

## Spread of *Microcosmus squamiger* (Ascidiacea: Pyuridae) in the Mediterranean Sea and adjacent waters

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### Abstract

The Mediterranean Sea is subject to an ever-increasing arrival of non-indigenous marine organisms. *Microcosmus squamiger* is a solitary ascidian that inhabits shallow rocky littoral habitats. It probably originated in Australia and it has shown great invasive potential in other parts of the world. In the Mediterranean, *M. squamiger* has only been reported at a few sites in Spain and Italy. However, the closely related species *Microcosmus exasperatus* has been reported in several areas of the western Mediterranean. As these species can be easily confused, we re-examined most of the material from previous studies and our personal collections. In addition, sampling was done at several sites along the western Mediterranean and Atlantic coasts. The results showed that the majority of the *M. exasperatus* reports correspond to *M. squamiger*, and that *M. squamiger* is common on the Atlantic shores. This suggests that *M. squamiger* has entered the Mediterranean through the Gibraltar Strait, while the restricted distribution in the eastern Mediterranean of *M. exasperatus* suggests that this species is probably a Lessepsian migrant. In the Mediterranean Sea, *M. squamiger* has the ability to occupy extensive areas of hard substrata and to outcompete native species. Further studies are necessary to assess what impacts this invasive species have on native communities.

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The Mediterranean Sea is subject to the ever-increasing arrival of non-indigenous marine organisms, at a pace that may result in serious alteration of the native flora and fauna (Zibrowius, 1991 reviewed in CIESM, 2002). *Microcosmus squamiger* Michaelsen, 1927 is a solitary ascidian (order Stolidobranchia, family Pyuridae) that inhabits shallow rocky littoral habitats, particularly in bays and harbours. It probably originated in Australia, where it was described and where it is widespread on

rocky substrates, be they natural or artificial (Kott, 1985). This solitary ascidian has great invasive potential, and its arrival and expansion in harbours and marinas in southern California is well documented (Lambert and Lambert, 1998, 2003). The species has recently been reported in South Africa (Monniot et al., 2001) and Mozambique (Monniot, 2002).

In the Mediterranean, *Microcosmus squamiger* has been reported by Naranjo (1995) and Naranjo et al. (1996) in southern Spain and by Mastrototaro and Dappiano (2005) in Salerno (Italy). However, the closely related species *Microcosmus exasperatus* Heller, 1878 has been reported since the sixties (Monniot, 1981; Turon, 1987;

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Table 1  
Material included in the present study

Zone	Locality	Source	Species	Previous report
Iberian Peninsula Atlantic	Santander Bay	XT collection *	<i>M. squamiger</i>	Unpublished
	Ría de S. Vicente de la Barquera	XT collection *	<i>M. squamiger</i>	Unpublished
	Chipiona	Naranjo (1995)	<i>M. squamiger</i>	Naranjo (1995), as <i>M. squamiger</i>
	Cádiz	Naranjo (1995)	<i>M. squamiger</i>	Naranjo (1995), as <i>M. squamiger</i>
	Cabo Trafalgar	Naranjo and García-Gómez (1994)	<i>M. squamiger</i>	Naranjo and García-Gómez (1994), as <i>M. exasperatus</i>
Iberian Peninsula Mediterranean	Cascais (Lisboa)	MR collection *	<i>M. squamiger</i>	Unpublished
	Algeciras Bay	Naranjo (1995)	<i>M. squamiger</i>	Naranjo (1995), as <i>M. squamiger</i>
	Patricia	Naranjo and García-Gómez (1994)	<i>M. squamiger</i>	Naranjo and García-Gómez (1994), as <i>M. exasperatus</i>
	Cabo de Gata	Ramos (1988)	<i>M. squamiger</i>	Ramos (1988), as <i>M. exasperatus</i>
	Alicante Bay and Port Valencia	Ramos (1988)	<i>M. squamiger</i>	Ramos (1988), as <i>M. exasperatus</i>
	Delta del Ebro	XT collection *	<i>M. squamiger</i>	Turon (1987), as <i>M. exasperatus</i>
	Torredembarra	XT collection *	<i>M. squamiger</i>	Turon (1987), as <i>M. exasperatus</i>
	Cubelles	XT collection *	<i>M. squamiger</i>	Turon (1987), as <i>M. exasperatus</i>
	Barcelona Port	MR collection *	<i>M. squamiger</i>	Unpublished
	Arenys	XT collection *	<i>M. squamiger</i>	Turon (1987), as <i>M. exasperatus</i>
	Blanes	XT collection *	<i>M. squamiger</i>	Unpublished
	Estartit	MR collection *	<i>M. squamiger</i>	Unpublished
	Palma Port (Balearic Islands)	Ramos (1988)	<i>M. squamiger</i>	Ramos (1988), as <i>M. exasperatus</i>
	Alcudia Bay (Balearic Islands)	XT collection *	<i>M. squamiger</i>	Turon (1987), as <i>M. exasperatus</i>
	France Mediterranean	St Raphael Port	MNHN collection *	<i>M. squamiger</i>
Nice Port		MNHN collection *	<i>M. squamiger</i>	Monniot (1981), as <i>M. exasperatus</i>
Porto-Vecchio (Corse)		MNHN collection *	<i>M. squamiger</i>	Monniot (1981), as <i>M. exasperatus</i>
Port de Solenzara (Corse)		MNHN collection *	<i>M. squamiger</i>	Unpublished
Italy	Porto Maurizio, Imperia	MNHN collection *	<i>M. squamiger</i>	Zibrowius (1991), as <i>M. exasperatus</i>
	Savona harbour	MNHN collection *	<i>M. squamiger</i>	Zibrowius (1991), Monniot (1981), as <i>M. exasperatus</i>
	La Spezia	R. Brunetti collection, revised by TN *	<i>M. squamiger</i>	Unpublished
	Naples	MNHN collection *, TN collection *	<i>M. squamiger</i>	Unpublished
	Taranto	TN collection *	<i>M. squamiger</i>	Unpublished
N Africa Mediterranean	Ceuta (Spain)	XT collection *	<i>M. squamiger</i>	Unpublished
	Nador (Morocco)	MNHN collection *	<i>M. squamiger</i>	Zibrowius (1991), as <i>M. exasperatus</i>
	Bizerte (Tunis)	MNHN collection *	<i>M. squamiger</i>	Monniot (1981), as <i>M. exasperatus</i>
	Jerba (Tunis)	Méliane (2002)	<i>M. exasperatus</i>	Méliane (2002), as <i>M. exasperatus</i>
N Africa Atlantic	Beyrouth (Lebanon)	MNHN collection *	<i>M. exasperatus</i>	Unpublished
	Sta. Cruz de Tenerife (Canary I.)	MR collection *	<i>M. squamiger</i>	Unpublished
	Madeira	MNHN collection *	<i>M. squamiger</i>	Unpublished
Red Sea	Gulf of Aden	MNHN collection *	<i>M. exasperatus</i>	Monniot (2002), as <i>M. exasperatus</i>
	Suez	MNHN collection *	<i>M. exasperatus</i>	Monniot (2002), as <i>M. exasperatus</i>
	Gimsah, Gulf of Suez	Hamburg Museum collection *	<i>M. squamiger</i>	Michaelsen (1919), as <i>M. exasperatus</i> subsp. <i>australis</i>

Sources marked with an asterisk have been directly examined by the authors (XT, MR and TN). Other sources are indicated by references. We have checked the identity of the species with the corresponding authors whenever it was not clear from the reference that the distinction between *M. exasperatus* and *M. squamiger* was adequately made.

Ramos, 1988; Zibrowius, 1991; Ramos et al., 1993; Naranjo and García-Gómez, 1994) in several areas of the western Mediterranean. Re-examination of most of the material included in these studies showed that the

majority of the reports correspond to *Microcosmus squamiger*. Differences between the two species are well documented in Kott (1985), and the most useful diagnostic character is the siphonal spines.

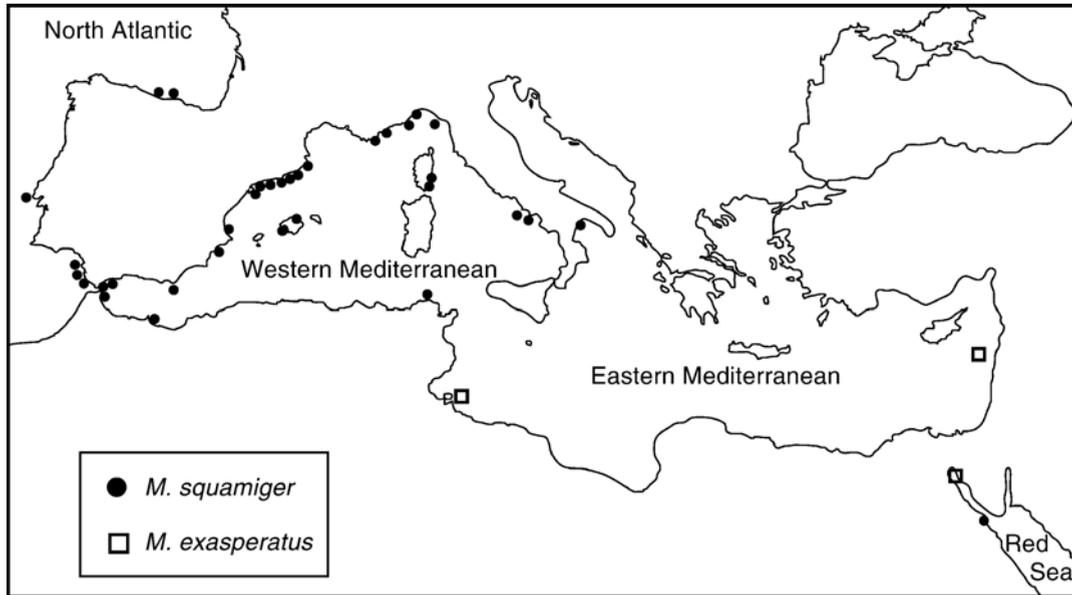


Fig. 1. Map of the locations of the confirmed reports of *M. exasperatus* and *M. squamiger* in the Mediterranean and adjacent waters.

The goal of this paper was to ascertain the relative spread of two species that have so far been confused, *Microcosmus squamiger* and *M. exasperatus*, in the Mediterranean and adjacent waters. To this end: (i) we have reviewed collection material housed Muséum National d'Histoire Naturelle, Paris; (ii) we have revised our personal collections and material donated by other researchers; (iii) we have sampled several points in the western Mediterranean and Atlantic; and (iv) we have revised the literature and asked recent authors to check the identity of specimens they classified as *M. exasperatus*. Table 1 lists the material included in the present account, as well as the name under which it has been previously published, when applicable.

The results (Fig. 1) show that specimens unambiguously attributable to *M. squamiger* are common in Spain, France and Italy, and that they are also found in Morocco and Tunis. They can form dense aggregations in harbours, bays, and shallow littoral habitats (personal observation). In addition, we also found *M. squamiger* for the first time on the Atlantic shores of the Iberian Peninsula. The species is also present in Canary Islands (authors' collection) and Madeira Islands (specimens in the MNHN, Paris, collected by Peter Wirtz in 1992). It seems, therefore, that *M. squamiger* has spread throughout the western Mediterranean, and there are also well-established Atlantic populations. A single early report of this species in the Red Sea from Gimsah, at the southern part of the Gulf of Suez (Michaelsen, 1919), has been confirmed by examination of material in the Hamburg

Museum. However, putting all the evidence together, it seems most likely that the species entered the Mediterranean through the Gibraltar Strait and not the Suez Canal. Although the eastern basin of the Mediterranean is much less explored than the western basin, neither *M. squamiger* nor *M. exasperatus* has been included in a checklist of eastern Mediterranean ascidians (Koukouras et al., 1995).

In contrast, we could confirm only a few reports of *M. exasperatus* in the Mediterranean, on the Lebanese coast. To these should be added the report of Méliane (2002) on the Tunisian coast (this author was aware of the differences between these species). *M. exasperatus*, therefore, has a restricted distribution in the eastern Mediterranean, and is probably a Lessepsian migrant, as this species has been found in Suez and in the Gulf of Aden and, in the latter, the species was collected as early as 1928 (Monniot, 2002).

The ability of *M. squamiger* to form dense, mono-specific crusts that outcompete native species in shallow water communities (authors' personal observation) indicates that it is a potential threat to Mediterranean littoral communities and deserves further monitoring.

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