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REVIEW ARTICLE

Review of alien decapods (Crustacea) in the Aegean Sea

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Abstract

The whole Aegean Sea hosts 27 alien decapod crustaceans (21 Indo-Pacific, 6 Atlantic species). Ten of these species (3 Dendrobranchyata, 1 Caridea, 6 Brachyura) were only reported along the Greek coasts of the Aegean Sea. Among them, six species were originated from the Indo-Pacific areas and four species from the Atlantic coasts. On the other hand, 6 of the 27 alien decapods were collected only on the Turkish Aegean coasts (5 Indo-Pacific species, 1 Atlantic species). The possible causes for this differentiation could be attributed to several factors.

Key words: invasive species, decapods, crustaceans, Aegean Sea, Mediterranean Sea

Introduction

Many alien species have been introduced to the Mediterranean Sea via two different pathways (i.e. the Suez Canal and shipping). A total of 955 alien species are known in the Mediterranean and the vast majority of them were reported from the eastern Mediterranean (718 species), less from the western Mediterranean (328), central Mediterranean (267) and Adriatic Seas (171). Of these, 535 species (56%) have become established in at least one area (Zenetos *et al.* 2010). It is worth noting that aliens have increased the total species richness of the Mediterranean Sea by 5.9% (Zenetos *et al.* 2010).

The eastern Mediterranean is more susceptible to biological invasions because of its location between the Atlantic, Pontic and Indo-Pacific regions, busy maritime traffic, and lagoons and bays that are crowded with fish and shellfish farms. Some invaders have outcompeted or replaced native species locally,

some are considered pests or cause nuisance, whereas other invaders are of commercial value (Galil and Zenetos 2002). The native range of four-fifths of the alien crustacean in the Mediterranean is in the Indo-Pacific Ocean, Indian Ocean and Red Sea (Zenetos *et al.* 2010). According to the most recent data, a total of 119 alien crustaceans have been reported in the eastern Mediterranean and 58 species belong to decapod crustaceans (Zenetos *et al.* 2010), presenting an accelerating entrance rate (Koukouras *et al.* 2010).

The Aegean Sea could be considered as a special place in the Mediterranean ecosystem in terms of its regional position, geomorphological structure, hydrographical and ecological features. The first Indo-Pacific decapods were collected in the recent years from the Greek coast of the Aegean Sea (Kevrekidis and Kevrekidis 1996; Galil 2007). Most of the alien decapods crustaceans observed in the Greek waters of the Aegean Sea have been encountered only in the south-eastern part of this sea (Dodecanese islands) and their occurrence decreasing substantially northwards and westwards (e.g. Pancucci-Papadopoulou *et al.* 2005a; ELNAIS 2010; Corsini-Foca *et al.* 2010). According to Simboura and Nicolaidou (1993), the hydrological conditions around the Rodos Island and Levantine Sea are similar, thus, a remarkable number of decapods having an Indo-Pacific origin have been established in this area (Kevrekidis and Galil 2003). The most recent data (Zenetos *et al.* 2011) point out that the alien marine crustaceans are almost accounted for 13.1% (31 species) of the total alien species reported along the Greek coasts (237 species).

Turkey is surrounded by four seas (Levantine Sea, Aegean Sea, Sea of Marmara and Black Sea) with different hydrographical characteristics. A total of 400 alien species belonging to 14 taxonomic groups occur along the Turkish coasts up to 2010, with the crustacean being the third group (64 species) after Mollusca (105 species) and Polychaeta (75 species) (Çinar *et al.* 2011). The majority of these species (306 species, 76% of the total number of species) have become established in the area, while 59 species (15%) are classified as casual, 23 species as questionable and 13 species (3%) as cryptogenic (Çinar *et al.* 2011). The proximity of Turkey to the Suez Canal has resulted in dense settlements of Indo-Pacific migrants (66% of the total alien species in Turkish waters), especially in habitats along the Levantine coast of Turkey. In the last years, some of them have expanded their distributional ranges to other areas of the Aegean Sea, i.e. Gökova Bay (Ateş *et al.* 2007; Yokes *et al.* 2007) or even more northern, like *Alpheus rapacida* in Kuşadasi Bay (Özcan *et al.* 2007). In the Aegean Sea 165 alien species have been found and 69% of these species have been found only in the period 2005-2010 (Çinar *et al.* 2011).

Taking into consideration that the Turkish Aegean is bounded from Dalaman River- in southern Turkey, near Marmaris, Fethiye and Dalyan- to the opening of the Dardanelles and the Greek Aegean includes the areas of Dodecanese, the Cyclades Islands, E. Peloponnesus, central and the south Aegean, this paper

attempts to review the presence of the alien decapods reported from the Greek and the Turkish coasts of the Aegean Sea. This report was based on scientific articles about the presence of alien decapods along the Greek and the Turkish Aegean coasts and constitutes the first comprehensive baseline study for comparative purposes in the future.

Results and Discussion

Table 1 shows a list of the alien decapod crustaceans found along the Greek and the Turkish Aegean coasts. These species have different origins, including Indo-Pacific, the Red Sea, the Indian, the Atlantic and the Pacific Ocean. Most of the decapods listed in Table 1 are considered as established species in both Aegean coasts. Seven decapods were recorded only once and considered as casual species. As there is no definite evidence of its native or introduced status, *Synalpheus tumidomanus africanus* and *Thalamita poissonii* were considered as cryptogenic species. The most common pathway of the Lessepsian decapod species is the Suez Canal and shipping, while the Atlantic species were introduced to the area via shipping.

A total of 27 decapods were found on the both coasts of the Aegean Sea (Table 1). Among these, 11 species were common in both coasts. Almost all these species, such as *M. japonicus, A. rapacida, A. roseus, C. tenuipes, C. helleri, C. longicollis, I. monodi, M. graeffei, M. subgranulata, P. segnis, T. poissoni* are also known from the Levantine Sea. According to CIESM Atlas (Galil *et al.* 2002) *C. sapidus* was transported by ballast waters from the Atlantic in the eastern Atlantic and Mediterranean ports and some special particularities of its ecology and biology (eurythermal and euryhaline, high fecundity, aggressive, good swimmer) contributed to its broad extension in the whole Mediterranean basin.

Table 1. Alien decapod crustaceans found on the Greek and the Turkish coasts of the Aegean Sea.

Species	**Origin**	**Vector**	**Establishment success**	**Reference (Greek Aegean)**	**Reference (Turkish Aegean)**
Marsupenaeus japonicus (Bate, 1888)	Indo-Pacific	Via Suez	established	Kevrekidis and Kevrekidis, 1996	Zaitsev and Öztürk, 2001
Melicertus hathor (Burkenroad, 1959)	Indian Ocean	Via Suez	established		Özcan *et al*. 2008
Metapenaeopsis aegyptia (Galil & Golani, 1990)	Indo-Pacific	Via Suez	established	Kevrekidis *et al.* 1998	

Table 1 Continued.

Species	Origin	Vector	Establishment success	Reference (Greek Aegean)	Reference (Turkish Aegean)
Metapenaeopsis mogiensis consobrina (Nobili, 1904)	Indo W. Pacific	Via Suez	established	Kevrekidis *et al.* 1998	
Metapenaeus affinis (H. Milne Edwards, 1837)	Indo W. Pacific	Shipping	established		Aydin *et al*. 2009
Trachysalambria curvirostris (Steinitz, 1932)	Red Sea	Via Suez	established	Kevrekidis *et al.* 1998	
Alpheus rapacida (De Man, 1908)	Indo W. Pacific	Via Suez	established	Pancucci-Papadopoulou *et al*. 2005a	Özcan *et al*. 2008
Leptochela pugnax (De Man, 1916)	Indo W. Pacific	Via Suez	established		Ateş 2003
Processa macrodactyla (Holthuis, 1952)	Tropical East Atlantic	Via Gibraltar	established		Ateş *et al.* 2004
Synalpheus tumidomanus africanus (Crosnier & Forest, 1965)	Tropical East Atlantic	Via Gibraltar	cryptogenic	Koukouras and Kattoulas, 1974	
Atergatis roseus (Ruppell, 1830)	Indo-Pacific/ Red Sea	Via Suez	established	Corsini-Foka and Pancucci-Papadopoulou, 2010	Yokes *et al*. 2007
Calappa pelii (Herklots, 1851)	Atlantic	Shipping	casual	Pancucci-Papadopoulou *et al*. 2005b	
Callinectes sapidus (Rathbun, 1896)	Atlantic	Shipping	established	Serbetis, 1959	Kocataş 1971
Carupa tenuipes (Dana, 1851)	Indo-Pacific	Via Suez	established	Pancucci-Papadopoulou *et al*. 2005a	Yokes *et al*. 2007
Charybdis helleri (A. Milne-Edwards, 1867)	Indo W. Pacific	Via Suez	established	Kirmitzoglou *et al.* 2006	Yokes *et al*. 2007

Table 1 Continued.

Species	Origin	Vector	Establishment success	Reference (Greek Aegean)	Reference (Turkish Aegean)
Charybdis longicollis (Leene, 1938)	Indo-Pacific	Via Suez	established	Galil and Kevrekidis, 2002	Yokes *et al*. 2007
Gonioinfradens paucidentatus (A. Milne Edwards, 1861)	Indo-Pacific	Via Suez	casual	Corsini-Foka *et al.* 2010	
Ixa monodi (Holthyis & Gottlieb, 1956)	Red Sea	Via Suez	established	Galil and Kevrekidis, 2002	Ceyhan and Akyol 2008
Coelusia signata (Paulson, 1875)	Indo-Pacific	Via Suez	casual	Corsini-Foka *et al.* 2006	
Macrophthalmus graeffei (A. Milne Edwards, 1873)	Indo-Pacific	Via Suez	casual	Pancucci-Papadopoulou *et al*. 2010	Ateş 2003
Micippa thalia (Herbst, 1803)	Indo-Pacific	Via Suez	established		Yokes *et al*. 2007
Myra subgranulata (Kossmann, 1877)	Indian Ocean/ Red Sea	Via Suez	casual	Corsini-Foka and Kondilatos, 2006	
Percnon gibbesi (A. Milne Edwards, 1853)	Atlantic	Via Gibraltar	established	Thassalou-Legaki *et al*. 2006	
Pilumnus minutus (De Haan, 1835)	Indo-Pacific	Via Suez	casual		Kocataş and Katağan 2003
Portunus segnis (Forskal, 1775)	Indian Ocean	Via Suez	established	Corsini-Foka *et al.* 2004	Yokes *et al*. 2007
Sirpus monodi (Gordon, 1953)	Atlantic	Shipping	casual	Pancucci-Papadopoulou and Naletaki, 2007	
*Thalamita poissonii** (Audouin, 1826)	Indo-west Pacific	Via Suez	cryptogenic	Kalopissis and Kalopissis, 1984	Kocataş 1981

*According Koukouras *et al.* (2010) this species has erroneously been considered as a Lessepsian migrant, since is a tropical-subtropical cosmopolitan species (D'Udekem D' Acoz 1999)

A total of 10 species (3 Dendrobranchyata, 1 Caridea, 6 Brachyura) were reported only on the Greek coasts of the Aegean Sea. Almost the half of them (*Synalpheus tumidomanus africanus*, *Percnon gibbesi*, *Calappa pelii* and *Sirpus monodi*) have the Atlantic origin, while the rest (*Metapenaeopsis aegyptia, Metapenaeopsis mogiensis consobrina, Trachysalambria curvirostris, Coelusia signata, Myra sudgranulata* and *Gonioinfradens paucidentatus*) have the Indo-Pacific origin. Most of these decapod species have already been recorded from the Turkish coasts, but not in the Aegean coast so far. For example, *C. signata* (Yokes and Galil 2006a), *P. gibbesi* (Yokes and Galil 2006b) and *M. aegyptia, M. mogiensis consobrina* and *T. curvirostris* (Yokes and Galil 2006a) were known from the Levantine coast of Turkey. The most recent data show that the grapsoid crab, *P. gibbesi* occurs in the Greek Aegean coast and in the Levantine coast of Turkey, but has not reported from the Turkish Aegean coast till now (Katsanevakis *et al.* 2011). This tropical Atlantic crab may be regarded as one of the most invasive decapod species in the Mediterranean Sea (Katsanevakis *et al.* 2011).

On the other hand, a total of 6 alien decapods were only collected on the Turkish Aegean coasts. Among them, 5 species (*Melicertus hathor, Metapenaeus affinis, Leptochela pugnax, Micippa thalia* and *Pilumnus minutus*) have Indo-Pacific origins and expanded their distributional ranges to the Aegean Sea. Only the caridean shrimp, *Processa macrodactyla* was entered to the Mediterranean by the Gibraltar Strait and it was recorded only on the Turkish coasts of the Aegean Sea. This species was also recorded in the Spanish waters (García Raso and Salas Casanova 1985).

The success of Indo-Pacific migrant decapods in the colonization of the eastern Mediterranean could be the result of occupation of an unsaturated niche and of out-competing local species on resources such as food and shelter (Golani, 1998). The similar number of the alien decapods found on both sides of the Aegean Sea could be attributed to the similar oceanographic sea parameters prevailed in both sides (Poulos *et al.* 1997). The alien decapods found in both Aegean coasts were previously reported from the Levantine Sea. It seems that they tended to expand their distributional ranges towards higher geographical latitudes (Koukouras *et al.* 2010). The timing of the initiation of a significant increase in the number of Indo-Pacific aliens along the southwestern Levantine and the southern Aegean coasts was positively correlated with the extensive inflow of the warm-water AMC (Katağan *et al.* 2004) and the following significant changes of the south Aegean waters mass characteristics termed the Eastern Mediterranean Transient (EMT) (Galil and Kevrekidis 2002). The alien decapods of Atlantic origin found only on the coasts of Greece could be attributed to fortuitous factors, such as the different sampling frequency of samplings, different methods used in biological investigations in both countries. Further surveys in broader sampling depths and covering more marine zones

will supply more detailed results and could give a better view concerning the alien decapods in the whole Aegean Sea.

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