INVADERS

HUMANS PLAYING GOD IN THE MEDITERRANEAN

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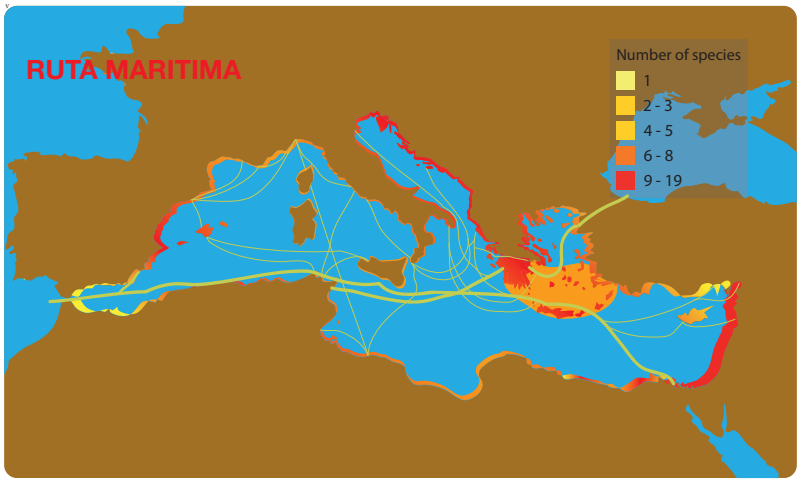
The Mediterranean Sea

is one of the seas of the world most affected by biological invasions in terms of how long the invaders have been present, in number of alien species detected and in the unprecedented rate of introductions. Triggered by warming waters and a newly improved route through the Suez Canal, tropical and subtropical marine species, some of them very invasive, have progressively moved into the Mediterranean, disrupting ecosystem stability of the basin.

What is an invasive alien species?

A number of definitions have been applied to describe the term Invasive Alien Species (IAS); basically the term invasive is associated with stablished species which are agents of change and threaten native biological diversity, or with species that threaten the diversity or abundance of native species, the ecological stability of infested ecosystems, economic activities dependent on these ecosystems and/or human health.

When colonizing new ecosystems, invasive alien species often owe their success to certain characteristics that make them more difficult to control and contain. These characteristics include the ability to thrive in different environments and tolerate a wide range of environmental conditions, high rates of growth and reproduction, lack of natural predators and the ability to exploit a wide variety of food sources.



Modified from Katsanevakis *et al.*, 2014

Adverse impacts

The extent of the impact has been so severe that invasive species are regarded as the second biggest cause of biodiversity loss after habitat destruction, constituting one of the four greatest threats to the world's oceans on local, regional and global scale, and although ameliorative action can be taken and their effects can be reversed, their impact is more often irreversible.

The introduction of invasive alien species is a major threat to ecosystem biodiversity, structure and function. They may displace native species, reduce community biodiversity, change species composition and abundance across habitats, modify habitat structure and produce cascading effects or trophic web shifts that could result in major negative impacts on the ecosystem. Marine invasions can also have economic and human health implications. Scientific research has only just started to glimpse the extent of some of these impacts in the Mediterranean and, for most of these introductions, the effects are completely unknown.

Rhopalema nomadica
www.segan.com

European Union Laws

The European Union is aware of the problem of invasive alien species in the Mediterranean Sea. On January 1st in 2015, came into force in the European Union the "Regulation on the prevention and management of the introduction and spread of invasive alien species".

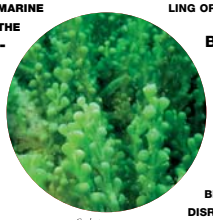
- Only species introduced by human intervention will be regarded as Invasive Alien Species.
- "The Union list" will include all the IAS that are able to or currently causing considerable damage.
- Centralized information system and coordination among the member States.
- Prevention in preferable: stablish monitory systems for early detection and controls to prevent intentional and unintentional introduction.
- Stablished IAS: eradicate the population as soon as possible, when there are still very few specimens.
- Widely propagated IAS: effective management measures, always proportional to the impact on the environment and after an analysis of costs and benefits. Will to repair the damaged ecosystem.
- Member States have to impose sanctions and ensure that they are implemented, according to the principle "Polluter pays".
- Any measure will not be taken only if it is technically non feasible, it involves a disproportionate cost compared to the benefits, or have negative effects on human health, the environment or other species.

How do alien species get into the Mediterranean Sea?

The Suez Canal

The Suez Canal has contributed to the greater number of alien species established successfully in the Mediterranean Sea in terms of magnitude, frequency and duration of the transfer. For decades, the continued migration of marine species through the Suez Canal has helped explain the richness of exotic species from the Red Sea in the eastern Mediterranean, particularly in the eastern area.

A total of 420 species have been introduced in the Mediterranean Sea through the Suez Canal. Its distribution shows a characteristic pattern of high species richness in the south-eastern Levantine Sea, which declines westward along the basin.



Caulerpa racemosa
www.seaguardmt.com

Siganus luridus
www.seaguardmt.com

The Suez Canal Authority is currently evaluating a new proposal to increase the depth of the channel or double its width in order to attract supertankers. A channel with greater width and depth would increase the passage of seawater into the Mediterranean and thus enable the migration of more species from the Red Sea.

Shipping - Ballast Water

Shipping has been implicated in the dispersal of numerous neritic organisms, from micro-organisms and macrophytes to fish. Ships can transport alien species in ballast water, as hull fouling or as solid ballast.

Ballast is usually taken into dedicated ballast tanks or into empty cargo holds when offloading cargo, and is discharged when loading cargo or bunkering (fuelling). Ballast water therefore consists mostly of port or near-port waters that can contain many viable alien organisms even after long voyages. After these organisms are flushed into a new port environment, some of them may begin to crowd out native species and disrupt local ecosystems.

Arcuatula senhousia
www.issg.org

Shipping, through ballast waters and hull-fouling, was the most probable pathway for the introduction of 308 species. Hotspots areas include the main ports in the Mediterranean Sea. Also the growth of marinas in many Mediterranean coastal areas in recent years could be providing a platform for the spread of IAS as these sites are closely associated with the movements of vessels (fishing or recreational boats or commercial ships) carrying alien species as hull fouling.

Mariculture

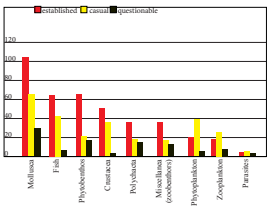
The increasing market-driven demands for exotic fish and shellfish and the decline in wild fisheries have created a surge of marine aquaculture (mariculture) along the shores of the Mediterranean in the last 30 years. Production of shellfish has increased exponentially, and two commercially important shellfish, the American oyster Crassostrea gigas and the Manila clam Ruditapes philippinarum, were intentionally introduced into the Mediterranean for this purpose in the 1960s and 1970s, respectively.

Ostrea patagonica
www.ceab.csic.es

Unrestricted transport of commercially important alien oysters has also resulted in numerous unintentional introductions of pathogens, parasites and pest species. Oyster farms have served as gateways into Mediterranean coastal waters for other associated species as well as several non-native algae. A total, of 64 species have been introduced in the Mediterranean Sea through aquaculture. Two main hotspot areas have been identified, the Thau lagoon (Gulf of Lion, France), and the Venice lagoon (northern Adriatic, Italy).

QUANTIFICATION

More than 5% of marine species in the Mediterranean are now considered non-native. According to the latest revisions to the regional level, 13.5% of these species are classified as invasive, being macrophytes (macroalgae and seagrass) the dominant group in the western Mediterranean and the Adriatic Sea, and polychaete, crustaceans, molluscs and fish in the eastern and central Mediterranean. The vast majority of exotic species appear in the eastern Mediterranean (Lessepsian species); some are exclusively on the southeast basin, others are restricted to the eastern basin, while others have colonized the whole Mediterranean. Mollusca are the most stablished group, followed by fish (especially Lessepsian fishes), phytobentos (including algae and rooted plants) and crustacean.



Modified from Zenetos *et al.*, 2005

Conclusions

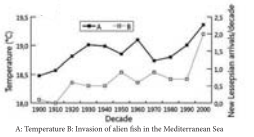
Scientists agree that invasive alien species represent a serious problem for the welfare of the marine ecosystem of the Mediterranean Sea. It has been proven that many of them arrived by man-made pathmways. In addition climate change also aggravates this situation by changing the environment. Moreover the number of alien biota appears to be underestimated, due to the limited funds.

It is important to detect invasions in their early stages, before the eradication is expensive, difficult or impossible. That is why watching the pathways and new management methods are indispensable, so is constanst surveillance and monitoring. It is also necessary to increase human resources, not only by professionals. But by volunteers who report the sighting of specimens, that can help the scientist find hotspots and creat a database, and also dispersion patterns of IAS.

For this purpose, we can implement awareness campaigns and identification guides to make a joint collaboration between authorities, researchers and citizens.

Why is the Mediterranean Sea such a favourable environment?

Climate change will have significant impacts on the structure of marine communities and provide further opportunities for alien species to spread and out-compete native species. According to scientific projections to date, coastal sea temperatures are expected to increase by at least 1-2.5 ºC by the end of the 21st century over the whole basin of the Mediterranean Sea. As the majority of alien species in the Mediterranean are thermophilic that originated in tropical seas of the Indo-Pacific, warming sea temperatures will favour the introduction of more Red Sea species into the south-eastern Mediterranean and their rapid spread northwards and westwards. Similarly, it will also assist the spread of species of tropical Atlantic origin into the western basin.



A: Temperature B: Invasion of alien fish in the Mediterranean Sea
from Ben Rais Lasram and Mouillot, 2009

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