Climate change and marine biodiversity
Dr. Alan Deidun

How many times have we heard it before? The earth is warming up – there is compelling evidence to suggest that temperature increases over both land and sea in the Northern Hemisphere have been much higher in the last century than in the last 1000 years, with a 0.7 degree Centigrade increase in temperature in the last decade (from MarClim paper) In lockstep with all this, much has been mused over the impacts of climate change on man and his commodities, condensed, for example, in the celebrated Stern Report by the eponymous economist. Very little is however spared on the potential impacts of climate change on marine biodiversity, despite their being very little doubt as to man's negative legacy on the oceans. In fact, a map of man's impacts on the oceans was recently published (15th February) in the journal 'Science', showing that over 40% of the world's oceans are heavily affected by human activities and few if any areas remain untouched.

One of the major caveats in studies on marine biodiversity is the relative inaccessibility of the deep (deeper than 1000m, covering more than 60% of the planet's surface area) ocean floor. Despite the apparent detachment of deep ocean system, researchers have recently demonstrated that an extensive climate anomaly (a funny term used by climate change researchers to signify an abrupt change in temperature), which occurred in the Eastern Mediterranean, caused a significant deep-sea biodiversity change. These results indicate that temperature shifts of 0.05-0.10 °C in the deep sea are sufficient to induce significant changes in species richness and that deep-sea fauna is highly vulnerable to environmental alteration. Climate change is also increasing the frequency of that phenomenon known as El Nino (the little one, as dubbed by Spanish-speaking fishermen off the Peruvian coast, due to its occurrence around Christmas time) which wreaks havoc with ocean temperatures and fish abundances. Bottom line: nowhere is far away to escape the predicament of climate change!

The impacts of climate change on marine biodiversity could be two-fold: direct or indirect. Direct mortality is rare, but mass mortality events, mainly involving corals, gorgonians and other stenoecious (narrow-range, fussy) species, have been documented in recent years, most notably in the north-west Mediterranean Sea following the 1999 and 2003 summer climate anomalies. In view of their high sensitivity, long life span and slow growth, gorgonians are frequently deployed as marine climate change indicators. An increase in surface sea temperatures could also facilitate the spread of certain pathologies in marine biota – e.g. morbiliviruses in monk seals.

One of the less trumpeted implications of climate change is the disruption of the Thermohaline Circulation. This is like a large conveyor belt at the bottom of our seas, which conveys bottom, cold, dense water from the poles to the tropics, and surface, warm, less dense water from the tropics to the poles, thus effectively circulating nutrients, heat and oxygen throughout the oceans and conditioning several different regional climatic regimes (e.g. the Gulf Stream, which skirts the UK). By wreaking havoc on such a circulation system, climate change would also effectively disrupt planktonic populations, which are the basis of most ocean food chains, and which would also trigger cascade effects, such a reduction in ocean productivity and in some fish populations. Upwelling (i.e. the rise to the surface of deep, nutrient-rich currents) events, of paramount importance to regional fisheries (e.g. anchovies off the western coast of South America) could also be disrupted. It might sound like an oxymoron by the melting of the

Greenland ice mass and the resulting freshwater input into the North Atlantic might cause the Gulf Stream to stutter and usher in an Ice Age for Europe – this happened already in the past with the melting of the North American glaciers.

Yet other unsavoury aspects of climate change could be an increased incidence of storminess (which in turn ravages marine biotopes such as coral reefs). possibility of hurricanes in the Med'n (e.g. Hurricane Vince was the first to make landfall in Spain, after forming off Madeira Islands, in 2005. Coastal areas are also under the Damocles sword of an increase in sea level, with a projected 30% loss in the global extent of coastal wetlands. You may not draw immediately the connection but tigers are also facing a decline in their already bedraggled habitat extent due to sea level rise, especially in areas such as Bangladesh, whilst turtles face the sobering prospects of not having a beach to return to lay their eggs.

Higher sea temperatures also facilitates the spread of alien species. According to the EEA (European Environmental Agency), the Mediterranean Sea is the regional sea with the highest percentage of 'alien' (i.e. non-indigenous) marine species – the current 'tropicalisation' (warming) of the Mediterranean Sea would facilitate the influx of and colonisation by marine species typical of warmer seas, such as Lessepsian migrants. Lessepsian migrants (so named after Ferdinand de Lesseps, the French engineer instrumental in the development of the Suez Canal), are mainly of East African or of Indian Ocean origin, which are finding the eastern Mediterranean much more congenial due to warmer temperatures. Hence, such an immigration into the Mediterranean could provide some hindsight to other geographical areas as to the outcome of the warming of our seas. Over 600 alien marine species have been reported so far from the Mediterranean (not all of which are Lessepsian migrants), the majority of which are molluscs. A notable example of a Lessepsian migrant recorded even locally includes the virulent green alga *Caulerpa racemosa*. Streftaris and Zenetos (Mediterranean Marine Science – 2006) compiled an intriguing list, also found online (see 'Further Reading') – the 100 most invasive marine species found in the Mediterranean Sea.

The term 'mucilage' conveys panic to tourist operators along the Adriatic coastline in Italy and Croatia, for its depreciating effect on bathing water quality, although the substance is produced for legitimate purposes. In fact, mucilage (a slimy substance) is secreted by phytoplankton in response to higher temperatures, as a buttress against increased water loss – hence, increased sea temperatures might lead to an increase in the incidence of mucilage events, which have significant ecological impacts too, besides rendering our seas unfit for bathing, especially on filter-feeders (may clog their siphons), on sea fans (might lead to entanglement) and on sessile organisms (might lead to smothering) when accumulations of mucilage fall to the sea bottom.

Burgeoning atmospheric carbon dioxide levels also result in an acidification of the oceans upon dissolution. In fact, it is predicted that, by 2050, the oceans will be more acidic than they were in the last 20 million years. Corals, calcareous phytoplankton, mussels, snails, sea urchins and other marine organisms use calcium and carbonate in seawater to construct their calcium carbonate shells or skeletons. As the pH decreases, carbonate becomes less available, which makes it more difficult for organisms to secrete calcium carbonate to form their skeletal material. For animals in general, including invertebrates and some fish, carbon dioxide accumulation and lowered pH may result in acidosis, or a

build up of carbonic acid in the organism's body fluids. In addition, coral reefs face greater prospects of erosion.

As rightly highlighted some months back by Prof. Serracino Inglott, lower lampuki catches were reported this year, as well as an anomalous presence of swordfish in the northern Mediterranean, allegedly as a result of higher sea temperatures. In fact, one of the best-documented consequences of climate change is a change in the distribution of native species (meridionalisation – 'meridione' is the 'north' in Italian, with poleward advances of southern (warm-water) species and retreat of northern species - e.g. the colourful fish species *Thalassoma pavo* (ornate or peacock wrasse – 'lhudi') has recently witnessed a population boom in the western Mediterranean, where it previously was not that abundant. Some parrotfish species are also finding the Mediterranean Sea more amenable, as are other countless species being encountered for the first time by our hapless fishermen. You might dispel these concerns as simple colourful additions to our fish list – however, the actual ecological implications of such invasions are yet to be assessed. Analogies from terrestrial invasions/introductions (e.g. the Cape Sorrel) are there for all to see. The unalienable truth is that there are no refuges in the Mediterranean for cold-water species, which, have either to seek greater depths (analogous to migrating to higher latitudes) or leaving the Mediterranean altogether.

It's time to act – the seas have a story to tell, if we are keen enough to listen. The Mediterranean Sea harbours an estimated 10,000 macroscopic marine species (8-14% of world's total), although occupying just 0.82% of the global ocean surface area and 0.32% of the global ocean volume, with 25% of these species being restricted to the Mediterranean Sea. It's hard not to heed the call to protect such a jewel.

Further reading

- CIESM (International Commission for the Scientific Exploration of the Mediterranean Sea) - http://www.ciesm.org/
- UNEP/WCMC (United Nations Environmental Programme/World Conservation Monitoring Centre) – http://www.unep-wcmc.org/
- EEA (European Environmental Agency) – http://www.eea.europa.eu/
- WWF (Worldwide Fund for Nature) – http://www.panda.org/
- IUCN (The World Conservation Union) – http://cms.iucn.org/
- The Ocean Acidification Network - http://www.ocean-acidification.net/
- IPCC (Inter-Governmental Panel on Climate Change) - http://www.ipcc.ch/
- Worst 100 invasions of the Mediterranean Sea - http://elnais.ath.hcmr.gr/PDF/Streftaris%20Zenetos%20worst%20IAS.pdf

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