

First record of the potentially invasive *Pinctada imbricata fucata* (Gould, 1850) (Bivalvia Pteriidae) along the Mediterranean coasts of Spain

Brian Cunningham Aparicio^{1*} & Iván Mulero Méndez²

¹Calle Aconcagua, 11, 30860, Puerto de Mazarrón, Murcia, Spain; e-mail: cabrian98@yahoo.es

²Calle Francisco Flores Muelas, 30B, 3°C, 30100, Murcia, Spain; e-mail: ivan.mulero@gmail.com

ABSTRACT

The taxonomy of pearl oyster species *Pinctada* Röding, 1798 (Bivalvia Pteriidae) is difficult due to the intraspecific variability of their morphological characters, making them hard to distinguish. However, previous studies reported the existence of two different taxa of this genus in the Mediterranean Sea; *Pinctada imbricata radiata* (Leach, 1818) and *Pinctada imbricata fucata* (Gould, 1850). *Pinctada imbricata radiata* is one of the first lessepsian species to be reported and it is nowadays considered a well-established species in the Mediterranean basin. *P. imbricata fucata* is native to the Indo-Pacific Ocean and entered the basin only in recent time. The first time this species was found in the Mediterranean was in 2015 for Sicily (Italy). In the present work, the Pteriidae species *Pinctada imbricata fucata* is reported for the first time in the Mediterranean waters of south Spain. This finding enlarges the known distribution of this alien species to the western side of the basin.

KEY WORDS

Pteriidae; Lessepsian; Spain; *Pinctada*; distribution; Mediterranean Sea; invasive.

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INTRODUCTION

The taxonomic status of the *Pinctada imbricata-radiata-fucata* group (Bivalvia Pteriidae) has been a matter of debate for the past few years, not only considering morphological characters but also under genetic framework. The molecular approach by pairs of this complex carried out by Temkin (2010) resulted in a lower level of divergence in contrast with other interspecific comparisons of other *Pinctada* Röding, 1798 species therein studied, but were reciprocally monophyletic between geographical populations, which led to provisionally consider them as subspecies. Shortly after, Cunha et al. (2011), also based on molecular features, supported the taxonomic status level of the

species *P. imbricata* Röding, 1798, *P. radiata* (Leach, 1818), and *P. fucata* (Gould, 1850), only questioning the species differentiation between *P. fucata* and *P. martensii* (Dunker, 1880), considering them conspecific. In a recent work carried out by Scuderi et al. (2019) based on morphological characters comparing *P. radiata* and *P. fucata*, where a large number of samples were examined, they were pointed out some morphological features of the shell and soft parts that are useful for their determination. Therein these features are considered sufficient to tend to appraise them as separated species. However, the World Register of Marine Species (WoRMS, 2021) considers both *P. imbricata fucata*, and *P. fucata* accepted, the latter being an alternate representation. According to these morphological

characters, both *P. imbricata radiata* and *P. imbricata fucata* have been reported to live in the Mediterranean Sea.

Although Barbieri et al. (2015) suggests a very recent expansion of *P. imbricata radiata* outside the eastern Mediterranean waters, the species was reported in the Mediterranean for the first time by Monterosato in 1878 (Scuderi et al., 2019) while the occurrence of *P. imbricata fucata* is much more recent (Villari & Scuderi, 2017). The current known distribution of this alien species was limited to the eastern side of the Mediterranean, being reported from Italy, Greece, Cyprus and Malta. Following the morphological features described on Scuderi et al. (2019) of the specimens found, this work reports for the first time the presence of *P. imbricata fucata* for the southern Mediterranean coast of Spain.

MATERIAL AND METHODS

The samples of *P. imbricata fucata* consisting in few fresh empty shells and one living specimen were collected in Hornillo Bay, Águilas, Murcia, southern Spain at depths between 1 to 2 meters on rocky/sandy bottoms between September 2019 and July 2020. The morphological features studied for the determination of the specimens are those contemplated in Scuderi et al. (2019). Nomenclature and systematics follow the World Register of Marine Species (WoRMS, 2021) considering the taxa as geographical subspecies. Acronyms used; BCAC: Brian Cunningham Aparicio collection (Murcia, Spain); IMMC: Iván Mulero Mendez collection (Murcia, Spain).

RESULTS

A total of 4 shells and 1 alive specimen were found and collected during several dives that took place in Hornillo Bay, Murcia (Spain). The empty shells were very fresh, some were found between *Posidonia* patches and others on hard substrate, and were probably predated by octopus. The alive specimen (Figs. 1–6) was found attached to a rock without any other organisms nearby, close to sand bottoms and affected by a moderate to high hydrodynamism, at around 1 m deep.

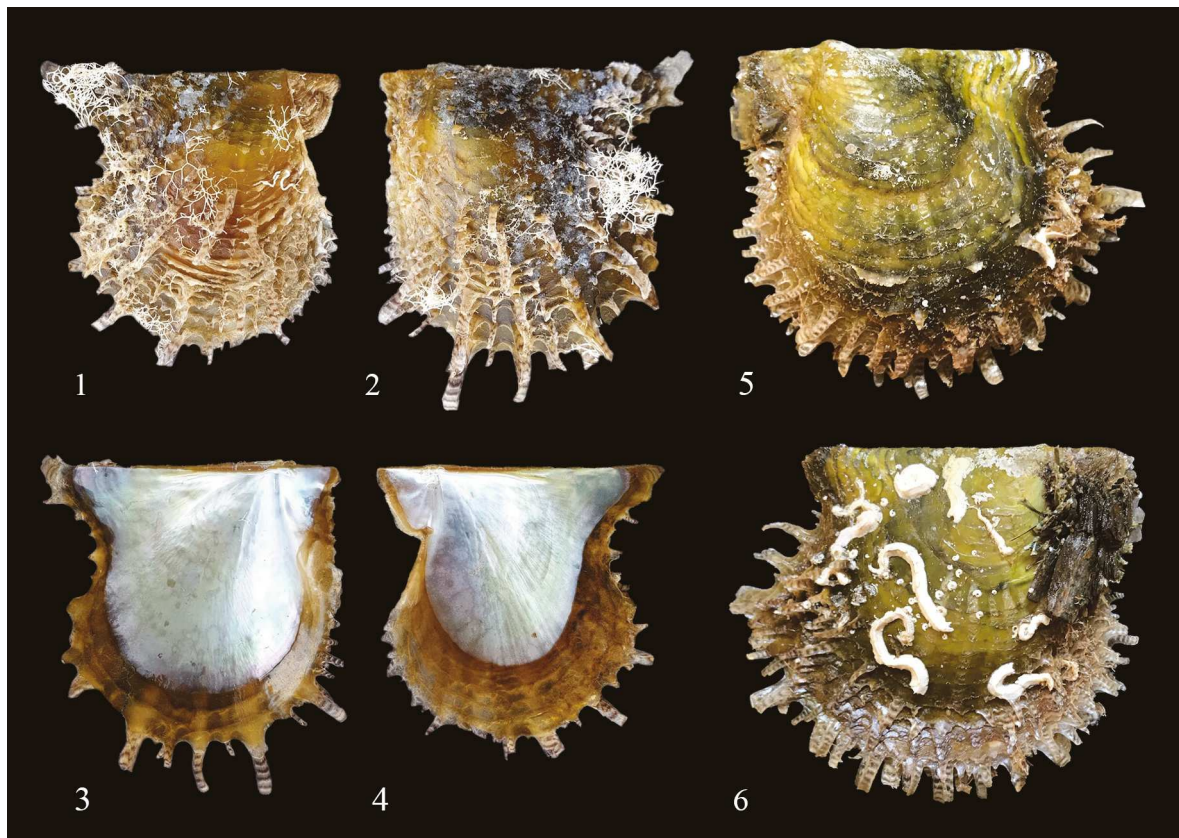
DISCUSSION AND CONCLUSIONS

The previously known records of *Pinctada* Röding, 1798 in the Mediterranean Sea are shown on Fig. 7. *Pinctada imbricata radiata* (red spots) has a wide range distribution along the Mediterranean, being one of the first lessepsian species reported to enter these waters. The first and only confirmed report of *P. imbricata fucata* (yellow spots) in the basin is from Scuderi et al. (2019), where it is cited for Italy, Greece, Cyprus and Malta, but the species was found before in Sicily and provisionally reported as *Pinctada* sp. by Villari & Scuderi (2017). The Mediterranean Science Commission (CIESM) also reports the presence of *Pinctada margaritifera* (Linnaeus, 1758) in Mediterranean Sea, with only two old records; one from Calabria, Italy (Bellet, 1899), and a further record from Alexandria, Egypt (Hasan, 1974). There are no known further reports of this latter species, and can be considered anecdotic.

The morphological characters observed on the shells and soft parts match with those ascribed to *Pinctada imbricata fucata* in Scuderi et al. (2019). According to these authors, this latter species is morphologically distinguishable of *P. imbricata radiata* on the accounts of these features: shell with transverse-oval outline, (mainly) greenish in colour with paler radial lines, sculpture constituted by concentric rows of sparse lamellae arranged in low number of blunt and large processes alternated by rows of smaller processes, anterior tooth of the left valve not duplicated, straight hinge line, wide ligament area and soft parts pigmentation mainly greenish.

In the exhaustive work of Scuderi et al. (2019) about the presence of *P. imbricata fucata* in the Mediterranean Sea, the species was not reported in Spain. Notwithstanding, Lopez Soriano & Quiñonero-Salgado (2019) recently reported the presence of *P. radiata* in Delta de l'Ebre, but this report should be verified since some of these specimens could instead be referred to as *P. imbricata fucata* as can be argued by the figures 2 and 3 of their work. The present record officially recognizes the presence of *P. imbricata fucata* along the Spanish coasts.

In addition to several human activities that may be related with the introduction and dispersal of this species, such as ballast water discharges, transport of aquaculture cages, etc., a relatively fast growth



Figures 1–6. *Pinctada imbricata fucata*. Figs. 1-4: Hornillo Bay, Águilas, Murcia, Spain. H= 46.40 mm, W= 42 mm (BCAC); Figs. 5, 6: Hornillo Bay, Águilas, Murcia, Spain. H= 60 mm, W= 66.30 mm (IMMC).

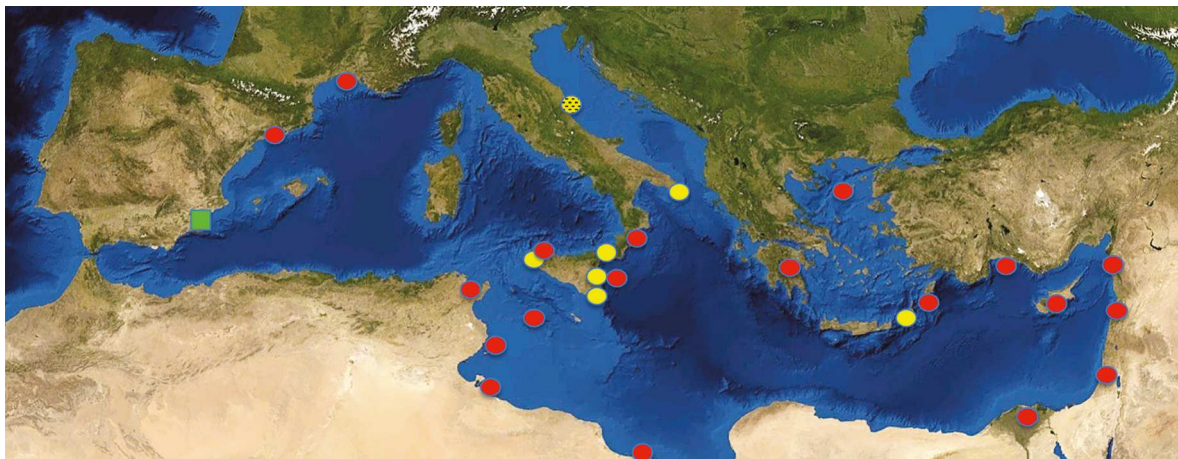


Figure 7. Distribution of *Pinctada imbricata radiata* (red circles) and *Pinctada imbricata fucata* (yellow circles). Green square represents the location of this report. Map extracted and implemented from Scuderi et al. (2019).

rate and presumably also fast reproductive periods has led to a very fast spreading of the species along the entire basin since its recent first confirmed signalization, and its potential invasive capability

should not be overlooked, as it appears to form numerous populations.

Several other lessepsian mollusk species have recently reached the area. A specially affected spot

is the Mar Menor lagoon, were due to its environmental and physicochemical characteristics many of these alien species have found an ideal place for their establishment and proliferation, such as *Cerithium scabridum* (Philippi, 1848), *Fulvia fragilis* (Forsskal in Niebuhr, 1775) and *Brachidontes pharaonis* (P. Fischer, 1870). However, these mentioned species, although extremely abundant, are not found in the area outside of the lagoon, where they face a more acused interspecific competence and potential predators. The presence of *P. imbricata fucata* in these waters suggests that the species is more competent and exceeds the action of these predators, and could be the prelude to an imminent invasive process.

New samplings in the next months should confirm the presence of new adult and juvenile specimens in the area. We presume that the nearby *Sparus aurata* (Linnaeus, 1758) and *Dicentrarchus labrax* (Linnaeus, 1758) aquaculture farms (which we were unable to sample) are a very suitable place for their pre-proliferation. If the establishment is confirmed, it would be a new invasive lessepsian mollusk to reach the westernmost side of the Mediterranean Sea.

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