

## Malta's other seaborne migrants



*Selene dorsalis* (African moonfish), one of the many newcomers to the Mediterranean, was first recorded in Maltese waters in 2008.

"Don't forget the sea" was the strident call of Carl Gustaf Lundin, head of International Union for Conservation of Nature's global marine programme, in the frantic run-up to the botched Copenhagen climate talks. His *cri du coeur* went largely unnoticed as the plight of the arctic, glaciers, and drought-stricken regions dominated the conference proceedings and media reports.

Malta's territorial waters are nearly 20 times its land area, so it has a vested interest in clamouring for the climate change talks to focus more on the plight of the sea. A progressive surge in sea temperature and salinity in the Mediterranean has been recorded by various studies in recent years.

For example, a 2006 report by Millot et al showed that since the mid-1990s, the Mediterranean outflow through the Straits of Gibraltar into the Atlantic has been continuously changing; temperature and salinity there have been increasing. In the early part of this decade, it was actually much warmer (0.30°C) and saltier (0.06psu) than 20 years ago. Similar surges have been recorded by other researchers in various parts of the Mediterranean, including the Tyrrhenian Sea and the Sicily Channel.

These related studies have been conducted within the ambit of the hydrochanges programme, conducted since 2002 by the Mediterranean Science Commission (CIESM). It aims to take long-term, continuous measurements of temperature and salinity in the depths of the Mediterranean Sea in key areas, such as straits and channels.

Moorings are set in place close to the seabed at depths ranging from 300 to 2,500 metres, for periods of between one to two years, in between which they are recovered to be maintained, calibrated and re-deployed. These moorings are silent observers of the changing nature of the deep areas of the Mediterranean, areas far removed from the media and the public's glare.

Some of the implications of the warming sea on marine species are relatively easy to monitor and quantify - one such example is the mass mortality of gorgonians populations (e.g. *Paramuricea clavata*) along the coasts of Liguria, Italy, and Provence, France, due to temperature anomalies in the summers of 1999 and 2003. Other impacts on marine biodiversity, such as shifts in distributions of species, are more subtle and therefore more difficult to track.

'Meridionalisation' is the term used to describe the northward or southward migration of indigenous species in the northern or southern hemispheres respectively, due to climate change. In the Mediterranean, the eastern basin is significantly warmer and saltier than the western basin. As a result, meridionalisation can also involve the westward expansion of species that usually prefer warmer temperatures (thermophilic), in the eastern basin.

Examples of fish species that are expanding westward in the Mediterranean include *Thalassamo pavo* (Peacock wrasse), *Epinephelus marginatus* (Dusky grouper, whose numbers have been steadily increasing in coastal areas of the northwestern Mediterranean), *Lobotes surinamensis* (Atlantic tripletail, whose juveniles were first recorded in coastal waters in the central Mediterranean in 2009), and the barracuda (*Sphyrna viridensis*).

Similarly, native thermophilic species usually restricted to the southern, warmer areas of the Mediterranean are now moving northwards, with over 30 native species already spread in the northern areas of the basin. CIESM's Tropical Signals programme seeks to identify species which could act as early warning signals of the progressive warming of the basin.

The warming of the Mediterranean is also leading to a constant revision of inventories of marine species found in this sea as a result of the ushering in of exotic (non-indigenous) species from the Red Sea, mainly of tropical Erythrean (East African) and Indo-Pacific origin. Such migrants are aptly called Lessepsian migrants, as tribute to the French diplomat Ferdinand de Lesseps, who steered the signing of the agreement that led to the development of the Suez Canal.

The opening of the canal (which handles about six per cent of global maritime traffic, equivalent to almost 20,000 large vessels per year) in 1869 has provided us with a snapshot of the ramifications of the warming sea by providing a corridor and paving the way for the tropical migrants to enter the warmer Mediterranean. German professors visiting the area in the late 19th century commented on the marked dissimilarity between marine species on both sides of the canal - the warming of the Mediterranean is bridging such a divide, and the impacts of this are mostly unknown, as yet.

The first record of a Lessepsian fish migrant dates back to 1902; nowadays, the count of such species has surpassed the 100 mark, or almost 15 per cent of all fish species in the Mediterranean. The total number of Lessepsian migrants to date hovers around the 750 mark, with over 50 being recorded so far in Maltese waters. The influx is significant indeed.

A small number of Lessepsian migrants are regularly sold in fish markets and restaurants in eastern Mediterranean countries. For example, the Erythrean conch (*Strombus persicus*) is offered in restaurants in Israel, and the Erythrean pearl oyster is regularly sold in Beirut.

From the earliest stages, the Suez Canal Company sought to exploit the biota in the canal, and hired A. Gruvel, a fisheries expert who was familiar with the Levantine fisheries, as chef de mission to identify possible commercially advantageous products.

However, other Lessepsians wreak havoc. Alien nomadic jellyfish species have shown up along eastern Mediterranean coastlines every summer since the mid-1980s, forming large swarms that erode the touristic value of the coastal areas and clog fishing nets. In 2001, the Israel Electric company was forced to remove tons of biomass of voracious exotic jellyfish from its seawater intake pipes, at an estimated cost of USD50,000.

Changes in the life cycle of selected Mediterranean marine species have also been interpreted as early warning signals of this regional sea. In particular, flowering and fruiting of the endemic seagrass species *Posidonia oceanica*, previously considered as an extremely rare and unpredictable event, has occurred more frequently in recent years. There appears to be a direct link between the occurrence and intensity of *Posidonia* flowering and the annual maximum surface temperature of the Mediterranean Sea. In addition, the high sea temperature anomaly in the summer of 2003 coincided with a massive *Posidonia* flowering event in both the western and the eastern basins.

Rising sea levels could eliminate already scarce haul-out sites of the Mediterranean monk seal (*Monachus monachus*) (bumerin in Maltese), especially by the flooding of caves that provide refuge for some groups. The species may be particularly vulnerable as it is reliant on a small number of caves or narrow beaches for breeding, and these could easily be destroyed or rendered unusable by rising sea levels and increased storm frequency.

In addition, in the past two decades, there has been an apparent increase in large-scale mortality events, such as morbillivirus infections, which caused massive die-offs of striped dolphins in the Mediterranean and seals in Europe, although the actual causes are not fully understood.

According to some studies, the ocean has captured between 28 and 34 per cent of the anthropogenic carbon dioxide emitted into the atmosphere between 1980 and 1994, leading to a reduction of about 0.1 pH units in ocean surface waters compared with pre-industrial times. A further decline by 0.3 to 0.5 pH units is expected by 2100. Ocean acidification is seen as posing a major threat for marine organisms, particularly shell-forming and calcifying organisms, with bivalves being the most vulnerable to changes in ambient pH.

A brief delving in the past is eye-opening. In 1935, researcher F. S. Bodenheimer had said "it is almost certain that the Indo-Pacific influx is still under way and it will be most interesting to study this process". It seems that while our appreciation of changes in our seas has waned significantly over the decades, the changes have increased greatly.