

## Indo-Pacific gastropod species in the Levantine and Aegean Seas

Bilal Öztürk<sup>1\*</sup> and Alp Can<sup>2</sup>

<sup>1</sup>Ege University, Faculty of Fisheries, Dept. Hydrobiology, 35100 Bornova-Izmir, Turkey

E-mail: [bilal.ozturk@ege.edu.tr](mailto:bilal.ozturk@ege.edu.tr)

<sup>2</sup>Ankara University, Biotechnology Institute, Besevler, 06500, Ankara, Turkey

E-mail: [alpcan@medicine.ankara.edu.tr](mailto:alpcan@medicine.ankara.edu.tr)

\*Corresponding author

Received 14 June 2006; accepted in revised form 5 August 2006

### Abstract

The present study reports the occurrence of three Indo-Pacific gastropod species at new localities in the Mediterranean Sea. *Chromodoris quadricolor* was recorded on the 29 May 2004 in the eastern Mediterranean, which is the third report of the species from the Mediterranean Sea. *Finella pupoides* and *Syrnola fasciata* are collected from the several sites in the Aegean Sea between 1997 and 2002. The morphological, ecological and distributional characteristics of these species are described.

*Key words:* *Chromodoris quadricolor*, *Finella pupoides*, *Syrnola fasciata*, Gastropoda, Lessepsian migrant, eastern Mediterranean, new records

### Introduction

Since the opening of the Suez Canal in 1869, which connected two different zoogeographical regions, the eastern Mediterranean Sea is colonized by species of Indo-Pacific origin. Although the number of immigrant species was initially low, their number has increased especially during the last decade. Now, more than 300 Lessepsian immigrants are known in the Mediterranean. Among these non-indigenous species, the molluscs are most numerous and many studies have focused on them.

Most of the Mediterranean alien molluscan species (including the Lessepsian immigrants and the species which have been carried by shipping or mariculture) have been incorporated by Zenetos et al. (2003) in the recently published mollusc part of the "CIESM Atlas of Exotic Species in the Mediterranean". They listed a total of 126 species of Indo-Pacific origin and a few additional migrants from the other parts of the world. They also rejected 26 Indo-Pacific species, due to various reasons such as unconfirmed records, mis-

identifications and species of an unclear origin. Soon thereafter, Mienis (2004) reported 23 new records for the Mediterranean Sea and additional data for 11 species, which were overlooked by Zenetos et al. (2003).

Although some of the immigrants constitute local populations near the Levant entrance of the Suez Canal, others have expanded their distributional ranges to the western Levantine Sea and to other regions of the Mediterranean system. A recent study reported the presence of the Lessepsian mantis shrimp, *Erugosquilla massavensis* (Koossmann 1880) in the Marmara Sea (Katagan et al. 2004), where the surface water is of Black Sea origin, and the bottom is of Mediterranean origin. In addition, two Polychaeta species, *Leonnates persicus* Wesenberg-Lund 1949 and *Pseudonereis anomala* Gravier 1900 were reported from Izmir Bay (Aegean Sea) by Çinar et al. (2002) and Çinar and Ergen (2005), respectively. Some mollusc species, like *Cerithium scabridum* stated by Albayrak (2001) from Gökçeada (North Aegean Sea), *Fulvia fragilis* (Bivalvia) reported by Vardala-Theodorou (1999)

and Öztürk and Poutiers (2005) from Elefsis and Izmir Bay, respectively, are also Lessepsian immigrants which have enlarged their distributional ranges to the Aegean Sea. Among Lessepsian fishes, 19 species have also reached to the Aegean Sea, some of which have established populations in the central and northern Aegean Sea (Bilecenoglu et al. 2002).

Among the Turkish coasts, the highest number of alien species are known from the Levantine coast. A total of 277 alien species have been reported from the Turkish coasts (of which 90 are molluscs) and 216 alien species (84 are molluscs) occur in the Levantine Sea (see the addendum given by Çınar et al. 2005). The introduction of alien species is an ongoing process and numbers are increasing day by day. For example, Çeviker and Albayrak (2006) have reported three new alien molluscs for the Turkish fauna.

In the present study, two gastropod species, *Finella pupoides* and *Syrnola fasciata*, are being reported for the first time from the Aegean Sea. Furthermore, we provide some ecological and distributional features of *Chromodoris quadricolor* (Gastropoda) as a first record from the eastern Mediterranean Sea.

## Materials and Methods

The samples, in which *F. pupoides* and *S. fasciata* were found, was collected from the Fethiye Bay (Levantine Sea) in 1997, and at the Salih Island coast near Bodrum (southern Aegean Sea coast of Turkey) in 2001 (Figure 1). The sampled material was studied within the framework of a project supported by TUBITAK [Project No: TBAG 2343 (103T154)]. The material taken from Salih Island mainly comprised of leaves and roots of

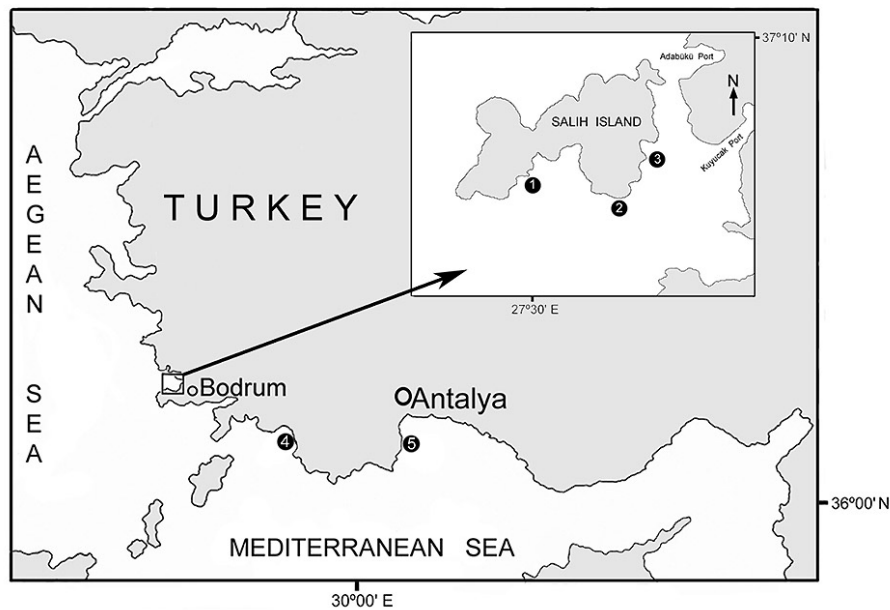


Figure 1. Map of the study area with location of sampling stations

*Posidonia* and sand, whereas the sample from Göçek (Fethiye Bay) was taken from muddy substratum. Both samples were taken by a dredge from depths of 15 and 33 m respectively, and were fixed in 4% formaldehyde in the field. Fixed material was washed through a sieve with 0.5 mm mesh size in the laboratory and samples were sorted under a stereomicroscope. The other species considered in the present study (*C. quadricolor*) was encountered at a depth of 15 m

at a locality called "İki Kaya" near Kemer-Antalya (Station 5, Figure 1) and it has been photographed at its natural environment by one of us (A.C.), without any specimen being collected. The sampling dates, coordinates and some ecological features of the stations are indicated in the Annex. The collected specimens and the photograph of *C. quadricolor* are deposited at the Museum of the Faculty of Fisheries, Ege University, Turkey (ESFM).

## Results and Discussion

*Finella pupoides* Adams, A. 1860  
(Gastropoda: Scaliolidae)  
(Figure 2)

*Finella pupoides* Adams, A. 1860, p 336; Thiele 1931 (1992), p 311, figure 209; Barash and Danin 1977, p 90, Fig. 4; Zenetos et al. 2003, p 72



**Figure 2.** *Finella pupoides* Adams A 1860 (A(h) = 3.1 mm; B(h)= 2.2 mm). Photographed by Bilal Öztürk

Of 11 specimens investigated in this study, one specimen (shell 2.3 mm in height, with series of indistinct brown patches on a whitish background) was encountered at station 1 on sandy-muddy substrate with *Posidonia oceanica* remainders; one specimen (shell 2.2 mm in height, with a shell colour pattern as it is in the former specimen) was found at station 2 on *Posidonia oceanica* leaves and roots with sandy and muddy substrata; one specimen (shell 3.1 mm in height with brownish colour) was sampled at station 3 from *Posidonia oceanica* leaves and roots with sand; and 8 specimens (largest 2.6 mm in height, with shells colour patterns similar to the specimens sampled at station 1 and 2) were found at station 4 in muddy substrate.

According to Barash and Danin (1992, p 76), the Indo-Pacific range of *Finella pupoides* is as follows: Gulf of Suez, Red Sea, Persian Gulf, India and Japan. In the Mediterranean Sea, this Lessepsian species has been known so far only from the Levantine Sea, where it is commonly encountered along the eastern and northeastern coasts and Cyprus (Zenetos et al. 2003, p 73). This record extends its distribution in the Mediterranean system to the Aegean Sea.

*F. pupoides* was first recorded in the Mediterranean during 1958 from the Israeli coast of the Levantine Sea (Barash and Danin 1977). Although its distribution was initially restricted, it has expanded its distributional area in the last 15 years westwards in the Levantine Sea and to the Aegean Sea according to Tringali and Villa (1990), Engl (1995) and the present study. Its successful dispersion may probably be due to its long planktonic larval stage, during which it can be transported to remote sites by water currents, as well as in ballast water of ships. It should be noted that two ports (Adabükü and Kuyucak) (Figure 1) are located close to Salih Island, where *F. pupoides* and *S. fasciata* were sampled.

*Syrnola fasciata* (Jickeli 1882)  
(Gastropoda:Pyramidellidae)  
(Figure 3)

*Syrnola solidula* var. *fasciata* Jickeli 1882, p 367-368 (original description), type locality from Suez, Egypt (in CLEMAM); *Syrnola massauensis* Micali and Palazzi 1992, p 87-89; *Syrnola fasciata* Aartsen 1995, p 94; Buzzurro and Greppi 1995, p 6-7)



**Figure 3.** *Syrnola fasciata* (Jickeli 1882) (h = 4.7 mm). Photographed by Bilal Öztürk

One specimen of this species (shell 4.7 mm in height with two brownish cords on a horny-whitish background on the body whorl) was encountered at station 3 in areas with *Posidonia oceanica* leaves and roots with sand

This probably Lessepsian migrant (not recorded so far in the Suez Canal) seems to have the same distributional pattern as *Finella pupoides*. It has been reported from the eastern and northeastern coasts of the Levantine Sea and all around Cyprus (in Zenetos et al. 2003, p 153). This distant locality in the present study enlarges its distribution to the Aegean Sea.

*Syrnola fasciata* was first found in the Mediterranean Sea in 1958 from the Israeli coast (Haifa) and in 1963 from the Turkish coast of the Levantine Sea (Aartsen et al. 1989, p 70). The expansion of this probably Lessepsian species to the west in the Levantine Sea appears to be similar to the *F. pupoides* according to information given by Tringali and Villa (1990) and Engl (1995), and the species recently reached the Aegean Sea (present study).

*Remark:* in the faunal assemblage of the autumn 2001 samples taken at station 1, a total of 689 individuals belonging to 35 species (including *F. pupoides* and *S. fasciata*) have been identified. Among them *Bittium latreillii* (Mollusca) was the dominant species, followed by *Echinocyamus pusillus* (Echinodermata).

*Chromodoris quadricolor* (Rüppell and Leuckart 1830)  
(Gastropoda: Chromodorididae)  
(Figure 4)

*Doris quadricolor* Rüppell and Leuckart, 1830, p 31, pl. 9, Figure 2 (original description), type locality from Tor (Red Sea/Egypt) (in CLEMAM).

*Chromodoris quadricolor* Cattaneo-Vietti 1986, p 167-168 (first report from Mediterranean Sea).

A single specimen of this species was encountered and photographed at station 5, on rocks covered by algae in an area with sand-gravel bottom, at a distance of approximately one mile to the Kemer marina (Antalya). The colour pattern of the specimen coincides well with the specimens from Red Sea, especially, with those reported by Cattaneo-Vietti (1986) from the Ligurian Sea.

According to Zenetos et al (2003, p 195), in the Red Sea, this species can be found on shallow

water coral reefs and feeds on sponges, similar to other *Chromodorid* species.



**Figure 4.** *Chromodoris quadricolor* (Rüppell and Leuckart 1830). Photographed by Alp Can

*Chromodoris quadricolor* originally described from the Red Sea and subsequently reported from Tanzania (Rudman 1977), has an elongate, dorso-ventrally flattened and smooth body. Its mantle is brightly coloured, with four distinct colour bands (Figure 4). The dorsal part of the mantle consists of two blue and three black bands which are wider than blue ones. The bands are surrounded by a narrow white and a wide orange band, with a peripheral lining in white colour. The side of the foot, which can be seen when the animal is crawling, has the same colour as the notum. The orange colour of the lamellated rhinophores and branchial plume is darker than the mantle.

This species naturally occurs in the western Indian Ocean and the Red Sea. In the Mediterranean, it was first reported by Cattaneo-Vietti (1986) from Capo Mortola in the Ligurian Sea (northwestern Mediterranean) and subsequently by Ben Souissi et al. (2004) from the Biban Lagoon (Tunisia). *C. quadricolor* is here reported from the eastern Mediterranean for the first time.

As for its occurrence in the Mediterranean, Zenetos et al. (2003, p 195) indicated the mode of introduction of this species as unknown, but possibly being an accidental release from a tropical aquarium. The area, where the single specimen has been found (station 5) is along a shipping route and because the region is open to the tourism, no mariculture activities are in close vicinity. Its mode of introduction as proposed by Zenetos et al. (2003, p 195) should be considered as questionable. In contrast, Ben Souissi et al. (2004, p 312) assume Lessepsian migration as its mode of introduction. Further specimens collected from other localities in the Mediterranean may

reveal a clearer picture of the mode of introduction.

There are many *Chromodoris* species in the world's oceans and the most important reliable criterion used for species identification is the colour pattern of the notum, foot, oral tentacles, gills and rhinophores (Rudman 1973, p 176). Although it has a wide distribution in the world's oceans, it is represented by few species in the Mediterranean Sea (*Chromodoris britoi* Ortea and Perez 1983, *Chromodoris elegantula* (Philippi 1844), *Chromodoris krohni* (Vérany 1846), *Chromodoris luteopunctata* (Gantès 1962), *Chromodoris luteorosea* (Rapp 1827), *Chromodoris purpurea* (Risso in Guérin 1831) and *Chromodoris quadricolor* (Rueppell and Leckart 1828). Among these, only *C. quadricolor* is of Indo-Pacific origin and of the eleven *Chromodoris* species in the Red Sea (Dekker and Orlin 2000, p 36), this is the only species that has immigrated into the Mediterranean.

According to Rudman (1977), *C. quadricolor* has been misidentified as *Chromodoris africana* Eliot 1904 in several studies such as with some reports from the Red Sea. According to the same author (p 374), *C. quadricolor* differs from *C. africana* by its colour, body shape and radula. Although *C. quadricolor* has four colours (black, blue, orange and white), *C. africana* does not have blue colour on the notum.

Despite some of the immigrants may thrive in their new environment by displacing the native fauna components, so far no native Mediterranean species is reported as endangered by non-native species (Gofas and Zenetos 2003). The number of the immigrant species into the Mediterranean will probably increase in the future and parallel to the species richness increasing, the gene pool of the recipient regions will also change.

### Acknowledgements

This work has been financially supported by TUBITAK [Project Number: TBAG 2343 (103T154), coordinated by Bilal Öztürk].

### References

- Aartsen J J van (1995) European Pyramidellidae: IV. The genera *Eulimella*, *Anisocycla*, *Syrnola*, *Cingulina*, *Oscilla* and *Careliopsis*. *Bollettino Malacologico* 30: 85-109
- Aartsen J J van, Barash A and Carrozza F (1989) Addition to the knowledge of the Mediterranean Mollusca of Israel and Sinai. *Bollettino Malacologico* 25: 63-76
- Adams A (1860) On some new genera and species of Mollusca from Japan. *Annals and Magazine of Natural History* 5: 299-303; 405-413
- Albayrak S (2001) Prosobranch Gastropods of the Imbros Island (NE Aegean Sea). *Acta Adriatica* 42: 35-42
- Barash A and Danin Z (1977) Addition to the knowledge of Indo-Pacific Mollusca in the Mediterranean. *Conchiglie* 13: 85-116
- Barash A and Danin Z (1992) Fauna Palaestina: Mollusca I. Annotated list of Mediterranean molluscs of Israel and Sinai. Jerusalem: The Israel Academy of Sciences and Humanities. 405 pp
- Ben Souissi J, Zaouali J, Rezig M, Bradai MN, Quignard, JP and Rudman B (2004) Contribution à l'étude de quelques récentes migrations d'espèces exotiques dans les eaux Tunisiennes. *Rapport du Commission Internationale pour l'Exploration Scientifique de la mer Méditerranée* 37:312
- Bilecenoglu M, Taskavak E, Mater S and Kaya M. (2002) Checklist of the marine fishes of Turkey. *Zootaxa* 113: 1-194
- Buzzurro G and Greppi E (1995) Note sul materiale tipico di origine lessepsiana della collezione Hornung & Mermod. *Notiziario CISMA* 17: 5-16
- Cattaneo-Vietti R (1986) On the probable presence of *Chromodoris quadricolor quadricolor* Mollusca: Nudibranchia in the Mediterranean Sea. *Bollettino Malacologico* 22: 167-168
- CLEMAM, published online at (<http://www.mnhn.fr/base/malaco.html>), 30/05/2006.
- Çeviker D and Albayrak S (2006) Three alien molluscs from Iskenderun Bay (SE Turkey). *Aquatic Invasions* 1: 76-79
- Çinar ME, Ergen Z and Dagli E (2002) Occurrence of the Lessepsian species *Leonnates persicus* (Polychaeta: Nereididae) in Izmir Bay, Aegean Sea. *Journal of the Marine Association of the United Kingdom* 82: 811-815
- Çinar ME and Ergen Z (2005) Lessepsian migrants expanding their distributional ranges; *Pseudonereis anomala* (Polychaeta: Nereididae) in Izmir Bay (Aegean Sea). *Journal of the Marine Association of the United Kingdom* 85: 313-321
- Çinar ME, Bilecenoglu M, Öztürk B, Katagan T and Aysel V (2005) Alien species on the coast of Turkey. *Mediterranean Marine Science* 6 (2) (in press)
- Dekker H and Orlin Z (2000) Check list of Red Sea Mollusca. *Spirula* 47 (Suppl.): 1-46
- Engl W (1995) Specie prevalentemente lessepsiane attestate lungo le coste Turche. *Bollettino Malacologico* 31: 43-50
- Gofas S and Zenetos A (2003) Exotic molluscs in the Mediterranean basin: current status and perspectives. *Oceanography and Marine Biology: an Annual Review* 41: 237-277
- Katagan T, Kocataş A, Zengin M and Ateş, AS (2004) An Indo-Pacific stomatopod from the Sea of Marmara: *Erugosquilla massavensis* (Kossmann 1880). *Crustaceana* 77: 381-383
- Micali P and Palazzi S (1992) Contributo alla conoscenza dei Pyramidellidae della Turchia, segnalazione di due nuove immigrazioni dal mar Rosso. *Bollettino Malacologico* 28: 83-90
- Mienis HK (2004) New data concerning the presence of Lessepsian and Indo-Pacific migrants among the molluscs in the Mediterranean Sea with emphasize on the situation in Israel. In Öztürk, B, Salman, A., (Eds.), *Ist National*

## Indo-Pacific gastropod species

- Malacology Congress, 1-3 September 2004, Izmir-Turkey, Turkish Marine Research Foundation Press, Istanbul, pp 117-131
- Öztürk B and Poutiers JM (2005) *Fulvia fragilis* (Bivalvia: Cardiidae): a Lessepsian mollusk species from Izmir Bay (Aegean Sea). Journal of the Marine Association of the United Kingdom 85: 351-356
- Rudman WB (1973) Chromodorid opisthobranch Mollusca from Indo-West Pacific. Zoological Journal of the Linnean Society 52: 175-199
- Rudman WB (1977) Chromodorid opisthobranch Mollusca from East Africa and the tropical West Pacific. Zoological Journal of the Linnean Society 61: 351- 397
- Thiele J (1931) Handbook of Systematic Malacology. Part 1 (Loricata; Gastropoda: Prosobranchia). Smithsonian Institution Libraries, The National Science Foundation, Washington, D C (1992 edition), 625 pp
- Tringali L and Villa R (1990) Rinvenimenti malacologici dalle coste Turche (Gastropoda, Polyplacophora, Bivalvia). Notiziario CISMA 12: 33-41
- Vardala-Theodorou CE (1999) The occurrence of the Indo-Pacific molluscan species *Fulvia fragilis* (Forsskål, 1775) and *Bulla ampulla* L., 1758 in Elefsis Bay. Newsletter Hellenic Zoological Society 31: 10-11
- Zenetos A, Gofas S, Russo G and Templado J (2003) CIESM Atlas of exotic species in the Mediterranean. Vol. 3: Molluscs. CIESM, Monaco, 376 pp

## Annex

Records of alien gastropods in Levantine and Aegean Seas in 1997-2004\*

Species	Location	Record coordinates		Record date	T (°C)	Salinity (psu)	PH	Oxygen mg/l
		Latitude, °N	Longitude, °E					
<i>Finella pupoides</i> Adams, A. 1860	Station 1 (Salih Island, 13 m)	37°08'59"	27°30'30"	05.09.2002	27.5	38.54	8.22	6.4
	Station 2 (Salih Island, 20 m)	37°08'46"	27°31'47"	05.09.2002	27	38.86	8.21	6.8
	Station 3 (Salih Island, 15 m)	37°09'13"	27°31'49"	21.10.2001	23	38.03	8.13	7.2
	Station 4 (Göçek, 33 m)	-	-	01.06.1997	-	-	-	-
<i>Syrnola fasciata</i> (Jickeli 1882)	Station 3 (Salih Island; 15 m)	37°09'13"	27°31'49"	21.10.2001	23	38.03	8.13	7.2
<i>Chromodoris quadricolor</i> (Rüppell and Leuckart 1830)	Station 5 (İki Kaya: Kemer, 15 m)	36°35'05"	30°35'41"	29.05.2004	-	-	-	-

\*Full reference to the data: Öztürk B and Can A (2006) Indo-Pacific gastropod species in the Levantine and Aegean Seas. Aquatic Invasions 1(3): 124-129