

Marginella glabella (Mollusca: Gastropoda: Marginellidae): a new alien species from tropical West Africa established in southern Mediterranean Spain through a new introduction pathway

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We report the occurrence in the inner fishing port of the Málaga harbour (southern Spain) of an established population of the gastropod Marginella glabella, native on West African Atlantic coasts of Morocco to Senegal and also present at the Canary Islands. This is the third gastropod species with a tropical Atlantic origin found as an established population in the Mediterranean. In spite of its presumably scarce self-dispersal ability due to its direct development, it should be considered an invasive species since it is potentially able to spread out from the area currently occupied and preys voraciously on autochthonous gastropods. It is suggested that this species was introduced during the 1990s as within port discarded by-catch of Málaga-based trawlers, which at that time were fishing on the Atlantic coast off Morocco and the Canary–Saharian bank.

Keywords: *Marginella glabella*, Gastropoda, West Africa, Mediterranean, southern Spain, alien species, new introduction pathway

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INTRODUCTION

Molluscs are relatively well known marine invertebrates from both taxonomic and biogeographical points of view, and represent a significant proportion of fauna in terms of diversity and biomass in any marine benthic community. Shelled molluscs are by far the most diverse and abundant and the persistence of shells after the animal dies make them easily detectable for long periods. This persistence, together with natural or man-mediated shells movement or transport may induce false records both for native or alien species. Many molluscs have planktonic larval stages (planktotrophic or nonplanktotrophic), which favour respectively a more or less high dispersal ability and wide distribution areas, whereas others have a so-called direct development, hatching as small individuals and usually settling down in the same area as their parents; the latter have restricted dispersal capacities and usually have smaller distribution ranges.

A total of 135 alien species of marine gastropods were recorded from the Mediterranean Sea, 112 (83%) of them originally from the tropical Red Sea or the Indo-Pacific. Most of these latter species migrated via the Suez Canal (lessepsian immigrants) and are still mainly confined to the

Eastern Basin (Gofas & Zenetos, 2003; Streftaris *et al.*, 2005; Zenetos *et al.*, 2010). The Western Mediterranean has a low incidence of alien gastropods, with 17 species (Zenetos *et al.*, 2010); only two of them (*Favorinus ghanensis* Edmunds, 1968 and *Mitrella psilla* (Duclos, 1846)) were introduced through shipping from tropical West Africa (Ben Souissi *et al.*, 2004; Antit *et al.*, 2010). Most records of species with tropical West African affinity in the Western Mediterranean Basin are not true aliens, but species whose range encompass at least part of the Alboran Sea since historical times (Gofas & Zenetos, 2003; Antit *et al.*, 2010) and therefore should be considered native (Moreno, 2010; Zenetos *et al.*, 2010). Except for the recent record of the South African nudibranch *Godiva quadricolor* (Barnard, 1967) (also recorded from Western Australia and the central Mediterranean) for the Algeciras harbour (Cervera *et al.*, 2010), no other alien species were found in the Alboran Sea (Zenetos *et al.*, 2010).

The Málaga province (Spain) is situated at the westernmost part of the Alboran Sea, close to the Strait of Gibraltar, which is considered a major hot spot of biodiversity (Coll *et al.*, 2010; Zenetos *et al.*, 2010; CIESM, 2011). The molluscan fauna of this strategic area as a means to detect inflow of Atlantic aliens is rather well known, and this area is also well covered by different marine research institutions. However, the presence of a conspicuous species such as the West African gastropod *Marginella glabella* (Linné, 1758), whose

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first occurrence as an established alien species in the Mediterranean Sea we report here, has apparently been overlooked for years.

MATERIALS AND METHODS

Samples were hand-picked by SCUBA diving in the fishing port of the Málaga harbour (36°42.608'N 04°25.362'W; Datum ETRS89), on 1 April and 10 December 2009, and 24 November 2010, at depths from 0 (low tide) to 9 m; water temperature in December 2009 sampling was 13°C, and 19°C in November 2010. The sampled area was the trawlers dock, where fishing catches are discharged and by-catch eventually discarded and thrown to the water. Two transects of 25 × 4 m were covered to estimate density from 3.5 to 6 m depth. Specimens were measured *in situ*.

Five specimens collected in November 2010 (four adults and a 39 mm subadult with no thickened outer lip) were preserved in 70% ethanol, and four adult specimens (one male and three females) collected alive in December 2009, were maintained during 2010 in a marine aquarium.

RESULTS

Numerous specimens of *Marginella glabella* were observed on the bottom of the fishing port, some of them crawling but most hidden or half-buried in daylight hours, and not associated with carrion or feeding; this species shows chiefly a nocturnal activity. Only one young specimen was found on the pier walls at low tide. From 35 measured specimens, 72.2% were adults with a fully thickened outer lip, reaching a maximum shell length of 44 mm; minimum length of a young specimen was 8 mm; mean shell length of sample was 32.75 mm (SD 9.74). Shells were homogeneous in colour pattern and frequently showed black coloured areas due to contact with anoxic muddy bottom (Figure 1). Mean density estimated in transects was 0.35 individuals/m², with maxima of 4–6 individuals/m².

The habitat at the sampled point corresponds to a severely polluted harbour area. Water column is extremely turbid (visibility 2–5 m), with a high number of particles in suspension and greenish colour due to chlorophyll. Floating solid



Fig. 1. *Marginella glabella*: specimen of 37 mm from the fishing port of the Malaga harbour showing black coloured areas, due to contact with anoxic muddy bottom.

debris, dead fish and fuel spots are common on the water surface. Pier walls are covered at intertidal level by a discontinuous belt of mussels (*Mytilus galloprovincialis* Linné, 1758), followed down by a fringe of the phaeophyte *Stypocaulon scoparium* (Linné) Kützing, 1843, some colonies of the ascidian *Clavelina lepadiformis* (Müller, 1776) and small chlorophycean algae. Other common species are the ascidians *Styela plicata* (Lesueur, 1823) and *Phallusia mammillata* (Cuvier, 1815), the sabellid polychaete *Sabella spallanzanii* (Gmelin, 1791) and the crustacean decapod *Pachygrapsus marmoratus* (Fabricius, 1787). The compacted muddy bottom is covered by abundant solid artificial waste (ropes, pieces of nets, tyres, diverse plastic, and metallic and glass objects) and organogenic debris from trawlers discards. The latter are mainly molluscan shells (*Acanthocardia tuberculata* (Linné, 1758), *Callista chione* (Linné, 1758), *Pecten maximus* (Linné, 1758), *Mytilus galloprovincialis* and *Cymbium olla* (Linné, 1758) are the most common), rotten fish and other invertebrate remains. Some discarded invertebrates remain alive, like the pennatulaceans *Veretillum cynomorium* (Pallas, 1766), *Pennatula rubra* (Ellis, 1761) and *Pteroeides spinosum* (Ellis, 1764) and the alcyonarian *Alcyonium palmatum* Pallas, 1766; the pagurid decapod *Dardanus arrosor* (Herbst, 1796) with its symbiotic anemone *Calliactis parasitica* (Couch, 1838) is common feeding on this carrion. The most abundant benthic species are the ascidian *Phallusia mammillata*, the echiurid *Bonellia viridis* Rolando, 1821 and the actinarian *Anemonia sulcata* (Pennant, 1777). The sabellid *Sabella spallanzanii*, the sea urchins *Arbacia lixula* (Linné, 1758) and *Paracentrotus lividus* (Lamarck, 1816), the starfish *Marthasterias glacialis* (Linné, 1758) and the decapod *Palaemon elegans* Rathke, 1837 are also common. The most abundant molluscs are the gastropods *Nassarius reticulatus* (Linné, 1758) and *Cerithium vulgatum* Bruguière, 1792; *Ocenebra erinaceus* (Linné, 1758), *Calyptrea chinensis* (Linné, 1758) and the bivalve *Anomia ephippium* Linné, 1758 are also frequent.

Specimens of *M. glabella* held in aquaria were sedentary and remained immobile for days at the same place, partially or totally buried in sand except for the distal part of the siphon. As in their habitat, they were more active at night. They were observed feeding on diverse gastropods, dead commercial fish and even a live fish (*Lepadogaster candolii* Risso, 1810). When feeding on gastropods, *M. glabella* extends its long pleurembolic proboscis under the shell; the prey seems to be paralysed and then partially involved with foot (Figure 2). The specimens in our aquarium preyed on *Phorcus richardi* (Payraudeau, 1826), *Nassarius reticulatus*, *Nassarius mutabilis* (Linné, 1758) and *Coralliophila brevis* (de Blainville, 1832). Time of feeding varied between 45 minutes (*P. richardi*) and 2 hours (*Nassarius mutabilis*). No mating or spawns were observed during observation time (one year), even at temperatures of 25°C.

DISCUSSION

Marginella glabella (Linné, 1758) is an easily recognizable, medium sized (up to 50 mm in length) species, with a brightly coloured shell. It was originally described from West Africa (type locality: 'in O. Africano'). The oldest available and precise record for this species seems to be that of Adanson (1757, as La Porcelaine) from Gorée (Senegal), to whose



Fig. 2. *Marginella glabella*: specimen of 39 mm from the fishing port of the Malaga harbour with everted proboscis preying in aquarium on *Phorcus richardi*.

illustration Linné (1767) referred in the twelfth edition of *Systema Naturae*. Linnean types seem to be lost (Dodge, 1955), but one specimen probably belonging to this species was recorded by Wallin (2001) from Linnean collection types housed at the Uppsala University Zoological Museum (no locality given).

The known distribution of *Marginella glabella* includes the West African coast from Morocco (El Jadida and Essaouira) south to Senegal and Guinea, and the Canary Islands (Pallary, 1920; Nicklès, 1950; Knudsen, 1956; Pasteur-Humbert, 1962; Lewy, 1975; Talavera, 1975; Altimira, 1978b; Pérez & Moreno, 1991; Goud & Neefs, 1996; Ardivini & Cossignani, 2004; Hernández *et al.*, 2011). Rolán (2005) denied the presence of this species in the Cape Verde Islands, suggesting that previous records were probably based on specimens brought by Cape Verdean fishermen from West African fisheries. According to Gofas & Zenetos (2003), *Marginella glabella* is established in Atlantic Morocco and Sahara and is liable to occur in the Mediterranean Sea, but it has not been recorded so far, except for the questionable record of hermit-crabs that inhabited shells trawled from Marbella (Málaga) at 100 m depth (Spada & Maldonado, 1974).

In its natural habitat *Marginella glabella* is a common species living from intertidal to subtidal soft bottoms both with or without rocks and stones, usually in sheltered areas at lower depths (McAndrew, 1853; Dautzenberg, 1891; Pérez & Moreno, 1991; authors, personal observations), or in sand of *Cymodocea nodosa* meadows (Espino *et al.*, 2008; authors, personal observations). Living specimens are found from the intertidal zone down to 90 m depth, but seem to be more frequent in the upper third of this range (0–30 m); shells are found down to 200–300 m (Dautzenberg, 1910; Knudsen, 1956; Pasteur-Humbert, 1962; Talavera, 1975; Altimira, 1978a, b; Goud & Neefs, 1996; authors, personal observations). In the Canary Islands this species shows nocturnal activity both in *Cymodocea* meadows and transition zones between sand and rocky bottoms (authors, personal observations).

True Mediterranean established alien gastropods of West African origin, i.e. species not previously recorded in the Mediterranean, man-introduced and fulfilling criteria for established species (European Commission, 2004; Zenetos *et al.*, 2010) are known up to now by two examples: *Mitrella*

psilla and *Favorinus ghanensis* from the Tunisian coasts (Antit *et al.*, 2010; Zenetos *et al.*, 2010). Thus, this is the third record of a gastropod with a tropical West African origin forming an established population in the Mediterranean, and the first record in the Alboran Sea.

Sinum bifasciatum (Récluz, 1851) is also a West African gastropod well-established on the Málaga coast, but it is apparently self-introduced by active dispersal and previously recorded since the 19th Century from the Balearic Islands and southern Italy (Rueda & Gofas, 2000; Gofas & Zenetos, 2003); thus, it might be considered native, according to Zenetos *et al.* (2010). *Euspira grossularia* (Marche-Marchad, 1957) also seems to be well-established (authors, personal observations) and self-introduced in the Alboran Sea, but its classification as native species is doubtful due to its relatively recent description and lower-shelf habitat. Other West African records from the Alboran Sea by Maldonado (1973) and Spada & Maldonado (1974), like *Bolinus cornutus* (Linné, 1758), *Nassarius wolffi* (Knudsen, 1956) or *Nassarius pinguis* (Adams A., 1853), should be considered questionable (*sensu* Zenetos *et al.*, 2010) and were mainly based on empty or hermit-crab inhabited shells, probably introduced by trawler boats coming back from West African fisheries to their Mediterranean base-ports.

Marginella glabella is a gonochoric species, as are other known marginellids (Covert & Covert, 1995). Purse-shaped egg capsules are found fixed under stones by a short stalk; they contain a single young specimen close to hatching (Boyer, 2009; L. Moro, personal observation at the Canary Islands). All known marginellids show paucispiral protoconch indicating direct development, and crawling young snails hatch from the capsule in all species studied (Covert, 1986; Ponder, 1998). Lack of a planktonic larval phase prevents such a dispersal means for *Marginella glabella*. Rafting dispersal of adults, juveniles and/or egg capsules is an alternative means of covering long distances for invertebrates without planktonic larvae, and it is frequent in bays or lagoons and facilitated by substrata of biotic origin, like seagrasses or algae (Thiel & Haye, 2006). However, rafting in *Marginella glabella* must also be disregarded due to heavy individuals and egg capsules usually fixed under stones. Even if some egg capsules were eventually fixed to seagrasses or algae, the main surface current flows southwards along the North African coast from latitudes north (Gyory *et al.*, 2011) of the northernmost record of this species (El Jadida, Morocco). Direct development also prevents transport in ballast water, and the habitat of the species also makes the possibility of egg capsules fixed to the hull of ships not feasible.

During the 1980s and 1990s, the Málaga port was the base of a fleet of trawlers (about 10 in 1990) usually fishing from South Morocco to the Western Sahara (Canary–Saharian Bank) up to the end of 1999, when fishing activity of this fleet ceased. *Marginella glabella* is a common species in this area, and specimens mixed with other fishing remains were easy to find in those years in trawler decks or nets left to repair in the Málaga fishing port (authors, personal observations). From the northernmost fishing area in Morocco, trawlers delayed about 20 hours in arriving to their base (Rafael Arias, personal communication). Therefore, it is probable that *Marginella glabella* arrived to the Málaga fishing port either as young or adult specimens still alive, or as spawns fixed to stones or other objects and then were discarded as by-catch within the port. As far as we know, this kind of

shipping transport represents a new introduction pathway of alien species in the Mediterranean. The occurrence of *M. glabella* in the Canary Islands could be due to the same introduction pathway, but further research and genetic studies of populations from West Africa, Malaga and the Canary Islands are needed to give more information about the geographical origin and genetic diversity of the latter two populations.

This tropical species seems to be well-adapted to low winter temperatures in the Málaga port and also to heavily polluted waters and hard harbour conditions, showing an established and apparently thriving population more than ten years after its presumable date of introduction. Once again, harbours prove to be a focus for established populations of alien species (Zenetos *et al.*, 2010). *Marginella glabella* should be considered an invasive species (*sensu* Zenetos *et al.*, 2010), since it is potentially able to spread widely from the area currently occupied and preys voraciously on autochthonous gastropods. Although it seems to be restricted to the inner fishing port of the Málaga harbour, we strongly recommend to the environmental authorities of Andalusia to establish a monitoring programme to test a possible spread of this population outwards of this area, and to disregard the occurrence of *Marginella glabella* in other fishing ports (Fuengirola, Marbella and Estepona) from trawlers that fished at that time in Morocco and the Canary–Saharian Bank.

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