

SHORT COMMUNICATION

The northward expansion of *Synaptula reciprocans* (Echinodermata) in the Mediterranean Sea

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Abstract

Synaptula reciprocans was reported in the Mediterranean Sea for the first time back in 1986. Since then there have been numerous reports, following the species' gradual expansion and establishment in the eastern Mediterranean basin. Here we report, by using citizen science methods, from the project titled "Is it Alien to you? Share it" of iSea, the most recent known expansion sites of *S. reciprocans*, including its new northern-most frontier. Furthermore, the provided photographic evidence testifies for possible interspecies relationships, for the first time.

Keywords: *Synaptula reciprocans*, invasive, Aegean Sea, Mediterranean Sea

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Synaptula reciprocans, is one of the 29 species of the *Synaptula* genus (WoRMS 2017) inhabiting the tropical shallow sublittoral zones of the Red Sea, Indo-Pacific and recently the Mediterranean Sea. The species is frequently found in shallow water, on rocky and sandy bottom substrates. Like all species of the Holothuroidea, it is gonochoric, with the spawning being external (Ruppert *et al.* 2004). The larvae stage is planktotrophic (Ruppert *et al.* 2004), indicating that the

species distribution highly depends on the water currents (Antoniadou and Vafidis 2009).

S. reciprocans is believed to have been introduced to the Eastern Mediterranean basin through the Suez Canal. It was originally reported in Israel and Cyprus in 1971 (Cherbonnier 1986), and later in several eastern Mediterranean countries, namely Lebanon (Zibrowius and Bitar 2003), Syria (Zibrowius and Bitar 2003), Turkey (Cinar *et al.* 2006; Galil 2006), Cyprus (Koukouras *et al.* 2007) and Greece (Pancucci-Papadopoulou *et al.* 2005; Koukouras *et al.* 2007; Antoniadou and Vafidis 2009). The current known northernmost boundary of the species distribution in the Mediterranean Sea, is considered the South Aegean Sea, between Amorgos and Symi Islands (Antoniadou and Vafidis 2009) (Figure 1).

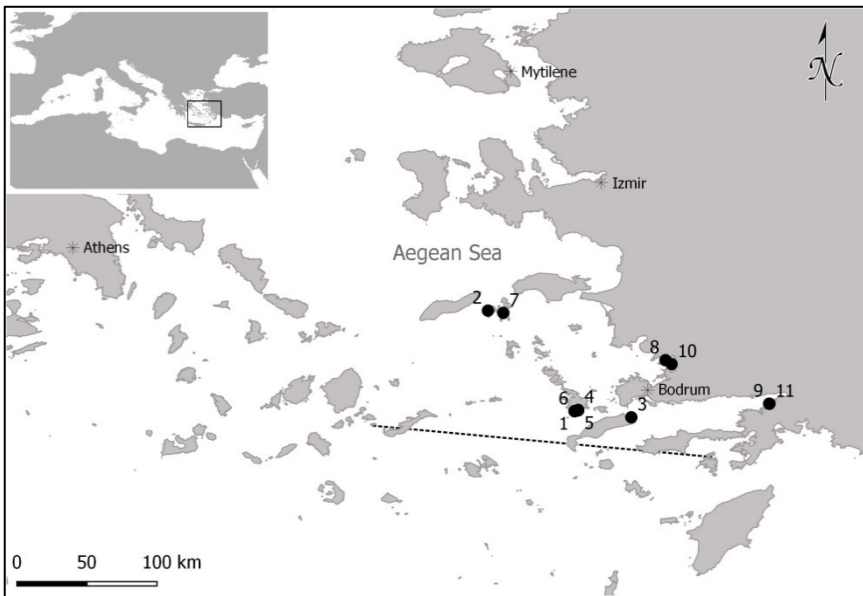


Figure 1. Records of *Synaptula reciprocans* reported to the citizen science project “Is it Alien to you...Share it!!!” The line indicates the northernmost boundary of the species expansion based on previous published observations and the numbers the location of each record presented in Table 1.

Recently, citizens, such as fishers, divers, naturalists and other sea users, along with the increasing use of social media networks, are playing an important role in documenting the distribution and the expansion of several non-indigenous species (Zenetos *et al.* 2013; Scyphers *et al.* 2015). Hereby, we present evidence of a northward expansion of *S. reciprocans* in the Mediterranean Sea by observations provided by citizens in the context of the citizen science project “Is it Alien to you? Share it”.

In 2016, iSea established an online data repository in which citizen scientists could easily upload photographic materials along with information on the size (length and/or weight), depth, number of specimens, exact location and date. A Google Form and a Group on Facebook were set up to facilitate these reports in Greek, Turkish and Albanian waters. The project's social media platform currently numbers around 3500 members, with 200 of whom are actively engaged on a daily basis. The vast majority of the participants are recreational fishers, followed by scuba divers, naturalists and professional fishers. Furthermore, several experts on marine non-indigenous species are part of this online social media community, offering their expertise for the identification of the specimens reported.

Table 1 presents all records of *S. reciprocans* reported to the project. Since the species is still the only member of the class Holothuroidea, invasive to the Mediterranean Sea (Galil 2008; Coll *et al.* 2010) and due to its unique morphological features in comparison with native Holothuridea species, identification was possible by sight and later examination of the photographic evidence (Figure 2).

Table 1. Observations of *Synaptula reciprocans* reported from Greek and Turkish waters of the Aegean Sea, on the "Is it Alien to you? Share it" platform.

Obs.No	No of Specimens	Depth (m)	Coordinates	Location	Obs. Date
1	10	9	36°55'44"N 26°57'54"E	Vlychadia, Kalymnos Island	24/05/2017
2	>15	5-30	37°34'26"N 26°24'37"E	Thimena Island	10/08/2017
3	30	15	36°53'14"N 27°19'55"E	Psalidi, Kos Island	14/08/2017
4	2	8	36°56'13"N 26°59'16"E	Liani Punta, Kalymnos Island	19/08/2017
5	3	12	36°56'20"N 26°59'15"E	Liani Punta, Kalymnos Island	19/08/2017
6	5	8	36°55'50"N 26°57'54"E	Vlychadia, Kalymnos Island	08/10/2017
7	>20	5-28	37°33'28"N 26°30'29"E	Fourni Island	16/10/2017
8	>10	5	37°15'11"N 27°32'51"E	Kuyukislacik, Mugla	03/12/2010
9	>5	5-10	36°58'40"N 28°12'57"E	Boncuk Cove, Gokova Bay	12/05/2012
10	8	19	37°14'25"N 27°35'47"E	Gullluk harbour, Mugla	04/06/2014
11	1	4	36°58'41"N 28°12'53"E	Boncuk Cove, Gokova Bay	2014

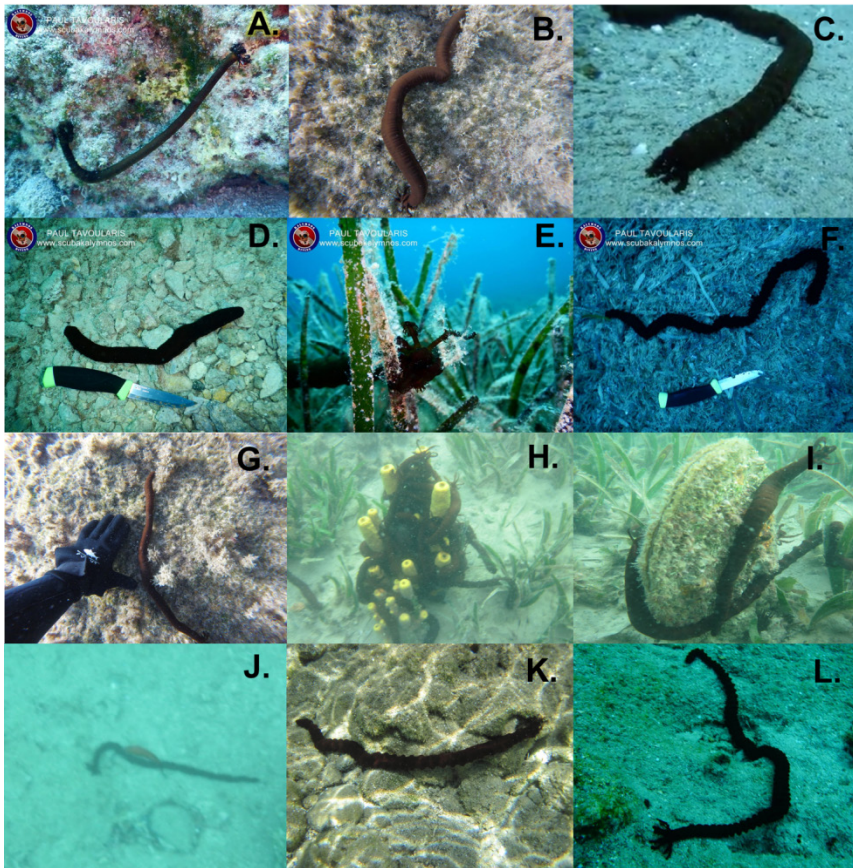


Figure 2. *Synaptula reciprocans*. A-L are some of the photographic evidences accompanied the report of *S. reciprocans* in the database of the project.

All records presented in the context of this study, were located outside the reported distribution range of the species in the East Mediterranean basin, with the two records from Fourni Korseon Archipelago Obs. Nos. 2 and 7; Table 1) being the new northern most report of *S. reciprocans* from the Mediterranean Sea, more than 50 nautical miles northwards from the previous northern most report (Antoniadou and Vafidis 2009). Our findings document a clear expansion of the species in the East Aegean Sea (Figure 1). In almost all cases, the observers reported several individuals, declaring robust populations, a clear sign of establishment (Kolar and Lodge 2001). Similar patterns of expansion in the eastern Mediterranean Sea have been reported for most Lessepsian migrants (Katsanevakis *et al.* 2013), but also for endemic thermophilic species (e.g. *Solea aegyptiaca*; Lasram *et al.* 2010) and is highly possible to be related to the ongoing climate change in the eastern Mediterranean basin (Occhipinti-Ambrogi 2007; Raitso *et al.* 2010). The latter might favours the expansion and

establishment of tropical and subtropical species towards the northern parts of the basin (Lasram *et al.* 2010).

Moreover, it is worth mentioning that *S. reciprocans* individuals were observed to interact at high densities with the Atlanto-Mediterranean sponge *Aplysina aerophoba* (Figure 2-H) and to a lesser extent with the endangered bivalve *Pinna nobilis* (Figure 2-I). *S. reciprocans* feeds primarily with diatoms and other micro-organisms and organic coated particles (Cherbonnier 1986). In the past, Hammond and Wilkinson (1985) provided experimental evidences that another *Synaptula* species (*S. lamperti*), gains nutritional advantage from its association with sponge species by ingesting and assimilating exudates. We suspect that *S. reciprocans* utilizes a similar feeding strategy upon *Aplysina aerophoba* (possibly in other similar species as well). Furthermore, this might be a case of symbiosis or parasitism between species whose original distribution did not permit interspecies relationships. However, targeted research is required to confirm these hypotheses and to measure the potential effects of *S. reciprocans* on the endemic species populations.

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