

New records of marine littoral Gastropoda and Bivalvia in the Azores Archipelago (Northeast Atlantic Ocean)

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ABSTRACT. The analysis of shell grit samples taken between 0 and 50 m from Faial, Pico and São Miguel revealed the presence of seven not yet reported marine species of molluscs from the Azores Archipelago, four gastropods species [*Caecum swinnyi* Nofroni, Pizzini & Oliverio, 1997 (Caecidae), *Granulina* cf. *canariensis* Boyer, 2001 (Marginellidae), *Mitromorpha engli* Mifsud, 2001 (Mitromorphidae), *Discotectonica discus* (Philippi, 1844) (Architectonicidae)] and three species of bivalves [*Acar clathrata* (Defrance, 1816) (Arcidae), *Rhomboidella canariensis* (Odhner, 1932) (Mytilidae) and *Kelliopsis jozinae* van Aartsen & Carrozza, 1997 (Lasaeidae)]. These species are considered today as part of the Archipelago's fauna and illustrated here. *Notodiaphana atlantica* Ortea, Moro & Espinosa, 2013 (Notodiaphanidae) replaces *Retusa multiquadrata* Oberling, 1970.

RESUME. L'analyse d'échantillons de sable coquiller prélevés entre 0 et 50 m à Faial, Pico et São Miguel a révélé la présence de sept espèces de mollusques marins non encore répertoriées dans l'archipel des Açores, quatre espèces de gastéropodes [*Caecum swinnyi* Nofroni, Pizzini & Oliverio, 1997 (Caecidae), *Granulina* cf. *canariensis* Boyer, 2001 (Marginellidae), *Mitromorpha engli* Mifsud, 2001 (Mitromorphidae) et *Discotectonica discus* (Philippi, 1844) (Architectonicidae)] et trois espèces de bivalves, [*Acar clathrata* (Defrance, 1816) (Arcidae), *Rhomboidella canariensis* (Odhner, 1932) (Mytilidae) et *Kelliopsis jozinae* van Aartsen & Carrozza, 1997 (Lasaeidae)]. Ces espèces sont considérées à ce jour comme appartenant à la faune de l'Archipel et sont illustrées ici. *Notodiaphana atlantica* Ortea, Moro & Espinosa, 2013 (Notodiaphanidae) remplace *Retusa multiquadrata* Oberling, 1970.

INTRODUCTION

The study of the benthic fauna of the Azores was initiated in the course of the 19th century by the launching of large seabed exploration expeditions in the North Atlantic Ocean. This enabled the collection of thousands of samples of deep-sea animals among them many benthic molluscs. The specimens of the dredging campaigns carried out by the expeditions of the « Josephine » were the subject of few comments by Jeffreys from 1878 to 1885.

Those of the « Travailleur » and the « Talisman » were reported by Locard (1897, 1898) and those of the

dredgings carried out by « L'Hirondelle » and « La Princesse Alice » between 1888 and 1896 at the initiative of Prince Albert 1^{er} of Monaco were extensively analysed by Dautzenberg (1889) and Dautzenberg & Fischer (1896). These authors are at the origin of the first faunistic inventories of mainly deep-sea benthic molluscs in the Azores and have contributed to the description of many previously unknown species. The inventory of intertidal molluscs, collected along the Azorean coasts at shallow depths, had begun earlier with a report written by the naturalist Drouët (1858) for the King of Portugal in which he mentioned the presence of 51 gastropods and 15 bivalves. It was not until the late

1990s and early 2000s that a new generation of young researchers was again conducting investigations related to the intertidal benthic fauna of the Archipelago. In the Biology Department of the University of the Azores, on the Ponta Delgada campus, Ávila and other researchers were very active on this topic (1998, 2000, 2005 among others). These works combined with that of Segers (2002), the illustrated checklist of infralittoral molluscs off Vila Franca do Campo (Martins et al. 2009), the checklist of the littoral gastropods from the Archipelago (Cordeiro et al. 2015) and the successive records of new species for the Azores (for example Paz Sedano et al. 2017 - Cacabelos et al. 2018) led to a total of 385 littoral molluscs species, 280 of which are gastropods distributed among 95 families, 90 bivalves, 8 cephalopods and 7 polyplacophores (Cacabelos et al. 2018) with a rate of endemism of 10,6 % (41 species).

Abbreviations

MNHN: Muséum national d'Histoire naturelle, Paris, France;

NMR: Natuurhistorisch museum Rotterdam, The Netherlands;

USC: Universidade de Santiago de Compostela (Museo de historia natural « Luis Iglesias »), Santiago de Compostela, Spain;

WoRMS: World Register of Marine Species.

Material

Littoral marine gastropods and bivalves are including here the intertidal species of molluscs up to 50 meters. 13 samples of shell grit were investigated (Table 1 and Fig.1). Beached and seaweed washing material was collected by Frank Swinnen (FS) in 2012 and by Roland Scaillet (RS) in 2017, all other samples were provided by a diver, Peter Wirtz (2012 - 2013).

Table 1. Sampling stations (capital letters between parentheses refer to the localities in Fig. 1)

Table 1					
Islands	Localities	Shell grit (Diver PW 2012/2013)		Shell grit (FS 2012 - RS 2017)	
Faial	Monte da Guia (A)	35 m	40 m		Beached (FS)
	Porto Pim (B)				
Pico	São Mateus (C)	35 m	42 m	48 m	
	São Roque (D)	12 m	40 m		
	Porto Calhau (E)	8 m			
	Ilhéus da Madalena (F)	21 m			
Terceira	Porto de São Fernando (G)				Beached (FS)
São Miguel	Ponta Delgada (H)				Beached - Seaweed washing (FS)
	Vila Franca do Campo (I)				Beached - Rocks (RS)

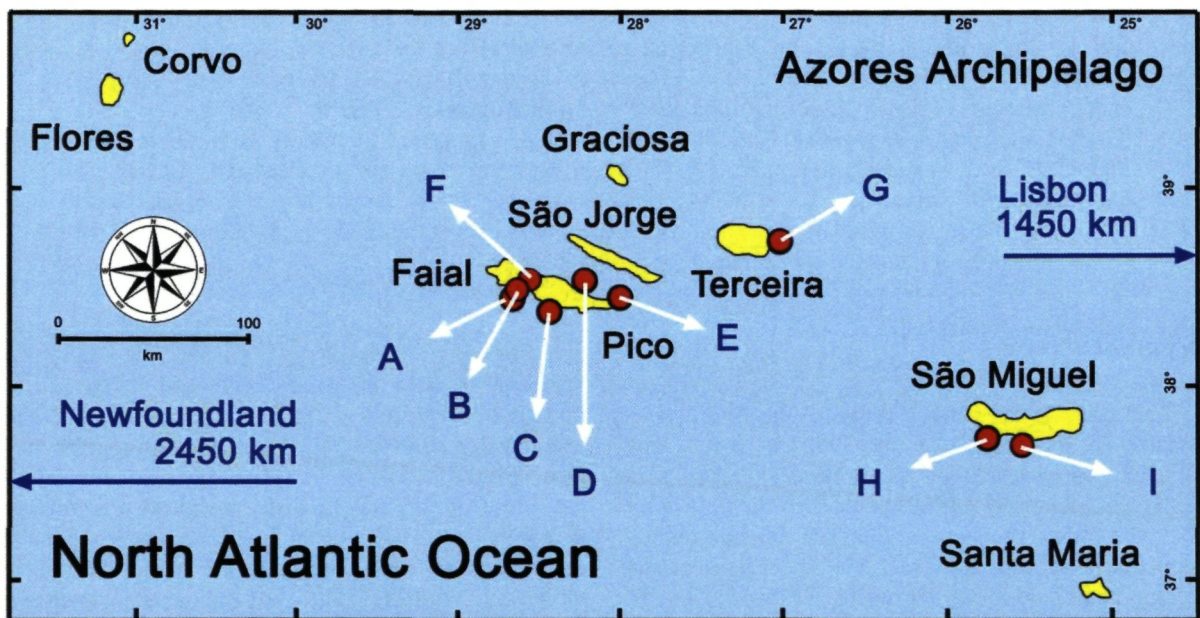


Figure 1. The Azorean Archipelago, geographical situation. A. Monte da Guia (Faial). B. Porto Pim (Faial). C. São Mateus (Pico), D. São Roque (Pico), E. Porto Calhau (Pico), F. Ilhéus da Madalena (Pico), G. Porto de San Fernando (Terceira), H. Ponte Delgada (São Miguel), I. Vila Franca do Campo (São Miguel).

RESULTS

142 shell-bearing gastropods, 38 bivalves and 3 polyplacophores were examined. Taking into account that gastropods without shell were by definition excluded from the working samples, it can be hypothesized that about more than half of Azorean littoral shell-bearing molluscs were present in the

analysed samples. On the other hand, it is interesting to point out that four gastropods species were not part of the 2015 checklist (Cordeiro et al. 2015) updated in 2018 (Cacabelos et al. 2018). Three species of bivalves were absent from the 2010 list of bivalves (Martins 2010). These seven species are considered as new records for the Archipelago (Table 2).

Table 2. New records

Table 2		
Family	Species	Locality
Gastropoda		
Caecidae	<i>Caecum swinnyi</i> Nofroni, Pizzini & Oliverio, 1997	Faial (A)
Marginellidae	<i>Granulina</i> cf. <i>canariensis</i> Boyer, 2001	Pico (C)
Mitromorphidae	<i>Mitromorpha engli</i> Mifsud, 2001	Pico (C)
Architectonicidae	<i>Discotectonica discus</i> (Philippi, 1844)	Pico (C)
Bivalvia		
Arcidae	<i>Acar clathrata</i> (Defrance, 1816)	Pico (C, D)
Mytilidae	<i>Rhomboidella canariensis</i> (Odhner, 1932)	Faial (A) Pico (C, D, F) São Miguel (H)
Lasaeidae	<i>Kelliopsis jozinae</i> van Aartsen & Carrozza, 1997	Faial (A) Pico (D)

DISCUSSION

Caecum swinnyi Nofroni, Pizzini & Oliverio, 1997
(Caecidae)
Fig. 2C-D

Occurrence in the Azores: Monte da Guia, 35m, Faial.

Caecum swinnyi was presently known only from the Islands of Lanzarote and Tenerife (Canary Islands) (Nofroni et al. 1997). The shell has been described as such: small, white, semitransparent, moderately curved, slender, subcylindrical, septum bearing a protruding triangular mucro, apertural swelling sculptured with small circular rings and surface with marked longitudinal slightly coiled ridges. All these peculiar features are found on the specimen collected in Faial and make it unmistakable (Fig. 2C-D). Two paratypes (coll. CD & RS) from Lanzarote are figured for comparison (Fig. 2A-B). Other Caecidae, *Caecum gofasi* Pizzini & Nofroni, 2001, *Caecum wayae* Pizzini & Nofroni, 2001 present in the Azores have also longitudinal lines, but these are very fine, straight and not coiled (Pizzini & Nofroni 2001).

Granulina cf. *canariensis* Boyer, 2001
(Marginellidae)
Fig. 2E

Occurrence in the Azores: São Mateus, 48 m, Pico.

Granulina canariensis is known from Fuerteventura and Gran Canaria (Canary Islands) around 60-100 m

to 180-240 m and is not recorded from Madeira (Segers et al. 2009). The holotype deposited at the MNHN (Paris, France) is here illustrated (Fig. 2F). This shell is quite large for the genus (average length 2.9 mm). Its columella is covered by a thick callus more developed towards the posterior part where it wraps the top of the shell (Boyer 2001).

In the Azores the genus *Granulina* is not listed in the Marginellidae family (Cordeiro et al. 2015). Although much smaller (half sized) than the Canarian specimens (Fig. 2G) (Rolán et al. 2011) this single shell from littoral water of Azores (Pico) strongly looks like them, particularly by the thickness of the columellar callus at the top of the shell (Fig. 2E). However, the inner margin of its labrum although finely crenulated bears fewer denticles.

It is known that molluscs species of Azores are often smaller than those found elsewhere what has been highlighted in bivalves (Morton et al. 2014). Because of the slight differences observed with the specimens of the Canary Islands we prefer to give it the name of *Granulina* cf. *canariensis*.

Discotectonica discus (Philippi, 1844)
(Architectonicidae)
Fig. 3A-B

Occurrence in the Azores: São Mateus, 48 m, Pico.

Discotectonica discus is known from the Bay of Biscay to West African coasts, including Madeira, Canary and Cabo Verde Archipelagos and into the Mediterranean Sea (Segers et al. 2009) and lives in the

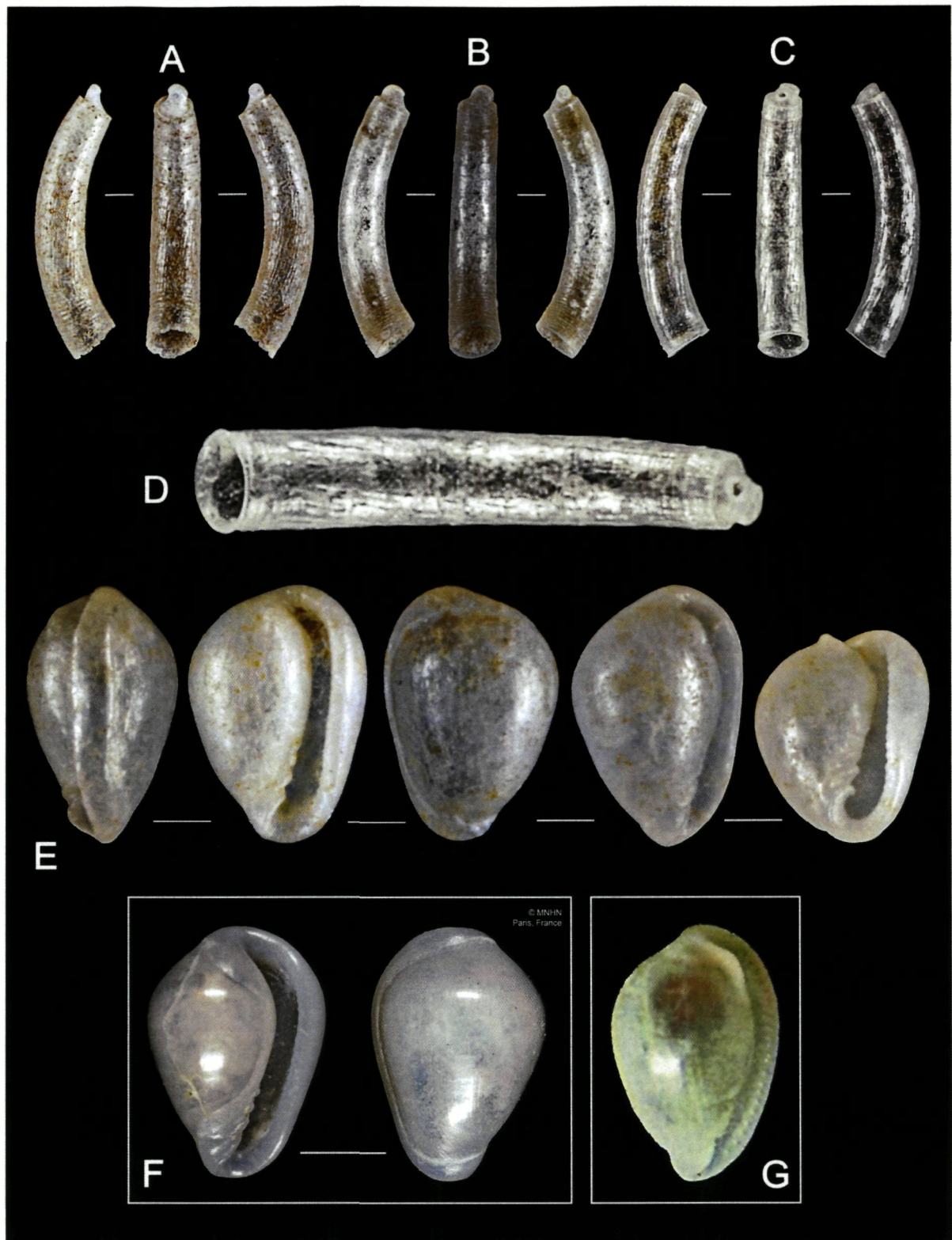


Figure 2.

A-D. *Caecum swinneni* Nofroni, Pizzini & Oliverio, 1997. A-B. Paratypes, coll. CD-RS, Brussels, Belgium: Puerto del Carmen, 40-50 m, Lanzarote, Canary Islands. A. 2.4 x 0.5 mm. B. 2.0 x 0.4 mm. C-D. Monte da Guia, 35 m, Faial, Azores, 2.3 x 0.4 mm. D. Same specimen enlarged.

E. *Granulina* cf. *canariensis* Boyer, 2001. São Mateus, 48 m, Pico, Azores, 1.8 x 1.2 mm. **F-G.** *Granulina canariensis* Boyer, 2001. F. Holotype, MNHN-IM-2000-373, Paris, France: Lobos Island, 100 m, Fuerteventura, Canary Islands, 3.0 x 2.0 mm. G. In Rolán 2011, plate 62, fig. E, Fuerteventura, Canary Islands, 3.1 mm.

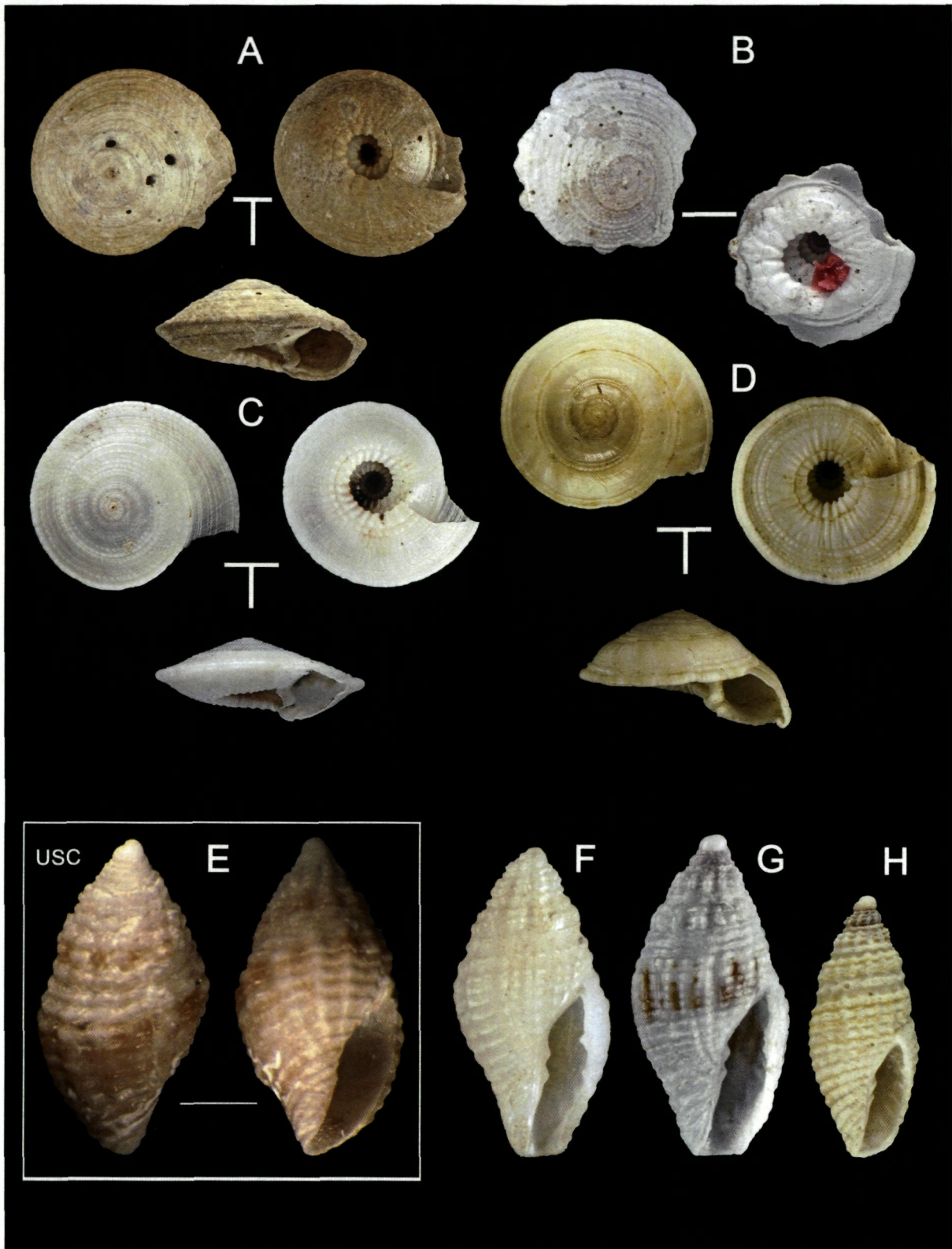


Figure 3.

A-C. *Discotectonica discus* (Philippi, 1844). A-B. São Mateus, 48 m, Pico, Azores, 12.6 x 11.6 mm (A) and 9.5 x 5.7 mm (B). C. Messine Strait, Italy, 13.1 x 11.6 mm.

D. *Basisulcata lepida* (Bayer, 1942). Off Martil, 120 m, Alboran Sea, Morocco, 19.3 x 16.4 mm.

E-H. *Mitromorpha engli* Mifsud, 2001. E. Paratype, ex coll. E. Rolán, Lanzarote, Canary Islands, 3.9 x 2.0 mm.

F. Porto Novo, Lanzarote, Canary Islands, 3.6 x 2.1 mm. G-H. São Mateus, Pico, Azores. G. 48 m, 4.3 x 2.1 mm. H. 42 m, 3.5 x 1.4 mm.

circumlittoral floor and far beyond. In the same geographical area, a neighboring species, *Basisulcata lepida* (Bayer, 1942) (Fig. 3D) can already be found from 25 meters depth (Gofas 2011), but it differs by its sculpture, the concavity of its base and its different profile.

The two specimens of *Discotectonica discus* collected off São Mateus (Fig. 3A-B) at the upper limit of the infralittoral floor are in bad condition, with no color and one of them was strongly broken which made its identification difficult. Nevertheless, when compared with a Mediterranean specimen (Fig. 3C) the base of the unbroken shell shows a comparable convex profile. They differ also from *Psilaxis krebsii* (Mörch, 1875) illustrated by Martins et al. (2009, plate XV, fig. 253).

Mitromorpha engli Mifsud, 2001 (Mitromorphidae)
Fig. 3G-H

Occurrence in the Azores: São Mateus, 42 and 48 m, Pico.

Mitromorpha engli is an infralittoral shell known in the Canary Islands in Lanzarote (Fig. 3E-F) and in El Hierro. It is characterized by a dozen strong axial ribs extending over most of the body whorl and forming distinct tubercles at the crossing of the spiral cords, by the presence of an excavated sub-sutural groove. Its color is whitish with yellowish-brown spots. The inside of the outer lips is crenulate and sometimes has in its upper part one or two more pronounced teeth (Mifsud 2001).

Among the numerous specimens of Mitromorphidae found in the shell grit samples from Pico [*Mitromorpha azorensis* Mifsud, 2001 and *M. crenipicta* (Dautzenberg, 1889)], some with axial ribs intersected by strong spiral cords (Fig. 3G-H) have retained our attention because of their similarities with the specimens of the Canary Islands.

Notodiaphana atlantica
Ortea, Moro & Espinosa, 2013
(Notodiaphanidae)
Fig. 4B

Occurrence in the Azores: Ponta Delgada (beached), São Miguel. Many other localities in Faial and Pico (see Table 2).

This is not a new species, but a new name that has to be used as replacement for *Retusa multiquadrata* Oberling, 1970 in the updated lists.

Notodiaphana atlantica was subject of nomenclatural discussions (Ortea et al. 2013) and it is concluded so far that *Retusa multiquadrata* Oberling, 1970 [name used by Mikkelsen (1995), Segers et al. (2009), then by Cordeiro et al. (2015)] and *Notodiaphana atlantica* could be synonyms, the first being considered as *nomen dubium* until Oberling's type material will be traced and studied (Micali, 2014).

Whatever it is, the specimens from the different samples studied here (Fig. 4B) undoubtedly belong to the same species as the one illustrated by Mikkelsen (1995) (Fig. 4A). This Cephalaspidea is common in the littoral waters of the Archipelago and was found in almost all samples studied here.

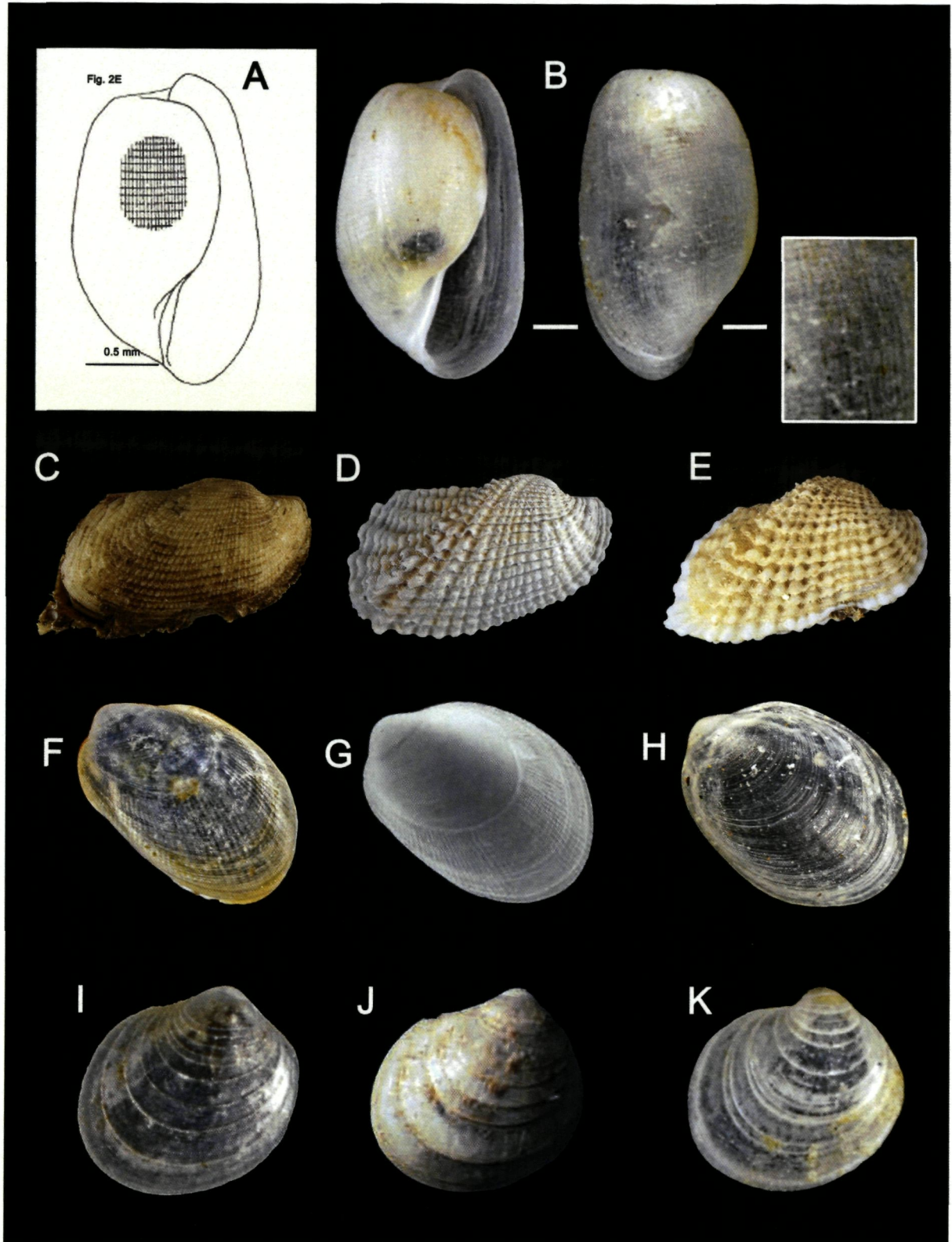
Acar clathrata (Defrance, 1816) (Arcidae)
Fig. 4D

Occurrence in the Azores: São Mateus, 35 m and São Roque, 40 m, Pico, loose valves in all localities.

Acar clathrata is known in the Atlantic Ocean from Galicia to Morocco, Madeira, Canary and Cabo Verde Archipelagos and into the Mediterranean Sea. White in color, its sculpture is quite rough with strong radial ribs crossed by commarginal lamellae forming at the point of intersection nodules that pile up like tiles (Fig. 4D-E).

Figure 4.

- A.** *Retusa multiquadrata* Oberling, 1970. In Mikkelsen 1995, fig. 2E, off Ponta da Pirâmide, 14m, São Miguel, Azores, 2.0 mm. **B.** *Notodiaphana atlantica* Ortea, Moro & Espinosa, 2013. Ponta Delgada, São Miguel (beached), Azores, 2.2 x 1.3 mm. **C.** *Asperarca nodulosa* (Müller, 1776). W. Iceland, 400 m, 64°00'N-26°43'W, 13.3 x 7.9 mm. **D-E.** *Acar clathrata* (Defrance, 1816). D. São Mateus, 35 m, Pico, Azores, 5.9 x 2.7 mm. E. Off Plakias, 70m, Crete, 9.2 x 4.9 mm. **F-G.** *Rhomboidella canariensis* (Odhner, 1932). F. São Roque, 12 m, Pico, Azores, 2.3 x 1.4 mm. G. In Segers et al. 2009, plate 72, fig. 5, Funchal Bay, 100-150 m, Madeira, 2.2 mm. **H.** *Crenella arenaria* Monterosato, 1875. Off Plakias, 70 m, Crete, 2.4 x 1.8 mm. **I-K.** *Kelliopsis jozinae* van Aartsen & Carrozza, 1997. I. Monte da Guia, 35 m, Faial, Azores, 1.1 x 1.0 mm. J. In Segers et al. 2009, plate 78, fig. 12, Madeira, 2.0 mm. K. Off Favignana, 80m, Aegadian Islands, Sicily, 1.5 x 1.5 mm.



A species of similar appearance, *Asperarca nodulosa* (Müller, 1776) (Fig. 4C) was reported from the Azores (Martins et al. 2009) and disappeared in Martins (2010). Compared to *A. clathrata*, *A. nodulosa* is less rough, brown in color and bears posteriorly lamellae that end in chitinous extremities. The shell represented on plate XVIII - 300 (Martins et al. 2009) could have been misidentified but the illustrations are not clear enough to draw a definitive conclusion.

Rhomboidella canariensis (Odhner, 1932)
(Mytilidae)
Fig. 4F

Occurrence in the Azores: São Roque, 12 m, Pico. Many other localities in Pico and Faial (see Table 2), loose valves in all localities.

Rhomboidella canariensis lives in the Madeira, Selvagens and Canary Archipelagos. It is new for the Azores (Fig. 4F) and was probably confused until today with *Crenella arenaria* Monterosato, 1875 that appears in the list of Azorean shells (Martins 2010) without a picture that can objectify the determination. *C. arenaria* is illustrated in the data bank of the NMR (n° 38802) as an Azorean shell. According to Gofas (2011), the sculpture of *C. arenaria* is exclusively composed of fine commarginal striae with no trace of radial striations (Fig. 4H). Shell n°38802 was misidentified, it is *Rhomboidella canariensis* characterized by its large smooth early stage occupying half the shell followed by fine radial striations. The same misidentification appears also in Rolán et al. 2011 (plate 105, figs R-S). It is correctly illustrated in Segers et al. 2009 (plate 72-5) (Fig. 4G). However, this does not exclude that *C. arenaria* is present in the Azores Archipelago.

Kelliopsis jozinae van Aartsen & Carrozza, 1997
(Lasaecidae)
Fig. 4I

Occurrence in the Azores: Monte da Guia, 35 m, Faial. Many other localities in Faial, Pico and São Miguel (see Table 2), loose valves in all localities.

Kelliopsis jozinae is a small circumlittoral bivalve whose distribution is poorly known. Reported first in the Mediterranean Sea (30-400 m) and in the Northeastern Atlantic from the Shetlands (van Aartsen & Carrozza 1997) and more recently reported from the Madeira Archipelago (407 m) (Segers et al. 2009). For comparison one specimen from Faial (Fig. 4I) is illustrated here together with specimens from Madeira (Fig. 4J) and Sicily (Fig. 4K).

CONCLUSIONS

The identification of these species considered as «new» for the Azores shows that the faunistic inventory of littoral marine molluscs of this zoogeographical region is far from complete and that it should encourage researchers to continue collecting shell grit samples along the coast or in shallow waters all around the islands of the Archipelago. It's a time-consuming job that remains to be done but the results are rewarding.

NOTE

All the shells illustrated are part of the author's collections, except when indicated. We follow the taxonomic nomenclature of WoRMS (MolluscaBase 2019).

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