

NEW RECORDS OF INDO-PACIFIC AND ATLANTIC MOLLUSC SPECIES  
(OPISTHOBRANCHIA) IN THE EASTERN MEDITERRANEAN  
AND ADRIATIC SEA

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## ABSTRACT

We report on three Indo-Pacific opisthobranch species found during scuba diving along the south-western coast of Turkey in Kas area. One species, a nudibranch *Spurilla major* is a new addition to the alien marine fauna in the Mediterranean Sea, while sacoglossan slug *Oxynoe viridis* and nudibranch *Flabellina rubrolineata* have already been found in that area. However, *O. viridis* has not yet been included in the CIESM Atlas of Exotic Molluscs. We also report on the first record of Atlantic subtropical mollusc species, *Chelidonura africana* and a circumtropical species of a sea hare, *Aplysia dactylomela* found in the aquatory of the Island of Sušac in the Southern Adriatic Sea, Croatia. Finally, we report on an unusual aggregation of a well established lessepsian migrant *Bursatella leachii* in Strunjan salterns, Slovenia.

**Key words:** opisthobranch molluscs, lessepsian migrants, Turkey, Adriatic Sea

NUOVE SEGNALAZIONI DI MOLLUSCHI INDO-PACIFICI E ATLANTICI  
(OPISTHOBRANCHIA) NEL MEDITERRANEO ORIENTALE E NEL MARE ADRIATICO

## SINTESI

Gli autori riportano la presenza di tre specie indo-pacifiche di opistobranchi, avvistate durante immersioni lungo la costa sud-occidentale della Turchia, nell'area di Kas. Una specie di nudibranchi, *Spurilla major*, viene così ad aggiungersi alla lista della fauna marina aliena del mare Mediterraneo, mentre il sacoglossa *Oxynoe viridis* ed il nudibranch *Flabellina rubrolineata* erano già stati segnalati per quest'area. In ogni caso, la specie *O. viridis* non è stata ancora inserita nell'Atlante dei Molluschi Esotici della CIESM. L'articolo segnala pure il primo ritrovamento di una specie subtropicale atlantica, *Chelidonura africana*, e di una specie circumtropicale di anaspidei, *Aplysia dactylomela*, segnalate per le acque dell'isola di Sušac, nell'Adriatico meridionale, in Croazia. Gli autori infine discutono l'inusuale aggregazione dell'immigrante lessepsiana *Bursatella leachii*, ben stabilita nelle saline di Strunjan, in Slovenia.

**Parole chiave:** molluschi opistobranchi, immigranti lessepsiani, Turchia, mare Adriatico

## INTRODUCTION

The migration of new species from warmer neighbouring areas to the Mediterranean Sea is a steady process which started with the opening of the Suez Canal. The opened connection between the Red Sea and the Mediterranean Sea slowly enabled some of the Red Sea (Indo-Pacific) species to migrate north into the Eastern Mediterranean basin. These organisms are so called lessepsian species named after the developer of the Suez Canal Ferdinand de Lesseps.

The process has recently been speeded up by global warming which enhances the survival of subtropical and tropical species in the already warm Eastern Mediterranean and particularly in the Levantine basin which is an entry port for the species migrating from the Red Sea. Warming of the Mediterranean as a whole also enables faster spreading of newcomers further to its northern and western parts. Similar process is taking place at the opposite end, where subtropical Atlantic species are entering the Western Mediterranean through the Strait of Gibraltar. However, the migration and spreading of these organisms to the east seems to be much slower compared to those entering through the Suez Canal.

According to the last data listed in CIESM Atlas of Exotic Species in the Mediterranean (2009 for fish, 2008 for crustaceans, and 2005 for molluscs) ([www.ciesm.org/online/atlas/index.htm](http://www.ciesm.org/online/atlas/index.htm)), the immigrants from the Red Sea, the Indian Ocean or the tropical Pacific prevail by wide margins over those entering the Mediterranean Sea from the temperate, subtropical or tropical Atlantic in all studied groups. The most extreme disproportion is found within the exotic molluscs where only one species originates from the tropical Atlantic as compared to 135 species that originate from the Indo-Pacific area.

In this paper we report on the observation of the Indo-Pacific immigrant *Spurilla major*, a new species for the Mediterranean Sea, and two species already recorded at few spots along the south-western coast of Turkey, *Flabellina rubrolineata* and *Oxynoe viridis*. We also report on the first record of the Atlanto-Mediterranean species *Chelidonura africana* in the Adriatic Sea and on the first record of circumtropical sea hare species *Aplysia dactylomela* in the same aquatory. At the last update of CIESM Atlas of Exotic Molluscs, three opisthobranch species *S. major*, *O. viridis* and *A. dactylomela* have not yet been included in the atlas. Finally, we also report on an unusual aggregation of a well established lessepsian immigrant *Bursatella leachii* in the salterns of Strunjan, Slovenia.

## MATERIALS AND METHODS

New records of opisthobranch molluscs were obtained during scuba diving in Turkey (Kas) and Croatia (the Island of Sušac). Identification was done according

to the taken UW pictures by visual comparison of depicted animals in the Sea Slug forum database. They were also identified by the help of Dr Bill Rudman from Australian Museum of National History, Sydney, Australia.

## RESULTS AND DISCUSSION

## NUDIBRANCHIA

## Aeolidiidae

***Spurilla major* (Eliot, 1903)**

This species is distributed through the Indo-West Pacific and this is the first reported record of the species in the Mediterranean Sea. The picture was taken during a scuba dive at the end of October 2007 near Kas (Turkey). The specimen was found on a wreck at the depth of about 25 m close to the sea anemone *Alicia mirabilis*. The surrounding bottom was sandy. The length of the slug was about 4 cm. *S. major* belongs to the Aeolidiidae family; its members are known to feed on sea anemones and sequester their nematocysts and zooxanthellae (Rudman, 2008). This species has been reported to keep live zooxanthellae in its body and is usually dark brown. However, a bright variant of this species was described by Eliot as a variation »ornata«. It seems that this is the case of the recorded specimen, which is bright probably due to the lack of zooxanthellae in its tissues. This may also reflect the lack of proper food. In the ceras just behind the rinophores, a dull brown ducts with short branches are visible. These are more or less empty digestive glands and their shortened side branches indicate the animal had not fed on sea anemones harbouring zooxanthellae for a while. The location of the slug near the sea anemone might be a sign of the slug seeking for appropriate food not easily found in the new environment. *S. major* is considered rare also in the Red Sea and the specimens from the Red Sea show the same type of coloration as compared to those from the Mediterranean Sea. This links both populations, reveals the probable Red Sea origin of the Mediterranean population and points to the similar diet of these slugs in both seas.

## NUDIBRANCHIA

## Flabellinidae

***Flabellina rubrolineata* (O'Donoghue, 1929)**

First record of the Indo-Pacific species *F. rubrolineata* in the Mediterranean Sea dates from 1988 in the aquatory of Aschelon, Israel (Gat, 1993). Since then several isolated records of this species have been obtained, mainly from Israel (Elayani, 2008) and the southern coast of Turkey (Yokes, 2001; Buyukbaykal, 2003; Bejjes, 2008). The reported specimens measured from 1.5 to 4 cm and were found at the depth from 5 to 30 m. We report on the specimen found in the area of Kas (Turkey). The specimen measured about 4 cm in length

and was crawling and possibly feeding on hydrozoans colony at the depth of 10 m. Recent observations show that *F. rubrolineata* is obviously a well established species with small but stable population in the southwestern Turkey. Mating and spawning were reported from localities near Bogzak and Antalya (Yokes, 2002a; Cox, 2007). *F. rubrolineata* obviously feeds on hydrozoans colonies *Eudedrium* sp. and *Halocordyle* sp. (Yokes, 2002a).

## SACOGLOSSA

## Oxynoidae

***Oxynoe viridis* (Pease, 1861)**

The sacoglossan sea slug *Oxynoe viridis* was already reported in Antalya (Turkey) as the newest lessepsian addition to the Mediterranean fauna (Yokes & Rudman, 2004), but it has not yet been listed in the CIESM Atlas of Exotic Molluscs. We report on several *O. viridis* specimens that were found in October 2007 near Kas (Turkey) at the depth of about 25 m. They measured more than 5 cm and were crawling on the sea bottom overgrown with alien alga *Caulerpa racemosa*. The snails were obviously feeding on the alga which is their favourite food. They were also reported to feed on the Mediterranean native species *C. prolifera* (Yokes, 2002b). The coloration of the Mediterranean population of *O. viridis* is typical for snails found in the western Indian Ocean (*i.e.*, Somalia, the Red Sea). They are greenish yellow with bright blue spots over the entire body. The fact that *O. viridis* feeds on invasive *Caulerpa* makes this slug interesting for biological control of the invasive *Caulerpa* species in the Mediterranean Sea. However, we have to be aware that previous attempts to control the spreading of a related alga *C. taxifolia* by means of biological control using sea slugs failed and actually helped in spreading the alga (Žuljević *et al.*, 2001).

## CEPHALASPIDEA

## Aglajidae

***Chelidonura africana* Pruvot-Fol, 1953**

This little known Atlantic cephalaspidean species was also described under the synonym *C. italica* for juvenile specimens from the Tyrrhenian Sea (Sordi, 1980; Martinez *et al.*, 2002). The specimens from Florida, the Bahamas and the Caribbean described under the names *C. berolina* or *C. cubana* might also belong to *C. africana* (Rudman, 2004). *C. africana* is a small slug measuring about 1–2 cm. In the Mediterranean it seems to be more common in the Alboran Sea close to the strait of Gibraltar which points to its Atlantic origin. We report on the first record of *C. africana* in the Adriatic Sea, so far also its easternmost Mediterranean location. In July 2006, a 1 cm long slug was spotted during a scuba dive off the island of Sušac (Croatia), on the coralline bottom at the depth of about 15 m. Its coloration was very similar to the one originally described by Pruvot-Fol

(1953) for the specimen from the Atlantic coast of Morocco. Hardly anything is known about the biology and ecology of this elusive species. As all aglajids, it probably preys on other molluscs or polychaets.

## ANASPIDEA

## Aplysiidae

***Aplysia dactylomela* Rang, 1828**

The distribution of this species is circumglobal and it can be found in tropical and warm temperate waters. The first Mediterranean record (2002) of this species comes from the Island of Lampedusa which is located in the central area of the Mediterranean Sea (Trainito, 2003). All later records are from the eastern part, mainly from various locations in Turkey, Greece and Cyprus (Cooke, 2005; David, 2005; Sterniuk-Gronek, 2005; Çinar *et al.*, 2006; Yokes, 2006). However, judged from the coloration of the recorded specimens they are more similar to those from the Atlantic Ocean than those from the Indo-Pacific. On the other hand, the fact that this is a large species (up to 25 cm) inhabiting shallow waters, its entrance through the Strait of Gibraltar would hardly be overlooked. At present it is not clear what is the origin of its migration to the Mediterranean, therefore *A. dactylomela* could be a lessepsian or/and an Atlantic immigrant. The species has not yet been listed in the CIESM Atlas of Exotic Molluscs. We report on the first record of *A. dactylomela* in the Adriatic Sea which is at present also its most northern Mediterranean location. The picture of this slug was taken in summer 2006 during a scuba dive off the shore of the island of Sušac (Croatia), at the depth of about 10 m. The rocky bottom, where the slug was found, was overgrown with alien alga *Caulerpa racemosa*. The snail was crawling amidst the *C. racemosa*, but there was no evidence of feeding on them. *A. dactylomela* are known to feed on different algae and in the Mediterranean it was reported to graze on red alga *Laurencia* sp. (Yokes, 2006).

## ANASPIDEA

## Aplysiidae

***Bursatella leachii* De Blainville, 1817**

This species is one of the first lessepsian invertebrate migrants recorded in the Mediterranean Sea. The very first record dates from Palestine (O'Donoghue & White, 1940). Today, this species has well established populations from Levantine coasts up to large parts of Turkish and Greek coastlines, Sicily, Southern Italy and Tunis and is obviously successfully spreading further to the west and north. At present its westernmost location is the north-eastern coast of Spain (Weitzmann, 2010), and at its northernmost distribution it could be found in the Venetian lagoons (CIESM Atlas of Exotic Molluscs). In the northern Adriatic *B. leachii* has previously been reported from the Gulf of Trieste area (Aurisina) (Jaklin & Vio, 1989) and from Slovenian coast where individual



**Fig. 1 / Sl. 1:** *Spurilla major* (Kas, Turkey) / (Kas, Turčija).



**Fig. 2 / Sl. 2:** *Flabellina rubrolineata* (Kas, Turkey) / (Kas, Turčija).



**Fig. 3 / Sl. 3:** *Oxynoe viridis* (Kas, Turkey) / (Kas, Turčija).



**Fig. 4 / Sl. 4:** *Chelidonura africana* (the island of Sušac, Croatia) / (otok Sušac, Hrvatska).



**Fig. 5 / Sl. 5:** *Aplysia dactylomela* (the island of Sušac, Croatia) / (otok Sušac, Hrvatska).



**Fig. 6 / Sl. 6:** *Bursatella leachii* (Strunjan salterns, Slovenia) / (Strunjanske soline, Slovenija).

sightings have been reported on several occasions since the first record in 2001. Larger aggregations of this species have been reported in Strunjan salterns by Lipej *et al.* (2008). In this paper, a winter record of *B. leachii* was also reported, which indicates that *B. leachii* is now adapted to survive even harsh winter conditions in the Gulf of Trieste, where sea water temperature during winter often drops below 10° C.

When a tropical species is exposed to such extreme conditions, the survival strategy obviously includes behaviour adaptations reported in the present article. In early autumn (7 October 2007), a large number of *B. leachii* was observed and photographed in the salterns basins in Strunjan (Slovenia). A large group of individuals aggregated there probably seeking shallow water which was warmer than open sea water. However, other factors cannot be excluded, *i.e.*, temporary availability of certain food that attracted larger number of individuals or even a mating behaviour although egg strings were not observed in the reported location.

## CONCLUSION

Among newcomers, Opisthobranch molluscs are not very common migrants into the Mediterranean Sea. The CIESM Atlas of Exotic Molluscs lists only 21 such species and only 7 of those have well established population, mostly in the Levantine basin. The rest are rare and have been so far found only in one or few locations. We can speculate that the reason for a relatively small number of immigrant species within the opisthobranch molluscs is due to their picky eating preferences. Many opisthobranch molluscs rely on specific food which cannot be found in the new environment, therefore only those with more generalistic feeding habits may find suitable food, survive and establish new and stable populations. Nevertheless, new species of opisthobranch molluscs have been discovered recently, and new locations and larger populations of already recorded alien species have been confirmed. Our paper is a small contribution to the knowledge of new and alien species of opisthobranch fauna in the Mediterranean Sea.

## NOVI PODATKI O INDO-PACIFIŠKIH IN ATLANTSKIH VRSTAH ZAŠKRGARJEV (OPISTHOBRANCHIA) V VZHODNEM SREDOZEMLJU IN JADRANSKEM MORJU

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### POVZETEK

Avtor poroča o treh indo-pacifiških vrstah zaškrigarjev, najdenih med potapljanjem ob jugozahodni obali Turčije, v predelu Kas. Ena od vrst, gološkrigar *Spurilla major*, predstavlja novo tujerodno morsko vrsto v Sredozemskem morju, medtem ko sta bila zeleni strgalec *Oxynoe viridis* in gološkrigar *Flabellina rubrolineata* že opažena na tem območju, čeprav zeleni strgalec *Oxynoe viridis* še ni vpisan v CIESM Atlas eksotičnih vrst mehkužcev. Članek posreduje tudi prve podatke o atlantski subtropski vrsti mehkužca *Chelidonura africana* in pegastem morskem zajčku *Aplysia dactylomela*, najdenih v akvatoriju otoka Sušca v južnem Jadranskem morju, Hrvaška. Poročilo vsebuje tudi opis nenavadne združbe že uveljavljene lesepske selivke *Bursatella leachii* v Strunjanskih solinah, Slovenija.

**Ključne besede:** zaškrigarji, lesepske selivke, Turčija, Jadransko morje

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