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MEDAC opinion on invasive species and algae

Invasive alien species (IAS) are foreign organisms introduced artificially, accidentally, or intentionally and which eventually adapt to and even colonize their new environment. IAS can have severe ecological effects on the invaded environments. They may lack natural predators in their new environments, allowing them to quickly increase their abundance and spread. They can carry diseases, out compete, or prey on native species, and even alter food chains, because they are favoured by the climate change and the new environmental conditions. These impacts can lead to local or global extinctions of native species.

Globalization and the ease of connections facilitate the movement of species from their place of origin to new areas, a phenomenon which is further intensified by global warming. They may arrive accidentally through transport, or voluntarily and intentionally when they are introduced by humans for activities such as hunting or fishing.

Ships' ballast water is apparently proving to be the most common involuntary vehicle for transporting certain invasive species to other areas. These waters are used by ships for navigation, and species can be released when they are discharged in the ports where these vessels dock at the ends of their journey. Some scientists consider this to be the main vector of introduction of invasive alien species, and efforts should focus on more specific regulation of their control.

Since 2016, the presence of an extremely aggressive foreign alga (***Rugulopteryx okamurae***) was detected in the **Strait of Gibraltar** (Altamirano et al. 2016,2017) and has since rapidly spread along southern coast of Spain, with confirmed populations from Cádiz until Almeria provinces (Muñoz et al. 2019). The species occupies sea bottoms with coverages ranging from 80-100%, producing important environment and economic impacts, mainly in fisheries and tourism sector. The habitat of this species includes rocky bottoms from rock-pools until depths more than 30 m, but also can fix on other surfaces, like on crustaceans, manufactured materials and even other algae (García-Gómez et al. 2018). A high reproductive performance, mainly related with vegetative propagation due to propagules, has been suggested as a key factor explaining its high dispersal and invasive capacities (Altamirano et al. 2016, 2017, 2019) which maybe favoured by new introductions from the discharge of untreated ballast waters into the sea and by fishermen's inexperience in dealing with drifted material of the species entangled in the nets. Furthermore, Mediterranean waters exhibit a high environment favourability for the presence of the species (Muñoz et al. 2019), so it can be expected that other European Mediterranean countries may suffer the invasion of this species as well. Economic impacts on the fishing economy in the affected area are severe, due to drastic reduction of the captures of many species, damage to nets and traps and cleaning works.

In the case of **Andalusia, it currently extends from Huelva to Almería**, variously affecting different types of fishing, from longline fishing to fishing with nets and traps, and it has even been detected when trawling in deep waters. The impact of this alga on the fishing economy in each area is severe and gradual, with a reduction of over 90% in the catches of different species in the case of the small-scale fishing fleet.

The American blue crab (***Callinectes sapidus***) was first sighted off the coast of **Catalonia** in around 2012, and **now extends as far as the Gulf of Cádiz**, where specimens have been observed and caught. This crustacean follows a similar pattern to other invasive species: it grows exponentially

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until it reaches an equilibrium due to the lack of food resources or the appearance of predators, with the logical effect on other species with low commercial value, in this case octopus.
The blue crab is an invasive species that is apparently impossible to eliminate from Mediterranean ecosystems; the only way to maintain these populations at manageable levels is maximum fishing pressure. It has become a target species in the sector, even in terms of marketing. A new model of action has been deployed against this invasive species that is now part of the circular economy, to maximise marine resources.
The appearance of these species poses a highly significant problem in the eastern Mediterranean, and they are gradually advancing westwards. Major changes have been detected in small-scale fisheries in Cyprus due to the emergence of various invasive species. ***Lagocephalus scelaratus*** is a main invader in the area creating problems such as damaging fishing gears by actively feeding on the commercial species caught by these and by decimating cephalopod populations. Other invasive species such as the Siganid species have a high commercial value in Cyprus and have entered the market for 3 decades now. ***Pterois miles***, the invasive lionfish is proving to be a particular health risk to fisherman with fisherman being stung more frequently and with more severity as individual get larger in size.
Mnemiopsis leidiyi is an invasive gelatinous organism of the phylum Ctenophora, originating from the Western Atlantic Ocean. Its accidental introduction through ballast waters in the early '80s has seriously altered fragile ecosystems of the Black and the Caspian Sea leading to the collapse of many important fisheries. Thus, the presence of *M. leidyi* in the **North-eastern (NE) Adriatic and Western Mediterranean** since 2009 (Boero et. al 2009; Fuentes et al., 2010) has risen concerns about the possible effects on fish stocks and the ecosystem of this semi-enclosed sea. The most recent observations include transitional environments, such as lagoons (Marambio et al., 2013; Thibault et al., 2014). The presence of M. leidyi in the S'Ena Arrubia Lagoon represents the first report in Sardinia and the first report of the species in a transitional ecosystem along the Italian coasts (Diciotti et al. 2016).
The appearance of this invasive species in 2017 & 2018 might have disturbed the zooplankton structure and abundance in the NE Adriatic with a negative effect on anchovy stock (*Engraulis encrasicolus*), similar to the effect recorded in the Black Sea (Paliaga et al, 2019). Fishermen's activity is also extremely burdened by gelatinous mass, which complicates the operations of emptying the fishing gear. Furthermore, the massive accumulation of the gelatinous mass near the fishing barricades may affect the lagoon sea exchanges. According to the fishermen's reports, the masses of M. *leidyi* clogging the fyke nets affected the European eel fishing activities in the S'Ena Arrubia Lagoon in autumn 2015. This aspect, accurately discussed by Palmieri et al. (2014) concerning the jellyfish blooms in Northern Adriatic, underlines the potential socio-economic harmfulness of this species.
More than 700 non-indigenous marine plant and animal species have been recorded so far in the Mediterranean, many of them are favored by the warmer conditions (Marbà et al., 2015; Azzurro et al. 2011). Of these, more than 600 have established populations in the Mediterranean (Galil et al. 2018).
Lessepsian species represent more than 50% of the nonindigenous species in the Mediterranean (Galil et al., 2018). The eastern Mediterranean is the area displaying the most severe environmental effects of invasive species. Some tropical invasive species create heavy

disturbances in ecosystems, like tropical rabbit fish, which devastate algal forests (Vergés et al., 2014).

Their communication route is assumed to be the Suez Canal, and – depending on their resistance – they are spreading throughout the Mediterranean and beyond the Strait of Gibraltar. Combined with rising water temperatures, these species may be causing the displacement of native species to other areas. The sighting and detection of several species began in 2010: common lionfish (***Pterois miles***), parrotfish (***Scaridae***), rabbitfish or dusky spinefoot (***Siganus luridus and S. rivulatus***), silver-cheeked toadfish (***Lagocephalus sceleratus***), puffer fish (**Tetraodontidae**), bluespotted cornetfish (***Fistularia commersonii***) among others.
Globalization, climate change and human intervention will surely lead to the progressive appearance of new invasive species that will directly affect our fishing industry; on the one hand, by making normal activity impossible and causing a serious socio-economic impact; and on the other hand, by incorporating new invasive species into the local fauna that cannot be eradicated, but which can be commercialized and thus serve to contain their expansion.
It is important to highlight the impact of this type of invasive species – both flora and fauna –on the fishing sector itself and on the entire local economy. This is even more so in areas that are dependent on fishing or tourism, where it affects both jobs and the fishing economy, which are also intermittently affected by the arrival of large shoals of fish on their coasts, with the consequent costs and repercussions for the local economy.

The following actions are therefore considered necessary:

1. Constituting and developing an international coordination centre and a Mediterranean warning network to detect, monitor and manage invasions. The centre should be based or have monitoring centres close to the entry points of invasive species, such as Strait of Gibraltar or the Suez Canal. Then, for example in Eastern Mediterranean they should be located in Cyprus or Greece.

2. As part of a policy of preventing the appearance and spread of these species from ships' ballast waters, the European Union must urgently lead more strict measures to monitor the quality of the sea waters and promote the incorporation of these measures by the rest of the countries involved in maritime trade. There are some measures from IMO but apparently more strict measures must be enforced. The European Union must ensure that the Member States effectively implement control measures and sanctions against those who fail to comply with the measures of the International Convention for the Control and Management of Ballast Water and Ship Sediments (BWM), in force since 8 September 2017, including the arrest or exclusion of the ship.

3. Coordinating the early warning network with the various advisory councils, foresee ably with the fleet and fishermen affected by the presence of this type of species, and with European institutions in order to transfer knowledge, activities, eradication measures, etc.

4. Assessing the damage to the professional fishing sector and designing action strategies, including the evaluation of their possible incorporation as target species for fishing.

5. Deciding on policies and tools to fight against invasive alien species and promoting outreach and dissemination actions.

6. Incorporating or arbitrating extraordinary direct and urgent aid to professionals in the fishing sector who have been negatively affected by the presence and spread of invasive species that hinder their fishing activities. Include compensation for damages caused by invasive species in the forthcoming programme of the new FEAMP.

7. Evaluating the social and economic impact of invasive species and their populations in coastal areas to incorporate measures to minimize the impact on their economic sectors.

8. Promote the collaboration between professionals' recreational fishers, Environmental associations and OIG[1] both in the detection and monitoring of invasive species, and in their control/elimination.[2]

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[1] FACOPE, CEPESCA and FNCP don't agree on specifying the ACs partners and suggested the sentence as it follows: "Promote the collaboration between ACs partners both in the detection and monitoring of invasive species, and in their control/elimination".

[2] IFSUA and EAA support the following specification as additional point of the list: "Promote the collaboration of recreational fishermen both in the detection and monitoring of invasive species, as well as in their control/elimination by fishing". *While FACOPE, CEPESCA and FNCP don't agree on this specification.*

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