard to invasive species. He presented some examples from northern Europe where invasive species colonized substrates that had been historically occupied by native species, but vacant at the time of invasion. Many of these species were introduced through aquaculture. Initially, the economic benefits of aquaculture activities seemed to overweigh their environmental impacts, but quickly became conspicuous. A legislation is already in place to prevent accidental introductions, but the problem is the lack of enforcement. A. Kellerman stressed the need for better compliance and regulations, implementation of technical measures, and better science for risk and impact analysis.

After the presentations a lively discussion touched on several key issues associated with change of Mediterranean ecosystems, and on how to evaluate this fast change in relation to that which occurred through evolutionary times. Our expectations of what is natural become lower generation after generation. The lack of meaningful baseline information on the environmental status of the Mediterranean Sea before the start of modern marine science makes it difficult to assess the degree of human impacts. Indeed, some even discuss whether the loss of biodiversity is truly worrisome. However, the settlement of more than 500 alien species, the collapse of fisheries throughout the basin, and the dramatic ecosystem shifts are sufficiently clear signals of ecosystem degradation.

This discussion also reminded us how ineffective scientists typically are when it comes to communicating scientific findings to the public. While scientists discuss whether statistically significant differences represent ecologically significant changes, the public is left confused and remains ignorant of the change. More efforts are sought from scientists to improve transfer of knowledge and raise public awareness.