

# *Microcosmus exasperatus* (Ascidiacea: Pyuridae), current distribution in the Mediterranean Sea

ALFONSO A. RAMOS-ESPLA<sup>1</sup>, ANDRES IZQUIERDO<sup>2</sup> AND MELIH ERTAN ÇINAR<sup>3</sup>

<sup>1</sup>Departamento de Ciencias del Mar y Biología Aplicada, Universidad de Alicante, 03080, Alicante, Spain, <sup>2</sup>Centro de Investigación Marina de Santa Pola (CIMAR), Universidad de Alicante—Ayuntamiento de Santa Pola, 03130 Santa Pola, Alicante, Spain, <sup>3</sup>Ege University, Faculty of Fisheries, Department of Hydrobiology, 35100 Bornova, İzmir, Turkey

*The presence of the pantropical ascidian Microcosmus exasperatus has been an object of some taxonomic confusion in the Mediterranean Sea. A closely related species, M. squamiger was previously reported in the north of Tunisia (in 1962) as M. exasperatus; it has spread to the western Mediterranean and the northern part of the Ionian Sea, whereas, the reliable report of M. exasperatus has been made more recently (in 1998) in the Gulf of Gabès (South Tunisia), and later studies have confirmed its presence in the eastern Mediterranean basin (Lebanon and Israel). The occurrence of this species in Izmir (Turkey) extends its distribution range to the Aegean Sea. At present, the distributions of both species of Microcosmus are not overlapping in the Mediterranean, suggesting a different route of entrance, probably by the maritime traffic (M. squamiger via the Strait of Gibraltar; and M. exasperatus via the Suez Canal). The discontinuity in the distribution of M. exasperatus in the Mediterranean is analysed and discussed.*

**Keywords:** ascidians, *Microcosmus* spp., alien species, lessepsian migrants, Mediterranean Sea, Aegean Sea

Submitted 19 January 2013; accepted 6 June 2013

## INTRODUCTION

The Mediterranean Sea represents an interesting and special part of the Atlantic–Mediterranean region with tropical and warm temperate waters, mainly in summer and in the inshore areas (Ekman, 1953; Briggs, 1974). Moreover, it supports an intense maritime traffic, aquaculture activities and it has been connected with the Red Sea (Indo-Pacific region) across the Suez Canal that has facilitated the progressive introduction of a high number of alien species (Por, 1978; Zibrowius, 1991, 2002; Boudouresque, 1999; Galil, 2000, 2007; Boero, 2002; Streftaris *et al.*, 2005; Zenetos *et al.*, 2005, 2010). Among the alien species, the ascidians are particularly abundant in some areas (i.e. harbour environment) and the maritime traffic is one of the principal introduction vectors for these species (Millar, 1971; Monniot & Monniot, 1983; Monniot *et al.*, 1991; Lambert, 2001).

The species of Pyuridae are solitary ascidians with hard tunics (particularly the genera *Herdmania*, *Microcosmus* and *Pyura*) and they are widely spread around the world, mainly in tropical and subtropical waters (Van Name, 1945; Kott, 1985, 2002; Monniot *et al.*, 2001; Lambert, 2002; Monniot, 2002). Two alien species of *Microcosmus* (*M. squamiger* Michaelsen, 1927 and *M. exasperatus* Heller, 1878) have been reported in the Mediterranean Sea. These species have very similar external and internal morphological characters, and therefore their specimens have been occasionally

misidentified in the Mediterranean Sea. The small siphonal spines appear to be the more useful characteristic to distinguish these species (Kott, 1985; Monniot, 2002). *Microcosmus squamiger* widely spreads in the western Mediterranean basin, whereas *M. exasperatus* has been only reported from some areas in the eastern Mediterranean (Turón *et al.*, 2007; Izquierdo-Muñoz *et al.*, 2009). New records of *M. exasperatus* confirm its presence in the Gulf of Gabès (Méliane, 1998) and extend its geographical distribution to the Aegean Sea. The discontinuity in the actual geographical distribution of *M. exasperatus* and the historical records of both species (with *M. squamiger*) are analysed and discussed.

## MATERIALS AND METHODS

Specimens of *Microcosmus exasperatus* were sampled (Table 1) from some localities in the Gulf of Gabès (south of Tunisia) and the Alsancak Harbour (Izmir Bay, Turkey). The Tunisian specimens (N = 37) were collected during the project ‘Biodiversity of the Gulf of Gabès (Tunisia)’ by SCUBA/snorkel diving inside harbours (0–12 m depth), and by sledge-dredge (10–25 m depth) and bottom trawling (>25 m depth) on degraded *Posidonia oceanica* (Linnaeus) Delile, 1813 meadows and muddy detritic bottoms. One specimen from Izmir was collected on the mussel *Mytilus galloprovincialis* Lamarck, 1819 by scraping off an area of 400 cm<sup>-2</sup> (Çinar *et al.*, 2008). Previously, two specimens from Beirut airport piers (collection date: 2002, by H. Zibrowius) were identified by one of us (A.A.R.E.).

**Corresponding author:**  
A.A. Ramos-Espla  
Email: alfonso.ramos@ua.es

Table 1. Sampled stations of *Microcosmus exasperatus* in the Mediterranean Sea.

Locality	Coordinates	Depth (m)	Date	SM	Observations
Alsancak Harbour (Izmir Bay, Turkey)	N38°26'38"–E27°08'54"	0.2	01.2004	Sk	Fouling community
Southern Kerkennah Islands (Tunisia)	N34°35'22"–E11°18'39"	23–25	18.07.09	SD	Degraded <i>Posidonia</i> meadows
Skhira Harbour (Tunisia)	N34°18'23"–E10°09'21"	1–10	31.07.09	Sc	Fouling community
Western Djerba Island (Tunisia)	N33°59'12"–E10°39'54"	13–15	19.07.10	SD	<i>Posidonia</i> dead matte
Western Djerba Island (Tunisia)	N33°56'51"–E10°38'17"	14–15	21.07.09	SD	<i>Posidonia</i> dead matte
Western Djerba Island (Tunisia)	N33°56'16"–E10°42'38"	9–10	21.07.09	SD	<i>Posidonia</i> dead matte
Eastern Djerba Island (Tunisia)	N33°50'40"–E11°12'22"	34–36	23.07.09	BT	Muddy detritic bottom
Zarzis Harbour (Tunisia)	N33°29'06"–E11°07'04"	1–2	26.07.09	Sk	Fouling community

SM, sampling method; SD, sledge-dredge; BT, bottom trawl; Sc, SCUBA diving; Sk, snorkelling.

The identification was made according to Kott (1985). The siphonal spines were extracted from the inhalant siphon and observed by dissecting microscope. Some scanning electron microscopy pictures were taken, after covering the dry spinules with gold. The material is deposited at the Institute National des Sciences et Technologies de la Mer (Salammbô, Tunisia), the Marine Research Centre of Santa Pola (University of Alicante, Spain: codes GG200901-07, GG201001-03 and AH200401) and the Museum of Faculty of Fisheries (Ege University, Turkey).

## RESULTS AND DISCUSSION

All specimens have a globular and irregular shape with the siphons, more or less prominent (Figure 1); the colour is brown, and some individuals have small epibionts (i.e. rhodophytes, foraminifers and serpulids) on the tunic. The smallest specimen (12 mm long) was found in Alsancak Harbour (January); and the sizes of the Tunisian specimens ranged between 15 and 35 mm (July). The siphonal spines (Figure 2) are curved ('shark-fin like', Kott, 1985) and about 50 µm in length. The gonads of the smaller specimen were

not fully developed; whereas the specimens from the Gulf of Gabès had well-developed gonads.

The individuals were not aggregated, and only small groups of 3–5 specimens were observed on dead *Posidonia oceanica* rhizomes. Some of the specimens were sampled on artificial substrata (concrete piers and harbours) in shallow waters (0–10 m depth), others on benthic habitats drastically influenced by trawling (*Posidonia* meadows and muddy detritic bottoms). In the degraded *P. oceanica* meadows (9–25 m depth), some shoots have still alive leaves, but the majority are dead matte with the alien bivalve *Pinctada radiata* (Leach, 1814). In muddy detritic bottoms (34–36 m depth), the ochrophyte *Arthrocladia villosa* (Hudson) Duby, 1830 and some rhodoliths are present. In the previous studies (Méliane, 2002; Bitar et al., 2007; Shenkar, 2008; Izquierdo-Muñoz et al., 2009; Shenkar & Loya, 2009), specimens of *Microcosmus exasperatus* were also collected mainly on artificial substrates (concrete reefs, piers, harbours and plastic nets).

This opportunistic species colonized altered or degraded communities, often forming monospecific aggregations (Rius et al., 2009). Although, *M. exasperatus* was observed in natural shallow rocky habitats in Israel (Shenkar & Loya, 2009), the community was impoverished with the dominance of the calcareous red algae (*Amphiroa*, *Jania*, *Corallina*,

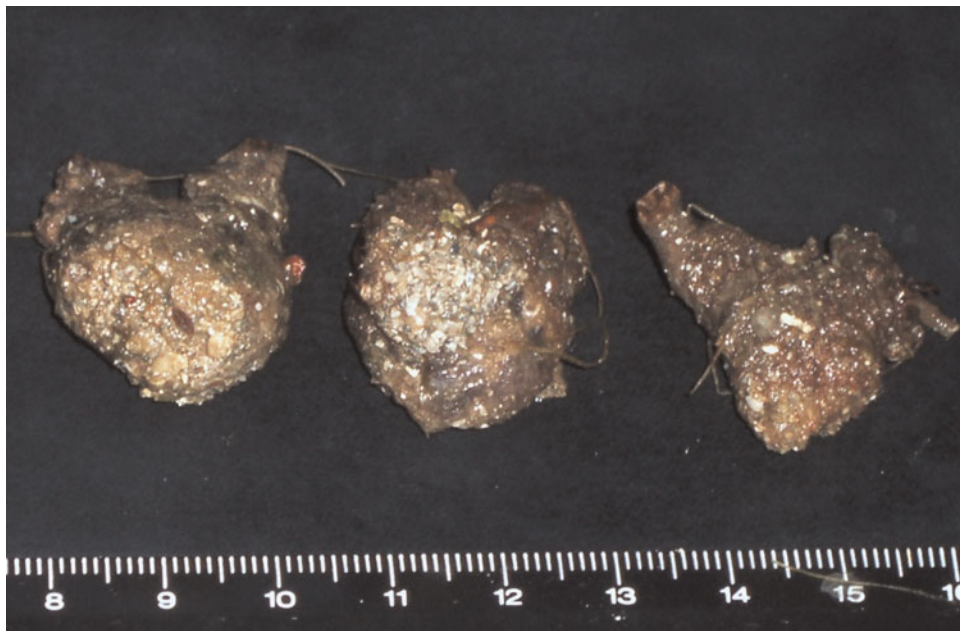


Fig. 1. *Microcosmus exasperatus* from south of Kerkennah (Tunisia) sampled by dredge, 23–25 m depth on dead *Posidonia oceanica* matte.

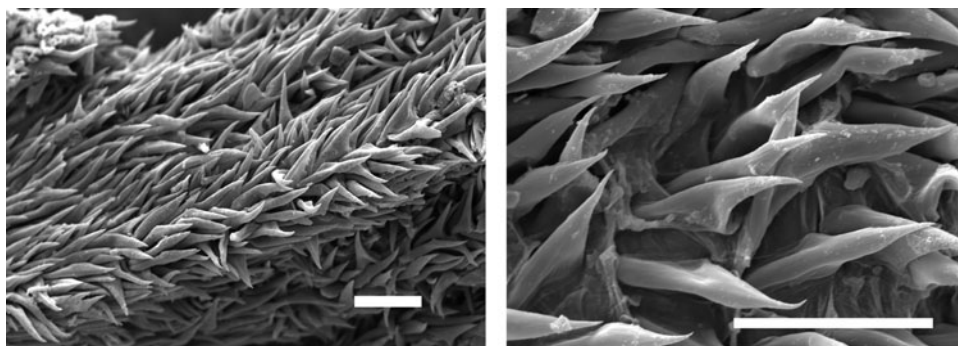


Fig. 2. Siphonal spines of *Microcosmus exasperatus* from Alsancak Harbour. Scale bars: 50  $\mu\text{m}$ .

*Lithophyllum* and *Neogoniolithon*), due to the high herbivorous pressure (*Siganus* spp., *Sparisoma cretense* (Linnaeus, 1758), *Conomurex persicus* (Swainson, 1821)). The area was also degraded by bottom trawling.

*Microcosmus exasperatus*, was first recorded from Djerba Island (south of Tunisia) in 1998 (Méliane, 2002), and then it was observed on the coasts of Lebanon and Israel (Bitar *et al.*, 2007; Turón *et al.*, 2007; Shenkar, 2008; Izquierdo-Muñoz *et al.*, 2009; Shenkar & Loya, 2009) in the eastern Mediterranean (Table 2). With regards to *M. squamiger*, it was first reported from northern Tunisia (identified as *M. exasperatus*) in 1962 (Monniot, 1981). Afterwards, *M. squamiger* was observed around the western Mediterranean and the Atlantic adjacent waters (Turón, 1987; Ramos-Esplá, 1988; Ramos-Esplá *et al.*, 1993; Naranjo, 1995; Mastrototaro & Dappiano, 2005; Turón *et al.*, 2007), and the northern part of the Ionian Sea (Monniot, 1981; Mastrototaro *et al.*, 2004; Izquierdo-Muñoz *et al.*, 2009) (Figure 3).

The distribution of *M. exasperatus* in the eastern Mediterranean basin (Figure 3) appears to be discontinuous, occurring in three areas (Gulf of Gabès, Levantine coasts and eastern Aegean Sea). The occurrence of this species along the Mediterranean coast of Israel and southern Lebanon (airport piers of Beirut) is more or less continuous (Shenkar & Loya, 2009), but not in northern Lebanon, as this species has not been observed in natural habitats (e.g. Ras Chekka and Anfeth; A.A.R.E., personal observation). On the other hand, it seems to be isolated at the location in the eastern Aegean Sea (Izmir Bay), as it was not found in previous studies performed along the Turkish coast (Çinar *et al.*, 2006, 2011).

At present, no *M. exasperatus* record has been made from the northern-central Ionian and western Aegean areas (Italy, Greece, Malta and eastern Tunisia). The introduction vector for the spread of this species within the Mediterranean Sea could have been by the maritime traffic through commercial harbours between the Gulf of Gabès and Izmir Bay (Skhira and Zarzis in Tunisia and Alsancak in Turkey). It is the first time that an alien ascidian (*M. exasperatus*) has been reported from the Turkish coast of the Aegean Sea. In the previous studies (Çinar *et al.*, 2006, 2011), three alien ascidians (*Phallusia nigra* Savigny, 1816, *Symplegma brakenhielmi* (Michaelsen, 1904) and *Herdmania momus* (Savigny, 1816)) were reported from the Levantine coast of Turkey. Kondilatos *et al.* (2010) and Thessalou *et al.* (2012) also observed *P. nigra* on the south-eastern coast of Rhodes and the Peristera Island in Greece, respectively.

Comparing the present distributions of the two alien *Microcosmus* in the Mediterranean Sea, it appears that their geographical areas are not overlapping and the colonization of *M. exasperatus* seems to be more recent than *M. squamiger* (Figure 3). *Microcosmus squamiger* occurs in the western Mediterranean and the northern part of the Ionian Sea, whereas *M. exasperatus* has become well established in the eastern Mediterranean basin (Levantine Sea) and the Gulf of Gabès (southern Ionian Sea). These findings might indicate that two different routes of colonizations are possible: one from the Atlantic through the Strait of Gibraltar (for *M. squamiger*); and another from the Indo-Pacific region through the Suez Canal (for *M. exasperatus*). The historical record might also suggest that the initial establishments of both species

Table 2. Records of *Microcosmus exasperatus* from the Mediterranean Sea.

Locality	Year	Reported	Observations
Western Djerba Island (Tunisia)	1998	Méliane (2002)	On concrete artificial reef
Beirut Airport piers (Lebanon)	2002	Identified by A.A.R.E.	Collection Zibrowius
Beirut Airport piers (Lebanon)	2005	Izquierdo-Muñoz <i>et al.</i> , 2009	Fouling community
Beirut (Lebanon)	–	Turón <i>et al.</i> , 2007	Muséum National d'Histoire Naturelle, Paris collections
Hadera, Shiqmona, Akko, Mikhmoret, Achziv (Israel)	2005–2006	Shenkar, 2008; Shenkar & Loya, 2009	Fouling community and natural rocky shore
Alsancak Harbour (Turkey)	2004	Present study	Fouling community
Southern Kerkennah Islands (Tunisia)	2009	Present study	Degraded <i>Posidonia</i> meadows
Eeastern Djerba Island (Tunisia)	2009	Present study	Detritic with <i>Arthrocladia villosa</i>
Skhira Harbour (Tunisia)	2009	Present study	Fouling community
Zarzis Harbour (Tunisia)	2009	Present study	Fouling community
Western Djerba Island (Tunisia)	2009–2010	Present study	<i>Posidonia</i> dead matte



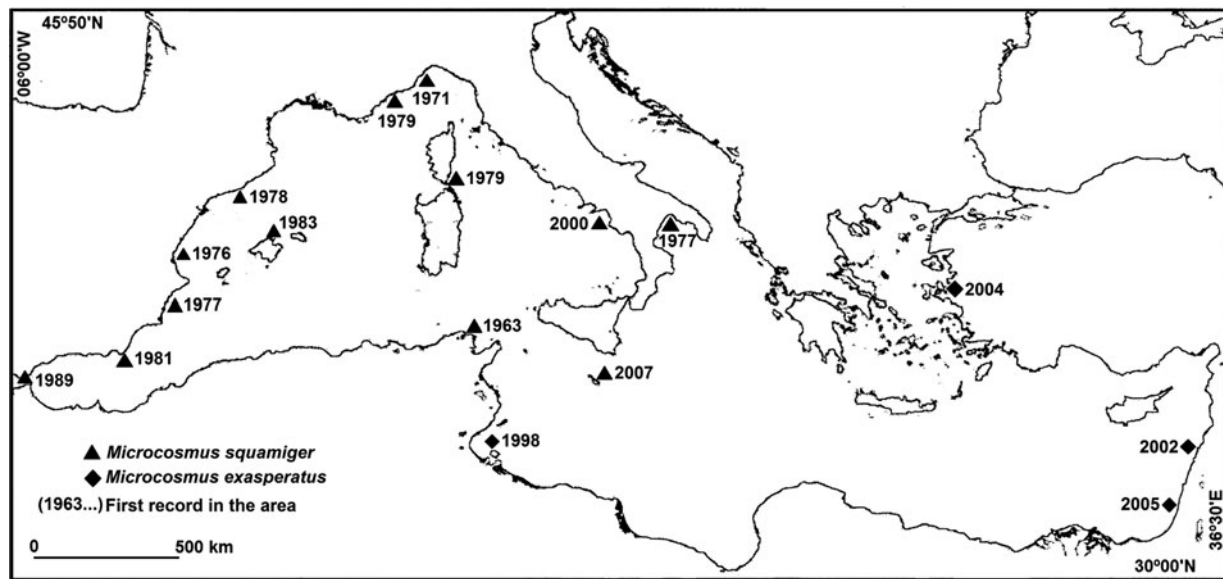


Fig. 3. Geographical distribution of the *Microcosmus squamiger* (triangles) and *M. exasperatus* (rhombus) in the Mediterranean Sea, with the first record/year of the species (from different sources; see text).

took place in the central Mediterranean, and that they have successfully expanded their distributional ranges to the western and eastern parts of the Mediterranean. This kind of spread might have been mediated by maritime traffic and/or current regimes in the area. Furthermore, different ecological conditions between the eastern and western Mediterranean basins (Pérès, 1967) could have affected their distributional patterns.

No discernible negative effect of *M. exasperatus* on the ecosystem and economy has been reported from the area so far. It is possible that this species could create problems in prevailing ecosystems and man-made structures, like other invasive ascidian species (see Lambert, 2007). However, the ecological and distributional features of this species in the area should be investigated and monitored to assess its possible impacts on the Mediterranean ecosystems.

## ACKNOWLEDGEMENTS

The authors thank Helmut Zibrowius for collecting the ascidians samples from the CEDRE project in Lebanon; Ghazi Bitar, Maite Vázquez, Carlos Valle and Oscar Ocaña for their assistance in the field work; and two anonymous referees for their useful suggestions.

## FINANCIAL SUPPORT

This work was partly supported by the Scientific Research Projects of Ege University (Project number: 03 SUF 005).

## REFERENCES

Bitar G., Ocaña O. and Ramos-Esplá A.A. (2007) Contribution of the Red Sea alien species to structuring some benthic biocenosis in the Lebanon coast (Eastern Mediterranean). *Rapports de la Commission International pour l'Exploration de la Mer Méditerranée* 38, 437.

Boero F. (2002) Ship-driven biological invasions in the Mediterranean Sea. *CIESM Workshop Monographs* 20, 87–91.

Boudouresque C.F. (1999) The Red Sea–Mediterranean link: unwanted effects of canals. In Sandlund O.T., Scheil P.J. and Viken A. (eds) *Invasive species and biodiversity management*. London: Kluwer Academic Publishers, pp. 213–228.

Briggs J.C. (1974) *Marine zoogeography*. New York: McGraw-Hill.

Çinar M.E., Bilecenoglu M., Öztürk B. and Can A. (2006) New records of alien species on the Levantine coast of Turkey. *Aquatic Invasions* 1, 84–90.

Çinar M.E., Katagan T., Koçak F., Öztürk B., Ergen Z., Kocatas A., Önen M., Kirkim F., Bakir K., Kurt G., Dagli E., Açık S., Dogan A. and Özcan T. (2008) Faunal assemblages of the mussel *Mytilus galloprovincialis* in and around Alsancak Harbour (Izmir Bay, eastern Mediterranean) with special emphasis on alien species. *Journal of Marine Systems* 71, 1–17.

Çinar M.E., Bilecenoglu M., Öztürk B., Katakagan T., Yokeş M.B., Aysel V., Dağlı E., Açık S., Özcan T. and Erdoğan H. (2011) An updated review of alien species on the coasts of Turkey. *Mediterranean Marine Science* 12, 257–315.

Ekman S. (1953) *Zoography of the sea*. London: Sidgwick & Jackson.

Galil B.S. (2000) A sea under siege—alien species in the Mediterranean. *Biological Invasions* 2, 177–186.

Galil B.S. (2007) Seeing red: alien species along the Mediterranean coast of Israel. *Aquatic Invasions* 2, 281–312.

Izquierdo-Muñoz A., Díaz-Valdés M. and Ramos-Esplá A.A. (2009) Recent non-indigenous ascidians in the Mediterranean Sea. *Aquatic Invasions* 4, 59–64.

Kondilatos G., Corsini-Foka M. and Pancucci-Papadopoulou M.A. (2010) Occurrence of the first non-indigenous ascidian *Phallusia nigra* Savigny, 1816 (Tunicata: Ascidiacea) in Greek waters. *Aquatic Invasions* 5, 181–184.

Kott P. (1985) The Australian Ascidiacea. Part 1. Phlebobranchia and Stolidobranchia. *Memoirs of the Queensland Museum* 23, 1–440.

- Kott P.** (2002) The genus *Herdmania* Lahille, 1888 (Tunicata, Ascidiacea) in Australian waters. *Zoological Journal of the Linnean Society* 134, 359–374.
- Lambert G.** (2001) A global overview of ascidian introductions and their possible impact on the endemic fauna. In Sawada H., Yokosawa H. and Lambert C.C. (eds) *The biology of ascidians*. Tokyo: Springer-Verlag, pp. 249–257.
- Lambert G.** (2002) Nonindigenous ascidians in tropical waters. *Pacific Science* 56, 291–298.
- Lambert G.** (2007) Invasive sea squirts: a growing global problem. *Journal of Experimental Marine Biology and Ecology* 342, 3–4.
- Mastrototaro F. and Dappiano M.** (2005) New record of the non-indigenous species *Microcosmus squamiger* (Ascidiacea: Stolidobranchia) in the harbour of Salerno (Tyrrhenian Sea, Italy). *Marine Biodiversity Records* e12, 1–3. doi: <http://dx.doi.org/10.1017/S1755267205001247>.
- Mastrototaro F., Petrocelli A., Cecere E. and Matarrese A.** (2004) Non-indigenous species settle down in the Taranto Seas. *Biogeographia* 25, 47–54.
- Méliane I.** (2002) *Contribution to the knowledge of the ascidian fauna in the south-east of Tunisia*. MSc thesis. University of Alicante, Spain.
- Millar R.H.** (1971) The biology of ascidians. *Advances in Marine Biology* 9, 1–100.
- Monniot C.** (1981) Apparition de l'ascidie *Microcosmus exasperatus* dans les ports méditerranéens. *Téthys* 10, 59–82.
- Monniot C.** (2002) Stolidobranch ascidians from the tropical western Indian Ocean. *Zoological Journal of the Linnean Society* 135, 65–120.
- Monniot C. and Monniot F.** (1983) Navigation ou courants? La colonisation des Açores et des Bermudes par les ascidies (Tuniciens benthiques). *Comptes Rendus des Séances de la Société de Biogéographie* 59, 53–58.
- Monniot C., Monniot F. and Laboute P.** (1991) *Coral reef ascidians of New Caledonia*. Paris: Collection Faune Tropicale 30, ORSTOM, 247 pp.
- Monniot C., Monniot F., Griffiths C.L. and Schleyer M.** (2001) South African ascidians. *Annals of the South African Museum* 108, 1–141.
- Naranjo S.** (1995) *Taxonomía, zoogeografía y ecología de las ascidias del Estrecho de Gibraltar. Implicaciones de su distribución bionómica en la caracterización ambiental de áreas costeras*. PhD thesis. University of Seville, Spain.
- Pérès J.M.** (1967) Mediterranean benthos. *Oceanography and Marine Biology: an Annual Review* 5, 449–533.
- Por F.D.** (1978) *Lessepsian migration. The influx of Red Sea biota into the Mediterranean by way of the Suez Canal*. Berlin: Springer-Verlag.
- Ramos-Esplá A.A.** (1988) *Ascidias litorales del Mediterráneo Ibérico. Faunística, ecología y biogeografía*. PhD thesis. University of Barcelona, Spain.
- Ramos-Esplá A.A., Buencuerpo V., Vázquez E. and Lafargue F.** (1993) Distribución bionómica de las ascidias litorales del Estrecho de Gibraltar (sector ibérico). *Publicaciones Especiales del Instituto Español de Oceanografía* 11, 185–191.
- Rius M., Pineda M.C. and Turón X.** (2009) Population dynamics and life cycle of the introduced ascidian *Microcosmus squamiger* in the Mediterranean Sea. *Biological Invasions* 11, 2181–2194.
- Shenkar N.** (2008) *Ecological aspects of the ascidian community along the Israeli coasts*. PhD thesis. University of Tel-Aviv, Israel.
- Shenkar N. and Loya Y.** (2009) Non-indigenous ascidians (Chordata: Tunicata) along the Mediterranean coast of Israel. *Marine Biodiversity Records* e166, 1–7. doi:10.1017/S175526720999075.
- Streftaris N., Zenetos A. and Papathanassiou E.** (2005) Globalisation in marine ecosystems: the story of non-indigenous marine species across European Seas. *Oceanography and Marine Biology: an Annual Review* 43, 419–453.
- Thessalou M., Aydoğan Ö., Bekas P., Bilge G., Boyacı Y.O., Brunelli E., Circosta V., Crocetta F., Durucan F., Erdem M., Ergolavou A., Filiz H., Fois F., Gouva E., Kapiris K., Katsanevakis S., Kljajic Z., Konstantinidis E., Konstantinou G., Koutsogiannopoulos D., Lamon S., Macic V., Mazzette R., Meloni D., Mureddu A., Paschos I., Perdikaris C., Piras F., Poursanidis D., Ramos-Esplá A.A., Rosso A., Sordino P., Sperone E., Sterioli A., Taskin E., Toscano F., Tripepi S., Tsiakkiris L. and Zenetos A.** (2012) New Mediterranean biodiversity records (December 2012). *Mediterranean Marine Science* 13, 312–327.
- Turón X.** (1987) *Estudio de las ascidias de las costas de Cataluña e Islas Baleares*. PhD thesis. University of Barcelona, Spain.
- Turón X., Nishikawa T. and Rius M.** (2007) Spread of *Microcosmus squamiger* (Ascidiacea: Pyuridae) in the Mediterranean Sea and adjacent waters. *Journal of Experimental Marine Biology and Ecology* 342, 185–188.
- Van Name W.G.** (1945) The North and South American ascidians. *Bulletin of the American Museum of Natural History* 84, 1–476.
- Zenetos A., Çınar M.E., Pancucci-Papadopoulou M.A., Harmelin J.G., Furnari G., Andaloro F., Bellou N., Streftaris N. and Zibrowius H.** (2005) Annotated list of marine alien species in the Mediterranean with records of the worst invasive species. *Mediterranean Marine Science* 6, 63–118.
- Zenetos A., Gofas S., Verlaque M., Çınar M.E., Garcia Raso J.E., Bianchi C.N., Morri C., Azzurro E., Bilecenoglu M., Froggia C., Siokou I., Violanti D., Sfriso A., San Martin G., Giangrande A., Katağan T., Ballesteros E., Ramos-Esplá A., Mastrototaro F., Ocaña O., Zingone A., Gambi M.C. and Streftaris N.** (2010) Alien species in the Mediterranean Sea by 2010. A contribution to the application of European Union's Marine Strategy Framework Directive (MSFD). Part I. Spatial distribution. *Mediterranean Marine Science* 11, 381–493.
- Zibrowius H.** (1991) Ongoing modification of the Mediterranean marine flora and fauna by the establishment of exotic species. *Mésogée* 51, 83–107.

and

**Zibrowius H.** (2002) Assessing scale and impact of ship transported alien fauna in the Mediterranean? *CIESM Workshop Monographs* 20, 63–68.

#### Correspondence should be addressed to:

A.A. Ramos-Esplá  
 Departamento de Ciencias del Mar y Biología Aplicada  
 Universidad de Alicante, 03080, Alicante, Spain  
 email: [alfonso.ramos@ua.es](mailto:alfonso.ramos@ua.es)