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Rapid Communication

# First record of the fissurellid mollusc *Diodora funiculata* (Reeve, 1850) (Mollusca: Gastropoda) in Libyan waters (central Mediterranean Sea)

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## Abstract

The Tripoli Harbour, with its cosmopolitan shipping traffic, is a well-known hub for alien molluscs. This is confirmed here by the first report of the Indo-Pacific fissurellid mollusc *Diodora funiculata* from Libya. While its arrival pathway remains unknown, shipping or natural dispersal from other populations in the Mediterranean Sea may constitute a possible vector. The high number of specimens and shells found suggest an establishment in the area. However, this should be confirmed by additional field work.

**Key words:** coastal monitoring, alien species, bioinvasions, range expansion, Tripoli Harbour

## Introduction

The phenomenon in which marine species native to the Red Sea and the Indo-Pacific region expand their distribution into the Mediterranean via the Suez Canal is commonly called "Lessepsian migration" (Por 1978). This invasion started with the completion of the Canal in 1869 and was aided by favouring factors, such as the enlargement of the Suez Canal, the global warming, and the reduced freshwater discharge of the Nile (Raitsos et al. 2010; Galil et al. 2017). The number of Lessepsian species invading the Mediterranean Sea is increasing fast, to the point that some authors proposed the Levant Sea to be a separate and man-made biogeographic province (Goren et al. 2010). Furthermore, once arrived in the Mediterranean Sea, these species continue spreading, often reaching the central or even the western parts of the Mediterranean basin (Galil et al. 2017, 2018; Servello et al. 2019).

Molluscs constitute a large proportion of either the Lessepsian or the other alien species colonizing the Mediterranean Sea, with more than 200 recorded species (Zenetos et al. 2017). However, numerous alien molluscan taxa are only known from few or sporadic records. Among them *Diodora funiculata* (Reeve, 1850), belonging to the family Fissurellidae J. Fleming, 1822

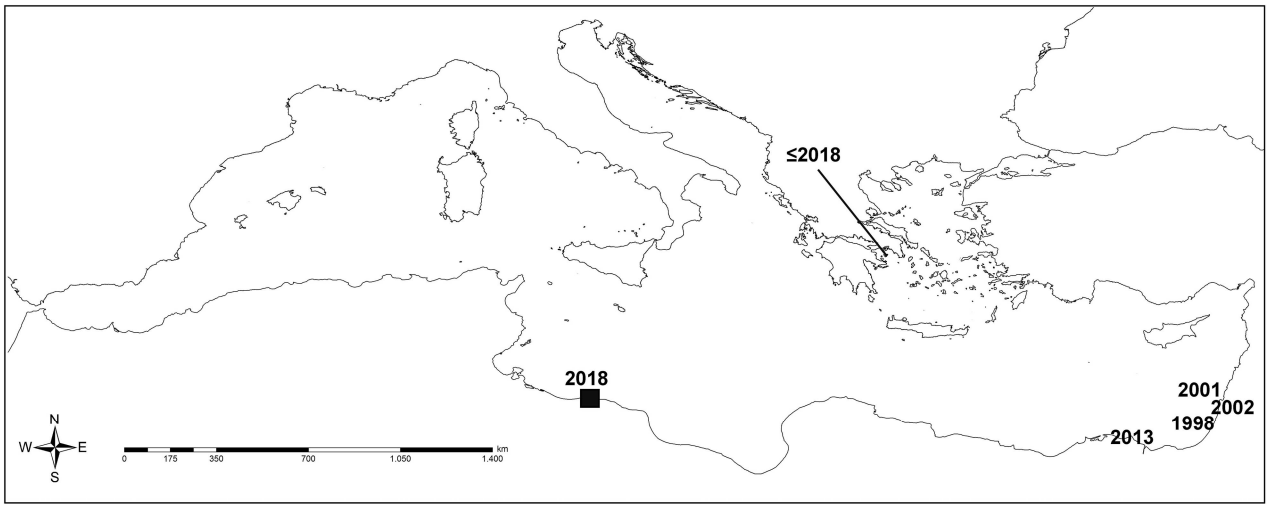


**Figure 1.** Map of the known records of *Diodora funiculata* in the Mediterranean Sea, with year of collection. Black square highlighting the present sighting. Localities, coordinates, and references reported in Table S1.

and characterized by a cone-like shell with a small hole in the apex and the presence of stronger and widely spaced primary radial ribs with finer intermediate secondary radial ribs (usually 3–4), all crossed by fine concentric ridges. This species was first recorded in the Mediterranean coast of Israel in 1998 (Mienis 2002, 2004); however, subsequent records were only held from the Mediterranean coastline of Egypt and Greece (Eastern Mediterranean) (Mytilineou et al. 2016; Manousis et al. 2018) (Supplementary material Table S1; Figure 1). We now first report its presence from Libya (Central Mediterranean) based on a field survey conducted at the Tripoli Harbour.

## Materials and methods

The sandy supralittoral zone of the Tripoli Harbour (32.901140°N; 13.212579°E) was surveyed from November 2018 to January 2019 (see also, Rizgalla et al. 2019a, b for the description of the terrain). Beached specimens or shells collected were photographed with an Olympus Tough TG4 and Huawei p8 light camera. For the identification, certain guides for Indo-Pacific and Red Sea taxa were used (Bosh and Bosh 1982, 1989; Bosh et al. 1995; Rusmore-Villaume 2008). Material (in dry or 90% ethanol storage) is kept in the private collection of F. Crocetta (Naples, Italy) and is available upon request.

## Results and discussion

Throughout the entire survey period, 22 shells and four live specimens of *D. funiculata* (Figure 2) were found. In accordance with the well-known role of marinas and harbours as being hotspots for invasive species in the Mediterranean Sea (e.g. Ulman et al. 2017; Sghaier et al. 2019), the Tripoli Harbour has already been described as a hub for alien molluscs (Rizgalla et al. 2019a, b; Rizgalla and Crocetta, in Dragičević et al. 2019). In fact, *D. funiculata*

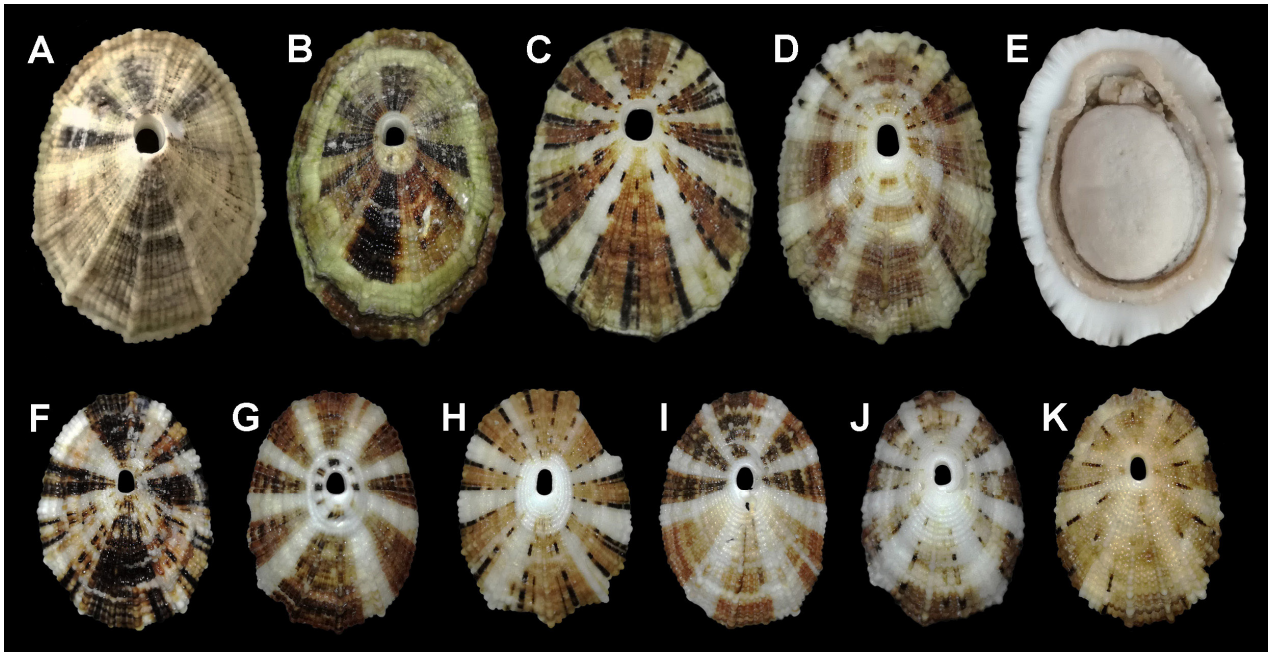


**Figure 2.** Specimens and shells of *Diodora funiculata* from Tripoli Harbour. Samples not to scale. First row (shells): (A) 37×27.3 mm; (B) 32.5×22.5 mm; (C) 32.3×23.3 mm; (D) 30.5×21 mm. First row (specimen): (E) 22.5×16.3 mm. Second row (shells): (F) 26.1×19.1 mm; (G) 25.9×17.8 mm; (H) 25.4×18.3 mm; (I) 24.5×17.2 mm; (J) 22.6×15.7 mm; (K) 21.2×14.7 mm. Photo credit: F. Crocetta.

is the last among other alien molluscs reported from the area, preceded by the gastropods *Cerithium scabridum* Philippi, 1848, *Diodora ruppellii* (G.B. Sowerby I, 1835) and *Crepidula fornicata* (Linnaeus, 1758), and the bivalves *Fulvia fragilis* (Forsskål in Niebuhr, 1775), *Brachidontes pharaonis* (P. Fischer, 1870) and *Pinctada imbricata radiata* (Leach, 1814) (Rizgalla et al. 2019a, b; Rizgalla and Crocetta, in Dragičević et al. 2019). The multitude and size of the findings suggest the presence of an established *D. funiculata* population in the Tripoli Harbour, although further study of the Libyan coastline would give the final answer. The finding area is not surprising *per se*, as, in its native range, *D. funiculata* is commonly found in the intertidal and shallow subtidal among rocks and stones, and even as a fouling species on floating anthropogenic debris (e.g. Bosh et al. 1995; El-Sorogy 2015; El-Sorogy and Youssef 2015; Ghani et al. 2018; Shabani et al. 2019; Abdollahi et al. 2020; Al-Kandari et al. 2020).

The present finding within the harbour's environs may lend support to its arrival by shipping traffic – e.g. attached to ship hulls or in ballast waters. However, it should also be noted that since all the previous records of the species from the Mediterranean Sea refer to natural environments (Mienis 2002; Mytilineou et al. 2016; Manousis et al. 2018), and that it was never previously detected in surveys of harbours and marinas in the east (Cyprus, Turkey and Greece) or the south (Egypt and Tunisia) Mediterranean Sea (Ulman et al. 2017; Sghaier et al. 2019), it is possible that there are as yet undetected Libyan populations from which the present population may have originated. At the same time, the absence of records from other Mediterranean harbours may be due to misidentifications with the native

*F. nubecula* (Linnaeus, 1758) (in case of juveniles) or *D. italica* (Defrance, 1820) (in case of adults), by which these two confamilial Mediterranean taxa differs in having fairly equal and weaker radial ribs with absence of concentric ridges (*F. nubecula*) and more irregularly-arranged primary and secondary radial ribs (*D. italica*) (see Cachia et al. 1991; Bosh et al. 1995; Gofas et al. 2012).

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**Supplementary material**

The following supplementary material is available for this article:

**Table S1.** Known records of *Diodora funiculata* in the Mediterranean Sea.

This material is available as part of online article from:
http://www.reabic.net/journals/bir/2020/Supplements/BIR_2020_Rizgalla_Crocetta_Table_S1.xlsx