

## Terrestrial molluscs from the R.N.I. "Grotta Conza" (Palermo, Sicily) (Gastropoda Architaenioglossa Pulmonata)

Agatino Reitano<sup>1\*</sup>, Fabio Liberto<sup>2</sup>, Salvatore Giglio<sup>3</sup>, Rosario Grasso<sup>4</sup> & Maria Teresa Spena<sup>4</sup>

<sup>1</sup>Via Gravina, 77 - I-95030 Tremestieri Etneo, Catania, Italy; e-mail: tinohawk@yahoo.it

<sup>2</sup>Strada Provinciale Cefalù - Gibilmanna, 93 - I-90015 Cefalù, Palermo, Italy; e-mail: fabioliberto@alice.it

<sup>3</sup>Contrada Settefrati, I-90015 Cefalù, Palermo, Italy; e-mail: hallucigenia@tiscali.it

<sup>4</sup>Dipartimento di Scienze Biologiche, Geologiche ed Ambientali, Università degli Studi di Catania, Via Androne, 81 - I-95124 Catania, Italy; e-mail: rosagra@unict.it, marisaspena@hotmail.com

\*Corresponding author

---

### ABSTRACT

The results of a study on the fauna of terrestrial molluscs from the R.N.I. "Grotta Conza" (Palermo, North-Western Sicily) are here described. Research has allowed us to compile a checklist of 41 species, 18 of which are endemic to Sicily. For each species ecological and distributional data are provided.

### KEY WORDS

Terrestrial molluscs; North-Western Sicily; endemic species; biodiversity.

Received 12.05.2012; accepted 21.10.2012; printed 30.12.2012

Proceedings of the 1<sup>st</sup> International Congress "Insularity and Biodiversity", May 11<sup>th</sup>-13<sup>th</sup>, 2012 - Palermo (Italy)

---

## INTRODUCTION

The Integral Natural Reserve, R.N.I. "Grotta Conza" is characterized by the presence of a karst cave of great speleological, paleontological and biological importance and an area outside the cave with rupicolous vegetation, Mediterranean maquis, grassland and forests of native and non-native species planted on lithosols (lithic xerorthents). The knowledge about terrestrial mollusc fauna in this area is scarce, and in the malacological literature only a few species are reported (Beckmann, 2004; La Mantia & Rizzo, 2009). The research carried out during the years 2007-2012, in the area of the R.N.I. "Grotta Conza", allowed us to compile the first checklist of terrestrial molluscs in the natural reserve and to observe the status of these species.

### Study area

The Natural Reserve "Grotta Conza" (Palermo, Sicily, cadastral number Si Pa 60, 38°11'13"N,

13°16'44"E) was established by D.A. Territorio e Ambiente n°292/44 del 16/05/1995 (Suppl. Ord. G.U.R.S. n.4, 20/01/1996) and is managed by Club Alpino Italiano - Sicilia. It is included in section 594040 (Tommaso Natale) of the Regional Technical Map (scale 1:10.000). The reserve is located between 100 and 220 m of altitude; it has an area of 12.34 hectares and is divided into a small "Zone A", where the entrance of the cave is located, and a wider "Zone B". The area is characterized by a Mediterranean climate, i.e., as "Csa" in the Köppen (1936) climate classification, with hot, dry summers and mild to cool wet winters. The cave opens at an elevation of 175 m, and extends for a total length of 100 m; sloping 30° upwards with a +30 m height difference; the inner part of the cave is connected to the external environment by small burrows (few centimeters in diameter). The cave is developed within Upper Triassic limestone rock (Schiaccia Formation; see Italian Geological Map 1:50.000 leaf 594 Partinico). This formation is composed of limestone, dolomitic limestone, stromatolitic and lofe-

ritic dolomite, megalodon limestone, algal biolite, and coral biolite. The cave is known for Paleolithic and Neolithic artifacts and Pleistocene mammal faunal remains (De Stefani, 1941; Mannino et al., 1986), and for invertebrate troglomorphic fauna (Brian, 1959; Caruso, 1982; 1995; Caruso & Costa, 1978; Spina, 2007; Krapp et al., 2010; Cottarelli et al., 2012). The cave is strongly affected by outside thermal fluctuations due to its small size (Mannino et al., 1986; Spina, 2007; Cottarelli et al., 2012), and as a result of the karstic conditions, the surrounding area is devoid of running water. The cave is fossil; it is never flooded, and the water input to the cave is exclusively due to rainfall expressed as temporary drips (Cottarelli et al., 2012). In the past, the area close to the cave was cultivated with olive, almond and carob trees, but today native shrub vegetation (oak and broom) is reclaiming the area (Figs. 1-6).

The rest of the territory of the reserve is occupied by non-native species (*Pinus*, *Cupressus*, *Eucalyptus*, *Acacia*) planted by the "Azienda Regionale Foreste Demaniali". There are also aspects of grassland (Gianguzzi et al., 2009). Overall, herbaceous plants make up 50% of the taxa listed by Gianguzzi et al. (2009), followed by perennial grasses, particularly hemicryptophytes (24%) and geophytes (13%). There are 14 endemic taxa, amongst which, of particular importance, one can mention *Asperula rupestris* Tineo (exclusive to North-Western Sicily), *Cymbalaria pubescens* (Presl) Cufod, *Helichrysum panormitanum* Guss., *Echium italicum siculum* (Lacaita), and *Eryngium bocconii* Lojac. The soils are mainly made of rocky outcrops and lithosols (lithic xerorthents).

## MATERIALS AND METHODS

The research in the field allowed us to make ecological observations on molluscs, and the finding of live specimens and shells for subsequent morphological and taxonomic classifications. Inside the cavity, different sampling methods were used, namely retrieval by sight, pitfall traps, and baiting. For visual collection, a careful search through the entire cave and in all possible microhabitats was carried out. Animals and shells were therefore collected on calcareous crusts on the walls, on clay, under large and small stones naturally lying on the

ground, under organic remains (dung, wood, organic matter in decomposition of natural plant and animal) (Bucciarelli, 1961) and in the vicinity of small water-filled containers. This was aimed at finding species with different ecological requirements. The other technique used was to put, within the cave, pitfall traps in environments characterized by different substrates and different morphology, in order to sample in all possible habitats (soil, sludge, and clastic elements with variable granulometry). This collection technique requires special precautions, especially inside the cave, because, if misused, it can cause serious damage to wildlife and degrade communities. Consequently, the traps were frequently and carefully monitored in such a way as to avoid any excess catch. The research carried out in the territory of the reserve spanned both the area of the Integral Reserve, "Zone A", and "pre-reserve Zone B". In both areas, samples were taken in different habitat types, using retrieval by sight and pitfall-traps (Figs. 7-8). Within the second zone, research was carried out in different microhabitats including hypolithic environment, litter and rock outcrops in the area in front of the entrance.

The species have been classified in the laboratory through the morphological analysis of the shell and the genitalia with the aid of a Leica microscope MZ12.5. Photos were taken with a digital camera. Taxonomical references are based on the checklist of the Italian fauna (Bodon et al., 1995; Manganelli et al., 1995, 1998, 2000) and the checklist of "Fauna Europaea", version 1.1. (Bank, 2011, available at: <http://www.faunaeur.org>). Chorological categories are those proposed by La Greca (1962) and later elaborated upon by Vigna Taglianti et al. (1993, 1999) and Parenzan (1994). All species here treated are accompanied by notes on ecology and biology. Since taxonomic revisions were not the scope of this work, taxonomic comments were reduced or delayed to works still in preparation. All examined specimens are preserved in the collections of the authors.

## RESULTS

### SYSTEMATICS

#### GASTROPODA

Ordo Architaenioglossa Haller, 1890

Familia Cochlostomatidae Kobelt, 1902





1



2



3



4



5



6

Figures 1-6. R.N.I. "Grotta Conza" environments. Figure 1. Entrance to Conza cave view by the inside. Figure 2. Idem, view by the outside. Figure 3. Wall of calcareous rock. Figure 4. Grassland and maquis with *Euphorbia dendroides*. Figure 5. Brushwood. Figure 6. Slope with rupicolous vegetation.



***Cochlostoma paladilhianum paladilhianum***  
(Saint Simon, 1869)

Endemic species of North-Western Sicily, with a subspecies *pirajnoi* (Paulucci, 1789) present on Favignana island (Zilch, 1958; Alzona, 1971; Bodon et al., 1995). It lives on limestone walls and rocks. On the area of the reserve it is rather localized to vertical rocky walls.

Familia Aciculidae J.E. Gray, 1850

***Acicula benoiti*** (Bourguignant, 1864)

Endemic species of Sicily. It lives in the crevices of limestone rocks and in underground environments (Boeters et al., 1989; Reitano et al., 2009). Only empty shells were found by sieving debris collected in the inner part of the cave and in the crevices of rocks outside the cave (Fig. 9).

Ordo Littorinimorpha Pchelintsev, 1963  
Familia Pomatiidae Newton, 1891

***Pomatias elegans*** (O.F. Müller, 1774)

European species, recently reported for Northern Tunisia (Ben Romdhane et al., 2008). In Sicily it lives in many kinds of biotopes: dune environments, from mid-mountain forests, in public gardens areas, in the litter shrub formations and

riparian forest. It is considered to belong to "keratoconchae" (Sacchi, 1952; Giusti & Castagnolo, 1982), being able to resist long periods of drought by burying itself in the soil or hiding under dead leaves, stones and vegetal debris. Living specimens were found under stones in the most humid places and with relatively greater vegetation cover.

***Tudorella panormitana*** (Sacchi, 1954)

Endemic species of the mountains of Palermo, distributed from a few meters above sea level up to medium altitudes, from Trabia to Monte Palmeto (Sacchi, 1954; Alzona, 1971). In Sicily another species *T. multisulcata* is present, which is widespread in the mountains of Trapani and Southern Sicily.

*T. panormitana* (Fig. 10) is morphologically characterized by the white or pale yellow shell (in *T. multisulcata*, the colour is variable from orange to dark red) and a reticulate sculpture of raised spiral threads and radial ribs (*T. multisulcata* has spiral striae only a little more pronounced than the radial ribs). Fossils of Pleistocenic *Tudorella* Fischer, 1885, found in the mountains of Palermo, have the same morphological characters of the shell of *T. panormitana*. Living and fossil specimens of the mountains of Trapani have the typical characters of *T. multisulcata* (Sacchi, 1954) (personal data). The two species are distinct also as regards genital morphology; *T. panormitana* has a penial apex which is much thinner and more elongated with respect to that of *T. multisulcata* (Lo Brano & Sparacio,



7



8

Figure 7. R.N.I. "Grotta Conza" environments: pitfall traps. Figure 8. Idem, pitfall traps hidden under a stone.

2006). On the basis of recent molecular studies of Pfenninger et al. (2010), it seems that the current distribution of *Tudorella* in the Western Mediterranean is due to the fragmentation of the original distribution area that occurred in the late Oligocene and Miocene, and dispersive phenomena that occurred in the late Miocene and Pleistocene. The molecular study of Pfenninger et al. (2010) also highlights the existence of significant genetic distances between populations of *T. panormitana* and *T. multisulcata*. *T. panormitana* is a xeroresistent species typical of limestone landscapes; in the reserves living specimens were found under stones, especially in grassland.

Infraclassis Pulmonata Cuvier in Blanville, 1824  
Ordo Stylommatophora A. Schmidt, 1855

Familia Cochlicopidae Pilsbry, 1900

***Hypnophila cylindracea*** (Calcara, 1840)

The genus *Hypnophila* Bourguignat, 1858 in Sicily is represented by three endemic species: *H. emiliana* (Bourguignat, 1858) from the Aegadian Islands, *H. incerta* (Bourguignat, 1858) from the Aeolian Islands and *H. cylindracea* with a disjunct distribution limited to North-Western Sicily. The species belonging to the genus *Hypnophila* are considered of great biogeographical interest for their distribution in the Mediterranean basin (Giusti & Manganelli, 1984). *H. cylindracea* lives in crevices of limestone or under stones in damp niches rich in plant debris. Many empty shells were found in the inner part of the cave (Fig. 11).

Familia Pleurodiscidae Wenz, 1923

***Pleurodiscus balmei*** (Potiez & Michaud, 1838)

Species with very fragmentary East Mediterranean distribution. In Italy it is reported for the Southern regions and Sicily (Alzona, 1971; Manganelli et al., 1995; Hallgass & Vannozzi, 2009). This xeroresistant species inhabits open environments, but also tree stumps or wet karstic or volcanic caves. This troglone species is common inside the cave.

Familia Chondrinidae Steenberg, 1925

***Granopupa granum*** (Draparnaud, 1801)

European-Mediterranean-Turanian species widespread along the Italian peninsula, *G. granum* is a xeroresistent species quite common in Sicily. In the reserve shells were found under rocks in areas with sparse vegetation cover.

***Rupestrella rupestris margritae*** (Beckmann, 2002)

*R. rupestris* (Philippi, 1836) is an endemic species of Sicily. Beckmann (2002) distinguishes five subspecies: *R. rupestris rupestris*, widespread in Western Sicily, *R. rupestris coloba* (Pilsbry, 1918) known for Levanzo island, *R. rupestris carolae* Beckmann, 2002, from the "Rocca di Cefalù", *R. rupestris lamellosa* Beckmann, 2002, from the area between Sciacca and Caltabellotta and *R. rupestris margritae* Beckmann, 2002 from the territory of Isola delle Femmine. The *R. rupestris* specimens found in the reserve show the typical morphological characters of the subspecies *margritae*: shell sleek, with a small and roundish mouth, with well-formed columellar tooth not visible in frontal view (Fig. 12). *Rupestrella* species are rupicolous, calciophilic and xeroresistant; in the reserve, *R. r. margritae* lives on limestone walls with small populations.

***Rupestrella homala homala*** (Westerlund, 1892)

Endemic species of Sicily, with three subspecies (Beckmann, 2002): *R. homala homala* (Westerlund, 1892), widespread in North-Western Sicily, *R. homala massae* Beckmann, 2002, known only for the southern slopes of Monte Cofano (Custonaci) and *R. homala falkneri* known for the area between Termini Imerese and Caccamo. *R. homala homala* is distinguished from *R. rupestris* by more convex whorls, greater convexity of the whorls, less marked suture, and a more stocky silhouette due to a wider last whorl (Fig. 13.) Biology is similar to that of the previous species. *R. homala* has been described for Monte Gallo, a place about 1.5 km far from the reserve.

Familia Vertiginidae Fitzinger, 1833

***Truncatellina callicratis*** (Scacchi, 1833)

European-Mediterranean-Turanian species, widely distributed in the Mediterranean region (Giusti et al., 1995). It lives in very dry limestone landscapes with herbaceous vegetation. Some shells have been found through the debris picked up in the crevices of rocks, under rocks and at the base of cliffs.

Familia Enidae B.B. Woodward, 1903

***Mastus pupa*** (Linnaeus, 1758)

Species with Holomediterranean distribution, present in Southern Italy, Sardinia and Sicily (Alzona, 1971; Manganelli et al., 1995). It is a thermophilic species, present in a wide variety of habitats. In the reserve is common, especially in areas with open grassland, or between stones in rocky environments.

Familia Ferussaciidae Bourguignat, 1883

***Cecilioides (Cecilioides)* cfr. *acicula*** (O.F. Müller, 1774)

Species with Turanian-European-Mediterranean distribution, extended to Macaronesia. The genus *Cecilioides* Férussac, 1814 comprises endogenous species that usually live buried under stones, between plant roots and on the soil of caves. Many shells have been found both in the inner part of the cave and in the debris picked up out from the cave, under rocks or in crevices of the limestone walls (Fig. 14).

***Hohenwarthiana aradasiana*** (Benoit, 1862)

Endemic species of Sicily (Giusti, 1973; Manganelli et al., 1995). It occurs in endogenous habitats, buried under stones or among the roots of the plants. Shells of *H. aradasiana* were found in the same habitats of the previous species (Fig. 15).

***Ferussacia folliculus*** (Gmelin, 1791)

Species with Mediterranean distribution, thermophilic, inhabiting arid environments with little ve-

getation cover. In the reserve both living specimens and empty shells were found under rocks or debris.

Familia Subulinidae P. Fischer & Crosse, 1877

***Rumina decollata*** (Linnaeus, 1758)

The genus *Rumina* Risso, 1826 is represented in Sicily with two species: *R. saharica* Pallary, 1901, recently reported for Marettimo island (Liberto et al., 2012) and *R. decollata*, widespread throughout the island. It has a Mediterranean distribution, and it is present throughout the Italian peninsula and the islands. It is a typical Mediterranean species belonging to keratoconchae, which populates natural environments but also degraded and anthropized ones. It is omnivorous and even necrophilic. It was introduced in many areas of Central-Northern America to be used in the biological control of the invasive helioid *Cornu aspersum* (Cowie, 2001). It lives frequently under stones, among organic debris, in dry walls, and under dead trunks, bushes and shrubs. It is a thermophilic and xeroreistant species thanks to the thick white epiphragm and to its habit of burying itself into the soil during summer.

Familia Clausiliidae J.E. Gray, 1855

***Siciliaria leucophryna*** (L. Pfeiffer, 1862)

Endemic species of Sicily, limited to the surroundings of Sferracavallo (Palermo). This species has been confused with *S. eminens* (Schmidt, 1868), particularly by Boettger (1879) and Benoit (1882), however Nordsieck (2002) specified its distribution area in the neighbourhoods of Sferracavallo and selected a lectotype (Senckenberg Museum, Frankfurt 67478, coll. O. Boettger ex-Dohrn ex-L. Pfeiffer). *S. leucophryna* is a calciophilic specie, that occurs in the crevices of the rocks and under stones in shaded places (Fig. 18).

***Papillifera bidens affinis*** (Philippi, 1836)

*P. bidens* is a very common species in Sicily and inhabits many natural and anthropized biotopes. It is a calciophilic species, but can form large populations in non-calcareous environments (like the





Figure 9. *Acicula benoitii* h: 4.35 mm, D: 1.33 mm; Figure 10. *Tudorella panormitana* h: 19 mm, D: 12.7 mm. Figure 11. *Hypnophila cylindracea* h: 6.2 mm, D: 2.1 mm. Figure 12. *Rupestrella r. margritae* h: 4.14 mm, D: 2 mm. Figure 13. *R. h. homala* h: 3.45 mm, D: 2 mm. Figure 14. *Cecilioides* cfr. *acicula* h: 6.16 mm, D: 1.45 mm. Figure 15. *Hohenwarthiana aradasiana* h: 4.3 mm, D: 1.45 mm. Figure 16. *Daudebardia b. sicula* D: 3.65 mm. Figure 17. *Oxychilus fuscus* h: 7.7 mm, D: 14 mm.

crystalline rocks of Peloritani Mountains, the volcanic rocks of the Iblean plateau and Mount Etna). In Sicily it is represented by three subspecies: *P. bidens affinis*, widespread in Sicily, *P. bidens tinei* (Westerlund, 1878) in South-Western Sicily, and *P. bidens rudicosta* (O. Boettger, 1878) in the Central-Eastern Sicily. The systematics of Sicilian populations of *P. bidens* is probably more complex and requires a modern revision. In the reserve the subspecies *P. bidens affinis*, described for the surroundings of Palermo, is abundant.

Familia Oleacinidae H. & A. Adams, 1855

***Poiretia dilatata dilatata*** (Philippi, 1836)

Species with S-European distribution, limited to the central-eastern sector (Central and Southern Italy, Sicily, the Peloponnese, and Crete); in Sicily it is present as nominal subspecies (Subai, 1980). It lives in forest and riparian environments, less frequently under stones or at the base of cliffs. Occasionally it is also present in caves. *P. dilatata* eats both plants and other molluscs that they actively hunt (Liberto et al., 2010). A few shells were found in the most shaded and vegetated areas of the reserve.

Familia Discidae Thiele, 1931

***Discus rotundatus rotundatus*** (O.F. Müller, 1774)

Species with European-Mediterranean distribution extending to Macaronesia, and present in almost all Italian territory (Alzona, 1971; Manganelli et al., 1995). It inhabits deciduous forests, under litter or under rotting wood, and ruderal environments under debris. In the reserve, *D. rotundatus* is uncommon and localized amongst the bushes close to the entrance of the cave.

Familia Pristilomatidae T. Cockerell, 1891

***Vitrea* cfr. *subrimata*** (Reinhardt, 1871)

Species with European-Mediterranean distribution spreading throughout Italy. *V. subrimata* comprises a complex of populations which differ by the

structure of flabelliform appendices of the inner wall of the proximal penis and therefore needing a modern revision (Manganelli et al., 1995; Ferreri et al., 2005). It inhabits mainly natural environments, usually cavities in soil, or under partly concealed rocks or boulders. In the reserve, only empty shells were found by sieving debris collected under rocks or in crevices.

Familia Oxychilidae P. Hesse, 1927

***Daudebardia brevipes sicula*** (Bivona, 1839)

Endemic subspecies of Central-Southern Italy and Sicily, described for the area around Palermo (Manganelli et al., 1995), occurs in litter of forests, also under stones and in wet and shaded debris. Few specimens and empty shells were found under stones, in damp environments, especially with autochthonous forest cover (Fig. 16).

***Oxychilus (Oxychilus) fuscus*** (Rossmässler, 1838)

Endemic species of North-Western Sicily, distributed along the mountains of Palermo in damp environments, especially with forest cover. The shell of *O. fuscus* is characterized by the well-rounded last whorls, a rather narrow umbilicus and especially by the presence in the upper part of the shell of a reticulate microsculpture consisting of very fine longitudinal furrows crossed by marked and irregular furrows and growth lines (Fig. 17). This microsculpture is well visible near the suture and gradually disappears towards the periphery of the last whorl of the spire. The dimensions of the shell are variable from one population to another, and in favorable environments the maximum diameter can reach 35 mm. Specimens of *O. fuscus* were found at the entrance of the cave, in front of the entrance and under the rocks in shaded and vegetated places.

Familia Milacidae Ellis, 1926

***Milax nigricans*** (Philippi, 1836)

Species with Holomediterranean distribution, widespread and common throughout Sicily, in na-



tural and anthropized habitats. This species was described for the surroundings of Palermo, therefore the population of the reserve is topotypic.

***Tandonia sowerbyi* (A. Férussac, 1823)**

The genus *Tandonia* Lessona et Pollonera, 1882 is widespread in Sicily with two species: *T. sowerbyi* with Holomediterranean-Atlantic distribution and *T. marinellii* Liberto, Giglio, Colomba & Sparacio, 2012, at present only known for the North-Western Sicily (Trapani mountains). These two species have a very similar external appearance and can be classified with certainty only after a morphological examination of the genitalia (Liberto et al., 2012). *T. sowerbyi* is found in open hilly and forest environments, but also in gardens and greenhouses. Some living specimens were found under rocks in the grassland of the reserve and in front of the entrance of the cave.

Familia Agriolimacidae H. Wagner, 1935

***Deroceras (Deroceras) panormitanum* (Lessona et Pollonera, 1882)**

*D. panormitanum* was considered a species very variable in colour and shape of the genitalia (Giusti 1973; 1976; Giusti & Manganelli, 1990; Giusti et al., 1995; Wiktor, 2000; Reise et al., 2011). We believe that *D. panormitanum* s.l. is a complex of different species, which require a detailed morphological and molecular analysis. *D. panormitanum* s. l. is very common in Sicily, where it lives in a wide range of environments. In the reserve two morphotypes live in sympatry, they differ in size of the body and in genital morphology.

Familia Trissexodontidae H. Nordsieck, 1987

***Caracollina (Caracollina) lenticula* (Michaud, 1831)**

Species with Mediterranean distribution. In Sicily it is very common from a few meters above sea level up to medium altitudes. In the reserve living specimens and empty shells were found under stones.

Familia Cochlicellidae Schileyko, 1972

***Cochlicella (Cochlicella) acuta* (O.F. Müller, 1774)**

Species with Mediterranean-Atlantic distribution, *C. acuta* is thermophilic, typical of the coast, but it can live at medium altitudes in natural or anthropized environments. In the reserve, living specimens were found in the xeric areas.

Familia Hygromiidae Tryon, 1866

***Monacha consona* (Rossmässler, 1839)**

Endemic Sicilian species with the locus typicus restricted to the surroundings of Palermo (Forcart, 1965). It has a globular shell, medium size, with a generally open umbilicus, and genitalia with a typical scheme of *Monacha* Fitzinger, 1833 sensu strictu, meaning without the retractor muscle, with vaginal appendix and mucous glands. Rather hygrophilous species, uncommon in the reserve.

***Szentgalya gregaria* (Rossmässler, 1839)**

Endemic Sicilian species (Manganelli et al., 1995; Liberto et al., 2010), characterized by a small to medium-sized sub-globose depressed shell, with a generally closed umbilicus (Fig. 19) and lacking of genital digitiform glands, vaginal appendix (which are present in *M. consona*) and retractor muscle. *S. gregaria* is less hygrophilous than *M. consona* and may form abundant populations also in xeric environments. When it is inactive it takes refuge a few centimeters under the soil. Liberto et al. (2010) elevate *Szentgalya* Pintér, 1977 to the rank of a full genus but Bank (2011) and Falkner et al. (2011) do not accept *Szentgalya* either as genus or as subgenus. We prefer to follow the choice of Liberto et al. (2010) waiting to publish our additional data. *S. gregaria* is included in the checklist of the International Union for Conservation of Nature (IUCN) as a "near threatened" species. The species is quite common in xeric grasslands of the reserve.

***Trochoidea (Trochoidea) caroni* (Deshayes, 1830)**

Species endemic to Southern Italy and Sicily (Manganelli et al., 1995), also reported as fossil for the Maltese Islands (Giusti et al., 1995). Currently, it is considered a species with a certain variability

in shape and size of the shell, including different populations which probably need a modern systematic review. Relatively widespread in Sicily, from coastal areas to medium altitudes, especially in grassy habitats. Uncommon in the reserve (Fig. 20).

***Trochoidea (Trochoidea) pyramidata*** (Draparnaud, 1805)

Species with W- Mediterranean distribution, reported for peninsular and insular areas of Italy. It is thermophilic and xeroreistant, common in low to medium altitudes. It inhabits herbaceous vegetation and shrubs, even several inches from the ground, in multiple environments, often degraded, natural and anthropized. This species shows a remarkable polymorphism of the shell, both in size and colour (Giusti, 1973). *T. pyramidata* is common and widespread in the reserve, especially on the grassland.

***Schileykiella reinae*** (Pfeiffer, 1857)

Endemic species of the N-W Sicily with disjunct distribution. The genus *Schileykiella* Manganelli, Sparacio et Giusti, 1989 includes two other species: *S. parlatoris* (Bivona, 1839), widespread in Sicily, and *S. bodoni* Cianfanelli, Manganelli et Giusti, 2004, known only for Marettimo island (Cianfanelli et al., 2004). *S. reinae* is a calciophilic and hygrophilous species that occurs in forest environments, Mediterranean maquis, at the base of limestone cliffs, or under rocks and debris. In the reserve only empty shells were found (Fig. 21).

***Xerotricha conspurcata*** (Draparnaud, 1801)

Species with Mediterranean distribution, reported in Italy for peninsular regions, Sicily and Sardinia. It is very common in Sicily under stones and debris from various coastal areas to medium altitudes. It lives in natural or anthropized environments.

***Cernuella (Cernuella)* cfr. *cisalpina*** (Rossmässler, 1837)

Species with an European-Mediterranean distribution (Manganelli & Giusti, 1987; Manganelli et al., 1995). The systematic position of the group *cisalpina-virgata* of the genus and subgenus *Cernuella* Schlüter, 1838 is somewhat complex

because of the variability of the shell, a character which has been fundamental for the description of many taxa. *Cernuella (C.) cisalpina* is a complex of small or medium sized species with many forms that require a systematic review (Manganelli & Giusti, 1987; Favilli et al., 1995; Giusti et al., 1995; Ferreri et al., 2005). In Sicily it is common, from back dunes up to medium altitudes, in natural and anthropized environments.

***Cernuella (Cernuella)* cfr. *virgata*** (Da Costa, 1778)

Species with European-Mediterranean distribution (Manganelli & Giusti, 1987; Manganelli et al., 1995). Many taxa with uncertain taxonomic value, generally characterized by medium to large sized shells, are attributed to *C. virgata*. Thermophilic and xeroreistant, it is widespread in Sicily, at low and medium altitudes, in different natural environments, even degraded and anthropized, often in numerous colonies. In the reserve is quite common in grassland.

Familia Helicidae Rafinesque, 1815

***Chilostoma macrostoma*** (Rossmässler, 1837)

Species endemic to the Palermo Mountains, the supraspecific status of which is yet to be determined. Some aspects of the taxonomy and nomenclatural position of this entity have recently been subject of deepening (Lo Brano & Sparacio, 2006; Colomba et al., 2008; Liberto et al., 2010). It inhabits natural forest and rocky environments. A few shells were collected in the crevices of the rocks of the reserve.

***Murella platychela platychela*** (Menke, 1830)

Endemic species of the North-Western Sicily, with several subspecies; the nominal subspecies was described for Monte Cuccio (Pfeiffer, 1931), a few kilometers South of the area covered by this study. It is strictly calciophilic and inhabits rocky sites. Specimens were found on the rocky walls of the reserve (Fig. 22).

***Eobania vermiculata*** (O.F. Müller, 1774)

Species with Holomediterranean distribution.

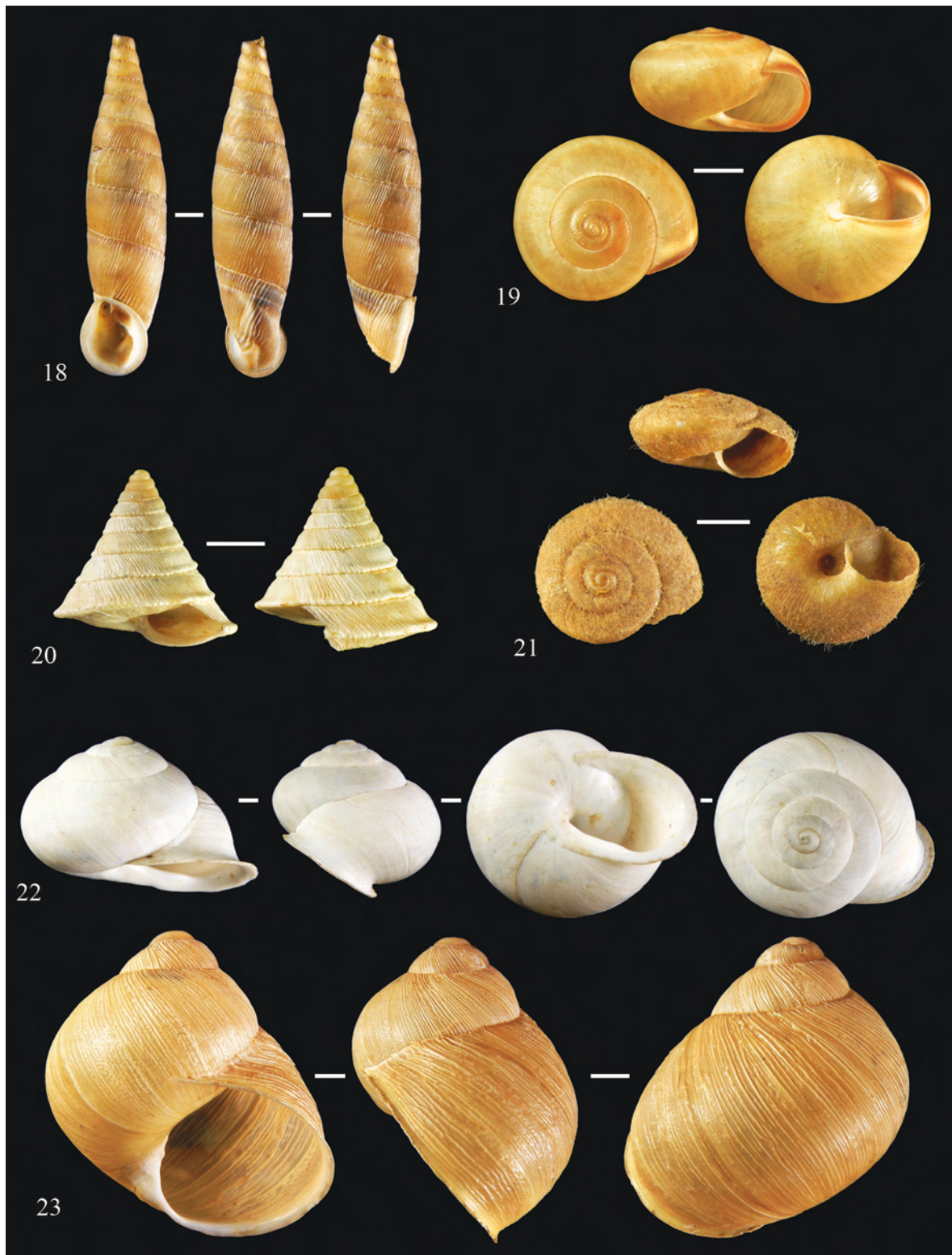


Figure 18. *Siciliaria leuchophryna* h: 20.5 mm, D: 4.8 mm. Figure 19. *Szentgalya gregaria* h: 6 mm, D: 9.4 mm. Figure 20. *Trochoidea* (T.) *caroni* h: 9.45 mm, D: 9.8 mm. Figure 21. *Schileykiella reinae* h: 3.5 mm, D: 6.4 mm. Figure 22. *Murella platychela* h: 16.2 mm, D: 23 mm. Figure 23. *Ercella mazzullii* h: 28.5 mm, D: 27 mm.



Dispersed by man in many non-Mediterranean countries. It is thermophilic, common in many types of environments, both natural and anthropized, from a few meters above sea level up to medium altitudes. In the reserve living specimens have been found under rocks or in crevices of limestone rock.

***Cantareus apertus* (Born, 1778)**

Species with Mediterranean distribution, present in almost all the Italian peninsula, Sicily and Sardinia. It is thermophilic, common in open, arid, even anthropized and degraded environments, at low and medium altitudes. During the summer it seeks refuge under the ground, closing the opening of the shell with a robust white and convex epiphragm. In the reserve it was found in grassland.

***Cornu aspersum* (O.F. Müller, 1774)**

Species with European-Mediterranean distribution, present in almost the whole peninsular and insular Italian territory, but passively introduced by man in many other countries (Giusti et al., 1995). Recent molecular studies (Guiller & Madec, 2010) have made it possible to reconstruct the phylogeny of the populations of *C. aspersum* in the Mediterranean area, recognizing the Kabylia area (North-Western Algeria), as the probable original region of the species; however, no populations from Sicily were analyzed in this study. The populations of Sicily and circum-Sicilian islands have a certain morphological variability that requires further study and investigation. *C. aspersum* sensu lato inhabits many habitats: the dune system, the Mediterranean maquis, dry meadow hills, the forests of high mountain (Lo Brano & Sparacio, 2006), and ruderal or anthropized areas. *C. aspersum* is common and widespread throughout the reserve.

***Ercella mazzulli* (De Cristofori & Jan, 1832)**

Endemic species of the Palermo Mountains, occurring from Monte Pellegrino to Monte Palmeto (Terrasini). Recently, the *E. mazzulli* complex has been the subject of a multidisciplinary revision work (morphological, molecular, paleontological, and biogeographical) (Colomba et al., 2011) that has allowed the re-evaluation of the genus *Ercella* Monterosato, 1894 and the recognition, as valid

species, of *E. mazzulli* (De Cristofori & Jan, 1832), *E. cephaloeditana* (Giannuzzi-Savelli, Oliva et Sparacio, 2012), endemic of the Rocca of Cefalù, and *E. insolida* (Monterosato, 1892), widespread in the mountains of Trapani. The species of *Ercella* genus are calciophilic and saxicavous; in fact they live exclusively on limestone rocks, on which they dig peculiar tunnels using acid to dissolve the hard Mesozoic limestone. Tunnels are used as a refuge from the summer temperature and from predators during periods of inactivity. The species is rather rare and localized within the reserve, on the walls of limestone (Fig. 23).

## CONSIDERATIONS AND CONCLUSIONS

The present study has allowed us to compile, for the Natural Reserve "Grotta Conza", a checklist of 41 species of terrestrial molluscs, a significant number in relation to the limited extension of the reserve (12.34 hectares). The high number of species is mainly related to three factors: 1) the reserve is North facing, which makes this area subject to the main cool and humid air masses coming from the North-West; 2) the lithological nature of the environment consisting of limestone; 3) the richness of microhabitats.

The humidity and the availability of calcium are fundamental for the biology of terrestrial molluscs, while the diversity of environments (slopes with scattered boulders, rocks, vertical cliffs, gorges, caves) and the diversity of the vegetation (xeric grassland, Mediterranean maquis, patches of scrub, rupicolous vegetation), provide microenvironments suitable for the demands of the different species.

From the ecological point of view, most of the molluscs are either calciophilic and rupicolous (*Cochlostoma paladilhianum*, *Rupestrella rupestris margaritae*, *R. homala homala*, *Murella platychela platychela* and *Ercella mazzulli*), calciophilic and interstitial (*Acicula benoiti*, *Hypnophila cylindracea*, *Ceciloides acicula* and *Hohenwartiana aradasiana*), calciophilic and typical of rocky masses (*Tudorella panormitana*, *Siciliaria leucophryna*, *Papillifera bidens*, and *Chilostoma macrostoma*), xerophilic and xeroresistant (*Truncatellina callicratis*, *Pleurodiscus balmei*, *Mastus pupa*, *Rumina decollata*, *Xerotracha cornspurcata*, *Cernuella* cf. *cisalpina*, *Cernuella* cf. *virgata*, *Szentgalya gregaria*, *Trochoidea caroni*,

*Trochoidea pyramidata*, *Cantareus apertus*, *Granopupa granum*, *Ferussacia folliculum*, *Caracollina lenticula*, and *Cochlicella acuta*), hygrophilous (*Pomatias elegans*, *Discus rotundatus*, *Vitrea* cf. *subrimata*, *Oxychilus fuscus*, *Daudebardia brevipes sicula*, *Schileykiella reinae*, and *Monacha consona*), and species with a larger ecology, also anthropophilic (*Milax nigricans*, *Tandonia sowerbyi*, *Deroceras panormitanum*, *Poiretia dilatata*, *Eobania vermiculata*, and *Cornu aspersum*).

The chorological data (Table 1) highlight the predominance of endemic taxa (41%), followed by species with Mediterranean (34%), European (20%)

and wide distribution (5%). This composition can be explained by the geographical location of the reserve in the northern mountains of Palermo (North-Western Sicily). This region, as a result of the succession of marine ingressions and regressions of the Pleistocene and the complex topography of the area, has undergone long periods of geographic isolation leading to speciation processes, followed by reunification with the near areas and then re-colonization by European and Mediterranean species. However, some endemisms have an even older, Mio-Pliocene origin: *T. panormitana* is phylogenetically related with North-West African and Sar-

CHOROTYPES	N. OF SPECIES	%
<b>CHOROTYPES WITH WIDE DISTRIBUTION</b>		4.88
EUROPEAN-MEDITERRANEAN-TURANIAN extended to MACARONESIA	2	4.88
<b>CHOROTYPES WITH EUROPEAN DISTRIBUTION</b>		19.51
EUROPEAN-MEDITERRANEAN-MACARONESIAN	1	2.44
EUROPEAN-MEDITERRANEAN	5	12.19
EUROPEAN	1	2.44
S-EUROPEAN	1	2.44
<b>CHOROTYPES WITH MEDITERRANEAN DISTRIBUTION</b>		34.15
MEDITERRANEAN	5	12.19
WEST MEDITERRANEAN	1	2.44
EAST MEDITERRANEAN	1	2.44
HOLOMEDITERRANEAN	3	7.32
HOLOMEDITERRANEAN-ATLANTIC	2	4.88
SOUTHERN APENNINE-SICILIAN	2	4.88
<b>ENDEMISMS</b>		41.46
SICILIAN	17	41.46
<b>TOTAL</b>	41	100%

Table 1. The chorological data of the terrestrial molluscs from R.N.I. "Grotta Conza".

dinian *Tudorella* (Pfenninger et al., 2010); *Ercella* shows morphological and ecological affinities with rupicolous and saxicavous Helicidae from Kabylia (North-Eastern Algeria) referable to *Helix subaperta* (Ancey, 1893) (Colomba et al., 2011); while *Hypnophila* is distributed on disjoint calcareous platforms, a phenomenon best explained in light of the series of geological events taking place in the Western Mediterranean region towards the end of the Oligocene and the early Pliocene (Giusti & Manganelli, 1984). The endemic taxa include 17 species and subspecies. Two of them, *S. leucophryna* and *R. rupestris margritae*, have their distribution limited to limestone coastal environments between Sferravallo and Isola delle Femmine and are therefore worthy of special attention and protection. *T. panormitana*, *C. macrostoma*, and *E. mazzullii* are endemic species with a distributional area limited to the mountains of Palermo. *C. paladilhianum*, *H. cylindracea*, *R. homala*, *O. fuscus*, *S. reinae*, and *M. platychela* are endemics to North-Western Sicily; finally, *H. aradasiana*, *P. bidens affinis*, *M. consona*, *S. gregaria*, and *D. panormitanum* s.l. are endemic to Sicily with a wider distribution.

Some of these endemic species are included in the Red List of Threatened Species of the International Union for Conservation of Nature (IUCN) (Falkner et al., 2011). The *E. mazzulli* complex is considered "endangered"; *S. gregaria*, *S. reinae*, *R. rupestris* are classified as "near threatened", and *R. homala* and *C. paladilhianum* are considered "vulnerable". The main threats are the destruction of the natural environment through quarries for the extraction of marble and gravel, the construction of roads, urban development, and uncontrolled fires. The presence of the R.N.I. "Grotta Conza" is therefore a very important tool for the conservation and protection of these species and the environment in which they live.

In particular, we believe it is desirable to take all appropriate measures to prevent fires, and to thin or eradicate non-native plant species (i.e. *Pinus*, *Cupressus*, and *Eucalyptus*), which cause the acidification of the soil, making it inhospitable to some endemic snail species (*D. brevipes sicula*, *O. fuscus*, *S. reinae* and *M. consona*). In addition, a thick reforestation of *Pinus* would compete with native tree species, which would reduce the development of a suitable undergrowth necessary to meet the ecological needs of almost all species of molluscs linked to the ground.

## ACKNOWLEDGMENTS

The authors wish to thank M. Vaccarella, President of the Club Alpino Italiano, Sicilian section, and G. Mento, Director of the R.N.I. "Grotta Conza", for supporting and encouraging biological research. Funding was provided by the "Assessorato Regionale Territorio e Ambiente della Regione Siciliana" to R. Grasso. We are grateful to Roberto Viviano and Arturo Viviano for their support on the field and to the operators Gianluca Chiappa and Giuseppe Lo Dico.

## REFERENCES

- Alzona C., 1971. Malacofauna Italiana. Catalogo e bibliografia dei molluschi viventi, terrestri e d'acqua dolce. Atti della Società Italiana di Scienze naturali e del Museo Civico di Storia Naturale di Milano, 111: 1-433.
- Bank R.A., 2011. Fauna Europaea: Mollusca Gastropoda. Fauna Europaea version 2.4. Checklist of the land and freshwater Gastropoda of Italy. Fauna Europaea Project: 1-49. Last update: July 24<sup>th</sup>, 2011. [http://www.nmbe.unibe.ch/sites/default/files/uploads/pubinv/fauna\\_europaea\\_gastropoda\\_of\\_italy.pdf](http://www.nmbe.unibe.ch/sites/default/files/uploads/pubinv/fauna_europaea_gastropoda_of_italy.pdf)
- Beckmann K.-H., 2002. Elemente einer Revision der endemischen Rupestrellen Siziliens. pp 49-78 et pls. 9-13. In: Falkner G., Groh K. & Speight M.C.D. (eds.). Collectanea Malacologica, Festschrift für Gerhard Falkner. MC Speight Conck Books, Hackenheim, 644 pp.
- Beckmann K. H., 2004. Zur Verbreitung der endemischen nordwestsizilianischen Clausiliidae der Unterart *Charpenteria* (Siciliaria) mit Beschreibung von zwei neuen Unterarten (Gastropoda: Stylommatophora: Clausiliidae) Archiv für Molluskenkunde, 133: 185-191.
- Ben Romdhane M., El Hedfi C. & Ben Slem M., 2008. Première mention de *Pomatias elegans* (O. F. Müller, 1774) (Gastropoda, Caenogastropoda, Pomatiidae) au Nord de la Tunisie. MalaCo, 5: 254-255.
- Benoit L., 1882. Nuovo catalogo delle conchiglie terrestri e fluviali della Sicilia e continuazione alla illustrazione sistematica critica iconografica de'testacei estramarini della Sicilia ulteriore e delle isole circostanti. Tip. D'Amico, Messina, 176 pp.
- Boeters H.D., Gittenberger E. & Subai P., 1989. Die Aciculidae (Mollusca: Gastropoda Prosobranchia). Zoologische Verhandlungen, 252: 1-234.
- Boettger O., 1879. In: Rossmässler E. A., Iconographie der Land- und SüßwasserMollusker, mit vorzüglicher Berücksichtigung der europäischen noch nicht abgebildeten Arten. Neue Folge, Wiesbaden, (1) 6 (4/5): 52-153, tav. 167-178.



- Bodon M., Favilli L., Giannuzzi Savelli R., Giovine F., Giusti F., Manganelli G., Melone G., Oliverio M., Sabelli B. & Spada G., 1995. Gastropoda, Prosobranchia, Heterobranchia, Heterostropha. In Minelli A., Ruffo S. & La Posta S. (eds.). Checklist delle specie della fauna italiana, 14. Calderoni, Bologna, 61 pp.
- Brian A., 1959. Nota su 3 triconiscidi provenienti da caverne della Sicilia raccolti dal Sig. G. Mannino con descrizione di un nuovo genere. *Studia Speleologica*, 4: 95-100.
- Bucciarelli I., 1961. La raccolta dei Coleotteri ipogei. L'informatore del giovane entomologo, Suppl. Bollettino della Società Entomologica Italiana, 9-10: 37-40.
- Caruso D. & Costa G., 1978. Fauna Cavernicola di Sicilia. *Animalia*, 5: 423-513.
- Caruso D., 1982. Il popolamento cavernicolo della Sicilia (Ricerche faunistiche ed ecologiche sulle grotte di Sicilia. VII). *Lavori della Società Italiana di Biogeografia*, 7: 587-614.
- Caruso D., 1995. L'attuale stato delle conoscenze sulla fauna delle grotte di Sicilia (Ricerche faunistiche ed ecologiche sulle grotte di Sicilia. VIII). *Atti I Convegno Regionale di Speleologia della Sicilia*, Vol. II, Ragusa, 349-378.
- Cianfanelli S., Manganelli G., Giusti F., 2004. A new species of *Schileykiella* from Marettimo (Aegadian islands, Italy) and discussion of relationships of cilielline Hygromiids (Gastropoda, Pulmonata, Hygromiidae). *Journal of Conchology*, 38: 209-230.
- Colomba M.S., Gregorini A., Liberto F., Reitano A., Renda W., Pocaterra G., Giglio S. & Sparacio I., 2008. Dati molecolari su *Chilostoma* (*Campylaea*) *planospira* (Lamarck, 1822) dell'Italia meridionale e Sicilia (Gastropoda Pulmonata Helicidae). *Atti 37° Congresso Nazionale Italiano di Biogeografia*, Catania, 7-10 ottobre 2008, p. 48.
- Colomba M.S., Gregorini A., Liberto F., Reitano A., Giglio S. & Sparacio I., 2011. Monographic revision of the endemic *Helix mazzullii* De Cristofori & Jan, 1832 complex from Sicily and re-introduction of the genus *Erctella* Monterosato, 1894 (Pulmonata, Stylommatophora, Helicidae). *Zootaxa*, 3134: 1-42.
- Cottarelli V., Bruno M.C., Spena M.T. & Grasso R., 2012. Studies on subterranean copepods from Italy, with descriptions of two new epikarstic species from a cave in Sicily. *Zoological Studies*, 51: 556-582.
- Cowie R.H., 2001. Can snails ever be effective and safe biocontrol agents? *International Journal of Pest Management*, 47: 23-40.
- De Stefani T., 1941. Materiali per uno studio scientifico delle Grotte del Palermitano. *Natura*, 32: 3-23.
- Falkner G., Falkner M. & Von Proschwitz T., 2011. *Monacha gregaria*. In: IUCN 2011. IUCN Red List of Threatened Species. Version 2011.2. [www.iucnredlist.org](http://www.iucnredlist.org). Last access: 30.08.2012.
- Favilli L., Manganelli G., Oliverio M. & Giusti F., 1995. Attempts at nomenclatural and taxonomic revision of the Italian *Cernuella* Schütler, 1838 (Gastropoda, Pulmonata, Hygromiidae). Abstract of the Twelfth International Malacological Congress, Vigo 1995, pp. 380-382.
- Ferreri D., Bodon M. & Manganelli G., 2005. Molluschi terrestri della provincia di Lecce. *Thalassa Salentina*, 28: 31-130.
- Forcart L., 1965. Rezenten Land- und Süßwassermollusken der süditalienischen Landschaften Apulien, Basilicata und Calabrien. *Verhandlungen der Naturforschenden Gesellschaft in Basel*, 76: 59-184.
- Gianguzzi L., D'Amico A., Caldarella O., Ottonello D. & Romano S., 2009. La flora vascolare della Riserva Naturale Grotta Conza (Sicilia Nord-Occidentale). *Il Naturalista Siciliano*, 33: 33-68.
- Giusti F., 1973. Notulae malacologicae XVIII. I molluschi terrestri e salmastri delle Isole Eolie. *Lavori della Società Italiana di Biogeografia*, 3: 113-306.
- Giusti F., 1976. Notulae Malacologicae, XXIII. I molluschi terrestri, salmastri e di acqua dolce dell'Elba, Giannutri e scogli minori dell'Arcipelago Toscano. *Lavori della Società italiana di Biogeografia*, 5: 99-355.
- Giusti F. & Castagnolo L., 1982. I molluschi terrestri delle dune italiane: brevi cenni di ecologia, elenco delle specie e chiavi per il loro riconoscimento. *Quaderni sulla "Struttura delle zoocenosi terrestri"*, 3. Ambienti mediterranei, 1. Le coste sabbiose. Consiglio Nazionale delle Ricerche, Roma, AQ/1/174, 51-102.
- Giusti F. & Manganelli G., 1984. Relationships between geological land evolution and present distribution of terrestrial gastropods in the western Mediterranean area. In: Solem A. & Bruggen A.C. Van (eds.), *World-wide snails. Biogeographical studies on non-marine Mollusca*, Backhuys, Leiden, 290, pp 70-92.
- Giusti F. & Manganelli G., 1990. Notulae Malacologicae, XLIV. A neotype for *Agriolimax caruanae* Polonera 1891 (Pulmonata: Agriolimacidae). *Archiv für molluskenkunde* 119: 235-240.
- Giusti F., Manganelli G. & Schembri P.J., 1995. The non-marine molluscs of the Maltese Islands. *Museo Regionale di Scienze Naturali, Torino, Monografie*, 15: 1-607.
- Guiller A. & Madec L., 2010. Historical biogeography of the land snail *Cornu aspersum*: a new scenario inferred from haplotype distribution in the Western Mediterranean basin. *Evolutionary Biology*, 10: 1-20.
- Hallgass A. & Vannozi A., 2009. Primo contributo alla conoscenza di molluschi continentali del promontorio del Circeo. *Atti del Secondo convegno malacologico pontino*, Sabaudia, 20 Settembre 2008, 19 pp.
- Köppen W., 1936. Das geographische system der klimate. In: Köppen W. & Geiger G. *Handbuch der Klimatologie*, Vol I, Gebrüder Borntraeger, Berlin, 1-44.

- Krapp T., Grasso R. & Ruffo S., 2010. New data on the genus *Jassa* Leach (Amphipoda, Ischyroceridae). *Zoologica Baetica*, 21: 85-100.
- La Greca M., 1962. Tipi fondamentali di distribuzione geografica degli elementi della fauna Italiana. *Archivio Botanico e Biogeografico Italiano*, 38: 12-30.
- La Mantia T. & Rizzo M., 2009. Il piano di Gestione della Riserva Naturale Integrale "Grotta Conza" (Palermo). *Il Naturalista Siciliano*, 32: 69-113.
- Liberto F., Giglio S., Colomba M.S. & Sparacio I., 2012. New and little known land snails from Sicily (Mollusca Gastropoda). *Biodiversity Journal*, 3: 121-228.
- Liberto F., Giglio S., Reitano A., Colomba M.S. & Sparacio I., 2010. Molluschi terrestri e dulciacquicoli di Sicilia della collezione F. Minà Palumbo di Castelbuono. *Monografie Naturalistiche*, 2. Edizioni Dadaus, Palermo, 136 pp.
- Lo Brano V.D. & Sparacio I., 2006. Molluschi terrestri e dulciacquicoli del S.I.C. Rupi di Catalano e Capo Zafferano Sicilia (Gastropoda, Neotaenioglossa, Pomatiidae, Basommatophora, Stylommatophora). *Il Naturalista siciliano*, 30: 555-589.
- Manganelli G. & Giusti F., 1987. Notulae Malacologicae XXXVIII. A new Hygromiidae from the Italian Apennines and notes on the genus *Cernuella* and related taxa (Pulmonata: Helicoidea). *Bollettino Malacologico*, 23: 327-380.
- Manganelli G., Bodon M., Favilli L. & Giusti F., 1995. Gastropoda Pulmonata. In: Minelli A., Ruffo S., La Posta S. (eds.), *Checklist delle specie della fauna italiana*, 16. Calderini, Bologna, 60 pp.
- Manganelli G., Bodon M., Favilli L., Castagnolo L. & Giusti F., 1998. Checklist delle specie della fauna d'Italia, molluschi terrestri e d'acqua dolce. Errata ed addenda, 1. *Bollettino Malacologico*, 33: 151-156.
- Manganelli G., Bodon M. & Giusti F., 2000. Checklist delle specie della fauna d'Italia, molluschi terrestri e d'acqua dolce. Errata e addenda, 2. *Bollettino Malacologico*, 36: 125-130.
- Mannino G., Zava B. & Catalano E., 1986. Le Grotte della cuspide Settentrionale dei monti di Billiemi (Palermo). In: *Le Grotte del Palermitano. Quaderni del Museo Geologico "G. G. Gemmellaro"*, 2: 127-129.
- Nordsieck H., 2002. Contributions to the knowledge of the Delimini (Gastropoda: Stylommatophora: Clausiliidae), *Mitteilungen der Deutschen Malakozoologischen Gesellschaft*, 67: 27-39.
- Parenzan P., 1994. Proposta di codificazione per una gestione informatica dei corotipi W-palearctici con particolare riferimento alla fauna italiana. *Entomologica*, 28: 93-98.
- Pfeiffer K.L., 1931. Die Murellen Westsiziliens. *Archiv für Molluskenkunde*, 63: 93-116.
- Pfenninger M., Vela E., Jesse R., Arantzazu Elejalde M., Liberto F., Magnin F. & Martínez-Orti A., 2010. Temporal speciation pattern in the western Mediterranean genus *Tudorella* P. Fischer, 1885 (Gastropoda, Pomatiidae) supports the Tyrrhenian vicariance hypothesis. *Molecular Phylogenetics and Evolution*, 54: 427-436.
- Reise H., Hutchinson J.M.C., Schunack S. & Schlitt B., 2011. *Deroceras panormitanum* and congeners from Malta and Sicily, with a redescription of the widespread pest slug as *Deroceras invadens* n. sp. *Folia Malacologica*, 19: 201-223.
- Reitano A., Liberto F., Sparacio I. & Giglio S., 2009. I Molluschi terrestri della R.N.I. "Grotta Palombara" (Melilli, Sicilia sud-orientale). *Il Naturalista Siciliano*, 33: 177-205.
- Sacchi C.F., 1952. Raggruppamenti dei Molluschi terrestri sul litorale italiano. Considerazioni e ricerche introduttive. *Bollettino della Società veneziana di Storia naturale e del Museo Civico di Storia naturale di Venezia*, 6: 99-158.
- Sacchi C.F., 1954. *Cyclostoma (Tudorella) sulcatum* Drap. in Sicilia occidentale. *Doriana*, 1: 1-4.
- Spina M.T., 2007. Studio biospeologico della Riserva Naturale Integrale "Grotta Conza". Tesi sperimentale di Laurea, Univ. degli Studi di Catania, Catania, Italy.
- Subai P., 1980. Revision der lebenden Arten der Gattung *Poiretia* (Gastropoda: Oleacinidae). *Archiv für Molluskenkunde*, 110: 151-172.
- Vigna Taglianti A., Audisio P.A., Belfiore C., Biondi M., Bologna M.A., Carpaneto G.M., De Biase A., De Felici S., Piattella E., Racheli T., Zapparoli M. & Zoia S., 1993. Riflessioni di gruppo sui corotipi fondamentali della fauna W-palearctica ed in particolare italiana. *Lavori della Società Italiana di Biogeografia*, 16: 159-179.
- Vigna Taglianti A., Audisio P.A., Biondi M., Bologna M.A., Carpaneto G.M., De Biase A., Fattorini S., Piattella E., Sindaco R., Venchi A. & Zapparoli M., 1999. A proposal for a chorotype classification of the Near East fauna, in the framework of the Western Palearctic region. *Lavori della Società Italiana di Biogeografia*, 20: 31-59.
- Wiktor A., 2000. Agriolimacidae (Gastropoda: Pulmonata) - A systematic monograph. *Annales Zoologici*, 49: 347-590.
- Zilch A., 1958. Die typen und Typoide der Natur-Museums Senckenberg, 21: Mollusca, Cyclophoridae, Craspedopominae-Cochlostominae. *Archiv für Molluskenkunde*, 87: 53-76.