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Impacts and risk of venomous and sting marine alien species in Turkish marine waters

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Abstract. Alien marine species are a global problem adversely affecting biological diversity and give a serious threat to conservation efforts. Turkey is surrounded by 3 different marine ecosystems, having high risk of entry of invasive alien species due to tropicalization of the Mediterranean. Therefore, About 80 % of IAS in the Black Sea comes via ballast water. Venomous and sting characteristics of some alien species lead us to take some precautions the alien species coming from the Red Sea, Indian and Pacific Oceans are able to adapt and proliferate quickly in the Eastern Mediterranean Sea. Currently, while over 1000 invasive alien species (IAS) are found in Mediterranean of which over 450 IAS are found along the Turkish Mediterranean coast and 21 species in the Turkish Black Sea. This number continues to grow 66 % of the 450 species, penetrating via the Suez Canal to the Mediterranean Sea. Against the dispersal of aliens among regions. The majority of the poisonous marine alien species in Turkish marine waters were introduced by the Suez Canal, a few were introduced by shipping. While all venomous marine alien species observed in both Turkish Aegean and Mediterranean Seas, no one is observed in both Sea of Marmara and Black Sea except elongated puffer. Venomous and sting marine alien species can generate significant threats to native species, habitats, fisheries, economy and human health, especially during the high tourism seasons.

Key words: alien species, venomous, sting, spread, Turkish marine waters.

Introduction

Biological invasions, both in land and sea, have been worldwide acknowledged as a man-induced ecosystem pressure that should be monitored and managed (Roy et al. 2015, 2017). The opening of Suez Canal, effects of climate change, and lack of biodiversity in the recipient environment have facilitated the establishment of new species. Alien species have rapidly spread in the Mediterranean causing experts to have concerns about their growth pace. If these species continue to grow in such pace, the number of alien aquatic plant species may exceed the number of local species found in the Mediterranean Sea in future. It is inevitable that commercial fishery will also face some challenges and damages since the Mediterranean species will disappear due to global warming. Furthermore, they will be replaced with the Red Sea species and the Black Sea will also become more like the Mediterranean Sea.

An increase in alien species introductions is observed for all regional seas. In particular, the Eastern Mediterranean, due to its proximity to the Suez Canal, has been susceptible to biological invasions and hosts more than 775 alien and cryptogenic species (Zenetos et al. 2012). 790 new fish species arrived at the Mediterranean Sea after the opening of the Suez Canal. The number of invasive alien species in the Turkish Eastern Mediterranean has reached 450 (Turan et. al. 2018, Uysal & Boz 2018). In this region over 160 new species have been recorded from 2000 to 2010 (~ 17 species per year) followed by the Ionian Sea and the Central Mediterranean Sea (~ 8 species per year), the Western Mediterranean Sea and the Black Sea (both with~7 species per year). This trend continued in the 2011-2014 period, with the highest number of NIS observed in the Aegean-Levantine Sea (25 species) (EEA, 2019). The majority of the species were of Red Sea/Indo-Pacific origin (97 species; 60.6 %). Italy, Turkey and Greece were the countries with the highest representation of species (159, 152 and 139 species respectively), due to their extended coastline and the number of scholars working on marine invasive species. The highest number of established species was recorded in Turkey (116 species) (Karachle et al. 2017). Lessepsian species decline westwards, while the reverse pattern is evident for ship-mediated species and for those introduced with aquaculture. There is an increasing trend in new introductions via the Suez Canal and via shipping (Zenetos 2012).

Similarly, the Black Sea, an enclosed marine system of particular physicochemical characteristics, low diversity and high marine traffic, is vulnerable to marine invasions (Leppäkoski & Mihnea 1996). Of particular importance among aliens are the invasive alien species, which are considered one of the greatest threats to biodiversity and on ecosystem services (Katsanevakis et al. 2014).

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Material and Methods

A list of venomous and sting marine invasive species in the Turkish marine waters was generated from the records given in the literatures (Turan et al. 2018). The existing literature were reviewed and expert judgments were taken for each species, then the species were classified for the Turkish marine waters as established, casual, invasive, and expected. The list also includes the species' origin and potential pathway/vector of introduction (CBD 2014). Finally, twenty one venomous and sting marine alien species in Turkish marine waters were compiled for a brief account per species is given in Table 1.

Table 1. List of poisonous and venomous marine alien species in Turkish marine waters for risk assessment and impacts

BS=Black sea, SM=Sea of Marmara, AS=Aegean Sea, MS=Mediterranean Sea, Pathway/Vector=potential vector of expansion, T/S= Transport/ stowaway, C=corridor (Canal), FR= First report in Turkish marine waters, RoS=risk of spread, M=medium, H=high, L=low, V=Venomous, S=Sting

	Turkish Seas				Danger	Pathway/			Impacts	
	BS	SM	AS	MS	status	Vector	FR	*RoS*	current	potential
Lagocephalus sceleratus	–	–	X	X	V	C	Akyol et al. 2005	H	impact on human health	human health; biodiversity (through predation)
Lagocephalus suezensis	–	–	X	X	V	C	Avsar & Cicek 1999	H	impact on human health	human health; biodiversity (through predation), and fisheries
Lagocephalus spadiceus	–	X	X	X	V	C	Kosswig 1950	H	impact on human health	human health; biodiversity (through predation), and fisheries
Lagocephalus guentheri	–	–	X	X	V	C	Akyol & Aydın 2016	M	impact on human health	human health; biodiversity (through predation), and fisheries
Tylerius spinosissimus	–	–	-	X	V	*T/S, C*	Turan & Y ağlıoğlu, 2011	L	impact on human health	human health
Torquigener flavimaculosus	–	–	X	X	V	C	Bilecenoglu 2003	H	impact on human health	human health; biodiversity (through predation), and fisheries
Callionymus filamentosus	–	–	–	X	S	C	Gücü et al. 1994	L	none to date	impact on local fisheries
Siganus rivulatus	–	–	X	X	S	T/S, C	Bilecenoğlu et al. 2002	L	impact on resulting in the eradication of algae locally	Impact on human health; biodiversity and ecosystem services (the energy transfer throughout a food web and significantly alter habitats)
Siganus luridus	–	–	X	X	S	C	Torcu H. & Mater, S. 2000	L	impact on resulting in the eradication of algae locally	impact on biodiversity and ecosystem services (the energy transfer throughout a food web and the quality of water, and reduces the carbon storage capacity)
Synanceia verrucosa	–	–	–	X	S	C	Bilecenoğlu 2012	L	impact on human health	impact on human health
Pterois miles	–	–	X	X	S	C	Turan et al. 2014	M	none to date	human health; biodiversity (through predation)
Pterois volitans	–	–	-	X	S	C	Gürlek et al. 2016	M	none to date	human health; biodiversity (through predation)
Plotosus lineatus	–	–	-	X	S	C	Doğdu et al. 2016	M	impact on human health	impact on human health, tourism and fisheries
Ostracion cubicus	–	–	–	X	S	C	Gökoğlu & Korun 2017	L	none to date	impact on biodiversity
Ruvettus pretiosus	–	–	X	X	V	C	Bilecenoglu et al. 2002	L	none to date	impact on human health (Consumption of the species may have adverse health effects and cause diarrhoea)
Diadema setosum	–	–	–	X	S	T/S, C	Yokes& Galil 2006	M	none to date	human health; biodiversity (through predation) and ecosystem services (e.g. tourism)
Eurythoe complanata	–	–	–	X	S	T/S, C	Ergen & Cinar 1997	L	none to date	impact on human health
Macrorhynchia philippina	–	–	X	X	S	Not known	Çinar et al. 2006	L	none to date	impact on human health
Cassiopea andromeda	–	–	X	X	S	C	Bilecenoğlu 2002	L	impact on human health	impact on biodiversity (through predation) and ecosystem services (e.g. tourism)
Phyllorhiza punctata	–	–		X	S	T/S	Cevik et al. 2011	L	none to date	impacts on the biota and human activities
Rhopilema nomadica	–	–	X	X	S	C	Kideys & Gücü 1995	L	impact on human health, tourism and fisheries	impact on human health and ecosystem services (e.g. tourism and fisheries)

Venomous and sting species

Pufferfish species

In Turkish marine waters, alien pufferfish belongs to Tetraondontidae family are represented with 7 species, *Lagocephalus sceleratus*, *L. spadiceus*, *L. suezensis*, *L. guentheri*, *Sphoeroides pachygaster*, *Torquigener flavimaculosus* and *Tylerius spinosissimus* (Turan et al. 2016). Pufferfish species show different risk factors for spread and have effects on human health, biodiversity and fisheries (Table 1). Available evidence indicated that arrival of the puffer fish has reduced the number of mollusk species (calamari, octopus, and squid) to a great extent. In addition to economic damages and ecological harms, they also pose a threat to human health since they generally contain a large amount of neurotoxin in their tissues, which is called tetrodotoxin (TTX). This toxin is known to be 1000 times more poisonous than cyanide (Uysal & Boz 2018).

The Turkish Ministry of Agriculture and Forestry issued a ban on the fishery of *L. sceleratus* (Fig. 1) in 2012. However, the results of a survey conducted by Beköz et al. (2013) examining awareness among fishermen, fish mongers, restaurant staff, medical staff and the public in Antalya, Turkey on the danger of consuming the locally abundant *L. sceleratus* are shocking. Fishermen, though aware that the fish is poisonous, admitted selling it to local markets and hotels, providing themselves with a good income. Restaurant managers and fish mongers denied selling the pufferfish, though specimens were in fact displayed for sale. Most customers had not heard of the pufferfish, were unaware of its lethality and admitted to relying on the sellers' advice (Galil 2018). Its risk of spreading along Turkish coasts is high. Its impacts on human health was evaluated in Table 1.

Figure 1. Pufferfish species *Lagocephalus sceleratus*.

Figure 2. Blotchfin Dragonet *Callionymus filamentosus* cuptured by Trawler in İskenderun Bay.

Figure 3. *Siganus rivulatus* feeding on the bottom.

Blotchfin Dragonet *Callionymus filamentosus*

Blotchfin Dragonet *Callionymus filamentosus* (Fig. 2) originates from the Indian Ocean. It came to the Mediterranean Sea by using the Suez Canal and has spread along the Mediterranean coast of Turkey. They usually live in the deep water (Uysal & Boz, 2018). The spines stretching from under their operculum secrete poisonous toxins. Its poison has lesser impact than the poisons of other species. Its risk of spreading along Turkish coasts is low. To date, no one data on impact of it is recorded in Turkey. Impacts of it was recorded on resulting in the eradication of algae locally (Table 1).

Spinefoot species (*Siganus* spp)

Spinefoots or rabbitfishes (*Siganus rivulatus* and *Siganus luridus*) (Fig. 3) found along the Aegean and Mediterranean coast of Turkey are perciform fishes in the family Siganidae that originates from the Indo-Pacific regions and came to the Mediterranean Sea by using the Suez Canal, transport. They have commercial value and their length are usually between 15 and 20 cm. The venom apparatus consists of 13 dorsal spines, 7 anal spines, 4 pelvic grooved spines and their venom glands which rupture and release their contents on penetration. Care must be taken during fishing and cleaning, as rabbitfishes will use their venomous spines in defense. Their venom is not life-threatening to adult humans, but causes severe pain. The stings may cause pain and swelling lasting several hours (Galil 2018). In contrast to other venomous fish species, this is the only venomous fish that is herbivore. All of its dorsal and ventral fins contain poison glands. It should also be noted that it keeps the impact of its poison in its spines even after it has died. For this reason, it is also possible to be poisoned when taking these fish from the fishnet. It is a very important species for the coastal fishing. Its risk of spreading along Turkish coasts is low. Its impacts on human health was evaluated in Table 1.

Stone fish *Synanceia verrucosa*

Stone fish *Synanceia verrucosa* (Fig. 4) originates from the Pacific Ocean, Indian Ocean. It came to the Mediterranean Sea by using the Suez Canal and has spread along (Yumurtalık-Adana) the Eastern Mediterranean coast of Turkey. It is one of the most poisonous fish in the world. They can swim in and out of shallow waters. It has 13 venomous spines in the dorsal fin. It usually has greater impact on children, the elderly and people with weaker immune systems. Surviving victims suffer nerve damage, which can also lead to atrophy of muscle tissues (Uysal & Boz 2018). Its risk of spreading along Turkish coasts is low. Its impacts on human health was evaluated in Table 1.

Lionfishes (*Pterois miles* and *Pterois volitans*)

There are two lionfish species (*Pterois miles* and *Pterois volitans*) (Fig. 5) in Turkish Marine waters found in the Mediterranean and Aegean part of Turkey (Table 1). It originates from the Western Indo-Pacific region and penetrated to the Mediterranean Sea by using the Suez Canal and has spread

Figure 4. Stone fish cuptured by fishermen at Yumurtalık, Adana, Turkey. The source of picture (http://www.milliyet.com.tr/gorenler--cirkin--diyor-ama-asil-zehiri-oldurucu-gundem-1475684/).

Figure 5. *Pterois miles* from Iskenderun Bay.

along the Aegean and Mediterranean coast of Turkey. It has venomous fin spines and its venom can cause severe poisoning and even death. The venom apparatus consists of 13 dorsal spines, 3 anal spines, 2 pelvic grooved spines and their venom glands (Halstead 1988). Envenomation produces intense pain and swelling, which may continue for several hours, depending on the amount of venom. A first-hand account of a *P. miles* sting inflicted by a juvenile specimen 10 cm long (Steinitz 1959, as *P. volitans* relates in precise detail the intense pain ('just short of driving oneself completely mad') and swelling that lasted 3 h (Galil 2018). Its risk of spreading along Turkish coasts is medium. To date, no one data on impact of it is recorded in Turkey (Table 1).

The striped eel cat fish *Plotosus lineatus*

The striped eel cat fish *Plotosus lineatus* (Fig. 6) is one of the most recent invaders, and it is rapidly becoming a dominant component of the benthic biota of the Levantine Sea. First record of *P. lineatus* in the Turkish marine waters was given in the Iskenderun Bay (Doğdu et al. 2016). This species will probably be well established like other invasive fish species and along the Mediterranean coast of Turkey. The striped eel cat fish can cause painful injuries for fishermen and other people in the coastal areas due to its sting spines. There is a record of clinical data of trawler fishermen stringed by his finger in the Iskenderun Bay (Gurlek et al. 2019)

Yellowbox Fish *Ostracion cubicus*

Yellowbox Fish *Ostracion cubicus* (Fig. 7) originates from the

Figure 6. The striped eel cat fish *Plotosus lineatus* in the İskenderun Bay.

Figure 7. Yellowbox Fish *Ostracion cubicus* from the Gulf of Antalya (picture from Gökoğlu and Korun, 2017).

Figure 8. *Ruvettus pretiosus* captured from Iskenderun Bay, the northeastern Mediterranean of Turkey.

Indo-Pacific, Southeast of the Atlantic and Coasts of the East Africa. It came to the Mediterranean Sea by using the Suez Canal and has spread in the East Mediterranean Sea Üçadalar, The Gulf of Antalya. It resembles pufferfish with its spiky structures and formations like honeycomb. When juvenile, it is yellow in color. As it ages, old specimens will have blue color. The fish produces a poisonous toxin. This toxin covers its body like armor and protects it from other fish species. They do no harm to humans (Uysal & Boz 2018). Its risk of spreading along Turkish coasts is low. To date, no data on its impact has been recorded in Turkey (Table 1).

Oilfish *Ruvettus pretiosus*

Oilfish *Ruvettus pretiosus* (Fig. 8) originates from the Indo-Pacific, Temperate Tropical Regions. It came to the Mediterranean Sea by using the Suez Canal and has spread along the Aegean and Mediterranean coast of Turkey (Gulf of Mersin, coasts of Alanya, Gulf of Alexandretta, and Gulf of Antalya). Consumption of the species may have adverse health effects and cause diarrhoea since it contains a toxin called gempylotoxin. This is caused by an intoxication called "gempylid fish

poisoning". Symptoms of the poisoning include severe diarrhoea that is orange-green in colour, fluid loss, abdominal cramps, headache, and nausea and vomiting. The first symptoms appear within 2.5 hours after the consumption and last for 2 days. The severity of poisoning depends on the amount of consumption. The United States Department of Agriculture (USDA), requested to put a ban on the sales of this fish both as a fresh or processed product (Uysal & Boz 2018). Its risk of spreading along Turkish coasts is low. To date, no one data on impact of it is recorded in Turkey (Table 1).

Long-spined black sea urchin *Diadema setosum*

Long-spined black sea urchin *Diadema setosum* (Fig. 9) originates from the Indo-Pacific region. It came to the Mediterranean Sea by using the Suez Canal, transport and has since spread along the Mediterranean coast of Turkey (from the Levantine Sea to Gökova Bay at the south-east Aegean Sea). This species may cause undesirable situations for people walking on rocky beaches or swimming around rocky shores. Well camouflaged sea urchins can cause injuries and people should be very careful when diving in the rocky regions. These injuries often result from stepping on the animal by mistake. Its risk of spreading along Turkish coasts is as medium. To date, no one data on impact of it is recorded in Turkey (Uysal & Boz 2018) (Table 1).

Figure 9. Long-spined black sea urchin *Diadema setosum* from İskenderun Bay.

Fireworm *Eurythoe complanata*

Fireworm, *Eurythoe complanate* (Fig. 10) originates from the Indian Ocean, Pacific Ocean, Atlantic Ocean and the Red Sea. It came to the Mediterranean Sea by using the Suez Canal, transport and has spread along the Mediterranean coast of Turkey. They can cause poisoning. It mainly feeds on corpses of other marine species. For this reason, it is important not to touch dead species underwater since even if the fireworm finished eating, its setae can be around. Fireworms, which are often seen among the fish species caught by the fishing nets, may also cause poisoning upon contact when collecting fish from the fishing net. They may also pose a threat for careless divers. Especially in summer, many divers dive without wetsuits. It is important to avoid rubbing against rocks and stones while walking in the rocky areas, considering that fireworms can be around. Its risk of spreading along Turkish coasts is low. To date, no one data on impact of it is recorded in Turkey (Uysal & Boz 2018) (Table 1).

Figure 10. Fireworm *Eurythoe complanate* from Iskenderun Bay.

Stinging hydroid *Macrorhynchia philippina*

Stinging hydroid *Macrorhynchia philippina* (Fig. 11) originates from the Southern Pacific Ocean region. Its pathway is not known and has spread along the Mediterranean coast of Turkey. It is found in shallow waters and has since expanded northwards to the Turkish coasts. It can create dense populations. It may cause pain, itching and burning especially in the naked body. They mainly feed on planktons. An increase in the abundance of *M. philippina* along the Levant coastline may hurt recreational activities such as swimming and snorkelling (Çinar et al. 2006). Its risk of spreading along Turkish coasts is low. To date, none impact of it is recorded in Turkey (Table 1).

Figure 11. Stinging Hydroid *Macrorhynchia philippina* from Iskenderun Bay.

Upside-down jellyfish *Cassiopea andromeda*

Upside-down jellyfish *Cassiopea andromeda* (Fig. 12) originates from the West Indian Ocean to West Pacific Ocean, and the tropical Atlantic. It came to the Mediterranean Sea by using the Suez Canal and has spread along the Mediterranean coast of Turkey. It was first recorded in our country in Sarsala Bay, Fethiye, Göçek. This species contains organs, which produce toxins called nematocyst, which may cause pain, skin rash, and itching, vomiting and skeletal pain. Its risk of spreading along Turkish coasts is low. Impacts of it was recorded on human health (Uysal & Boz 2018) (Table 1).

Figure 12. Upside-down jellyfish *Cassiopea andromeda* from Iskenderun Bay.

The white-spotted jellyfish *Phyllorhiza punctata*

The white-spotted jellyfish *Phyllorhiza punctate* (Fig. 13) originates from the Western Pacific Ocean, from Australia to Japan. It came to the Mediterranean Sea by using transport and has spread in some parts of the Levantine Sea and Aegean Sea since 1965. They create adverse effects on other species by eating too much zooplankton in the ecosystem. Its risk of spreading along Turkish coasts is low. To date, no one data on impact of it is recorded in Turkey (Uysal & Boz 2018) (Table 1).

Nomad jellyfish *Rhopilema nomadica*

Nomad jellyfish *Ropilema nomadica* (Fig. 14) originates from the Indian Ocean and Pacific Ocean. It came to the Mediterranean Sea by using the Suez Canal and has spread along partly Aegean Sea and the Mediterranean coast of Turkey. It has a voracious appetite and causes collapses in the food chain by feeding on shrimps, mussels and fish larvae (Uysal & Boz 2018). Nomad jellyfish can cause damages in the coastal tourism. They are often seen during the summer months in the east of Mersin-Taşucu. They pose a potential threat for the swimmers, fishermen and divers. Larger nomad jellyfish can also cause damages by entering fishing nets and coastal facilities. In summer 2009 alone, 815 hospitalizations due to *R. nomadica* envenomation's were recorded along the southeastern coast of Turkey. Turkey affected by the nomadic jellyfish swarming are major tourist destinations in the Mediterranean Sea. Jellyfish envenomation pose a threat to the countries' investments in marine recreational tourism (Öztürk & İşinibilir 2010). Its risk of spreading along Turkish coasts is low. Impacts of it was recorded on human health (Table 1).

Figure 13. The White-Spotted Jellyfish *Phyllorhiza punctate* from Iskenderun Bay.

Figure 14. Nomad jellyfish *Ropilema nomadica* from Iskenderun Bay.

Discussion

Invasive alien species are a global problem adversely affecting biological diversity and give a serious threat on human health, biodiversity and ecosystem services. Turkish marine waters have been facing increasing number of alien species (Turan et al. 2018) and up to date, more than 20 venomous and sting marine alien species have been recorded in the Turkish marine waters, coming via the Suez Canal or transport/stowaway.

More than 20 venomous/sting marine alien species are given in this paper found in the marine waters of the Turkish Mediterranean, Aegean and Marmara. The Mediterranean coasts of Turkey have highest number of venomous and sting alien species, and Aegean Sea has second. The Marmara Sea has only two pufferfish species. Current observations available in various parts of the Mediterranean Sea indicate as increasing abundance of alien species, whose establishment success may be attributed to the combination of their life history characteristics including the rapid growth, high fecundity and capability of spawning throughout the year, tolerance to a wide range of environmental conditions, overfish of native fishes and climate change (Turan et al. 2016, Bilecenoğlu 2018). The Mediterranezation of the Sea of Marmara and Black Sea will probably increase the number of alien species coming from the Suez Canal in the near future (Turan et al. 2016).

Danger status of alien spiny and venomous species for human health and fisheries can be scaled to understand potential impact of each species. The danger status each species can vary according to its impact that a species can be very

Table 2. Danger status of alien sting and venomous species for human health and fisheries from Red as most Dangers or impact to White-yellow as least dangers or impact.

Species	Danger status for human health	Species	Impact on fisheries
Synanceia verrucosa		*Lagocephalus sceleratus*	
Plotus lineatus		*Lagocephalus suezensis*	
Rhopilema nomadica		*Lagocephalus spadiceus*	
Lagocephalus sceleratus		*Lagocephalus guentheri*	
Lagocephalus suezensis		*Torquigener flavimaculosus*	
Lagocephalus spadiceus		*Rhopilema nomadica*	
Lagocephalus guentheri		*Plotus lineatus*	
Torquigener flavimaculosus		*Synanceia verrucosa*	
Pterois miles		*Pterois miles*	
Pterois volitans		*Pterois volitans*	
Diadema setosum		*Phyllorhiza punctata*	
Eurythoe complanata		*Eurythoe complanata*	
Cassiopea andromeda		*Diadema setosum*	
Phyllorhiza punctate		*Cassiopea andromeda*	
Siganus rivulatus		*Siganus rivulatus*	
Siganus luridus		*Siganus luridus*	
Callionymus filamentosus		*Callionymus filamentosus*	
Macrorhynchia philippina			
Tylerius spinosissimus			
Ostracion cubicus			
Ruvettus pretiosus			

dangers for human health, but less impact on fisheries in Table 2. For example, *Macrorhynchia philippina* is dangers for human but no impact on fisheries (Table 2).

Venomous and sting marine alien fish species contain venomous spines on the tail or on the operculum are mostly dangerous because of their poisonous thorns whereas the passive venomous fish species poison when they are eaten by human can be more dangerous. These toxins can cause morbidity and rarely, mortality in humans.

While there is no one data to date about current impacts on human health in Turkey for *Callionymus filamentosu, Pterois miles, Himantura uarnak, Ostracion cubicus, Ruvettus pretiosus, Diadema setosum, Eurythoe complanata, Macrorhynchia philippina, Phyllorhiza punctata,* impacts on human health of *Lagocephalus sceleratus*, *Synanceia verrucosa, Cassiopea andromeda* and *Rhopilema nomadica.* However, impacts of *Siganus rivulatus* and *Siganus luridus* were recorded on resulting in the eradication of algae locally.

Natural predators of poisonous and venomous alien marine species are not well documented. Turan et al. 2017 reported that *Epinephelus marginatus* eat lionfish in the Mediterranean coast of Turkey. Therefore, in addition to the eradication and control of poisonous and venomous alien marine species, the natural top predators such as grouper, sharks and sea turtles should be protected. Management efforts of venomous and sting alien marine species should be enhanced and generalized including monitoring activities, increasing public awareness for human health risks.

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