



## The shallow-water Rissoidae (Mollusca, Gastropoda) of the Azores and some aspects of their ecology

### Los Rissoidae (Mollusca, Gastropoda) de las Azores y algunos aspectos de su ecología

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#### ABSTRACT

A critical review of the distribution of the Rissoidae on the islands of the Azorean Archipelago is made, on the basis of bibliographic data as well as newly-collected samples. Twenty three taxa of Rissoidae are given to the Azores: twelve endemic species, three restricted to the Azores and Madeira/Selvagens archipelago and two with wider distribution. Of the remaining taxa, one is an unidentified species of *Setia* and five are records not confirmed by this study. The assemblage of Rissoidae associated with heterogeneous algae on a rocky shore on the northern coast of São Miguel Island, Azores, is also described. Aspects of community structure (species composition, abundance and zonation) were studied and a multispecies analysis conducted using clustering techniques. Some comments are also made regarding the Rissoidae speciation that has occurred in the Azores and its relation to the main sea-surface circulation in this area of the Atlantic Ocean.

#### RESUMEN

Se realiza una revisión crítica de la distribución de los Rissoidae de las Azores, en base a datos bibliográficos y a muestras recientes. Se han encontrado 23 táxones de Rissoidae: 12 especies endémicas, 3 restringidas a las Azores y a Madeira/Salvajes y otras dos con una distribución mayor. De las especies restantes, una es una especie sin identificar de *Setia* y otras 5 son citas no confirmadas en el presente estudio. Se describe también la asociación de Rissoidae con algas en una costa rocosa del norte de São Miguel (Azores). Se incluyen datos sobre la estructura de la comunidad (composición específica, abundancia y zonación), así como un análisis multiespecífico empleando técnicas de cluster. Se comenta también la especiación que ha tenido lugar en las Azores con la familia Rissoidae y su relación con las principales corrientes superficiales en esta zona del Atlántico.

KEY WORDS: Rissoidae, Azores, taxonomy, ecology, geographic range.

PALABRAS CLAVE: Rissoidae, Azores, taxonomía, ecología, distribución geográfica.

#### INTRODUCTION

The marine Rissoidae of the Azores were studied by DROUËT (1858), DAUT-

ZENBERG (1889) and NOBRE (1924; 1930), who provided annotated check-lists.

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During the scientific expeditions made by the Prince of Monaco to the Azores, 25 species of Rissoidae were described from deep-water samples, most of them *Alvania* (11 species) (DAUTZENBERG, 1889). Using SEM techniques, two new species were described by AARTSEN (1982a; 1982b; 1982c; 1982d) and Amati (1987), from material collected by the Prince of Monaco. With the same methodology (SEM photos of the protoconch and of the microsculpture of the body whorl), MOOLENBEEK AND FABER (1987) revised the genus *Manzonina* in the Macaronesian islands, identifying a single species from the Azorean archipelago (*Manzonina unifasciata* Dautzenberg, 1889).

As a result of the scientific expeditions organized by the Department of Biology of the University of the Azores to some of the islands (e.g.: "Graciosa/88", "Flores/89", "Santa Maria e Formigas 1990" and "Pico/1991") and also the scientific expedition "Açores 89", organized by the Department of Oceanography and Fisheries (DOP/UA) of the University of the Azores, several check-lists (some of them not yet published) have allowed preliminary reports on the geographical distribution of Rissoidae species on the islands of the Azores (AZEVEDO AND MARTINS, 1989; AZEVEDO, 1990; AZEVEDO AND GOFAS, 1990; ÁVILA AND AZEVEDO, 1996; ÁVILA AND AZEVEDO, 1997; ÁVILA, 1998; ÁVILA, AZEVEDO, GONÇALVES, FONTES AND CARDIGOS, 1998; ÁVILA, AZEVEDO, GONÇALVES, FONTES AND CARDIGOS, *in press*).

During the "I International Workshop of Malacology" held at Vila Franca do Campo (São Miguel island), GOFAS (1989; 1990) refers to 11 species of Rissoidae from the Azorean littoral (*Alvania angioyi* Van Aartsen, 1982, *A. cancellata* (Da Costa, 1778), *A. mediolittoralis* Gofas, 1989, *A. poucheti* Dautzenberg, 1889, *A. sleursi* (Amati, 1987), *Botryphallus ovum-muscae* (Gofas, 1990), *Cingula trifasciata* (Adams, 1798), *Crisilla postrema* (Gofas, 1990), *Manzonina unifasciata* (Dautzenberg, 1889), *Rissoa guernei* Dautzenberg, 1889 and *Setia subvaricosa* Gofas, 1990) to

which we must add *Alvania formicarum* Gofas 1989, a species endemic to Formigas and Santa Maria (GOFAS, 1989; 1990).

Samples taken by the author from several locations in the Azores revealed another species at São Miguel island that was formerly reported by Gofas (1990) to be restricted to the islands of the central and western groups *i.e.*, *Onoba moreleti* Dautzenberg, 1889. AZEVEDO AND GOFAS (1990) recorded a species of *Setia* from Flores. This species was later found by ÁVILA ET AL. (1998) at Pico and São Miguel. A new species of *Alvania*, described by Hoenselaar and Goud (1998) as *A. internodula*, was also collected from Formigas by Ávila and AZEVEDO (1997). The revision of the material of the CANCAP expeditions (1976-1986) has confirmed some species and described a few others to the Azores (Hoenselaar and Goud, 1998).

The Rissoidae is one of the best represented families of shallow-water marine molluscs in the Azores, with 8 genera and 18 confirmed taxa, of which 12 species are considered as endemic (MOOLENBEEK AND FABER, 1987; GOFAS, 1989; 1990; KNUDSEN, 1995; HOENSELAAR AND GOUD, 1998).

This study had three main objectives: to undertake a taxonomic revision of Rissoidae in the Azores, to identify any island to island endemisms, that is species restricted to some of the islands and to describe the zonation of the Rissoidae on the Azorean shores.

## MATERIAL AND METHODS

A bibliographic analysis was made, in order to compile published information about the shallow-water Rissoidae of the Azores (intertidal to a depth of about 50m). The synonymy and the distribution of the species, by islands, was also annotated. A table with the distribution of the Rissoidae species, by islands, was constructed and multivariate analysis was performed on the data obtained (Bray-Curtis similarity index/UPGMA as well as MDS). The

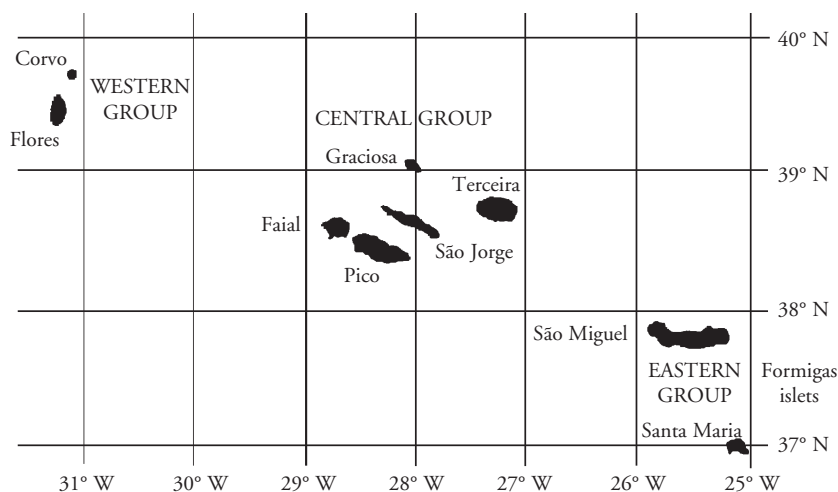


Figure 1. Map of the Azores Archipelago.  
 Figura 1. Mapa del archipiélago de las Azores.

gastropod classification follows PONDER AND LINDBERG (1997). CLEMAM (Check List of European Marine Mollusca) database classification was quite useful for synonymy.

Protoconchs of almost all the Azorean Rissoidae were photographed with a SEM, as well as other detailed structures of the shells (*e.g.* microsculpture of the last whorl and protoconch, shell aperture and the whole shell).

The zonation of the Rissoidae was examined for São Miguel, which is located in the eastern group of islands of the archipelago (Fig. 1). Several dives were performed in July 1996 at Porto da Baleia, a former whaling ramp boat, located at São Vicente (Capelas) on the north coast of São Miguel (Fig. 2). In the selected zone, a 400m long transect was done, from the intertidal zone to a depth of 30m (Fig. 3). Quadrates of 50x50 cm, placed on algae covering the rocky substratum were scrapped, and the material collected put into labeled cotton drawstring bags. Three replicates were obtained from eight chosen depths, *i.e.*, 3.5m, 5.1m, 8m, 12m, 13.6m, 16.3m, 22m and 26.8m. In the laboratory, each of the replicates was washed several times and the animals removed from the algae by

pouring the washing water through a sieve tower with decreasing mesh sizes (1mm, 0.5mm and 0.25mm). Samples were then labeled and preserved in 70% ethanol. The molluscs from the 1mm mesh were sorted and the Rissoidae identified and counted.

Multispecies analysis between all the samples were conducted using ordination techniques. Prior to the multivariate analysis, the absolute values of the counts were transformed, in order to standardize the data and ensure that the multivariate ordination would not be determined by the most abundant species (CLARKE AND AINSWORTH, 1993). Absolute counts were transformed by double square root transformation, which weights the abundant species and is advisable when a Bray-Curtis measure is used as a similarity coefficient in further steps (FIELD, CLARKE AND WARWICK, 1982).

Triangular matrices of similarities between every pair of samples were then computed from transformed data of absolute counts, using the Bray-Curtis coefficient (FIELD *ET AL.*, 1982; CLARKE AND AINSWORTH, 1993). The similarity matrices were subjected to clustering by an hierarchical agglomera-

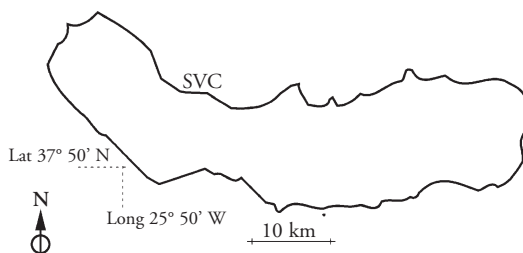


Figure 2. São Miguel island. SVC - São Vicente.  
 Figura 2. Isla de São Miguel. SVC - São Vicente.

tive method employing group-average linking (UPGMA).

Data analysis were undertaken using the PRIMER (Plymouth Routines in Multivariate Ecological Research) set of programs developed and tested by Plymouth Marine Laboratory.

All the material is deposited at the reference collection of the Department of Biology of the University of the Azores (DBUA), unless otherwise stated.

Abbreviations used in text:

DBUA: marine molluscs reference collection of the Department of Biology of the University of the Azores.

MCM(HN): Museu Carlos Machado /História Natural, Ponta Delgada, Azores.

MNHN: Muséum National d'Histoire Naturelle, Paris (Malacologie).

NNM: Nationaal Natuurhistorisch Museum, Leiden.

## RESULTS

Phylum MOLLUSCA  
 Class GASTROPODA  
 Subclass ORTHOGASTROPODA  
 Superorder CAENOGASTROPODA  
 Order SORBEOCONCHA  
 Suborder HYPGASTROPODA  
 Superfamily RISSOIDEA  
 Family RISSOIDAE  
*Alvania* Risso, 1826

*Alvania abstersa* Van der Linden and Van Aartsen, 1994

References to the Azores:

*Alvania obsoleta* Van der Linden, 1993: 79-82.

*Alvania abstersa* Van der Linden and Van Aartsen, 1994: 2; Hoenselaar and Goud, 1998:71.

**Occurrence:** Pico(Lajes do Pico), Terceira (Porto Martins), São Jorge (Fajã da Caldeira), São Miguel (Lagoa and Mosteiros), Santa Maria (VAN DER LINDEN, 1993: 80). Azores (CANCAP expeditions) (HOENSELAAR AND GOUD, 1998: 71).

DBUA 726.

**Comments:** although more common just below the intertidal, it may appear to a depth of 35m.

**Dimensions:** up to 3.3 mm long, 1.7mm wide.

**Geographic distribution:** endemic to the Azores.

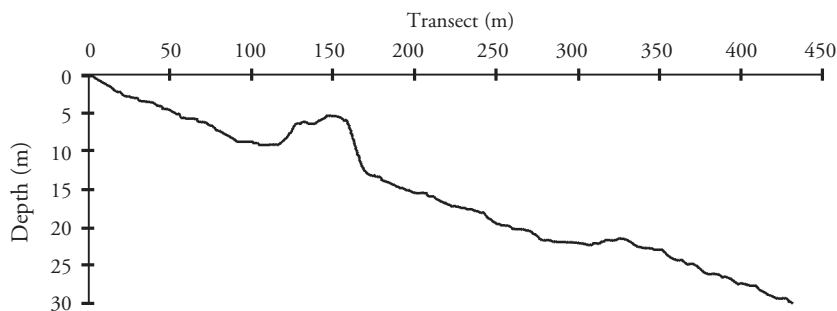


Figure 3. Transect performed at Porto da Baleia (São Vicente, Capelas), north coast of São Miguel island, Azores.

Figura 3. Transecto realizado em Porto da Baleia (São Vicente, Capelas), costa N de la isla de São Miguel, Azores.

### *Alvania angioyi* Van Aartsen, 1982

#### References to the Azores:

- Alvania (Alvinia) watsoni* Schwartz, in Watson, 1873: Dautzenberg, 1889: 51.  
*Alvania watsoni* (Schwartz MS) Watson, 1873: Bullock, Turner and Fralick, 1990: 45.  
*Alvania angioyi* Van Aartsen, 1982: Azevedo and Martins, 1989: 69; Gofas, 1990: 112; Azevedo and Gofas, 1990: 85; Ávila, 1996: 27; Ávila and Azevedo, 1996: 106; Ávila and Azevedo, 1997: 326; Bullock, 1995: 16; Knudsen, 1995: 140; Hoenselaar and Goud, 1998: 72.  
*Alvania angioyi* Van Aartsen, 1982d: Azevedo 1991b: 44.

**Occurrence:** São Miguel, Faial (Bay of Horta, -15 to -20 m, Stn. 103, "Hirondelle", 1887), Pico (-1287 m) (DAUTZENBERG, 1889: 51), Graciosa (AZEVEDO AND MARTINS, 1989: 69), Flores (Santa Cruz, -20m) (AZEVEDO AND GOFAS, 1990: 85), São Miguel (BULLOCK ET AL., 1990: 45); São Miguel (Vila Franca (-24m) and Morro das Capelas ("Biaçores" 1971 expedition); Lagoa (-10 to -22m); Feteiras (-15 to -22m); Ponta da Galera (intertidal and -13 to -18m); Ponta Delgada; Capelas (intertidal); Ilhéu de Vila Franca; Ponta da Pirâmide (-13m)), Faial (Horta, -3m; -7m; Monte da Guia, -20m, "Biaçores" 1971), Terceira (Pedra Furada, Angra do Heroísmo; Praia da Vitória), Flores ("Pr. Alice" st. 703, 1896; Santa Cruz, -20m) and Formigas (west coast, -16m, "Biaçores" 1971) (GOFAS, 1990: 112), São Miguel (Caloura and Ribeirinha) (AZEVEDO, 1991a: 22), Santa Maria (Vila do Porto, Ponta do Marvão) (AZEVEDO, 1991b: 44), São Miguel (Ilhéu de Vila Franca) (BULLOCK, 1995: 16; KNUDSEN, 1995: 140), Pico (intertidal)

(ÁVILA, 1996: 27), Pico (ÁVILA AND AZEVEDO, 1996: 106), Formigas islets (ÁVILA AND AZEVEDO, 1997: 326) and Azores (CANCAP expeditions) (HOENSELAAR AND GOUD, 1998: 72).

DBUA 119, 173, 188, 227, 274, 277, 281, 335, 340, 343, 350, 352, 353, 355, 372, 374, 379, 394, 398, 400, 407, 410, 412, 462, 493, 496, 499, 556, 560, 564, 568, 571, 574, 579, 666, 675, 715, 719.

MCM(HN) 7, 9.

**Comments:** this species is closely related to specimens from Madeira and is also similar to *Alvania oranica* (Pallary, 1900) from Ceuta (GOFAS, 1990). It occurs to a depth of 35m, but is commonest in the first 10m. Although Gofas raises the hypothesis of its existence at Madeira archipelago, its presence was not confirmed in the samples from the CANCAP expeditions (HOENSELAAR AND GOUD, 1998: 72).

**Dimensions:** 1.8mm long, 1.1 mm wide.

**Geographic distribution:** endemic to the Azores.

*Alvania beani* (Hanley in Thorpe, 1844)

References to the Azores:

*Rissoa calathus* Forbes and Hanley, 1858: Mac Andrew, 1856: 121.

*Alvania (Turbona) reticulata* (Montagu, 1803): Simroth, 1888.

**Occurrence:** Azores (-10 to -90m) (MAC ANDREW, 1856: 121). São Miguel (Ponta Delgada) (SIMROTH, 1888).

**Comments:** this record needs to be confirmed. Its occurrence in the Azores is possible and, if so, it lives predominantly at depths >50m and I have only a few samples collected by scuba diving at these depths. However, in the significant amount of samples

collected at the Azores by the CANCAP expeditions, not a single specimen was found (HOENSELAAR AND GOUD, 1998).

**Dimensions:** 3.5mm long, 2.0mm wide (FRETTER AND GRAHAM, 1978).

**Geographic distribution:** Norway to the Mediterranean, Azores (?) and Canary Islands (FRETTER AND GRAHAM, 1978; ROLÁN, 1984).

*Alvania cancellata* (Da Costa, 1778)

References to the Azores:

*Rissoa crenulata* Michaud, 1832: Mac Andrew, 1856: 148.

*Rissoa (Alvania) cancellata* Da Costa: Watson, 1886: 592.

*Alvania laxa* Dautzenberg and Fischer, 1896: 62-63, pl. 19, figs. 10,11.

*Alvania cancellata* Da Costa: Dautzenberg, 1889: 49.

*Alvania cancellata* (Da Costa, 1778): Nobre, 1924: 80; 1930: 57; Morton, 1967: 36; Azevedo, 1990: 59; Gofas, 1990: 104; Azevedo and Gofas, 1990: 85; Azevedo, 1991a: 21; 1991b: 44; Ávila, 1996: 27; Ávila and Azevedo, 1997: 326; Hoenselaar and Goud, 1998: 73.

**Occurrence:** Azores (MAC ANDREW, 1856: 148); Faial (-823 to -914m) (WATSON, 1886: 592), Faial (Horta, -15 to -20m, Stn. 103, "Hirondelle", 1887), Pico (-1287m) and São Miguel (DAUTZENBERG, 1889: 49), Azores (NOBRE, 1924: 80; 1930: 57), São Jorge (Velas) (MORTON, 1967: 36), Pico (Baía de São Pedro, Lajes do Pico) (AZEVEDO, 1990: 59), Flores (Santa Cruz) (AZEVEDO AND GOFAS, 1990: 85), São Miguel (Ponta Delgada; Vila Franca do Campo, -10m, -24m; Morro das Capelas ("Biaçores" 1971 expedition); Feteiras, -15 to -22m; Ponta da Galera, -13 to -18m, -20m; Lagoa, -10 to -22m; Ponta da Pirâmide, -13m), Formigas (east coast, -16m), Terceira (Ponta de São Diogo, Pedra Furada - Angra do Heroísmo), Flores (Santa Cruz, -20m) and Pico (-1287m) (GOFAS, 1990: 104), São Miguel (infralittoral of Ribeirinha) (AZEVEDO, 1991a: 21), Santa Maria (Vila do Porto, Ilhéu da Vila) (AZEVEDO, 1991b: 44), São Miguel (Ilhéu de Vila Franca) (KNUDSEN, 1995: 141), Pico (sub-

tidal) (ÁVILA, 1996: 27), Formigas islets (ÁVILA AND AZEVEDO, 1997: 326) and Azores (CANCAP expeditions) (HOENSELAAR AND GOUD, 1998: 73).

DBUA 127, 168, 173, 176, 197, 240, 274, 281, 341, 350, 379, 394, 395, 405, 408, 410, 411, 415, 421, 422, 438, 441, 446, 448, 459, 489, 493, 496, 499, 500, 555, 558, 561, 569, 570, 574, 579, 605, 608, 609, 614, 658, 659, 660, 661, 662, 665, 666, 667, 670, 672, 675, 677, 719.

**Comments:** it occurs from low tide level to a depth of 45m (SALDANHA, 1995), but its presence at low depths is rare (GRAHAM, 1988; GOFAS, 1990). It is detritivorous (GRAHAM, 1988). The populations in the Azores are conspecific with those on European mainland, their protoconchs matching exactly (KNUDSEN, 1995). GOFAS (1990) also states their conspecificity with the populations of Madeira and the Canary Islands, because of external similarities and the existence of a multispiral protoconch, denoting a planktotrophic development.



*Dimensions:* 3.7 mm long, 2.4 mm wide.

*Geographic distribution:* Atlantic, Azores, English Channel and North Sea (CAMPBELL, 1994), Madeira (NOBRE,

1889, 1937; GOFAS, 1990), British isles, Mediterranean, Canary islands and Cape Vert Islands (KNUDSEN, 1995). São Tomé island (FERNANDES AND ROLÁN, 1993).

*Alvania cimex* (Linnaeus, 1758)

References to the Azores:

*Rissoa granulata* Philippi, 1836: Mac Andrew, 1856: 121.

*Occurrence:* Azores from shores (dead) (MAC ANDREW, 1856: 121).

*Comments:* DAUTZENBERG (1889), raised doubts about the specific status

of the specimen(s) identified by Mac Andrew. I agree with him and consider that this record needs to be confirmed.

*Alvania formicarum* Gofas, 1989

References to the Azores:

*Alvania formicarum* Gofas, 1989: 40-41; Hoenselaar and Goud, 1998: 72.

*Occurrence:* Formigas and Ilhéu de São Lourenço (Santa Maria) (GOFAS, 1989:40-41).

DBUA 332, 335, 338, 340, 341, 342, 343, 345, 348, 350, 352, 353, 355, 359.

*Comments:* the zonation of this species is not known. However, living

specimens have been collected from 15 to 43m depth.

*Dimensions:* 2.4mm long, 1.4mm wide.

*Geographic distribution:* restricted to Formigas islets and Santa Maria island.

*Alvania internodula* Hoenselaar and Goud, 1998

References to the Azores:

*Alvania* sp.: Ávila and Azevedo, 1997: 326.

*Alvania internodula* Hoenselaar and Goud, 1998: 83.

*Occurrence:* Formigas (ÁVILA AND AZEVEDO, 1997: 326). Azores (CANCAP expeditions: Sta. 5033, 35m/1 specimen; Sta. 5039, 43m/2; Sta. 5040, 41-47m/25; Sta. 5091, 33m/7; Sta. 5098, 40m/1; Sta. 5113, 45m/12; Sta. AZO.022, at shore/1) (HOENSELAAR AND GOUD, 1998: 83).

DBUA 336, 338.

*Comments:* in their check-list of the shallow-water marine molluscs of Formigas, ÁVILA AND AZEVEDO (1997) indicated the presence of a new species of *Alvania* in 6 lots of the DBUA collection: DBUA 332, 335, 336, 338, 350, 355. Later work at the SEM level revealed the existence of a species already described as *A.*

*internodula* Hoenselaar and Goud, 1998. Also, only the specimens in the DBUA 336 and 338 lots were correctly assigned to this new species, all other specimens being *Alvania angioyi* Van Aartsen, 1982d. The shells of the young specimens of *Alvania internodula* resemble *Alvania angioyi* Van Aartsen, 1982d, but the adults are quite different, with stronger knobs in the whorls and with deeper sutures.

*Additional description:* Protoconch sculptured with 5-6 marked spiral ribs, the interstices covered with numerous very small nodules, not aligned. In the second whorl of the teleoconch, the intermediate 3 ribs are more prominent than the others,

the same happening in the body whorl. The crossings of spiral ribs and costae produce nodules, that are stronger in the intermediate 3 ribs. The ribs located in the anterior part of the body whorl are quite

smooth. Inside the outer lip there are 8-9 faint denticles (Fig. 8: A-J).

*Dimensions*: 2.3 mm long, 1.3 mm wide.

*Geographic distribution*: restricted to the Formigas islets, Azores.

### *Alvania mediolittoralis* Gofas, 1989

References to the Azores:

*Alvania mariae* (D'Orbigny): Dautzenberg, 1889: 49.

*Rissoa* (*Alvania*) *reticulata* Montagu var. *mariae* D'Orbigny: Nobre, 1924: 81.

*Alvania* (*Turbona*) *reticulata* (Montagu, 1803): Martins, 1980: 17 (misidentification, A.M.F. Martins, pers. comm).

*Alvania mediolittoralis* Gofas, 1989: Gofas, 1989: 39; Azevedo and Martins, 1989: 69; Azevedo, 1990: 59; Azevedo and Gofas 1990: 85; Gofas, 1990: 110-112; Azevedo, 1991a: 21; 1991b: 44; Ávila, 1996:27; Hoenselaar and Goud, 1998: 91.

*Occurrence*: São Miguel and Pico (-1287m) (DAUTZENBERG, 1889: 49), São Miguel (Ponta Delgada; Praia do Rosto do Cão), Terceira, Pico and Graciosa (NOBRE, 1924: 81; 1930: 57), São Miguel (Atalhada, Lagoa) (MARTINS, 1980: 17), Graciosa (mediolittoral of Porto Afonso and Santa Cruz; infralittoral of Baía da Folga) (AZEVEDO AND MARTINS, 1989: 69), Flores (Santa Cruz) (AZEVEDO AND GOFAS, 1990: 85), Pico (Baía de São Pedro, Lajes do Pico) (AZEVEDO, 1990: 59), São Miguel (Caloura, -4m; Vila Franca, -9m, -24m "Biaçores" 1971 expedition; Ponta da Galera, intertidal; Capelas, intertidal; Água d'Alto, intertidal; Calheta - Ponta Delgada, intertidal), Faial (Horta, -7m), Terceira (Praia da Vitória; Cais da Silveira; Pedra Furada - Angra do Heroísmo); Flores (Santa Cruz) (GOFAS, 1989: 39; 1990: 110), São Miguel (mediolittoral of Caloura; infralittoral of Caloura and Ribeirinha) (AZEVEDO, 1991a: 21), Santa Maria (Vila do Porto, Ponta do Marvão) (AZEVEDO, 1991b: 44), Ilhéu de Vila Franca (BULLOCK, 1995: 16), Pico (mediolittoral) (ÁVILA, 1996: 27) and

Azores (CANCAP expeditions) (HOENSELAAR AND GOUD, 1998: 91).

DBUA 124, 188, 193, 197, 229, 240, 274, 442, 444, 445, 446, 448, 449, 450, 451, 452, 453, 455, 456, 457, 458, 459, 460, 461, 462, 471, 473, 474, 475, 476, 483, 486, 489, 490, 492, 493, 496, 499, 500, 551, 553, 558, 560, 561, 564, 565, 566, 568, 570, 571, 574, 579, 614, 632, 659, 661, 662, 663, 665, 666, 667, 715, 719.

*Comments*: common in sheltered places, especially under rocks. Sometimes present in large numbers in the intertidal zone, together with *Fossarus ambiguus* (Linnaeus, 1758) and *Cingula trifasciata* (Adams, 1798) (GOFAS, 1990). It is similar to *Alvania manzonii* (Nordsieck, 1972) from the Canary Islands and Selvagens, and resembles also *Alvania leacocki* (Watson, 1873), from Madeira (GOFAS, 1989).

*Dimensions*: up to 2.7 mm long, 1.5 mm wide.

*Geographic distribution*: Azores and Madeira archipelago (CANCAP expeditions, Sta. 1.D48, 0-22m / 1 specimen; Sta.1.K14, at shore / 1 and Sta. 1.K16, at shore / 2) (HOENSELAAR AND GOUD, 1998: 91).

### *Alvania poucheti* Dautzenberg, 1889

References to the Azores:

*Alvania poucheti* Dautzenberg, 1889: 49-50; Bullock *et al.*, 1990: 45; Gofas, 1990: 108; Morton and Britton, 1995: 70; Knudsen, 1995: 141; Ávila, 1996: 27; Ávila and Azevedo, 1996: 106; Ávila and Azevedo, 1997: 326; Ávila *et al.*, 1998: 497; Hoenselaar and Goud, 1998: 99.

*Alvania poucheti* var. *cingulifera* Dautzenberg, 1889: 50.



*Occurrence:* São Miguel (DAUTZENBERG, 1889: 49-50), São Miguel (Ponta da Galera; Queimada, Água d'Alto; Mosteiros; Ilhéu de Vila Franca) (BULLOCK *ET AL.*, 1990: 45), São Miguel (Capelas, -24m ("Biaçores" 1971 expedition); Feteiras, -15 to -22m; Ponta Delgada, -10 to -20m; Lagoa; Ilhéu de Vila Franca, -1m; Ponta da Pirâmide, -13m; Calheta, Ponta Delgada; Ponta da Galera, -13 to -18m), Faial (Horta, -17 and -20m), Terceira (Praia da Vitória; Angra do Heroísmo, Pedra Furada) (GOFAS, 1990: 108), São Miguel (off Vila Franca do Campo) (MORTON AND BRITTON, 1995: 70), São Miguel (Ilhéu de Vila Franca) (KNUDSEN, 1995: 141), Pico

(intertidal) (ÁVILA, 1996: 27), Pico (ÁVILA AND AZEVEDO, 1996: 106), Formigas islets (ÁVILA AND AZEVEDO, 1997: 326), Flores (ÁVILA *ET AL.*, 1998: 497) and Azores (CANCAP expeditions) (HOENSELAAR AND GOUD, 1998: 99).

DBUA 119, 173, 240, 350, 352, 353, 355, 447, 465, 493, 499, 500, 556, 563, 570, 631, 666.  
MCM(HN) 3, 11, 107, 108.

*Comments:* usually associated with brown algae. It may occur at 20m depth, but is commonest in the first 10m.

*Dimensions:* up to 2.2mm long, 1.3mm wide.

*Geographic distribution:* endemic to the Azores.

### *Alvania sleursi* (Amati, 1987)

#### References to the Azores:

(?) *Rissoa* (*Alvania*) *hispidula* Monterosato: Watson, 1886: 593 (misidentification).

*Alvania hirta* Monterosato: Dautzenberg and Fischer, 1896: 456 (misidentification).

*Manzonella sleursi* Amati, 1987: 25-30.

*Alvania sleursi* (Amati, 1987): Gofas, 1990: 107; Knudsen, 1995: 142; Ávila, 1996: 27; Ávila and Azevedo, 1996: 106; Ávila and Azevedo, 1997: 326.

*Occurrence:* Faial (-823 to -914 m) (WATSON, 1886: 593), Banco Princesa Alice (st. 46, -1385 m) (DAUTZENBERG AND FISCHER, 1896: 456), São Miguel (Ponta da Galera, -7 to -8m, -13 to -18m and -20m; Vila Franca, -24m; Morro das Capelas, -15 to -20m; Lagoa, -10 to -22m; Feteiras, -15 to -22m; Ponta da Pirâmide, -13m; Ilhéu de Vila Franca, -1m), Pico (-1287m), Terceira (Angra do Heroísmo, Pedra Furada; Praia da Vitória), Flores (Santa Cruz, -40m) (GOFAS, 1990: 107), Ilhéu de Vila Franca (KNUDSEN, 1995: 142), Pico (intertidal) (ÁVILA, 1996: 27), Pico (ÁVILA AND AZEVEDO, 1996: 106) and Formigas islets (ÁVILA AND AZEVEDO, 1997: 326).

DBUA 173, 335, 340, 341, 342, 343, 350, 352, 353, 355, 446, 448, 458, 459, 493, 496, 499, 500, 666, 667, 719.

MCM(HN) 40.

*Comments:* occurs from the intertidal to 45m depth, being more abundant on rocky shores, between -10 to -20m. HOENSELAAR AND GOUD (1998) reported this species to Selvagens archipelago (CANCAP expeditions, Sta. 3070, 645m depth/8 specimens; Sta. 3072, 830m/3; Sta. 3087, 322m/8, with all specimens strongly eroded).

*Dimensions:* up to 2.5 mm long, 1.6 mm wide.

*Geographic distribution:* Azores and Selvagens archipelago (HOENSELAAR AND GOUD, 1998: 103).

### *Alvania tarsodes* (Watson, 1886)

#### References to the Azores:

*Rissoa* (*Alvania*) *tarsodes* Watson, 1886: 595, pl. XLIV, fig. 2.

*Alvania tarsodes* (Watson, 1886): Bouchet and Warén, 1993: 642; Hoenselaar and Goud, 1998: 106.

*Occurrence:* Azores, from 35m depth to 620m (HOENSELAAR AND GOUD, 1998: 106).

*Comments:* although first reported to be a bathyal species (480-1385m depth,

BOUCHET AND WARÉN, 1993), HOENSELAAR AND GOUD (1998) have found specimens in some shallow samples of the CANCAP expeditions (Sta. 5033, 35m/3 specimens; Sta. 5039, 43m/8; Sta. 5040, 41-47m/8; Sta. 5050, 55m/3; Sta. 5096,

52m/4; Sta. 5100, 55m/1 and Sta. 5113, 45m/1).

*Dimensions*: 2.2mm long, 1.3mm wide (WATSON, 1886).

*Geographic distribution*: restricted to the Azores.

*Botryphallus* Ponder, 1990

*Botryphallus ovummuscae* (Gofas, 1990)

References to the Azores:

*Peringiella nitida* Brusina: Dautzenberg, 1889: 53.

*Cingula* (*Peringiella*) *nitida* (Brusina) Monterosato: Martins, 1980: 5.

"*Peringiella*" sp.: Azevedo and Gofas, 1990: 85.

"*Peringiella*" *ovummuscae* (Gofas, 1990): Gofas, 1990: 119-121, fig. 11.

*Botryphallus ovummuscae* (Gofas, 1990): Ávila, 1996: 27; 1998: 466; Ávila and Azevedo, 1996: 106.

*Occurrence*: Faial (-15 to -20m) and São Miguel (DAUTZENBERG, 1889, p. 53), Terceira (Poça dos Frades, Silveira; Caminho de Baixo, São Mateus) e São Miguel (Água d'Alto; Pópulo; Atalhada, Lagoa) (MARTINS, 1980, pp. 9-16), Flores (Santa Cruz, mediolittoral) (AZEVEDO AND GOFAS, 1990: 85), São Miguel (Ponta da Galera, intertidal; Calheta, Ponta Delgada), Terceira (Porto Martins), Flores (Santa Cruz, upper intertidal zone), (GOFAS, 1990, p. 120), Pico (intertidal) (ÁVILA, 1996: 27; 1998: 466) and Pico (ÁVILA AND AZEVEDO, 1996: 106).

DBUA 209, 493, 499, 500, 659, 661, 662, 665, 666, 715.

*Comments*: according to GOFAS (1990), there are related species in the Straits of Gibraltar (*Peringiella epidaurica* Brusina, 1886), at Madeira and also on the Canary Islands (in this last archipelago there are two species similar to the Azorean one).

*Dimensions*: up to 1.3 mm long, 0.7 mm wide.

*Geographic distribution*: endemic to the Azores.

*Cingula* Fleming, 1828

*Cingula ordinaria* Smith

References to the Azores:

*Cingula ordinaria* Smith: Chapman, 1955: 803.

*Occurrence*: Faial (Feteira, mid-tide) (CHAPMAN, 1955: 803).

*Comments*: this species was probably misidentified. Most probably, it

represents *Cingula trifasciata* (J. Adams, 1800), the only representative of this genus that lives at the Azores Archipelago.

*Cingula trifasciata* (J. Adams, 1800)

References to the Azores:

*Rissoa* (*Cingula*) *cingillus* Montagu, 1803: Mac Andrew, 1856: 148.

*Cingula cingillus* Montagu, 1803: Dautzenberg, 1889: 52; Knudsen, 1995: 143.

*Rissoa* (*Cingula*) *cingillus* Montagu, 1803: Nobre, 1924: 80; 1930: 57.

*Cingula* (*Cingula*) *cingillus* (Montagu, 1803): Martins, 1980: 5; Lemos and Viegas, 1987: 65.

*Cingula trifasciata* (Adams, 1798): Azevedo and Gofas, 1990: 85.

*Cingula trifasciata*, (Adams, 1800): Gofas, 1990: 97-134; Bullock, 1995: 9-55; Ávila, 1996: 27 Ávila and Azevedo, 1997:326.

**Occurrence:** Azores, at shore (Mac Andrew, 1856: 122, 148), São Miguel (DAUTZENBERG, 1889: 52), São Miguel (Ponta Delgada), Faial (Horta), Terceira (Angra do Heroísmo), Graciosa, Pico and São Jorge (Calheta; Velas) (NOBRE, 1924: 80; 1930: 57), São Jorge (Velas) (MORTON, 1967: 36), Terceira (Poça dos Frades, Silveira; Fanal, São Pedro, Angra do Heroísmo; Caminho de Baixo, São Mateus) and São Miguel (Água d'Alto; Calheta, Ponta Delgada; Pópulo; Atalhada, Lagoa) (MARTINS, 1980: 9-17), São Miguel (Vila Franca do Campo: intertidal) (LEMONS AND VIEGAS, 1987: 65), Flores (mediolittoral of Santa Cruz) (AZEVEDO AND GOFAS, 1990: 85), São Miguel (Ponta da Galera, intertidal; Água d'Alto, intertidal) (GOFAS, 1990: 119), São Miguel (Ilhéu de Vila Franca) (BULLOCK, 1995: 9-55), Pico (intertidal) (ÁVILA, 1996: 27) and Formigas islets (ÁVILA AND AZEVEDO, 1997: 326).

DBUA 128, 205, 240, 352, 442, 445, 448, 449, 457, 460, 461, 470, 474, 475, 489, 490, 496, 499, 500, 659, 632, 660, 661, 662, 663, 665, 666, 667.

**Comments:** NOBRE (1924; 1930) states that this species is common in littoral debris. It is extremely common in sheltered places, especially under rocks (ÁVILA AND AZEVEDO, 1997). This species is detritivorous and usually occurs from the upper limit of barnacles (*Chthamalus stellatus*) to a few meter's depth (GRAHAM, 1988). It has non-planktotrophic development (KNUDSEN, 1995) and because of this, GOFAS (1990) has some doubts about its conspecificity with populations in Europe. The specimens collected by the author at Lajes do Pico, have a wide range of external color, from almost black to light-brown (pers. obs.).

**Dimensions:** 3.9 mm long, 2.1 mm wide.

**Geographic distribution:** Bay of Biscay to the West coast of Norway, the English Channel, Azores (GRAHAM, 1988; POPPE AND GOTO, 1991; HAYWARD, WIGHAM AND YONOW, 1995; KNUDSEN, 1995), Madeira (NOBRE, 1937), Berlenga (Portugal) (BURNAY, 1986).

### *Crisilla* Monterosato, 1917 *Crisilla postrema* (Gofas, 1990)

#### References to the Azores:

*Setia abjecta* (Watson, 1873): Dautzenberg, 1889: 52.

*Setia picta* (Jeffreys, 1867): Dautzenberg, 1889: 53.

*Alvania* (*Crisilla*) sp.: Azevedo and Gofas, 1990: 85.

*Alvania* (*Crisilla*) *postrema* Gofas, 1990: 114.

*Alvania postrema* Gofas, 1990. Azevedo, 1991b: 44; Ávila and Azevedo, 1997: 326; Hoenselaar and Goud, 1998: 99.

**Occurrence:** Azores (colec. G. Dollfus), São Miguel and Faial (-15 to -20 m) (DAUTZENBERG, 1889: 53), Flores (Santa Cruz) (AZEVEDO AND GOFAS, 1990: 85), São Miguel (Capelas, -12m; Ilhéu dos Mosteiros, -3 to -5m; Morro das Capelas, intertidal and at -29m ("Biaçores" 1971 expedition); Ponta da Galera, intertidal and from -13 to -18m; Ponta Delgada, -10 to -20m, Ilhéu de Vila Franca; Ponta da Pirâmide, -13m; Calheta, Ponta Delgada), Faial (Horta, -3m, -7m and -17m),

Terceira (Praia da Vitória; Angra do Heroísmo, Pedra Furada), Flores (Santa Cruz, intertidal pool), Formigas (-16m) (GOFAS, 1990: 114-115), Caloura and Ribeirinha (AZEVEDO, 1991a: 22), Santa Maria (Vila do Porto, Ilhéu da Vila, Ponta do Marvão) (AZEVEDO, 1991b: 44), São Miguel (Ilhéu de Vila Franca) (BULLOCK, 1995: 16), Pico (intertidal) (ÁVILA, 1996: 27), Pico (ÁVILA AND AZEVEDO, 1996: 106) and Formigas islets (ÁVILA AND AZEVEDO, 1997: 326).

DBUA 121, 173, 188, 198, 274, 277, 340, 350, 351, 352, 353, 355, 359, 447, 462, 465, 470, 472, 492, 496, 499, 500, 545, 564, 632, 670.

*Comments:* this is an uncommon species. It occurs from the low-tide level to a depth of 20m. Two specimens were

recently found at Madeira (CANCAP expeditions, Sta. 4.K27, at shore) (HOENSELAAR AND GOUD, 1998: 99).

*Dimensions:* 1.5mm long, 0.9mm wide.

*Geographic distribution:* Azores and Madeira (HOENSELAAR AND GOUD, 1998: 99).

### *Manzonina* Brusina, 1870

#### *Manzonina unifasciata* Dautzenberg, 1889

##### References to the Azores:

- Manzonina costata* J. Adams, 1797 var. ex colore: *unifasciata*: Dautzenberg, 1889: 51, pl. III, fig.10.  
*Manzonina costata* J. Adams var. ex colore: *bifasciata*: Dautzenberg, 1889: 51, pl. III, fig. 9.  
*Manzonina costata* J. Adams var. ex colore: *luteola*: Dautzenberg, 1889: 51.  
*Manzonina aurantiaca* (Watson, 1873): Dautzenberg, 1889: 52.  
*Manzonina costata* (Adams, 1797). Pico (Nobre, 1924: 80; 1930: 56).  
*Alvania* (*Manzonina*) *crassa* (Kanmacher, 1798): Morton, 1967: 36.  
*Manzonina aurantiaca* (Watson, 1873): Nordsieck, 1972: 176, pl. R VI, fig. 2.  
*Alvania* (*Manzonina*) *costata* (Adams): Martins, 1980: 5, 16.  
*Manzonina unifasciata* Dautzenberg, 1889: Moolenbeek and Faber, 1987, p.26, fig. 42; Azevedo and Martins, 1989: 69; Azevedo, 1990: 59; Azevedo and Gofas, 1990: 85; Gofas, 1990: 116, figs. 9; 59-64; Azevedo, 1991a: 22; Ávila, 1996: 27; Ávila and Azevedo, 1997: 326.  
*Manzonina crassa* (Kanmacher, 1798) (misidentification?): Bullock *et al.*, 1990: 45.  
*Manzonina unifasciata* (Dautzenberg, 1889): Azevedo, 1991b: 44.  
*Alvania crassa* (Kanmacher, 1798) (misidentification?): Knudsen, 1995: 141.

*Occurrence:* São Miguel (Ponta Delgada), Faial (Horta), Pico, Graciosa and Terceira (Angra do Heroísmo) (DAUTZENBERG, 1889: 51-52), São Miguel (Ponta Delgada), Faial (Horta), Pico, Graciosa and Terceira (Angra do Heroísmo) (NOBRE, 1924: 80; 1930: 56) São Jorge (Velas) (MORTON, 1967: 36), Pico (-1276m) and São Miguel (NORDSIECK, 1972: 176), São Miguel (Brejela, Atalhada, Lagoa) (MARTINS, 1980: 5, 16), Graciosa (mediolittoral of Fonte da Areia, Porto Afonso and Santa Cruz. Infralittoral of Baía da Folga and Carapacho) (AZEVEDO AND MARTINS, 1989: 69), Faial (Monte da Guia) (AZEVEDO, 1990: 59), Flores (Santa Cruz) (AZEVEDO AND GOFAS, 1990: 85), São Miguel (Ponta da Galera; Queimada, Água d'Alto; Mosteiros; Calheta, Ponta Delgada; Ilhéu de Vila Franca) (BULLOCK *ET AL.*, 1990: 43, 45), São Miguel (Caloura, -4m; Vila Franca do Campo, -24m; Ilhéu de Vila Franca do Campo; Morro das Capelas, -29m ("Biaçores" 1971 expedition); Cape-

las, intertidal; Lagoa, intertidal; Calheta, Ponta Delgada, 0 to -1m; Ponta da Galera, -13 to -18m), Faial (Horta, -3m, -20m), Terceira (Porto Martins; Praia da Vitória; Pedra Furada-Angra do Heroísmo); Flores (Santa Cruz, intertidal) (GOFAS, 1990: 116), São Miguel (mediolittoral of Caloura. Infralittoral of Caloura and Ribeirinha) (AZEVEDO, 1991a: 22), Santa Maria (Vila do Porto, Ilhéu da Vila, Ponta do Marvão) (AZEVEDO, 1991b: 44), São Miguel (Ilhéu de Vila Franca) (BULLOCK, 1995: 16; KNUDSEN, 1995: 142), Pico (intertidal) (ÁVILA, 1996: 27) and Formigas islets (ÁVILA AND AZEVEDO, 1997: 326).

DBUA 173, 188, 266, 273, 274, 281, 332, 338, 340, 341, 346, 350, 352, 353, 355, 442, 443, 445, 446, 449, 451, 452, 462, 470, 471, 475, 476, 486, 492, 493, 496, 499, 500, 556, 571, 574, 579, 657, 660, 661, 662, 665, 666, 667, 670, 715, 719.

MCM(HN) 1, 75.

*Comments:* from low-tide level to -20m. This species has a quite variable

color pattern (pers. obs.). The diameter of the protoconch (340  $\mu$ m, KNUDSEN, 1995: 142, fig. 3B), seems to indicate that *M unifasciata* has non-planktotrophic development (KNUDSEN, 1995). *Manzonina crassa*, a species that exists on the Portuguese mainland (e.g.: Berlenga, see BURNAY, 1986: 27; BULLOCK ET AL., 1990), *Rissoa costata*, reported from the Canary Islands (MAC ANDREW, 1852: 5) and *Alvania costata*, reported from Madeira

by NOBRE (1937: 45) have also been reported from the Azores. I believe that all of them were misidentified with *Manzonina unifasciata*, which is endemic to the Azores and is the only representative of this genus in the Azorean Archipelago.

*Dimensions*: 2.5 mm long, 1.2 mm wide.

*Geographic distribution*: endemic to the Azores.

*Onoba* Adams H. and A., 1854

*Onoba moreleti* Dautzenberg, 1889

References to the Azores:

*Onoba moreleti* Dautzenberg, 1889: 52; Moolenbeek and Hoenselaar, 1987: 154; Ávila et al., in press.

*Occurrence*: Pico, Faial and Flores (ÁVILA ET AL., 1998: 498), Faial, Horta bay (Stn. 193) (-20m) (MOOLENBEEK AND HOENSELAAR, 1987: 154), São Miguel (ÁVILA ET AL., in press).

DBUA 181, 410, 411, 500, 556, 666, 748.

*Comments*: this is a rare species of the Azorean littoral. AARTSEN, MENKHORST AND GITTENBERGER (1984) were surprised to find specimens of *Onoba moreleti* at the Bay of Algeciras (Southern Spain), but this species was later described as *Onoba josae* by MOOLENBEEK AND HOENSELAAR (1987). Its presence was also reported from Graciosa, Canary Islands (collection M. C. Fehr-de Wal) by

AARTSEN ET AL. (1984) but, once again, it was a different species, described as *Onoba manzoniana* by ROLÁN (1987). According to MOOLENBEEK AND FABER (1987) this species is *Manzonina manzoniana* (Rolán, 1987). Formerly thought to be restricted to the western and central groups of islands of the Azores, recent sorting of material collected at São Miguel island (DBUA 748 - Capelas, north coast, 14m depth) has revealed that *O. moreleti* also occur in the eastern group.

*Dimensions*: 2.6mm long, 1.3mm wide.

*Geographic distribution*: endemic to the Azores.

*Rissoa* (Fréminville, ms.) Desmarest, 1814

*Rissoa guerini* Récluz, 1843

References to the Azores:

*Cingula costulata* Alder, 1844: Chapman, 1955: 803.

*Occurrence*: Faial (Feteira, mid tide) (CHAPMAN, 1955: 803).

*Comments*: a dubious record. This species has not since been cite from the Azores yet, although its distribution ranges from the British isles to the Canaries (FRETTER AND GRAHAM, 1978; POPPE AND GOTO, 1991). Probably, Chapman

misidentified specimens of *Rissoa guerini* Dautzenberg, 1889 for his species *Cingula costulata*.

*Dimensions*: 6.0 mm long, 3.0 mm wide (FRETTER AND GRAHAM, 1978).

*Geographic distribution*: British isles to Portugal and the Canaries (FRETTER AND GRAHAM, 1978; POPPE AND GOTO, 1991).



*Rissoa guernei* Dautzenberg, 1889

References to the Azores:

*Rissoa guernei* Dautzenberg, 1889: 47-48, pl. 3, figs. 1a, b; Azevedo and Gofas, 1990: 85; Bullock *et al.*, 1990: 45; Gofas, 1990: 100; Azevedo, 1991a: 21; 1991b: 44; Bullock, 1995: 16; Knudsen, 1995: 140; Ávila, 1996: 27; Ávila and Azevedo, 1996: 106.

*Rissoa obesula* Dautzenberg, 1889: 48, pl. 3, figs. 2a, b.

*Rissoa jousseaumei* Dautzenberg and Fischer, 1896: 60-61, pl. 19, fig. 9 *fide* Gofas, 1990, p. 99.

*Monizella moniziana azorica* Nordsieck, 1972: 173, pl. R V, fig. 28.

**Occurrence:** São Miguel and Faial (-15 to -20 m) (DAUTZENBERG, 1889: 47-48), Pico (-1287m) (DAUTZENBERG, 1889: 48, pl. 3, figs. 2a, b), São Miguel (-1385m) (DAUTZENBERG AND FISCHER, 1896: 60-61, pl. 19, fig. 9), São Miguel (Ponta Delgada) (NORDSIECK, 1972: 173, pl. R V, fig. 28), Graciosa (mediolittoral of Porto Afonso; infralittoral of Baía da Folga) (AZEVEDO AND MARTINS, 1989: 69), Pico (Lajes do Pico) (AZEVEDO, 1990: 59), Flores (Fajã Grande; Santa Cruz) (AZEVEDO AND GOFAS, 1990: 85), São Miguel (Ponta da Galera; Queimada, Água d'Alto; Mosteiros; Calheta, Ponta Delgada; Ilhéu de Vila Franca; Porto do Ilhéu, Vila Franca do Campo) (BULLOCK *ET AL.*, 1990: 43, 45), Flores (infralittoral of Fajã Grande and Piscina of Ponta Delgada) (NETO AND AZEVEDO, 1990: 96, 98), São Miguel (Vila Franca ("Biaçores" 1971 expedition); Ponta Delgada; (-10 to -20m); Ponta da Galera (intertidal); Capelas (intertidal); Vila Franca (0 to -5 m); Ilhéu de Vila Franca (0 to -1 m); Calheta, Ponta Delgada (intertidal); Ponta da Pirâmide (-13m) (GOFAS, 1990: 100), São Miguel (mediolittoral of Caloura; infralittoral of Caloura and Ribeirinha) (AZEVEDO, 1991a: 21), Santa Maria (Vila do Porto, Ponta da Malbusca, Ilhéu da Vila,

Ponta do Marvão) (AZEVEDO, 1991b: 44), São Miguel (Ilhéu de Vila Franca) (BULLOCK, 1995: 16; KNUDSEN, 1995: 140), Pico (intertidal) (ÁVILA, 1996: 27) and Pico (ÁVILA AND AZEVEDO, 1996: 106).

DBUA 188, 190, 193, 195, 220, 240, 274, 281, 442, 443, 448, 451, 452, 459, 460, 462, 468, 470, 471, 472, 473, 475, 492, 493, 496, 499, 500, 551, 554, 556, 565, 566, 568, 570, 571, 574, 579, 632, 661, 662, 666, 667, 719.

**Comments:** feeds on detritus and on epiphytic algae (GRAHAM, 1988). According to GOFAS (1990) this species is sexual dimorphic. It occurs from the low-tide level to -8m. PONDER (1985) states that the genus *Rissoa* has pelagic larvae, being restricted to the Mediterranean and north-eastern Atlantic. *Rissoa guernei* however, is a direct development species and one may hypothesize that the ancestral of this species probably lost its planktotrophic veliger larvae after colonizing the Azores.

**Dimensions:** up to 2.3 mm long, 1.3 mm wide.

**Geographic distribution:** endemic to the Azores, even though it is closely related to Macaronesian/European species (GOFAS, 1990).

*Setia* H and A. Adams, 1852

*Setia* sp.

References to the Azores:

*Setia* sp. Azevedo and Gofas, 1990: 85; Ávila *et al.*, 1998: 496.

**Occurrence:** Flores (Santa Cruz, -20m) (AZEVEDO AND GOFAS, 1990: 85), Pico and Flores (ÁVILA *ET AL.*, 1998: 496).

DBUA 274, 276, 277, 281, 446, 449, 478, 496, 499, 662.

**Comments:** the small dimensions of this species has probably led to its being

overlook in samples. The sorting of samples with a mesh size of 0.5mm will help to clarify its zonation and its geographical distribution.

**Dimensions:** 1.0mm long, 0.8mm wide.

**Geographic distribution:** Flores, Pico and São Miguel.



*Setia pulcherrima* (Jeffreys, 1848)

References to the Azores:

*Cingula pulcherrima* (Jeffreys, 1848): Bullock *et al.*, 1990: 45; Knudsen, 1995: 143-144.

*Occurrence*: São Miguel (Ponta da Galera; Queimada, Água d'Alto; Mosteiros; Calheta, Ponta Delgada; Ilhéu de Vila Franca; Porto do Ilhéu, Vila Franca) (BULLOCK *ET AL.*, 1990: 45), São Miguel (Ilhéu de Vila Franca) (KNUDSEN, 1995: 143-144).

*Comments*: this record needs to be confirmed. This species is reported to live on rocky shores, among fine weeds at the low tide (FRETTER AND GRAHAM,

1978). However in all the samples collected from such places in the Azores, I have never found this species. It might be a misidentification for *Setia subvaricosa* Gofas, 1990.

*Dimensions*: 1.2 mm long, 0.8 mm wide (FRETTER AND GRAHAM, 1978).

*Geographic distribution*: Azores (?). North to the Channel islands (FRETTER AND GRAHAM, 1978).

*Setia quisquiliarum* Watson, 1886

References to the Azores:

*Setia quisquiliarum* Watson, 1886: Dautzenberg, 1889: 53.

"Rissoa" *quisquiliarum* Watson, 1886: Gofas, 1990: 103.

*Occurrence*: São Miguel (DAUTZENBERG, 1889: 53). Off Faial (38° 38' N, 28° 28' 30" W, in 730-910 m), Terceira (GOFAS, 1990).

*Comments*: GOFAS (1990) states that this species is restricted to the central

group of islands, but DAUTZENBERG (1889) quotes it from São Miguel, in the eastern group.

*Dimensions*: 1.4mm long, 0.9mm wide.

*Geographic distribution*: Faial, Terceira and São Miguel.

*Setia subvaricosa* Gofas, 1989

References to the Azores:

*Setia abjecta* Watson, 1873: Dautzenberg, 1889: 52.

*Setia subvaricosa* Gofas, 1989: Azevedo, 1990: 58; Gofas, 1990: 102-104; Ávila, 1996: 27; Ávila and Azevedo, 1996: 106; Ávila and Azevedo, 1997: 326; Ávila *et al.*, 1998: 496.

*Occurrence*: Faial (-15 a -20 m) (DAUTZENBERG, 1889: 52), Faial (Monte da Guia) (AZEVEDO, 1990: 58), São Miguel (Ilhéu de Vila Franca, intertidal; Capelas, intertidal; Feteiras, -15 m; Lagoa, -10 to -22 m; Ponta da Galera, intertidal; Ponta da Pirâmide, -13 m; Calheta, Ponta Delgada, intertidal), Terceira (Praia da Vitória, Pedra Furada - Angra do Heroísmo), Flores (Santa Cruz, -20 m) (GOFAS, 1990: 102-103), Pico (intertidal) (ÁVILA, 1996: 27), Pico (ÁVILA AND AZEVEDO, 1996: 106), Formigas islets (ÁVILA AND AZEVEDO, 1997: 326), Flores (ÁVILA *ET AL.*, 1998: 496).

DBUA 176, 188, 193, 195, 223, 274, 281, 332, 335, 336, 338, 343, 345, 350, 352, 355, 447, 451, 462, 465, 467, 471, 481, 496, 499, 500, 545, 557, 564, 571, 574, 660, 662, 666.

*Comments*: this is an uncommon species. The outer lip of the adult shell of *S. subvaricosa* is thicker than that in the other species of *Setia* from the Mediterranean and the Atlantic (GOFAS, 1990).

*Dimensions*: up to 1.4 mm long, 0.8 mm wide.

*Geographic distribution*: endemic to the Azores.

Table I. Distribution of the Rissoidae on the islands and islets of the Azorean Archipelago.

Tabla I. Distribución de los Rissoidae en las islas e islotes del archipiélago de las Azores.

	western group	central group					eastern group		
	Flores	Pico	São Jorge	Faial	Graciosa	Terceira	São Miguel	Santa Maria	Formigas
<i>Alvania abstersa</i>		1	1			1	1	1	
<i>Alvania angioyi</i>	1	1		1	1	1	1	1	1
<i>Alvania cancellata</i>	1	1	1	1	1	1	1	1	1
<i>Alvania formicarum</i>								1	1
<i>Alvania internodula</i>									1
<i>Alvania mediolittoralis</i>	1	1		1	1	1	1	1	
<i>Alvania poucheti</i>	1	1		1		1	1		1
<i>Alvania sleursi</i>	1	1		1		1	1		1
<i>Botryphallus ovummuscae</i>	1	1		1		1	1		
<i>Cingula trifasciata</i>	1	1	1	1	1	1	1		1
<i>Crisilla postrema</i>	1	1		1		1	1	1	1
<i>Manzonina unifasciata</i>	1	1	1		1	1	1	1	1
<i>Onoba moreleti</i>	1	1		1			1		
<i>Rissoa guernei</i>	1	1		1	1		1	1	
<i>Setia quisquiliarum</i>				1		1	1		
<i>Setia subvaricosa</i>	1	1		1		1	1		1
<i>Setia</i> sp.	1	1					1		
Total number of taxa	13	14	4	13	6	12	15	8	10

Table II. Morphometry of the Rissoidae of the Azores. #Wp: number of protoconch whorls; #Wt: number of teleoconch whorls; Di p: diameter of the protoconch; I: protoconch 1; II: protoconch 2; L: total length of the shell; W: total breadth of the shell (based on own data; WATSON, 1886; GOFAS, 1990; KNUDSEN, 1995; HOENSELAAR AND GOUD, 1998).

Tabla II. Morfometría de los Rissoidae de las Azores. #Wp: número de vueltas de la protoconcha; #Wt: número de vueltas de la teleoconcha; Di p: diámetro de la protoconcha; I: protoconcha 1; II: protoconcha 2; L: longitud total de la concha; W: anchura total de la concha (basado en datos propios; WATSON, 1886; GOFAS, 1990; KNUDSEN, 1995; HOENSELAAR AND GOUD, 1998).

RISSOIDAE	#Wp	#Wt	Di p (m)	L (mm)	W (mm)
<i>Alvania abstersa</i> Van der Linden and Van Aartsen, 1994	1.5	3.5	300-400	2.3 - 3.3	1.5 - 1.7
<i>Alvania angioyi</i> Van Aartsen, 1982	1.5	3.25 - 3.75	283.3 - 292.3	1.2 - 1.8	0.7 - 1.1
<i>Alvania cancellata</i> (Da Costa, 1778)	I: 1	3.5	I: 120.0 - 175.0	2.7 - 3.7	1.8 - 2.4
	II: 1.5		II: 375.0 - 440.0		
<i>Alvania formicarum</i> Gofas, 1989	1.25	3	366.7	2.4	1.4
<i>Alvania internodula</i> Hoenselaar and Goud, 1998	1.25	3.5	310.0-333.3	2.0 - 2.3	1.1 - 1.3
<i>Alvania mediolittoralis</i> Gofas, 1989	1.25	3.25 - 3.75	294.1 - 304.0	2.2 - 2.7	1.3 - 1.5
<i>Alvania poucheti</i> Dautzenberg, 1889	1.25	3.25	363.4 - 383.4	1.8 - 2.2	1.0 - 1.3
<i>Alvania sleursi</i> (Amati, 1987)	1.25	3.75 - 4	358.3 - 400.0	2.2 - 2.5	1.5 - 1.6
<i>Alvania tarsodes</i> (Watson, 1886)	?	?	?	2.2	1.3
<i>Botryphallus ovummuscae</i> (Gofas, 1990)	1.25	3	222.2	1.1 - 1.3	0.6 - 0.7
<i>Cingula trifasciata</i> (Adams, 1798)	2.0 - 2.5	4	500.0	3.2 - 3.9	1.8 - 2.1
<i>Crisilla postrema</i> (Gofas, 1990)	1.25	3	?	1.4 - 1.5	0.8 - 0.9
<i>Manzonina unifasciata</i> (Dautzenberg, 1889)	1.25	4	304.3 - 347.8	2.0 - 2.5	1.0 - 1.2
<i>Onoba moreleti</i> Dautzenberg, 1889	1.25	3	322.7 - 333.3	1.9 - 2.6	0.9 - 1.3
<i>Rissoa guernei</i> Dautzenberg, 1889	1.25	4	258.8 - 281.3	1.9 - 2.3	1.1 - 1.3
<i>Setia</i> sp.	0.6	2.0-2.5	200.0 - 213.0	0.8 - 1.0	0.6 - 0.8
<i>Setia quisquiliarum</i> Watson, 1886	?	3	?	1.4	0.
<i>Setia subvaricosa</i> Gofas, 1990	1.25	3	238.5	1.1 - 1.4	0.7 - 0.8

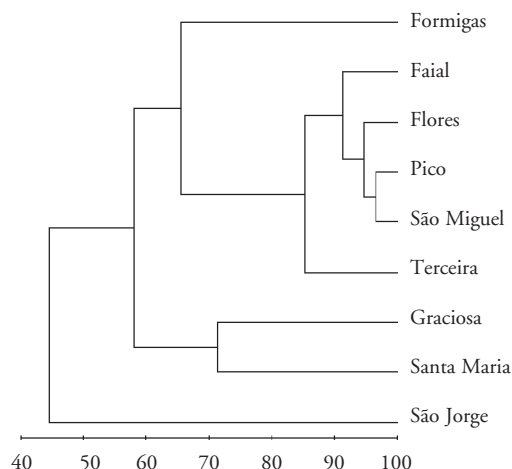


Figure 4. Bray-Curtis/non transformed presence/absence data / UPGMA for the Rissoidae of the Azores.

Figura 4. Análisis Bray-Curtis/no transformado de presencia/ausencia data / UPGMA de los Rissoidae de las Azores.

## RESULTS

At the present status of our knowledge, 23 taxa of Rissoidae are given to the Azores: 12 are endemic species, three are restricted to the Azores and Madeira/Selvagens archipelago, two have a wider distribution, one is an unidentified species of *Setia* and there are five records that were not confirmed by this study. The presence/absence of Rissoidae species on the islands of the Azores, based on the literature and new data, is shown in Table I. Classification techniques used for this table, resulted in Figure 4. São Miguel, Pico and Flores, clustered at more than the 95% similarity level, form a consistent group, to which Faial (92%) and Terceira (85%) are also joined. Formigas, clustered at 65%, seems to be different from the first group of islands in terms of the Rissoidae species. São Jorge is the last island to cluster, at only the 44% similarity level.

**Morphometry:** The largest Rissoidae present on Azorean littoral are *Alvania cancellata* (3.7 x 2.4 mm) and *Cingula trifasciata* (3.9 x 2.1 mm), whereas the sma-

llest are *Setia* sp. (1.0 x 0.8 mm), *Botryphallus ovummuscae* (1.3 x 0.7 mm) and *Setia subvaricosa* (1.4 x 0.8 mm). Almost all protoconchs have 1 <sup>1</sup>/<sub>4</sub> whorls, *Alvania cancellata* being the exception with 2 <sup>1</sup>/<sub>2</sub> whorls. The smallest protoconchs belong to *Setia* sp. and *S. subvaricosa* (200 to 238,5 µm). *Alvania cancellata*, with a multispiral protoconch, has the largest (protoconch I= 120 µm; protoconch II= 440 µm). The number of the teleoconch whorls range from 3 to 4 in all rissoids (Table II).

**Zonation:** Nine species of Rissoidae were found at São Vicente, Capelas, on the north coast of São Miguel, Azores. A total of 1,564 specimens were counted, on the 24 collected quadrates of 50 x 50 cm, *Manzonina unifasciata* Dautzenberg, 1889 being the most abundant with a total of 631 individuals, whilst *Setia* sp. and *S. subvaricosa* Gofas, 1990 uncommon species, (11 and 13 specimens, respectively) (Table III).

The zonation of the Rissoidae at São Vicente, Capelas, seems to indicate the

Table III. Rissoidae collected in July 1996 at São Vicente-Capelas, north coast of São Miguel (all specimens larger than 1mm).

Tabla III. Rissoidae recogidos en julio de 1996 en São Vicente-Capelas, costa norte de São Miguel (todos los especímenes mayores de 1mm).

Depth (m)	3.5	3.5	3.5	5.1	5.1	5.1	8	8	8	12	12	12
<i>A. angioyi</i>	6	6	27	27	24	4	6	15	16	0	1	9
<i>A. cancellata</i>	1	0	1	1	0	1	8	6	1	1	3	4
<i>A. poucheti</i>	2	4	3	3	2	0	0	2	3	0	1	1
<i>A. sleursi</i>	16	19	28	18	30	23	11	15	20	6	5	11
<i>C. postrema</i>	0	0	8	0	1	0	0	0	4	0	0	0
<i>M. unifasciata</i>	10	11	28	87	116	16	51	138	89	0	5	13
<i>R. guernei</i>	16	14	41	16	19	11	8	7	9	0	0	1
<i>S. subvaricosa</i>	1	0	2	2	3	0	0	2	0	0	0	2
<i>Setia</i> sp.	1	1	1	2	2	0	0	0	1	0	1	2
TOTAL	53	55	139	156	197	55	84	185	143	7	16	43

existence of common species at shallow depths (from low tide level to -10 m), such as *Rissoa guernei*, *Manzonia unifasciata* and *Alvania angioyi*, and species more abundant from 15 m down, such as *Alvania sleursi*, *A. cancellata* and *A. poucheti* (Figs. 5 and 6).

By clustering the stations, at the 60% similarity level, two groups appear. The first one, with the highest number of stations and with the exception of replicates 20 and 21 (22 m depth), contains stations in shallow/medium depths. The second group, with the exception of stations 10 (12 m depth) and 14 (13.6 m depth) are all medium/high depths (Fig. 7).

## DISCUSSION

It seems evident that there is some island to island endemism, as suspected by GOFAS (1990), *Alvania formicarum* and *A. internodula* being restricted to the eastern group of islands (São Miguel, Santa Maria and Formigas islets). Pico, Faial, Flores and São Miguel, the best studied islands, are almost identical in the composition of the Rissoidae, with the exceptions of *Setia quisquiliarum* (not found yet at Flores and Pico), *Alvania abstersa* (not found at Flores and Faial) and *Setia* sp. (not found at Faial). There is a clear distinction between the Rissoidae of Formigas islets and the remain-

ing islands of the Azores. In fact, *A. internodula* is restricted to these islets and *A. mediolittoralis* and *Rissoa guernei*, common species in the other islands, do not occur at Formigas. The importance of the Formigas islets as a Nature Reserve is therefore reinforced by the results of this study.

Santa Maria, São Jorge and Graciosa must be considered as outsiders in this biogeographic puzzle, as long as the number of samples and the quality of them is not increased (Table I and Fig. 4). As for *Setia* sp., it may have been overlooked in some samples because of its small size.

The abundance of the Rissoidae in the littoral of the Azores seems to be variable. AZEVEDO (1991) found that *Crisilla postrema* (= *Alvania postrema*) (mediolittoral) and *Rissoa guernei* (infralittoral) were the most abundant species associated with macroalgae in two sites at São Miguel island (Caloura/south coast and Ribeirinha/north coast). At Lajes do Pico (rocky intertidal conditions), the most abundant species is *Cingula trifasciata*, which may reach densities of 32,500 specimens/m<sup>2</sup> (ÁVILA, 1998). In this study, *Manzonia unifasciata* and *Alvania sleursi* are revealed to be the most abundant species, both in the infralittoral. Only long term and seasonal studies will answer this apparent discrepancy between mine and Azevedo's data.

Table III. Continuación.  
 Tabla III. Continuation.

13.6	13.6	13.6	16.3	16.3	16.3	22	22	22	26.8	26.8	26.8	TOTAL
0	1	0	4	0	8	0	3	0	0	0	3	160
4	2	2	3	0	2	2	19	6	2	1	1	71
2	1	0	2	0	11	3	16	2	0	1	0	59
20	47	8	16	6	11	11	106	13	4	4	7	455
0	0	0	0	0	5	0	0	0	0	0	0	18
18	8	3	14	2	2	0	19	3	0	0	1	631
0	0	0	1	0	0	0	0	0	0	0	0	143
0	0	0	1	0	0	0	0	0	0	0	0	13
0	0	0	0	0	0	0	0	0	0	0	0	11
44	59	13	41	8	39	16	163	24	6	6	12	1,564

With the sole exception of *Alvania cancellata* none of the other species of Rissoidae in the Azores has a long planktotrophic larval development, because their protoconchs are bigger than about 200  $\mu\text{m}$  (VERDUIN, 1982; 1985) (Table II). However, studies on other marine Prosobranchs (e.g. Turridae) have demonstrated that a paucispiral protoconch (as seen in the majority of the Azorean Rissoidae) must not be interpreted as evidence for lacking a planktonic phase (SHIMEK, 1986; BOUCHET, 1990). Nevertheless, if there is a planktonic phase, it must be of small duration, but of high importance to the dispersal of the species within the archipelago.

The similarity between the shells of *Alvania cancellata* and *A. sleursi* was pointed out by GOFAS (1990), who thought the latter species could have speciated from the former, by losing the planktotrophic phase. On the other hand, *Alvania abstersa*, *A. formicarum* and *A. mediolittoralis* are so similar in their protoconchs as well as in their teleoconchs, that we may hypothesize their relation with a common ancestor.

MAC ANDREW (1854: 49), stated that the marine molluscs of the Azores, Madeira and Canary Islands were «closely related to that of the old continent, notwithstanding that the prevailing set of currents is from America».

The surface currents in the Northern Atlantic, especially the Gulf Stream, have been studied in detail during this century (ISELIN, 1936; GOULD, 1985; FIALHO AND BARROS, 1988; KLEINE AND SIEDLER, 1989; ALVES, 1990; 1992;). All studies indicate that the surface currents are mainly from West to the East, that is, from America to Europe.

The larvae of *Alvania formicarum* probably did not reach the islands of the central and western groups because of the main direction of surface currents in the Azores. The same may be true for *A. internodula*, but the scarcity of data on this last species, does not allow for a stronger conclusion. Additional samples must be taken at Formigas, in order to determine the zonation of *A. internodula*. If it becomes apparent that it usually occurs at depths of about 45 m (as is the case at Formigas islets), this species may be common on the other islands of the Azores, but not found yet, because no representative samples have been collected by me at depths greater than 30m. However, this species was not found in any of the CANCAP samples (ranging from 33 to 47 m depth), so we have some evidence that it may be restricted to Formigas.

A non-planktotrophic species may be distributed over a large area if there is another plausible means of transport. It is likely that those species of Rissoidae

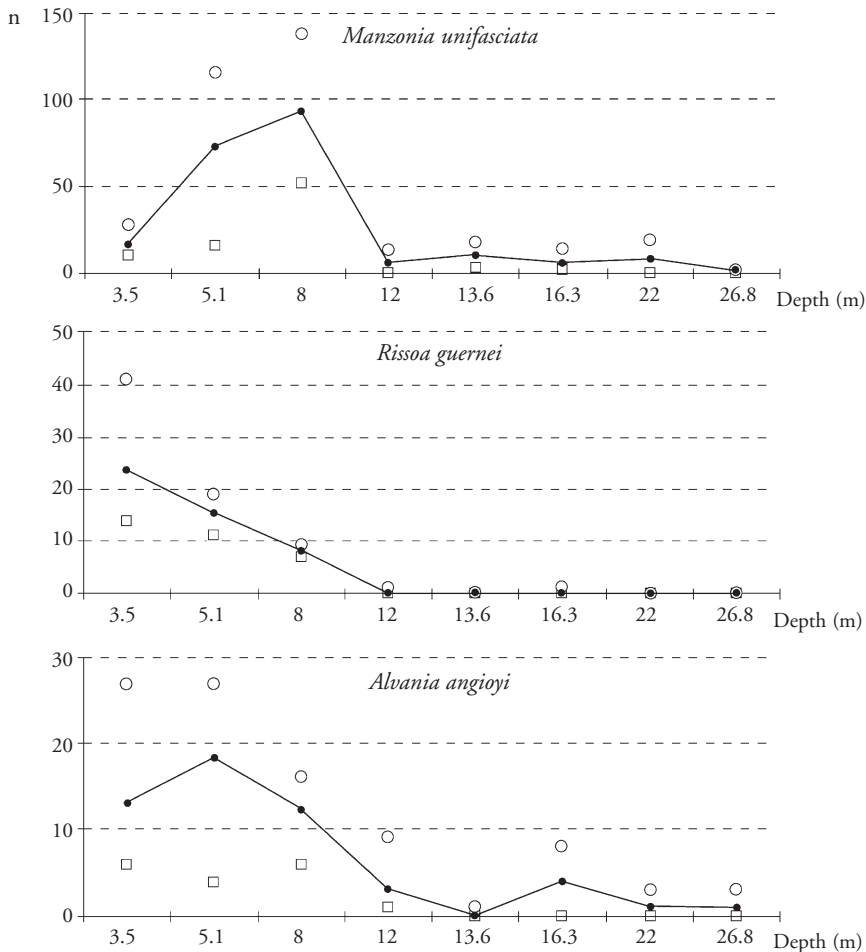


Figure 5. Common Rissoidae species collected at shallow depths (from low tide level to -10m) collected at São Vicente, Capelas, São Miguel, Azores (○: maximum; ●: average; □: minimum values).

Figura 5. Especies de Rissoidae comunes en aguas someras (del nivel de bajamar hasta -10m) recogidas en São Vicente, Capelas, São Miguel, Azores (○: máximo; ●: media; □: mínimo).

living in the first few meters of water (e.g. *Alvania angioyi*, *Manzonía unifasciata* and *Rissoa guernei*) may drift from island to island on "rafts" of algae provided by heavy seas breaking into the shore.

There are 231 confirmed species of shallow-water molluscs on the littoral of the Azores (ÁVILA, 2000). Only 16 species (6.9%) are amphi-Atlantic species, in contrast to the 181 species (78.4%) shared with the western Mediterranean, or the

147 species (63.6%) shared with Madeira (with the Desertas and Selvagens). Mainland Portugal and Canary Islands, share 144 (62.3%) and 137 species (59.3%), respectively, with the Azores, whereas Saint Helena (5.2%) and Ascension island (5.6%) share only a small number of species. A total of 112 species (48.5%) occurs simultaneously in the Azores, Madeira and the Canary Islands, and 53 species (22.9%) occur in all the Macaronesian Ar-



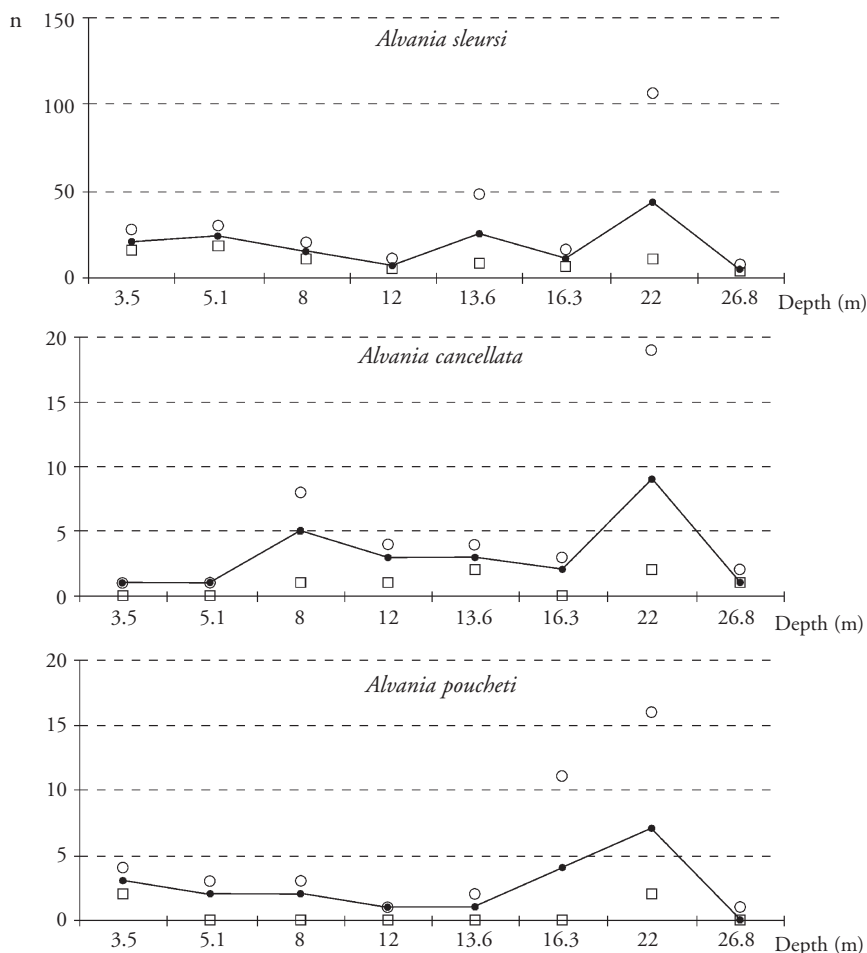


Figure 6. Common Rissoidae species collected at high depths (-15 to -30m) collected at São Vicente, Capelas, São Miguel, Azores (○: maximum; ●: average; □: minimum values).

Figura 6. Especies de Rissoidae comunes en aguas profundas(-15 a -30 m) recogidas en São Vicente, Capelas, São Miguel, Azores (○: máximo; ●: media; □: mínimo).

chipelagos (ÁVILA, 2000). Of the 231 reported species, 19 are endemic (8,2%) and of these, 13 (5,6%) are endemic Rissoidae (ÁVILA, 2000). The dominance of the Rissoidae in the littoral fauna of the Azores, is one piece of evidence that supports its higher similarity with that of Europe (GOFAS, 1990).

An understanding of the colonization and subsequent speciation that has occurred in the molluscan fauna of the Azores, with special emphasis on the

Rissoidae, clearly merits further research. Samples of plankton should be taken in the three groups of islands, in order to evaluate the dispersal capabilities of the endemic Rissoidae, especially the most problematic species (*Alvania formicarum*, *A. internodula*, *Onoba moreleti* and the undescribed *Setia*). Deeper samples should also be collected in order to respond to the questions raised by the so far apparent restricted range of *Alvania internodula*.

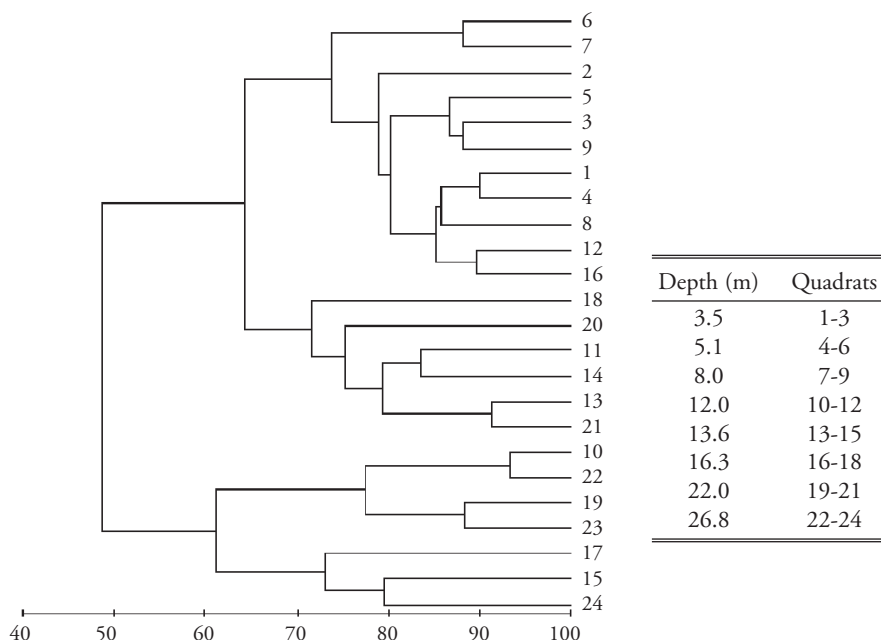


Figure 7. Rissoidae at São Vicente, Capelas, São Miguel, Azores. Double Square Root/Bray-Curtis/UPGMA.

Figura 7. Rissoidae de São Vicente, Capelas, São Miguel, Azores. Doble Raíz/Bray-Curtis/UPGMA.

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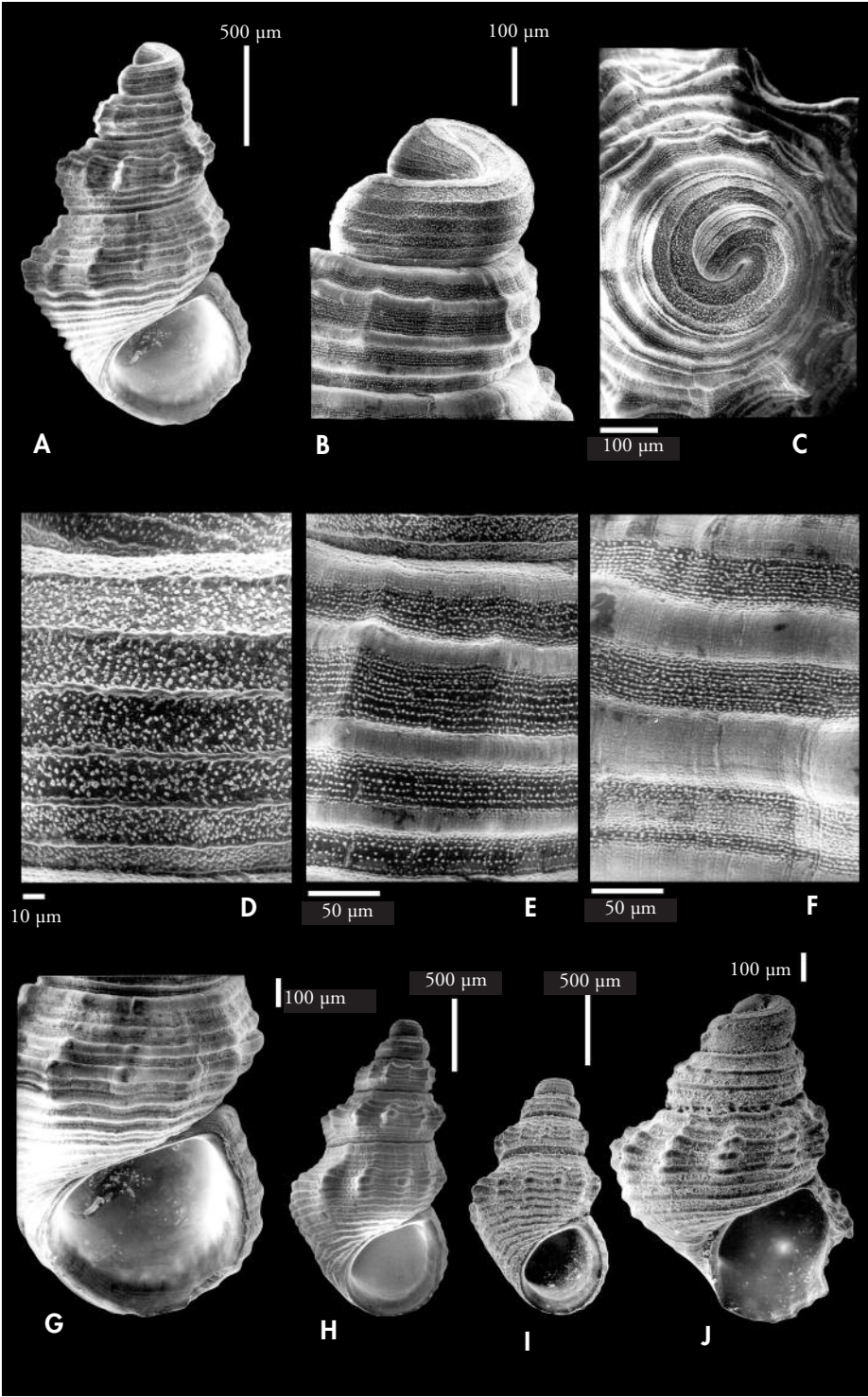
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(Right page) Figure 8. *Alvania internodula* Hoenselaar and Goud, 1998. A: shell (DBUA 338/19-3) 2.3 x 1.3 mm; B, C: protoconch (lateral and frontal view); D: microsculpture of protoconch; E: microsculpture of 1<sup>st</sup> post-larval whorl; F: microsculpture of body whorl; G: aperture of the shell; H: shell (DBUA 338/19-4), 2.0 x 1.1 mm; I: shell (DBUA 338/31-4), 1.6 x 0.9mm; J: shell of juvenile (DBUA 338/31-2), 1.1 x 0.9 mm.

(Página derecha) Figura 8. *Alvania internodula* Hoenselaar y Goud, 1998. A: concha (DBUA 338/19-3) 2,3 x 1,3 mm; B, C: protoconcha (vistas lateral y frontal); D: microescultura de la protoconcha; E: microescultura de la primera vuelta postlarvaria; F: microescultura de la vuelta del cuerpo; G: apertura de la concha; H: shell (DBUA 338/19-4), 2,0 x 1,1mm; I: concha (DBUA 338/31-4), 1,6 x 0,9mm; J: concha de juvenil (DBUA 338/31-2), 1,1 x 0,9mm.



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