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# Decapoda and Stomatopoda (Crustacea) of Rodos island (Greece) and the erythrean expansion NW of the Levantine sea

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## Abstract

*The Decapoda and Stomatopoda (Crustacea) of the sublittoral zone of Rodos island were studied between 1995 and 2000. Twenty-five sites, at depths ranging from the intertidal to 119 m, were sampled. Three species of stomatopods and 52 species of decapods were identified, bringing the number of decapods known from Rodos to 83. One Stomatopode and nineteen decapods, though previously known from the Aegean Sea, are new records for Rodos. The presence of seven species of Erythrean origin testify to a trend of increasing tropicalization of the area. A remarkable number of Erythrean taxa (fish, Crustacea, Mollusca, Polychaeta) have been established in Rodos, the Dodecanese and the southern Aegean Sea, whereas few reached the northern Aegean and the Ionian Seas. The expansion of the Erythrean species NW of the Levantine Sea is discussed.*

**Keywords:** Crustacea, Decapoda, Stomatopoda, Rodos island, Aegean, Ionian, Levantine, Erythrean invasion.

## Introduction

The study of the Crustacea of Rodos island has began in the early years of the 20th century (PARISI, 1913; COLOSI, 1923; SANTUCCI, 1928; MALDURA, 1938; TORTONESE, 1947a,b; KINZELBACH, 1965, 1970; PRETZMANN, 1971). Following the expedition of the Hebrew University - Smithsonian Institution to Rodos, LEWINSOHN (1976) published a list of the decapod crustaceans of Rodos. Eleven species of decapods were added since (THESSALOU-LEGAKIS, 1986; THESSALOU-LEGAKI *et al.*, 1986; PANCUCCI-PAPADOPOULOU *et al.*, 1999; KOUKOURAS & DOUNAS, 2000). Only one stomatopod, *Squilla mantis* (L.), has been reported from Rodos (MALDURA, 1938; TORTONESE, 1947a,b).

A study of the sublittoral Decapoda and Stomatopoda of Rodos was conducted between 1995-2000. The material collected included 6 decapods and a stomatopod of Indo-Pacific origin (KEVREKIDIS & KEVREKIDIS, 1996; KEVREKIDIS *et al.*, 1998;

GALIL & KEVREKIDIS, 2002). A list of the entire decapod and stomatopod fauna of Rodos is presented.

## Materials and Methods

Twenty-five sites along the coasts of Rodos island were sampled (Fig. 1), at depths ranging from the intertidal to 119 m. Samples were collected by a commercial trawler in deeper sites, and by diving in shallow ones. The samples are deposited in the School of Fisheries and Technology, Igoumenitsa, TEI Eperou. The site data (e.g. location, distance from shore, depth, sampling date) is presented in Table 1.

## Results and Discusssion

The island of Rodos, close to the coast of Asia Minor, borders the Aegean and the Levantine seas. The Rodos gyre, southeast of the island, and the Asia Minor Current (AMC) are the major hydrological features nearby. The AMC runs along the Turkish coastline carrying westwards warm, salty water from the Levantine Sea, passing northward through the eastern Cretan Arc Straits, mainly the Rodos and Karpathos straits (THEOCHARIS *et al.*, 1993; NITTIS & LASCARATOS, 1999). Water masses of the area are characterised by high temperature and salinity values, even in deep waters (PANCUCCI-PAPADOPOULOU *et al.*, 1992). Surface temperature ranges between 17,6 °C in February and 26,4 °C in August and salinity is about 39‰ (NCMR, 1988). Since the hydrological characteristics of the area around Rodos resemble that of Levantine Sea, close faunal relations between the two were expected (SIMBOURA & NICOLAIDOU, 1993).

A total of 52 decapods were collected, increasing the number of decapod crustaceans known from Rodos to 83 (Table 2). Six species originated in the Indo-Pacific: *Marsupenaeus japonicus* (Bate, 1888), *Metapenaeopsis aegyptia* Galil 1990, *Metapenaeopsis mogiensis*

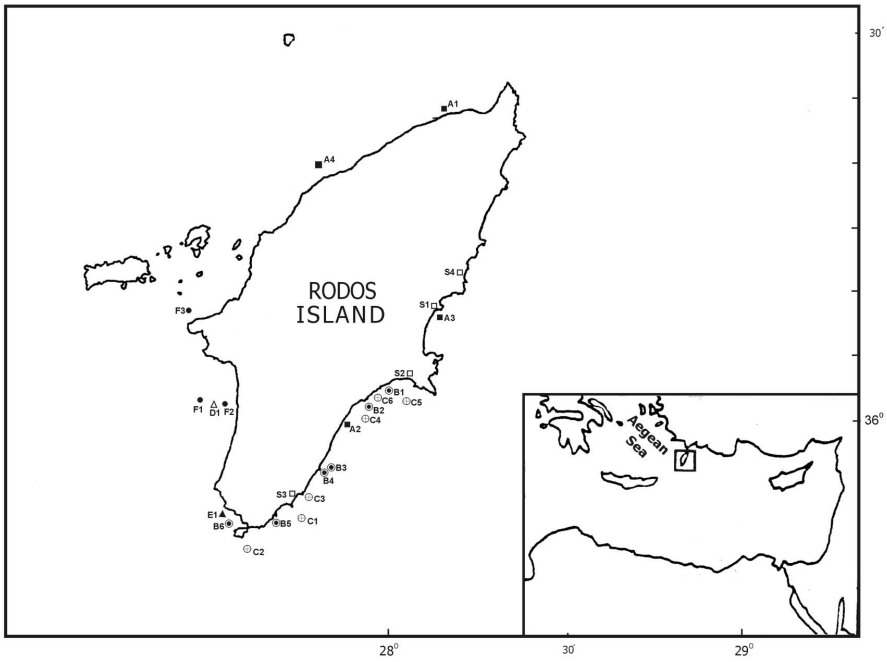


***Fig. 1:*** Map of Rodos Island (Greece) with sampling stations.

**Table 1**
**Code of sampling stations, sampling stations, day of sampling, distance from the coast and respective depth.**

| Code | Sampling stations | Date | Distance from coast (km) | Depth (m) |
|---|---|---|---|---|
| **A1** | Aerodromio | 13.3.1995 | 0.74 | 29-31 |
| **A2** | Genadi | 23.3.1995 | 1.11-1.57 | 14.5-22 |
| **A3** | Haraki | 24.3.1995 | 1.48-1.85 | 14.5-40 |
| **A4** | Kameiros | 26.3.1995 | 1.7 | 47-64 |
| **B1** | Pefkoi-Kiotari | 3.10.1996 | 0.9-1.85 | 20-29 |
| **B2** | Genadi-Pefkoi | 3.10.1996 | 1.7-2 | 29-31 |
| **B3** | Plimmiri-Genadi | 3.10.1996 | 1.6-1.7 | 33-36.5 |
| **B4** | Plimmiri-Genadi | 4.10.1996 | 1.2-1.7 | 25.5-36.5 |
| **B5** | Prassonisi-Plimmiri | 4.10.1996 | 1.3-1.8 | 18-47.5 |
| **B6** | Prassonisi-Karavolas | 4.10.1996 | 1.4-1.5 | 29-33 |
| **C1** | Plimmiri-M. Kavos | 29.10.1997 | 1.5-3.3 | 33-51 |
| **C2** | Prasssonisi | 29.10.1997 | 2.4-4.6 | 63-85 |
| **C3** | Lahania-Plimmiri | 30.10.1997 | 1.85 | 33 |
| **C4** | Genadi-Kiotari | 30.10.1997 | 1.67-2.2 | 31-49 |
| **C5** | Pefkoi | 30.10.1997 | 2.4-2.6 | 80.5-93.3 |
| **C6** | Lardos-Kiotari | 30.10.1997 | 0.93 | 18.3-20 |
| **D1** | Isl. Strogillo-Isl. Ktenia | 27.5.1998 | 0.93-3.05 | 49.4-69.5 |
| **E1** | Isl. Ktenia-Mandilas | 20.11.1999 | 1,3 | 29 |
| **F1** | Isl. Strogillo-Isl. Ctenia | 21.11.1999 | 4-4,6 | 109-119 |
| **F2** | Isl. Strogillo-Isl Ctenia | 21.11.1999 | 0,9-2,4 | 29,7-40 |
| **F3** | Glifada - Isl. Strogillo | 21.11.1999 | 0,9-1,85 | 68-95 |
| **S1** | Haraki | 9.9.2000 | - | 0-1 |
| **S2** | Lardos | 9.9.2000 | - | 0-1 |
| **S3** | Plimmiri | 9.9.2000 | - | 0-1 |
| **S4** | Archagellos | 9.9.2000 | - | 0-1 |
| **S2** | Lardos | 10.9.2000 | - | 0-1 |

*consobrina* (Nobili, 1904), *Trachysalambria palaestinensis* (Steinitz, 1932), *Charybdis longicollis* Leene, 1938 and *Ixa monodi* Holthuis & Gottlieb, 1956 (KEVREKIDIS & KEVREKIDIS, 1996; KEVREKIDIS *et al.*, 1998; GALIL & KEVREKIDIS, 2002). Nineteen species, previously known from the Aegean sea (KOUKOURAS *et al.*, 1992; D'UDECEM D'ACOZ, 1999), are newly recorded from Rodos.

Three stomatopod species were identified from our samples: *Squilla mantis* (L., 1758), reported previously by MALDURA (1938) and TORTONESE (1947a,b); *Rissoides pallidus* (Giesbrecht, 1910), already reported from the Aegean sea (KOÇATAS & KATAGAN, 1995); and *Erugosquilla massavensis* (Kossman, 1880), a species of Indo-Pacific origin (GALIL & KEVREKIDIS, 2002). *E. massavensis* has been known along the Levantine coast, southern and southwestern Turkey, (Fethiye Bay, opposite the island of Rodos) (HOLTHUIS, 1961; KOÇATAS & KATAGAN, 1995; KOÇATAS, 1981) and from northern Kriti (Crete) (DOUNAS & STEUDEL, 1994).

TORTONESE (1947b) noted that 'The marine fauna [of Rodos] does not seem to be a very rich one', but that 'Crustaceans were fairly abundant'. A more recent study of the benthic macrofaunal communities off the NW coast of Rodos found that decapods were poorly represented (PANCUCCI-PAPADOPOULOU *et al.*, 1999). Those studies were far from exhaustive as 25 of the 52 decapod species collected during the present study are new records for Rodos. All but the six Indo-Pacific

**Table 2**
**List of Stomatopoda and Decapoda (Crustacea) from Rodos island.**

| A. Stomatopoda | | | |
|---|---|---|---|
| | Maldura, 1938 | Tortonese, 1947a,b | Present study | Sampling stations |
| **Squillidae** | | | | |
| *Erugosquilla massavensis*** | | | + | B1 |
| *Rissoides pallidus** | | | + | C2 |
| *Squilla mantis* | + | + | + | C4 |

| B. Decapoda | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Parisi 1913 | Colosi 1923 | Santucci 1928 | Maldura 1938 | Tortonese 1947a,b | Kinzelbach 1965;1970 | Pretzmann 1971 | Lewinsohn 1976 | Thessalou Legakis *et al* 1986; | Pancucci-Papadopoulou *et al.* 1999 | Koukouras-Dounas 2000 | Present study | Sampling stations |
| **Solenoceridae** | | | | | | | | | | | | | |
| *Solenocera membranacea** | | | | | | | | | | | | + | C1,C2,C4, C5,D1 |
| ***Penaeidae*** | | | | | | | | | | | | | |
| *Marsupenaeus japonicus*** | | | | | | | | | | | | + | A1,A2,A3 A4,B5,E1 |
| *Melicertus kerathurus* | | | | + | + | | | | | | | | |
| *Metapenaeopsis aegyptia ** | | | | | | | | | | | | + | B1,B2,F2 |
| *Metapenaeopsis mogiensis consobrina ** | | | | | | | | | | | | + | A3,B1,C6 |
| *Parapenaeus longirostris ** | | | | | | | | | | | | + | B2,C5 |
| *Trachysalambria palaestinensis** | | | | | | | | | | | | + | A3,B1 |
| **Sicyonidae** | | | | | | | | | | | | | |
| *Sicyonia carinata** | | | | | | | | | | | | + | C6 |
| **Pandalidae** | | | | | | | | | | | | | |
| *Plesionika edwardsii* | | | | | | | | | + | | | + | C5,C6 |
| *Plesionika narval* | | | | | | | | | + | | | + | B2 |
| **Alpheidae** | | | | | | | | | | | | | |
| *Alpheus dentipes* | | | | | | | | + | | | | | |
| *Synalpheus gambarelloides* | | | + | | | | | | | | | | |
| **Processidae** | | | | | | | | | | | | | |
| *Processa acutirostris ** | | | | | | | | | | | | + | B6,C2,C1 |
| *Processa macrophthalma* | | | | | | | | | | | | + | D1 |
| **Palaemonidae** | | | | | | | | | | | | | |
| *Palaemon elegans* | | | + | | + | | | + | | | | + | S1,S2,S3,S4 |
| *Palaemon xiphias* | | | | | | | | + | | | | + | B6 |
| *Palaemonetes antennarius* | | | + | | | | | + | | | | | |
| *Pontonia pinnophylax* | | | + | | | | | + | | | | + | C5 |

**Table 2 (Continued)**

| B. Decapoda (cont.) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Parisi 1913 | Colosi 1923 | Santucci 1928 | Maldura 1938 | Tortonese 1947a,b | Kinzelbach 1965;1970 | Pretzmann 1971 | Lewinsohn 1976 | Thessalou Legakis *et al* 1986; 1986; | Pancucci-Papadopoulou *et al.* 1999 | Koukouras-Dounas 2000 | Present study | Sampling stations |
| **Crangonidae** | | | | | | | | | | | | | |
| *Aegaeon cataphractus** | | | | | | | | | | | | + | B1,C1,C2, C3,C4,C5,D1 |
| **Palinuridae** | | | | | | | | | | | | | |
| *Palinurus elephas* | | | | | + | | | + | | | | | |
| **Scyllaridae** | | | | | | | | | | | | | |
| *Scyllarides latus* | | | | + | + | | | | | | | + | D1 |
| *Scylarrus arctus* | | | | | + | | | | | | | + | B6 |
| *Scylarrus pygmaeus* | | | | | | | | + | | | | + | C1 |
| **Callianassidae** | | | | | | | | | | | | | |
| *Callianassa candida* | | | | | | | | + | | | | + | S2 |
| *Callianassa subterranea* | | | | | | | | | + | | | | |
| *Callianassa tyrrhena** | | | | | | | | | | | | + | S3 |
| *Gourretia denticulata* | | | | | | | | | + | + | | | |
| **Upogebiidae** | | | | | | | | | | | | | |
| *Gebiacantha talismani* | | | | | | | | | + | + | | | |
| *Upogebia pusilla** | | | | | | | | | | | | + | S2,S3 |
| *Upogebia stellata* | | | | | | | | | + | + | | | |
| *Upogepia tipica* | | | | | | | | + | + | + | | | |
| **Diogenidae** | | | | | | | | | | | | | |
| *Calcinus tubularis* | | | | | | | | + | | | | | |
| *Clibanarius erythropus* | | | + | | | | | + | | | | + | S3 |
| *Dardanus arrosor* | | | | | + | | | | | | | + | F3 |
| *Dardanus calidus* | | | | | | | | + | | | | + | B6 |
| *Diogenes pugilator* | | | | | | | | + | | | | | |
| *Paguristes eremita* | | | + | | | | | + | | | | + | C1 |
| **Paguridae** | | | | | | | | | | | | | |
| *Anapagurus laevis* | | | | | | | | + | | | | | |
| *Cestopagurus timidus* | | | | | | | | + | | | | | |
| *Pagurus anachoretus* | | | | | | | | + | | | | | |
| *Pagurus prideaux* | | | | | | | | + | | | | + | B3,C1 |
| **Galatheidae** | | | | | | | | | | | | | |
| *Galathea intermedia* | | | | | | | | | | + | | | |
| *Galathea machadoi* | | | | | | | | | | | + | | |
| *Galathea squamifera* | | | + | | | | | | | | | | |
| *Galathea strigosa* | | | | | + | | | | | | | | |
| **Porcellanidae** | | | | | | | | | | | | | |
| *Pisidia bluteli* | | | | | | | | + | | | | | |
| *Porcellana ptatycheles* | | | | | | | | + | | | | | |
| **Homolidae** | | | | | | | | | | | | | |
| *Homola barbata** | | | | | | | | | | | | + | D1,F3 |

**Table 2 (Continued)**

| B. Decapoda (cont.) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Parisi 1913 | Colosi 1923 | Santucci 1928 | Maldura 1938 | Tortonese 1947a,b | Kinzelbach 1965;1970 | Pretzmann 1971 | Lewinsohn 1976 | Thessalou Legakis *et al* 1986; 1986; | Pancucci-Papadopoulou *et al.* 1999 | Koukouras-Dounas 2000 | Present study | Sampling stations |
| **Latreillidae** | | | | | | | | | | | | | |
| *Latreillia elegans** | | | | | | | | | | | | + | F2 |
| **Dromiidae** | | | | | | | | | | | | | |
| *Dromia personata* | | | | | + | | | | | | | + | D1 |
| **Dorippidae** | | | | | | | | | | | | | |
| *Ethusa mascarone** | | | | | | | | | | | | + | F3 |
| **Calappidae** | | | | | | | | | | | | | |
| *Calappa granulata* | | | | | + | | | | | | | + | B3,C3 |
| **Leucosiidae** | | | | | | | | | | | | | |
| *Ilia nucleus* * | | | | | | | | | | | | + | C6 |
| *Ixa monodi*** | | | | | | | | | | | | + | F2 |
| **Majidae** | | | | | | | | | | | | | |
| *Acanthonyx lunulatus* | | | + | | + | | | + | | | | | |
| *Eurynome aspera* | | | | | | | | | | + | | | |
| *Inachus communissimus** | | | | | | | | | | | | + | B1,C4 |
| *Inachus dorsettensis** | | | | | | | | | | | | + | D1,F2 |
| *Inachus leptochirus** | | | | | | | | | | | | + | D1 |
| *Inachus thoracicus** | | | | | | | | | | | | + | B2,C1, C4,F2 |
| *Macropodia rostrata* | | | | | | | | | | + | | + | F2 |
| *Maja crispata* | + | | | | + | | | + | | | | | |
| *Maja squinado* | | | | | + | | | | | | | + | D1 |
| *Pisa armata** | | | | | | | | | | | | + | C2,D1, F2,F3 |
| *Pisa corallina* | | | | | | | | + | | | | + | B6 |
| *Pisa muscosa** | | | | | | | | | | | | + | B6 |
| *Pisa tetraodon* | | | | | | | | + | | | | | |
| **Portunidae** | | | | | | | | | | | | | |
| *Callinectes sapidus* | | | | | | + | | | | | | | |
| *Charybdis (Goniohellenus) longicollis ** | | | | | | | | | | | | + | B1,C1,C3, C4,C6,F2 |
| *Liocarcinus arcuatus* | | | + | | + | | | | | | | + | B6,F2 |
| *Liocarcinus corrugatus* | | | | | + | | | | | | | + | B6,C2 |
| *Liocarcinus depurator* | | | | | + | | | | | | | + | C2,D1 |
| *Liocarcinus zariquieyi* | | | | | | | | + | | | | | |
| *Portunus hastatus* | | | | | + | | | | | | | + | C1,C3, C4,C6 |
| **Xanthidae** | | | | | | | | | | | | | |
| *Monodaeus guinotae** | | | | | | | | | | | | + | F1 |
| *Xantho granulicarpus* | | | | | | | | + | | | | | |
| *Xantho poressa* | | | + | | + | | | + | | | | + | S2,S3 |

**Table 2 (Continued)**

| B. Decapoda (cont.) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Parisi 1913 | Colosi 1923 | Santucci 1928 | Maldura 1938 | Tortonese 1947a,b | Kinzelbach 1965;1970 | Pretzmann 1971 | Lewinsohn 1976 | Thessalou Legakis *et al* 1986; 1986; | Pancucci-Papadopoulou *et al.* 1999 | Koukouras-Dounas 2000 | Present study | Sampling stations |
| **Eriphiidae** | | | | | | | | | | | | | |
| *Eriphia verrucosa* | + | + | | | + | | | | | | | + | S1 |
| **Pilumnidae** | | | | | | | | | | | | | |
| *Pilumnus hirtellus* | | | + | | | | | | | | | | |
| **Goneblacidae** | | | | | | | | | | | | | |
| *Goneplax rhomboides* | | | | | | | | | | + | | | |
| **Grapsidae** | | | | | | | | | | | | | |
| *Pachygrapsus marmoratus* | | | + | | + | | + | + | | | | + | S2,S3 |
| **Ocypodidae** | | | | | | | | | | | | | |
| *Ocypode cursor* | | | | | | + | | | | | | | |
| **Palicidae** | | | | | | | | | | | | | |
| *Palicus caronii* * | | | | | | | | | | | | + | C2 |

* New records for Rodos island previously known from the Aegean Sea

** Erythrean species

species (see above), occur in the Aegean Sea (KOUKOURAS *et al.*, 1992; D'UDEKEM D'ACOZ, 1999). Our results thus confirm BARASH & DANIN's (1989) statement that the fauna of Rodos shows biogeographical affinity with that of the Aegean Sea. The presence of the seven Erythrean species, however argues an Indo-Pacific incursion, and testify to a trend of increasing tropicalization of the area.

A considerable number of Erythrean invaders (fish, Crustacea, Mollusca, Polychaeta) have been established in the Levantine Sea, and some have spread into the southern Aegean Sea. Examination of the expansion of the Erythrean invaders NW of the Levantine Sea shows that the majority of the species first appear at Rodos and the Dodecanese islands, and whereas a significant number spread into other parts of the southern Aegean Sea, few have reached the northern Aegean and the Ionian Seas (Table 3). This pattern of distribution is apparent for Erythrean fish as 'the prevailing currents direct the spreading of fishes along the Asiatic coasts northward and then westward toward the Aegean Islands' (PAPACONSTANTINOU, 1990). Eight of the 16 Erythrean fish recorded from Rodos and the Dodecanese islands are known from the south Aegean (PAPACONSTANTINOU, 1990; CORSINI & ECONOMIDIS, 1999; www.ciesm/org/atlas). No Erythrean fish has been reported

**Table 3**
**Number of established Erythrean species of fish, Crustacea, Mollusca, and Polychaeta NW of the Levantine Sea.**

| | Fish | Crustacea (Decapoda-Stomatopoda) | Mollusca (Bivalvia-Gastropoda) | Polychaeta | Total |
|---|---|---|---|---|---|
| **Rodos-Dodekanese islands** | 16 | 7 | 4 | 4 | 31 |
| South Aegean Sea excl. Dodekanese | 8 | 2 | 7 | 5 | 22 |
| North Aegean Sea | - | - | - | 5 | 5 |
| Ionian Sea | 5 | - | 2 | 2 | 9 |

from the north Aegean Sea, possibly due to unfavourable abiotic factors (PAPACONSTANTINOU & TORTONESE, 1980), whereas 5 species have spread into the Ionian Sea (e.g., TORTONESE, 1967; KASPIRIS, 1976). Four Erythrean molluscs and four Erythrean polychaetes have been collected off Rodos (BARASH & DANIN, 1989; BEN-ELIAHU & FIEGE, 1996; www.ciesm/org/atlas), seven and five species respectively recorded in the south Aegean (FOUNTOULAKIS & SABELLI, 1999; SIMBOURA & NICOLAIDOU, 2001; www.ciesm/org/atlas), and two molluscs and two polychaetes have been found in the Ionian Sea (ARCIDIACONO & DI GERONIMO, 1976; SIMBOURA & NICOLAIDOU, 2001; www.ciesm/org/atlas). However, five polychaete species of Erythrean origin were found in the north Aegean sea (SIMBOURA *et al.*, 1995; ARVANITIDIS, 2000). The first Erythrean invader, *Siganus rivulatus* Forskål, 1775 was reported from the Dodecanese islands by BRUNELLI & BINI (1934) noting «è notevolmente diffuso e di facile cattura». Already TORTONESE (1947b) claimed that the fish fauna of Rodos acquired a tropical character, as some invading fish were so abundant they were exploited commercially (TORTONESE, 1947a). POR (1978) believed Rodos the farthest point Erythrean invaders would reach and rejected the possibility of them spreading into the Aegean Sea. However, spread they did: PAPACONSTANTINOU (1990) suggested that inadequate sampling was at the root of the error. In the past decade a significant number of molluscs and polychaetes have been recorded in the south Aegean sea (VARDALA-THEODOROU, 1999; SIMBOURA & NICOLAIDOU, 2001).

Climatic factors play an important role in bioinvasion: POR (1990) maintained that the distribution of Erythrean immigrants 'will certainly expand or shrink according to the climatic evolution in the area' and that 'immigrants will expand further west if the climate warms up further' (POR, 1978), and PAPACONSTANTINOU (1990) attributed the westward advance of Erythrean invaders to the rise of the sea temperature in the '50s. Recently, GALIL & KEVREKIDIS (2002) attributed the influx of the exotic crustaceans into the southeastern Aegean Sea in the past decade to the augmented salinity and to the more extensive inflow of the AMC following the significant changes of the south Aegean water mass characteristics termed the Eastern Mediterranean Transient (EMT). The EMT provides favourable conditions for the maintenance and spread of Erythrean species in the south Aegean Sea and signals the possible invasion of the area by species of Levantine or Erythrean origin. Thus, if the present characteristics of the south Aegean hydrography persist, a modification of the composition and structure of the fauna is entirely possible.

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***Dedication***

*Sailing near to Asia Minor; motherland of both my grandmother Alexandra KEVREKIDOU (Kars, Pontos) and my grandfather Dimitrios VOGDANOU (Proussa, Aeolia). A need for dedication of this work to their memory.*