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The role of the Aquarium of Rhodes (eastern Mediterranean Sea) on raising public awareness to marine invasions, with a note on the husbandry and trade of marine aliens

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Abstract: A total of 33 alien species collected from the wild, has been listed among the displays of the public Aquarium of Rhodes (Greece), mainly since 2000. The essential contribution of the Aquarium to document the intensification of marine alien species introduction, disseminate knowledge and increase public awareness on the ecological and socio-economic risks linked to biological invasions is underlined. The diffusion of aliens in other eastern Mediterranean Aquaria is reported. The potential use of these organisms in the aquarium trade and its eventual effects on marine ecosystems are discussed. Details on collection and aquarium maintenance conditions are also provided.

Résumé: *Le rôle de l'Aquarium de Rhodes (Mer Méditerranée orientale) pour sensibiliser le public aux invasions marines, ainsi qu'une note sur la gestion du marché des espèces exotiques.* Un total de 33 espèces exotiques prélevées dans le milieu naturel a été répertorié depuis le début des années 1980 dans les bassins de l'Aquarium public de Rhodes (Grèce), surtout depuis 2000. La contribution essentielle de l'Aquarium à documenter l'intensification de l'introduction d'espèces exotiques marines, à disséminer la connaissance et à sensibiliser le public sur les risques écologiques et socio-économiques associée aux invasions biologiques est mis en évidence. La diffusion d'espèces exotiques dans d'autres Aquariums de la Méditerranée orientale est signalée. L'utilisation potentielle de ces espèces exotiques dans le commerce aquariophile et ses effets éventuels sur les écosystèmes marins sont discutés. Des détails sur la collecte et les conditions de maintenance sont aussi fournis.

Keywords: Mediterranean Sea ● Biological invasions ● Aquarium missions ● Environmental education ● Aliens display ● Marine ornamental

Introduction

Rhodes Island (Greece) is situated in the southeastern Aegean Sea, at the limits of the northwestern Levantine Sea, an interesting oceanographic position, due to the intense hydrological phenomena of the surrounding marine area (Pancucci-Papadopoulou et al., 2012). Its pelagic and subtropical environment is favorable to native thermophilic biota (Papaconstantinou, 1988) and to tropical or sub-tropical alien biota as well (the term "alien species" follows the definition of the Convention on Biological Diversity). This marine region presents therefore a great zoo-geographical significance for the whole Mediterranean, as

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it is the first Aegean area which Red Sea/Indo-Pacific Ocean aliens introduced via the Suez Canal (the so-called Lessepsian migrants) meet in their way from the Levantine following the Asia Minor coasts, and the main pathway of their further spreading (Corsini-Foka & Pancucci-Papadopoulou, 2012). In fact, most of the earlier alien species reported in the Greek waters of the Aegean Sea, but also many other recently signalled were firstly recorded in the above area (Zenetos et al., 2009; ELNAIS, 2013).

During the last two decades, an intensification of the spread out of alien species has been observed in the region. In addition to the above mentioned oceanographic characteristics, the intensification of arrivals and spreading was supported by other natural phenomena, such as the evolution of the East Mediterranean Transient (EMT), and it was furthermore amplified by climate changes and the rise of sea temperature (Galil & Kevrekidis, 2002; Raitsos et al., 2010; Pancucci-Papadopoulou et al., 2012). However, the increase in the number of known species is also to be coupled to the increased interest of the scientific community to the phenomenon and to the scientific effort exerted in research on various taxa (Golani, 2010).

Up to date and taking into account the recent review on alien species in the Mediterranean Sea by Zenetos et al. (2012), non indigenous biota reported in the marine area of Rhodes and the southern islands of the Dodecanese Archipelago account 105 species, about all warm-water, the majority (86 %) entered via the Suez Canal from the Red Sea/Indo-Pacific Ocean. They constitute approximately 42 % of the total marine aliens registered in the Greek seas (Corsini-Foka & Pancucci-Papadopoulou, 2012; Pancucci-Papadopoulou et al., 2011 & 2012).

The Hydrobiological Station of Rhodes with its public Mediterranean life Aquarium, constitutes a unit of the Hellenic Centre for Marine Research (www.hcmr.gr), where activities addressed to education, research, conservation and visitors recreation are performed, integrating each other and interacting (Corsini-Foka, 2010a).

The present study focuses on the role that the Aquarium has assumed in increasing public awareness on biological invasions and their ecological and socio-economic impact. The occurrence of aliens in other eastern Mediterranean Aquaria and their possible use in the marine ornamental trade is discussed. Life support systems and water parameters along with behavioral observations on alien species recorded in the displays are furthermore described.

Materials and Methods

Sample collection

Most of the organisms intended for the stocking of the tanks were collected mainly from the near shore waters of the island (1-50 m depth), through experimental fishing using professional vessels for boat seining, a traditional method performed in coastal fishery, which was banned for depths less than 50 m since June 2010 (EC Fisheries Regulation n°1967/2006). Other experimental methods currently applied for the Aquarium purposes, are fishing with nets, fishing rods, and, sometimes, traps, long lines, scuba diving and/or snorkelling.

Operation of the Aquarium and maintenance of organisms

The main maintenance data for marine species are summarized in Table 1. Profiles and trends of seawater temperature values obtained in the older open system (1985-2001) and in a more recent one (2001-2008) have been already analyzed (Pancucci-Papadopoulou et al., 2011 & 2012).

Properly developed protocols for collection, prevention treatment, acclimatization and growth of aquatic animals, crucial for the overall sustainability of such establishment, are applied.

Carnivorous organisms are fed daily on defrozen feed-stuff such as shrimps, mussels, squids, octopuses and fishes (mainly picarels, blotched picarels, bogues and round sardinellas), prepared according to the size and species of the targeted organism. In contrast to the invertebrates, generally imported frozen from India, China and Chile and bought at the local markets, fish is collected fresh through experimental samplings performed by the HSR or from the local commercial fishery and subsequently frozen at the HSR facilities. It is worth to mention that the alien *Etrumeus teres* (DeKay, 1842), caught with purse-seine by professional fishermen, has been recently added to the variety of food species, due to its abundance during 2012 and 2013. Herbivorous organisms are fed on algae, frozen vegetables and the respective pellets for herbivores. Phytoplankton and *Artemia* nauplii are administered when necessary.

Census of livestock

Over the last 10 years the census of the aquatic organisms in terms of species and their population in the Aquarium is applied every 6 months, whereas during the previous years this was performed yearly.

Results

The average number of marine fauna stocked and displayed at the Aquarium is 80 species, equally distributed among a variety of invertebrates (mainly sea-anemones, polychaetes, molluscs, crustaceans and echinoderms) and fish species.

The archived data obtained from October 1985 to

Table 1. Main operational data and maintenance conditions of marine organisms at the Aquarium of Rhodes.

WCS	Years of operation	Depth of water inlet	Total volume (L)	Number of tanks	Tank volume (L)	T (^{0}C) Monthly averages		Salinity	Filtration	Lighting
O1	-2001	3 m Well in the beach	70000	42	50-24000	15-16 W	24-25 Su	39-39.4	Natural	HQI, Fluorescent
O2	2001-2008	32 m Directly at sea	70000	42	50-24000	16-17 W	22-25 Su	39-39.4	Sand filters	HQI, Fluorescent
O3	2009-	13 m Well in the beach	70000	42	50-24000	22-24 Au	19-20 Su	35-37	Sand filters	HQI, Fluorescent
C1	2005-2008		1000	10	100	Air		39-39.4	LSS	Fluorescent
C2	2009-		1000	1		20-21.5		35-37	LSS	HQI

WCS, Water Circulation System; O1, O2, O3, Open Circulation Systems; C1, C2, Closed Circulation Systems; T, seawater temperature; W, winter; Su, summer; Au, Autumn; LSS, Life Support System (Biological and mechanical filter, UV lamp and skimmer).

October 2012 showed that the number of alien species present in the tanks reached a total of 33 (2 phytobenthic, 17 zoobenthic and 14 fish species), the majority tropical-warm water species, most of Red Sea/Indo-Pacific origin (Table 2). 79% of these aliens (26 species) have appeared in the exhibits since 2000, half of them in the last four years. They constituted 22% of the total species of the exhibition, following the first 2012 semester census. Successful maintenance in the Aquarium facilities was observed for 67% of aliens.

A preliminary investigation on alien display in other eastern Mediterranean public Aquaria showed that eight of the non native species reported at the Aquarium of Rhodes are included in their exhibits (Table 3).

Observations and remarks on alien biota in captivity conditions

Caulerpa racemosa var. cylindracea (Sonder) Verlaque, Huisman & Boudouresque is relatively easy to keep, and grows quite fast using HQI lamps or fluorescent (6500-10000 °K) in both open and closed systems. Despite the proper illumination regime and substrate, the maintenance of *Halophila stipulacea* (Forsskål) Ascherson had no success up to date.

The first samples of the recent incomer *Cassiopea andromeda* (Forsskål, 1775) (Nikolaidou et al., 2012) were successfully maintained in a devoted reservoir, under intense lighting and fed upon newly hatched brine shrimps as supplemental food (Pearce-Kelly et al., 1991). Specimens of another new incomer, *Phallusia nigra* Savigny, 1816 (cf ELNAIS, 2013) were only once introduced in the Aquarium and demonstrated difficulties in maintenance. In general, this ascidian is a very sensitive species when it comes to aquarium keeping and furthermore, there are dietary issues as no data are available in the literature. The maintenance of the spotted sea hare *Aplysia dactylomela* Rang, 1828, abundant in the field at 0-1 m depth in small ports, pools and stagnant waters, depends prevalently on a correct nutrition based on algae collected at field or growing on the tank walls.

Almost all the remaining alien invertebrates show a great durability in aquarium conditions, especially brachyurans. Individuals of *Percnon gibbesi* (H. Milne Edwards, 1853), *Atergatis roseus* (Rüppell, 1830) and the five portunids (Table 2) are regularly present in the displays. Among the portunids, *Thalamita poissonii* (Audouin, 1826), abundant on the port wharfs and used as bait for fishing rod, is prevalently herbivorous in captivity, while the remaining four are carnivorous. *Charybdis hellerii* (A. Milne-Edwards, 1867), *Portunus segnis* (Forsskål, 1775), *Gonioinfradens paucidentatus* (A. Milne Edwards, 1861) and especially *Callinectes sapidus* Rathbun, 1896, show an aggressive behavior against co-specific individuals. Although egg-bearing females of *P. gibbesi*, *G. paucidentatus* (Fig. 1) and *P. segnis* have been sometimes introduced, only very recently the release of zoeae was observed for the first time. It was the case of an ovigerous female of the pelagic swimcrab *P. segnis* (carapace length 61 mm, width 140 mm), caught on 12 April 2012 (nets, 5 m depth, sandy bottom, sea surface temperature 17.5°C, salinity 39.1) and introduced in a display tank of 2000 Lit (seawater temperature 19.8-19.9°C, salinity 37, Ph 8.8, photoperiod 13 hours). On 30 May, under the same physicochemical conditions and lighting, zoeae were observed (Fig. 2). Due to the presence of *Diplodus puntazzo* (Walbaum, 1792) individuals feeding on them, a large number of zoeae was removed and transferred in appropriate reservoir, under the same above conditions. Larvae were fed on rotifers and *Artemia* nauplii (Arshad et al., 2006), but they survived few days.

The keeping of alien fish shows the same problems

Table 2. Information on the collection and maintenance of alien species at the Aquarium of Rhodes.

Origin*	Species	Date	MC	WCS	Diet	MS
	Chlorophyta					
IP	*Caulerpa racemosa* var. *cylindracea* (Sonder)	2002	1	O, C2		VG
	Spermatophyta					
RS	*Halophila stipulacea* (Forsskål) Ascherson	1992	2, 3	O		NO
	Cnidaria					
IP	*Cassiopea andromeda* (Forsskål, 1775)	2011	1	C1	*Artemia* nauplii, formulated diets	A
	Crustacea					
I/RS	*Erugosquilla massavensis* (Kossmann, 1880)	2011	3	O	Mussel, shrimp, fish	A
IP	*Marsupenaeus japonicus* (Bate, 1888)	2001	3	O	Mussel, shrimp	A
I/RS	*Myra subgranulata* Kossmann, 1877	2004	3	O, C1	Mussel, shrimp	VG
WAT	*Percnon gibbesi* (H. Milne Edwards, 1853)	2010	1	O, C2	Chlorophyta,	VG
WAT	*Callinectes sapidus* Rathbun, 1896	2005	3	O	Mussel, shrimp, fish	VG
IWP	*Charybdis hellerii* (A. Milne-Edwards, 1867)	2011	3, 4	O	Mussel, shrimp, fish	VG
IP	*Gonioinfradens paucidentatus* (A. Milne Edwards, 1861)	2011	3, 4	O	Mussel, shrimp, fish	VG
I	*Portunus segnis* (Forsskål, 1775)	2000	2, 3	O, C1, C2	Mussel, shrimp, fish	VG
IWP	*Thalamita poissonii* (Audouin, 1826)	2010	1, 3, 4	O, C1	Chlorophyta	VG
IP	*Atergatis roseus* (Rüppell, 1830)	2011	3, 4	O, C2	Mussel, shrimp	VG
	Mollusca					
IP/RS	*Pinctada radiata* (Leach, 1814)	2010	1	O	Phytoplankton	VG
I/RS	*Cerithium scabridum* Philippi, 1848	2008	1	O	Algae	VG
PG	*Conomurex persicus* (Swainson, 1821)	1992	1	O, C1	Phytoplankton, mussel, shrimp	VG
CT	*Aplysia dactylomela* Rang, 1828	2010	1	O	Natural algae	A
	Echinodermata					
IP	*Synaptula reciprocans* (Forsskål, 1775)	2006	1	O	Mussel, shrimp	VG
	Ascidiacea					
CT	*Phallusia nigra* Savigny, 1816	2010	1	O	Phytoplankton, mussel broth, shrimp	A
	Bony fishes					
IP	*Sargocentron rubrum* (Forsskål, 1775)	<1985	2, 3, 4	O	Fish, mussel	VG
IP	*Fistularia commersonii* (Rüppell, 1835)	2004	2, 3	O	Fish	A
IP	*Apogonichthyoides (Apogon) pharaonis* (Bellotti, 1874)	2002	2	O	Fish, mussel	VG
IP	*Upeneus moluccensis* (Bleeker, 1855)	2004	2, 3	A	Mussel, shrimp, fish	NO
IP	*Sphyraena chrysotaenia* Klunzinger, 1884	2001	2, 3	A	Mussel, shrimp, fish	NO
I	*Pteragogus pelycus* Randall, 1981	1994	2, 4	O, C1, C2	Mussel, shrimp	VG
I	*Petroscirtes ancylodon* Rüppell, 1838	2009	2, 3	C1	Mussel, shrimp, fish	A
IP	*Callionymus filamentosus* Valenciennes, 1837	2012	3	O	Fish, mussel	VG
IP	*Siganus luridus* (Rüppell, 1829)	<1985	2, 3	A, K2	Mussel, algae, pellets , vegeta-bles	VG
IP	*Siganus rivulatus* Forsskål, 1775	<1985	2, 3	A, K2	Mussel, algae, pellets, vegeta-bles	VG
RS	*Stephanolepis diaspros* Fraser-Brunner, 1940	<1985	2, 4	A, K2	Mussel, shrimp, fish	VG
RS	*Lagocephalus suezensis* Clark and Gohar, 1953	2006	2, 3	O, C1	Mussel, shrimp, fish	A
IP	*Lagochephalus sceleratus* (Gmelin, 1788)	2007	2, 3, 5	O, C1, C2	Squid, mussel, shrimp, fish	VG
I	*Torquigener flavimaculosus* Hardy and Randall, 1983	2011	2, 3	K2	Mussel, shrimp	VG

* From Zenetos et al., 2009 & 2010

IP, Indo-Pacific; RS, Red Sea; I, Indian; WAT, West Atlantic; IWP, Indo-West Pacific; PG, Persian Gulf; CT, Circumtropical; Date, Year of first introduction in the Aquarium; MC, Methods of collection; 1, by hand; 2, boat seining; 3, nets; 4, traps; 5, long lines; 6, fishing rod; WCS, Water Circulation System; O, Open Circulation System; C, Closed Circulation System (see Table 1); MS, Maintenance success; VG, very good; A, average; NO, no success.

Table 3. Alien species collected in the Aegean Sea and/or Levantine Sea, exhibited today in some eastern Mediterranean public Aquaria, excluding Rhodes Aquarium.

Name of Aquarium, country, year of establishment	Species								References
	C.aulerpa racemosa	*Callinectes sapidus*	*Sargocentron rubrum*	*Siganus luridus*	*Siganus rivulatus*	*Stephanolepis diaspros*	*Pteragogus pelycus*	*L.agocephalus sceleratus*	
Alexandria Aquarium Egypt, 1930s			+		+	+	+	+	N. A. Shabana, 2013, pers. comm.
Ocean Aquarium Cyprus, 1999			+	+	+			+	N. Koutsoloukas, 2012, pers. comm.
Syros Aquarium Greece, 2000				+	+	+			A. Dimitropoulos, 2013, pers. comm.
Cretaquarium, Greece, 2005	+	+		+	+	+	+	+	A. Sterioti, 2012, pers. comm.; Thessalou-Legaki et al., 2012
Istanbul Aquarium Turkey, 2011			+	+					P.G. Miguel, 2013, pers. comm.
Antalya Aquarium Turkey, 2012			+	+		+			E. Çağlar, 2013, pers. comm.

encountered for autochthonous ones, since they share the same collection methods and captivity conditions. For example, the outbreaks of the protozoan *Cryptocaryon irritans* Brown, 1951, appearing in certain cases at temperatures > 22°C, affect indiscriminately native and non native bony fishes.

Apart the above, alien fishes do not show any special difficulties in their maintenance (Table 2), both the earlier and more recent colonizers (Corsini & Stamatellos, 1999; Golani, 2010; Corsini-Foka, 2010b), except *Sphyraena*

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Figure 1. An egg-bearing female of *Gonioinfradens paucidentatus*.

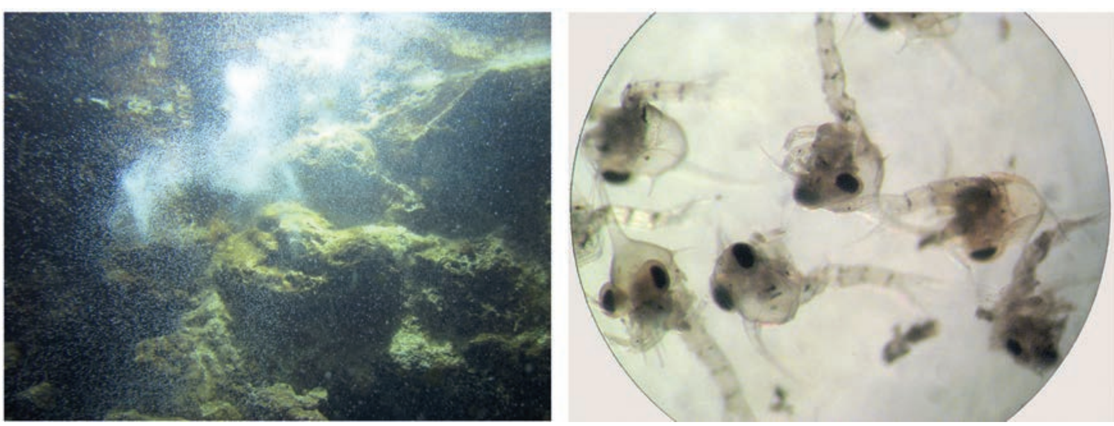

Figure 2. Zoeae of *Portunus segnis* newly hatched on 30 May 2012 in a tank (left) and under the stereoscope (Zoea 1, abdomen-telson length 1.0-1.2 mm) (right).

chrysotaenia Klunzinger, 1884 and *Upeneus moluccensis* (Bleeker, 1855), two species that always suffer serious external injuries when collected by experimental boat seining or nets, despite the proper handling during sampling.

Specimens of *Fistularia commersonii* (Rüppell, 1835), with standard length > 40 cm resulted difficult to manage. However, when young specimens of standard length 20-30 cm, were introduced in a tank along with young picarels, the results were encouraging as they survived for several months. Picarels are part of the bluespotted cornetfish's natural diet (Corsini-Foka, 2010b) and they were added in order to facilitate its acclimatization until the uptake of defrosted food was feasible.

Among Tetraodontidae, *Lagocephalus suezensis* Clark & Gohar, 1953, although common, was kept in very few occasions, while *Lagocephalus sceleratus* (Gmelin, 1788), quite abundant (Corsini-Foka, 2010b), is an almost constant guest both in open or closed water circulation systems (Table 2). Young specimens of 10-30 cm in standard length, form herds and prefer swimming over sandy substrates and in shadowy areas (Fig. 3). When single individuals of 30-40 cm in length share the tank with red porgies and European seabasses, they tend to follow the swim pattern of the cohabitant species.

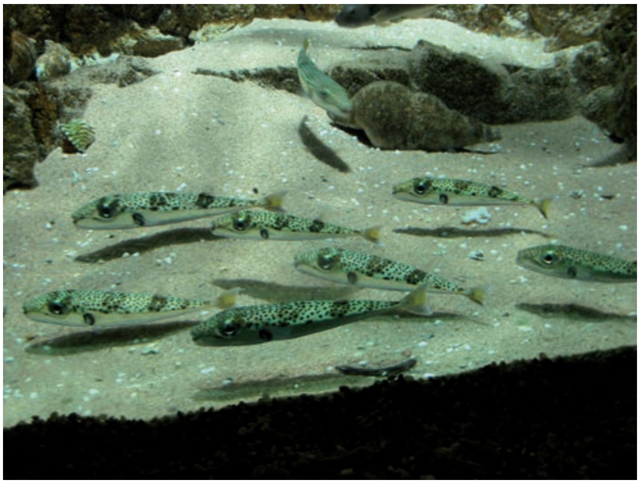

Figure 3. Juvenile specimens of *Lagocephalus sceleratus* in aquarium (Total length 15-18 cm).

The first sample of *Torquigener flavimaculosus* Hardy & Randall, 1983 (10.5 cm in total length) was kept since 2011 (Table 1), followed by other individuals (5-7 cm in total length). They cohabit with the aliens *A. roseus*, *P. gibbesi, Siganus luridus* (Rüppell, 1829), *Siganus rivulatus Forsskål, 1775, Sargocentron rubrum* (Forsskål, 1775), and various native species of sea stars, anemones and algae. This fish, provided of a soft-sandy substrate, buries itself in the sand and it initially only comes out to feed; after feeding, it swims over the bottom for some time (Fig. 4), before burying again. After the first days of acclimatization however, a longer permanence and dwelling in the water column of the tank was observed. The typical behaviour of *T. flavimaculosus* to bury itself in the sand was first reported *in situ* by Bilecenoglu (2005) and it is directly associated to the predator-prey tactics. It is rather interesting that the same pattern is initially showed even when the animal is kept in captivity. Most likely, the yellowspotted puffer is incapable of developing enough speed to escape enemy attacks, as is the case with many species of invertebrates and fish, consequently it hides under sand. Such behavior is not exhibited by the cofamiliar silver-cheeked toadfish *L. sceleratus* since the beginning of acclimatization in captivity conditions. This species probably has developed other anti predatory adaptations like high toxicity (meat, internal organs, eggs), strong aggressiveness, enhanced by the practice of juveniles to be in dense schools, and ability to reach high speed in a brief time (Pancucci-Papadopouloulou et al., 2012).

The fatal effect of sudden accidental decrease of water temperature in a closed system has been already reported and it could give an indication relative to the minimum temperature limit for the survival of certain Erythrean species in the newly occupied environment (Corsini-Foka, 2010b). According to Golani (2010) however, "once a Lessepsian migrant has arrived into the Mediterranean and established a sustainable population, there are no significant physical barriers preventing its dispersal westward".

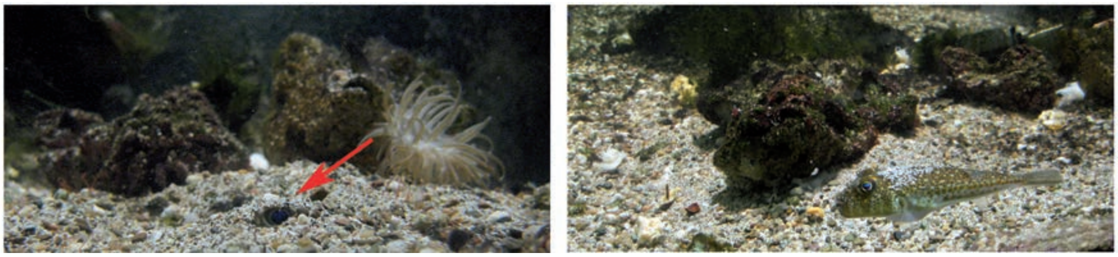

Figure 4. *Torquigener flavimaculosus* (Total length 10.5 cm) in an aquarium, completely hidden under the sand except the eyes (red arrow), at left and swimming after feeding, at right.

Discussion

The phenomenon of warm-water alien introductions in the eastern Mediterranean, in particular of those of Red Sea/Indo-Pacific origin, amplified by climatic changes (Raitsos et al., 2010), is accomplished to the rapid integration and often population explosion of this new biota. This conduces to an accelerated alteration of the native marine communities (Fishelson, 2000; Rilov & Galil, 2009; Golani, 2010; Edelist et al., 2013), with impact on biodiversity and socioeconomics (Coll et al., 2010; Costello et al., 2010; Pancucci-Papadopoulou et al., 2012).

Only few of the aliens analyzed show or are achieving locally some economical interest (Corsini-Foka et al., 2010), while many of them, such as *P. gibbesi*, *S. rubrum*, *F. commersonii*, *L. sceleratus* and many varieties of *C. racemosa*, have commercial value for aquaria purposes worldwide (Baensch & Debelius, 1992; Calado et al., 2003; Klein & Verlaque, 2008; Froese & Pauly, 2012; Aquarium Fish International Portal). Furthermore, *C. andromeda* is a well-known inhabitant of tropical tanks displayed in European and worldwide Aquaria (London Zoo Aquarium, Zoo Aquarium of Madrid, Aquarium of La Rochelle, Monterey Bay Aquarium) and *S. diaspros*, provided by a supplier of tropical fishes, is maintained for example at the Haus der Natur Aquarium in Salzburg (I. Illich, 2013, pers. comm.). In agreement with the experience described here, various alien species shown at Rhodes Aquarium have been tested for suitability in aquarium display as reported in the interactive encyclopedia Meerwasserlexikon.

Many of the aliens mentioned in this study are considered invasive or potentially invasive species in the Eastern Mediterranean (Zenetos et al., 2010 & 2012 and references within). Therefore, due to their diffusion and abundance in the field, some of them are maintained also in various other Aquaria of the region, the majority recently opened to the public. It is interesting to note that the displayed alien fish are quite the same species, four of the earlier colonizers and two of the more recent ones (cf Golani, 2010).

Several of the listed alien species occur as far as the central Mediterranean, while others have spread both to the central and the western coasts of the basin (Golani, 2010; Zenetos et al., 2010 & 2012). If their establishment proceeds successfully enabling their easy collection, they have the potential to become suitable for display in older and newer Aquaria of the central and western Mediterranean coasts as well. Therefore, in the Mediterranean region, many warm-water aliens are acquiring the characteristic of ornamental species, if they have not yet this characteristic in other parts of the world, while many other tropical invasive, already abundant in the eastern Levant, could become so in the future. This might be the case of the recently introduced and rapidly expanding *Plotosus lineatus* (Thunberg, 1787), a venomous fish with a significant commercial value in the aquarium industry (Edelist et al., 2012; Froese & Pauly, 2012).

The trade of ornamental tropical marine species (algae, corals, other invertebrates and fish) for home and public Aquaria supply is a large industry, that plays a significant economic role in both source and destination countries but also with impacts on the wildlife, in particular of the Southeast Asia region (Wabnitz et al., 2003; Rhyne et al., 2012). Moreover, the trade of marine ornamental species relies heavily on the export and import of introduced species worldwide (Semmens et al., 2004; Weigle et al., 2005; Papavlasopoulou et al., 2014).

The sally lightfoot crab *P. gibbesi*, a species traded worldwide as marine ornamental, is the most invasive crustacean to enter the Mediterranean (Galil, 2011; Katsavenakis et al., 2011). Calado (2012) highlights the potential benefits that could be obtained through the collection of this alien crab from the invaded habitats and its farther trade for private and public aquarium purposes: it could contribute to partially reduce the removal of specimens from their home range and to alleviate the impact of this invasive species to the Mediterranean native biodiversity.

A similar potential use for the aquarium trade has been suggested by Nader et al. (2012) for the highly toxic and invasive to the Mediterranean *L. sceleratus*, underlying nevertheless that "this is not considered to have a significant impact on the wild populations".

Taking into account the global climate changes, the ongoing tropicalization of the Mediterranean and the uncontested ability of adaptation to new environments manifested by tropical aliens, in particular those of Red Sea/Indo-Pacific origin (Golani, 2010), in our opinion this type of Mediterranean aliens' management for ornamental trade is not to be encouraged, although difficult to avoid. Considering that several native Mediterranean species are already involved in the European marine aquarium trade, while others may start to be targeted by marine ornamentals fisheries (Calado, 2012 and literature herein), alien species, in particular the invasive ones, may be involuntary included in this type of commerce.

An eventual official practice to "export" certain Mediterranean aliens interesting for aquarium purposes, imperatively under strict regulations, code of conduct and special protocols, could nevertheless constitute a vector of accidental secondary introductions, contributing to accelerate their dispersion in the same Mediterranean basin. Furthermore, the use of Mediterranean aliens for ornamental trade could be a vector of primary introductions to other seas out of their native range, promoting their invasive potentialities, already heavily tested in the eastern

Mediterranean. Escape from aquarium trade or accidental release or discard of these invasive species may have unexpected consequences worldwide.

Aquaria all over the world have a central role in making connection between people and the oceans and the natural world, the ultimate goal they seek to achieve is healthy oceans and aquatic ecosystems. Their central mission is to engage and activate the public in the conservation of aquatic life and ecosystems through three fundamental components, intimately interlinked, education, conservation and research (Ounaïs & Theron, 2004; Packard, 2004; IAC, 2004 & 2008; EUAC, 2013).

In agreement with the above statements, the Aquarium of Rhodes has addressed efforts to invest most of its human and economic resources to broaden its mission toward education, environmental conservation and research activities next to the recreational ones, these above components interdependent with mutual benefits (Karydis, 2011). This institution is embedded in a research structure and performs its activities in strict collaboration with school authorities and universities. Furthermore, it has evolved its organization so that the information achieved through research and husbandry flow among scientific, animal care and education staff in a constructive way.

The display of non native organisms, documented at least since the 1980s of the past century, is assisted by the geographical position of Rhodes (the southeastern corner of the Aegean Sea), a region rather prone to biological invasions. In parallel with the relevant biological studies on new incomers and their establishment, spreading and impact on natural environment (cf ELNAIS, 2013), the displays emphasize the acceleration of the biological invasion phenomenon signalled in the last decades in the shallow waters of the area (Pancucci-Papadopoulou et al., 2011 & 2012). The opportunity to study and monitor aliens in the field combined to their management and display to the public, under the support of appropriate educational material and actions (seminars, conferences, workshops), allows the Aquarium to apply directly the acquired scientific expertise on the nearby marine ecosystem and the changes it is facing, on the dissemination of knowledge achieved on marine biological invasions and the alarming ecological and socioeconomic traits associated to them, involving visitors and the population at all levels, the scientific community included.

The Aquarium of Rhodes is visited by more than hundred thousand tourists, most from European countries. European seas are severely affected by biological invasions (Katsavenakis et al., 2013; EASIN, 2013) - the Mediterranean biodiversity the most threatened worldwide by aliens (Costello et al., 2010) - and public Aquaria can and must make common citizens aware to the risks associated to this phenomenon.

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