Pleistocene and Recent Mediterranean species of Granulina (Gastropoda, Marginelliidae), with description of four new species

Rafael La Perna

KEY WORDS: Granulina, Marginelliidae, systematics, new species, Mediterranean, Pleistocene, Recent.

ABSTRACT


Six species are Pleistocene to Recent, i.e. G. temulabaia n. sp., G. ocella, G. margiata, G. bouchei, G. minusculina and G. gofasi, while G. jhomisensis n. sp., G. ovulina and G. marini n. sp., are only known from the Pleistocene. Two species, G. melitensis and G. gattula n. sp., are only known as Recent species. Main evolutionary trends of Granulina in the Mediterranean are: colonization of the outer shell and the upper slope, endemicy and high speciation rate.

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INTRODUCTION

The genus Granulina Jousseaume, 1888 includes small ovate, colourless and smooth-shelled "marginelliform" gastropods. The last whorl envelopes the previous ones, the lip is thickened, inflected and usually denticulate. Four columellar plications and a parietal callus are present. As stressed by Gofas (1992), species identification needs careful examination of shell shape, lip, denticles, columnar plications, etc. In the present work, a diagnostic value is also stressed for the parietal callus.

Traditionally included in Marginelliidae Fleming, 1828 (e.g. Coan, 1963; Gofas, 1992), Granulina was recently transferred to Cystiscidae Stimpson, 1865 by Coovert & Coovert (1995). Marginelliidae and Cystiscidae prove to be not as closely related as previously thought, the former sharing instead relations to Volutidae and the latter to Olividae (Coovert & Coovert, 1995). Anyway, there is not fully agreement about the allocation of Granulina in Cystiscidae (S. Gofas, pers. com.). Granulina has a simple bifurcate head ("Type 2 animal" of Coovert & Coovert, 1995), strongly pointing to the Marginelliidae. The "modified cystiscid internal whorls", mostly resorbed, of Granulina [which led Coovert & Coovert (1995) to rise the subfamily Granulininae] may be convergent to Cystiscidae due to the small size of the genus. Coovert & Coovert (1995) also stressed radial peculiarities of Granulina, but no other anatomical information is available. At present, the move of Granulina to Cystiscidae seems not well supported and the allocation in Marginelliidae is then maintained.

The Eastern Atlantic and Mediterranean species of Granulina were reviewed by Gofas (1992), who checked four species from the Mediterranean (excluding Gibraltar), i.e. G. margiata (Bivona, 1832), G. bouchei Gofas, 1992, G. ocella (Monteiroso, 1869) and G. minusculina (Locard, 1897). A fifth Mediterranean species, G. gofasi, was described by Smriglio & Mariottini (1995) and a sixth one, G. melitensis, by Smriglio et al. (1998). The European species of Granulina were previously accounted by van Aartsen et al. (1984), Contreras (1987) and Muniz Solis (1987). Bouchei & Warren (1985) reported Granulina from the Northeast Atlantic deep waters.

Little is known about the fossil Mediterranean species. The past records of two species from the Plio-Pleistocene, i.e. G. clandestina (Brocchi, 1814) and G. ocella (Monteiroso, 1869), prove to be mostly based on incorrect interpretations of these species and on a general poor knowledge of this genus (see Gofas, 1992).
MATERIAL AND METHODS
Descriptive terminology and morphometry is mainly based on GOFAS (1992) and COOVERT & COOVERT (1995). Descriptions and measurements are based on full-grown specimens. The examined Recent material consists all of empty shells. The following abbreviations are used:

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<td>University Paleontological Museum, Catania</td>
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<td>Zoological Museum, Rome</td>
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SYSTEMATIC ACCOUNT
Class Gastropoda Cuvier, 1797
Order Neogastropoda Thiele, 1929
Family Marginellidae Fleming, 1828

Genus Granulina Jousseaume, 1888

Type-species Marginella pygmaea Issel, 1869 (by monotypy)

Granulina rosarioi n. sp.
Figs. 1-3

Type material
Holotype and 2 paratypes (both partly broken). UPMC.

Type locality
Pleistocene shallow-shelf silts cropping out near Comiso ("Cartiera Mulino"), along the Ippari River valley, southeastern Sicily.

Etymology
Named from Jhomisus, ancient name of Comiso.

Description
Shell ovoid-elongate (L/D 1.46-1.50), outline weakly rounded. Posterior rostrum well defined. Maximum diameter posterior to half shell length (Ld/L 0.63-0.65). Siphonal notch very weak. Lip markedly thickened, posteriorly bevelled; denticles well defined. Parietal callus narrow, making a deep and wide sinus on body-whorl. Aperture narrow. Four notably broad columellar plications, the uppermost two weaker. Surface smooth, polished. Holotype: L 3.07 mm, D 2.10 mm. Paratypes: L 3.10-3.15 mm, D 2.05 mm.

Distribution
Only known from the type locality. G. clandeistica and G. attenda, formerly listed from this locality (DI GERONIMO et al., 1994, tab. 2), now prove to be G. rosarioi and G. gofasi. Silts are overlaid by shallow-shelf coarse beds, which yielded G. marginata and G. haurceti.

Remarks
G. rosarioi is somewhat similar to G. gofasi. In the former the lip is thicker and bevelled ("labre biseauté" of GOFAS, 1992) and the posterior rostrum is sharper. The broad columellar plications are also distinctive to G. rosarioi.

Granulina jhomisensis n. sp.
Figs. 29-32

Type material
Holotype and 11 paratypes (one subadult, 6 juveniles). UPMC.

Type locality
Pleistocene shallow-shelf muddy-sandy beds cropping out near Comiso ("Cartiera Mulino"), along the Ippari River valley, southeastern Sicily.

Other examined material
Grammichele ("Catallarga"), southeastern Sicily, Pleistocene, 1 sh.

Etymology
Named from Jhomisus, ancient name of Comiso.

Description
Shell ovoid-elongate (L/D 1.47-1.56, outline weakly rounded. Posterior ending rather truncated. Maximum diameter posterior to half shell length (Ld/L 0.70-0.71). Siphonal notch distinct. Lip moderately thickened; denticles well defined. Aperture narrow. Four columellar plications, strongly doubled into an outer and an inner series. Outer plications partly merged to form a zigzag, the uppermost two weaker. Surface polished, smooth. Parietal callus wide, making a shallow sinus on body-whorl and an axial ridge almost inside aperture. Holotype: L 2.71 mm, D 1.84 mm. Paratypes: L 2.56-2.71 mm, D 1.82-1.64 mm.

Distribution
The type material comes from fine-grained beds, rich in small-sized molluscs (mainly rissoids and Bittium), for which a shallow-water bottom sheltered by Posidonia oceanica grasses is inferred (COSTA, 1989). The single shell from Grammichele comes from shallow-water coarse beds (see LA PERNA, 1997).

Remarks
Due to its elongate shape, G. jhomisensis appears similar to G. occulta. The former differs mainly by a less slender shape, a well distinct posterior slope-break, a more bevelled lip and by being almost non-rostrated. An ill-defined sulcus makes the columellar folds strongly doubled, as known for other species (see GOFAS, 1992, p. 4).
Figures. 1-3. Granulina rosi sp. Belice River valley, Pleistocene. 1, 2. Holotype, 3.07x2.10 mm. 3. Paratype, 3.10x2.05 mm (oral side broken). Figures. 4-6. Granulina gofasi Smriglio & Mariottini, 1996. Belice River valley, Pleistocene. 4. 3.01x1.99 mm. 5-6. 2.98x2.04 mm. Figs. 7-9. Granulina gofasi Smriglio & Mariottini, 1996. Off Lazio coast, 550 m. 7, 8. 2.64x1.88 mm. 9. 2.68x1.82 mm. Figures. 10, 11. Granulina tenuilabiata n. sp. Vallone Catrica, Pleistocene. Holotype, 3.43x3.05 mm. Figures. 12. Granulina tenuilabiata n. sp. Off eastern Sardinia, 1281-130 m. 2.30x2.05 mm. Figures. 13-16. Granulina guttula n. sp. Off Isola di Ponza, 84 m. 13, 14. Holotype, 1.92x1.26 mm. 15, 16. Paratype, 2.13x1.38 mm. Figures. 17. Granulina sp. A. Vallone Catrica, Pleistocene. 2.71x1.71 mm.
Granulina ovulina (Monterosato, 1891)
Figs. 43, 44

Gibberulina ovulina Monterosato, 1891: p. 4.

Examined material

Description
Shell ovoid-elongate (L/D 1.63-1.65), outline rounded. Maximum diameter posterior to half shell length (Ld/L 0.65-0.67). Posterior rostration weak. Siphonal notch very weak. Lip thickened; denticulations well developed. Parietal callus hardly distinct, narrow, making a wide and deep sinus on body-whorl. Aperture narrow. Four strong columellar plications. Surface polished, smooth, with ill-defined growth striae. Lectotype: L 3.30 mm, D 2.10 mm. Largest specimen: L 3.80 x D 2.30 mm.

Distribution
Only known from the original material. The Ficarazi beds contain Pleistocene deep-shelf faunas with scarce epibathyal species (see Di Geronimo & La Perna, 1997: p. 417

Remarks
Gibberulina ovulina was reported as a fossil from Ficarazi (Palermo) by Monterosato (1891), with a brief and vague description: "Bellissima forma del gruppo della G. ovulina ma assai più grande" [A very nice form of the G. ovulina group, but much larger]. G. ovulina is indeed rather similar to G. ovulina, but markedly larger and more inflated. Due to its size, G. ovulina appears notably similar to G. tenuilabiata n. sp., but the two species differ in several respects: G. tenuilabiata is more inflated and rostrated than G. ovulina, the lip is notably thicker, less arched and slightly bevelled posteriorly, the aperture is narrower and with well developed denticulations.

The date of G. ovulina is labelled as "1896" (Fig. 45), but this was probably due to a misspelling for "1891".

Granulina tenuilabiata n. sp.
Figs. 10-12

Type material
Holotype: UPMC.

Type locality
Epibathyal muddy beds cropping out at Vallone Catrica, southern Calabria, Pleistocene.

Other examined material
Off eastern Sardinia, BS78/2, 41°51'.03N, 10°34'.06E, 1281-330 m, 1 sh. UPMC.

Etymology
Latin tenuilabiatus (= thin-lipped), due to its comparatively thin lip.

Description
Shell ovoid-elongate (L/D ca. 1.50), outline well rounded. Maximum diameter posterior to half shell length (Ld/L 0.60). Posterior rostration moderate. Siphonal notch absent. Lip weakly thickened; denticulations faint to lacking. Parietal callus hardly distinct, narrow, making a wide and deep sinus on body-whorl. Aperture rather wide. Four columellar plications, the uppermost two weaker. Surface polished, smooth, with ill-defined growth striae. Holotype: L 3.43 mm, D 2.30 mm.

Distribution
Pleistocene to "Recent" (see below), epibathyal. Paleodepths within 500-600 m are inferred for the type-locality beds (Di Geronimo & La Perna, 1997).

Remarks
The single shell from off Sardinia is old looking and might come from Wiirmian (Latest Pleistocene) beds, as suggested by the molluscan assemblage occurring in the sample. It only differs from the holotype by being smaller and with a comparatively thinner lip, lacking denticulations (faint denticulations are anteriorly present in the holotype). It is difficult to find a very close matching between fossil and Recent forms of Granulina, and no reason other than size can be found to keep this shell distinct from G. tenuilabiata.

Granulina occulta (Monterosato, 1869)
Fig. 27

Marginella occulta Monterosato, 1869: p. 17, fig. 10. Volutella parvulina Locard, 1897: p. 126, pl. 21, figs. 3-5. Granulina occulta (Monterosato) - Gofas, 1992: p. 12, figs. 11 (lectotype), 12, 27.

Examined material
Off southeastern Sicily, PS81/10C, 36°43'.48N, 15°11'.30E, 61-58 m, 3 shs. UPMC.

Distribution
G. occulta was described from off "Palermo, 50 m". It is a mid-to deep-shelf species, in Mediterranean and Ibero-Moroccan Gulf (Gofas, 1992).

MONTEROSATO (1872, 1877) recorded this species as a fossil from Monte Pellegrino and Ficarazi (Palermo) and a lot of 60 shells from "Monte Pellegrino" (labelled by Brugnone) is present in ZMR (C. Smriglio, pers. com.).

Remarks
G. occulta has a markedly slender shell, compared with the other species. The callus makes a wide and deep sinus on the body-whorl. Lip denticulations are weakly developed.
Pleistocene and Recent Mediterranean Granulina

Figures 18-22: *Granulina melitensis* Smriglio, Manostitti & Rufini, 1998. Off southeastern Sicily, 200 m. 18, 19. 2.10x1.32 mm. 20, 21. 2.32x1.62 mm. 22. 2.01x1.40 mm. Figures 23, 24: *Granulina minorculina* (Locard, 1897). Aeolian Archipelago, 248 m. 2.21x1.73 mm. Figures 25, 26: *Granulina minorculina* (Locard, 1897). Furnari, Pleistocene. 2.54x1.87 mm. Figure 27: *Granulina oculata* (Monterosato, 1869). Off southeastern Sicily, 61-58 m. 2.52x1.50 mm. Figure 28: *Granulina* sp. B. Off eastern Sardinia, 1281-330 m. 2.83x1.77 mm. Figures 29-32: *Granulina ibesiensis* n. sp. Ippari River valley, Pleistocene. 29, 30. Holotype, 2.71x1.84 mm. 31. Paratype, 2.75x1.82 mm. 32. Paratype, 2.50x1.70 mm. Figures 33, 34: *Granulina bouleti* Gofas, 1992. Acitrezza, 24-38 m. 33. 2.50x1.88 mm. 34. 2.22x1.66 mm. Figure 35: *Granulina bouleti* Gofas, 1992. Grammichele, Pleistocene. 2.27x1.72 mm. Figures 36, 37: *Granulina cf. bouleti* Gofas, 1992. Ippari River valley, Pleistocene. 36. 1.80x1.44 mm. 37. 1.75x1.36 mm. Figs. 38, 39: *Granulina marginata* (Bivona, 1832). Acitrezza, 24-38 m. 38. 2.11x1.72 mm. 39. 2.00x1.55 mm. Figure 40: *Granulina marginata* (Bivona, 1832). Grammichele, Pleistocene. 2.22x1.77 mm. Figures 41, 42: *Granulina cf. marginata* (Bivona, 1832). Ippari River valley, Pleistocene. 41. 1.80x1.44 mm. 42. 1.61x1.33 mm.
The synonymy between *Marginella oculata* Monterosato and *Volutella parvulina* Locard was proved by Gofas (1992), but the retracted and thick-lipped specimen from off Morocco (1.713 m) reported by Bouchet & Warén (1985, fig. 711) as *G. parvulina* (Locard) seems a distinct Atlantic species.

Some deep-water shells from off eastern Sardinia (BS78/2, 41°51'.03N, 10°34'.06E, 1,281-330 m) are similar to *G. oculata*, but larger (up to 2.85 mm in length), more inflated (L/D ca. 1.60) and with a thinner well-arched lip, without denticulations (Fig. 29). Shells appear as old as as *G. tenulabíscata* from the same station. The taxonomic status of this material is not understood (a deep-water ecotype of *G. oculata*?) and it is tentatively referred to as *Granulina* sp. B.

### *Granulina marginata* (Bivona, 1832)
Figs. 38-40

*Volvaria marginata* Bivona, 1832: p. 24, pl. 3, fig. 5.

*Granulina marginata* (Bivona) - Gofas, 1992: p. 6, figs. 5-8, 25.

### Examined material


### Distribution

*G. marginata* is widespread in the western and eastern Mediterranean, in shallow waters (Gofas, 1992; Koutsoubas et al., 1997). Gofas (1992), who examined and illustrated the material from Grammichele first, proved the occurrence of the Pleistocene.

### Remarks

See under *G. boucheti*.

### *Granulina boucheti* Gofas, 1992
Figs. 33-35


### Examined material


### Distribution

*G. boucheti* was described from Acitrezza and reported from other localities in Sicily, as well as from Corsica, Tunisia, Algeria (Gofas, 1992) and the Aegean Sea (Koutsoubas et al., 1997). It occurs in shallow waters, often together with *G. marginata*, but less commonly (Gofas, 1992).

Gofas (1992) first proved its occurrence in the Pleistocene, on material from Grammichele.
Remarks

The closeness of *G. boucheti* to *G. marginata* was noted by GOFAS (1992), who noted orange spots on the foot, the base of tentacles and the inner mantle of *G. boucheti* (while these anatomical parts are colourless in *G. marginata*). Conchologically, *G. marginata* is a little smaller and broader (L 1.80-2.30 mm, L/D 1.20-1.31) than *G. boucheti* (L 1.90-2.55 mm, L/D 1.25-1.36). *G. marginata* is also more truncated posteriorly, and with a slightly bevelled lip. Some values of L/d/L are recorded for both species (0.65-0.69). In both species, the calyx is notably wide, but not very distinct, and forms a thin ridge almost inside the aperture. The columellar folds are moderately doubled.

While the Pleistocene shells from Grammichele (Figs. 35, 40) and from the Belice River valley, all from shallow-water beds, match the Recent shells of *G. boucheti* and *G. marginata*, the abundant material from the Ippari River valley (same outcrop as for *G. johnvensis*) is puzzling. Shells are all notably small (L 1.50-1.82 mm, D 1.20-1.45 mm), and most of them (ca. 87%) are slightly less truncated and more elongate (L/D 1.25-1.29) than the few remaining ones (L/D 1.20-1.29). The former group (Figs. 36, 37) is tentatively referred to as *G. cf. boucheti* and the latter as *G. cf. marginata* (Figs. 41, 42). It should be also noted that the columellar folds are strongly doubled in both groups, while they are slightly to moderately doubled in the Recent shells of both species. The Ippari River valley deposits are probably older than the Grammichele and the Belice River valley ones. The taxonomic status of the Ippari River material is still unclear. It might represent an ancestral form from which both *G. marginata* and of *G. boucheti* became more and more distinct in shape and size through the Quaternary. This could be better understood when other material, possibly from the Pliocene, will be available.

**Granulina minusculina** (Locard, 1897)

Figs. 23-26

*Volutella minusculina* Locard, 1897: p. 127, pl. 21, figs. 6-8.

*Granulina minusculina* (Locard) - Gofas, 1992: p. 16, figs. 15, 16.

Examined material

Furnari, northeastern Sicily, Pleistocene, 2 shs and fragments. Aeolian Archipelago, Southern Tyrrhenian, Eoucumm95 st. 37, 38°29'.33N, 15°50.31E, 248 m, 1 shs. UPMC.

Distribution

*G. minusculina* is known from the Atlantic (Ibero-Moroccan Gulf) and the Mediterranean (Western Basin), at bathyal depths (down to ca. 1,300 m) (GOFAS, 1992).

The undetermined *Granulina* listed by Di GERONIMO & LA PERNA (1997, tab. 1) from the bathyal Pleistocene of Furnari is *G. minusculina* (Figs. 25, 26). Depths close to 1,000 m are inferred for this deposit.

Remarks

*G. minusculina* is characterised by a markedly inflated shell, with an almost central maximum diameter (Ld/L ca. 0.58). As noted by GOFAS (1992), denticles extend slightly to the outer surface of the lip.

The examined Pleistocene shells in these respects, but they are slightly larger and more egg-shaped than the Recent ones.

*G. occulta* of BOUCHET & WEBEN (1985, figs. 713) is *G. minusculina*, as noted by GOFAS (1992).

**Granulina gofasi** Smirglio & Mariottini, 1996

Figs. 4-9


Examined material

Belice River valley (locality "Case Catarinichia"), south-western Sicily, Pleistocene, 2 shs. Off Lazio coast, 550 m (ex C. Smriglio coll.), 5 shs. Off eastern Sardinia, BS78/2, 41°51'.05N, 10°34'.06E, 1,281-330 m, 4 shs. UPMC.

Distribution

*G. gofasi* was described from 300-600 m in the Central Tyrrhenian Sea (off Lazio coast). For the fossil record, see under *G. rocartii*.

Remarks

*G. gofasi* is characterised by a marked egg shape and a well-arched posterior lip. Size is up to ca. 3.0 mm in length and 2.0 mm in diameter, L/D 1.44-1.53 and Ld/L ca. 0.65. The two Pleistocene specimens differ from the Recent one by being slightly larger, the lip almost lacking in denticulation (it is faint in the Recent material), and the shape more egg-shaped.

**Granulina guttula** n. sp.

Figs. 13-16

Type material

Holotype and 18 paratypes (one badly broken, one subadult). UPMC.

Type locality

Off Isola di Ponza, eastern Tyrrhenian, 40°52'.23N, 12°55'.85E, 84 m.

Etymology

Latin diminutive of *gutta* (= drop), due the drop-shaped shell.

Description

Shell ovoid-elongate (L/D 1.48-1.55), outline rounded. Posterior rostrum well-defined. Maximum diameter posterior to half shell length (Ld/L 0.62-0.67). Siphonal notch distinct. Lip moderately thickened, posteriorly bevelled; denticulations
faint but well defined. Aperture narrow. Four indistinctly doubled columnar plications. Surface smooth, polished. Parietal callus narrow. Holotype: L 1.92 mm, D 1.26 mm. Paratypes: L 1.91-2.25 mm, D 1.28-1.45 mm.

Distribution
Only known from the type locality.

Remarks
G. guttula appears rather similar to G. oculata. The former has a more bevelled lip and is markedly inflated posteriorly. It can be also distinguished from G. melitensis by being more slender and by lacking the thick posterior callus.

A fossil shell (Fig. 17) from Vallone Carica (same outcrop as for G. teunilabiata) looks rather similar to G. guttula (and to G. rosarioi as well), but it is notably larger and with a more central maximum diameter. It might be an undescribed species, but the available material is too scarce to attempt its interpretation. It is referred to as Granulina sp. A.

Granulina rosarioi n. sp.
Granulina jhonisensis n. sp.
Granulina ovalina (Monterosato, 1891)
Granulina tenabilabiata n. sp.
Granulina oculata (Monterosato, 1869)
Granulina marginata (Bivona, 1832)
Granulina boucheti Gofas, 1992
Granulina minusculina (Locard, 1897)
Granulina gosais Smriglio & Mariottini, 1996
Granulina guttula n. sp.
Granulina melitensis Smriglio, Mariottini & Rufini, 1998

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Table 1. Species of Granulina occurring in the Pleistocene (P) and in the Recent (R) Mediterranean, with the ecological distribution.

Distribution
G. melitensis was described on shells from 100-120 m in Gnejna Bay, Malta, and was also reported from the Central Tyrrhenian in 250 m (previously as G. minusculina: Smriglio & Mariottini, 1996, figs. 4a,b). The living specimen reported by Mifsud (1996: fig. 18) from Malta as G. minusculina is G. melitensis (S. Gofas, pers. com.). Also G. oculata of Bouchet & Warén (1985: fig. 712) from off south-western Sicily is G. melitensis. It is rather commonly found on deep-shelf (70-250 m) muddy-sandy bottoms.

Remarks
G. melitensis has a thick posterior callus, sometimes making almost a shallow "tubercle". None of Mediterranean and Eastern Atlantic species shows such a feature. This species differs from G. minusculina mainly by being less inflated, less "rhomboidal" in shape and with a fairly well defined siphonal canal. Further, some soft-part features make the two species well distinct (S. Gofas, pers. com.).

Discussion
Eleven species of Granulina are proved to occur in the Quaternary Mediterranean (Tab. 1). Six of the eight extant species range back to the Pleistocene, namely G. tenabilabiata, G. oculata, G. marginata, G. boucheti, G. minusculina and G. gosais. Three species, i.e. G. rosarioi, G. jhonisensis and G. ovalina are only known from the Pleistocene, while G. guttula and G. melitensis are only known as Recent species.

Granulina clandestina (Brocchi, 1814), a Pliocene species, deserves some comments. Gofas (1992) faced with Brocchi's species identity proposing a neotype. Coovert & Coovert (1995: p. 74) disagreed with Gofas' interpretation, remarking some discrepancies between Brocchi's figure (1814, p. 642, pl. 15, fig. 11) and Gofas' neotype (1992, p. 5, fig. 3). Although the Pliocene species of Granulina are too poorly-known to face critically this problem, G. clandestina sensu Gofas was probably present in the Pleistocene too.
Cerulli-Irelli's record (1911, p. 281, pl. 21, figs. 9-14) of Cryptospira clandestina from Early Pleistocene beds: see Bonadonna, 1968) seems to be based on this species.

A poorly known Pleistocene deep-water species from southern Calabria, Marginella ovuliforvis G. Seguenza, 1879 also needs some comments. The original description and drawing (Seguenza, 1879: p. 253, pl. 16, fig. 12) suggest a large Granulina (ca. 5 mm in length), but the examination of topotypic material (L. Seguenza coll., UPMC; La Perna, in prep.) leads to exclude such an allocation, because of the size, the elongate-pyrfiform shape, the smooth and not inflected lip. A preliminary allocation could be in the marginellid Oruginella Laseron, 1937 (see Coovert & Coovert, 1995).

The diversification of Granulina in the Mediterranean and its trend to occupy the deep shelf and the upper slope are remarkable. None of the three shallow-water species (G. marginata, G. bonbeiti and G. joibienensis) seems to be markedly close to the shallow-water extra-Mediterranean ones (including Gibraltar), i.e. G. vanhorensi (Van Aartsen, Menkhorst & Gittemberger, 1984), G. torosa Gofas, 1992, G. granda (d'Orbigny, 1840), G. mauretanica Gofas, 1992 (see Gofas, 1992).

Although G. joibienensis differs notably in shape from G. marginata and G. bonbeiti, two features are anyway shared between them, i.e. the wide parietal callus and the apertural calloside ridge. G. tenabilabia, G. gofasi, G. rosarii, G. ovulina, G. oculata, G. melitensis and G. guttula range, as a whole, from the outer shelf to the upper slope, while G. minuscula is the sole truly bathyal species. Some of these species, i.e. G. rosarii, G. ovulina, G. guttula and G. oculata seem to form a distinct morphological group with outer-shelf distribution. G. gofasi and G. tenabilabia also seem rather close to each other, and both have a deeper distribution. G. minuscula clearly belong to a distinct lineages, owing to the squash shape and the lip denticulations extending slightly to the outside (soft-part differences were also reported by Gofas, 1992). G. melitensis is morphologically similar to G. minuscula and might represent an "intermediate" form between this species and the outer-shelf group.

G. oculata and G. minuscula are the sole species spreading into the Ibero-Moroccan Gulf (Gofas, 1992), while most species, including the extra-Mediterranean ones have narrow to endemic geographical distribution. Slow gene flow and high speciation rate (probably due to non-planktotrophic larval development) are suggested by this distribution pattern and by the differences between Pleistocene and Recent populations outlined in the present work.

CONCLUDING REMARKS

Some aspects of Granulina in the Quaternary Mediterranean remain open; particularly the taxonomic status of the deep-water forms tentatively referred as Granulina sp. A and Granulina sp. B, and that of the small Pleistocene form referred to the marginata-bonbeiti complex. Further studies on Plio-Quaternary material will surely help to clear up these problems, as well as to achieve a better knowledge of Granulina in the Mediterranean.

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REFERENCES


While the present paper was in press, additional material was examined. Some of it is worth of being reported.

1. **G. melitensis**. Grammichele ("Caramitaio", southeastern Sicily), Pleistocene deep-shelf silts, 3 shs. This species is thus proved to range back to the Pleistocene. 2. **G. cf. occulta**. Mineo (southeastern Sicily), Pleistocene, 22 shs (De Fiore coll., UPMC). Shells are notably larger (up to 3.4 mm) than the Recent ones. 3. **G. ovulina**. Grammichele ("Catal larga", southeastern Sicily), Pleistocene shallow-water sands, 1 sh.

### Notes added in proof

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