Biodiversity Journal, 2014, 5 (2): 151–164

MONOGRAPH

The continental molluscs from Mount Circeo (Latium, Italy)

Alessandro Hallgass[1] & Angelo Vannozzi[2]

[1]Via della Divina Provvidenza 16, 00166 Roma, Italy; e-mail: hallgass@hotmail.com
[2]Via Pietro de Cristofaro 46, 00136 Roma, Italy; e-mail: ang.vannozzi@gmail.com

ABSTRACT This paper is the second step in a process that aims to asses biodiversity of land and freshwater molluscs fauna of Mount Circeo (Latium, Italy). Forty species of land and freshwater molluscs are listed, three more than in the previous work. A species of *Oxychilus* Fitzinger, 1833 and two species of *Limax* Linnaeus, 1758 remain undetermined, to date. The presence of *Pleurodiscus balmei balmei* (Potiez et Michaud, 1838) and *Siciliaria gibbula honii* (O. Boettger, 1879) are confirmed and this is the known northern limit of their distribution areas in Italy. Moreover, the presence of some species of biogeographical interest has allowed us to formulate some hypotheses on the origin of this fauna, in the light of the most recent theories on the formation of the Italian peninsula.

KEY WORDS Continental molluscs; Mount Circeo; checklist.

Received 28.01.2014; accepted 21.03.2014; printed 30.06.2014
Proceedings of the Seventh Malacological Pontine Meeting, October 5th-6th, 2013 - San Felice Circeo, Italy

INTRODUCTION

The 2nd Malacological Pontine Conference of 2008, gave us the opportunity to presented a first contribution on the biodiversity of land molluscs of Mount Circeo (Hallgass &Vannozzi, 2008). The research carried out in this territory, which progressed in the recent last years, allowed us to update our knowledge of this fauna which is reported in the following.

Study area

Mount Circeo is a promontory composed mostly of marl and sandstone from the Paleogene and of limestone from the lower Early Jurassic, which is different from that constituting the nighbouring Ausoni Mountains (Fig. 1). The shape of the promontory is elongated in east-west direction with a length of about 6 km, and a maximum height of 541 m above sea level (reached at the "Pizzo di Circe"); other important heights are the "Semaforo" (412 m) and the "Le Crocette" (352 m).

The geographical position of the promontory contributes to create some sub-environments in relation to their different exposure:

• "Quarto Freddo" with northern exposure.

• "Quarto Temperato" with western exposure; it is a transition from the south side to the north side, therefore it has no particular interest.

• "Quarto Caldo" with southern exposure.

• "Quarto Comunale" with eastern exposure; it is anthropized and altered and therefore of little naturalistic interest.

Our interest was, therefore, focused on the two slopes, the northern and the southern ones. The vegetation in Mount Circeo is typically Mediterranean but is very different by structure and composition in the two mains slopes.

QUARTO FREDDO. The vegetation on the northern slope of the mountain is made up of a dense forest of tall trees dominated by holmoak. At the baseline, however, there are scattered examples of Italian oak, oak, and hornbeam, which represent the penetration of the neighboring plainforest.

Other trees or shrubs species well represented are: mock privet, ash, arbutus, heather and buck thorn. Towards the plain, however, the beautiful "Sughereta di Mezzomonte", whose underwood is characterized by fallen branches of which soon remains only the thick bark that provides a shelters for many species of molluscs (Figs. 3, 6). At about 200 meters above the sea level, we observed there forestation of conifers that made the canopy of the forest higher; the oaks adapted and have a very slender truncks while the cork oaks were not able to reach the canopy and are found as skeletons in the underwood. At the top of the mountain on both lopes there is the limestone exposed, which is the exclusive habitat of strictly calciphilous species.

QUARTO CALDO. In the medium and high area of the mountain, the vegetation is very compact and consists of high and low maquis species dominated by arborescent layer of oak with plenty of ash, arbutus, mastic, heather and broom.The low maquis is prevalent mostly in the lower part of the promontory and is dominated by mastic, phillyrea, myrtle, and holm oak which, in addition, shows a bushy shape. Very interesting is the presence of several specimens of the dwarf palm (*Chamaerops humilis* L.), the only spontaneous palm in Italy. On all the rock sand cliffs overlooking the sea, we found a discontinuous grouping characterized by lavender pillows placed near to the ground, sea fennel and compact clumps of weeds beaches, sometimes associated to the enula. In more humid valley sholm returns to be dominant in the tree shape.

On the promontory several species of molluscs from different neighboring environments can be found. The thermophilic species can reach the promontory from the adjacent dune and colonize hot-arid environments. From the adjacent plain forest are the species characteristic of a moist environment; however, much more interesting are the strictly calciophilous species that could be the remains of the old fauna of the promontory. For some species, we cannot rule out an anthropogenic input.

MATERIAL AND METHODS

The research of terrestrial molluscs was made by manual sampling for most species. The list of localities under consideration is shown in Table 1.

Collected samples were deposited in the malacological collection of the "Museo del Mare e della Costa" of Sabaudia. Some very small species, isolated

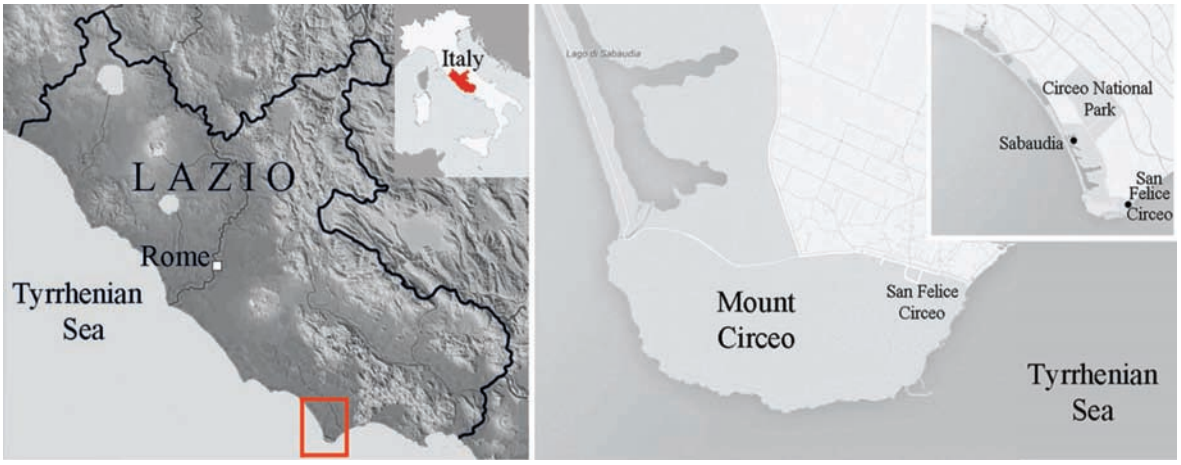


Figure 1. Study area: Mount Circeo, Latium, Italy.

locality ID	locality	slope	coordinates	altitude a.s.l. (m)	type of environments
1	From the road to "le Crocette" at the beginning of the trail to "la Guardia di Orlando"	Quarto freddo	41°14'15"N 13°04'57"E	192	Ilex (Holly) trees
2	Top trail between "il Semaforo" and " il Fortino Rosso"	Quarto freddo	41°13'55"N 13°04'09"E	352	High maquis
3	Source of "Mezzomonte"	Quarto freddo	41°14'23"N 13°04'13"E	45	Dense woods of Ilex (Holly) and cork oak trees
4	"La Cava"	Quarto freddo	41°14'36"N 13°04'55"E	42	drystony ground and limestone wall exposed
5	Beginning of trail 1 (Torre Paola)	Quarto freddo	41°14'48"N 13°02' 23"E	30	Holly trees
6	Crossroads between"del Faro" road and "del Sole" road	Quarto caldo	41°13'25"N 13°03'59"E	49	limestone wall exposed and low maquis
7	On the walls of the houses of "S. Felice al Circeo"	Quarto comunale	41°13'60"N 13°05'16"E	98	ruderal

Table 1. List of sampled localities of Mount Circeo (Latium, Italy).

species	1	2	3	4	5	6	7	B	figs.
Platyla cf. *microspira* (Pini, 1884)								x	
Pomatias elegans (O.F. Müller, 1774)	vvv	vvv	vv	vv		vv		x	2, 12
Pseudamnicola moussonii (Calcara, 1841)								x	
Islamia pusilla (Piersanti, 1952)								x	
Galba truncatula (O.F. Muller, 1774)								x	
Carychium tridentatum (Risso, 1826)								x	
Rupestrella philippii (Cantraine, 1840)						vvv			13
Granopupa granum (Draparnaud, 1801)						c			14
Acanthinula aculeata (O.F. Müller, 1774)								x	
Lauria cylindracea (Da Costa, 1778)				vv1				x	15
Pleurodiscus balmei (Potiez et Michaud, 1838)						cc			18

Table 2 (continued). List of continental molluscs found in Mount Circeo (Latium, Italy) in the seven localities reported in Table 1. Additional species collected by M. Bodon (pers. comm.) are listed in coloumn B. Abbreviations. v: living specimen; c: empty shell. Single specimen: +; some specimens (2-4): + +; several specimens: + + +. In the case of many living specimens, data on empty shells have been omitted. 1 in wall; 2 ilex wood; 3 juv.; 4 on road cut rocks.

species	1	2	3	4	5	6	7	B	figs.
Chondrula tridens (O.F. Müller, 1774)						cc			17
Punctum pygmaeum (Draparnaud, 1801)								x	
Discus rotundatus (O.F. Müller, 1774)	vvv	vvv	vvv	vv	vv			x	3
Vitrea contracta (Westerlund, 1871)			c					x	16
Oxychilus sp.	cc		v-cc	cc		cc2		x	19
Daudebardia rufa maravignae (Pirajno, 1840)								x	
Tandonia sowerbyi (Férussac, 1823)			vv3						4
Limax sp. 1	vv3		vv		vv				5
Limax sp. 2			vv						6
Cecilioides acicula (O.F. Müller, 1774)								x	
Rumina decollata (Linnaeus, 1758)		cc		cc		cc			28
Leucostigma candidescens (Rossmässler, 1835)	vvv4	vvv	vvv	vvv		vvv4		x	8, 22
Cochlodina incisa (Küster, 1876)	vv								20, 21
Siciliaria paestana (Philippi, 1836)	vvv	vvv	vvv	vv	vvv	cc2		x	9,25,26
Siciliaria gibbula honii (O. Boettger 1879)					vv				27
Papillifera bidens (Linnaeus, 1758)				vvv					23, 24
Xerotricha apicina (Lamarck, 1822)				v-ccc					29
Xerotricha conspurcata (Draparnaud, 1801)						vv-ccc			31
Hygromia cinctella (Draparnaud, 1801)			c						35
Cernuella cisalpina (Rossmässler, 1837)				vv-ccc		c			34
Trochoidea trochoides (Poiret, 1789)				vvv					30
Cochlicella acuta (O.F. Müller, 1774)				vvv					33
Cochlicella conoidea (Draparnaud, 1801)				vv				x	32
Chilostoma planospira (Lamarck, 1822)	v		vv					x	10,36,37
Marmorana muralis (O.F. Müller, 1774)							cc		38
Marmorana fuscolabiata circeja (Kobelt, 1903)	vv-cc4					vv-cc		x	11, 39
Eobania vermiculata (O.F. Müller, 1774)		cc		v-ccc		cc		x	
Cantareus apertus (Born, 1778)				cc					
Cantareus aspersus (O.F. Müller, 1774)				cc					

Table 2. List of continental molluscs found in Mount Circeo (Latium, Italy) in the seven localities reported in Table 1. Additional species collected by M. Bodon (pers. comm.) are listed in coloumn B. Abbreviations. v: living specimen; c: empty shell. Single specimen: +; some specimens (2-4): + +; several specimens: + + +. In the case of many living specimens, data on empty shells have been omitted. 1 in wall; 2 ilex wood; 3 juv.; 4 on road cut rocks.

Figs. 2–9. Land snails from Mount Circeo. Fig. 2. *Pomatias elegans*. Fig. 3. *Discus rotundatus*. Fig. 4. *Tandonia sowerbyi*. Fig. 5. *Limax* sp. 1. Fig. 6. *Limax* sp. 2. Fig. 7. *Limax maximus* from Terracina. Fig. 8. *Leucostigma candidescens.* Fig. 9. *Siciliaria paestana*.

by sieving litter and soil, and some freshwater species found in the source Coppelia in San Felice Circeo, were collected by M. Bodon and have been added to the list of species found in this study (Table 2). It was not possible to carry out surveys of freshwater species in the source "Mezzomonte", the main source of the promontory, which provides water to the town of San Felice Circeo and now completely captured and inaccessible.

For the systematic nomenclature we referred mainly to the Checklist of the species of the Italian Fauna (Bodon et al., 1995; Manganelli et al., 1995); for the supra-generic systematic see the "Classification and nomenclator of gastropod families" (Bouchet & Rocroi, 2005).

All specimens illustrated are from the Mount Circeo, unless otherwise stated.

RESULTS

At present, 40 species of continental molluscs are known from Mount Circeo, the most interesting of which will be briefly commented on below. The full list is shown in Table 2.

Taxonomic list

Familia ACICULIDAE

Platyla cf. ***microspira*** (Pini, 1884)

This species is morphologically referable to *P. microspira* and is also known from the rear Ausoni Mountains (Bodon & Cianfanelli, 2008). There still remains, however, uncertainty concerning the identity of the species, taken into account the geographic isolation from the typical populations of Lombardy and Liguria.

Familia CHONDRINIDAE

Rupestrella philippii (Cantraine, 1840)

Two empty shells of this small species (Fig. 13) were found among the rocks of a road cut along with *Granopupa granum* (Draparnaud, 1801). The association of these two species has already been documented by Giusti (1970) for the Pianosa Island. It would be extremely useful to study these two small species from a genetic stand point, being almost impossible to understand the relationships among their populations either by anatomical or morphometric analysis.

Granopupa granum (Draparnaud, 1801)

This small species (Fig. 14) is widespread in Italy and in Holomediterranean-Macaronesian-Turanian region, albeit discontinuously, since it is closely associated with a limestone substrate. It is common in Mount Circeo and the shell is morphologically little variable.

Familia PLEURODISCIDAE

10

11

Figs. 10, 11. Land snails from Mount Circeo. Fig. 10. *Chilostoma planospira*. Fig. 11. *Marmorana fuscolabiata circeja.*

Pleurodiscus balmei balmei (Potiez et Michaud, 1838)

Only some empty shells of this species were found (Fig. 18); however, one of them was a very fresh shell, and we believe that this species actually lives in Mount Circeo. This is the most northern record of the species in the Italian peninsula. Recently it has also been reported for Apulia (Ferreri et al., 2005; Bassi, 2007). Instead, it is well known for southern Calabria, Sicily and Malta (Giusti et al., 1995). The population of Mount Circeo could be a relict population, but we cannot exlude a passive introduction by man, as *P. balmei* is frequent in ruderal habitats, gardens etc. (Kerney & Cameron, 1979).

Familia DISCIDAE

Discus rotundatus (O.F. Müller, 1774)

A very common species and widely distributed throughout Italy and Europe, *D. rotundatus* is characteristic of the underbrush (Fig. 3). The diameter of the shell does not exceed 7 mm. In the forests of the "Quarto Freddo" the thick bark of fallen branches of cork oaks creates an ideal habitat for this small gastropod.

Familia PRISTILOMATIDAE

Vitrea contracta (Westerlund, 1871)

It has been found only a shell of this European widespread species (Fig. 16). In Italy it is found at low altitudes along the coast, while at higher altitudes it is replaced by other congeneric species (Giusti et al., 1985).

Familia OXYCHILIDAE

Oxychilus sp.

One living specimen and some shells of this species were found (Fig. 19). Although it is morphologically similar to a small form of *O. draparnaudi* (Beck, 1837), it will be necessary to investigate anatomical features in detail to determine its specific identity. As already pointed out by Manganelli & Giusti (2001), species of *Oxychilus* Fitzinger, 1833 with well characterized genitalia may show identical shells.

Familia MILACIDAE

Tandonia sowerbyi (Férussac, 1823)

The species of *Tandonia* Lessona et Pollonera, 1882 genus are necrophagous and carnivorous molluscs. Only some juveniles were observed in mount Circeo. Externally it is distinguished from congeners by the dorsal hull orange and the clear sole (Fig. 4). It is widely spread throughout Italy, probably dispersed by man.

Familia LIMACIDAE

Limax sp. 1

This species (Fig. 5) is of medium size for the genus, about 10–12 cm long; it is characterized by colour, ocher-yellow, with a lighter uniform sole, colour similar to *Limax bivonae* Lessona et Pollonera,1882, reported for north-eastern Sicily (Reitano et al., 2007). It was sampled at different localities of the promontory.

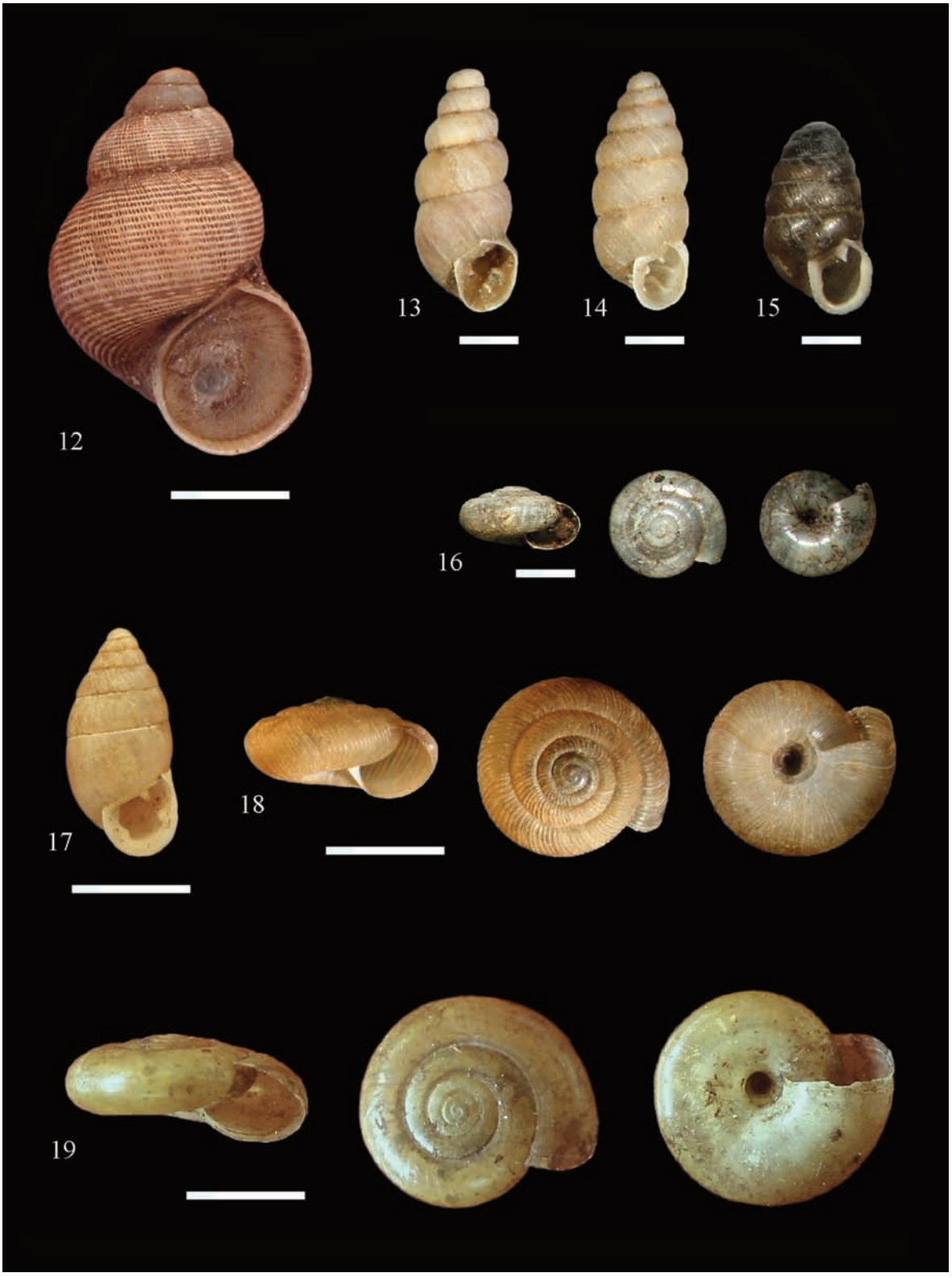
Limax sp. 2

Same size as the previous one, with darker color and a pattern of small irregular spots limited to the clypeus, looking as a variation of *L. maximus* Linnaeus, 1758. Only two specimens were found in the cork trees of Mezzomonte (Fig. 6). It is currently not possible to determine whether *Limax* sp. 1 and *Limax* sp. 2 belong to a single or two distinct species. For the external morphology, both species are attributable to the group of *L. maximus*. However a few miles from these findings, out of the promontory, towards Terracina, we observed *L. maximus* specimens with the characteristic spotted livery (Fig. 7).

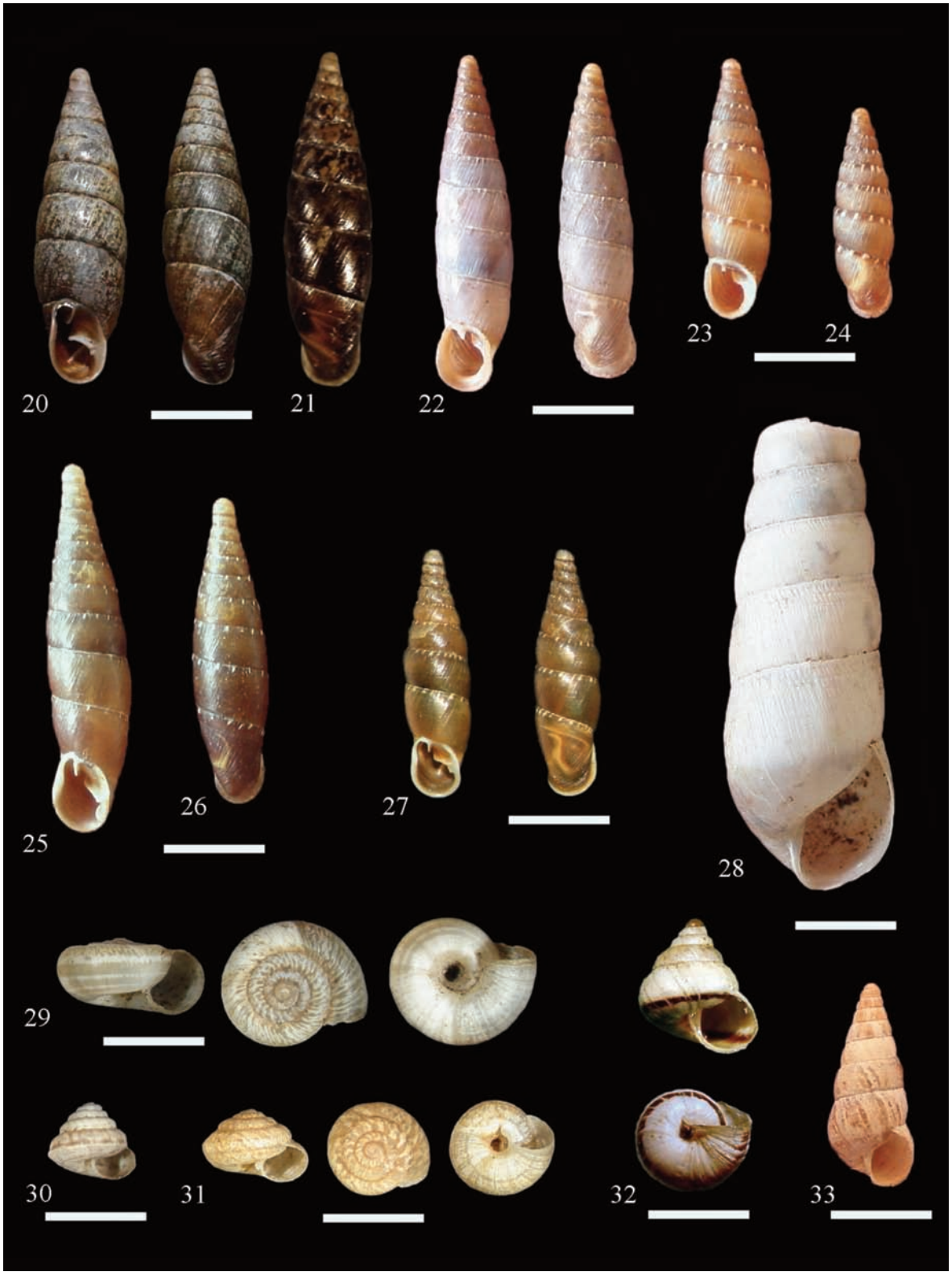
Familia CLAUSILIIDAE

Leucostigma candidescens (Rossmässler, 1835)

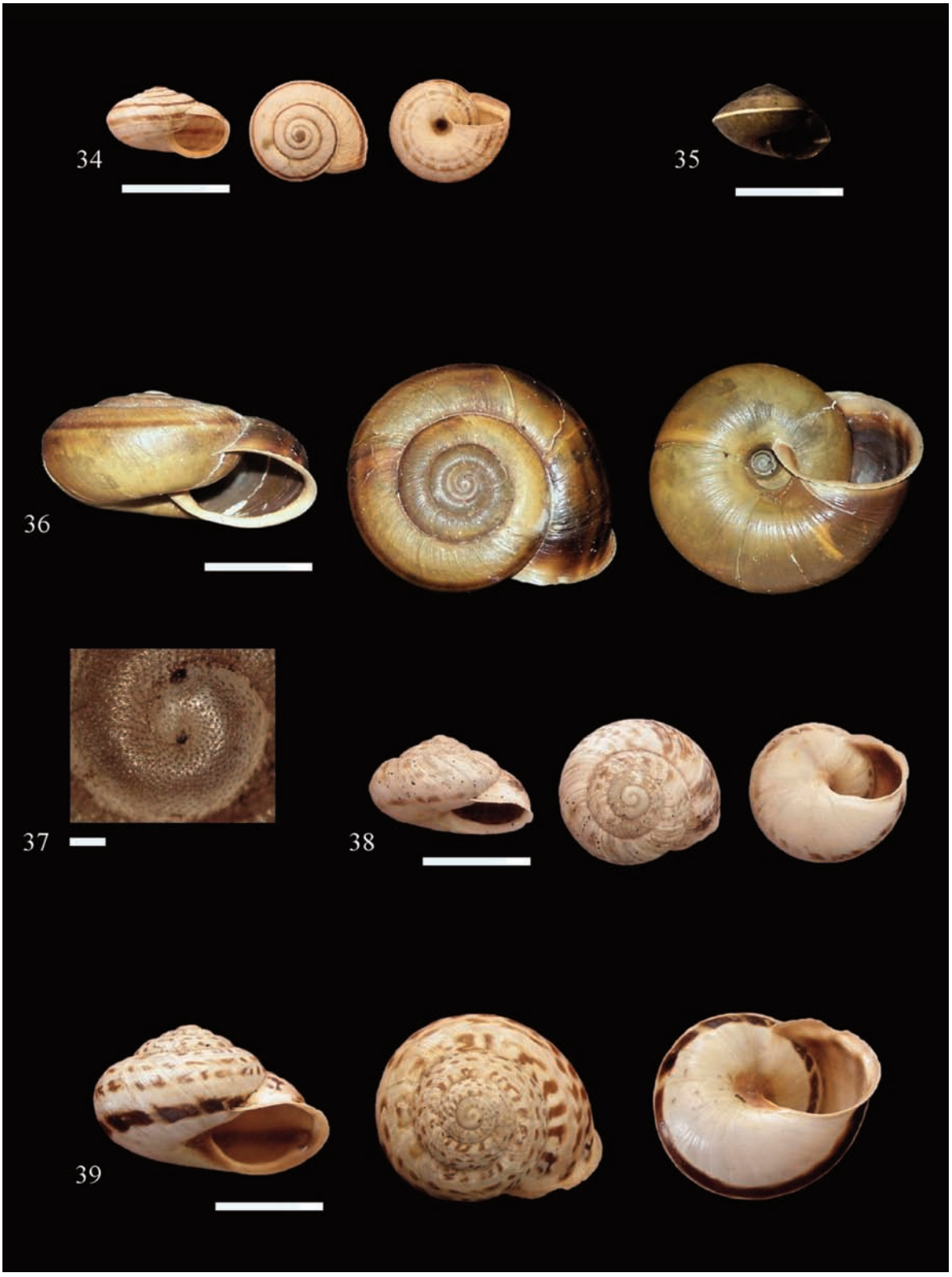
This species (Figs. 8, 22) is strictly calciophilous



Figs. 12–19. Land shells from Mount Circeo. Fig. 12. *Pomatias elegans*. Fig. 13. *Rupestrella philippii*. Fig. 14. *Granopupa granum*. Fig. 15. *Lauria cylindracea*. Fig. 16. *Vitrea contracta*. Fig. 17. *Chondrula tridens*. Fig. 18. *Pleurodiscus balmei.* Fig. 19. *Oxychilus* sp.



Figs. 20–33. Land shells from Mount Circeo. Fig. 20, 21. *Cochlodina incisa*. Fig. 22. *Leucostigma candidescens*. Figs. 23, 24. *Papillifera bidens*. Figs. 25, 26. *Siciliaria paestana*. Fig. 27. *S. gibbula honii*. Fig. 28. *Rumina decollata*. Fig. 29. *Xerotricha apicina*. Fig. 30. *Trochoidea trochoides*. Fig. 31. *X. conspurcata*. Fig. 32. *Cochlicella conoidea*. Fig. 33. *C. acuta*



Figs. 34–39. Land shells from Mount Circeo. Fig. 34. *Cernuella cisalpina*. Fig. 35. *Hygromia cinctella*. Fig. 36. *Chilostoma planospira*. Fig. 37. *C. planospira*: protoconch with numerous tubercles. Fig. 38. *Marmorana muralis*. Fig. 39. *Marmorana fuscolabiata circeja*.

and is distributed in the Italian peninsula (Umbria, Latium, Abruzzo and Campania). It is characteristic of exposed walls however, it can also be found in the woods, always on the rocky walls. The populations of Mount Circeo, not particularly abundant, are of medium-small size for the species (h: 12–17 mm). It is morphologically similar to the southern morphs of the species, i.e. whitish with small papillae, and almost indistinguishable from the forms present on Ausoni Mountains at Terracina. In the nearby Lepini Mountains is dominant *Leucostigma leucostigma* with purplish-brown shell and papillae more evident. In Latium there are populations of giant specimens, that exceed 22 mm.

Cochlodina incisa (Küster, 1876)

Species widely distributed in Italian peninsula at low altitudes. Above1000 m it is replaced by *C. laminata* (Montagu, 1803), a species widespread all over Europe. In the contact areas the two species are found in sympatry. *C. incisa* from Mount Circeo (Figs. 20, 21) compared to the Apennine populations, shows a more obese shell, sometimes with numerous intermediate palatal plicae. As far as converns its anatomical features, no differences were observed. *C. incisa* was found, with the same character, even in the littoral ilex trees wood of Macchiagrande (Rome).

This species is closely related to *C. kuesteri* (Rossmässler, 1836) and *C. meisneriana* (Shuttleworth, 1843) which are found in Sardinia and Corsica, respectively.

Siciliaria paestana (Philippi, 1836)

A common species (Figs. 9, 25, 26) in the coastal area of the Tyrrhenian coast, in alluvial plain between the ancient Pliocene coast line and the present coast, from low lands behind the dunes to the inner areas with low vegetation, never in very humid environments. The southern boundary for this species is Paestum, its locus typicus. In the south and east part of the species range (Campania and Basilicata), there are some forms of uncertain taxonomic status.

Siciliaria gibbula honii (O. Boettger, 1879)

Poorly known species (Fig. 27), widespread from the Vesuvian area to southern Latium. It is generally uncommon, abundant only on the Ventotene island where it is the dominant species.

Nordisieck (2013) considers doubtful the subspecific relationship with *S. gibbula*. Further research is needed to clarify the relationship of *S. gibbula honii* with some form of *S. gibbula* in Calabria, the Aeolian Islands and with *Siciliaria vulcanica* (Paulucci, 1878) from Mount Etna.

Papillifera bidens (Linnaeus, 1758)

Synonyms: *Papillifera papillaris* (O.F. Müller, 1774). It is one of the species of Clausiliidae most widely dispersed by man. It is common on old walls. In Italy, *P. bidens* lives in natural habitats only in Apulia, Basilicata, Calabria, Sicily and Sardinia. Within the Mount Circeo it was found in the locality known as "La Cava" and on the walls of the town of San Felice (Figs. 23, 24) with *Marmorana muralis* (O.F. Müller, 1774).

Familia HYGROMIIDAE

Xerotricha apicina (Lamarck, 1822)

Species common (Fig. 29) in uncultivated lands to the low lands behind the dunes. It is widespread in Italy up to the Mediterranean coast of France. The shell of the juvenile specimens has hairs on the periostracum that do not persist in the adult.

Xerotricha conspurcata (Draparnaud, 1801)

This species is similar to *X. apicina*, however, is smaller and with hairs of periostracum persisting in adults (Fig. 31). It prefers areas less exposed respect to the congener. Widespread throughout Italy.

Hygromia cinctella (Draparnaud, 1801)

Species common in humid environments of the Italian peninsula and Sicily. In the Mount Circeo (Fig. 35) as found only one shell, not very fresh, in the cork oak of Mezzomonte.

Familia HELICIDAE

Chilostoma planospira (Lamarck, 1822)

This species lives under brushes among the rocks (Fig. 36). Anatomical examination of a living specimen revealed an asymmetry in the morphology of the two mucous glands, one being simple and the other one bifid. This feature is not mentioned by any authors and could fall within the variability of the species.The protoconch is adorned with numerous tubercles (Fig. 37).

Marmorana muralis (O.F. Müller, 1774)

This species has a Sicilian distribution, but it has been dispersed by man in many site in the western Mediterranean area. In the Italian peninsula it is known only in anthropic environments, with the exception of two localities in Umbria and Calabria. In Sicily it is rather widespread either in natural or ruderal environments. In Mount Circeo (Figs. 10, 38) it was found on the walls of the town of San Felice with *Papillifera bidens*.

Marmorana fuscolabiata circeja (Kobelt, 1903)

Marmorana fuscolabiata (Rossmässler, 1842) is widespread in the Southern Apennines. Geographical isolation of the population of Mount Circeo (Figs. 11, 39) and the relative genetic distance compared to other neighboring population it seems to justify the use of the rank of subspecies (Oliverio et al., 1992). In recent years, probably because of the drought, there has been a substantial decrease in the number of individuals.

DISCUSSION AND CONCLUSIONS

Mount Circeo has long been an island; indeed a sea bottom that does not exceed 300 m below the sea level joins it to the Pontine Islands. This is a group of volcanic islands, but still retains, in the island of Zannone, a portion of the limestones that possibly were part of a bigger platform.

The theory of Alvarez et al. (1974) explains the formation of Italy and of the western Mediterranean by the counterclockwise rotation of the Sardo-Corsican plate. Originally joined to the European plate in correspondence of Provence, during its rotational movement eastward, fragments detached to form Balearic Islands, Corsica and Sardinia. Of great importance is the Calabro-Peloritan micro-plate that detached from the whole Sardo-Corsican complex giving rise to the Tyrrhenian Sea. This theory has allowed us to explain the fragmented distribution of species with very low dispersal ability, including *Papillifera solida* and the species of the genus *Solatopupa* Pilsbry, 1917 as well as the close relationship that occurs between *Cochlodina kuesteri* and *C. incisa* (Giusti, 1976; Ketmaier et al., 2006).

The distribution of *Cochlodina* Férussac, 1821 species may be explained by the fragmentation of the Alps occurred during the Oligocene. It is possible that the distribution area of one species of *Cochlodina* living with in the entire Alpine region was fragmented and that the various isolated populations differentiated in different species over time. In fact, we note that the center of diffusion of the genus *Cochlodina* is the Alpine region,where there are a dozen species, occurring – in addition to the Alps and the Italian mainland – also in Corsica with *C. meisneriana*, in Sardinia with *C. kuesteri*, and in Algeria (Kabilya) with *C. bavayana* Hagenmüller, 1884 (Nordsieck, 1969), all fragments of the original Alps, as well as it could have occurred in the micro-plates that huddled to form the Apennines.

With the change of latitude the "Tyrrhenian" *Cochlodina* adapted to warmer climates. It is therefore possible that the populations of *C. laminata* that live at high altitudes in the Apennines are a relict fauna that came down from the north in the colder periods and, subsequently, *C. incisa*, coming from the west, colonized habitats at lower altitudes. However, genetic studies are needed to test this hypothesis.

However, although the theory of Alvarez et al. (1974) is now universally accepted, it leaves a large margin of uncertainty as to how and when the various plates did move. Duermeijeret et al. (1997) believe that the separation between the Sardo-Corsican complex and the Calabro-Peloritan microplate occurred between 8.6 and 7.8 Mya, with the opening of the Tyrrhenian Sea. The study on enzyme polymorphisms on the genus *Marmorana* (*Ambigua*) (Oliverio et al., 1992) partly confirms and partly is in contrast with this opinion. In fact, these times are well suited for the separation between the *Tyrrheniberus ridens* (Martens, 1884) from Sardinia and the *Marmorana signata* group (Férussac, 1821), but do not justify neither the much lower distance between *Tyrrheniberus* and the *Marmorana fuscolabiata*

group nor the proximity of this latter to *Marmorana saxetana* (Paulucci, 1886) occurring in the Argentario. The genetic distance between *Tyrrheniberus* and these latter two species would suggest a separation occurred between 4 and 5 Mya.

A model that could justify these inconsistencies would require the separation, at different times, of the various plates travelling separately and subsequently fused to form the current Italian peninsula. The Calabro-Peloritan microplate at the time of separation from the whole Sardo-Corsican complex might appear as an island very elongated in north-south direction that, for a certain time, traveled as a whole block.

During the movement from north-west to south-east this microplate broke in several pieces, some of which moved away to form the Argentario and the calcareous parts of the Tuscan Archipelago, respectively; this event could might have occurred between 3.5 and 3 Mya.

In more recent times there was a sliding movement of the plate to the south (Van Dijk & Scheepers, 1995) that might have caused a new division of the plate from which it broke away the part that we find today as Mount Circeo and the limestone debris of Zannone Island. This event may be dated between 1 and 0.7 Ma. This model could explain the presence of *Marmorana fuscolabiata* on Mount Circeo, the relatively close genetic distance between *M. fuscolabiata* and *M. saxetana* and the greater genetic distance that separates these two species from *M. signata* of Ausoni Mountains, less than 15 km far from Mount Circeo, and could also explain other biogeographic mysteries such as the presence of *Pegea carnea* (Risso, 1826) in Pantelleria Island (Sparacio, 1997), the Aeolian Islands and the Tuscan Archipelago and the presence of *Pleurodiscus balmei* at Mount Circeo. Only an additional contribution of genetic data related to groups and species strictly calciphilous with very low dispersal abilities may corroborate or refuse this hypothesis.

ACKNOWLEDGEMENTS

We are grateful to Marco Bodon (Genoa, Italy) who put at our disposal data of his samplings on the promontory. We are also grateful to Aldo Marinelli and Mauro Grano (both Rome, Italy) for support in the field and for the permission to publish the photos of figures 4 and 10, 11, 20 and 35, respectively.

REFERENCES

Alvarez W., Cocozza T. & Wezel F.C., 1974. Fragmentation of the Alpine orogenic belt by microplate dispersal. Nature 248: 309–314.

Bassi V., 2007. Pleurodiscus balmei (Potiez & Michaud, 1838). http://www.naturamediterraneo.com/forum/topic.asp?TOPIC_ID=36805 (accessed 1.6.2013).

Bodon M. & Cianfanelli S., 2008. Una nuova specie di Platyla per il sud Italia (Gastropoda: Prosobranchia: Aciculidae). Bollettino Malacologico, 44: 27–37.

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. (a cura di), Checklist delle specie della fauna italiana 14, Bologna (Calderini): 1–60.

Bouchet P. & Rocroi J.P., 2005. Classification and nomenclator of gastropod families. Malacologia, 47: 1–397 pp.

Duermeijer C.E., Van Vugt N., Langereis C.G., Meulenkamp J.E. & Zachariasse W.J., 1998. A major late Tortonian rotation phase in the Crotone basin using AMS as tectonic tilt correction and timing of the opening of the Tyrrhenian basin. Tectonophys, 287: 233–249.

Ferreri D., Bodon M. & Manganelli G., 2005. Molluschi terrestri della provincia di Lecce. Thalassia Salentina, 28: 31–130.

Giusti F., 1970. Notulae malacologicae XII. L'isola di Pianosa e lo scoglio La Scola (Arcipelago Toscano). Annali del Museo Civico di Storia Naturale Genova, 78: 59–148.

Giusti F., 1976. Notulae malacologicae XXIII. I molluschi terrestri, salmastri e di acqua dolce dell'Elba, Giannutri e scogli minori dell'Arcipelago Toscano e descrizione di una nuova specie. Lavori della Società Italiana di Biogeografia, NS, 5: 99–355.

Giusti F., Castagnolo L. & Manganelli G., 1985. La malacofauna delle faggete italiane: brevi cenni di ecologia, elenco delle specie e chiavi di riconoscimento dei generi e delle entità più comuni. Bollettino Malacologico, 21: 69–144.

Giusti F., Manganelli G. & Schembri G.J., 1995. The non marine molluscs of the Maltese islands. Monografie del Museo Regionale di Scienze Naturali, Torino, 15: 1–607.

Hallgass A. & Vannozzi A., 2008. Primo contributo alla conoscenza di molluschi continentali del promontorio del Circeo. Atti del Secondo convegno malacologico pontino. Sabaudia, 20 settembre 2008, 19 pp. http://www.naturamediterraneo.com/atticonvegno/Hallgass&Vannozzi2008.pdf

Kerney M.P. & Cameron R.A.D., 1979. A field guide to the land snails of Britain and north-west Europe. London, Collins, 288 pp.

Ketmaier V., Giusti F. & Caccone A., 2006. Molecular phylogeny and historical biogeography of the land snail genus *Solatopupa* (Pulmonata) in the peri-Tyrrhenian area. Molecular Phylogenetics and Evolution, 39: 439–451.

Lepri G., 1909. Contributo alla conoscenza dei molluschi terrestri e d'acqua dolce del Lazio. Bollettino della Società zoologica italiana, 18: 347–444.

Manganelli G., Bodon M., Favilli L. & Giusti F., 1995. Gastropoda Pulmonata - In: Minelli A., Ruffo S. & La Posta S. (a cura di), Checklist delle specie della fauna italiana 16, Bologna (Calderini): 1–60.

Manganelli G. & Giusti F., 2001. Redescription of *Oxychilus meridionalis* (Paulucci, 1881) (Pulmonata: Zonitidae). Bollettino Malacologico, 37: 187–206.

Nordsieck H., 1969. Die *Cochlodina*-Arten des westlichen Mittelmeerraumes. Archiv für Molluskenkunde, 99: 21–25.

Nordsieck H., 2013. Delimini (Gastropoda, Pulmonata, Clausilidae) from Apennine Italy, whit the description of three new subspecies from Calabria. Conchylia, 44, July 2013.

Oliverio M., De Matthaeis E. & Hallgass A., 1992. Genetic divergence between Italian populations of *Marmorana* (*Ambigua*) (Gastropoda, Pulmonata, Helicidae). Lavori della Società Italiana di Malacologia, 24: 225–248.

Reitano A., Liberto F. & Sparacio I., 2007. Nuovi dati su molluschi terrestri e dulciacquicoli di Sicilia. 1° contributo (Gastropoda Prosobranchia: Neotaenioglossa; Gastropoda Pulmonata: Basommatophora, Stylommatophora). Il Naturalista siciliano, 31: 311–330.

Sparacio I., 1997. La *Ferussacia* (*Pegea*) *carnea* (Risso, 1826) dell'isola di Pantelleria (Gastropoda, Pulmonata). Il Naturalista siciliano, 21: 237–241.

Statuti A., 1885. Catalogo sistematico e sinonimico dei molluschi terrestri e fluviatili viventi nella provincia romana. Bullettino della Società Malacologica Italiana, 8: 5–128.

Van Dijk J.P. & Scheepers P.J.J., 1995. Neotectonic rotations in the Calabrian Arc; implications for a Pliocene-Recent geodynamic scenario for the Central Mediterranean. Earth-science Reviews, 39: 207–246.