

ALIENS IN ALBANIA —WHICH, WHEN, WHERE, WHY? A CHRONOLOGICAL ANALYSIS OF THE INVASION OF ALIEN SPECIES IN THE ALBANIAN, IONIAN, AND ADRIATIC COASTS

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Abstract

The Albanian part of the Adriatic and Ionian Sea covers almost 316K of coasts, about 40% of the Albanian territory. This means that monitoring for changes in marine ecosystems and conserving biodiversity are of great importance. The invasion of the Mediterranean seas by alien species and the extension of the distribution area of some species in other sub-regions forces the need for constant monitoring of the non-indigenous marine fauna of Albania. This paper provides a list of species introduced into Albanian waters in recent years. A total of 54 species were reported from 1978 until 2023 in the waters of the Ionian and Adriatic of Albania. Among these: Foraminifera 2; Algae 7 species; Mollusca 17; Annelid 2; Arthropoda 5; bryozoa 2; Tunicata 3 and Vertebrata 16.

Most of these species are thermophilic species with origins from the Suez Canal. The main factors in the transport and distribution of these species are related to sea routes and the presence of aquaculture. The greatest number of species reported is in two of the major ports of Albania: the ports of Durres and Vlora Bay.

Keywords: Alien species; range expansion Albania, Adriatic Sea, Mediterranean Sea, Ionian Sea.

1. Introduction

The Mediterranean Sea is considered a biodiversity hotspot, counting 10 different areas particularly rich in biodiversity (Frédéric Médail and Pierre Quezél, 1999), which represent about 22% of the total area of the basin and contain 5,500 endemics, exclusive to these areas (Coll et al., 2010; Katsanevakis et al., 2014). This number of endemics makes the Mediterranean Sea one of the world's major biodiversity hotspots and at the same time one of the most globally affected areas in terms of biodiversity loss due to climate change, biological invasions, and other anthropogenic factors (Halpern et al., 2008; Costello et al., 2010; Mouillot et al., 2011; Coll et al., 2012; Micheli et al., 2013; Lejeusne et al., 2010; Zenetos et al., 2012; Katsanevakis et al., 2013; Katsanevakis et al., 2014). One of the main threats to the biodiversity of the Mediterranean Sea is the invasion of its ecosystems by alien species (Zenetos et al., 2003). From the moment of the first sightings until now there have been more than 1000 alien species introduced (Mediterranean CIESM Atlas Series) among which some are considered in expansion and others are reported every day (Galil & Zenetos, 2002; Zenetos et al., 2003; Katsanevakis et al., 2013). Over the years some of these species have become invasive, modifying and influencing the balance of the ecosystem and acting as engineers in the structure of food webs (Wallentinus and Nyberg, 2007). In some cases, these modifications can be positive for the increase of biodiversity, given

that in some cases these species create biogenic structures that serve as habitats for degraded or homogenous ecosystems (Vilà et al., 2010; Schlaepfer et al., 2011). However, several of those species have caused substantial economic losses (Molnar et al., 2008). The main cause of the invasion of the Mediterranean Sea was the opening of the Suez Canal, causing the so-called Lessepsian migration (Por, 2012). This phenomenon has been promoted by transport via fouling and ballast transport along sea routes, voluntary introductions for aquaculture, and climate change which have favored the establishment of these non-indigenous species (Zenetos et al., 2012; Katsanevakis et al., 2017).

In Albania, despite monitoring and reporting efforts, there are still many gaps to fill about the knowledge of the presence of alien species. In recent years, many alien species present on the Albanian coasts have been reported, but there is still a lack of a knowledge base on the dynamics of their distribution and their status. Furthermore, considering the Albanian coasts as a gateway to the Adriatic, such reports should be more numerous considering the presence of other alien species reported in neighboring countries (Nunes et al., 2014; Katsanevakis & Crocetta, 2014).

The European Alien Species Information Network (EASIN; Katsanevakis et al., 2012), World Register of Introduced Marine Species (WRiMS), and other networks have increased the accessibility of spatial information on alien species by creating a network of interoperable web services through which data is accessed in distributed sources (Katsanevakis et al., 2014).

This paper aims to create the first database of species reported so far in Albanian waters. It will analyze the geographical areas with the highest alien species presence and also report the presence of three other new alien species in these waters.

Methodology

The EASIN exotic species inventory (available online at: <http://easin.jrc.ec.europa.eu/use-easin/species-search/combined-criteria-search>) was used for the creation of the database and the World Register of Introduced Marine Species (WRiMS) and over thirty- three papers where alien species have been reported over the years in Albanian waters. Each species was classified, the date of the first sighting recorded, and other data if there was any in the consulted literature.

Consulting the literature and also the unpublished data from the staff of the Department of Biology, we found a lack of data on the presence of some recently found species, therefore we decided to report them together with the database presented in the paper herein.

Results

From the literature, we have ascertained the presence of 54 species reported from 1978 until 2023 in the waters of the Ionian and Adriatic of Albania. Among these: Foraminifera 2; Algae 7 species; Mollusca 17; Annelid 2; Arthropoda 5; bryozoa 2; Tunicata 3 and Vertebrata 16.

The alien species present in Albanian waters are represented in the following table with all the data collected for each of them.

Table 1. List of non - indigenous marine fauna reported in Albanian waters between 1978 and 2023.

Species	First observation	Location	Coordinates	Reported Paper
<i>Foraminifera</i>				
<i>Mimosina affinis</i> Millett, 1900	2020	Saranda; Porto Palermo; Dhermi; Himara Port; Sazani Island; Shen Jani; Radhime	unknown	Hayward et al., 2021; Stulpinaite et al., 2020
<i>Sigmamiliolinella australis</i> (Parr, 1932)	2021	unknown	unknown	Hayward et al., 2021
<i>Algae</i>				
<i>Ganonema farinosum</i> (J.V.Lamouroux) K.-C.Fan & Y.-C.Wang, 1974	2010	Stillo Cape; Ksamil, Dhermi, Jali; Himara	Stillo Cape 39.6885 19.9918 Ksamil 39.7712 19.9990 Dhermi 40.1377 19.6458 Jali 40.1183 19.7024 Himara Port 40.1000 19.7400	Katsanevakis et al., 2012
<i>Asparagopsis taxiformis</i> (Delile) Trevisan de Saint-Léon, 1845	2010	Porto Palermo, Dhermi	Porto Palermo: N 40.0627 E 19.7947 Dhermi: N 40.1377 E 19.6458	Katsanevakis et al., 2011
<i>Chondria pygmaea</i> Garbary & Vandermeulen, 1990	1996	unknown	unknown	Kashta & Pizzuto, 1996
<i>Lophocladia lallemandii</i> (Montagne) F.Schmitz, 1893	2010	Dhermi; Jali, Sazani Island	Dhermi 40.1377 19.6458 Jali 40.1183 19.7024, Sazani Island 1 40.4912 19.2725	Katsanevakis et al., 2013
<i>Womersleyella setacea</i> (Hollenberg) R.E.Norris, 1992	2023	unknown	unknown	Rius et al., 2023
<i>Caulerpa racemosa</i> (Forsskål) J.Agardh, 1873	1995	Ftelea; Ksamil; Porto Palermo; Llaman; Himara; Vlora Bay; Spille	unknown	Di Martino & Giaccone, 1995; Xhulaj & Kashta, 2007
<i>Halophila stipulacea</i> (Forsskål) Ascherson, 1867	2005	Ftelea; Ksamil; Saranda; Vlora Bay	unknown	Xhulaj & Kashta, 2007
<i>Mollusca</i>				
<i>Conomurex persicus</i> (Swainson, 1821)	2015	Porto Palermo Bay	40.063056° N, 19.793333° E	Gerovasileiou et al., 2017
<i>Aplus dorbignyi</i> (Payraudeau, 1826)	2020	unknown	unknown	Dhora & Dhora, 2020
<i>Ropana venosa</i> (VALENCIENNES 1846)	2020	unknown	unknown	Dhora & Dhora, 2020
<i>Bursatella leachii</i> Blainville, 1817	2013	Vlora Bay	40.420278° N, 19.429722° E	Gerovasileiou et al., 2017
<i>Cellana rota</i> (GMELIN 1791)	2020	unknown	unknown	Dhora & Dhora, 2020
<i>Fulvia fragilis</i> (Forsskål, 1775)	2016	Vlora Bay	40.063611° N, 19.793333° E	Gerovasileiou et al., 2017
<i>Ruditapes philippinarum</i> (A. Adams & Reeve, 1850)	2012; 2013	Vlora Bay	40.457222° N, 19.398055° E	Nasto, 2012 Unpublished data;

<i>Andara inaequalvis</i> (BRUGUIERE 1789)	2020	unknown	unknown	Dhora & Dhora, 2020
<i>Arcuatula senhousia</i> (BENSON IN CANTOR 1842)	2020	unknown	unknown	Dhora & Dhora, 2020
<i>Brachidontes pharaonis</i> (P. FISCHER 1870)	2020	unknown	unknown	Dhora & Dhora, 2020

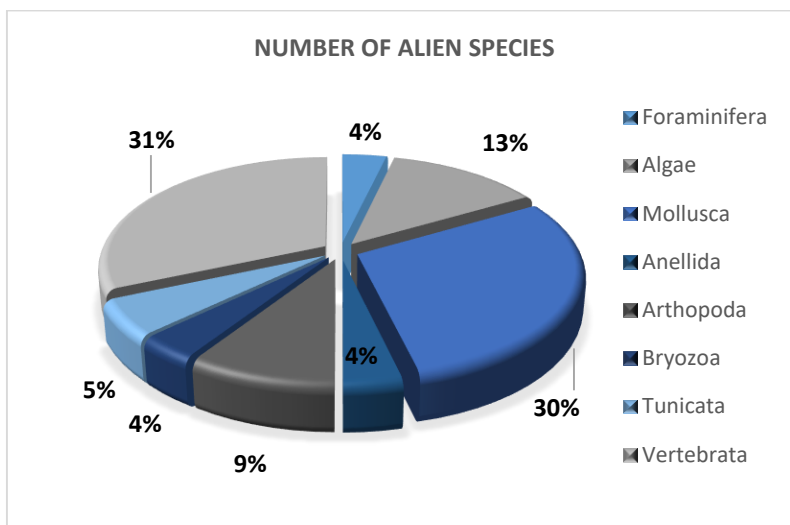


Figure 20. Number of alien species according to the classification

Among the species introduced into Albanian waters, there is a difference in the extent of the richness of the groups reported. The groups with the greatest number of evidences of the presence are fish and mollusks, i.e., Vertebrata and Mollusca with 30% and 31% of all reports so far. It is assumed that this result is due to the limited number of researches carried out in the field of other taxa given the limited number of Albanian researchers working in the field of marine alien species (Figure 1).

This has also been observed during the study of the relevant literature, where most of the species have been reported as a result of European monitoring projects.

The main obstacle observed during the study was the limited presence of data on the dynamics of distribution of these species after the first discovery. Such data exist only for some species such as *Callinectes sapidus* Rathbun, 1896; *Perchnon gibbesi* (H. Milne Edwards, 1853); *Caulerpa racemosa* (Forsskål) J. Agardh, 1873, (Katsanevakis et al., 2011; Milori et al., 2017 a, b).

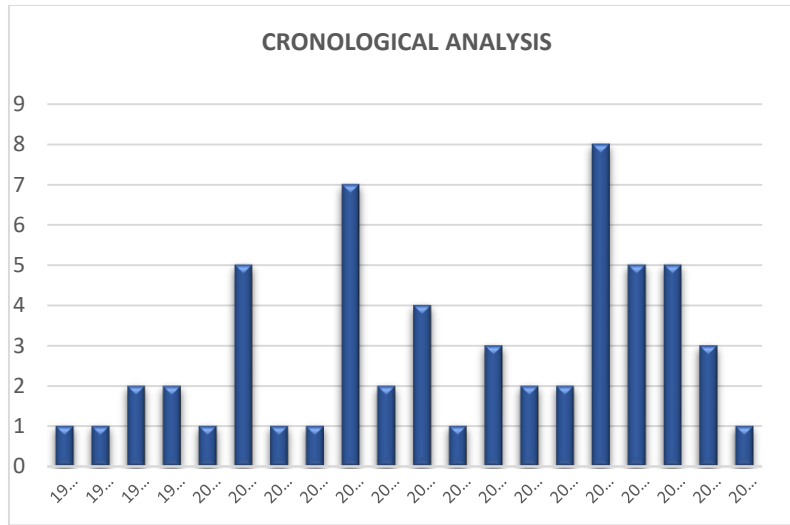


Figure 21. Number of alien species reports for every year

From the chronological analysis of the number of reports on alien species present in Albanian waters (figure 2), we came to the result that from 2013 up to 2023 there was an increase in the number of reports of alien species, with a peak in 2010 with 8 new findings for Albania thanks to some publications (Katsanevakis et al., 2011; 2012; 2013; 2014). It can be considered that the year 2013 is the year where the awareness of the presence of alien species in the Albanian waters had increased, also due to the presence of the blue crab *Callinectes sapidus* Rathbun, 1896 which was made known as extremely invasive during this year (Beqiraj & Kashta, 2010).

The maximum number of species reported within a year was in 2018, with 8 alien species reported. We must also underline that the graph includes all the testimonies, therefore the number of reports is greater than the number of species for the reason that a species may have been reported more than once in different areas, both in the Ionian Sea and in the Adriatic Sea.

In addition, we have to consider that given the time of publication of the data and the waiting time for the publication (an average of almost two years from the time of sighting) the data regarding 2021 - 2023, may be incomplete and may be greater than in previous years.

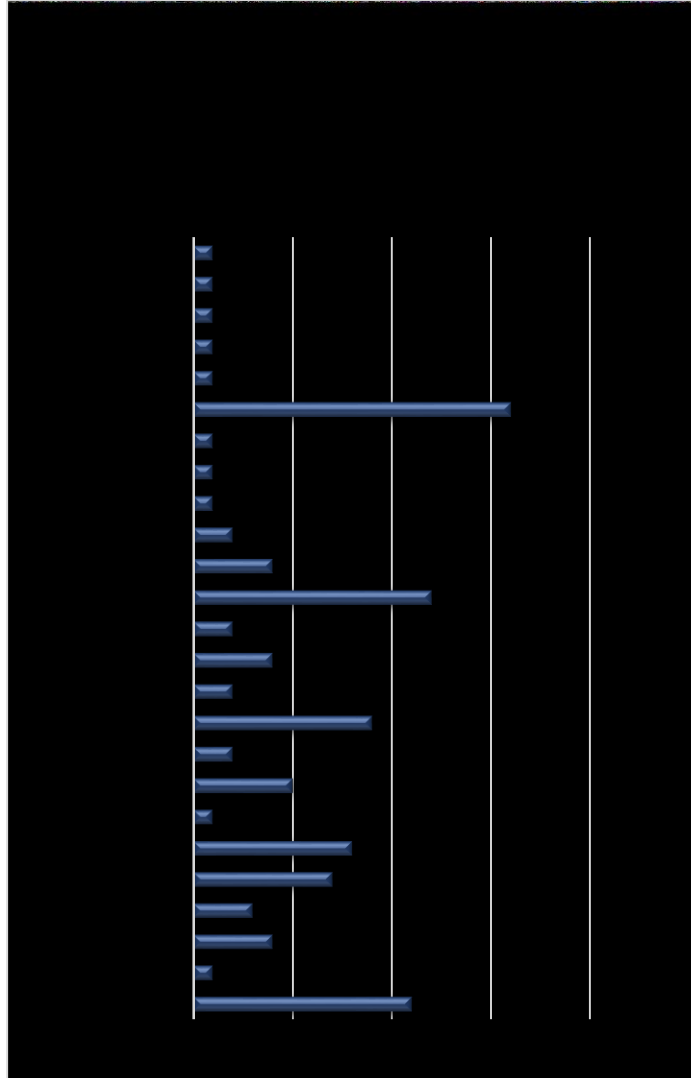


Figure 22. Geographical analysis of alien species reports according to the location site

In recent assessments of the dynamics of dispersion and population of the alien species in the Mediterranean, it has been stated that one of the main factors in the expansion of these species is maritime transport and all that this includes (Katsanevakis & Crocetta, 2014) i.e. transport via fouling, floating waters and also predefined and always fixed sea routes. This main phenomenon is also supported by other elements such as the aquaculture trade of aquariums have been identified among the most important (in descending order).

This phenomenon is also confirmed by the analysis of the data reported on the species according to the location in which they were reported (Figure 3). From the graph, it can be seen that the greatest number of species reported, is in two of the major ports of Albania: the port of Durres and Vlora Bay. Currently, the Durres marine area has the highest number of alien species as all the ports in this area have been reported with the same location, however, the Vlora area should also include Oricumi Lagoon, Shen Vasil Bay and Shen Jan Bay and also part of the Karaburuni Peninsula. But since these two areas are geomorphologically and ecologically different, we preferred

to report more than one area in the case of the Bay of Vlora since it has rocky shores and soft bottom sea beds. The sites with the greatest presence of alien species reported are also consistent with the presence of one or more aquaculture plants, as in the case of Lake Butrinti (Lagoon) where there is an aquaculture of *Mytilus galloprovincialis*. The species reported in this lagoon are directly related to aquaculture (Osca & Crocetta, 2020). The same is true for the Porto Palermo site where there is currently both a fishing port and a sea bream aquaculture plant. Also, for the Bay of Vlora, where there is an extensive aquaculture activity of sea bream *Sparus aurata* and sea bass *Dicentrarchus labrax* (Udhezuesi for ZPA, 2020).

New locations of alien species distribution

***Styela plicata* (Lesueur, 1823)**

Styela plicata is a worldwide distributed solitary ascidian with mostly unknown origins although some suggestions show its origin in the northwestern Pacific Ocean (Barros et al., 2018; Yokeş et al., 2018). Its presence is often connected to the fouling phenomenon on boats and fishing tools. Here is presented the presence of this species in the aquaculture facilities of Vlora Bay, where it often creates problems with the overpopulation of the aquaculture cage networks. The presented photo (figure 4) was identified by one of the students of the "Aquaculture and fish hygiene" program of the University of Vlora, during his professional practice in January 2023.



Figure 23. *Styela plicata* (Lesueur, 1823) on the aquaculture equipment

***Pterois miles* (Bennett, 1828)**

Since the first sighting of the lion fish *Pterois miles* (Bennett, 1828) in the Mediterranean in 1991 (Golani and Sonin 1992) this species has been widespread across almost all the coasts of the Aegean Sea (Dimitriadis et al., 2020), also reaching the sea coasts Ionian and Adriatic in 2019 (Di Martino & Stancanelli, 2021; Crocetta et al., 2021) counting its presence in Saranda and Dhermi (Table 1). This species is considered among the most invasive and dangerous for the Mediterranean biome, it is in fact, endowed with great voracity and high reproductive rate, characteristics that make it one of the greatest dangers for Mediterranean species (Di Martino & Stancanelli, 2021).

During an underwater tourist visit near the Karaburun Peninsula, this species was sighted in depths of 2-2.5 m. The specimen observed in the Karaburun Peninsula was photographed (Figure 4) on August 2022 in the following coordinates: 40.3244608 N; and 19.3704426 E, and was sent by chance to our group of researchers. We could say that this find is a good example of the citizen science in the city of Vlora.



Figure 24. *Pterois miles* (Bennett, 1828) (Photo Oazi Blu 2022)

Oxynotus centrina (Linnaeus, 1758)

The shark *Oxynotus centrina* (Linnaeus, 1758) is a rarely reported species in the Albanian waters. Its distribution is throughout the Mediterranean Sea and the eastern Atlantic from the British Isles in the north to South Africa in the south (Compagno, 1984). Although it exists in the lists of fish fauna of Albania (Soldo & Bakiu, 2021), due to the rarity of the species, little is known about its distribution and biology within these waters. Here is reported the capture of a shark *Oxynotus centrina* in the off-shore waters of Vlora in 2021. The photos were sent by the fishermen to the University of Vlora, to ask for information about the species since they had never seen it before.



Figure 6. *Oxynotus centrina* (Linnaeus, 1758)

Conclusions and Recommendations

Considering the growing expansion of alien species in the Mediterranean Sea, Albania could not stand up to this invasion. The introduction of alien marine species into Albanian waters has occurred at an alarming rate and is likely to increase in the future. However, even if the contribution of researchers is invaluable regarding the presence of these species, the need arises to build a national database for the reporting of these species, for the possible danger and also for the collection of data on their distribution.

We hope that this article provides valuable information on the need to fund research on this area to update the list of marine alien species of Albanian waters.

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