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Further additions to the alien mollusc fauna along the Cypriot coast: new opisthobranchia species

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The finding of some alien opisthobranchia previously unknown from Cyprus confirms that Indo-Pacific alien species are spreading at an increasing rate in the Levantine Sea. This work reports on the occurrence of four new alien species recorded in the form of images that have been taken over a period spanning more than 8 years. These are Chelidonura fulvipunctata*,* Chromodoris annulata, Flabellina rubrolineata *and* Hypselodoris infucata*. In addition, finding of* Melibe viridis, *which was considered hitherto as casual, confirm its establishment success around Cyprus.* Chromodoris annulata, *a recent invader in the Mediterranean and little known from the Levantine basin, is currently well established on the Cypriot coast.*

Key words: alien Opisthobranchia, *Chelidonura fulvipunctata, Hypselodoris infucata, Melibe viridis, Chromodoris annulata, Flabellina rubrolineata,* Cyprus, Mediterranean Sea

INTRODUCTION

The alien mollusca of Cyprus have been summarised in OZTURK *et al.*, 2004. Thirty five out of 645 (5%) of the species of molluscs cited from Cyprus are alien (CECALUPO & QUADRI, 1994, 1996; BUZZURRO & GREPPI, 1997; OZTURK *et al.*, 2004). Recently, ZENETOS *et al*. (2009) reported on the occurrence of six more alien bivalve species previously unknown from Cyprus.

This work reports on additional sightings of alien mollusca reported in the literature after ZENETOS *et al*. (2009) and KATSANEVAKIS *et al.* (2009) and adds significant information on the spread of reported alien species and on the occurrence of new ones.

MATERIAL AND METHODS

The records are in the form of images and these have been taken by one of the authors (LT) over a period spanning more than 8 years. Nikon cameras with a Nikkor 105 mm macro lens in Ikelite housing and Dual Strobes were used.

Water temperature was recorded by means of a dive computer (SUUNTO EON model for dives between 2000-2004 and SUUNTO VYTEC model from 2004-to date).

Dive sites are summarised in Table 1, whilst biotope details are provided for each species.

Table 1. Location of dive sites

	Longitude	Latitude
Cyclops Cave (Protaras)	34°59'10,34"N	34°04'35,8"E
Agios Georgios Alamanou (Limassol)	34°42'22,9"N	33°13'11,7"E
Limassol - new port	34°38'38,2"N	33°00'49,4"E
Amathus (Limassol)	34°42'41,6"N	33°08'43,3"E
The Canyon (Famagusta)	34°57'40,5"N	34°03'50,6"E
Dhekelia (Larnaka)	34°58'44,7"N	33°43'48,1"E
Wreck of the Zenobia, (Larnaka)	34°53'49,5"N	33°39'27,1"E

The distribution of species in chronological order is based on the 2010 update of the HCMR database (ZENETOS & FRAGGOS, 2008).

RESULTS

The newly reported species are *Chelidonura fulvipunctata, Hypselodoris infucata, Chromodoris annulata* and *Flabellina rubrolineata.* Some additional data are reported on *Melibe viridis.*

Family: Aglajidae

Chelidonura fulvipunctata Baba, 1938

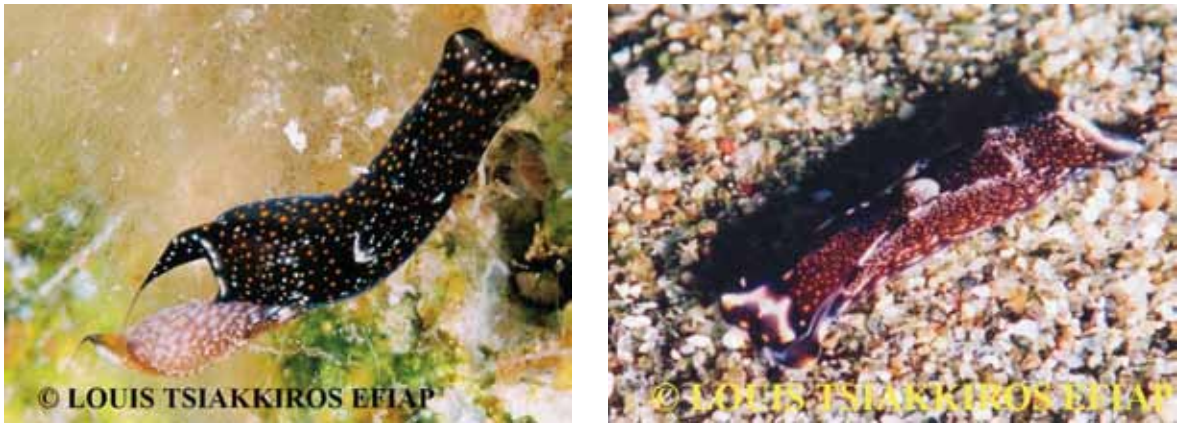

Fig. 1. Chelidonura fulvipunctata *observed at a) Cyclops Cave (Protaras), and b) Agios Georgios Alamanou (Limassol)*

The specimen illustrated in Fig. 1a comes from Cyclops Cave (Protaras). It was found in June 2003 near a crevice of a big rock boulder covered with marine plants, at a depth of 9 m and at a water temperature of 26°C. A different colour variance (Fig. 1b) was found at Agios Georgios Alamanou (Limassol) in December 2006, on a sandy seabed surrounded by rock formations, at a depth of 3 m and at a water temperature of 21°C. Both locations are situated at a great distance from ports and harbours. The characteristic W marking on the head of the slug is more prominent on the Limassol specimen (Fig. 1b).

Chelidonura fulvipunctata is a slug mostly recorded as from Japan and eastern Australia (BABA, 1938). It is believed to be present in other areas as well. Records exist from South Africa and the Red Sea. The colour pattern of this species is extremely variable and even the two specimens illustrated here show dissimilarities. In fact, the characteristic W marking on the head

of the slug, that makes it unmistakable when present, is more prominent on the Limassol specimen (Fig. 1b), while it appears even faded away on the Protaras one (Fig. 1a). Another distinctive feature is its long thin tapering left 'tail'. Additionally, the white edged tail and the white patch on the anterior portion of the head-shield are present in both colour forms. *C. fulvipunctata* is most probably a Lessepsian immigrant as its colour forms match specimens recorded in the Red *Sea* (KORETZ, 2005).

The species has a sparsely documented distribution in the Mediterranean

1959: Selimiye harbour, Antalaya, Turkey (SWENNEN, 1961).

1986**:** Ashkelon, Israel (MIENIS & GAT, 1987).

1993: Malta (PERRONE & SAMMUT, 1997).

2005: Lebanon (LAKKIS & LAKKIS, 2005).

http://www.ciesm.org/atlas/Chelidonurafulvipunctata.html

http://www.seaslugforum.net/showall/chelfulv

Family: Chromodorididae

Hypselodoris infucata (Ruppell & Leuckart, 1830)

The specimens shown in Fig. 2a are from Amathus (Limassol). This site lies a significant distance from Limassol port. The first one (Fig. 2a) was found in September 2002 moving along a sandy patch of seabed adjacent to the ancient harbour of Amathus at a depth of 4 m and at a water temperature of 25°C. Another specimen (Fig. 2b) was observed at the same site in August 2004, at a water temperature of 27°C. As seen from the photos both specimens were found on coarse sandy bottoms.

Hypselodoris infuncata is a tropical species widespread in the Indo & West Pacific regions. Additional sighting records exist from the Indian Ocean coast of South Africa, the Persian Gulf, the Arabian Sea, the Red Sea and the Mediterranean coast of Israel, Lebanon, Turkey and Cyprus (JOHNSON & VALDES, 2001; ZENETOS *et al*., 2004). This is yet another Lessepsian immigrant that appears in the eastern Mediterranean basin.

The species has a moderately documented distribution in the Mediterranean

1965: Caesarea, Israel (BARASH & DANIN, 1977 as *Glossodoris runcinata*; MIENIS & GAT, 1981; FISHELSON, 2000).

1999: Yumurtalik, Iskenderun Bay, S. Turkey (ÇEVIK & ÖZTÜRK, 2001).

2000: Fethiye, S. Turkey (AYTUR, 2003).

2000-2001: Ramkine Island, Lebanon, 4 specimens;

Beirut Harbor, Lebanon, 3-8 m, 9 specimens;

El Heri, Lebanon, 2-3 m, 2 specimens 7-10 mm;

Selaata, Lebanon, 1 specimen (VALDÉS & TEMPLADO, 2002).

2007: Zeyko Diving Site / Girne, 15 m, N. Cyprus, Mediterranean (PERSONN, 2009)

2008: Israel (HAKIM, 2008).

2010: Gulf of Antalya (OZVAROL *et al*., 2010)

Hypselodoris infucata was rarely seen in Turkish waters. It is found on, or around, sponges of the genus *Dysidea* (RUDMAN, 2003), but these sponges are mostly found in the North Aegean, Marmara and the Black Seas, which is probably too cold for *H. infucata*. Therefore the

Fig 2. Hypselodoris infucata *from Amathus (Limassol): a) 2002 sighting, b) 2004 sighting*

distribution of *H. infucata* is limited to a few locations in the Mediterranean coast of Turkey, where sponges are plentiful (RUDMAN, 2003).

http://www.seaslugforum.net/showall/hypsinfu

http://www.ciesm.org/atlas/Hypselodorisinfucata.html

Family: Chromodorididae

Chromodoris annulata (Eliot, 1904)

The specimens shown in Fig. 3 come from Dhekelia (Larnaka). The first one (Fig. 3a) was found in April 2009 at a depth of 5 m and at a water temperature of 22°C. It was observed grazing on marine plants on an abandoned submerged mooring structure. In August 2010, a second sighting was recorded at the same dive site in Dhekelia, Cyprus. A pair in mating behaviour was observed (Fig. 3b) and three separate egg masses were found. Another solitary specimen was located a few metres away. The mating pair and the egg masses support the statement that this species is now established in Cyprus.

Chromodoris annulata is a tropical species widespread in the Red Sea and the Indian Ocean. On its back, there is a clear pattern that shows two solid purple circular lines, around the rhinophores and the branchial lobe, that are not joined together. Moreover, the clearly formed yellow-orange spots denote that the specimens originate from the Red Sea.

The species has a sporadically documented distribution in the Mediterranean.

2004: Salamina Island, (Saronikos Gulf), Greece (DASKOS & ZENETOS, 2007).

2008: A single specimen *of C. annulata* was found in a rocky habitat, at 2.5 m depth in Beldibi, Antalya (GÖKOĞLU & ÖZGÜR, 2008).

2009: Iskenderun, S. Turkey (YOKES *et al*., 2009).

2008-9: A total of eleven specimens of *C. annulata* were collected at various locations from 15 June 2008 to 15 December 2009, at depths of 0-15 m (OZCAN *et al.,* 2010).

2009: Caesarea, Israel, 6 m (LAVI, 2009).

http://www.seaslugforum.net/showall/chroannu

Family: Flabellinidae

Flabellina rubrolineata

(O'Donoghue, 1929)

The specimen depicted in Fig. 4 comes from the coastal area of the town of Larnaka. Larnaka Bay is home to the second largest port in Cyprus. It was found on the wreck of Zenobia, a Ro-Ro ferry that sank 1 nautical mile off Larnaka in 1980 and now rests at depths from 42 m to 14 m. This specimen was observed in April 2008, located at a depth of 18 m and at a water temperature of 17°C. This single specimen was observed grazing among the marine plants encrusting the ship's hull. Later, during the same year (October 2008), a juvenile specimen was found at 'The Canyon', Cape Greco area, at a depth of 14 m and at a water temperature of 24°C.

In March 2009 a mating pair was spotted on the Wreck of the Zenobia at a depth of 22 m, and at a water temperature of 17°C. In April 2010 multiple spawning pairs were located

Fig. 3. Chromodoris annulata *from Dhekelia (Larnaka*): *a) 2009; b) mating pair observed in 2010*

on the wreck of the Zenobia at varying depths from 17-23 m, showing that the species is now established.

Flabellina rubrolineata is considered to be a tropical and subtropical species commonly found in the Indo-West Pacific. It is present as far south as New South Wales, Australia with many sightings from China, South Africa, the Persian Gulf, Red Sea and the Mediterranean coast of Israel, Turkey and Cyprus. It is one of the newly recorded species that can be said with certainty to have become established in the eastern Mediterranean basin.

The species has a sparsely documented dis-

Fig. 4. Flabellina rubrolineata *from Larnaka*

tribution in the Mediterranean (ZENETOS *et al*., 2004).

1988: Israel, off Ashkelon (GAT, 1993); Achziv canyon (Nahariya) (ELAYANI, 2008).

2001: Adalar, Kaas, Bodrum, Turkey : 10-20m on rocky habitats Adalar: 2001, 2002 & 2003 (YOKES & RUDMAN, 2004).

http://www.ciesm.org/atlas/Flabellinarubrolineata.html

http://www.seaslugforum.net/showall/flabrub

Family: Tethydidae

Melibe viridis Kelaart, 1858 (= *Melibe fimbriata* Alder & Hancock, 1864)

The specimen of Fig. 6 comes from Amathus (Limassol, Cyprus). It was found in August 2002 at a depth of 6 m and at a water temperature of 27°C. The first sighting of *Melibe viridis* dates back to July 2001 in the Cavo Greco area (Famagusta, Cyprus). During subsequent years

Fig. 6. Melibe viridis *from Amathus (Limassol, Cyprus)*

sightings were guaranteed during the summer months. Mating behaviour was observed and recorded. Sightings are regular along the south and south east coasts of Cyprus. Specimens are usually found to be solitary although other individuals can be regularly found in the area. They are predominantly found grazing on sandy sea beds scraping marine organisms.

Melibe viridis is a tropical species widespread across the Indo-West Pacific region. Sighting records exist from Mozambique (http://www.sealifebase.org) and the Arabian Sea (DEOMURARI, 2005).

There are numerous records from other Mediterranean areas (see references below). Based on the authors' records and photos it can be stated with certainty that *M. viridis* is an established species in Cypriot waters.

The species has an extremely well documented distribution in the Mediterranean:

1970: from the Bay of Argostoli, Cefalonia Island as Melibe sp (MOOSLEITNER, 1986)

1982: Astakos, Ionian Sea, Greece (THOMPSON & CRAMPTON, 1984).

1990 Gulf of Gabès & Djerba (CATTANEO-VIETTI *et al*., 1990)

1991: S Calabria (CROCETTA *et al.*, 2009)

1994: Milos (Paleochori Bay), Greece (KOUTSOUBAS & CINELLI, 1997)

1997: Kass, Turkey (YOKES & RUDMAN, 2004)

1998: Strait of Messina (MOJETTA, 1998); eastern Sicily (SCUDERI & RUSSO, 2003).

1999: Marine Reserve of Porto Cesareo; 2003

2001: Croatia, a large number of specimens

was observed in Stari Grad Bay, Hvar Island (DESPALATOVIĆ *et al*., 2002).

2003: near Herceg Novi, Boka Kotorska Bay, Montenegro at 8 m depth (JANČIĆ, 2004)

2003: Mar Piccolo & Mar Grande, 85 specimens on muddy bottoms (depth 4-13m) covered with dense algal beds mainly composed of *Chaetomorpha*, *Gracilaria* and *Caulerpa racemosa* (CARRIGLIO *et al*., 2004).

2006: Agios Dimitrios Saronikos, Greece (ZENETOS *et al.*, 2007).

2007: Larnaka Harbour, Cyprus, 8 m depth, on sandy and muddy bottoms. Length: approximately 20 cm (SANCHEZ VILLAREJO, 2007).

2008: Malta (BORG *et al.*, 2009).

2008: Israel Atlit former salt ponds (MIENIS, 2010).

http://www.seaslugforum.net/showall/meliviri

http://www.ciesm.org/atlas/Melibefimbriata.html

DISCUSSION

The findings of *Percnon gibbesi* (KATSANEVAKIS *et al.*, 2011) and *Scarus ghobban* Forsskål, 1775 (IOANNOU *et al.*, 2010), in addition to the latest reports in Cyprus of *Sepioteuthis lessoniana* Lesson 1830 and *Aquilonastra* (ex *Asterina*) *burtoni* Gray, 1840 (TZOMOS *et al*., 2010), *Gambierdiscus* spp. (ALIGIZAKI *et al*., 2010), *Chama aspersa* Reeve, 1846 (DELONGUEVILLE & SCAILLET, 2010), *Paradella dianae* Menzies, 1962 (KIRKIM *et al*., 2010) and *Neopseudocapitella brasiliensis* Rullier & Amoureux, 1979 (CINAR, 2005), increases the number of known alien marine species in Cyprus to 135, 44 of which are mollusca (KATSANEVAKIS *et al*., 2009). The present work presents four more alien opisthobranchs, thus increasing the number of alien molluscs to 48 species which represent 7% of the malacofauna of Cyprus and increases the total alien biota in Cyprus to 139.

The majority of these alien species are considered to have reached Cypriot shores by progressively marching their way through the Suez Canal, as their sighting records show a migration pattern beginning from the Mediterranean coast of Israel, moving north to the south coast of Turkey and Cyprus before entering the Aegean Sea and pushing westwards towards Malta and Italy. The Lessepsian migration pattern also applies for *Chromodoris annulata* whose colour pattern matches the Red Sea variety and not the Persian one as documented for the Saronikos Gulf specimen, which was presumably ship transferred (DASKOS & ZENETOS, 2007). The Lessepsian mode of introduction is also supported for the population of *C. annulata* that has become established in southern Turkey (YOKES *et al*., 2009; OZKAN *et al*., 2010).

This distribution pattern is not observed in *Melibe viridis*. According to ZENETOS *et al.* (2010), *Melibe viridis* is one of the seven species of tropical Indo-Pacific origin which are proven non-Lessepsians (whose introduction started elsewhere than on the Levantine coast and have no Suez Canal record). The Suez Canal as a pathway is not ruled out but the vector of *Melibe viridis* introduction is suspected to be ballast waters.

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Novi prilozi poznavanju alohtone faune mekušaca uzduž ciparske obale: novi stražnjoškržnjaši u ciparskoj fauni

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SAŽETAK

Nalazi nekoliko stranih vrsta stražnjoškržnjaša, prethodno nepoznatih na Cipru, potvrđuju da je širenje Indo-Pacifičkih vrsta sve izražajnije u istočnom dijelu Sredozemnog mora. U ovom radu se iznose podaci o pojavi četiri nove alohtone vrste zabilježene fotografijom tijekom vremenskog razdoblja od preko 8 godina. Zabilježene su slijedeće vrste: *Chelidonura fulvipunctata, Chromodoris annulata, Flabellina rubrolineata* i *Hypselodoris infucata.* Dodatno nalaz vrste *Melibe viridis*, koja se do tada smatrala povremenom vrstom, potvrđuje njezinu značajniju prisutnost oko Cipra.

Invazivna vrsta *Chromodoris annulata*, dosada malo poznata iz istočnog dijela Sredozemnog mora, trenutno je značajnije zastupljena uzduž ciparske obale.

Ključne riječi: alohtone vrste Opisthobranchia, *Chelidonura fulvipunctata, Hypselodoris infucata, Melibe viridis, Chromodoris annulata, Flabellina rubrolineata,* Cipar, istočno Sredozemlje