Annotated list of marine alien species in the Mediterranean with records of the worst invasive species

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Abstract

This collaborative effort by many specialists across the Mediterranean presents an updated annotated list of alien marine species in the Mediterranean Sea. Alien species have been grouped into six broad categories namely established, casual, questionable, cryptogenic, excluded and invasive, and presented in lists of major ecofunctional/taxonomic groups. The establishment success within each group is provided while the questionable and excluded records are commented in brief.

A total of 963 alien species have been reported from the Mediterranean until December 2005, 218 of which have been classified as excluded (23%) leaving 745 of the recorded species as valid aliens. Of these 385 (52%) are already well established, 262 (35%) are casual records, while 98 species (13%) remain “questionable” records. The species cited in this work belong mostly to zoobenthos and in particular to Mollusca and Crustacea, while Fish and Phytobenthos are the next two groups which prevail among alien biota in the Mediterranean.

The available information depends greatly on the taxonomic group examined. Thus, besides the three groups explicitly addressed in the CIESM atlas series (Fish, Decapoda/Crustacea and Mollusca), which are however updated in the present work, Polychaeta, Phytobenthos, Phytoplankton and Zooplankton are also addressed in this study. Among other zoobenthic taxa sufficiently covered in this study are Echinodermata, Sipuncula, Bryozoa and Ascidiae. On the contrary, taxa such as Foraminifera, Amphipoda and Isopoda, that are not well studied in the Mediterranean, are insufficiently covered.
gap of knowledge is also noticed in Parasites, which, although ubiquitous and pervasive in marine systems, have been relatively unexplored as to their role in marine invasions. Conclusively the lack of funding purely systematic studies in the region has led to underestimation of the number of aliens in the Mediterranean.

Emphasis is put on those species that are current or potential threats to the marine ecosystems, namely the Worst Invasive Alien Species providing their record across major groups.

**Keywords:** Alien taxa; Establishment success; Worst IAS; Mediterranean.

**Introduction**

The significance of alien species in marine ecosystems worldwide has been highlighted in recent years. International organisations (UNEP/MAP/RAC/SPA, FAO/DIAS, IUCN, ICES, IMO, CIESM) and the scientific community have addressed the issue through articles, review papers, databases and directories. The most representative and recent work regarding the distribution, impact and management of invasive aquatic species in Europe can be found in a series of papers compiled in one edition by LEPPAKOSKI et al. (2002).

STREFTARIS et al. (2005) have summarised and compiled a list of alien species in European Seas including 615 species in the Mediterranean up to the end of 2003 plus 23 additional species from literature accessible within 2004. This led them to consider the Mediterranean as a major recipient of alien species.

Following POR (1978) who focused on introductions via the Suez Canal, the so-called Lessepsian migrants, ZIBROWIUS (1992) attempted a compilation of data on alien species in the Mediterranean. He pointed out that while taxa with well-known taxonomy and established historical distribution records (e.g. benthic organisms, fish) have received more attention than other groups, many of the small, less-conspicuous, less-studied species are necessarily overlooked, leading to an underestimation of the extent of aliens’ presence.

The chaos in nomenclature and fragmentary and sporadic information, based widely on selective scientific interest, prompted CIESM to issue a series of atlases (GOLANI et al., 2002; GALIL et al., 2002; ZENETOS et al., 2004). The list of STREFTARIS et al. (2005) intended to include as many seemingly valid records as possible and compared trends between the various European Seas. However, even in this work the effort has been focused on certain taxonomic groups, mainly fish and benthos (major “popular” groups treated extensively in the recent CIESM atlas series) while many pelagic groups have not even been mentioned. Other recent efforts to compile updating lists in marine algae, phytoplankton and zooplankton are those by ATHANASIADIS (2002); CORMACI et al. (2004); VERLAQUE et al. (2005); GÓMEZ, 2005; UYSAL et al., (2002); BOUILLON et al. (2004). However, in spite of these efforts, one should remain aware, that as stated by STREFTARIS et al. (2005), there are arguments against the accuracy and validity of registration of various groups (these authors specially mentioned bryozoans, entoprocts, hydroids, sponges, polychaetes, oligochaetes, amphipods, flatworms, nematodes, nemerteans).

As an important step in the ongoing review of implementation of the European Community Biodiversity Policy, a broad consultative process culminating in a conference in Malahide, Ireland (25-27 May, 2004), reconfirmed Invasive Alien Species (IAS) as
a priority issue. The Environment Council, on 28 June, 2004 asked the Commission to come forward with a communication taking the “Message from Malahide” into account.

Under the Sixth Framework Programme, there are currently ongoing Community-funded research projects and collaborative partnerships which address marine IAS issues. ALARM (Assessing Large-scale environmental Risks for biodiversity with tested Methods) and DAISIE (Delivering Alien Invasive Species Inventories for Europe) being two of those. The latter aims to create an inventory of IAS that threaten European environments structured in such a way as to provide the basis for prevention and control of biological invasions.

In January 2005, the European Environment Agency commenced a project on “Streamlining European 2010 Biodiversity Indicators” (SEBI2010). One of the expert groups (Group 5) in this project is addressing the indicator on “number and cost of IAS”. The cumulative increase in the number of alien species in Europe over time, with 1900 as a baseline, is one of the first indicators to be demonstrated at European level (http://biodiversity-chm.eea.eu.int/information/indicator).

The aim of the current work (a collaborative effort by many specialists across the Mediterranean) is to present an updated annotated list of alien marine species in the Mediterranean Sea including information on excluded species. Emphasis is put on those species that are current or potential threats to the marine ecosystems, namely the Worst Invasive Alien Species.

Methodology

The list is updated based on species records up to December 2005. Alien species have been grouped into six broad categories namely established, casual, questionable, cryptogenic, excluded and invasive.

Alien: Species, subspecies or lower taxa occurring outside their historically known range (occupied naturally) and beyond their natural dispersal potential (minor climate oscillations) as a result of direct or indirect introduction or care by humans. Synonyms are non-native, non-indigenous, foreign, and exotic.

Established: Introduced or feral population of species established in the wild with free-living, self-maintaining and self-perpetuating populations unsupported by and independent of humans (EUROPEAN COMMISSION, 2004). As established here are also classified species with at least two records spread over time and space in the sense of CIESM atlas series. Synonym: Naturalized.

Casual: Casual species are identified those having been recorded only once (no more than twice for fishes) in the scientific literature: they are presumed to be non-established in the basin. In this paper casual is used in the same sense as alien in the CIESM atlas series.

Questionable: Species with insufficient information - ‘suspects’. Also native/ new entries not verified by experts. Species with taxonomic status unresolved.

Cryptogenic: Species with no definite evidence of their native or introduced status according to CARLTON (1996) and species whose probable introduction has occurred “in early times” and not been witnessed e.g., prior to 1800. Often these species are excluded from lists of aliens or included among the established ones. In this review we considered it best to separate them.

Excluded: We have tabulated those species fulfilling some of CIESM’s criteria for exclusion such as:

- Misidentification
- Native species, falsely identified as alien or exotic: species formerly considered exotic and later revealed to be indigenous.
- Spurious records. This category reflects a
problem which is specific to molluscs. The shells of molluscs are liable to be transported by man for food or ornament and left in places where they do not live.

Invasive: Introduced species that have overcome biotic and abiotic barriers, and are able to disseminate away from their area of initial introduction through the production of fertile offspring with noticeable impact. An earlier presentation by RICHARDSON et al. (2000) did not refer to impact. In many definitions the term invasive is also associated with established species which are agents of change and threaten native biological diversity (IUCN, 2002) or species that threaten the diversity or abundance of native species, the ecological stability of infested ecosystems, economic activities dependent on these ecosystems and/or human health (EPA, 2001). In this paper we are adapting the definition that encompasses impacts as an essential dimension for the categorisation of an alien species as invasive.

Commented synonyms. In compiling the list, for taxonomic groups other than those treated by CIESM atlas series, we came across various records which needed further investigation. Thus we addressed experts in the fields of phytoplankton, zooplankton, phytobenthos, various invertebrate groups such as amphipods, polychaetes etc. In addition, the ITIS (Integrated Taxonomic Information System), and the ALGAEBASE (Information on the algae of the world, including terrestrial, marine, and freshwater forms) websites were visited. The species removed from the list as synonyms are presented in the list of excluded.

The species lists are presented in 9 units which are ecofunctional/taxonomic groups. These are: 1: Fish, 2: Zoobenthos/Mollusca, 3: Zoobenthos/Polychaeta, 4: Zoobenthos/Crustacea, 5: Zoobenthos/Miscellanea, 6: Parasites, 7: Phytoplankton, 8: Zooplankton and 9: Phytobenthos. The reasoning for questioning or excluding some species per group is presented in detail only for the Bryozoa. A full list of the experts who contributed in various ways is provided in the acknowledgements.

Results
A total of 963 species have been reported as aliens from the Mediterranean until December 2005, 218 of which are classified as excluded and 745 as valid species among which 98 as questionable (Fig. 1). The species retained as aliens in this study belong mostly to zoobenthos and in particular to Mollusca, while Fish and Phytobenthos are the next two groups rich in species. In the lists that follow, the establishment success within each group is provided with no further comments for the species established and those with casual records. In contrast, the questionable and excluded records are commented in brief (citation of source and reason for exclusion, questioning the validity). No details are provided for the excluded species of Mollusca, Fish and Decapoda treated extensively in the CIESM atlas series and the reader is referred for further details on those to (GOLANI et al., 2002; GALIL et al., 2002; ZENETOS et al., 2004). It should be pointed out that many of the questionable records are expected to be clarified in the near future and most probably moved to the casual records.
Fig. 1: Establishment success of recorded alien species including non-valid records.

Species lists per group
1. Fish

Fish established
Note: * denotes species reported as casual in CIESM 2005 on line

*Acanthurus monroviae  *Lagocephalus sceleratus  Scomberomorus commerson
Alepes djedaba  Lagocephalus spadiceus  Seriola carpenteri
Apogon pharaonis  Lagocephalus suenzensis  Seriola fasciata
Atherinomorus lacunosus  Leiognathus klunzingeri  Siganus luridus
Callionymus filamentosus  Liza haematocheila  Siganus rivulatus
Carcharhinus altimus  Microchirus hexophthalmus  Silhoutta aegyptia
Carcharhinus falciformis  Oxyurichthys petersi  Sillago sihama
Chelon carinata  Pagellus bellotti  Solea senegalensis
Crenidens crenidens  Parexocoetus mento  *Spratelloides delicatulus
Cynoglossus sinusarabici  Pelates quadrilineatus  Sphoeroides pachyaster
Diplodus bellottii  Pempheris vanicolensis  Sphyraena chrysotaenia
Dussumieta elopoides  *Petroscirtes anguodon  *Sphyraena flavicauda
*Enchelycore anatina  Pisolophis semicincnctus  Stephanolepis diaspros
Epinephelus coioides  Platycephalus indicus  Synaptura lusitanica
Epinephelus malabaricus  Plotosus lineatus  Syngnathus rostellatus
Etrumeus teres  Pomadasys stridens  Terapon puta
Fistularia commersonii  Psnesis pellucidus  Tetrosomus gibbosus
Gymnammodytes  Pteragogus pelycus  Trachyscorpa cristulata
semisquamatus  Rhabdosargus haffara  echinata
Hemiramphus far  Sargocentron rubrum  Upeneus moluccensis
Herklotichthys punctatus  Saurida undisquamis  Upeneus pori
Himantura uarnak  Scarus ghobban
Fish casual
Note: underlined species are new species post CIESM 2005 on line

Abudefel vaigiensis
Anarichas lupus
Arius parkii
Beryx splendens
Centralabrus exoletus
Chaunax suttkusi
Cheilopogon furcatus
Chilomycterus spilostylus
Coryogalops ochetica
Diodon hystrix
Fistularia petimba
Galaxias cuvier
Gephyroberyx darwini
Halosaurus ovenii
Heniochus intermedius
Hippocampus fuscus
Hyporhamphus affinis
Iniaius pavo
Lutjanus argentimaculatus
Makaira indica
Microchirus boscanion
Muraenesox cinereus
Omobranchus punctatus
Papilloculiceps longiceps
Pinguipes brasilianus
Priacanthus hamrur
Pseudupeneus prayensis
Pterois miles
Rachycentron canadum
Rastrilliger kanagurta
Rhizoprionodon acutus
Rhynochocer trevavasae
Scorpaena stephanica
Seriola rivoliana
Sorsogona prionota
Spherooides marmoratus
Sphyra mokarran
Synagrops japonicus
Torquigener flavimaculosus
Tylerius spinosisimus
Tylosurus choram
Tylosurus crocodilus

Fish Questionable

<table>
<thead>
<tr>
<th>Species</th>
<th>Cited by</th>
<th>Reasoning</th>
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<td>Alopias superciliosus</td>
<td>SAAD et al., 2005</td>
<td>Insufficient data, origin uncertain</td>
</tr>
<tr>
<td>Torpedo sinuspersici</td>
<td>SAAD et al., 2004</td>
<td>Insufficient data</td>
</tr>
<tr>
<td>Dasyatis sp. cf. tortonesei</td>
<td>SAAD et al., 2005</td>
<td>Complex taxonomy</td>
</tr>
<tr>
<td>Gaidropsarus granti</td>
<td>ZACHARIOU-MAMALINGA, 1999</td>
<td>Insufficient data, origin uncertain</td>
</tr>
<tr>
<td>*Pampus argenteus</td>
<td>ŠOLJAN, 1975</td>
<td>See details</td>
</tr>
</tbody>
</table>

*Pampus argenteus* (Euphrasen, 1788). A specimen of silver pomfret captured in Rijeka (northern Adriatic) in 1896, was initially identified as *Stromateus fiatola*. The specimen, which is preserved in the collection of the Zoological Museum of Zagreb, was tentatively identified as *Pampus argenteus* by ŠOLJAN (1975), but he doubted its identification. The validity of the record was re-examined by DULČIĆ et al. (2004) who claim that the record of 1896 represents the first lessepsian migrant in the Mediterranean.

Fish excluded: for reasoning see GOLANI et al. (2002)

<table>
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<tr>
<th>Species</th>
<th>Cited by</th>
<th>Reasoning</th>
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<td>Ammodytes tobianus</td>
<td>Bothus pantherinus</td>
<td>Cataetix laticeps</td>
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<tr>
<td>Aphanius dispar</td>
<td>Caranx gallus</td>
<td>Clupea kowal</td>
</tr>
<tr>
<td>Apogon taeniatus</td>
<td>Caranx kiliche</td>
<td>Coryphaenoides guentheri</td>
</tr>
<tr>
<td>Arius thalassinus</td>
<td>Carcharhinus brevipinna</td>
<td>Demichthys unicolor</td>
</tr>
<tr>
<td>Borostoma antarcticus</td>
<td>Carcharhinus melanopterus</td>
<td>Dussumieria acuta</td>
</tr>
</tbody>
</table>
Epinephelus coromandelicus  
Epinephelus morrhua  
Epinephelus tauvina  
Gobius couchi  
Gobius roulei  
Hemiramphus gamberur  
Hemiramphus marginatus  
Hemiramphus unifasciatus  
Hyporhamphus dassumieri  
Hyporhamphus xanthopterus  
Istiophorus gladius  
Laemonema latifrons  
Lepidion guentheri  
Lipophrys pholis  
Melanostigma atlanticum  
Oxyurichthys papuensis  
Parablemmius pilicornis  
Parexocoetus brachypterus  
Pempheris molucca  
Pempheris oualensis  
Pristis pectinata  
Remora australis  
Rhinobatos halavi  
Sardinella sirm  
Sargus noct  
Scarichthys  
coeulopunctatus  
Sebastapistes nuchalis  
Serranus melanurus  
Serranus morrhua  
*Sphoeroides spengleri  
Sphyraena viridensis  
Squalus megalops  
Therapon jarbua  
Trichiurus haumela  
Upeneus asymmetricus  
Upeneus barberinus  
Upeneus tragula  
Upeneus vittatus  

*Sphoeroides spengleri, originally reported by REINA-HERVAS et al. (2004), has been added to the excluded list since it is regarded a misclassification of Sphoeroides marmoratus (M. Vacchi pers. commun.)

2. Zoobenthos/Mollusca

Mollusca established

Notes: underlined are new species post CIESM 2005 on line  
Bold indicates cryptogenic species

Acteocina mucronata  
Adelactaeon amoenus  
Adelactaeon fulvus  
Afrocardium richardi  
Alvania dorbignyi  
Amathina tricarinata  
Anadara demiri  
Anadara inaequivalvis  
Anadara natalensis  
Aplysia dactylomela  
Brachidontes pharaonis  
Bulla ampulla  
Bursatella leachi  
Cellana rota  
Cerithiopsis pulvis  
Cerithiopsis tentrenois  
Cerithium scabridum  
Chama pacifica  
Chelidonura fulvipunctata  
Chrysallida fischeri  
Chrysallida maiae  
Chrysallida pirintella  
Clathrofenella ferruginea  
Clementia papyracea  
Crassostrea gigas  
Crepidula aculeata  
Crepidula fornicata  
Cycloscala hyalina  
Cylichnina girardi  
Diala varva  
Diodora fimbriata  
Diodora formosa  
Discodoris lilacina  
Divalinga arabica  
Elysia grandifolia  
Ergalatax contracta  
Ergalatax obscura  
Erosaria turdus  
Favorinusghanensis  
Finella pupoides  
Flabellina rubrolineata  
Fulvia australis  
Fulvia fragilis  
Fusinus verrucosus  
Gafrarium pectinatum  
Gastrochaena cymbium  
Gibborissoa virgata  
Haminoea callidegenita  
Haminoea cyanomarginata  
Hiatula ruppelliana  
Hypselodoris infulata  
Laternula anatina  
Littorina saxatilis  
Mactra lilacea  
Mactra olorina  
Malvufundus regulus  
Melibe fimbriata  
Mercenaria mercenaria  
Metaxia bacillum  
Murex forskoehlii  
Musculista perfragilis  
Musculista senhousia  
Mya arenaria  
Natica gualteriana  

**Mollusca casual**

Note: underlined species are new species post CIESM 2005 on line

<table>
<thead>
<tr>
<th>Species</th>
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<tbody>
<tr>
<td><em>Octopus aegina</em></td>
<td><em>Rhinoclavis kochi</em></td>
<td><em>Syrnola fasciata</em></td>
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<tr>
<td><em>Paphia textile</em></td>
<td><em>Rissoina bertholleti</em></td>
<td><em>Tellina valtonis</em></td>
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<td><em>Perna picta</em></td>
<td><em>Ruditapes philippinarum</em></td>
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<td><em>Pinctada margaritifera</em></td>
<td><em>Saccostrea commercialis</em></td>
<td><em>Teredo navalis</em></td>
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<tr>
<td><em>Pinctada radiata</em></td>
<td><em>Saccostrea cuculata</em></td>
<td><em>Thais lacera</em></td>
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<tr>
<td><em>Plocharmerus ocellatus</em></td>
<td><em>Sepia pharaonis</em></td>
<td><em>Thais sacculum</em></td>
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<td><em>Plocamopherus emertoni</em></td>
<td><em>Sepioeuthis lessoniana</em></td>
<td><em>Theura lubrica</em></td>
</tr>
<tr>
<td><em>Pseudochama corbieri</em></td>
<td><em>Siphonaria crenata</em></td>
<td><em>Timoclea maurica</em></td>
</tr>
<tr>
<td><em>Pseudominolia nedyma</em></td>
<td><em>Smaragdia souverbiana</em></td>
<td><em>Trochus erythraeus</em></td>
</tr>
<tr>
<td><em>Purpuradusta gracilis notata</em></td>
<td><em>Spondylus spinosus</em></td>
<td><em>Turbonilla edgarii</em></td>
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<td><em>Pyrunculus fourierii</em></td>
<td><em>Strombus persicus</em></td>
<td><em>Xenostrobus securis</em></td>
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<tr>
<td><em>Rapana venosa</em></td>
<td><em>Styloptygma beatrix</em></td>
<td><em>Zafra savignyi</em></td>
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<tr>
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<td><em>Syphonota geographic</em></td>
<td><em>Zafra selasphora</em></td>
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*Acar plicata*                               | *Dosinia erythraea*                        | *Petricola hemprichi*                     |
| *Aeolidiella indica*                        | *Electroma vexillum*                       | *Petricola pholadiformis*                |
| *Anadara inflata*                           | *Elysia tomentosa*                         | *Planaxis griseus*                       |
| *Angiola punctostriata*                     | *Engina mendicaria*                        | *Pleurobranchus forskali*                |
| *Antigona lamellaris*                       | *Glycymeris arabicus*                      | *Polycera hedgpathi*                     |
| *Atactodea glabrata*                        | *Haliotis pustulata cruenta*               | *Psammotreta praerupta*                  |
| *Caloria indica*                            | *Hinemoa cylindrica*                       | *Retusa desgenetti*                      |
| *Cantharus tranquebaricus*                  | *Iolaeus neofelixoides*                    | *Rissoina desgenetti*                    |
| *Cardites akabana*                          | *Leucotina cfr. eva*                       | *Semipallium coruscans*                  |
| *Cerithium egemen*                          | *Lienardia mighelsi*                       | *coruscans*                              |
| *Cerithium nesioticum*                      | *Limopsis multisstriata*                   | *Septifer forskali*                      |
| *Chama aspera*                              | *Modiolus auriculatus*                     | *Siphonaria belcheri*                    |
| *Chiton hululensis*                         | *Murchisonella columna*                    | *Sphenia rueppelli*                      |
| *Chlamys lischkei*                          | *Nassarius arcularius plicatus= N. obvelatus? | *Spondylus nicobarius*                  |
| *Chromodoris annulata*                      | *Nerita sanguinolenta*                     | *Sticteulima cfr. lentiginosa*          |
| *Chromodoris quadricolor*                   | *Octopus cyanea*                           | *Stomatella impertusa*                   |
| *Circenta callipyga*                        | *Odostoma forioli*                         | *Syrnola cinctella*                      |
| *Clypeomorus bifasciatus*                   | *Oscilla jocosa*                           | *Trapezium oblongum*                     |
| *Conus fumigatus*                           | *Oxyne viridis*                            | *Tremoctopus gracilis*                   |
| *Cuthona perca*                             | *Palmadusta lentiginosa*                    | *Vexillum depexum*                       |
| *Dendrodoris tumata*                        | *lentiginosa*                               |                                            |
| *Diplodonta cfr. subrotunda*                |                                            |                                            |

**Mollusca questionable**

Note: * denotes species collected alive from biofouling on the pillars of a gas platform, which had been towed from Australia to its current position off the coast of Ashqelon (Israel) (MIENIS, 2004).

<table>
<thead>
<tr>
<th>Species</th>
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<th>Reasoning</th>
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<td>Acteocina crithodes</td>
<td>MIENIS, 2004</td>
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<td>*Alectryonella crenulifera</td>
<td>SHARON et al., 2005</td>
<td>One specimen epibiont on a spiny oyster</td>
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<td>Angulus flacca</td>
<td>MIENIS, 2004</td>
<td>Insufficient data</td>
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<td>*Aplysia parvula</td>
<td>TERLIZZI et al., 2003</td>
<td>Identification uncertain</td>
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<td></td>
<td></td>
<td>See remark under table</td>
</tr>
<tr>
<td>Atys cylindricus</td>
<td>MIENIS, 2004</td>
<td>Insufficient data</td>
</tr>
<tr>
<td>*Barbatia trapezina</td>
<td>MIENIS, 2004</td>
<td>Offshore gas platform March 2003</td>
</tr>
<tr>
<td>Callista florida</td>
<td>MIENIS, 2005</td>
<td>Old record (1927-32), shells in museum collection</td>
</tr>
<tr>
<td>Cerithium columna</td>
<td>MIENIS, 2003a</td>
<td>Insufficient data</td>
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<td></td>
<td>1 single shell from Caesarea 1966</td>
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<tr>
<td>Cerithium erythraeoense</td>
<td>HAAS, 1937</td>
<td>Its record merits further investigation (MIENIS, 2001b)</td>
</tr>
<tr>
<td>/Cerithium nodulosum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Chama asperella</td>
<td>MIENIS, 2004</td>
<td>Offshore gas platform March 2003</td>
</tr>
<tr>
<td>*Chama brassica elatensis</td>
<td>MIENIS, 2004</td>
<td>Offshore gas platform March 2003</td>
</tr>
<tr>
<td>Ethminolia hemprichi</td>
<td>MIENIS, 2004</td>
<td>Insufficient data</td>
</tr>
<tr>
<td>*Hyotissa hyotis</td>
<td>MIENIS, 2004</td>
<td>Offshore gas platform March 2003</td>
</tr>
<tr>
<td>*Isognomon ephippium</td>
<td>MIENIS, 2004</td>
<td>Offshore gas platform March 2003</td>
</tr>
<tr>
<td>*Leiosolenus hanleyanus</td>
<td>MIENIS, 2004</td>
<td>Offshore gas platform March 2003</td>
</tr>
<tr>
<td>*Malvufundus decurtatus</td>
<td>MIENIS, 2004</td>
<td>Offshore gas platform March 2003</td>
</tr>
<tr>
<td>Nanostrea exigua</td>
<td>LUBINEVSKY &amp; MIENIS, 2005</td>
<td>Record based on one specimen only</td>
</tr>
<tr>
<td>*Parahyotissa imbricata</td>
<td>MIENIS, 2004</td>
<td>Offshore gas platform March 2003</td>
</tr>
<tr>
<td>Patelloida saccharina</td>
<td>MIENIS, 2004</td>
<td>Insufficient data</td>
</tr>
<tr>
<td>Pedicirce sulcata</td>
<td>MIENIS, 2004</td>
<td>Insufficient data</td>
</tr>
<tr>
<td>*Planostrea pestigris</td>
<td>MIENIS, 2004</td>
<td>Offshore gas platform March 2003</td>
</tr>
<tr>
<td>*Plicatula chinensis</td>
<td>MIENIS, 2004</td>
<td>Offshore gas platform March 2003</td>
</tr>
<tr>
<td>Pteria occa</td>
<td>BEN-ELIAHU &amp; HOVE TEN, 1992</td>
<td>Insufficient data</td>
</tr>
<tr>
<td>Rapana rapiformis</td>
<td>BARASH &amp; DANIN, 1977</td>
<td>Insufficient data</td>
</tr>
<tr>
<td>Rhinoclavis sinensis</td>
<td>MIENIS, 2004</td>
<td>Insufficient data</td>
</tr>
<tr>
<td>Rissoina ambiguia</td>
<td>MIENIS, 2004</td>
<td>Insufficient data</td>
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</table>

### Mollusca excluded

Aplysia parvula Guilding in Mörch, 1863 was originally described from St. Thomas, Lesser Antilles, in the Caribbean. It has been recorded worldwide between about 40° N and 40° S. The species recorded as Aplysia parvula in the Indo-Pacific area is clearly different from the Mediterranean specimens attributed to this species. So, two or more species may be involved worldwide under this name. The Mediterranean specimens may be young specimens of Aplysia punctata (J. Templado, pers. commun.)

**Mollusca excluded** (including very old records): For reasoning see ZENETOS et al. (2004)

<table>
<thead>
<tr>
<th>Species</th>
<th>Cited by</th>
<th>Reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Octopus macropus</td>
<td>BELLO et al., 2004</td>
<td>Known in the Mediterranean, Lefkaditou, pers. commun.</td>
</tr>
<tr>
<td>Trochus niloticus</td>
<td>MIENIS, 2003b</td>
<td>Only shells, old records</td>
</tr>
<tr>
<td>Tricornis tricornis</td>
<td>MIENIS, 2004</td>
<td>Fragment of a shell only</td>
</tr>
<tr>
<td>Vexillum cadaverosum</td>
<td>MIENIS, 2004</td>
<td>Incorrect locality data</td>
</tr>
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</table>

**Additional excluded mollusca** post ZENETOS et al. (2004)
3. Zoobenthos/Polychaeta

**Polychaeta established**

Note: bold indicates cryptogenic species

- **Branchiomma boholense**
- **Branchiomma luctuosum**
- **Ceratonereis mirabilis**
- **Desdemona ornata**
- **Eunice tubifex**
- **Eusyllis kupfferi**
- **Ficopomatus enigmaticus**
- **Glycindre bonhourei**
- **Hydroides cf. branchyacanthus**
- **Hydroides dianthus**
- **Hydroides diramphus**
- **Hydroides elegans**
- **Hydroides heterocerus**
- **Hydroides homocerus**
- **Hydroides minax**
- **Hydroides operculatus**
- **Leonnates decipiens**
- **Leonnates indicus**
- **Leonnates persicus**
- **Linopherus acarunculata**
- **Metasychis gotoi**
- **Nereis zonata persica**
- **Notomastus aberans**
- **Ficopomatus unibranchia**
- **Hydroides cf. steinitzi**
- **Laonome elegans**
- **Leiochrides australis**
- **Lepidonotus tenuisetosus**
- **Hydroides dianthus**
- **Hydroides diramphus**
- **Hydroides elegans**
- **Hydroides heterocerus**
- **Hydroides homocerus**
- **Hydroides minax**
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- **Ficopomatus unibranchia**
- **Hydroides cf. steinitzi**
- **Laonome elegans**
- **Leiochrides australis**
- **Lepidonotus tenuisetosus**

**Polychaeta casual**

- **Amphicorina pectinata**
- **Fabriciola ghardaqa**
- **Hydroides albiceps**
- **Hydroides steinitzi**
- **Laonome elegans**
- **Leiochrides australis**
- **Lepidonotus tenuisetosus**
- **Hydroides dianthus**
- **Hydroides diramphus**
- **Hydroides elegans**
- **Hydroides heterocerus**
- **Hydroides homocerus**
- **Hydroides minax**
- **Hydroides operculatus**
- **Leonnates decipiens**
- **Leonnates indicus**
- **Leonnates persicus**
- **Linopherus acarunculata**
- **Metasychis gotoi**
- **Nereis zonata persica**
- **Notomastus aberans**
- **Ficopomatus unibranchia**
- **Hydroides cf. steinitzi**
- **Laonome elegans**
- **Leiochrides australis**
- **Lepidonotus tenuisetosus**

**Polychaeta questionable**

<table>
<thead>
<tr>
<th>Species</th>
<th>Cited by</th>
<th>Reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cirriformia semicincta</strong></td>
<td>LAUBIER, 1966; BITAR &amp; KOULI-BITAR, 2001</td>
<td>Insufficient data, identification is not certain</td>
</tr>
<tr>
<td><strong>Cossura coasta</strong></td>
<td>BOGDANOS &amp; FREDJ, 1983</td>
<td>Insufficient data, identification is not certain</td>
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<tr>
<td><strong>Epidiopatra hupferiana</strong></td>
<td>CANTONE &amp; FASSARI, 1982</td>
<td>Insufficient data, identification is not certain</td>
</tr>
<tr>
<td><strong>Eunice indica</strong></td>
<td>BEN-ELIAHU, 1976</td>
<td>Insufficient data, identification is not certain</td>
</tr>
<tr>
<td><strong>Eurythoe complanata</strong></td>
<td>FAUVEL 1937; ERGEN &amp; CINAR, 1997</td>
<td>Insufficient data, identification is not certain</td>
</tr>
<tr>
<td><strong>Isolda pulchella</strong></td>
<td>CANTONE, 2001</td>
<td>Insufficient data, identification is not certain</td>
</tr>
<tr>
<td><strong>Lysidice collaris</strong></td>
<td>BEN ELIAHU, 1972a</td>
<td>Probably confused with the native species <em>L. margaritacea</em></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Species</th>
<th>Cited by</th>
<th>Reasoning</th>
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<tbody>
<tr>
<td><em>Amphicorina eimeri</em></td>
<td>GAMBI et al., 1983</td>
<td>Atlanto-Mediterranean</td>
</tr>
<tr>
<td><em>Bhawania goodei</em></td>
<td>BITAR &amp; KOULI-BITAR, 2001</td>
<td>Circumtropical</td>
</tr>
<tr>
<td><em>Branchiosyllis exilis</em></td>
<td>MONRO, 1937; BEN ELIAHU 1972b</td>
<td>Widespread even in the eastern Atlantic</td>
</tr>
<tr>
<td><em>Chrysopetalum debile</em></td>
<td>LAUBIER, 1966</td>
<td>Native: type locality Villefranche</td>
</tr>
<tr>
<td><em>Discipio uncinata</em></td>
<td>ICES, 2001</td>
<td>widespread in the Atlantic</td>
</tr>
<tr>
<td><em>Fabricia filamentosa</em></td>
<td>GIANGRANDE &amp; CASTELLI, 1986; SIMBOURA, 1990</td>
<td>Misidentification of Pseudofabriciola analis and P longipyga</td>
</tr>
<tr>
<td><em>Hydroides novaepommeraniae</em></td>
<td>ZIBROWIUS &amp; BITAR, 1981 as <em>H. grubei</em></td>
<td>Undeterminable juvenile (HOVE TEN &amp; BEN ELIAHU, 2005)</td>
</tr>
</tbody>
</table>
Monticellina dorsobranchialis
HARMELIN, 1969a; BEN ELIAHU 1972b
Type locality Atlantic, widespread in the Mediterranean and Atlantic

Neopsodocapitella brasiliensis
GRAVINA & SOMASCHINI, 1990
A circumtropical species

Opisthosyllis brunnea
MONRO, 1937
Widespread even in the eastern Atlantic

Paleonotus chrysolepis
BITAR & KOULIBITAR, 2001
Cosmopolitan

Opisthosyllis brunnea
MONRO, 1937
Widespread even in the eastern Atlantic

Paleonotus chrysolepis
BITAR & KOULIBITAR, 2001
Cosmopolitan

Prionospio salzi
LAUBIER, 1970
Endemic in the Mediterranean

Questa caudicirra
SOMASCHINI & GRAVINA, 1993
Questa mediterranea sp. n.
GIERE & ERSEUS, 1998

Rhodine loveni
FAUVEL, 1957; BEN ELIAHU 1972a
Type locality north Atlantic, widespread in Mediterranean and Atlantic

Scoloplos (Leodomus) chevalieri candiensis
HARMELIN, 1969a
Type locality Crete, endemic species for the eastern Mediterranean

Spirobranchus giganteus
LAUBIER, 1966
Misidentification, the reports belong to S. tetraceros

4. Zoobenthos/Crustacea

Crustacea established

Decapoda+Stomatopoda

Alpheus audouini
Eucrate crenata
Micippa thalia

Alpheus inopinatus
Herbstia nitida
Myra subgranulata

Alpheus migrans
Ixa monodi
Ogyrides mjoebergi

Alpheus rapacida
Leptochea pugnax
Palaemonella rotundata

Atergatis roseus
Leucosia signata
Penaeus semisulcatus

Calappa pelii
Libinia dubia
Percon gibbesi

Callinectes sapidus
Maruspenaeus japonicus
Pilumnopeus vaquelini

Carupa tenuipes
Melicertus hathor
Portunus pelagicus

Charybdis helleri
Metapenaeopsis aegyptia
Rhithropanopeus harrisi

Charybdis longicollis
Metapenaeopsis morgiensi
Trachysalambria

Dorippe quadridens
consobrina
palaestinensis

Dyspanopeus sayi
Metapenaeus monoceros

Erugosquilla massavensis
Metapenaeus stebbingi

**Crustacea (other than Decapoda)**

Note: species in bold are ancient records, possibly cryptogenic

| Amphipoda | Caprella scaura, Elasmopus pectenicrus, Maera hamigera, Stenothoe gallensis, Cymadusa filosa |
| Cirripedia | **Balanus improvisus**, **Balanus eburneus**, **Balanus reticulatus**, **Balanus trigonus**, Elminius modestus, Megabalanus tintinnabulum |
| Cumacea | Eocuma sarsii |
| Isopoda | Paracerceis sculpta, Sphaeroma walkeri |

**Crustacea casual**

Notes: * denotes species described as established in CIESM 2005 on line underlined are new species post CIESM 2005 on line

| Decapoda | Actumnus globulus, Ashtoret lunaris, Calappa hepatica, Callinectes danae, Cryptosoma cristatum, Daira perlata, Dromia spinirostris, Eriocheir sinensis, Halimede tyche, Hemigrapsus sanguineus, *Heteropanope laevis*, *Hyastenus hilgendorfi*, Leptochela aculeocaudata, Lucifer hansenii, Macrophthalmus graeffei, Menaeithius monoceros, Merhippolyte ancirostra, Notopus dorsipes, Panulirus ornatus, Periclimenes calmani, Pilumnus hirsutus, Plagusia squamosa, Processa macrodactyla, Scyllarus caparti, Scyllarus posteli, Solenocera crassicornis, Sphaerozius nitidus, Thalamita gloriiensis |
| Amphipoda | Bemlos leptocheirus, Gammaropsis togoensis, Photis lamelligera |
| Isopoda | Apanthura sandalensis, Paradella dianae |
| Tanaidacea | Leptocheilia dubia |

**Crustacea questionable**

Note: * denotes species described as established in CIESM 2005 on line

| Species | Cited by | Reasoning |
| Decapoda | *Thalamita poissonii* | HOLTHUIS, 1956 | Cosmopolitan: known from E. Atlantic as *T. africana* (D’UDEKEM D’ACOZ, 1999) |
| Cumacea | Iphinoe crassipes haifae | BACESCU, 1961a | Widely distributed |

**Crustacea excluded:** for reasoning see GALIL et al. (2002)

- Automate branchialis
- Chaceon maritae
- Charybdis sexdentata
- Gonodactylaceaus falcatus
- Gonodactylus chiragra
- Hymenopenaeus debilis
- Panulirus regius
- Peneopsis serrata
- Persephona mediterranea
- Pethrolisthes boscii
- Petrolisthes digitalis
- Philyra globosa
- Plagusia chabrus
- Platymaia wyvillethomsoni
- Portunus sanguinolentus
- Synalpheus tumidomanus
- Thalamita admete
- Thenus orientalis
- Uca coarctata
Additional excluded Crustacea post GALIL et al. (2002)

<table>
<thead>
<tr>
<th>Species</th>
<th>Cited by</th>
<th>Reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lucifer typus (Decapoda)</td>
<td>HENDRICKX &amp; ESTRADA-NAVARRETE, 1994</td>
<td>Atlanto-Mediterranean</td>
</tr>
<tr>
<td>Urocaridella antobrunii (Decapoda)</td>
<td>YOKES &amp; GALIL, 2004</td>
<td>Misidentification of Urocaridella n. sp. (YOKES &amp; GALIL, in press)</td>
</tr>
<tr>
<td>Echinogammarus pungentoides (Amphipoda)</td>
<td>COGNETTI, 1994</td>
<td>Native: type locality Po estuary</td>
</tr>
<tr>
<td>Unciolella lunata (Amphipoda)</td>
<td>BELLAN–SANTINI et al., 1998</td>
<td>Native: Described from Algeria</td>
</tr>
<tr>
<td>Kalliapseudes omercooperi (Tanaidacea)</td>
<td>BACESCU, 1961b</td>
<td>Wide distribution: Atlantic, Indo-Pacific</td>
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<tr>
<td>Apsuedes intermedius (Tanaidacea)</td>
<td>LARWOOD, 1940</td>
<td>Wide distribution: Atlantic, Indo-Pacific</td>
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5. Zoobenthos/Miscellanea

Miscellanea established

<table>
<thead>
<tr>
<th>Group</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Echinodermata</td>
<td>Asterina burtoni, Ophiactis savignyi, Ophiactis parva, Synaptula reciprocans</td>
</tr>
<tr>
<td>Foraminifera</td>
<td>Amphisorus hemprichii, Astacolus insolitus, Astacolus sublegumen, Heterostegina depressa, Planogypsina acervalis, Planogypsina squamiformis, Amphistegina lobifera</td>
</tr>
<tr>
<td>Cnidaria/Actinaria</td>
<td>Haliplanella lineata</td>
</tr>
<tr>
<td>Cnidaria/Anthozoa</td>
<td>Oculina patagonica, Acabaria erythraea</td>
</tr>
<tr>
<td>Cnidaria/Hydrozoa</td>
<td>Bugainvillia niohe, Macrorhynchia philippina, Garveia franciscana, Gonionemus vertens, Clytia hummelinckii</td>
</tr>
<tr>
<td>Cnidaria/Scyphozoa</td>
<td>Cassiopea andromeda</td>
</tr>
<tr>
<td>Tunicata/Ascidiacea</td>
<td>Herdmania momus, Botryllus schlosseri, Microcosmus squamifer, Phallusia nigra, Polyandrocarpa zorritensis, Rhodosoma turcinum, Symplegma brakenhielmi</td>
</tr>
<tr>
<td>Arthropoda/Pycnogonida</td>
<td>Amnothea hilgendorfi, Anoplodactylus digitatus, Anoplodactylus californicus</td>
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### Miscellanea casual

<table>
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<tr>
<th>Group</th>
<th>Species</th>
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<tr>
<td>Echinodermata</td>
<td>Amphitriplis laevis</td>
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<tr>
<td>Sipuncula</td>
<td>Apionsoma trichocephalus, Phascolosoma scolops</td>
</tr>
<tr>
<td>Cnidaria/Anthozoa</td>
<td>Diadumene cincta</td>
</tr>
<tr>
<td>Cnidaria/Hydrozoa</td>
<td>Diphasia margarita, Euphyssora bigelowi</td>
</tr>
<tr>
<td>Ascidiacea</td>
<td>Ascidia cannelata, Ascidia cf. savignyi, Eusynstyela hartmeyeri, Microcosmus exasperatus, Symplegma viride</td>
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### Miscellanea questionable

<table>
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<tr>
<td>Enteropneusta</td>
<td>Saccoglossus querneyi</td>
<td>STEUER, 1939</td>
<td>Old record, insufficient data</td>
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<tr>
<td>Sipuncula</td>
<td>Aspidosiphon mexicanus</td>
<td>MURINA &amp; ZAVODNIC, 1986</td>
<td>Wide distribution, Atlantic, Indian Ocean</td>
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<td></td>
<td>Aspidosiphon elegans</td>
<td>WESENBERG-LUND, 1957</td>
<td>Wide distribution, its mode of introduction is disputed by POR, 1978</td>
</tr>
<tr>
<td>Porifera</td>
<td>Haliclona viridis</td>
<td>BURTON, 1936</td>
<td>Unverified record, J. Vacelet pers. commun.</td>
</tr>
<tr>
<td></td>
<td>Cinachyrella australiensis</td>
<td>BURTON, 1936</td>
<td>Unverified record, J. Vacelet pers. commun.</td>
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<tr>
<td></td>
<td>Lissodendoryx schmidtii</td>
<td>TSURNAMAL, 1969</td>
<td>Unverified record, J. Vacelet pers. commun.</td>
</tr>
<tr>
<td></td>
<td>Geodia micropunctata</td>
<td>TSURNAMAL, 1969</td>
<td>Unverified record, J. Vacelet pers. commun.</td>
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<td>Hyrtios erecta</td>
<td>TSURNAMAL, 1969</td>
<td>Unverified record, J. Vacelet pers. commun.</td>
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<td></td>
<td>Mycale erythraeana</td>
<td>BURTON, 1936</td>
<td>Unverified record, J. Vacelet pers. commun.</td>
</tr>
<tr>
<td></td>
<td>Reniera spinosella</td>
<td>BURTON, 1936</td>
<td>Unverified record, J. Vacelet pers. commun.</td>
</tr>
<tr>
<td>Arthropoda/</td>
<td>Pigrogromitus timsanus</td>
<td>ARNAUD, 1987</td>
<td>Old record, insufficient data circum-tropical and Mediterranean R. Bamber pers. commun.</td>
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<tr>
<td>Pycnogonida</td>
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</table>
Miscellanea excluded

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<th>Group</th>
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<tr>
<td>Porifera</td>
<td>Haliclona loosanoffi</td>
<td>SOEST, 1976</td>
<td>Absent from the Mediterranean</td>
</tr>
<tr>
<td>Cnidaria/Hydrozoa</td>
<td>Bugainvillia platygaster</td>
<td>GOY et al., 1988</td>
<td>According to BOUILLON et al., 2004 all previous records from E. Mediterranean are B. niobe</td>
</tr>
<tr>
<td>Cnidaria/Hydrozoa</td>
<td>Pennaria disticha australis</td>
<td>BILLARD, 1926</td>
<td>BOUILLON et al., 2004</td>
</tr>
<tr>
<td>Ascidiacea</td>
<td>Ecteinascidia turbinata</td>
<td>HARANT, 1927</td>
<td>Old records circumtropical, A. Ramos, pers.commun.</td>
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<tr>
<td></td>
<td>Botrylloides nigrum</td>
<td>PÉRES, 1954</td>
<td>Old records circumtropical, A. Ramos, pers.commun.</td>
</tr>
<tr>
<td>Brachiopoda</td>
<td>Frenulina sanguinolenta</td>
<td>TADDEI RUGGIERO, 2000</td>
<td>Confused origin: see LOGAN et al., 2004</td>
</tr>
</tbody>
</table>

Other Miscellanea: BRYOZOA

The following list is partial as it only includes published records. A survey of bryozoans in progress from Lebanon (J.G. Harmelin, in prep.) will show evidence of several new Lessepsian immigrants well established in the Levantine basin. Furthermore, it is most likely that a thorough study of the bryozoan assemblages from Mediterranean harbours and sites of oyster culture will bring evidence of introduced species. Among the species recorded by HASTINGS (1927) in the collection by the Cambridge Expedition in the Suez Canal (1924), only those collected at Port Said are considered here. Questionable and excluded records are discussed below.

<table>
<thead>
<tr>
<th>Species</th>
<th>*Origin</th>
<th>Establishment success</th>
<th>Cited by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rhynchozoon lareyi</td>
<td>RS, IO</td>
<td>established</td>
<td>UNSAL &amp; D’HONDIT, 1979</td>
</tr>
<tr>
<td>Scrupocellaria jolloisi</td>
<td>RS, IO</td>
<td>established</td>
<td>HASTINGS, 1927</td>
</tr>
<tr>
<td>Smittina malleolus</td>
<td>RS, IO</td>
<td>established</td>
<td>D’HONDIT, 1988</td>
</tr>
<tr>
<td>Tricellaria m opinata</td>
<td>IP</td>
<td>established</td>
<td>D’HONDIT &amp; OCCHIPINTI, 1985</td>
</tr>
<tr>
<td>Aeverrillia setigera</td>
<td>PO, Atlantic</td>
<td>casual</td>
<td>HASTINGS, 1927</td>
</tr>
<tr>
<td>Celleporaria aperta</td>
<td>circumtropical</td>
<td>casual</td>
<td>HASTINGS, 1927</td>
</tr>
<tr>
<td>Celleporella carolinensis</td>
<td>W Atlantic</td>
<td>casual/ established</td>
<td>OCCHIPINTI AMBOGI &amp; D’HONDIT, 1996</td>
</tr>
<tr>
<td>Electra tenella</td>
<td>W Atlantic</td>
<td>casual</td>
<td>ROSSO, 1994</td>
</tr>
<tr>
<td>Species</td>
<td>Location</td>
<td>Status</td>
<td>Reference</td>
</tr>
<tr>
<td>---------------------------------------</td>
<td>----------</td>
<td>------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>Hippopodina flegeensis</td>
<td>PO</td>
<td>casual</td>
<td>POWELL, 1969</td>
</tr>
<tr>
<td>Reteporella jermanensis</td>
<td>RS</td>
<td>casual</td>
<td>D’HONDT, 1988</td>
</tr>
<tr>
<td>Pherusella brevituba</td>
<td>PO</td>
<td>casual</td>
<td>CHIMENZ GUSSO &amp; D’HONDT, 2005</td>
</tr>
<tr>
<td>Crepidacantha poissonii</td>
<td>circumtropical</td>
<td>questionable</td>
<td>OCCHIPINTI AMBROGI, 1986</td>
</tr>
<tr>
<td>Hippaliosina acutirostris</td>
<td>IP</td>
<td>questionable</td>
<td>POWELL, 1969</td>
</tr>
<tr>
<td>Parasmittina egyptiaca</td>
<td>RS, IP</td>
<td>questionable</td>
<td>HASTINGS, 1927</td>
</tr>
<tr>
<td>Arachnoidea protecta</td>
<td>IP</td>
<td>excluded</td>
<td>CHIMENZ GUSSO et al., 1998</td>
</tr>
<tr>
<td>Thalamoporella gothica (Busk)</td>
<td>IP</td>
<td>excluded</td>
<td>POWELL, 1969; BITAR &amp; KOULI-BITAR, 2001</td>
</tr>
<tr>
<td>Watersipora subtorquata</td>
<td>??</td>
<td>excluded</td>
<td>D’HONDT, 1988</td>
</tr>
</tbody>
</table>

*Origin: IO=Indian Ocean, IP=Indo-Pacific, RS=Red Sea, PO=Pacific Ocean

*Aeverrillia setigera* (Hincks, 1887)
This ctenostome bryozoan widely distributed in warm waters, including Australia, Indonesia and Brazil, has never been noticed again in the Mediterranean since its finding by HASTINGS (1927).

*Celleporaria aperta* (Hincks, 1882)
This species was fouling barges in the Suez Canal in 1924 (HASTINGS, 1927). It was collected in 1968 at Ashod Port and Acre by POWELL (1969), who previously found it in the southern Red Sea (POWELL, 1967). The alleged circumtropical (from Cape Verde to Philippines), eurybathic distribution of this species may indicate the existence of a species group.

*Crepidacantha poissonii* (Audouin, 1826)
This ‘circumtropical’ species has not been recorded again in the Mediterranean since the finding of OCCHIPINTI AMBROGI (1986) on rhizomes of *Posidonia oceanica* from the Apulian coast of Italy. Although presumably considered as a lessepsian species by OC-CHIPINTI AMBROGI (1986) considering its occurrence in the Gulf of Suez (BALAVOINE, 1959), this species has also been listed from Madeira and Canaries. The specific status of the Atlanto-Mediterranean material should thus be re-examined.

*Hippaliosina acutirostris* Canu & Bassler, 1929
The record of this Indo-Pacific species in the Levantine basin (POWELL, 1969) is questionable. Particularly diagnostic features of the avicularium are not visible on the illustration by POWELL (1969), who curiously did not compare his specimens with *H. depressa* (Busk, 1854), a Mediterranean endemic particularly abundant in the eastern basin (HARMELIN, 1969b; HAYWARD, 1974). *Hippaliosina acutirostris* is known from the Philippines and various Indo-Pacific localities (HARMER, 1957).

*Parasmittina egyptiaca* (Waters, 1909)
Species recorded from the Red Sea and the
Indian Ocean, and only once from the Mediterranean (HASTINGS, 1927). However, the identification of Parasmittina species is difficult and the bryozoan fauna of the Eastern Mediterranean is poorly documented.

**Arachnoidea protecta** Harmer, 1915

*Arachnoidea protecta* was only known from the Celebes archipelago (Indonesia). As noticed by CHIMENZ GUSSO *et al.* (1998), the present knowledge of the geographic distribution of *A. protecta* is probably very partial because of the difficulty to notice and identify this inconspicuous ctenostomate bryozoan. However, the morphological divergence observed between the Celebes and Mediterranean forms may justify the existence of a new species.

**Thalamoporella gothica** (Busk) *indica* (Hincks, 1880)

? = **Thalamoporella harmelini** Soule, Soule & Chaney, 1999

The intricate status of the form described by Hincks was clarified by SOULE *et al.* (1999), who gave it a species rank, *T. indica* (Hincks, 1880). This species is presently known only from the Indian Ocean. In the same paper they described a new species, *T. harmelini*, from a specimen collected at Beirut, Lebanon. The differences between *T. harmelini* and the Mediterranean specimens from Israel figured by POWELL (1969) and D’HONDT (1988) appear to be light and may fall within the range of variation of this species. Presently known only from the Levantine basin, *Thalamoporella harmelini* cannot be considered as an alien species.

**Watersipora subtorquata** (d’Orbigny, 1852)

D’HONDT (1988) recorded both *W. subtorquata* and *W. cucullata* (Busk, 1854) from the same Israeli locality (Acre old harbour, 1-2m) but did not comment the differences observed between these specimens. Considering that *W. cucullata* has been described from the Aegean Sea and that the assessment of morphological differences between *Watersipora* species requires precise comparative studies (SOULE & SOULE, 1975), it seems preferable not to include *W. subtorquata* among the alien bryozoans in the Mediterranean.

6. Parasites

<table>
<thead>
<tr>
<th>Group</th>
<th>Establishment success</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monogenea</td>
<td>casual</td>
<td>Neothoracocotyle acanthocybii: accidental parasite on fish</td>
</tr>
<tr>
<td>Digenea</td>
<td>questionable</td>
<td>Hysterolecitha sigani: accidental parasite on wild Siganidae (DIAMANT, 1989). Never observed again</td>
</tr>
<tr>
<td>Trematoda</td>
<td>casual</td>
<td>Hirudinella ventricosa: accidental parasite on fish</td>
</tr>
<tr>
<td>Protozoa</td>
<td>casual</td>
<td>Bonamia ostrea: accidentally with aquaculture</td>
</tr>
<tr>
<td>Crustacea/Copepoda</td>
<td>established</td>
<td>Mytilicola orientalis, Myicola ostreae: on oyster beds</td>
</tr>
<tr>
<td>Crustacea/Cirripedia</td>
<td>established</td>
<td>Heterosaccus dollfusi: mostly on Charybdis longicollis (GALIL &amp; LÜTZEN, 1998)</td>
</tr>
<tr>
<td>Crustacea/Cirripedia</td>
<td>casual</td>
<td>Loxothylacus texanus: on Callinectes sapidus</td>
</tr>
</tbody>
</table>
7. Zooplankton

Zooplankton established

<table>
<thead>
<tr>
<th>Group</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copepoda</td>
<td>Acartia (Acanthacartia) tonsa, Acartia centrura, Arietellus pavoninus, Calanopia elliptica, Calanopia media, Centropages furcatus, Labidocera madurae, Labidocera pavo, Paracartia grani, Pontellina plumata, Pseudocalamus elongatus, Pteriacartia josephinae</td>
</tr>
<tr>
<td>Ctenophora</td>
<td>Mnemiopsis leidyi</td>
</tr>
<tr>
<td>Cnidaria/Scyphozoa</td>
<td>Rhopilema nomadica</td>
</tr>
<tr>
<td>Siphonophora</td>
<td>Forskalia formosa</td>
</tr>
<tr>
<td>Cnidaria/Hydrozoa</td>
<td>Eucheilota paradoxa, Moerisia carine, Tetrorhchis erythrogaster</td>
</tr>
</tbody>
</table>

Zooplankton casual

<table>
<thead>
<tr>
<th>Group</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copepoda</td>
<td>Acartia (Acanthacartia) fossae, Calanopia biloba, Calanopia minor, Corycaeus speciosus, Eucalanus crassus, Eucalanus subcrassus, Euchaeata concinna, Labidocera agilis, Labidocera detruncata, Labidocera orsini, Oncaea rufa, Paracalanus crassirostris, Parvocalanus elegans, Parvocalanus latus, Scaphocalanus amplius, Scaphocalanus brevirostris, Scolecithrix valens, Spinocalanus terranovae</td>
</tr>
<tr>
<td>Cnidaria/Hydrozoa</td>
<td>Aequorea conica, Kantiella enigmatica, Laodicea fijiana, Nubiella mitra, Paracytaeis octona, Russellia mirabilis</td>
</tr>
<tr>
<td>Cnidaria/Scyphozoa</td>
<td>Phyllorhiza punctata</td>
</tr>
</tbody>
</table>
### Zooplankton questionable

<table>
<thead>
<tr>
<th>Group</th>
<th>Species</th>
<th>Cited by</th>
<th>Reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Canuellina insignis</td>
<td>POR, 1972</td>
<td>Old record. Only in Bardawil lagoon</td>
</tr>
<tr>
<td>Copepoda</td>
<td>Enhydrosoma hopkinsi</td>
<td>POR, 1972</td>
<td>Old record. Only in Bardawil lagoon</td>
</tr>
<tr>
<td></td>
<td>Robertsonia salsa</td>
<td>POR, 1972</td>
<td>Old record. Only in Bardawil lagoon</td>
</tr>
<tr>
<td></td>
<td>Scottolana longipes</td>
<td>POR, 1964</td>
<td>Possible pre-lessepsian element (POR, 1978)</td>
</tr>
<tr>
<td></td>
<td>Stenhelia inopinata</td>
<td>POR, 1972</td>
<td>Old record. Only in Bardawil lagoon</td>
</tr>
<tr>
<td></td>
<td>Stenhelia minuta</td>
<td>POR, 1964</td>
<td>Possible pre-lessepsian element (POR, 1964)</td>
</tr>
</tbody>
</table>

### Zooplankton excluded

<table>
<thead>
<tr>
<th>Group</th>
<th>Species</th>
<th>Cited by</th>
<th>Reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Acartia hasanii</td>
<td>ÜNAL et al., 2002</td>
<td>Native: Described as new species in the area</td>
</tr>
<tr>
<td></td>
<td>Paracartia ioannae</td>
<td>ÜNAL et al., 2002</td>
<td>Native: Described as new species in the area</td>
</tr>
<tr>
<td></td>
<td>Paracartia janetae</td>
<td>ÜNAL et al., 2002</td>
<td>Native: Described as new species in the area</td>
</tr>
<tr>
<td></td>
<td>Paramphiascella sirbonica</td>
<td>POR, 1972</td>
<td>Native: First described in Mediterranean</td>
</tr>
<tr>
<td></td>
<td>Pseudodiaptomus salinus</td>
<td>THOMPSON &amp; SCOTT, 1903</td>
<td>Not in Mediterranean: WALTER, 1998</td>
</tr>
<tr>
<td></td>
<td>Scottolana bulbosa</td>
<td>POR, 1967</td>
<td>Insufficient data</td>
</tr>
<tr>
<td>Chaetognatha</td>
<td>Sagitta neglecta</td>
<td>GUERGUESS &amp; HALIM, 1973</td>
<td>Insufficient data (CASANOVA, 1985)</td>
</tr>
<tr>
<td>Ctenophora</td>
<td>Coeloplana sp.</td>
<td>HAAS, 1942</td>
<td>Insufficient data</td>
</tr>
<tr>
<td>Siphonophora</td>
<td>Muggiaea atlantica</td>
<td>GAMULIN &amp; KRŠINIČ, 1999</td>
<td>According to BOUILLON et al., (2004), it is a neritic cosmopolitan species</td>
</tr>
<tr>
<td>Foraminifera</td>
<td>Globigerina bulloides</td>
<td>LAKKIS et al., 1996</td>
<td>circumtropical</td>
</tr>
<tr>
<td></td>
<td>Globigerinoides ruber</td>
<td>LAKKIS et al., 1996</td>
<td>cosmopolitan</td>
</tr>
<tr>
<td></td>
<td>Orbulina universa</td>
<td>LAKKIS et al., 1996</td>
<td>cosmopolitan</td>
</tr>
</tbody>
</table>
8. Phytoplankton

**Phytoplankton established**  
Note: bold indicates cryptogenic species

*Alexandrium andersonii*  
*Alexandrium catenella*  
*Alexandrium taylori*  
*Ceratium breve*  
*Chaetoceros coarctatus*  
*Coolia monotis*  
*Gonyaulax grindley*  
*Gymnodinium catenatum*  
*Gymnodinium fusus*  
*Ostreopsis ovata*  
*Phaeocystis poucheti*  
*Skeletonema tropicum*  

**Additional established species cited in GÓMEZ, 2005**

*Chaetoperidinium cf. yeye*  
*Gonyaulax ligustica*  
*Gymnodinium canus*  
*Gymnodinium sphaeroideum*  
*Gyrodinium acutum*  
*Leptodiscus medusoides*  
*Oxytoxum areolatum*  

**Phytoplankton casual**

*Asterodinium gracile*  
*Chattonella antiqua*  
*Lingulodinium polyedrum*  
*Ostreopsis lenticularis*  
*Ostreopsis cf. siamensis*  
*Prorocentrum mexicanum*  
*Protoceratium pepo*  
*Trichodesmium erythreum*  

**Additional casual species cited in GÓMEZ, 2005**

*Alexandrium insuetum*  
*Amphidinium inflatum*  
*Amphidinium lissae*  
*Amphidinium vasculum*  
*Amphidoma elongata*  
*Amphisolenia complanata*  
*Centrodinium elongatum*  
*Cochlodinium turbineum*  
*Craspedotella pileolus*  
*Gonyaulax rugosum*  
*Gymnodinium attenuatum*  
*Gymnodinium lineatum*  
*Gymnodinium lira*  
*Gymnodinium multilineatum*  
*Gymnodinium ovulum*  
*Gymnodinium ravenescens*  
*Gymnodinium sulcatum*  
*Gymnodinium translucens*  
*Gyrodinium biconicum*  
*Gyrodinium rubricaudatum*  

**Phytoplankton questionable**

<table>
<thead>
<tr>
<th>Species</th>
<th>Cited by</th>
<th>Reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Ceratium egyptiacum</em></td>
<td>DOWIDAR, 1972</td>
<td>Origin questionable. Defined by HALIM (1990) near Suez canal. Absent from the IP.</td>
</tr>
<tr>
<td><em>Gymnodinium breve</em></td>
<td>SATSMADJIS &amp; FRILIGOS, 1983</td>
<td>Complex taxonomy</td>
</tr>
</tbody>
</table>
Gymnodinium mikimotoi
ICES, 2001
Complex taxonomy

Gyrodinium aureolum
MOSCATELLO et al., 2004
Complex taxonomy

Heterosigma cf. akashiwo
BIZSEL & BIZSEL, 2002
Insufficient data

Phytoplankton excluded

<table>
<thead>
<tr>
<th>Species</th>
<th>Cited by</th>
<th>Reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alexandrium minutum</td>
<td>HALIM, 1960</td>
<td>Native: type locality Alexandria</td>
</tr>
<tr>
<td>Alexandrium pseudogoniaulax</td>
<td>BIECHELER, 1952</td>
<td>Native: type locality France</td>
</tr>
<tr>
<td>Alexandrium tamarense</td>
<td>WALLENTINUS, 2002</td>
<td>Cosmopolitan</td>
</tr>
<tr>
<td>Rhizosolenia alata</td>
<td>KIMOR, 1973</td>
<td>Cosmopolitan</td>
</tr>
<tr>
<td>Scrippsiella precaria</td>
<td>MONTRESOR &amp; ZINGONE, 1988</td>
<td>Native: type locality Naples</td>
</tr>
</tbody>
</table>

9. Phytobenthos

Phytobenthos established

Acetabularia calyculus  Chordra filum  Laurencia okamurae
Acrochaetium codicola  Chrysonephos lewisti  Leathesia difformis
Acrothamnion preissii  Chrysymenia wrightii  Lithophyllum yessoense
Acrothrix gracilis  Cladophoropsis javanica  Lomentaria hakodatensis
Agardhiella subulata  Codium fragile  Lophocladiella lallemandi
Aglaothamnion feldmanniae  Codium tomentosoides  Monostroma obscurum
Ahnfeltiopsis flabelliformis  Codium taylorii  Neosiphonia harveyi
Antithamnion amphigenium  Colpomenia peregrina  Neosiphonia sphaerocarpa
Antithamnion pectinatum  Derbesia rhizophora  Padina boergeseni
Apoglossum gregarium  Fucus spiralis  Pleonosporium caribaenum
Asparagopsis armata  Galaxaura rugosa  Polysiphonia morrowii
Bonnemaisonia hamifera  Grateloupa asiatica  Pterosiphonia tanakae
Botryocladia madagascariensis  Grateloupa patens  Sarconema filiforme
Caulerpa racemosa  Grateloupa lanceolata  Sargassum muticum
Caulerpa scalpelliformis  Grateloupa subpectinata  Scytothallus dotyi
Caulerpa taxifolia  Grateloupa turuturu  Solieria dura
Chondria collinsiana  Griffithsia corallinoides  Stypodium schimperi
Chondria curvilineata  Halophila stipulacea  Ulva pertusa
Chondria polyrhiza  Halothrix lumbricalis  Undaria pinnatifida
Chondrus pygmaea  Herposiphonia parca  Womersleyella setacea
Chondrus giganteus f. flabellatus  Hypnea cornuta

**Phytobenthos casual**

<table>
<thead>
<tr>
<th>Species</th>
<th>Cited by</th>
<th>Reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antithamnionella ternifolia</td>
<td>Heterosiphonia japonica</td>
<td>Rhodymenia erythraea</td>
</tr>
<tr>
<td>Audouinella robusta</td>
<td>Hypnea spicifera</td>
<td>Sarconema scinafoides</td>
</tr>
<tr>
<td>Audouinella subseriata</td>
<td>Neomeris annulata</td>
<td>Solieria filiformis</td>
</tr>
<tr>
<td>Caulerpa mexicana</td>
<td>Padina antillaru</td>
<td>Sphacelaria sp.</td>
</tr>
<tr>
<td>Ceramium strobiliforme</td>
<td>Padina boryana</td>
<td>Sphenotrichia firma</td>
</tr>
<tr>
<td>Dasya sessilis</td>
<td>Plocamium secundatum</td>
<td>Symphyocladia</td>
</tr>
<tr>
<td>Derbesia boergesenii</td>
<td>Porphyra yezoensis</td>
<td>Marchantioides</td>
</tr>
</tbody>
</table>

**Phytobenthos questionable**

<table>
<thead>
<tr>
<th>Species</th>
<th>Cited by</th>
<th>Reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acanthophora muscoides</td>
<td>ZEYBEK et al., 1986</td>
<td>Needs confirmation (ALGAEBASE). According to PERRONE et al., 2006 it is a Taxon inquirendum.</td>
</tr>
<tr>
<td>Batophora sp.</td>
<td>ICES/IOC/IMO, 2003</td>
<td>Insufficient data</td>
</tr>
<tr>
<td>Cladophora cf. patentireama</td>
<td>VERLAQUE, 1994</td>
<td>Identification uncertain</td>
</tr>
<tr>
<td>Goniotrichopsis sublittoralis</td>
<td>MAGNE, 1992</td>
<td>Probably confused with species of Stylonema</td>
</tr>
<tr>
<td>Hypnea variabilis</td>
<td>ZEYBEK et al., 1986</td>
<td>Not documented records</td>
</tr>
<tr>
<td>Laminaria japonica</td>
<td>PEREZ et al., 1984</td>
<td>Insufficient data</td>
</tr>
<tr>
<td>Laurencia caduciramulosa</td>
<td>FURNARI et al., 2001</td>
<td>Taxonomic complexity</td>
</tr>
<tr>
<td>Laurencia intricata</td>
<td>GODEH et al., 1992</td>
<td>Probably confused with other species of Laurencia</td>
</tr>
<tr>
<td>Laurencia chondrioides</td>
<td>BOISSET et al., 1998</td>
<td>Overlook deep water species. Probably confused with Chondria sp.</td>
</tr>
<tr>
<td>Laurencia majuscula</td>
<td>CACCAMESE et al., 1986</td>
<td>Probably confused with L obtusa</td>
</tr>
<tr>
<td>Parvocaulis parvula</td>
<td>ALEEM, 1948</td>
<td>Probably Tethyan relict</td>
</tr>
<tr>
<td>Polysiphonia atlantica</td>
<td>BEN MAIZ et al., 1986</td>
<td>Probably confused with other Mediterranean species of Polysiphonia</td>
</tr>
<tr>
<td>Polysiphonia kampsaxii</td>
<td>AYSEL, 1984</td>
<td>Insufficient data</td>
</tr>
<tr>
<td>Polysiphonia paniculata</td>
<td>LAURET, 1970</td>
<td>Insufficient data</td>
</tr>
<tr>
<td>Rhodophysema georgei</td>
<td>VERLAQUE, 1981</td>
<td>Insufficient data</td>
</tr>
<tr>
<td>Sargassum latifolium</td>
<td>ZEYBEK et al., 1986</td>
<td>Not documented records</td>
</tr>
</tbody>
</table>
**Phytobenthos excluded**

**A. Not occurring in the Mediterranean**

<table>
<thead>
<tr>
<th>Species</th>
<th>Cited by</th>
<th>Reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Audouinella spatoglossi</em></td>
<td>ALEEM, 1950</td>
<td>Old record based on cast ashore thalli</td>
</tr>
<tr>
<td><em>Cystoseira myrica</em></td>
<td>VERLAQUE, 1994</td>
<td>Doubtful old record</td>
</tr>
<tr>
<td><em>Gracilaria arcuata</em></td>
<td>BOUDOURESCUE &amp; RIBERA, 1994</td>
<td>Doubtful record: GARGIULO <em>et al.</em> (1992)</td>
</tr>
<tr>
<td><em>Gracilaria disticha</em></td>
<td>VERLAQUE, 1994</td>
<td>Old record to be confirmed</td>
</tr>
<tr>
<td><em>Hypnea nidifica</em></td>
<td>REINBOLD, 1898</td>
<td>Old record based on cast ashore thalli</td>
</tr>
<tr>
<td><em>Mastocarpus stellatus</em></td>
<td>FURNARI <em>et al.</em>, 2003</td>
<td>Misidentification</td>
</tr>
<tr>
<td><em>Spatoglossum variabile</em></td>
<td>ALEEM, 1950</td>
<td>Old record based on cast ashore thalli</td>
</tr>
<tr>
<td><em>Spatoglossum asperum</em></td>
<td>LUNDBERG, 1989</td>
<td>Misidentification</td>
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</tbody>
</table>

**B. Occurring in the Mediterranean**

<table>
<thead>
<tr>
<th>Species</th>
<th>Cited by</th>
<th>Reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Acanthophora navadiformis</em></td>
<td>BOUDOURESCUE &amp; RIBERA, 1994</td>
<td>Tethyan relict</td>
</tr>
<tr>
<td><em>Antithamnion decipiens</em></td>
<td>Various authors</td>
<td>Native: type locality: Nice, France</td>
</tr>
<tr>
<td><em>Antithamnionella elegans</em></td>
<td>CORMACI &amp; FURNARI, 1988</td>
<td>Native: type locality: Naples</td>
</tr>
<tr>
<td><em>Antithamnionella spirographidis</em></td>
<td>RIBERA &amp; BOUDOURESCUE, 1995</td>
<td>Native: type locality: Trieste</td>
</tr>
<tr>
<td><em>Asparagopsis taxiformis</em></td>
<td>VERLAQUE, 1994</td>
<td>Tethyan relict</td>
</tr>
<tr>
<td><em>Bryopsis plumosa</em></td>
<td>GIACCONE, 1969</td>
<td>Not introduced/ cosmopolitan</td>
</tr>
<tr>
<td><em>Ceramium bisporum</em></td>
<td>SARTONI &amp; BODDI, 2002</td>
<td>Probably confused with <em>C. codii</em></td>
</tr>
<tr>
<td><em>Cladophora liebetruthii</em></td>
<td>DURAL &amp; AYSEL, 1996</td>
<td>Old record: present in the Mediterranean Sea since 1854</td>
</tr>
<tr>
<td><em>Chondrophycus papillosus</em></td>
<td>ZEYBEK, 1969</td>
<td>Tethyan relict</td>
</tr>
<tr>
<td><em>Cladosiphon zosterae</em></td>
<td>BATTIATO &amp; PONTE, 1975</td>
<td>Not introduced/ cosmopolitan</td>
</tr>
<tr>
<td><em>Desmarestia viridis</em></td>
<td>VERLAQUE, 1981</td>
<td>KÜTZING, 1849: Adriatic</td>
</tr>
<tr>
<td>Species</td>
<td>Author(s)</td>
<td>Status</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>Dipterosiphonia dendritica</td>
<td>VERLAQUE, 1981</td>
<td>Not introduced</td>
</tr>
<tr>
<td>Ectocarpus siliculosus</td>
<td>BELLEMO et al., 1999</td>
<td>Not introduced</td>
</tr>
<tr>
<td>Ganonema farinosum</td>
<td>VERLAQUE, 1994</td>
<td>Tethyan relict</td>
</tr>
<tr>
<td>Halymenia ulvoidea</td>
<td>ALEEM, 1993</td>
<td>Endemic species of the Mediterranean Sea</td>
</tr>
<tr>
<td>Hypnea musciformis</td>
<td>GIACCONE, 1969</td>
<td>Not introduced/cosmopolitan</td>
</tr>
<tr>
<td>Microdictyon tenuissus</td>
<td>ZEYBEK, 1969</td>
<td>Old record: present in the Mediterranean Sea since 1860</td>
</tr>
<tr>
<td>Myrionema strangulans</td>
<td>AYSEL, 1997</td>
<td>Cosmopolitan several ancient reports of this species</td>
</tr>
<tr>
<td>Pilayella littoralis</td>
<td>BEN MAIZ et al., 1986</td>
<td>Not introduced</td>
</tr>
<tr>
<td>Polysiphonia fucoides</td>
<td>BOUDOURESQUE &amp; RIBERA, 1994</td>
<td>Known in ancient flora as P violacea</td>
</tr>
<tr>
<td>Polysiphonia elongata</td>
<td>GIACCONE 1969</td>
<td>Not introduced</td>
</tr>
<tr>
<td>Punctaria tenuissima</td>
<td>RIBERA et al., 1992</td>
<td>Not introduced</td>
</tr>
<tr>
<td>Radicilingua thysonorhizans</td>
<td>CURIEL et al., 1994</td>
<td>Not introduced</td>
</tr>
<tr>
<td>Spyridia hypnoides</td>
<td>FURNARI et al., 1999</td>
<td>Native: Type locality: Algeria</td>
</tr>
<tr>
<td>Sphacelaria rigidula</td>
<td>ZEYBEK et al., 1986</td>
<td>Old record: Istria, 1901</td>
</tr>
<tr>
<td>Ulva fasciata</td>
<td>DELILE, 1813</td>
<td>Not introduced</td>
</tr>
<tr>
<td>Ulva scandinavica</td>
<td>BATTELLI &amp; TAN, 1998</td>
<td>Not introduced</td>
</tr>
</tbody>
</table>

* Species classified among the potentially invasive ones in the Mediterranean by VERLAQUE et al. (2005).
** Species classified among the most invasive ones in the Mediterranean, by VERLAQUE et al. (2005).

**Synonyms / Misidentifications / Species Updates**

In the lists that follow, the first name is the current name used in this paper. For full synonymity of fish, decapods and molluscan the reader is referred to the CIESM atlas volumes 1 to 3.

**Fish**

*Apogon pharaonis* = *Apogon nigripinnis*

*Chelon carinata* = *Liza carinata*

*Liza haematocheila* = *Mugil soiuy*

*Sphyraena pinguis* = *Sphyraena chrysotaenia*

*Sphyraena obtusata* = *Sphyraena flavicauda*
### Zoobenthos

<table>
<thead>
<tr>
<th>Group</th>
<th>Synonyms/misidentifications</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mollusca/Cephalopoda</strong></td>
<td>Octopus aegina = Octopus kagoshimensis</td>
</tr>
</tbody>
</table>
| **Polychaeta** | Branchiosyllis exilis = Branchiosyllis uncinigera = Syllis exilis  
Branchiomma boholene = Branchiomma cingulata =  
Dasyochone cingulata  
Chrysopetalum debile = Chrysopetalum sp.  
Hydroides diramphus = Hydroides lunulifera  
Hydroides novaepommeraniae = Hydroides grubei  
Hydroides operculatus = Hydroides inornata  
Linopherus acarunculata = Pseudeurythoe acarunculata  
Neanthes willeyi = Neanthes capensis  
Nereis zonata persica = Nereis persica  
Leonnates indicus = Leonnates jousseaumei  
Spirobranchus tetracerus = Spirobranchus jousseaumei |
| **Crustacea/Decapoda** | Erugosquilla massavensis = Squilla africana |
| **Crustacea/Tanaidacea** | Kalliapseudes omercooperi = Cristapseudes omercooperi |
| **Crustacea/Amphipoda** | Maera hamigera = Linguimaera caesaris |
| **Arthropoda/ Pycnogonida** | Anoplodactylus californicus = Anoplodactylus portus |
| **Echinodermata** | Synaptula reciprocans = Synaptula nigra |
| **Porifera** | Haliclona viridis = Callyspongia viridis  
Cinachyrella australiensis = Chrotella cavernosa  
Lissodendoryx schmidt = Damiriana schmidtii  
Hyrtios erecta = Heteroneme erecta |
| **Asciidae** | Botrylloides nigrum = Metrandrocarpa nigra  
Ecteinascidia turbinata = Ecteinascidia moorei  
Botryllus schlosseri = Botryllus violaceus |
| **Bryozoa** | Aeverrillia setigera = Buskia setigera  
Celleporaria aperta = Holoporella aperta  
Parasmittina egyptiaca = Smittia egyptiaca  
Reteporella jermanensis = Sertella jermanensis |
| **Cnidaria/Hydrozoa** | Macrorhynchia philippina = Lytocarpus philippinus |

### Zooplankton

Enhydrosoma hopkinsi = Enhydrosoma vicinum  
Spinocalanus terranovae = Ctenocalanus citer  
Stenhelia inopinata = Sunaristes inopinata  
Scottolana longipes = Canuella longipes  
Sagitta neglecta = Aidanosagitta neglecta
**Phytoplankton**

*Alexandrium catenella* = *Gonyaulax catenella*
*Alexandrium minutum* = *Alexandrium lusitanicum*
*Alexandrium tamarense* = *Gonyaulax tamarensis*
*Ceratium egyptiacum* = *Ceratium pulchellum*
*Coolia monotis* = *Ostreopsis monotis* = *Glenodinium monotis*
*Gonyaulax grindleyi* = *Protoceratium reticulatum*
*Gymnodinium mikimotoi* = *Gymnodinium nagasakiense* = *Gyrodinium aureolum*
*Gymnodinium breve* = *Karenia brevis*
*Gymnodinium fusus* = *Pseliodinium vaubanii*
*Prorocentrum mexicanum* = *Prorocentrum maximum*
*Rhizosolenia alata* = *Rhizosolenia truncata* = *Rhizosolenia alata f. indica*
*Pyrodinium bahamense* = *Pyrodinium schilleri*

**Phytobenthos**

*Acrochaetium (Rhodothamniella) codicola* = *Audouinella codicola*
*Agardhiella subulata* (also reported as *Solieria chordalis*)
*Antithamnion amphigeneum* = *Antithamnion algeriense*
*Antithamnion pectinatum*; quoted as *Antithamnion nipponicum*
*Asparagopsis armata* = *Falkenbergia rufolanosa*
*Audouinella robusta* = *Acrochaetium sargassicola*
*Chondrophycus papillosus* = *Laurencia papillosa*
*Cladophoropsis javanica* = *Cladophora/Cladophoropsis zollingeri*
*Dasya sessilis* = *Dasya sp.*
*Galaxaura rugosa* = *Galaxaura lapidescens*
*Grateloupia asiatica* = *Grateloupia sp.* and erroneously as *Grateloupia filicina*
*Grateloupia patens* = *Prionitis patens*
*Grateloupia subpectinata* = *Grateloupia filicina var. luxurians* = *Grateloupia luxurians*
*Grateloupia turuturu*; recorded as *Grateloupia doryphora*
*Heterosiphonia japonica* = *Dasysiphonia sp.*
*Hypnea spicifera* = *Hypnea harveyi*
*Hypnea spinellla* = *Hypnea cervicornis*
*Hypnea valentiae* var. *hamulosa* = *Fucus hamulosa*
*Mastocarpus stellatus*; recorded as *Gigartina stellata* and *Petrocelis cruenta*
*Microdictyon tenuiiss*; quoted as *Microdictyon agardhianum*
*Monostroma obscurum* = *Ulvaria obscura*
*Myrionema strangulans* = *Myrionema vulgare*
*Neosiphonia harveyi* = *Polysiphonia mottei* = *Polysiphonia harveyi*
*Padina antillarum* = *Padina tetrasymatica*
*Parvocaulis parvula* = *Acetabularia parvula* = *Acetabularia moebii*
*Porphyra yezoensis*; recorded as *P. tenera*
*Pterosiphonia tanakae* = *Pterosiphonia sp.*
*Sphacelaria rigidula* = *Sphacelaria furcigera*
*Sphaerotrachia divaricata* is a misidentification of *Sphaerotrichia firma*
*Spyridia hypnoides* = *Spyridia aculeata*
*Stypopodium schimperi* = *Stypopodium tubruqense* = *Stypopodium zonale*
*Womersleyella setacea* = *Polysiphonia setacea*
Worst Invasive Alien Species in the Mediterranean coastal ecosystem

Among invasive alien species, a list of the worst invasive species threatening biodiversity in Europe has been endorsed by the SEBI2010 Working Group 5. The list is not an indicator by itself. However, it can be developed into an indicator and it will serve as a basis for more specific indicators focusing on impacts and economic cost of invasive alien species. Further, and perhaps most importantly, it is a very powerful awareness tool.

As worst IAS threatening biodiversity have been defined species that:

a. have a serious impact on biological diversity e.g. severe impacts on ecosystem structure and function (alteration of habitat, competing with native species, entering food chain, altering energy and nutrient flow etc.); replacement of native species throughout a significant proportion of its range; hybridization with native species; and threats to unique biodiversity (e.g. habitats in need of conservation measures, isolated ecosystems, endemic species).

b. may have negative consequences for human activities, health and/or economic interests (e.g. are pests, pathogens or vectors of disease)

Documenting impacts of marine invaders is a subject of hot debate. The evidence and nature of the impact of invasive species on particular ecosystems and habitats are often unclear and it appears that it is the interaction between invaders and other anthropogenic stresses that influence the impact (RUIZ et al., 1999). Invasion success depends not only on the invader's advantage over potential native enemies/competitors but also on the environmental characteristics of the host ecosystem (primarily species richness and disturbance) and the level of stress already imposed on it (SIMBERLOFF, 1989; RIBERA, 1995; COHEN & CARLTON, 1998; GOODWIN et al., 1999; OCCHIPINTI AMBROGI, 2000; KEANE & CRAWLEY, 2002).

The adverse impacts of invasive species on genetics, populations, ecosystems and economics in the Mediterranean have been discussed to some extent in synthetic studies (BOUDOURESQUE, 1994; BOUDOURESQUE & RIBERA, 1994; VERLAQUE, 1994; RIBERA, 1995; GOLANI, 1998; OCCHIPINTI AMBROGI, 2000; 2001; 2002a; 2002b; GALIL, 2000a, and 2000b; ZIBROWIUS, 2002; BOUDOURESQUE & VERLAQUE, 2002a and 2002b; GALIL & ZENETOS, 2002; OCCHIPINTI AMBROGI & SAVINI, 2003; GOFAS & ZENETOS, 2003).

In the Mediterranean, stressed environments (polluted or physically degraded) appear to be more prone to invasion than pristine sites (RIBERA & BOUDOURESQUE, 1995, GALIL, 2000b; OCCHIPINTI AMBROGI, 2000; RIBERA SIGUAN, 2002; OCCHIPINTI AMBROGI & SAVINI, 2003). The fact that mariculture introductions are mostly restricted to lagoonal or estuarine habitats and vessel-transported aliens to polluted harbours (ZIBROWIUS, 1992), environments that are known for their low biodiversity, support this theory. A recent study of macrofouling organisms concluded that many more species are found in a polluted than in a non-polluted marina (KOÇAK et al., 1999). However, there are suggestions of the opposite. According to KLEIN et al., (2005) there is no relationship between the number of introductions, diversity of the host ecosystem and disturbance acting on the community when examining the impact of introduced macrophytes on the shallow subtidal macrophytic assemblages along the French Mediterranean coast.
Invasive records

A number of alien species have been described as invasive or locally invasive by different authors in different parts of the Mediterranean. The qualification as invasive is based on their proliferation, and/or their geographical spread and/or impact on native populations. The Worst Invasive Species among them are presented below per eco-functional/taxonomic group.

1. Fish

The term invasive is debatable if used for describing the present situation in the Levantine Sea given the lack of reliable information on distribution and abundance prior to the opening of Suez Canal (GOLANI, 1998). Notwithstanding, definite changes in fish assemblages in the Levantine ecosystem have been attributed to Lessepsian migrants (GOLANI et al., 2002; GOREN & GALIL, 2005; HARMELIN-VIVIEN et al., 2005; SAAD, 2005).

Eighteen of the alien fish species were already considered as very common and of positive economic importance by GOLANI et al. (2002). These are: Alepes djedabo, Atherinomorus lacunosus, Dussumieria elopsoides, Etrumeus teres, Gymnammodytes semisquamatus, Hemiramphus far, Herklotsichthys punctatus, Liza carinata, Sargocentron rubrum, Saurida undosquamis, Scombromorus commerson, Siganus luridus, S. rivulatus, Sillago sihama, Sphyraena chrysoptera, Solea senegalensis, Upeneus moluccensis and Upeneus pori. Seriola fasciata and Fistularia commersonii now have to be added to that list, following recent records of their spread across the Mediterranean.

Abundant populations of alien fish without direct economic use are also included in the worst IAS since they are considered as pests, an economic burden to fishermen who have to discard them from their gear (GOLANI et al., 2002: Sphoeroides pachygaster, Cynoglossus sinusarabici, Stephanolepis diaspros, Lagocephalus spadiceus, Lagocephalus suzensis and Callitonymus filamentosus).

2. Zoobenthos/Mollusca

Ten species of molluscs have been described as locally invasive: the gastropods Cerithium scabridum, Rhinoclavis kochi, Strombus persicus and Bursatella leachi and the bivalves Pinctada radiata and Brachidontes pharaonis in the eastern Mediterranean, the gastropod Rapana venosa and the bivalves Anadara inaequalvis, Musculista senhousia, and Xenostrobus securis in the northern Adriatic and the western Mediterranean lagoons (GOFAS & ZENETOS, 2003). In addition, the bivalves Chama pacifica and Spondylus spinosus have been regarded as invasive in the Levantine (ZENETOS et al., 2004) and in the western Mediterranean lagoons Crepidula fornicata has been found to compete with commercial shellfish (BLANCHARD, 1996).

When assessing the scale and impact of ship transported alien fauna in the Mediterranean ZIBROWIUS (2002) regarded the following molluscan species as invasive, primarily based on their spread: Crepidula aculeata (Alicante harbour Spain), Anadara demiri (in the Adriatic and Aegean Seas along with the aforementioned A. inaequalvis) and Mya arenaria (with mass proliferation in the Berre lagoon near Marseilles). More recently the bivalve Musculista senhousia also proliferated in Berre lagoon.

Bivalves originally imported for aquaculture purposes such as the venus clam Ruditapes philippinarum, the Pacific oyster Crassostrea gigas and Anadara inaequalvis are well known examples of negative impact caused by alien species in the Mediterranean, as it has been demonstrated in the case of the Venice lagoon. They are out-competing native species (OCCHIPINTI AMBROGI, 2000) and their harvesting has...
caused heavy stress on bottom communities and the whole lagoon ecosystem (OCCHIPINTI AMBROGI, 2002b; PRANOVI et al., 2003; 2004).

The cryptogenic shipworm *Teredo navalis* can be included here, being one of the most effective and harmful marine invaders (HOPPE, 2002).

3. **Zoobenthos/Polychaeta**

Various species have been considered as invasive in various parts of the Mediterranean. *Pomatoleios kraussii* has been highly successful in the Levantine basin (Lebanon, G. Bitar & H. Zibrowius, unpublished; Iskenderun Bay, M.E. Çinar, unpublished), *Hydroides elegans*, *H. dianthus* and *Spirorbis marioni* in harbour environments all over the Mediterranean. In addition to *P. kraussii*, various other lessepsian serpulids spread over the Levantine area. Among these, *Hydroides minax* now seems to be omnipresent and may locally have particular dense populations. Of the soft bottom species *Branchiomma luctuosum*, *Polydora cornuta*, *Streblospio gynobranchiata*, *Leonnates persicus* and *Pseudonereis anomala* have to be added to the worst IAS (ÇINAR et al., 2002; 2005; ÇINAR & ERGEN, 2005; KAMBOUROGLOU & NICOLAIDOU, 2006).

4. **Zoobenthos/Crustacea**

A number of alien decapod crustaceans have been described as abundant in the Mediterranean. More common are: *Charybdis helleri* and *Charybdis longicollis* (the latter constituting 70% of the benthic biomass on sandy-silt bottoms off the Israeli coast (GALIL, 1986). Further species have been described as either abundant or very abundant and have an impact on the environment and/or the economy (GALIL et al., 2002); *Dyspanopeus sayi* (very abundant in the Venice lagoon), *Marsupenaeus japonicus* (very abundant in the Levantine and southern Turkey), *Metapenaeus monoceros*, *M. stebbingi*, and *Penaeus semisulcatus* (abundant along the Levantine coast), *Callinectes sapidus* (common in Greece), *Portunus pelagicus* (abundant along the Levantine since the 1920’s, presently rare), *Melicertus hathor* (locally common and of some commercial importance in Iskenderun Bay), and *Erugosquilla massavensis* (abundant in the eastern Levantine and southeastern Turkey).

In addition, the decapods *Libinia dubia* (in Tunisia), *Rithropanopaeus harrissi* (established in North Adriatic lagoons along with *Dispanopeus sayi*), and the amphipod *Elasmopeneus pectenecurcis* (Levantine Sea and Venice lagoon) have been regarded as invasive (ZIBROWIUS, 2002). The shrimps *Alpheus lobidens* and *A. edwardsii* have also been reported as invasive in the Eastern Mediterranean (GALIL & ZENETOS, 2002). The Atlantic crab *Percnon gibessi*, first recorded in the central Mediterranean (RELINI et al., 2000) has rapidly spread to the western and eastern Mediterranean (THESALOULEGAKI et al., 2006).

5. **Zoobenthos/Miscellanea**

ZIBROWIUS (2002) regarded the following species as invasive primarily based on their spread: *Oculina patagonica* (Scleractinian coral reported in Spain, Ligurian coast of Italy, Alexandria, Lebanon, Israel and recently in Turkey and Greece); the ascidian *Microcosmus exasperatus* (dense populations in Mediterranean harbours). The echinoderm *Asterina burtoni* has been regarded as invasive in the Eastern Mediterranean (GALIL & ZENETOS, 2002). In addition, the bryozoan *Tricellaria inopinata* was discovered to have a profound impact on the bryozoan community by colonizing all possible hard substrata in the Lagoon of Venice and out competing the native species (OCCHIPINTI AMBROGI, 2000; OCCHIPINTI AMBROGI & SAVINI, 2003). However, the synergy between the invader and the stress already imposed in the ecosystem is not clear.
Two foraminiferan species, namely, *Amphistegina lobifera* and *Amphisorus hemprichii* show invasive characteristics. *A. lobifera* populations have been expanded to such an extent that the dead tests locally accumulated as a 30-60cm thick layer on the sea bed [Antalya, Kâş, Kekova, Beş Adalar and Üç Adalar] (MERİÇ et al., 2002; 2004; YOKES & MERİC, 2004). *Amphistegina lobifera* has been reported on the Eastern Mediterranean coasts as far as Cyprus (HYAMS et al., 2002) and *Amphisorus hemprichii* has been reported in Southwestern Turkey and Israel (B. Yokes, pers. commun.)

6. Parasites
Parasites are ubiquitous and pervasive in marine systems, yet their role in marine invasions is relatively unexplored. Although data on parasites of marine organisms exist, the extent to which parasites can mediate marine invasions, or the extent to which invasive parasites and pathogens are responsible for infecting or potentially decimating native marine species have not been examined.

Parasitic copepods that infect shellfish have been widely introduced with the transport and culture of bivalves. *Mytilicola orientalis* and *Myicola ostrae* are both parasitic copepods of the Pacific oyster, *Crassostrea gigas*, in Asia, where they are native. Both species infect native bivalves and *M. orientalis* is considered a serious pest (HOLMES & MINCHIN, 1995).

7. Zooplankton
The zooplanktonic jellyfish *Rhopilema nomadica* have been reported as invasive in the Levantine (Eastern Mediterranean) (GALIL et al., 1990). The jellyfish has entered the Mediterranean via the Suez Canal in the 1970s, and since the mid 1980s forms large swarms annually along the Levantine coast. When the jellyfish swarms draw nearer shore they adversely affect tourism, fisheries and coastal installations.

8. Phytoplankton
Algal species responsible for the occurrence of Harmful Algal Blooms have been regarded as invasive. The toxics *Alexandrium catenella*, *Ostreopsis ovata* and *Coolia monotis* and the non toxic dinoflagellate *Alexandrium taylori* have been detected in the western Mediterranean (PENNA et al., 2005; GIACOBBE & YANG, 1999; GARCÉS et al., 1999; GARCÉS et al., 2000; SIMONI et al., 2003, 2004; BASTERREXTEA et al., 2005), and also in Greece (STRATEGY Workshop, 2004). *Alexandrium catenella* toxic blooms have been reported in the western Mediterranean (GARCÉS et al., 2000; VILA et al., 2001) and concern has been raised about the eastern Mediterranean (MIKHAIL, 2001) for the same species. The presence of *Gymnodinium catenatum* in the western Mediterranean has also been perceived as a probable ‘protagonist of future red tides events’ (GÓMEZ & CLAUSTRE, 2001) but has not been included in the worst IAS as it is regarded a potentially invasive species.

9. Phytobenthos
Many authors have provided lists of invasive macrophytes in Mediterranean. WALLENTINUS (2002) for example has provided a different aspect where 25 macroalgae are considered as invasive and nine as highly invasive. A more accurate account has been provided by Mediterranean experts.

*Caulerpa taxifolia* and *Caulerpa racemosa* aff. var. *cylindracea* are perhaps the most notorious invaders in the Mediterranean. In many cases their invasive spread has radically altered the structure and function of native ecosystems causing a decrease in macrofaunal and macroalgal biodiversity (RUITTON & BODURESQUE, 1994; BODURESQUE et al., 1995; HARMELIN-VIVIEN et al., 1996; CECCHERELLI & CAMPO,
In fact the invasive proliferation of *Caulerpa taxifolia*, the ‘killer algae’ (MEINESZ, 1999), consists the most infamous example of the impact of invasive species in the Mediterranean. According to BOUDOURESQUE & VERLAQUE (2002a), and references therein, at least eight phytobenthic species can be described as invasive organisms in the Mediterranean as “they play a conspicuous role in the recipient ecosystems, becoming the dominant species and/or taking the place of keystone species”. These are: *Acrothamnion preissii* in western Italy, *Asparagopsis armata* in the north-western basin, *Lophocladia lallemandii* in the Balearic Islands, *Womersleyella setacea* in western Italy, Corsica and the Aegean Sea, *Sargassum muticum* in Thau lagoon, France, *Stypopodium schimpieri* in the eastern Mediterranean, especially along the Levantine coasts. *Caulerpa racemosa* aff. var. *cylindracea* in various localities throughout the Mediterranean and *Caulerpa taxifolia* along the French and Italian Rivieras. An additional species, *Halophila stipulacea* in the Eastern Mediterranean, can be tentatively added to this list.

A specific study on algal introductions to European waters (ALIENS project: VERLAQUE et al., 2005) considered as generally invasive the following species: *Asparagopsis armata, Heterosiphonia japonica, Asparagopsis taxiformis, Bonnemaisonia hamifera, Colpomenia peregrina, Codium fragile, Grateloupia turuturu, Antithamnion pectinatum and Undaria pinnatifida.*

**Discussion**

Of the examined records about 23% are excluded. A total of 745 alien species are reported, 98 of which (13%) are questionable records. The available information depends greatly on the taxonomic group examined. The establishment success per ecofunctional/taxonomic group is shown in Figure 2. In the sections that follow the state of art in species introduced to European waters (ALIENS project: VERLAQUE et al., 2005) considered as generally invasive the following species: *Asparagopsis armata, Heterosiphonia japonica, Asparagopsis taxiformis, Bonnemaisonia hamifera, Colpomenia peregrina, Codium fragile, Grateloupia turuturu, Antithamnion pectinatum and Undaria pinnatifida.*

**Fig. 2:** Establishment success per ecofunctional Pycnogonida/taxonomic group. Miscellanea (zoobenthos) include Foraminifera, Echinodermata, Ascidiacea, Cnidaria, Sipuncula, Pycnogonida, Enteropneusta, Porifera and Bryozoa.
diversity and distribution and in alien monitoring per ecofunctional/taxonomic group is discussed.

1. Fish

Fish is a well studied group in the Mediterranean. The paper version of the CIESM atlas (GOLANI et al., 2002) enumerated 90 alien species. By December 2005 the updated CIESM check-list of alien species included 8 more species (CIESM on line, 2005). As with all groups, more intensive observations and modifications of the status of the already reported species, have increased the number of aliens which is now 110 species. Species of uncertain origin, reported in latest publications such as that of SAAD (2005) are tentatively classified as questionable.

Nomenclature composes the major concern for monitoring alien fish species. Considering that Official Lists and Indexes of Names and Works in Zoology is not updated, we normally use the FISHBASE names that are generally used by ichthyologists. The FISHBASE is not a perfect instrument; for example, Mugil soiny Basilewsky, 1855 and Chelon haematoocheilus (Temminck & Schlegel, 1845) are both listed as valid names in FISHBASE as separated species. However, there is presently no other common reference point for ichthyologists world-wide and it is the reference list for “Species 2000 catalogue of life”.

2. Zoobenthos/Mollusca

Mollusca are also well studied in the Mediterranean. By the end of 2002, 139 alien species were recorded and 62 species were excluded as spurious records (GOFAS & ZENETOS, 2003). As suggested by GOFAS & ZENETOS (2003), there is still a pool of about 90 species reported from the Suez Canal, which are likely to be found in the Mediterranean in the near future. Indeed, the number of molluscan alien species has increased to 196, of which 31 are recorded as questionable. The rate of increase is due to the increased interest of malacologists and the relatively easy collection/identification of mollusca.

3. Zoobenthos/Polychaeta

Absence of an updated monograph of polychaetes covering all families is an obstacle for determining changes in polychaete diversity in the Mediterranean. FAUVEL’s outdated fauna (1923; 1927) is still widely used for identifying polychaetes, leading to erroneous lists and confusions as a number of species have been synonymized or proved to be absent in the Mediterranean while many additional species were discovered. However, promising attempts have been recently made in the understanding of the superfamily Aphroditoidae (BARNICH & FIEGE, 2003), and the families Glyceridae (BÖGGEMANN, 2002), Gonidiidae (BÖGGEMANN, 2005) and Syllidae (SAN MARTÍN, 2003).

Within Polychaeta, more reliable evidence of Lessepsian migration is only known in Nereidae and Serpulidae. Records of alien species within the families Syllidae, Cirratulidae, Maldanidae, Terebellidae seem to be speculative. Another possibility, that should not be neglected, is that the seemingly Indo-Pacific species recognized in the Mediterranean might be Miocene relicts. Currently 69 species are described as valid records.

4. Zoobenthos/Crustacea (85 species)

4.1. Decapoda

A well studied group with a recent inventory (D’ UDEKEM D’ACOZ, 1999), a photographic website of the Eastern Atlantic, the Mediterranean Sea, and the adjacent continental waters decapoda (CRUSTIKON) and the CIESM atlas with regular updates online

4.2. Amphipoda

There are few alien species documented even on a worldwide scale. Although there are a lot of carcinological studies in the Mediterranean, very few have been identified as
aliens which represent 1.7% of the total amphipod fauna of the region (KOCATAŞ et al., 2002). The recent inventories of BEL-LAN-SANTINI et al., (1998), BELLAN-SANTINI & COSTELLO (2001), BELLAN-SANTINI & RUFFO (2003) and the AMPHIPODA homepage, accurately list the species’ distribution. However, as BELLAN-SANTINI & RUFFO (2003) report “...we have no confirmation on the true origin of these species...”.

4.3. Isopoda

One of the least studied groups; not even an inventory exists for the whole Mediterranean. Effort is increasing, but at a regional scale: covering Spain only (JUNOY & CASTELLÓ, 2003) and Italy (ARGANO et al., 1995). Collections from Lebanon are under current study by J. Castelló (Barcelona, Spain) and it is assumed that some Indo-Pacific species not yet reported will ‘discovered’. A new species known from tropical areas was recorded in Salerno harbour (Tyrrhenian Sea, southern Italy): it is probably Mesanthura romulea (LORENTI et al., in press).

4.4. Tanaidacea

Relatively few comprehensive faunal lists of Tanaidacea exist. The only recent comprehensive study of this group in the Mediterranean by S. Riggio tends to cover the fauna observed in Italy (ARGANO et al., 1995). The collection from Lebanon studied by R. Bamber (pers. commun.) bears no evidence of newcomers from the Red Sea.

5. Zoobenthos/Miscellanea (66 species)

5.1. Arthropoda / Pycnogonida

Four species have been recorded so far, three of which are established. The taxon is well studied in Italy and France and in addition to a review in 1987 (ARNAUD, 1987) there are regular updates on the distribution of the species in Italy including alien ones (CHIMENZ GUSSO & LATTANZI, 2003).

5.2. Porifera

Studies on Porifera in general in the Mediterranean and Red Seas are poor. To the very experienced J. Vacelet, the identifications and interpretations, by BURTON (1936) and TSURNAMAL (1969) do not seem reliable (J. Vacelet, pers. commun.). It is therefore difficult to compare the species new to the Mediterranean with the Red Sea fauna since the Red Sea sponge fauna is not well known. Hence, the presence of Red Sea species in the SE Mediterranean cannot be excluded. A recent collection from the Lebanon included two new species which cannot be aliens from the Red Sea (PEREZ et al., 2004). But incertitudes prevail concerning other species under study.

5.3. Asciidacea

Ascidians have a great invasive potential, and their expansion in the Mediterranean harbours and marinas since the seventies is well documented. Interest has revived and Italian (MASTROTOTARO & DAPPIANO, 2005), and Spanish (RAMOS et al., 1992) experts are examining material from Mediterranean ports. To ascertain the spread of Microcosmus squamiger and M. exasperatus in the Mediterranean, the material in the collection of the Museum National d’Histoire Naturelle, Paris, was re-examined and the identification of specimens previously classified as M. exasperatus revised. The results show that specimens unambiguously attributable to M. squamiger are common in Spain, France, Italy and Morocco (TURON & NISHIKAWA, 2005; A. Ramos pers. commun). This instance illustrates the crucial importance of taxonomy in studies of invasive species.

5.4. Cnidaria/Anthozoa

The Mediterranean is the first area in the world where the invasion by an alien scleractinian coral has been reported. The coral in
question is now commonly known as *Oculina patagonica* and is considered to be of temperate Atlantic-South American origin. This invasive coral in the Mediterranean was hypothesised (ZIBROWIUS, 1974) to be the same species as a coral described from the Holocene beach deposit from Argentina. The invasive Mediterranean form still needs to be compared with live samples from the presumed area of origin. It is exceptional that a scleractinian coral invades a distant area. The second case recognized is the spreading of *Tubastraea* over the tropical American Atlantic.

**Cnidaria/Hydrozoa**

The knowledge of the biogeography of the Mediterranean Hydrozoa is far from being complete not only due to the continuous recording of new species in the basin, but also due to insufficient or geographically too concentrated research efforts, so leading to inefficient coverage of distribution areas. All presently known Mediterranean hydrozoan species including hydroids, hydromedusae and siphonophores are well covered in the recent book of BOUILLON *et al.* (2004). Species newly entered the Mediterranean basin via the Suez canal were first compiled by POR (1978). According to BOUILLON *et al.* 2004, not many of Por’s records were noticed until recent times. A modest collection from Lebanon is under study. The study of the Hydrozoa of the Alboran Sea has led to many new records of Atlantic origin which are however not treated in this study.

**5.5. Bryozoans**

Bryozoans are common components of fouling communities and can disperse over long distances on rafting substrates. Despite these capacities, the number of non-indigenous species recorded in the Mediterranean is relatively modest (ROSSO, 2003; D’HONDT, in press). The latest record presented as an alien was *Pherusella brevituba*, which was collected from Ustica Island in 1996 growing on *Posidonia* leaves (CHIMENZ GUSSO & D’HONDT, 2005). Together with other species of Bryozoa previously recorded in Italian waters, it should better be considered a cryptogenic species, being inconspicuous and belonging to a difficult taxonomic group.

**5.6. Foraminifera**

It is far more difficult to document the invasion of alien meiofaunal elements into the Mediterranean Sea, as early records are significantly scarce. However, benthic foraminifera have a good preservation potential and may be present in large numbers, tending to leave behind a superior record of their presence over time, in comparison with macrofaunal elements. A recent, extensive study on benthic foraminifera from the shallow continental shelf along the SE Mediterranean (HYAMS, 2001) indicates that nearly 20% of the local Foraminifera species are suspected to be of an exotic origin. The ability to make this estimation may in part be attributed to the recent publication of the Atlas of Recent Foraminiferida of the Gulf of Aqaba (HOTTINGER *et al.*, 1993) and modern compilations of Mediterranean species (YANKO *et al.*, 1998), which enable comparison of the benthic Foraminifera assemblages in both regions. According to B. Yokes (pers. commun.) in Turkish waters there are more than 30 alien lessepsian Foraminifera species. The new findings are to be published by the local scientists.

**6. Parasites**

Parasites of Mediterranean lessepsian immigrants have been investigated very little over the years pioneered by Ilan Paperna in the early 70s. Only few scientists have been looking for parasitological aspects in the wild. Alien monogeneans have been reported more commonly from freshwater fish.
species than from marine fishes. In an early parasitological study of Lessepsian Siganiidae, the digenean *Hysterolecitha sigani* was mentioned from the rabbitfish *Siganus luridus* and *S. rivulatus* (DIAMANT, 1989). Later studies concluded that there is no serious data on potentially Lessepsian trematodes (DIAMANT, 1998). Cymothoids (Isopoda) are a group of crustaceans typically parasitic of teleost fishes. However, they are poorly studied animals and some groups remain completely undescribed. Studies of parasitic isopods on Lessepsian fish are in progress in the Levantine.

The best known parasites in the Mediterranean are the benthic copepods *Mytilicola orientalis* and *Myicola ostreae* on oyster beds. They were likely introduced with infected oysters imported for culture.

A rhizocephalan barnacle, *Heterosacculus dollfusi*, followed its portunid host crab, *Charybdis longicollis*, from the Red Sea through the Suez Canal to the Mediterranean Sea (GALIL & LÜTZEN, 1998). Other reports of rhizocephalans introduced with their hosts are anecdotal and lack confirmation (TORCHIN et al., 2002).

### 7. Zooplankton

Only 18 zooplanktonic alien species seem to be well established in the Mediterranean, while 32 are considered casual or questionable records. The continuity of the marine pelagic environment, as well as the seasonality of species appearance have to be considered as the most important causes of this lack of information (VAN DER SPOEL, 1994). The eastern Mediterranean zooplankton have been distinctly understudied until the second half of the 20th century while a large number of species of Atlantic origin found in the Western Basin during the past century have been reported without any attempt to discriminate if their presence was due to natural water exchange or human mediation. Moreover, the huge increase of aquaculture and commercial and tourism activities during the last century have obviously enhanced the transport of planktonic species in ballast waters. Relatively few seem to be planktonic lessepsian migrants, even though it is believed that their contribution will increase with time, due to the decreasing of the Nile fresh water inflow into the Mediterranean and lower salinity in the Bitter lakes (HALIM, 1990).

### 8. Phytoplankton

The list of Mediterranean Indo-Pacific taxa is full of dubious or poorly known species. As an example of a recent Erythrean invader *Ceratium egyptiacum* was reported by HALIM (1990). The taxon shows variable morphology associated with the stress of environmental changes (salinity > 47psu) in the Suez Canal (DOWIDAR, 1972). It was reported only from the proximity of the Suez Canal, with no records in the Indian or Pacific Oceans. The absence of information on several groups such as the dinoflagellates before the opening of the Suez Canal hinders attempts to determine biogeographical origins of present Mediterranean species (GÓMEZ, 2005). HALIM (1990) reported a tentative list of 17 Mediterranean Indo-Pacific species. Most of these dinoflagellates have been also reported in the Tyrrhenian Sea. However, the Indo-Pacific origin of these species is questionable due to the fact they were also reported in the Atlantic. Furthermore, as with many other groups, several of the species are dubious or invalid taxa. Results of recent EU funded research projects such as STRATEG as well as compiled works for a few countries have been considered in this update i.e. LAKKIS (1984; 1990), LAKKIS & ZEIDANE (1988; 2004), LAKKIS et al. (1990; 1996; 2002), MALT et al. (1989) (Lebanon); SIMONI et al. (2003) (Italy), VILLA et al. (2001) (Spain), KORAY (2002) (Turkey). One of the latest findings is the planktonic diatom *Skeletonema tropicum* which was
found for the first time in the Gulf of Naples, in the autumn of 2002 (SARNO et al., 2005) and seems to be established in the Gulf.

9. Phytobenthos

A well studied group with many representatives. Easy access to alien plants and high level of expertise at Mediterranean scale has resulted in the recognition of a high number of aliens especially in transitional waters (west Mediterranean and Adriatic Sea lagoons). However, many species considered as introduced in literature are under criticism. To a great extent this was due to the chaos in nomenclature and literature. The issue is partly resolved in a recent review (CORMACCI et al., 2004) which is further updated in the current work. The establishment success still remains unclear for some records. Discrepancies were brought forward among specialists and the results of the ALIENS project (VERLAQUE et al., 2005). However, genetics along with morphological studies are expected to further clarify the situation. For example, *Asparagopsis taxiformis* is a red alga, originally described from an Egyptian specimen (DELILE, 1813), but considered a cosmopolitan member of subtropical and tropical communities worldwide. A debate has risen whether the species is introduced, or native. In this work, *Asparagopsis taxiformis* is proposed to be excluded (tethyan relict), along with *Acanthophora naydiformis* although they are considered as invasive by some Mediterranean specialists. Genetic studies in *A. taxiformis* have demonstrated that several strains co-occur in the Mediterranean and one of them is definitely introduced (ANDREAKIS et al., 2004). The same situation applies for *Desmarestia viridis*; it is believed that the strains reported in the coastal lagoons have been introduced with oysters imported from NE Atlantic or NW Pacific (M. Verlaque pers. commun.).

Conclusions

The number of alien biota in the Mediterranean appears to be underestimated. Some hot spot areas for possible species introductions such as the coast of the Levantine basin, North Africa coasts, big commercial harbours and estuarine areas are not well studied. The biased scientific interest towards taxa with well-known taxonomy and established historical distribution records (e.g. benthic organisms, fish) coupled with the chaos in nomenclature and fragmentary and sporadic information have lead to a possible underestimation of the extent of aliens' presence particularly of the small, less-conspicuous, less-studied species. Thus, despite the collective effort, the information presented in these annotated lists depends greatly on the taxonomic group examined.

On-going monitoring studies along the coasts of the Mediterranean reveal continuous changes in the biodiversity of the region and evidence new alien species. At the same time genetics becomes an increasingly powerful tool in further investigating the identity and origin of many species that, constitute complexes of what may be cryptogenic or sibling (closely related) species. Most studies focus on ecological problems and omit the precise identification of species collected. This is mainly due to the lack of funding for supporting essentially systematic studies and concomitantly the extinction of taxonomists.

Over the last 5 years the scientific interest on alien species in the Mediterranean has revived and many new aliens are recorded each year. Within 2006, at least ten new alien species have been recorded, nine of them in the eastern Mediterranean. Services like the new on-line journal “Aquatic Invasions” (http://www.aquaticinvasions.ru), ensure a rapid publication and communication of new findings.

In order to maintain a valid list of the alien species in the Mediterranean, it becomes necessary to ensure its continuous updating and revision and promote more systematic
efforts supported by modern taxonomical tools such as genetics.

Addendum

After the original deadline of December 2005, additional alien species have been recognized. The following 10 species are just those that came to our attention. These are:

a. the Indo-Pacific crab *Charybdis feriata* caught in a gillnet off Barcelona (ABELLO & HISPANO, 2006)
b. the isopod *Cymothoa indica* parasitizing mainly barracudas (Sphyraenidae) from Lebanon (TRILLES & BARICHE, 2006)
c. the parasitic cymothoid isopod *Anilocra pilchardi* n. sp., from off Lebanon (BARICHE & TRILLES, 2006)
d. the western Atlantic ascidian *Distaplia bermudensis*, found for the first time in 2000 at Taranto (Ionian Sea, southern Italy), where an abundant population of colonies is now present (MASTROTOTARO & BRUNETTI, 2006);
e. the Indo-Pacific mantis shrimp *Clorida albolitura* from Ashdod, Israel (AHYONG & GALIL, 2006);
f. the needle-spined urchin *Diadema setosum* from off Kaş peninsula, Turkey (YOKES & GALIL, 2006);
g. the fish *Platax teira* captured off Boğrüm (S. Turkey), possibly a specimen escaped from aquaculture facilities (BILECENOĞLU & KAYA, 2006);
h. the fish *Parupeneus forsskali*, from Tasunu (Levantine coast of Turkey) (ÇINAR et al., 2006);
i. the fish *Nemipterus japonicus* from Haifa Bay (GOLANI & SONIN, 2006) and
j. the fish *Decapterus russelli* from Haifa Bay (GOLANI, 2006)

Acknowledgements

Taxonomic expertise for identifying organisms was provided by the following individuals, whose generous efforts and contributions to this project are gratefully acknowledged.

**Fish:** Daniel Golani (Israel); Adib Saad (Syria); Maria Corsini-Foka (Greece)

**Mollusca:** Baki Yokes (Turkey); Serhat Albayrak (Turkey); Jose Templado (Spain)

**Amphipoda:** Denise Bellan-Santini (France); Sandro Ruffo (Italy)

**Foraminifera:** Baki Yokes (Turkey); Ahuva Almogi-Labin (Israel)

**Porifera:** Eleni Voultsiadou (Greece); Jean Vacelet (France)

**Pycnogonida:** Valerio Bartolino (Italy); Roger Bamber (U.K.)

**Ascidia:** Alfonso Ramos (Spain)

**Zooplankton:** Sami Lakkis (Lebanon); Ahmet Kideys (Turkey); Ioanna Siokou-Frangou (Greece); Jean Paul Casanova (France)

**Phytoplankton:** Fernando Gómez (France), Sami Lakkis (Lebanon); Kalliopi Pagou, Olympia Gotsis-Sketras (Greece)

**Phytoenhos:** Inger Wallentinus (Sweden), Athanasios Athanasiadis (Sweden); Jose Rico (Spain); Marc Verlaque (France).

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