Quaternary International 390 (2015) 15–20

Contents lists available at ScienceDirect

Quaternary International

journal homepage: www.elsevier.com/locate/quaint

Mapping alien Mollusca distribution in the Mediterranean Sea: the Lessepsian immigrant *Retusa desgenettii* (Audouin, 1826) reaches Turkey

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ARTICLE INFO

Article history:
Available online 14 April 2015

Keywords:
Mollusca
Cephalaspidea
Retusa desgenettii
Mediterranean Sea
Turkey
Alien species

ABSTRACT

The opening of the Suez Canal in 1869 has led to the colonisation of the Mediterranean Sea by a large number of tropical/subtropical species, including several sea slugs and shelled relatives. Among them, the Red Sea taxon *Retusa desgenettii* (Audouin, 1826) is a well known Lessepsian invader, being first recorded from the Suez Canal and subsequently from the Mediterranean waters of Egypt and Israel. We hereby review *R. desgenettii* Mediterranean literature and offer an updated map of its Mediterranean spreading. On the basis of the analysis of a bioclastic sediment from Bozburun, we also considerably extend the known invaded Mediterranean range, first reporting its presence from Turkey, presumably reached via natural dispersal. *R. desgenettii* shell is redescribed and compared with the most similar native *Retusa sensu stricto* and alien Cephalaspidea recorded from the Mediterranean Sea, as to facilitate possible future records in the wide area between previous records and present ones. Within this framework, *Retusa candidula* (Locard, 1892), *Retusa pellucida* (T. Brown, 1827) and *Retusa obtusa* (Montagu, 1803) are also excluded from the Mediterranean fauna.

1. Introduction

The Mediterranean molluscan fauna is considered as the best known in the world (Oliverio, 2003). However, despite continuous efforts to provide updated data sets for the entire basin, a general discrepance occurs between western/northern and eastern/southern parts (Crocetta et al., 2015). The general knowledge of the latter is still considerably poor when compared with that of the central and western basins, despite the presence of updated check-lists based on both bibliographic and unpublished data (Barash and Danin, 1992; Öztürk et al., 2004, 2014; Crocetta et al., 2013a, 2013b; 2014). So far, ~2000 molluscan species are known from the Mediterranean Sea, of which ~200 are aliens (Zenetos et al., 2012; Sabelli and Taviani, 2014). Thirty of them are sea slugs, the majority of which has an Indo-Pacific origin (recent reviews in Yokeş et al., 2012; Bogi and Galil, 2013; Crocetta et al., 2013b). Among them, *Retusa desgenettii* (Audouin, 1826) is a well known Lessepsian invader, occurring in the Red Sea (Yonow, 2008) and being first recorded from the Suez Canal (Moazzo, 1939) and subsequently from the Mediterranean waters of Egypt and Israel (Bogi and Galil, 2002, 2006, 2007; Mienis, 2004; Mienis and Zaslow, 2004; Scaperrotta et al., 2009; Cossignani and Ardovini, 2011; Perna, 2013). Starting from the analysis of *R. desgenettii* collected in a bioclastic sediment from Bozburun (Turkey, Mediterranean), we hereby redescribe its shell and compare it with the most similar alien and native Mediterranean *Retusa sensu stricto*. In addition, we review the Mediterranean literature covering the species and offer an updated map of its Mediterranean spreading, first reporting the presence from Turkey and considerably extending the known Mediterranean invaded range.

2. Materials and methods

2.1. Abbreviations and acronyms

The following abbreviations and acronyms were used: coll – collection/s; FS – Francesco Settepassi, Roma (Italy); GA – Gaetano Ambrosiano, Roma (Italy); LPT – Lionello Paolo Tringali, Roma (Italy); m – meter/s; MO – Marco Oliverio, Università di Roma "La Sapienza" (Italy); MTRS – Monterosato coll (Museo Civico di Zoologia, Roma–Italy); NMBE – Naturhistorisches Museum, Bern

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http://dx.doi.org/10.1016/j.quaint.2015.03.009
1040-6182/

(Swisse); RR – Ruggero Ruggeri, Roma (Italy); sh – shell/s; spm – specimen/s; SR – Stefano Rufini, Università di Roma 2 – "Tor Vergata" (Italy); ZMR – Zoological Museum Rome ("Museo Civico di Zoologia, Roma" – Italy).

2.2. Unpublished data and laboratory work

Unpublished material was obtained by a sample of bioclastic sediment collected on the beach of Bozburun (southern Turkey) and is currently deposited in SR coll. Shells were air dried, mounted on SEM stubs and gold–palladium coated for SEM examination with a Philips XL30.

2.3. Taxonomy, Mediterranean literature and updated map

Updated taxonomy and nomenclature hereby used follow World Register of Marine Species (WoRMS). Published Mediterranean records of *R etusa desgenettii* (Audouin, 1826) were searched both in indexed and grey literature (i.e. non peer-reviewed and/or non indexed papers), and carefully reviewed. Published and unpublished data were used to build an updated distributional map.

3. Results

3.1. Systematics

Class GASTROPODA Cuvier, 1795
Order CEPHALASPIDEA P. Fischer, 1883
Family RETUSIDAE Thiele, 1925
Genus *Retusa* T. Brown, 1827
Retusa desgenettii (Audouin, 1826)
(Figures 2 A–B, E)

3.2. Material examined

Type material: not examined. **Note:** a syntype (Savigny coll) is figured in Bouchet and Danrigal (1982) and Valdés and Héros (1998). **Additional material:** Bozburun (Turkey, Mediterranean Sea), 08/2002, beached bioclastic sediment, 3 sh (SR *legit*), with *Pyrunculus fourierii* (Audouin, 1826) (Fig. 2C, F) and *Acteocina mucronata* (Philippi, 1849) (Fig. 2D, G); Abu Ramada (Hurghada, Egypt, Red Sea), 1991, bioclastic sediment, 13 m, 5 sh (GA *legit*); Marsa Fijab (Sudan, Red Sea), 28/01/1992, beached bioclastic sediment, 76 partially preserved spm and sh (MO *legit*); Green Island (Massawa, Eritrea, Red Sea), 1970, beached bioclastic sediment, 1 sh (ex RR coll, LPT coll).

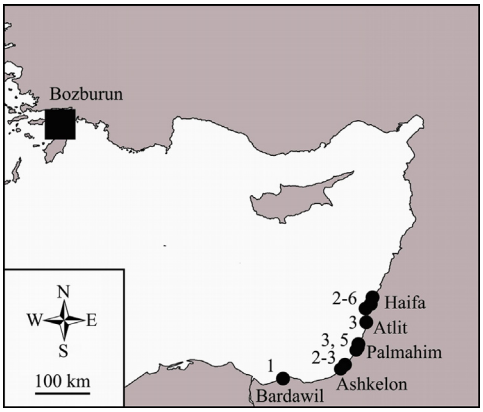

Fig. 1. The eastern Mediterranean and the known distribution of *Retusa desgenettii* (Audouin, 1826) (main localities of presence highlighted). Circles: published records. Square: present record. Numbers corresponding to bibliographic references and geographic coordinates reported in Table 1.

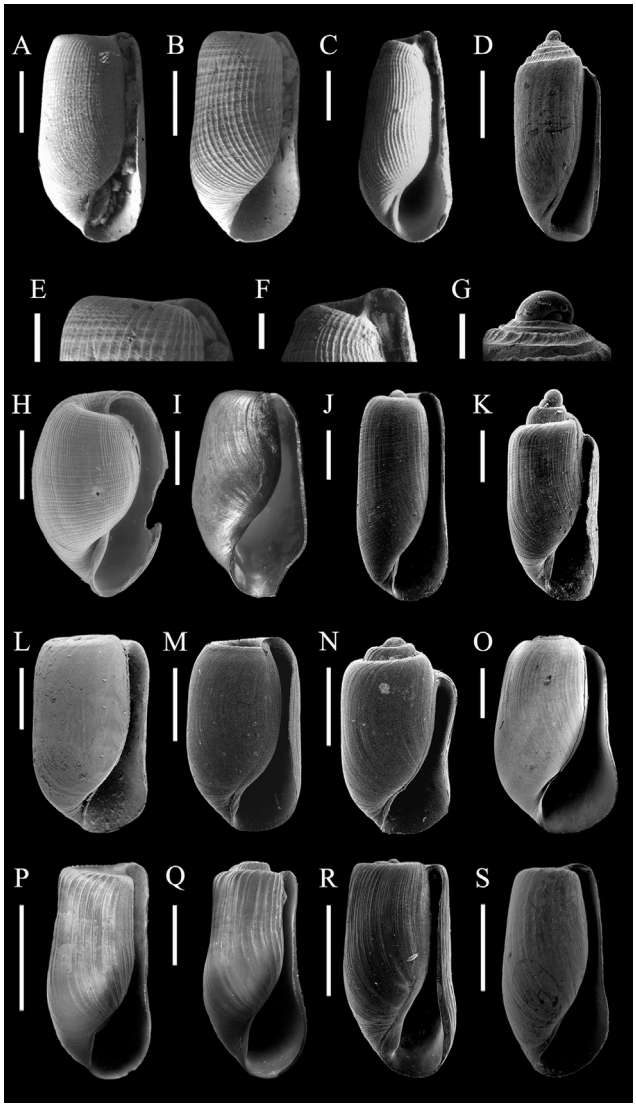

Fig. 2. A–G. Lessepsian Cephalaspidea. **H–P**. Native northeastern Atlantic-Mediterranean *Retusa sensu stricto* listed as living in the Mediterranean Sea by recent authors. **A–B, E**. *Retusa desgenettii* (Audouin, 1826). **A**. Abu Ramada (Hurghada, Egypt, Red Sea) – sediment 13 m. **B, E**. Bozburun (Turkey, Mediterranean Sea) – beached bioclastic sediment. **C, F**. *Pyrunculus fourierii* (Audouin, 1826). Data as B. **D, G**. *Acteocina mucronata* (Philippi, 1849). Data as B. **H**. *Retusa multiquadrata* Oberling, 1970 *sensu* Buzzurro and Greppi (1997) (after Segers et al., 2009). Madeira. **I**. *Retusa candidula* (Locard, 1892) – syntype (MNHN-IM-2000-28257). Ile de Ré (France). **J–K**. *Retusa mammillata* (Philippi, 1836) (after Oliverio and Tringali, 2001). Kaş (Turkey) – bioclastic sediment 34 m. **L–N**. *Retusa minutissima* (Monterosato, 1878) (after Oliverio and Tringali, 2001). **L**. Paleohora (Crete Island) – bioclastic sediment 10 m. **M–N**. Valencia (Spain) – unrecorded depth – MTRS (ZMR). **O**. *Retusa obtusa* (Montagu, 1803) (after Oliverio and Tringali, 2001). Le Verdon-sur-Mer (Aquitanie, western France) – unrecorded depth – FS coll (ZMR). **P–Q**. *Retusa truncatula* (Bruguière, 1792) (after Oliverio and Tringali, 2001). **P**. Kaş (Turkey) – bioclastic sediment 34 m. **Q**. Djerba Island (Tunisia) – unrecorded depth. **R**. *Retusa leptoeneilema* (Brusina, 1866) (after Oliverio and Tringali, 2001). Umag (Croatia) – beached bioclastic sediment. **S**. *Retusa pellucida* (T. Brown, 1827). Ura-Guba (Russia). **Scale bars**: D, I, O–S: 1.0 mm; A–C, H, J–N: 500 μm; E–G: 200 μm.

3.3. Mediterranean literature and updated map

R etusa desgenettii (Audouin, 1826) is a well-known Lessepsian invader, being first recorded from the Suez Canal (Moazzo, 1939) and then from Egypt, in 1969 (Mienis, 2004) and Israel, in 1997 (Bogi and Galil, 2002), where the species has been subsequently found in several sampling sites (Bogi and Galil, 2006, 2007; Scaperrotta et al., 2009; Perna, 2013). Cossignani and Ardovini (2011) also reported a specimen generically stating a provenience as from