

# PATTERNS OF BIOINVASION IN THE MEDITERRANEAN SEA – MANAGEMENT AND MISMANAGEMENT

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## Abstract

The synthesis of data on Mediterranean alien species' native region, human-mediated transfer mechanisms and spatial and temporal occurrence, generate "apparent patterns" of invasion: (a) most species have been introduced through the Suez Canal; (b) most species occur in the Levant; (c) their native region and vector differ greatly among basins; (d) more rapid and extensive geographical spread in the past two decades; (f) apparent rate of invasion corresponds to shifts in vectors, alterations of recipient regions, and sporadicity of research efforts. Climate change is a significant factor. The challenges for environmental management are discussed.

**Keywords:** *Alien species, Global Change, Suez Canal*

Six hundred-and-twenty metazoan species are recorded as alien in the Mediterranean Sea [1]. All are littoral and sublittoral benthic or demersal species (or their parasites). Their native range is most commonly the Indo-Pacific Ocean, Indian Ocean, and the Red Sea. The majority entered through the Suez Canal (54%), with additional 10% primarily introduced through the Canal and then transported by vessels. The means of introduction differ greatly among the phyla and among basins. The numbers of alien species which have been recorded in the Mediterranean each decade over the past century have increased in recent decades. The figure reflects political crises, economic development and scientific interest in recording marine alien species. The inventory of the alien species in the Mediterranean provides us with data that allows examination of the efficacy of regulatory instruments and environmental management options either in place or soon to be. Due to the high permeability of aquaculture facilities, transport and transplantation of farmed alien species in the 1970s and 1980s markedly increased the number of intentionally and unintentionally introduced species. The impact of the voluntary guidelines, the restriction of importation due to self-sustaining spat production and the realization by the industry that the imported species may arrive with their complement of parasites and pathogens, led to institution of "zoosanitary precautions" that have already contributed to a reduction in the numbers of mariculture-associated alien species. Still, segments of the industry resort to illegal importations: a bilaterally ablated female banana prawn, *Fenneropenaeus merguensis*, was collected in the Bay of Iskenderun, Turkey, in late 2006 [2]. Because eyestalk ablation is commonly used in aquaculture to induce maturation of gonads, there is no doubt that specimen escaped or was released from a nearby aquaculture facility. However, neither the Turkish authorities nor FAO have been aware of the importation of that species. A great number of alien species in the Mediterranean Sea have been vessel-introduced and vessel-dispersed. The International Maritime Organization (IMO) sponsored an international instrument to regulate ballast water management which was adopted by a Diplomatic Conference in 2004, but only 20 contracting states have signed on ([www.imo.org](http://www.imo.org)). Assuming that the Convention will be ratified and implemented, the number of ballast-transported aliens may be reduced. However, hull fouling, long acknowledged as a dominant vector of transport of alien biota, may soon be on the increase as a result of the implementation of another IMO Convention: the International Convention on the Control of Harmful Anti-Fouling Systems on Ships, which calls for a global prohibition on the application of organotin compounds, entered into force in 2008 ([www.imo.org](http://www.imo.org)). Alternative ship coating recently introduced as a substitute to TBT based antifouling paints may not be as effective, possibly resulting in more species being transported, and the number of introductions by hull fouling may increase significantly [3]. The increasing role of the Mediterranean as a hub of international commercial shipping has been reflected in the growing number of vessel-introduced aliens in the past 20 years. Unless ballast- and hull transport are strictly controlled, shipping-mediated introductions of alien species are set to increase. Climate change and biological invasions are key drivers affecting biodiversity, yet their impacts are rarely considered in tandem. As Erythrean aliens make their way northwards and westwards across the Mediterranean Sea, the most invasive of the lot attract attention for their realized or potential impacts on the native biota, or as health hazards. The result of the ongoing climate change is an increasing discrepancy between the requirements of native species and altered environmental conditions. In climate-facilitated invasions, the occurrence of alien species depends on change in the receiving environment that drives native species to become increasingly ill adapted to the local environment, whereas the aliens are better adapted to the new conditions. The Erythrean aliens are thermophilic species and it is likely that the rising sea-water temperature favour their colonization, reproduction, growth, persistence and

spread, and provide them with a distinct advantage over native temperate Mediterranean taxa. Their presence alters population dynamics of native biota, the structure and composition of communities and functioning of ecosystems. However, no implicit or explicit management strategies has yet been discussed to curb the influx of Erythrean aliens that impact the already teetering fisheries, mariculture, and tourism through proliferation of alien parasitic, noxious and poisonous species, displacement of commercially-important native species. The changes in biodiversity patterns in the Mediterranean are linked to climate change and invasive species, as well as to the well-established drivers of habitat change, overexploitation and pollution, and pose complex challenges for the maintenance of biodiversity and ecosystem function. Thus far, we have failed to assess the cost of environmental damage, and ignored the depletion of resources, environmental degradation and health impacts caused by alien invasion. There is a need for better Mediterranean marine governance. The EU recently introduced the Marine Strategy Framework Directive (MSFD, EU Commission 2008), which aims at achieving good environmental status in European Waters. The peri-Mediterranean countries need to develop their own optimal marine management capacity to avoid irreversible negative outcomes. While researching, defining and agreeing on management strategies and governance by the diverse communities of scientists, stakeholders and policymakers have barely begun, native and alien communities re-assemble and establish under a new climate regime in the Mediterranean Sea.

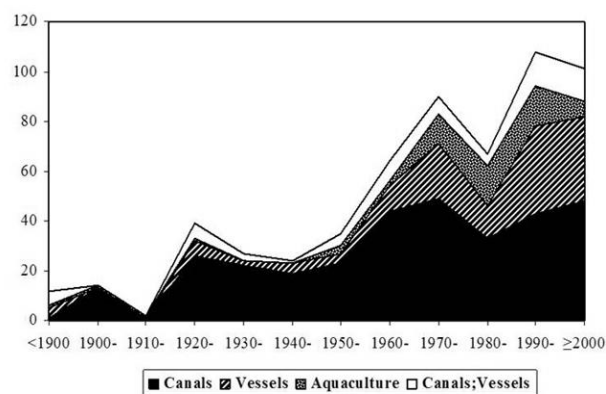


Fig. 1. Alien species recorded each decade in the Mediterranean and their vectors.

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