New gastropod records for the Eastern Mediterranean Sea and one new alien (Emarginula decorata Deshayes, 1863) for the Mediterranean Sea from NW Aegean Sea, Greece

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Abstract

Background: The NW Aegean Sea has a complex topography, high quality waters, oligotrophic to eutrophic conditions, is connected with estuaries and wetlands, is of high ecological interest, harbours all the types of human activities and yet few researchers work on its marine biodiversity. With this study, the contribution to the knowledge of the Hellenic and Eastern Mediterranean gastropod biodiversity of the studied families is continued, and an expansion of the search in other substrates and deeper waters of the NW Aegean Sea with emphasis on the minor in size species during the period from October 2008 to January 2014.

Results: Thirty seven species belonging to seven families (Cerithiopsidae, Fissurellidae, Phasianellidae, Scissurellidae, Siliquariidae, Skeneidae, and Triphoridae) were identified and their biodiversity was compared with the current checklists of marine gastropod molluscs for the Hellenic Seas based on previous surveys. In this collection of gastropods, one species (Emarginula decorata Deshayes, 1863) is a new alien for the Mediterranean Sea, 14 species are new for the Eastern Mediterranean Sea and 16 species are new for the Hellenic fauna (with the one above mentioned alien species included). The main identification characteristics and ecological information such as habitat, distribution, alien expansion paths to the NW Aegean Sea and origin of the species are given and discussed.

Conclusions: The Hellenic gastropod biodiversity of the studied families was enriched with 37 new records for the N Aegean Sea, out of which 16 are new for Greece, 14 are new for the Eastern Mediterranean Sea while one (Emarginula decorata) is a new alien for the Mediterranean Sea.

Keywords: Aegean Sea, Alien species, Biodiversity, Gastropods, Mediterranean Sea, Greece

Background

The N Aegean Sea comprises a marginal sea that connects the Eastern Mediterranean basin with the Black Sea through the Dardanelles Strait. Its North West (NW) area exhibits a complex topography that includes estuarine areas, long gurfs and peninsulas of both shallow and deep, and high quality waters (51 or 13% of the 393 blue flags of Greece, 2nd world rank for 2013 by Blue Flag [1] of depths up to 1500 m in the western part of the N Aegean Trough [2] (Figure 1)). The area receives significant loads of riverine nutrients and low-salinity productive waters from the Black Sea. In the surface of the open sea (around the peninsulas of Chalkidiki as well as in the Toronaeos Gulf), the concentration of chl-a is low (0.2 μg l⁻¹) rising to eutrophic levels by the estuaries while its values are much higher (0.4 μg l⁻¹) close to the bottom [3].

Thermaikos Gulf (with the second big for Greece City and Port of Thessaloniki) is affected by the riverine loads and the human activities (agriculture, mussel culture, fishery and industry at the N and W coasts; tourism and navigation at the E and SW of 1250000 people) [4].
In between the three Peninsulas of Chalkidiki, the Toronaeos and Siggitikos Gulfs are deep marine basins of high quality waters with coasts of variable type from calm and sandy to exposed rocky cliffs; 70000 people live permanently in that area employed in jobs related to tourism and agriculture while in the summer that number increases sharply with the tourists to an estimated 1200000 [4].

As a whole, the ecological importance of the NW Aegean coastal zones is based upon the high quality of the sea water, the small or extended wetlands (all protected by NATURA 2000 and Ramsar Convention) and the Mount Athos Peninsula (Figure 1) with its virgin forests and the incredible floristic biodiversity all aided by the monastic life of its inhabitants. In addition, NW Aegean comprises one of the main oil tanker and cargo ship traffic routes of the E Mediterranean Sea [5] - known vectors for the transfer of alien organisms.

After a long and slow cooling period from the late 1960s to the early 1990s, Aegean Sea started to warm rapidly. The warming rate over 1992–2008 was several times higher than the estimated global mean warming rate over the same period [6]. During the early 1990s, a significant change in the E Mediterranean thermohaline circulation was observed, that of the shift of dense waters from the Adriatic Sea to the Aegean Sea, a phenomenon now known as the “Eastern Mediterranean Transient” [3]. These environmental changes were not followed by extensive faunistic studies and thus their impact on the biodiversity of the area was not assessed. Only few and sporadic investigations are referred to the gastropod fauna of the Hellenic Seas - mainly as a part of faunistic research (e.g. [7-12]) - and fewer are referred to the NW Aegean Sea with most recent those of Manousis et al. [13] and among the previews publications by Sakellariou [7], Tenekidis [8], Koutsoubas et al. [9], Antoniadou et al. [10] and Koroneos [14]. At the same time, it is known that progress in benthos research, human activities and environmental conditions change significantly the recorded marine biodiversity while detailed and persisting surveys usually increase the number of the recorded species, mainly of those of small size [15-18].

The aim of this study was: a) to continue contributing to the knowledge of the Hellenic gastropod biodiversity with an updated list for the gastropod species of the
studied families from the NW Aegean Sea, and b) to expand the research effort in other substrates and deeper waters.

**Results**

**The records**

As a result of this investigation, approximately 150 specimens were collected and 37 species were identified. They are listed within families in Table 1 and presented in Figures 2, 3, 4, 5, 6 and 7. Among the identified species, 14 are recognized as new for the gastropods fauna of E Mediterranean Sea and 16 are referred for the first time to the Hellenic fauna, one of which is alien. The alien is *Emarginula decorata* Deshayes, 1863 was referred from the SE Africa, Reunion Islands and Red Sea and is recorded for the first time from the Mediterranean Sea. All species with data on their habitat, mode of life and origin are presented in Table 1.

**Documented first records for the Hellenic waters**

The specimens’ descriptions per family with basic eco-geographical information for the new records are given below:

**Fissurellidae**

*Emarginula decorata* Deshayes, 1863 (synonym of *E. spinosa*)

(Figure 2a).

**Collection station**

One live individual (16.55 mm long, 11.35 mm wide and 7.80 mm high) was found on a sponge collected from mixed bottom at 120 m depth of station 14.

**Description**

The strong and oval shell has a moderately high profile, a very small slightly coiled apex located at the posterior 1/5 and a slightly curved base that makes it rest on its anterior and posterior margins. The sculpture consists of 55–57 alternating strong and weaker radial ribs more or less of equal strength by the posterior margin and interstices equally wide as the ribs. High co-marginal cords form tubers when passing over the ribs and produce a prominent lattice. Wide and rectangular slit reaching 1/8 the distance between the anterior margin and the apex. Color; yellowish white.

**Similar species**

At first impression, *E. decorata* looks similar to some native Mediterranean species. Nevertheless, although it is of a similar oval shape as *E. christiaensi* Piani, 1985 it has a lower profile and a more prominent sculpture; it has a less coiled apex and more prominent sculpture than *E. sicina* JE Gray, 1825 with the ratio of the length of the fissure to the distance to the shell’s apex to be 1/9 in *E. spinosa* [21], while it is <1/5 in *E. sicina* according to Gofas et al. [22]; it is much lower and more oval than *E. fissura* (Linnaeus, 1758) and it is of more oval shape and higher than *E. octaviana* Coen, 1939.

**Habitat and distribution**

It was found live foraging on a sponge. Its known distribution is from SE Africa [23], Reunion, Arabian Gulf and Red Sea [21].

**Status**

*Emarginula decorata* Deshayes, 1863 is recently referred as a synonym of *E. spinosa* Deshayes, 1863 [21,24,25] while the World Register of Marine Species [23] accepts *Emarginula spinosa* Deshayes, 1863 as a separate species from *E. decorata* Deshayes GP, 1863.

**Scissurellidae**

*Anatoma micalii* Geiger, 2012 (Figure 2b).

**Collection station**

Four shells (0.75–0.85 mm long and 0.85–1.00 mm wide) were found in detritus material trapped in small scale fishing nets at 120 m depth from mixed bottom of station 14.

**Description**

The very delicate, biconic, pearly white and rather depressed in its outline shell is formed by a globose spiral of two finely reticulate convex whorls that are flattened above and rapidly enlarging. The protoconch is approximately 3/4 of a whorl succeeded by the teleoconch I that bears 17–18 axial ribs in 3/4 of a whorl and exhibits an elevation of the spire by the upper outer lip immediately before the onset of the selenizone of the teleoconch. The teleoconch II sculpture consists of numerous fine, curved and longitudinal axial ribs, interrupted by a long furrow with raised margins (selenizone) and intersected by dense minute spiral striae in the interstices. Six of those spiral striae on the upper part (roof) of the shell over the selenizone stand out as they are more robust than the rest. The furrow lies at nearly one-third of the whorl’s height from the suture and is deep, striated across and with sharp and prominent edges forming a peripheral carina. The aperture is oblique and the peristome continuous with a thin outer lip. The inner lip is folded back on the columella without covering the umbilicus. The umbilicus is deep, funnel-shaped, exposing only the body whorl and bearing a very prominent funiculus which starts from behind the edge of the inner lip.

**Similar species**

Based on descriptions and detailed figures of Geiger [26] and the *Anatoma micalii* specimens of this study, *A. micalii* is similar, though smaller by half to *A. aspera* (Philippi, 1844) (an inhabitant of the Greek Seas) but differs from the late in that a) it has proportionally more wide the two carinas of the selenizone, b) it has a more rapidly enlarging and,
Table 1 Gastropods records, habitat and distribution details (in the study area)

| FAMILY (the change of species number/genus, % additions for Greece based on Koukouras [19] and Manousis et al. [17]) | Species | New record | The collection Stations in the Gulfs | Zone/Depth (m) | Habitat | Mode of life [20] | Found | Origin |
|---|---|---|---|---|---|---|---|---|
| FISSURELLIDAE | *Emarginula adriatica* Costa, 1829 | R, EM, A | Thermaikos (1–4 stations) | 9, 10 | 14, 15 | 10 - 120 | Posidonia, & mixed bottom | Feeds on sponges | Alive & shells | Mediterranean Sea |
| | *Emarginula decorata* Deshayes, 1863 | | Toronaeos (5–12 stations) | 14 | | 120 | Mixed bottom | Feeds on sponges | Alive | Red Sea & SE Africa |
| | *Emarginula huzardii* (Payraudeau, 1826) | 1, 3 | Siggitikos: (13–15 stations) | 5, 7, 9, 12 | 14 | 60 | Zostera, biogenic & mixed bottom | Feeds on sponges | Alive & shells | Mediterranean Sea |
| | *Emarginula octaviana* Coen, 1939 | | | 15 | | 10 - 45 | Biogenic & mixed bottom | Feeds on sponges | Alive | Mediterranean Sea |
| | *Emarginula rosea* Bell, 1824 | 1 | | 8, 9, 12 | 14 | 10 - 60 | Biogenic & mixed bottom | Feeds on sponges | Shells | Mediterranean Sea |
| | *Emarginula sicula* Gray, 1825 | 3 | | 9 | | 9 | Mixed bottom | Feeds on sponges | Alive & shell | Mediterranean Sea |
| SCISSURELLIDAE (new genus for Greece) | *Anatoma micalii* Geiger, 2012 | R, EM | | | 14 | 120 | Mixed bottom | Euryphagous | Shells | Mediterranean Sea & Sea of Marmara |
| | *Scissurella costata* d’ Orbigny, 1824 | 1, 2 | | 7, 8, 11 | 14 | 10 - 70 | Posidonia & biogenic bottom | Feeds on live plant matter | Alive & shells | Mediterranean Sea |
| SKENEIDAE (new genus for Greece) | *Skeneoides exilissima* (Philippi, 1844) | R, EM | | | 1 | 18 | Mixed bottom | Feeds on hydroids | Shell | Mediterranean Sea |
| PHASIANELLIIDAE | *Tricola pullus* (Linnaeus, 1758) | R, EM | | | 1, 3 | 5 | 15, 14 | 0 - 120 | Zostera, biogenic & mixed bottom | Feeds on marine algae and grasses | Alive & shells | Mediterranean Sea |
| | *Tricola deschampsii* Gofas, 1993 | | | | | 14 | 120 | Mixed bottom | Feeds on marine algae and grasses | Alive & shells | Mediterranean Sea |
| | *Tricola speciosa* (Von Muehlfeldt, 1824) | 3 | | | 15 | 0 - 30 | Mixed bottom | Feeds on marine algae and grasses | Alive & shells | Mediterranean Sea |
| | *Tricola tenuis* (Michaud, 1829) | 1 | | 5 | 14, 15 | 5 - 60 | Zostera, biogenic & mixed bottom | Feeds on marine algae and grasses | Alive & shells | Mediterranean Sea |
| SILIQUARIIDAE (new genus for Greece) | *Petalopoma elisabettae* Schiaparelli, 2002 | R, EM | | | 1, 4 | 10 | 15 | 10 - 70 | Biogenic & mixed bottom | Feeds on sponges | Alive & shells | Central Mediterranean Sea |
| | *Tenagodus obtusus* (Schumacher, 1817) | 1 | | | | 10 | Mixed bottom | Feeds on sponges | Shells | Mediterranean Sea |
| TRIPHORIDAE | *Monophorus perversus* (Linnaeus, 1758) | 1 | | | 14 | 14 | 5 - 120 | Mixed bottom | Feeds on sponges | Alive & shells | Mediterranean Sea |
| | *Monophorus erythrosoma* (Bouchet & Guillemot, 1978) | 3 | | | 0 | Zostera | Feeds on sponges | Shell | Mediterranean Sea |
| Table 1 Gastropods records, habitat and distribution details (in the study area) (Continued) |
|-----------------------------------------------|----------------|----------|-----------------|-----------------|-----------------|
| **Monophorus thiriotae** Bouchet, 1985        | **R**          | **4**    | **15**          | **30 - 70**     | Mixed bottom    |
| **Obesula marinostri** Bouchet, 1985          | **R, EM**      | **1**    | **10**          | **Mixed bottom** | Feeds on sponges|
| **Similiphora similior** (Bouchet & Guillenot, 1978) | **1, 2, 3, 4** | **6**    | **0 - 70**      | **Zostera, biogenic & mixed bottom** | Feeds on sponges|
| **Similiphora tricolor** (Bouchet, 1996)      | **R, EM**      | **2**    | **14**          | **40 - 60**     | Mixed bottom    |
| **Strobiligera flammulata** Bouchet & Waren, 1993 | **R, EM**      | **14, 15** | **30 - 120**    | **Mixed bottom** | Feeds on sponges|
| **Cerithiopsis atayla** Watson, 1885          | **R, EM**      | **1, 4** | **15**          | **10 - 70**     | Mixed bottom    |
| **Cerithiopsis barleei** Jeffreys, 1867       | **1**          | **15**   | **5 - 30**      | **Mixed bottom** | Feeds on sponges|
| **Cerithiopsis diadema** Monterosato, 1874    | **R, EM**      | **14**   | **60**          | **Mixed bottom** | Feeds on sponges|
| **Cerithiopsis fayalensis** Watson, 1886      | **R, EM**      | **1**    | **14**          | **20 - 120**    | Mixed bottom    |
| **Cerithiopsis horrida** (Monterosato, 1874)  | **4**          | **70**   |                | **Mixed bottom** | Feeds on sponges|
| **Cerithiopsis micali** (Cecalupo & Villari, 1997) | **R, EM**      | **4**    | **70**          | **Mixed bottom** | Feeds on sponges|
| **Cerithiopsis minima** (Brusina, 1865)       | **3**          | **14, 15** | **0 - 30**      | **Mixed bottom** | Feeds on sponges|
| **Cerithiopsis nana** Jeffreys, 1867          | **R**          | **1**    | **15**          | **5 - 50**      | Mixed bottom    |
| **Cerithiopsis cf. oculisfictis** Prkic & Mariottini, 2010 | **R, EM**      | **4**    | **100**         | **Mixed bottom** | Feeds on sponges|
| **Cerithiopsis scalais** Locard, 1892         | **1**          |          | **10**          | **Mixed bottom** | Feeds on sponges|
| **Cerithiopsis tubercularis** Montagu, 1803   | **1, 2, 4**    |          | **5 - 70**      | **Mixed bottom** | Feeds on sponges|
| **Dizoniopsis concatenata** (Conti, 1864)     | **R, EM**      | **1**    | **20 - 30**     | **Mixed bottom** | Feeds on sponges|
| **Dizoniopsis coppolae** (Aradas, 1879)       | **1, 4**       |          | **20 - 70**     | **Mixed bottom** | Feeds on sponges|
| **Meteisia metaxia** (delle Chiage, 1828)     | **1**          | **13, 14, 15** | **10 - 70**    | **Biogenic & mixed bottom** | Feeds on sponges|
hence, more compressed spire, c) it has six prominent spiral striae on its upper part of the dome, d) its inner apertural lip does not cover the umbilicus, e) it has a more prominent funiculus by the umbilicus and f) it exhibits an elevation of the spire by the upper outer lip immediately before the onset of the selenizone.
Habitat and distribution It lives on muddy-detrital bottoms of the circalittoral zone. The species has a rather wide distribution as it has been referred from Angola, Morocco (Strait of Gibraltar), the south coast of France, the west and south coasts of Italy and from the Bosporus [26].

Status It is a recently described new species by Geiger [26] who has re-identified erroneous references of *Anatoma* species from the Mediterranean Sea.

Skeneidae *Skeneoides exilissima* (Philippi, 1844) (Figure 2c).

Collection station One shell (0.60 mm long, 1.20 mm wide) was found in detritus material trapped in small scale fishing nets at 18 m depth from mixed bottom of station 1.

Description The pearly and uniformly white shell is almost planispiral and with a wide and deep umbilicus. Sculpture of 3 spiral cords per whorl visible on the spire, 4 evenly spaced spiral cords on the body whorl plus one on the umbilical wall; axial sculpture of fine, sharp, widely spaced and at equal interspaces axial ribs intersecting with the spiral cords and forming squarish pits. The aperture is circular, continuous and, due to the prominent spiral cords, with a honey comb cell-like periphery. The outer lip is simple.

Similar species Resembles *Parviturbo fenestratus* (Chaster, 1896) from which it differs in its much lower spire and...
therefore the more depressed profile and the much wider umbilical region [27].

**Habitat and distribution** West Mediterranean Sea [21] up to the northern part of the Central Mediterranean Sea [27].

**Status** Less frequent [21] to common [27].

**Phasianellidae**

*Tricola deschampsi* Gofas, 1993 (Figure 3a).

**Collection station** One shell (0.65 mm long, 0.65 mm wide) was found in detritus material from mixed bottom of station 15.

**Description** The shell has over two whorls and a low spire with an ample body whorl. Its protoconch consists of nearly one whorl, is nearly 90 μm wide and with a strong sculpture decoration. The first quarter of a whorl of the teleoconch bears a spiral microsculpture of 6–7 spiral cords, narrower than the interspaces, gradually replaced on later whorls by spiral rows of small punctures. Umbilical chink narrow, bordered by a sharp and white keel. The aperture is broad and rounded. The protoconch

![Figure 4](http://www.jbiolres.com/content/21/1/20)
is opaque white. The first quarter of a whorl of the teleoconch is also white and the rest with pink, narrow and sharp lines arranged parallel to the growth lines and opaque white anastomosing lines on a translucent background. The periumbilical area exhibits a wavy contour of alternating pink and white patches.

Similar species With slightly smaller dimensions, this species is morphologically similar to the congeneric Tricolia tingitana with which it shares the same shape of the umbilicus but has a different color pattern [28]. *T. deschampsi* is also similar to *T. entomocheila* but the late is different in the color pattern and its direction, the shell’s outline and its protoconch lacks the sculptural decoration present in our specimen. Moreover the specimen is dissimilar to *T. pullus* because of the color pattern, the shell’s outline and because *T. pullus* protoconch lacks a sculptural decoration [28].

**Habitat and distribution** Lives in the infralitoral zone (<40 m) between photophilic algae [28,29]. Species originally known from the area of the Strait of Gibraltar but subsequently collected in several other locations in the Mediterranean [27-29].

**Status** Uncommon [27].

*Siliquariidae*

**Petalopoma elisabettae** Schiaparelli, 2002 (Figures 3b, c,d and e).
Figure 6 The new recorded species of the family Cerithiopsidae: a. Cerithiopsis nana, b. Cerithiopsis cf. oculisfictis, c, d, e and f. Dizoniopsis concatenata. Bar = 1 mm.

Figure 7 Additional samples collected and photographed by C. Kontadakis: a. Obesula marisnostri and G. Mpazios: b. Strobiligera flammulata. Scale bars = 1 mm.
Collection station Two juvenile shells (2.00 mm and 5.00 mm long, 0.70 mm and 1.60 mm wide, respectively) were found in detritus material trapped in small scale fishing nets at 10 m depth from mixed bottom of station 1. One live individual (9.60 mm long, 0.30 mm wide) still with its operculum and three shells (7.10 mm long, 0.20 mm wide; 11.15 mm long, 2.90 mm wide; 14.00 mm long, 2.90 mm wide) were trawled trapped in a piece of sponge from 70 m at station 4. One shell (4.00 mm long, 1.30 mm wide) was found in detritus material trapped in small scale fishing nets at 30 m depth from mixed bottom of station 15.

Description The shell-shaped tubes (characteristic feature of the family) are small and slender, some with an intact lecithotrophic white protoconch and with a side slit of irregular width. The shell bears very irregular and alternating narrow and wider zones. The general outlook of the shell resembles the tip of a spear. The color is light cream-yellow to light cream-pink still retaining in places a brown periostracum.

Similar species Very similar in its general outlook to Tenagodus obtusus (Schumacher, 1817) from which it differs in its smaller size, its more slender and wiry tube (T. obtusus is more depressed and hunched over with the first few laps forming a regular spiral and then taking a variable form), its lecithotrophic protoconch (in contrast to the planktotrophic one of T. obtusus), its more irregular in width side slot (in T. obtusus it is of a constant width), the alternating narrower and wider zones in the total length of the tube and in its cream color (in contrast to the brown of T. obtusus). Petalopoma elizabetae seems to be strongly associated with sponges upon which it feeds while T. obtusus lives attached to rocks [30].

Habitat and distribution It has been found live in sponges from 20 to 40 m of depth in the Central Mediterranean Sea [30] and the W Mediterranean Sea [22].

Status Rare [27].

Triphoridae

Monophorus thiriotae Bouchet, 1985 (Figure 4a).

Collection station Two live individuals (7.15 mm and 6.85 mm in length, 1.65 mm and 1.55 mm wide, respectively) and one immature shell (8.95 mm in length, 1.95 mm wide) were collected from detritus material trapped in small scale fishing nets at 70 m depth from mixed bottom of station 15. One more (second)
Description The sinistral shell has a high and regularly conical spire. The protoconch is formed by four moderately convex whorls, the first of which is covered with tiny granules and followed by numerous axial ribs interrupted by a single keel up to the beginning of the teleoconch. The late is formed by 10 almost flat whorls separated by a deep suture which is highlighted in relation to the interspaces between the spiral cords. The sculpture consists of spiral cords wider than the interspaces and formed by smooth and rounded pearl-like tubercules which are aligned axially. In the first whorl of the teleoconch there are only two cords, with a third one sandwiched in between them from the fourth whorl and growing rapidly to become of even thickness with the two others. The last whorl is tapered at its base, with an additional granular cord in prolongation of the suture and two more cords between that fourth cord and the siphonal canal. Aperture with a simple, somewhat expanded outer lip and a deep notch near the suture. A thick siphonal canal opened only by a narrow slit and forming a conical projection. The shell is pale chestnut in color, with slightly darker the protoconch, the adapical part of the teleoconch and the tip of the siphonal canal and with slightly lighter the pearls of the third cord.

Similar species This species is very easily recognized by the single keel on the protoconch and the two additional granulated cords in the last whorl, in contrast to the smooth or slightly wrinkled ones of the other species [22].

Habitat and distribution In funds between 30 m and 200 m of the circalittoral gravel floor of the Atlantic and the Western Mediterranean from the Alboran Sea to Italy, France and Algeria [27].

Status Uncommon in the W Mediterranean Sea [22,27]. Similiphora triclotae (Bouchet, 1996) (Figure 4c).

Collection station Two live individuals (6.80 mm and 5.00 mm in length, 2.10 mm and 1.70 mm wide, respectively) and two shells (8.00 mm and 5.00 mm in length, 2.55 mm and 2.10 mm wide, respectively) were collected from detritus material trapped in small scale fishing nets at 40 m depth from mixed bottom of station 2.

Description The sinistral shell has a high and regularly conical spire. The protoconch is pointed, with five moderately convex whorls, the first of which is covered with tiny granules, while the rest ones with numerous axial ribs. In its second whorl there is only one spiral keel and in the following whorls two keels narrower than their interspace. The more or less slender teleoconch consists of 11 almost flat whorls. The sculpture consists of spiral cords wider than the interspaces and formed by smooth and rounded pearl-like tubercules which are aligned axially. In the first round of the teleoconch there are only two cords with a third appearing in between them from the sixth whorl and then increasing in thickness. The last whorl narrows sharply at its base with an initially slightly wrinkled cord and subsequently beaded cord in the prolongation of the suture and two more cords between that and the siphonal canal. The aperture bears a simple, somewhat expanded external lip with fragile edge and a deep notch by the suture. The cords by the end of the spire do not divide. The siphonal canal is short, almost closed and forming a conical projection. Very deep chestnut-brown background color all over the shell including the protoconch and its adapical part and much lighter to pale yellowish pearls. The animal had white and translucent tentacles.

Similar species Similiphora triclotae has a smaller and more slender shell than Marshallora adversa (Montagu, 1803), is very similar to S. similior (Bouchet & Guillemot, 1978) from which it differs in the white tentacules of the animal in contrast to the black foot and the black line on the tentacles of S. similior and from both M. adversa and S. similior in its pale-yellowish pearls against a dark chestnut-brown background [22].

Habitat and distribution In infralittoral rocky bottoms on sponges. Only known from the Strait of Gibraltar and Southern Portugal [22,27].

Status Rare [22].

Strobiliger a flammulata Bouchet & Waren, 1993 (Figure 4d).

Collection station One live individual (8.00 mm in length, 1.55 mm wide) and a juvenile shell (3.05 mm in length, 1.00 mm wide) were collected from detritus material trapped in small scale fishing nets at 120 m depth from mixed bottom of station 14 and at 30 m from mixed bottom of station 15, respectively. One more (first) record by the collector Mr. G. Mpazios from S Greece is discussed in the relevant section.

Description The very slender sinistral shell has a high and regularly conical spire. The pointed protoconch bears four very convex whorls, the first of which is covered with tiny intersecting lines while the last two whors bear a double keel the cords of which are narrower than the interspace and are crossed by numerous, irregular and fine axial ribs. The teleoconch bears 16 almost flat whorls separated by a shallow suture which is
difficult to distinguish from the spaces between the cords. The sculpture consists of spiral cords the interspaces of which are much wider than their pointed tubercules which are aligned but not attached axially. At the onset of the teleoconch there are only two cords with a third cord appearing below the suture from the fourth whorl and then increasing in thickness. The last whorl bears an additional wrinkled cord in prolongation of the suture. Aperture with a simple lip, a straight columella and a short siphonal canal. Color of randomly arranged alternating cream-white and chestnut-brown areas covering sections of the shell but without conforming to its sculpture.

**Similar species** The species is easily differentiated from the other European Triforids as its first cord of the teleoconch appears on the top of the other two instead of in-between those [22,27].

**Habitat and distribution** In circalittoral rocky bottoms. Atlantic and W and SW Mediterranean Sea [22,27].

**Status** Rare [22,27].

*Cerithiopsidae*

*Cerithiopsis atalaya* Watson, 1885 (Figures 4e and f).

**Collection station** Two shells (6.90 mm and 6.45 mm in length, 1.35 mm and 1.25 mm wide, respectively) were collected from detritus material trapped in small scale fishing nets at 70 m depth from mixed bottom of station 4, and three shells (5.90, 4.95 and 4.50 mm long, 1.15, 0.95 and 0.85 mm wide, respectively) also from detritus material trapped in small scale fishing nets at 25 m from mixed bottom of station 15.

**Description** The shell has a high and regularly conical slender spire. The pointed protoconch bears four highly convex whorls with sculpture formed by two prominent and narrow keels positioned in the middle of the whorls and axial ribs crossed by even thinner, slightly prosocline, ones that extend from suture to suture. The teleoconch bears 14 almost straight whorls, with axial ribs and spiral cords forming cross-shaped pearls in their intersection with the ribs. The first three whorls show two cords with a third one appearing gradually under the suture and progressively increasing in thickness to become equivalent in width to the two others by the last whorl. The pearls of the cords are acute and give the sculpture a rough appearance. The last whorl bears at its base a fourth, more or less, smooth cord below the suture and forms a somewhat concave smooth base. The square aperture has a straight columella, a short siphonal canal and a simple outer lip. The shell exhibits an uneven chestnut-brown color, lighter to yellowish in the first whorls of the teleoconch and in some parts of the later whorls.

**Similar species** *Cerithiopsis atalaya* is very similar to *C. horrida* Monterosato, 1874 from which it differs in that the late is generally larger, its protoconch exhibits a less dense sculpture, the fourth cord of the last whorl is beaded and the pearls are pointed upwards creating a more rough than *C. atalaya* appearance [22].

**Habitat and distribution** In deep rocky bottoms between 80 m and 200 m. Atlantic and SW Mediterranean [22].

**Status** Uncommon [27].

*Cerithiopsis diadema* Monterosato, 1874 (Figure 5a).

**Collection station** One shell (3.50 mm in length, 0.90 mm wide) was collected from biogenic material trapped in small scale fishing nets at 60 m depth from mixed bottom of station 14.

**Description** Shell with high and regularly conical spire. The pointed protoconch is formed by four moderately convex whorls, the first of which bears only very fine spiral striae that extent to the rest three whorls. In addition to that sculptural decoration, these late three whorls are decorated with numerous, somewhat curved, fine axial ribs that extend from suture to suture and are interrupted by a carina which bears a thin spiral cord up to the end of the protoconch. The teleoconch has 10 slightly convex whorls and a fairly deep suture. The sculpture is made up initially of two spiral cords, but from the fourth whorl of the teleoconch a third cord appears just below the suture and increases in width to become equally wide with the other two cords by the last whorl. The cords are approximately of equal width as the interspaces, with smooth and rather flat tubercules that are aligned axially to form ribs. The last whorl diminishes sharply in width by its base and exhibits an additional rather smooth cord in prolongation of the suture. In the proximity of that cord there is a smoother one preceding a concave area before a short siphonal canal. Light honey color all over the shell including the protoconch.

**Similar species** The very characteristic protoconch in combination with the rest of the shells characteristics separate the species from the superficially similar congeneric and sympatric *C. atalaya* Watson, 1885, *C. fayalensis* Watson, 1885 and *C. horrida* Monterosato, 1874 [22,29].

**Habitat and distribution** In circalittoral rocky funds of the Atlantic and the W and Central Mediterranean Sea [22,27].
Description Shell with high and regularly conical spire. The pointed protoconch is formed by five moderately convex whorls decorated with numerous, somewhat curved, fine axial riblets that extend from suture to suture; these riblets are overlaid by an extremely thin curved, fine axial riblets that extend from suture to sutures, respectively, from mixed bottom of station 14 and two shells (4.15 mm and 3.40 mm in length, 1.35 mm and 1.10 mm wide, respectively) were also collected from detritus material trapped in small scale fishing nets at 20 m depth from mixed bottom of station 1.

Similar species Cerithiopsis micalii has a very similar sculpture and configuration of its last whorl with that of C. tubercularis (Montagu, 1803) but is different from the late in the shape of its teleoconch and its characteristic protoconch [22].

Habitat and distribution In infralittoral rocky bottoms, presumably on sponges. Atlantic and Mediterranean Sea but only known from a few locations of its western basin [22,27].

Status Rare [22] and uncommon [27].
Cerithiopsis nana Jeffreys, 1867 (Figure 6a).

Collection station One live individual (4.05 mm in length, 1.25 mm wide) was collected from detritus material trawled at 100 m depth from mixed bottom of station 4, and one shell (3.35 mm in length, 1.05 mm wide) was collected from detritus material trapped in small scale fishing nets at 50 m depth from mixed bottom of station 15.

Description Shell with cirtoconoid “obese” spire. Protoconch ivory-white, styliform, with four moderately convex whorls bearing flexural axial ribs. Teleoconch with five whorls and a deep suture. Sculpture consisting of tree spiral cords, only two in the first whorl of the teleoconch with a third one formed below the suture and increasing in width in the following whorls. The last whorl which narrows towards its base bears a wrinkled cord as a continuation of the suture and an additional very prominent and also wrinkled one before the siphonal canal. The outer lip of the aperture is simple, fragile and white in contrast to the rest of the teleoconch which is of bright red-brown color.

Collection station One live individual (3.50 mm in length, 0.90 mm wide) and one shell (3.30 mm in length, 0.85 mm wide) were collected from detritus material trapped in small scale fishing nets at 60 m and 120 m depth, respectively, from mixed bottom of station 14 and two shells (4.15 mm and 3.40 mm in length, 1.35 mm and 1.10 mm wide, respectively) were also collected from detritus material trapped in small scale fishing nets at 20 m depth from mixed bottom of station 1.

Similar species Cerithiopsis micalii has a very similar sculpture and configuration of its last whorl with that of C. tubercularis (Montagu, 1803) but is different from the late in the shape of its teleoconch and its characteristic protoconch [22].

Habitat and distribution In infralittoral rocky bottoms, presumably on sponges. Atlantic and Mediterranean Sea but only known from a few locations of its western basin [22,27].

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Collection station One live individual (4.05 mm in length, 1.25 mm wide) was collected from detritus material trawled at 100 m depth from mixed bottom of station 4, and one shell (3.35 mm in length, 1.05 mm wide) was collected from detritus material trapped in small scale fishing nets at 50 m depth from mixed bottom of station 15.

Description Shell with cirtoconoid spire. The protoconch consists of four slightly convex whorls that form a blunt apex. Just below its suture there is a series of tiny elongated nodules while just over it there is an additional series of nodules forming a very thin cord. The three adapical whorls form a weak carina at their lower part. The teleoconch consists of seven slightly convex whorls. The sculpture is made up of three spiral cords and two more in the last whorl below the suture. The upper cord on the spire is weaker than the medium cord and stuck to it, gradually increasing in width and distancing away until by the last whorl it becomes the wider cord. The last whorl narrows at its base, with an extra grainy cord in prolongation of the suture and another one between that and the siphonal canal. The aperture bears a simple, fragile and white outer lip. Light brown color on the protoconch, cinnamon-brown on the spire.

Collection station One live individual (1.75 mm in length, 0.70 mm wide) and a shell (1.45 mm in length, 0.60 mm wide) were collected from detritus material trapped in small scale fishing nets at 70 m depth from mixed bottom of station 15.
with brighter the pearls and the additional cords of the base.

**Similar species** *Cerithiopsis nana* is quite similar to *Cerithiopsis tuberculais* (Montagu, 1803) from which it differs in its smaller size, its blunter protoconch and the additional fine cord of tiny nodules over the suture, not present in *C. tuberculais* [22].

**Habitat and distribution** In infralittoral rocky bottoms on sponges. Atlantic and Mediterranean Sea [22].

**Status** Uncommon [27].

*Cerithiopsis cf. oculisfictis* Prkic & Mariottini, 2010 (Figure 6b).

**Collection station** Two live individuals (4.05 mm and 4.00 mm in length, 1.15 mm and 1.10 mm wide, respectively) were collected from detritus material trawled at 100 m depth from mixed bottom of station 4.

**Description** The small shell has L/D (length/max diameter) ratio of 3.50, is conical, glossy and slightly scalaroid. Its also conical protoconch (460 μm high, 255 μm wide) is smooth, chocolate-brown in color, semi-transparent, with nearly 4.5 convex whorls and a suture bearing a series of tiny nodules forming a very thin cord. The teleoconch consists of eight, nearly flat, whorls. Its spiral sculpture is composed of three cords made of series of smooth pearls. The adapical cord is initially weaker than the two lower ones but eventually grows equally strong in the last four whorls to become the dominant cord that gives the shell its scalaroid outlook and is distant from the median cord. The body whorl narrows smoothly at its base, with an extra wavy cord in prolongation of the suture and another one between that and the siphonal canal. This last whorl is decorated with 21 ribs weaker than the spiral cords and giving rise to equidistant conspicuous nodules. These nodules become axially ovate on the last three whorls. The suture is deep leading the whorls to be well separated from each other. Aperture subquadrangular, smooth and wide. Outer lip simple, thin, orthocline and white. Columellar callus weak. Anal canal broad and short, siphonal canal open and short. Viewed through the aperture, transparency makes visible the sculptural pattern of the spire. Chocolate-brown color on the protoconch, the background of the teleoconch and the base with brighter pearls on the spire. The animal, that quickly withdrew itself into the shell, had a white foot and a dark grey head.

**Similar species** *Cerithiopsis cf. oculisfictis* is quite similar to *Nanopsis nana* from which it differs in that the protoconch of *C. cf. oculisfictis* bears more convex whorls that lack the weak carina of *N. nana*, the upper cord on the spire is strong in contrast to the weak of *N. nana* and the color is chocolate-brown in contrast to the light brown of *N. nana* [22]. *Cerithiopsis cf. oculisfictis* is also similar *C. tuberculais* (Montagu, 1803) from which it differs in that the late has a more slender shell; its protoconch whorls bear a very fine spiral thread just above the suture as well as short axial riblets; the columnellar callus is well marked and conspicuously elevated and the propodium is gray to black [32].

**Habitat and distribution** From the intertidal to the upper sublittoral zones (0–8 m), associated to small sponges and known only from certain localities along the Dalmatian coast, North Adriatic Sea [32].

**Status** *Cerithiopsis oculisfictis* is a recently described species and is rather common in the N Adriatic Sea [32].

*Dizoniopsis concatenata* (Conti, 1864) (Figures 6c,d,e and f).

**Collection station** Three live individuals (4.35 mm to 3.00 mm in length, 1.45 mm to 1.00 mm wide) and 3 shells (4.00 mm to 2.50 mm in length, 1.35 mm to 0.90 mm wide) were collected from detritus material trapped in small scale fishing nets at 25 m depth from mixed bottom of station 1. Two shells (3.45 and 2.10 mm in length, 1.15 and 0.70 mm wide, respectively) were collected from detritus material trapped in small scale fishing nets at 30 m depth from mixed bottom of station 15.

**Description** The conical, slightly cyrtoconoid shell has a protoconch with something more than two whorls the first of which is rough with or without minor dotty axial ribs, is globose, narrowing sharply to continue with the second whorl which, in turn, bears on its middle part two close to each other spiral keels. The teleoconch consists of eight almost flat whorls. The sculpture is formed by two cords of about the same width as the interspaces, with rounded pearl-like tubercules. The cord below the suture shows pearls with a tendency to widen axially forming elongated tubercules that finally divide as they approach the outer edge of the aperture (*concatenata*). The last whorl narrows at its base and bears two extra cords, a grainy one in prolongation of the suture and a smooth narrower one between the grainy one and the siphonal canal. The outer lip of the aperture is simple, fragile, flairy and white in contrast to the vivid chestnut-red color of the rest of the shell, which becomes paler towards the shells apex.

**Similar species** *Dizoniopsis concatenata* is quite similar to *D. coppolae* (Aradas, 1870) from which it differs in its characteristic protoconch, the dividing pearls of its
upper cord by the aperture and by having two additional cords on its last whorl (instead of three in _D. coppolae_). _Dizoniopsis clarkii_ (Forbes & Hanley, 1848) and _D. bilineata_ (Hornes, 1848) are erroneous identifications [22].

**Habitat and distribution** In infralittoral rocky floors, of unknown with precision hosts and quite often collected live [22]. Known from the Atlantic and the E Mediterranean Sea [22,27].

**Status** Uncommon [22].

**Discussion**

Among the 37 identified species, 16 are referred for the first time for the Hellenic fauna raising its gastropod biodiversity from 631 species [19] and additions by Manousis et al. [17] to 651. One more new alien new species of the genus _Emarginula_ originated from the Indian Ocean is recorded in the Mediterranean Sea thus enriching significantly (20%) the members of the family Fissurellidae in Greece. Five genera of different families are new for the Hellenic fauna (see Table 1).

The current enrichment of the studied families in the NW Aegean with 16 new species for Greece (with the vast majority of them being minute in size and collected from hard biogenic substrates), 14 of which are new for the E Mediterranean Sea and one of them being new for the Mediterranean Sea, was expected to take place. It is attributed to i) the few and, in some cases, old studies on the gastropod fauna of the area, ii) the lack of search in various environments as far as the different depths and the types of substrate is concerned iii) the collection tactics related to the type of habitats, to all possible and available material and substrate sources (e.g. discarded material from the fishing boats), to the collection equipment, to the detailed sorting of minute in size organisms and to the repeated search efforts and iv) study areas with variable substrates and clean marine environment promise a rich biodiversity.

_Anatoma aspera_ (Philippi, 1844) - one of the small and fragile members of the genus _Anatoma_ - has been reported by Geiger [26] for the first time from the S Aegean Sea and Sporades in coordinates of ~36° N, 27° E (most probably he means South Sporades - the old name of the Dodecanese - because the coordinates of the name that he uses “Sporades” are ~39° N, 24° E and is located in the N Aegean Sea). The finding of the newly described minute species of _Anatoma micalli_ reveals, apart from the research gaps, the identification difficulties on the _Anatoma_ species, attributed to numerous misidentifications, the various chresonyms and synonyms mainly of the species _A. aspera_, _A. micalli_ and _A. umbilicata_ [26] and the lack of useful tools for identification, such as publications with full descriptions and comparisons of the species, and the shortage of detailed and high quality images.

After the collection of _Obesula marisnstri_ specimen during this study, three more live individuals and a shell (7.75 to 5.05 mm in length, 2.30 to 1.50 mm wide) (Figure 7a) were collected by the collector Constantinos Kontakakis from biogenic material trapped in small scale fishing nets at 60–100 m depth from mixed bottom of Central Saronikos Gulf (S Greece). The specimen of _Strobiligerella flammulata_ of this study was collected one month later (26 June 2013) after (26 May 2013) the collector George Mpazios collected one shell (8.90 mm in length, 1.95 mm wide) (Figure 7b) from biogenic material trapped in small scale fishing nets at 80–120 m depth from mixed bottom of SW Saronikos Gulf by Epidaurus (37° 38.000’ N, 23° 11.500’ E). The almost simultaneous findings of _Obesula marisnstri_ and _Strobiligerella flammulata_ both from N and S Greece indicates that i) they are wider distributed in the Hellenic Seas and the Eastern Mediterranean Sea, ii) independent searches from the same type of substrates (e.g. biogenic bottom) and direct sampling might bring to light more species that could otherwise be lost during the fishing procedure and handling and iii) the potential source of information on biodiversity issues through the use of appropriate fora).

The unexpected and simultaneous finding of two live individuals very similar to the species _Cerithiopsis oculisfictis_ did not give us the time to examine in detail the color pattern of the living animal and look for the two (characteristic for the species) black spots on the propodium [32], and, therefore, their identification has to remain as _C. cf. oculisfictis_. Moreover, at the species level, the color pattern of the head-foot (propodium) comprises a diagnostic feature in the _Cerithiopsis tubercularis_ complex [33].

Among the new findings, _Emarginula decorata_ - referred from SE Africa [23], the Reunion Islands, Red Sea and the Arabian Gulf [21] - is a new alien mollusc species for the Mediterranean Sea added to the already recorded 215 ones by 2012 [34]. The dispersal of such a benthic organism is attributed to biological (endogenic) and environmental (exogenic) parameters. More specifically, among the biological parameters, the potential migration of a gastropod species in the form of teleplanic larvae could be a result of i) the larvae “escape” degree from the “parent area”, ii) their survival as meroplankton and iii) the chance for reproduction as adults in the new environment [35]. As far as the environment itself is concerned, the parameters include human activities and their effects on the dispersal of the larvae (directly by means of currents and ships and indirectly by means of aquacultures) and the juveniles/adults ratio (directly by means of aquacultures and indirectly by means of transportation as epibenthic/epibionts). Nevertheless, the climate changes in
the Mediterranean Sea and the almost 1000 different alien species recorded by 2012 [34] have particularly changed the biodiversity during the last two or three decades having as a result the publication of numerous articles in which the reasons for occurrence of aliens in the Mediterranean Sea, the frequency of the records, the vectors and the distribution pathways have been extensively discussed (e.g. [34,36-41]).

More than half (54%) of the marine alien species in the Mediterranean have, most probably, entered the area through “corridors” such as - and mainly - the Suez Canal. Shipping is directly connected with the introduction of only 12 species, whereas it is indirectly assumed as being the most probable way for the introduction (via ballasts or fouling) of another 300 species [34]. The alien species Emarginula decorata recorded from Siggitikos Gulf indicate that its possible vector is the sea currents rather than the limited navigation in that area. Suez Canal is one of the most significant hot points for alien dispersal to the East and the West [41]. Following the sea currents model in the Mediterranean Sea, the eastern current direction is correlated with the northward progressive dispersal of the Lessepsian molluscs along the coasts of Israel, Lebanon, Syria, and from there towards the southern coasts of Turkey and the coasts of Cyprus, and, finally, in-between the Greek islands of the E Aegean and the Aegean coasts of Turkey [41-45]. Taking, though, into account the directions of the sea currents in the Aegean Sea (Figure 8), the proposed by Tzomos et al. [41] corridor along the E Aegean seems to be a rather secondary one for the molluscs of deeper waters, as the main currents move parallel and along the western coasts of the

![Figure 8 The sea surface currents in the Eastern Mediterranean Sea.](image) The pink arrows represent the currents probably responsible for the expansion of the Lessepsian molluscs and the blue thinning zone shows the probable pathway of that expansion from the Suez Canal towards north up to the NW Aegean Sea. Heavy ink arrows indicate the main pathway and the light ones a secondary pathway. Reconstructed map for the currents according to Robinson et al. [42], Olson et al. [43], Sayin et al. [44] and Poulain et al. [45].
Hellenic islands of the E Aegean Sea. As these currents approach the Dardanelles and due to the Black Sea SW currents of lower salinity waters, they turn west, continue towards the NW Aegean in a pathway of the same higher salinity than that of the NE Aegean Sea, pass south of the Chalkidiki Peninsulas branch and enter Siggitikos and Toroneos Gulfs and subsequently Thermaikos Gulf (Figure 8).

The work continues on other molluscan families and expands in more areas while collaborations between researchers and collectors could effectively improve the marine biodiversity profiles of the Hellenic Seas.

**Conclusions**

Thirty seven species, the majority of which is of minute size, belonging to seven families (Cerithiopsidae, Fissurellidae, Phasianellidae, Scissurellidae, Siliquariidae, Skeneidae, and Triphoridae) were identified. Among those, one (Emarginula decorata Deshayes, 1863) is a new alien for the Mediterranean Sea, 14 are new for the Eastern Mediterranean Sea and 16 are new for the Hellenic fauna with the two above mentioned alien species included. The new findings are attributed both to the sampling methods employed and the under- or unsearched marine environments as far as different types of substrates and depths are concerned. Based on the new findings of this study, the pathway of alien species distribution to the N and NW Aegean Sea [46] is extended up to Thermaikos Gulf.

**Methods**

The sampling of specimens was conducted from October 2008 to January 2014 in certain locations of Thermaikos, Toroneos and Siggitikos Gulfs (Figure 1) by i) sieving soft bottom surface of shallow waters through a series of sieves with a mesh of 5 mm, 2 mm and 0.5 mm, ii) diving down to a depth of 10 m of the infralittoral zone, iii) searching the supralittoral of several coasts of the Gulfs and iv) searching only fresh trawled and discarded material from the supralittoral of several coasts of the Gulfs and iv) searching for molluscs, participated in the identification of the species, processed the images and participated in the study's design and coordination and helped to draft the manuscript. SG-M collected biogenic sea-bottom material, searched for molluscs, participated in the identification of the species, designed figures and participated in the study's design and coordination and helped to draft the manuscript, supported with the bibliography sources and is the corresponding author. Both authors read and approved the final manuscript.

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**References**

1. Blue Flag. [www.blueflag.org]
2. Kourafalou VH, Barbopoulos K. High resolution simulations on the North Aegean Sea seasonal circulation. Ann Geophys 2003, 21:251–265.
3. Tisaras AP, Kourafalou VH, Raisos DE, Triantis FY, Gopas G, Pitisakis G, Korres G: Inter-annual productivity variability in the North Aegean Sea: Influence of thermohaline circulation during the Eastern Mediterranean Transient. J Mar Syst 2012, 96–97:724–814.
4. Hellenic Statistical Authority (ELSTAT). [www.statistics.gr]
5. Safemed Project - Maritime traffic flows and risk analysis in the Mediterranean Sea. [www.safemedgis.org]
6. Skliris N, Sfakianos SS, Gkanasos A, Axaipoulos P, Mantzafou A, Vrettas V: Long-term sea surface temperature variability in the Aegean Sea. Adv Oceanogr Limnol 2011, 1:125–139.
7. Sakellariou E: Living Molluscs of the Gulf of Thessaloniki and their contribution in stratigraphy. PhD thesis. University of Athens, 1957.
8. Tenekidis N: A Sea Shell Collection from the Greek Seas. Athens: Brothers Protopapa Ltd. 1989.
9. Kououtsoudas D, Koudouras A, Voutsisaidou-Koudoura E: Prosobranch Mollusc fauna of the Aegean Sea. New information, checklist, distribution. Isr J Zool 1997, 43:19–54.
10. Antoniadou C, Koutsoukis Y, Chintenigoiu C: Structure of the "Amphioxous sand" community in Thermaikos bay (Eastern Mediterranean). Fresen Envir Bull 2004, 13:1122–1128.
11. Koulouri P, Dououras C, Arvanitidis C, Kououtsoudas D, Eleftheriou A: Mollusc diversity along a Mediterranean soft bottom sublittoral ecotone. Sci Mar 2006, 70:573–583.
12. Delamotte M, Vardala-Theodorou E: Sea Shells from the Greek Seas. Kifisia: Goulandris Museum of Natural History; 2008.
13. Manousis T, Mpardakis G, Zamora Silva A, Paraskevopoulos C, Manois D, Galinou-Mitsoudi S: New findings of Gastropods in the Hellenic seas on emphasis on their origin and distribution status. J Biol Res-Thessalon 2012, 18:249–264.
14. Koroneos J: Les mollusques de la Grece. Athens: Papadakis Press; 1979.
15. Steffanis N, Zententos A: Mollusc diversity in the N. East Aegean-Greece. Rapp Comm int Mar Biol 2007, 38:607.
16. Manousis T, Mparidakis G, Zamora Silva A, Paraskevopoulos C, Manois D, Galinou-Mitsoudi S: The Bivalvia Mollusca of Thessaloniki and Thermaikos Gulfs (North Aegean Sea, Greece) with emphasis on new species for Hellenic waters. J Biol Res-Thessalon 2010, 14:161–179.
17. Manousis T, Galinou-Mitsoudi S: New findings of Gastropods for the Hellenic Seas. Preliminary presentation. In Proceedings of the 15th Panhellenic Symposium of Ichthyologists: 10–13 October 2013. Thessaloniki; 2013, 13141–144.
18. Manousis T, Galinou-Mitsoudi S: New and uncommon Bivalvia Mollusca of Thermaikos Gulf (NW Aegean Sea). J Biol Res-Thessalon 2013, 20:339–366.
19. Kououtsoudas A: Check-list of marine species from Greece. Aristotle University of Thessaloniki. Assembled in the framework of the EU FP7 PESI project. http://www.marinespecies.org/aphia.php?p=source&details&id=142068.
20. NMITA (Neogene Marine Biota of Tropical America) Todd JA: Introduction to molluscan life habits databases. http://nmita.iowauiowa.edu/database/mollusc/mollusc0flsets.htm
21. Hardy’s Internet Guide to Marine Gastropods. http://www.gastropods.com
22. Gofas S, Moreno D, Salas C: Molluscos Marinos de Canarias, Volume 1. Malaga: Universidad de Malaga; 2011.
23. World Register of Marine Species (WoRMS). http://www.marinespecies.org
24. WMSDB – Worldwide Mollusc Species Data Base. www.bagnilligitta.it/WMSDB/PDFFamily/FISSURELIDAE.pdf.
25. Famille des FISSURELIDAE Fleming, 1822. http://vieoceane.free.fr/mollusques/issurelidae.htm.
26. Geiger Dl: Monograph of the little slit shells, Volume 2. Santa Barbara: Santa Barbara Museum of Natural History; 2012.
27. Repetto G, Orlando F, Arquito G: Conchiglie del Mediterraneo. Alba: Amici del Museo ‘Federico Eucario’, 2005.
28. Gofas S: Notes on some Ibero-Moroccan and Mediterranean Tricola (Gastropoda, Tricolidae), with descriptions of new species. J Mollus Stud 1993, 59:351–361.
29. Scaparrotta M, Bartolini S, Bogi C: Stadi di accrescimento dei Molluschi Marini del Mediterraneo/Stages of Growth of Marine Molluscs of the Mediterranean. Volume 3. Ancona: L’Informatore Piceno; 2011.
30. Natura Mediterraneo. http://www.naturamediterraneo.com.
31. Bouche-P. Les Triphoridae de Mediterranée et du proche Atlantique (Mollusca, Gastropoda). Lavois Var. Mat Zool 1985, 215–58.
32. Prikic J, Mariniotis P: Description of two new Cerithiopsis species from the Croatian coast, with comments on the Cerithiopsis tuberculatus complex (Gastropoda: Cerithiopsidae). Acta Zool 2009, 93:3–27.
33. Modica MV, Mariniotis P, Prikic J, Oliverio M: DNA-barcoding of sympatric species of ecto-parasitic gastropods of the genus Cerithiopsis (Mollusca: Gastropoda: Cerithiopsidae) from Croatia. J Mar Biol Assoc UK 2013, 93:1059–1063.
34. Zenetas A, Gofas S, Morri C, Rosso G, Violanti D, Garcia Raso JE, Cinar ME, Almgloiani A, Lepetra S, Azerou B, Ballestros E, Kioroglou N: DNA-phylogenetic and molecular studies of the species composition of the Mediterranean Cerithiopsis tuberculatus complex. Bull Inst Thessaloniki 2008, 75:166–173.
35. Zenetas A: Cassidulina gamespot (Gastropoda: Turbinellidae), with comments on the structure and the organic partnership of the Mediterranean Cassidulina gamespoth. J Mollus Stud 2006, 72:11–15.
36. Zenetas A: Cassidulina gamespot (Gastropoda: Turbinellidae), with comments on the structure and the organic partnership of the Mediterranean Cassidulina gamespoth. J Mollus Stud 2006, 72:11–15.
sources, patterns and effects on the ecosystem. J Biol Res-Thessalon 2009, 12:135–172.

60. Marine Biodiversity and Ecosystem Functioning EU Network of Excellence (MarBEF). [www.marbef.org]

61. Taxonomic on-line Database on European Marine Mollusca (CLEMAM). http://www.somali.asso.fr/clemam/biotaxis.php.

62. Ellenic Network on Aquatic Invasive Species (ELNAIS). https://services.ath.hcmr.gr.

63. Marine Mediterranean Invasive Alien Species Database (MAMIAS). http://www.mamias.org.

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