

# New Distributional Records of Four Indo-Pacific Species from Astypalaia Island, South Aegean Sea, Greece

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**Abstract:** During in situ investigation carried out in July and August 2016 and 2017 successively by the authors in Astypalaia (South Aegean, Greece) the following alien species were recorded: (1) a colony of epibyssal pteriid *Isognomon australica* (Reeve, 1858) in shallow water under rocks, (2) two specimens of *Isognomon legumen* (Gmelin, 1791), (3) a live group of Indo-Pacific triphorid *Viriola cf. bayani* (Jousseume, 1884), trawled at a depth of 35-50 m, and (4) a freshly dead specimen of *Euthymella colzumensis* (Jousseume, 1898) also trawled at a depth of 35-50 m. A comparative study of collected material using type data, resulted in their identification and recording as Indo-Pacific newcomers to Greek waters. Moreover, it led to a first Mediterranean record for *I. australica* and *E. colzumensis*. These occurrences considerably far from the mouth of the Suez Canal support the assumption that a combination of conditions consisting an "Invasion window" converge in Astypalaia and favour the successful establishment of alien species not necessarily following the patterns of Lessepsian Migration.

## Introduction

The main island of Astypalaia, with a number of adjacent islets form a small complex positioned between the Dodecanese and the Cyclades in the centre of the Southern Aegean Sea. The island's lace-like coastline with coves and canals and its subtropical waters, though far from the mainland seem to favour the establishment of alien species expected to spread westwards to the rest of the Mediterranean. The present rather unexpected records draw interest to the study of conditions and vectors that make possible alien invasions (Carlton, 1996) in the east Mediterranean basin that are not explained by the Lessepsian Migration pattern alone. Four new alien species are

recorded and described in this paper; their identification was quite difficult involving examination of original descriptions in old literature and type material of Indo-Pacific mollusc genera that are not yet adequately studied. A morphological approach for their identification was only possible because existing type material is not biologically described. Nevertheless, we managed to make three new taxonomic identifications recorded for the first time from Mediterranean waters and a fourth one which is a first record for Greek waters.

## First Mediterranean record of the epibyssal pteriid *Isognomon australica* (Reeve, 1858).

## Systematics

Family: Pteriidae Gray, (1847-1820)

Genus: *Isognomon* (Lightfoot, 1786)

*Isognomon australica* (Reeve, 1858) Fig. 1

## Introduction

Bivalves of genus *Isognomon* are widely spread in the intertidal zones of the tropics and the subtropics. They have nacreous interior and highly irregular shapes. They are related to pearl oysters but recent molecular phylogeny studies have shown that they belong to the family Pteriidae (Temkin, 2010). Genus *Isognomon* (Lightfoot, 1786) is easily distinguished from the rest of Pterioidea by its multivincular ligament (Stenzel, 1971). The most recent assessment recognized fifteen valid species (Huber, 2010). Four of them (*I. australica*, *I. isognomum*, *I. legumen*, *I. nucleus*) were officially recorded from the Red Sea. *I. ephippium* is recorded from Israel (Mienis, 2004) as a non-Eritrean Indo-Pacific immigrant. *I. legumen* is also recorded from the Mediterranean (Mienis et al., 2016). *Isognomon australica* (Reeve, 1858) is recorded from the Red Sea by Vine, P. (1986). There is no other more recent documented record of distribution.

## Material and methods

Numerous specimens in various stages of growth were observed in the same area of Astypalaia Island during two successive visits in summer of 2016 and 2017. This interesting occurrence forming a small established colony was discovered in shallow water attached on the underside of rocks. All individuals were pleurothetically attached by their byssuses in smooth depressions of rather bare and hard substrata in a little cove, protected from wave activity. A total of 12 live individuals of different sizes and shapes were hand-collected by the authors, and some of them were preserved in alcohol for further examination. During the first visit only juvenile specimens were observed of an approximate size of 10x16mm whereas during the second visit, a year later, adult individuals measuring up to 45mm were discovered.

**Locality:** Kounoupi Islet, Astypalaia. Coord. N 36,531331°, E 26,466363°



Fig.1: Astypalaia complex, shape and position of the island on major Shipping Routes offers shelter to introduced marine life. Arrows indicate material collection points and brush mark the area of the trawled material.

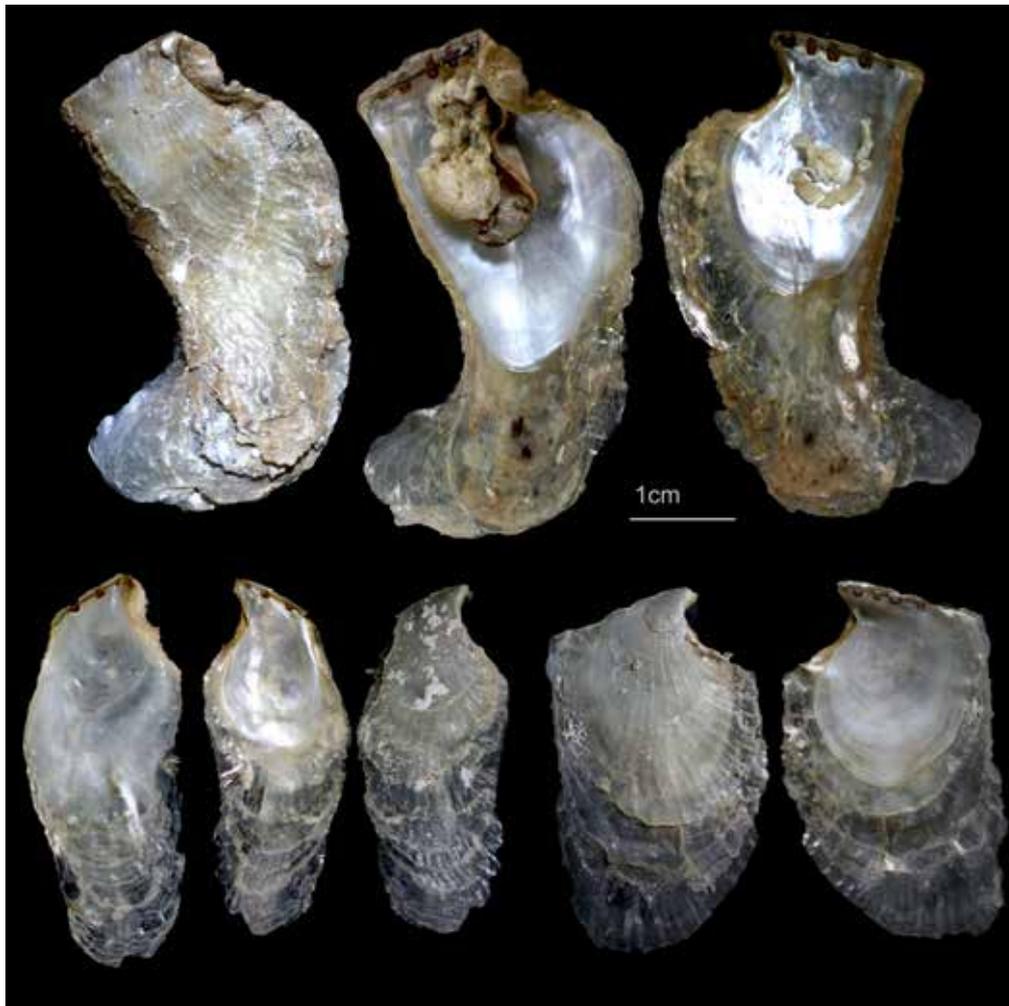


Fig 2. *Isognomon australica* (Reeve, 1858), 3 specimens from Astypalaia

### Description

Medium size, thin, semi-transparent, anomia like, shell with highly irregular shape following the shape of its habitat. Colour is whitish in juvenile specimens and light yellow in adult ones. Interior of both valves is nacreous followed by a wide fringe of a non-nacreous shell extension irregularly developed. Muscular scar is separate. Rudely laminated with laminae compressed together so as to be almost obsolete. The external surface of both valves is similar in texture with blister-like weak radial lines on the laminae. The ligament is multivincular with 4 to 5 pits relatively widely spanned. Valves are unequal to form the byssal opening. Byssus is formed by thin threads.

### Remarks

The original description of *I. australica* was made by Reeve under two species: *Perna anomiooides* and *Perna australica*. Today both are accepted (WORMS) as synonyms to *Isognomon australica* (Reeve, 1858). *Perna anomiooides* is described originally as “the *Anomia*-like *Perna*”: Shell obliquely longitudinal, thin rather transparent, concentrically peculiarly fimbriately laminated; yellowish white. Hab. California. A delicate yellowish white semitransparent shell, in which the concentric laminae are curiously fimbriated (fringed) in a blistered-like manner. The *Perna australica* is described originally as “the Australian *Perna*”: Shell obliquely fan-shaped, thin, rather transparent, densely irregularly rayed with serrated superficial ridges; reddish white. Hab. Australia. Broadly obliquely fan shaped, of thin transparent substance, peculiarly sculptured with irregularly flexuous delicately serrated superficial ridges.

The combination of the above descriptions together with their illustrations in Vol. 11 of *Conchologia Iconica* (Reeve, 1858) form the “lectotype” of the species used for its identification. Collected material was also compared to photos retrieved from Wikimedia Commons on the Internet<sup>1</sup>. The dichotomic characters of the superficial ridges or fringes (fimbriated) together with the thinness of this anomia-like isognomoniid present in all descriptions, securely led to the identification of the Astypalaia specimens as *Isognomon australica* (Reeve, 1858).

The re-examination of juvenile specimens (Fig. 3), collected in the same locality in Astypalaia in 2016 as the adult ones the following year, does not leave any doubt that they belong to the *I. australica* species, and that they were misidentified as *Malleus regula* (Forsskål in Niebuhr, 1775) by the author Angelidis in Lipej et al. (2017). Indeed the existence of radial ribs, the thinness and transparency of the shell and the development of the multivincular ligament in proportion to the overall size, let us conclude with safety that these juvenile specimens (Fig.3), cannot belong to the smaller and more solid species of *I. legumen* as claimed by (Crocchetta et al. 2017). For the same reason we believe that the specimen photos published by Micali et al. (2017) as *I. legumen* also belong to *I. australica* species.

1 <https://commons.wikimedia.org/w/index.php?search=isognomon+austrlica&title=Special:Search&fulltext=1&searchToken=68q62knds8pdazdwclnua4y0r>.



Fig.3 Juvenile *I. australica* specimens from Astypalaia (14-16X10-11mm) (Lipej et al. 2017)

***Isognomon legumen* (Gmelin, 1791)** The small Indo-Pacific crevice dweller is a newcomer to Greek waters

**Locality:** Kounoupi Islet, Astypalaia. Coord. N 36,531704°, E 26,470238°

**Systematics**

Family: Pteriidae Gray, 1847(1820)

Genus: *Isognomon* (Lightfoot, 1786)

***Isognomon legumen* (Gmelin, 1791) Figs. 4 and 5**

**Description**

Shell small and solid, conspicuously concentrically laminated with laminae loosely overlapping at narrow increments. Multivincular ligament with 6 pits at 7mm. Shape erratic, rather oblong. Colour is variable from brown to yellowish. Interior is nacreous. Muscular scar in *I. Legumen* (Fig. 5) coalesces.



Fig. 4 Adult specimen of *Isognomon legumen* (Gmelin, 1791) from Astypalaia



Fig. 5 Adult specimen of *isognomon legumen* (Gmelin, 1791) from Astypalaia. Muscle scar is screened.

**Introduction**

*I. legumen* is a widely distributed epibyssal isognomonid and a relatively common dweller of the intertidal zone, from the Red Sea to the Pacific Ocean. This species inhabits narrow crevices and depressions on the undersides of rocks and is one of the smallest members of the Isognomonidae family. The species' first Mediterranean occurrence was recently recorded from Israel (Mienis et al. 2016).

**Material and methods**

Two adult specimens measuring 12 x 16mm and 11 x 16mm were found in bioclastic sand samples taken from a depth of 4 m. One of them was empty (Fig. 5) and the other had died recently and the animal was still inside.

**Remarks**

The original description of shell characters for this taxon was particularly problematic because seemingly obvious descriptive features, such as the outline of the shell margin, obliquity, the extent of the auricles, and various aspects of shell shape and colour, do not constitute discrete, easily diagnosable non-independent characters (Temkin, 2006). It is indicative that Reeve (1858) describes four different species in his monograph of the genus *Perna* that shortly after Cooke (1860) states as the same species that today is accepted as *Isognomon legumen*. This species differs from the rest of the genus being solid, small, with a surface that is very roughly flaked on both valves following concentric lines and with coalesce muscle scar (Iredale, 1939). Astypalaia specimens were identified as adult *I. Legumen*, possessing all the characters mentioned above. The first record of *I. legumen* for the Greek waters made by (Micali

et al. 2017) is doubtful because the figured specimens present the character of weak radial lines only present in *I. australica* juveniles. (Fig. 3)

### Establishment record of a *Viriola* cf. *bayani* population from Astypalaia, South Aegean Sea

#### Systematics

Family: Triphoridae Gray, 1847;

Genus: *Viriola* (Jousseume, 1884)

***Viriola* cf. *Bayani* (Jousseume, 1884) Fig. 6**

#### Introduction

*Viriolas* are Indo-Pacific triferids very recently recorded in the Mediterranean Sea (Micali et al. 2017). Genus *Viriola* (Jousseume, 1884) was described on the basis of its unique character of smooth spiral cords of the teleoconch unlike the rest of the Triphoridae Genera that present nodulous ones. The first description of species referred later as belonging the genus *Viriola* (mollusca triphoridae) was made by Hinds R. B., in 1844, before the genus was described by Jousseume in 1884. There are 27 known species belonging to the genus *Viriola*, all of them, Indo-Pacific and Tropical Eastern Pacific inhabitants. Seven species, namely *Viriola tricineta* (Dunker, 1882); *Viriola cancellata* (Hinds, 1843); *Viriola corrugata* (Hinds, 1843); *Viriola incisa* (Pease, 1861); *Viriola morychus* (Jousseume, 1898); *Viriola senafirensis* (Sturany, 1903); and *Viriola trilirata* (Deshayes, 1863) are recorded in the Red Sea (Dekker & Orlin, 2000). As Marshall (1984), states the *Viriola* genus must await more study especially from the regions where it is mostly distributed. Taxonomic evaluation cannot be precise due to the existence of many similar species including undescribed ones that are poorly known and possibly require revision. Micali et al. (2017) ascribed his recent findings in Karpathos to *V. corrugata* taxon, recording the *Viriola* genus for the first time in the Mediterranean Sea, we tend to believe that this is a misidentification only for the species. *Viriola bayani* was the species used to describe the *Viriola* genus. Its original description by (Jousseume, 1884)<sup>2</sup> is based on a specimen lacking

2 *V. bayani* description by Jousseume, 1884 (translated from French)

Solid shell, long and pointed, narrow, elegantly attenuated from bottom to the top, brown-reddish with some grey reflections, surface with protruding smooth keels separated by furrows finely vertically corded. The specimen that we possess is truncated so that there are only 23 flattened turns left, separated by a well-defined linear suture that is boarded by a thin and rounded string. There are 3 protruding and a little acute keels in each turn, the middle one is smaller than the others and disappears near the top of the spire. The last turn is compressed at the base and a little angular in the periphery, it has five keels, four of them on the external face of the turn and one on the base. Under the base a smooth deep furrow slightly strangulates the base of the siphonal channel. The aperture is rhomboid and striped interiorly by brown and white lines. The columellar margin is slightly lifted, rather thick, smooth and shiny and yellowish brown, it welds with the channel's margin forming a whitish gibbosity in the interior of the aperture. The exterior lip is slightly crenelated and welds to the back on the keel of the before-last turn to form a slightly deep rip. The channel is long, almost straight with contiguous lips; its base is surrounded by a low cord while a second cord less

protoconch, but is thorough and accurate. Since then, there is poor evidence of this taxon in literature and documentation.

#### Material and methods

A total of 12 specimens trawled as a group together with bioclastic coralligenous material at a depth of 35-50 m (8/2017), one more specimen and a rather significant fragment, found in bioclastic sand samples from a depth of 6 to 8 m (8/2016). All trawled specimens were freshly dead and had perfectly preserved protoconchs and apexes. Two adult specimens were considerably different in overall size. An operculum was retrieved from one of the specimens.

**Locality:** South-east Astypalaia waters sheltered from north currents and prevailing winds, for the trawled specimens; Koutsomitis Islet for the bioclastic sampling specimens (Fig. 1)

#### Description

Slender and solid sinistral shell, conical with a mean l/w ratio: 4.4. (Fig. 6)

Planctonotrophic protoconch with 5.25 whorls, first whorl is dome-shaped with hemispherical granules, ranging in size from 145 to 155 µm, the rest 4 whorls with axial threads, 2nd and 3rd whorl monocarinated, 4th and 5th bi-carinated. The teleoconch has an elegant axial sculpture with whorls presenting two prominent spiral keels smooth and of rounded profile. A 3rd intermediary weaker keel, slightly undulate is developed after the 3rd whorl. Keels are separated by dark coloured furrows with weak axial costae. Suture is distinct with a fine sutural cord of lighter colour developing after the 3rd whorl. Colour is dark brown in the furrows and whitish on the keels with some overall grey reflections. Body whorl with four spiral cords and two more that start to develop between the 2nd-3rd and the 3rd-4th main cords in the adult specimens. The base is compressed with one spiral cord in specimens with 16 whorls and a second in specimens with 18 whorls. The exterior lip is slightly crenulated and welds to the back on the keel of the before-last whorl to form a slightly deep rip. The columellar margin is slightly lifted, rather thick, smooth and shiny; it welds with the channel's margin forming a gibbosity in the interior of the aperture. The aperture is rhomboid and striped interiorly by brown and white lines. The channel is long almost straight with contiguous lips. Operculum excentrally developed.

#### Remarks

Considering existing literature and available type data we conclude in ascribing the Astypalaia specimens to the *Viriola* cf. *bayani* (Jousseume, 1884) species. The other possible species to identify, *Viriola corrugata* (Hinds, 1843) was excluded after comparison of the specimens with syntype photos of both species. (Fig. 7). Despite the facts that *V. bayani* is not yet recorded from the Red Sea and that *V. corrugata* is accepted as an extremely variable species (Marshall, 1984) similarities to the first taxon were clearly evident. The main characters giving access to the species' identity are colour pattern, width to height ratio, existence of sutural cord and rounded profile of keels (Fig. 6 and Fig. 7). Length to width ratio in particular

accentuated is placed on the middle part. This species differs from *Cerithium comaum* (Montrouzier 1835) by its narrow shape and the difference in colour between its keels and its furrows

Fig. 6: *Viriola* cf. *bayani* (Jous-seaume, 1884) adult specimen from Astypalaia.

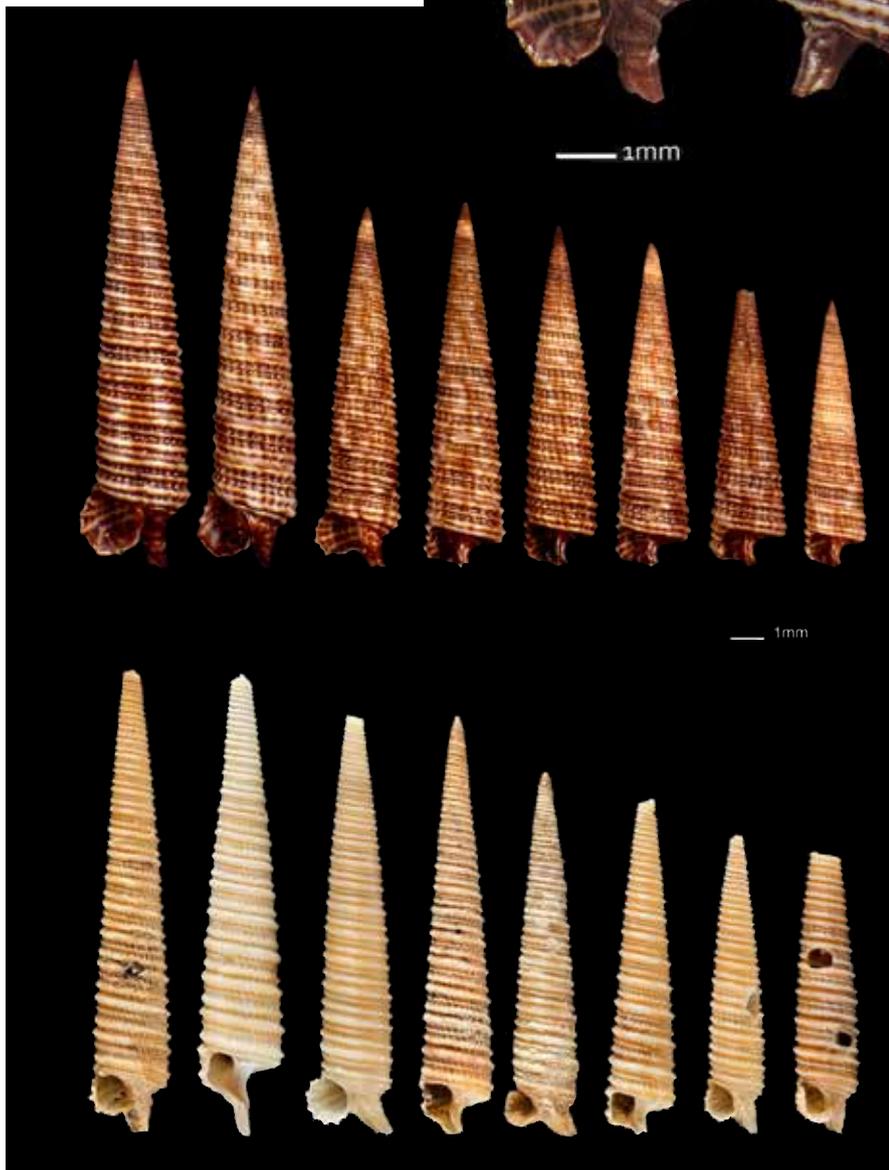
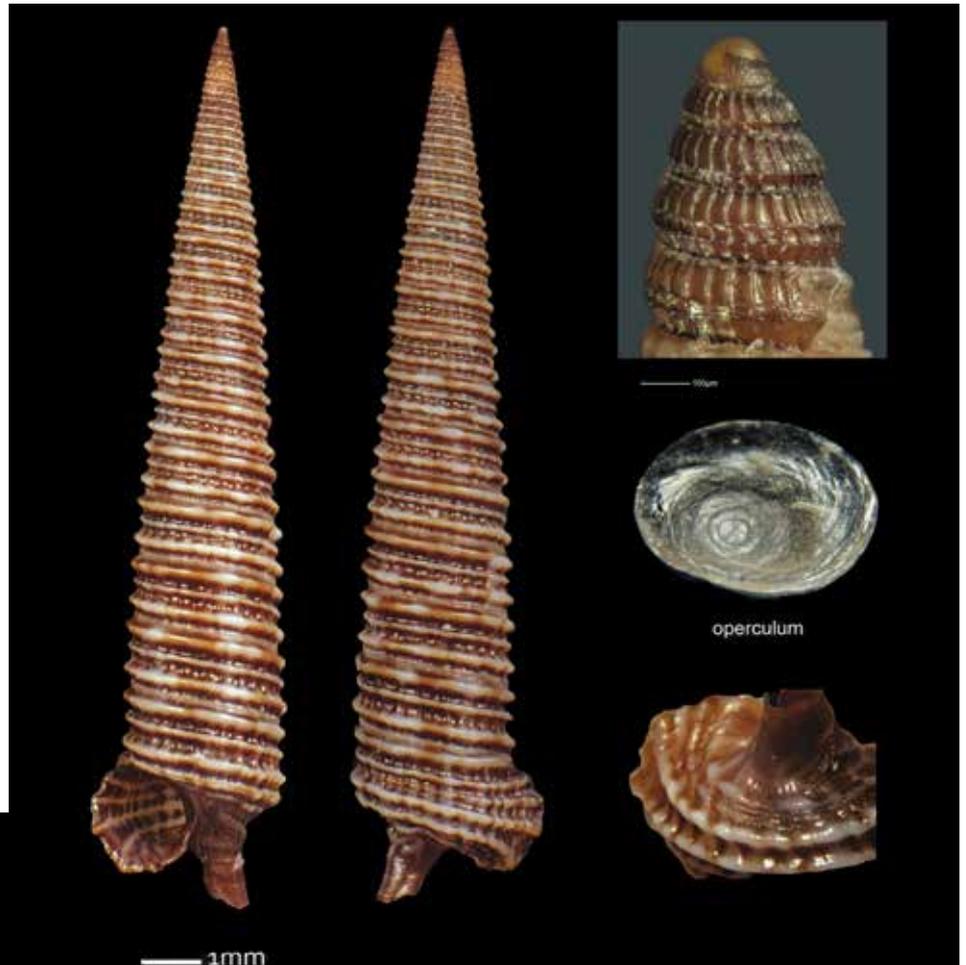


Fig. 7 Top : *Viriola* cf. *bayani* (Jous-seaume, 1884) population from Astypalaia.

Bottom: *Viriola corrugata* (Hinds, 1843) syntypes.

*V. corrugata* images are copyright of the Natural History Museum of London , taken by Kevin Webb, NHMUK Photographic Unit.

which was found to be 4.4 in *Astypalaia* specimens was very different in the more slender *V. corrugata* syntypes from BMNH (mean value 5.6). (Fig.7). The number and condition of the collected gastropods (Fig.7) indicate establishment of this taxon in *Astypalaia*.

**First Mediterranean record of an Eritrean Triphorid from *Astypalaia***

**Systematics**

Family: Triphoridae Gray, 1847,  
Genus: *Euthymella* (Thiele, 1929)

***Euthymella colzumensis* (Jousseau, 1898) Fig. 8**

**Introduction**

*Euthymella colzumensis* was first described by Jousseau in 1898, from the Red Sea (Suez and Jibuti). It is very variable in size and its main dichotomic character is the elongated granules of its spiral cords.<sup>3</sup>

*Euthymella colzumensis* is easily identifiable but poorly documented so far and its worldwide distribution remains fairly unknown.

**Material and methods**

One freshly dead specimen 10.9 x 2.4 mm in excellent condition trawled at a depth of 35-50 m together with coralligenous material.

In the same material the *Viriola* cf. *bayani* specimens described above were found.

**Locality:** South-east *Astypalaia* waters (Fig. 1)

**Description**

Shell sinistral, narrowly conical 10.9 x 2.4 mm of 15 whorls. Colour of protoconch yellowish brown. Teleoconch hyaline, pale yellow with light brown background. The 3<sup>rd</sup> cord appears lighter in colour than the 1<sup>st</sup> and 2<sup>nd</sup>.

Protoconch multispiral of 4<sup>1/2</sup> whorls, 400 µm in diameter. The first whorl is 160 µm, sculptured with hemispherical granules.

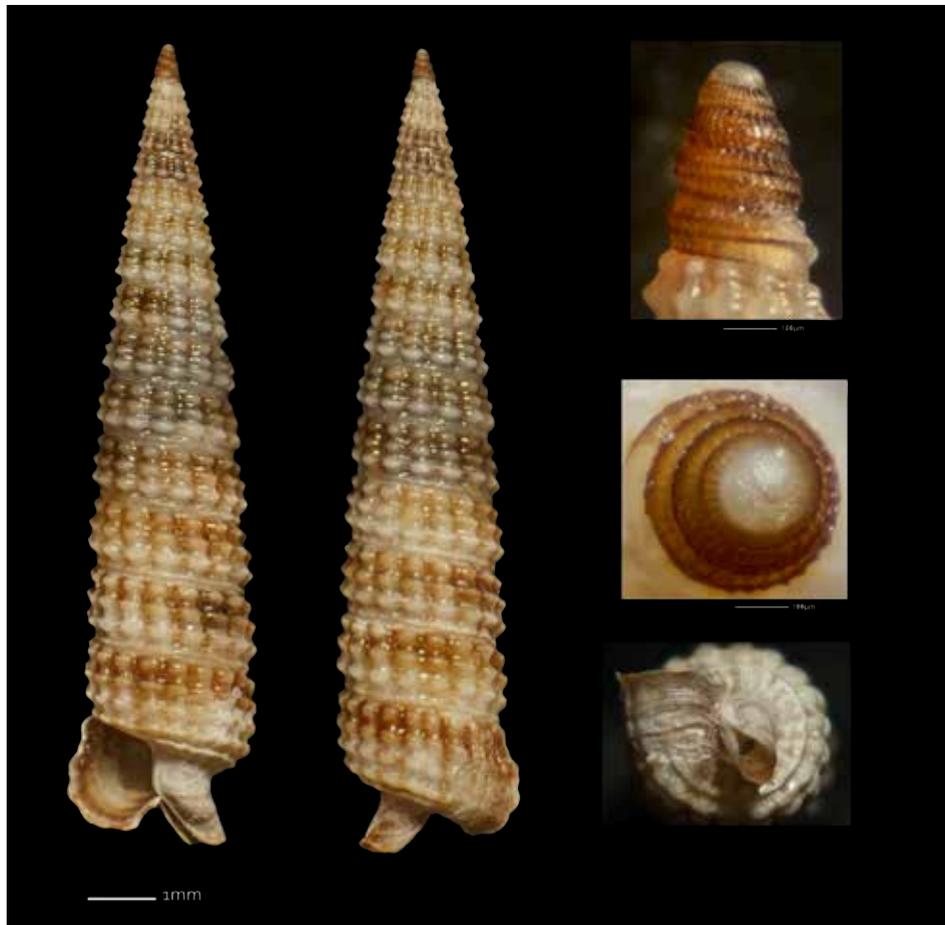


Fig. 8 : *Euthymella colzumensis* (Jousseau, 1898) from *Astypalaia*

3 *Euthymella colzumensis* (Jousseau, 1898) - the original description translated from Latin is as follows: "Solid shell, conical and slender, light brown, teleoconch whorls with three granulated spiral cords. Spiral cord granules elongated and longitudinally arranged in opposing series. 13-14 whorls normally developing. The first whitish to be followed by light brown ones. Distinct channelled suture. Last whorl attenuated with 5 granulated and corrugated cords, subsircular opening with lateral fissure. Chanel long and bended backwards. Length 7mm, diameter 1 to 7mm."

The subsequent whorls have 2 strong keels (bicarinate) with axial riblets that produce a cancellate appearance. The teleoconch consists of 15 whorls, each one with 4 spiral cords, low rounded axial costae and no microsculpture. Suture shallow. The first 3 cords are nodular and the 4<sup>th</sup> subsutural almost smooth. Cord 2 appears later than 1 and 3. The nodules are characteristically flattened in the transverse axis. Cords 1 and 2 are similar in height while the 3<sup>rd</sup> is higher which angulates the whorl. The body whorl has 4 nodular spiral cords and one undulate cord

on the base. Aperture ovate. Siphonal canal bended backwards.

### Remarks

The shell's perfect condition permits its secure identification. All the diagnostic criteria of its original description by Jousseume were fulfilled.

It also presents the characteristics for the genus described in the review of Triphoridae by Marshall, 1984. We also had the opportunity to compare our specimen with high resolution images of syntypes from the museum Collection which were kindly provided to us by the MNHN that led to the same conclusion. It is obvious though, that more specimens have to be discovered to safely assume its establishment in the region.

### DISCUSSION

Our research conducted in two successive years, which showed the recent establishment of 4 alien species in Astypalaia, draws attention to the combination of conditions that constitute an "invasion window" (Carlton, 1996) on the island. Considering the commercial shipping and "open sea ballast water discharging" as the main vector (Flagella & Abdulla, 2005) of invasions in the area we can assume that the Red Sea is not the only donor region for this area. The Persian Gulf and a number of African ports may also directly donate invasive biogenic material to the Astypalaia recipient region. Astypalaia's hydrography and its position on the main shipping route connecting the Indian Ocean across the Suez Canal with the port of Eleusis and the Black Sea ports, make it very possible that ballast water discharges from passing ships often affect its coastline dispersing larvae in the open sea at a short distance from the coast, especially after the 2004 direction for off-port discharging. Migration of Indo-Pacific species that are not Eritrean may also be explained by various ways of transportation of epibions such as ship hauls or diverse floating material (Mienis, 2004). The survival and establishment of the taxons recorded in this paper in the particular time and space, await more study concerning the conditions (climatic change, sea currents, etc.) that made them possible. In the case of this island we believe many interesting conclusions can be drawn.

### ACKNOWLEDGEMENTS

For the needs of the taxonomic evaluation in our study, syntype photos of *Viriola corrugata* (Hinds, 1843) were kindly forwarded to us from the Natural History Museum of London, taken by Kevin Webb, NHMUK Photographic Unit. We are grateful for this collaboration.

We would also like to thank the MNHN in the person of Virginie Heros, for her care to provide us syntype images for *Euthymella colzumensis* (Jousseume, 1898) and *Viriola bayani* (Jousseume, 1884) necessary for our study.

We would also like to thank Prof. Bruce A. Marshall of the New Zealand Museum for his kind response to our communication and his expert opinions.

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