

— SHORT COMMUNICATION —

## ***Mya arenaria* Linné, 1758 (Mollusca: Bivalvia) in the Mediterranean Sea: its distribution revisited**

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The alien soft-shell clam *Mya arenaria* Linné, 1758 is first reported in the central Mediterranean Sea, while its presence in the eastern Mediterranean Sea is definitively confirmed by living specimens. There are no data to assess a certain origin of the Italian specimens, but its presence, after two years from oral communications and initial records, confirms that the species constantly occurs in the area. The Mediterranean distribution and local impact dates of observation are reviewed and an updated distributional map is given.

**Key words:** *Mya arenaria*, mollusc, alien species, Mediterranean Sea, distribution.

### INTRODUCTION

The opening of the Suez Canal in 1869 linked two different zoogeographical regions, removing natural geographic barriers and causing the colonization of the Mediterranean Sea by tropical-subtropical species of Indo-Pacific origin. Furthermore, the increase in human activities, aquaculture and leisure boating in the past century, dramatically enhanced the introduction of non-indigenous species in the Mediterranean Sea (Zenetos *et al.*, 2008; Galil, 2009). The natural migration and human-facilitated introduction of non-native species contribute to the alteration of autochthonous communities and could disrupt the dynamic stability between native biota and their physical and biological environments (Boudouresque & Verlaque, 2002; Occhipinti-Ambrogi, 2007; Galil, 2007). We add new data clarifying the Mediterranean distribution of *Mya arenaria* and first reporting live specimens from the Central and the Eastern Mediterranean Sea.

### MATERIALS AND METHODS

#### *Description of the area*

Sacca di Goro (44° 47'–44° 50' N and 12° 15'–12° 20' E, Fig. 1, station 1) is an Adriatic coastal lagoon situated at the southern edge of the Po river delta. Water exchange with the sea is guaranteed both by a natural opening and by an anthropic cut of the “scanno”. The main tributary of the Sacca di Goro Lagoon is the Po di Volano river, with other freshwater inlets located along the Po di Goro river and Canal Giralda, Bianco and Bonello. The fresh water inflow can cause marked changes in salinity, varying from 5 to 33‰. Due to its high trophic level, the Sacca di Goro Lagoon is one of the largest clam-farming grounds in Europe and about 1300 fishermen, associated in cooperatives, exploit about 10 km<sup>2</sup> of the aquatic surface, with an annual production, mainly of *Ruditapes philippinarum*, that reaches around 12,000–15,000 tons (Turolla, 2008).

The overall biodiversity, the composition and structure of the molluscan assemblage and the presence of clam seed production are seasonally assessed in the Sacca di Goro Lagoon by C.Ri.M. (Cen-

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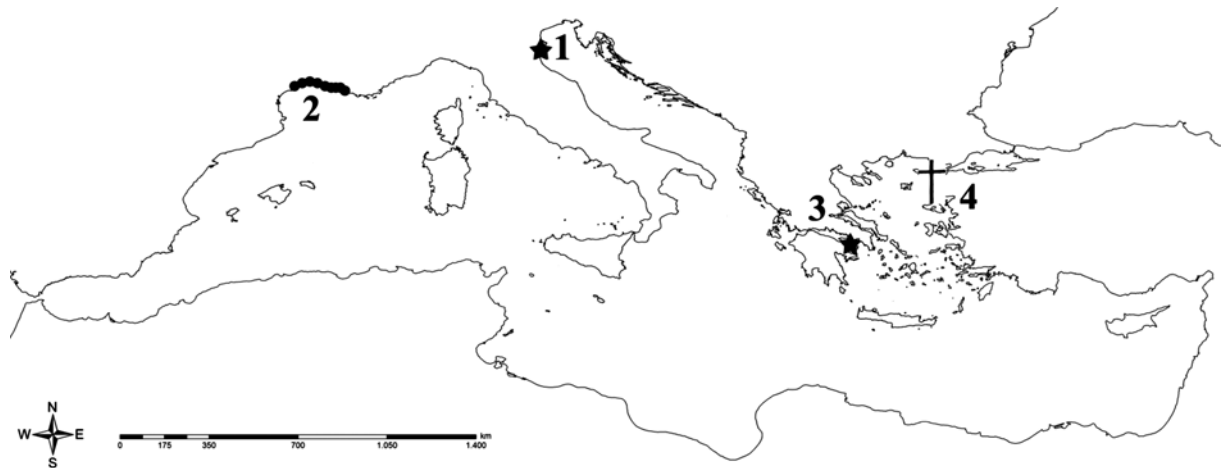


FIG. 1. The reliable Mediterranean distribution of *Mya arenaria* Linnè, 1758. Stars and cross constitute respectively new records of living and dead specimens.

tro Ricerche Molluschi). Local fishermen are also advised to communicate or bring to C.Ri.M. laboratories each unusual species recorded among commonly exploited ones. Since February 2008, several oral communications of a new recorded species came to one of us (ET), followed in March 2008 by a first living specimen of *Mya arenaria* and by several others in the following months. Many loose valves were also collected (Fig. 2). Samples recorded were compared with diagnostic characters reported in Bernard (1979) and with *M. arenaria* specimens from worldwide localities (see “Material examined”) to confirm our identification; they were then measured with vernier calipers.

Sizes reported in “Material examined” are in millimeters and given as shell length (SL) × shell width (SW).

*Mya arenaria* Linnaeus, 1758

Not *Mya arenaria* sensu Danilo & Sandri, 1856 in Cesari & Ghisotti (1986): 10.

Not *Mya arenaria* sensu Bussani & Zuder (1976): 28.

*Mya areanaria*, Zibrowius, 2002: 64, 66: fig. 1.

*Mya arenaria*, Jeffreys, 1875: 275; Hidalgo, 1917: 460-461; Lamy, 1927: 160; Ziegelmeier, 1957: 52; Bernard, 1979: 196; Poutiers, 1987: 438-439; Stora *et al.*, 1995: 127; Pelorce, 1995: 5, fig.; Porcheddu *et al.*, 1999: 167; Zenetos *et al.*, 2004: 306-307, fig.; Repetto *et al.*, 2005: 344; Pelorce, 2007: 49.

Material examined

**Atlantic Ocean:** Ireland, Sligo, 18 II 2004, 1 specimen (119.2 × 70.8) (ET). **Barents Sea:** Norway, Forsøl, 4 VIII 1996, 1 specimen (79.5 × 48.5) (FC). **Irish Sea:**

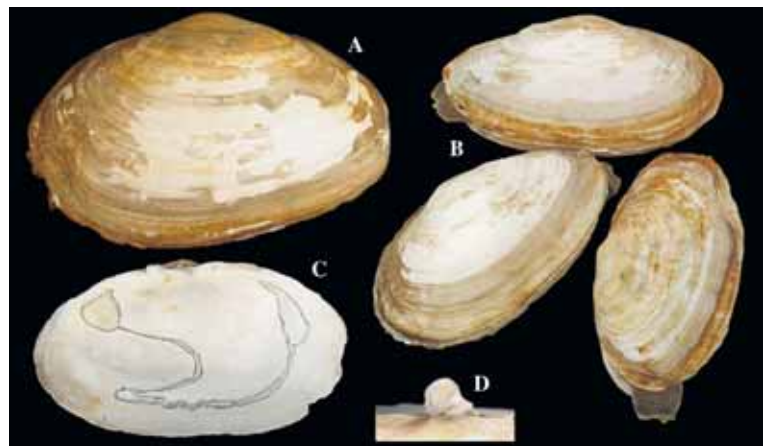


FIG. 2. *Mya arenaria* Linnè, 1758 from Sacca di Goro Lagoon (not to scale). A. 74,6 × 47,95 mm. B. living specimens. C, D. Loose left valvae of 69,55 × 38,2 mm, pallial scar and chondrophore evidenced.

TABLE. 1. Confuted Mediterranean distributional data for *Mya arenaria* Linné, 1758

Reference	Record / Statement	Confuted / Questioned
Danilo & Sandri, 1856 in Cesari & Ghisotti, 1986	“Unica a Brevilacqua (Croatia)”.	Confuted by direct examination of the specimen (Brusina, 1866). Confuted, species not living in the Mediterranean (Cesari & Ghisotti, 1986).
Jeffreys, 1875	“Artic seas to Adriatic”.	Confuted, statement not supported by concrete specimens.
Hidalgo, 1917	“Muy rara en las playas arenosas” of the Gibraltar area (Spain).	Accepted by Porcheddu <i>et al.</i> (1999), De Oliveira (2007) and implicitly by Rolán & Acuña (2008), but the area is well studied, the record is unreliable (Gofas, personal communication) and needs to be confuted. Moreover, no Mediterranean <i>Mya arenaria</i> is present in the Hidalgo collection to support such distributional data (Araujo, personal communication).
Lamy, 1927	“Il existe aussi dans la Méditerranée”.	Confuted, statement not supported by concrete specimens. No <i>M. arenaria</i> from the Mediterranean Sea were listed among the specimens preserved in the MNHN and examined by Lamy (1927).
Ziegelmeier, 1957	“Auch im Westteil des Mittelmeeres”.	Confuted, no exact sites (Strasser, 1999).
Bussani & Zuder, 1976	Miramare area (Trieste).	Confuted, the paper should not be taken into account because of uncertainties regarding native and non-native species (Ghisotti, 1978; Vio & De Min, 1994).
Bernard, 1979	From Valencia to the western Turkish shores, referring to “Gignoux (1969)”.	Confuted, the cited reference could not be found in Bernard (1979) literature list (Strasser, 1999). Moreover, no traces of “Gignoux (1969)” could be found and a so wide distribution cannot go un-noticed.
Poutiers, 1987	“Elle fait l’objet d’une pêche artisanale en haute Adriatique”. Reported for the northern Adriatic, from the whole eastern Istrian shores (Slovenia, Croatia) up to Rimini area (Italy), and for the Calabrian-Sicilian Tyrrhenian shores (Italy, from Gizzzeria area to Milazzo area).	Uncritically accepted by several workers (e.g. Duclerc & Quero, 1992; Pelorce, 1995; Porcheddu <i>et al.</i> , 1999; Bello <i>et al.</i> , 2000; Ceviker, 2002; Occhipinti-Ambrogi <i>et al.</i> , 2011), but questioned by Zenetos <i>et al.</i> (2004) and Schiaparelli (2008). Here definitively confuted since not supported by concrete specimens nor by bibliographic sources. Moreover <i>M. arenaria</i> was not reported either in reviews concerning alien species of the northern Adriatic Sea (De Min & Vio, 1998; Vio & De Min, 1999; Mizzan, 1999; Orlando Bonaca, 2001) or in old (e.g. Stossich, 1880; Coen, 1937; Vatova, 1949; Stolfi Zucchi, 1973) or recent (e.g. Orel <i>et al.</i> , 1987; Rinaldi, 1991; Cesari, 1994; Mizzan, 1996; Vio & De Min, 1996) papers or books concerning molluscan fauna of the northern and central Adriatic Sea. The same situation is assumed for distributional data by Poutiers (1987) from Tyrrhenian shores of Calabria and Sicily. It is also strongly remarking the absence of <i>M. arenaria</i> in Sabelli <i>et al.</i> (1990), and the occurrence of several problems connected with distributional data declared in Poutiers (1987) – see Turolla (2006) and Zenetos <i>et al.</i> (2009a). Finally, a so wide distribution cannot go un-noticed.
Repetto <i>et al.</i> , 2005	The whole Mediterranean Sea.	Confuted, statement not supported by concrete specimens. Again, moreover, a so wide distribution cannot go un-noticed.

Ireland, Drogheda, 2 V 2000, 1 terathologic specimen (85.2×54) (FC). **Marmara Sea:** Istanbul, Florya, I 2000, 1 specimen (63.2×38.6) (FC). **Mediterranean Sea:** France, Etang de Berre, 21 II 2009, 4 specimens (69.5×41.4; 67.65×43; 64.95×42.2; 56.15×37.2) (FC). Italy, Sacca di Goro Lagoon: Goara, 14 III 2008, 1 specimen alive in intertidal (57.35×32.25) (ET); Spiggina, 20 V 2009, 1 specimen alive at 0.5-1 m (92.3×53.7) (ET); Madonnina, 10 II 2010, 4 specimens alive at 1 m (61.65×34.8; 53.15×31.25; 48×28.55) (ET); (61.85×38.5 preserved in 95% alcohol) (FC); Madonnina, 16 II 2010, 1 specimen alive at 1 m (74.6×47.95) (FC); Canal Bianco, 16 III 2010, 1 specimen alive at 0.5 m (13.4×8.4) (ET). **North Sea:** Netherlands, Mokbaai – Texel, 22 II 1992, 2 specimens (31.5×18.5; 37×21.55) (FC). **Pacific Ocean:** Californian shores, 1 specimen (74.3×47) (FC).

## RESULTS

### *Mediterranean distribution and relevant notes*

Literature analysis revealed widespread confusion about the Mediterranean distribution of *Mya arenaria* and we finally decided to reject 9 statements (Table 1). Moreover, we speculate about additional wrong or unchecked old distributional data in the past and chaotic malacological literature. Our general approach has been to reject all claims that were not supported by concrete specimens that could be examined to prevent misidentifications or entry errors.

Consequently, the first reliable Mediterranean record of living specimens seems to be along the French shores in the '90s (Stora *et al.*, 1995) and not in 1976 [as stated in Zenetos *et al.*, (2004) referring to Stora (1976), where there are no traces of *M. arenaria*]. This previous statement was unfortunately due to a misunderstanding among local researchers (Zenetos, Zibrowius personal communication). The species is actually strongly invasive mainly in the Gulf of Lion (Fig. 1, station 2) (Stora *et al.*, 1995; Pelorce, 1995; Porcheddu *et al.*, 1999; Zenetos *et al.*, 2004; Pelorce, 2007). For a visual evaluation of the local situation in February 2002 (Zibrowius, personal communication), about ten years after the first records, see Zibrowius (2002: 66, fig. 1).

Regarding Greece, only a single fresh dead specimen was found in 1984 in Saronikos Gulf (Zenetos *et al.*, 2005; Zenetos *et al.*, 2009b). Very recent unpublished records of living specimens from Saronikos Gulf (Greece) (Fig. 1, station 3) and fresh dead ones from Tenedos (Turkey) (Fig. 1, station 4) (Zenetos,

personal communication) definitively confirm the living presence of this species in the eastern Mediterranean Sea, where two introduction patterns seem to be involved: shipping (Saronikos) and natural dispersal from the Marmara Sea (Tenedos) [where it is also included among the alien species]. Additional records of empty shells come from the Dardanelles (Ovalis, personal communication). Further data on these specimens will be given in a paper in preparation (Zenetos, personal communication) and further research is needed to define the living presence of *M. arenaria* along the Turkish Mediterranean shores.

The redacted and updated Mediterranean distribution of *Mya arenaria*, in the light of the present notes and records, is mapped in Figure 1.

## DISCUSSION

*Mya arenaria* is considered among the 100 Mediterranean Worst Invasives (Streftaris & Zenetos, 2006) and, when common, outcompetes native bivalves. It affects the composition and the granulometric structure of shallow water and sea shore deposits and its shells form a secondary hard substrate available for associated species in mobile bottoms (Leppäkoski, 1991). Due to unreliable old records, wrong distributional data and suspected presence of *Mya arenaria* in the Adriatic and Italian seas, the inference of the common and wide historical presence of this alien species in such area is far strongly to be eradicated, especially in non-molluscan specialists. There are no data to ascertain the origin of the Italian specimens, but the presence of different sized living specimens in different years confirms that the species does stably occur in the area and the findings outside of farming areas suggest a spreading not directly connected with seeding of larvae or juveniles coming from other areas or hatcheries. However, given the worldwide commercial interest on the species, we cannot rule out illegal seeding activities and strongly suppose that such findings are human-mediated. Long-term studies and help from researchers engaged in projects in estuaries and other reduced salinity Adriatic areas are needed to properly assess the actual density and distribution of the species.

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#### Addendum

While the present note was in press we received additional material from the Sacca di Goro Lagoon (Italy): further oral communications arrived to us, and six more living *Mya arenaria* were found at low depths, together with some loose valves, confirming our suggestions that the species is stable in the area. We hereby add data of living specimens:

Italy, Sacca di Goro Lagoon: Madonnina, 11 V 2010 (38×21.05) (ET); Madonnina, 23 V 2010 (42.5×23.8; 45.05×26.35) (ET); Vallazza, 13 VI 2010 (39×21.3) (ET); Madonnina, 8 VII 2010 (34.15×19.5) (ET); 9 VII 2010 (50.65×28.2) (ET).

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