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# LOWER TO MIDDLE MIOCENE MOLLUSC ASSEMBLAGES FROM THE TORINO HILLS (NW ITALY): SYNTHESIS OF NEW DATA AND CHRONOSTRATIGRAPHICAL ARRANGEMENT

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*Key words*: Torino Hills, molluscs, Gastropoda, Burdigalian, Langhian, Mediterranean, Paratethys, Aquitanian Basin.

*Abstract*. The goal of this study is to correlate in chronostratigraphic order the fossil assemblages of selected, historical Lower and Middle Miocene localities of the Torino Hills. More than 18,000 specimens have been classified and assigned to 798 taxa (cf. Tab. I). The compositional analyses mainly concern the 672 listed gastropods, most of which were already described in classical monographies. The critical evaluation of the morphological and architectural shell parameters let to a significant reduction of the species that could be realistically maintained in comparison to those cited in literature from the Torino Hills Miocene. Six localities have been analyzed: Valle Ceppi (VC) and Val Sanfrà (VS) referred to the middle part of the Burdigalian stage (N7a Biozone), Villa Bertini at the topmost Burdigalian, Villa Allason (VA) and Villa Forzano (VF) at the early Langhian (N8 Biozone) and Monte dei Cappuccini (MC) at the late Langhian (N9 Biozone). On the whole, the fossil assemblages show a taxonomic variation of both biochronologic and palaeobiogeographic meaning. Actually, the similarity in specific biodiversity of VC, VS, VB, VA and VF reflects homogeneity among late Burdigalian to early Langhian palaeocommunities. As to MC, its deep difference on VC is correlatable with the eastern closing between the Mediterranean areas and the Tethyan Realm, at the boundary Burdigalian-Langhian, that brought to disjoint evolutions of the Mediterranean and Indo-Pacific palaeocommunities, the former being influenced by oceanic current changes and related climatic variations.

*Riassunto*. La famosa "Collezione Bellardi e Sacco" (1872-1904) di molluschi del Cenozoico superiore norditaliano ha costituito la base di primo riferimento tassonomico nella classificazione di alcune associazioni fossili provenienti dalle classiche località del Miocene inferiore e medio della Collina di Torino. L'obiettivo dello studio è stato quello di organizzare queste raccolte in sequenza cronostratigrafica sulla base sia di recenti definizioni litostratigrafiche dell'area torinese, sia di mirate analisi biostratigrafiche su foraminiferi planctonici. Sono stati determinati circa 18.000 esemplari in rappresentanza di 798 specie, tra cui 672 gasteropodi, 115 bivalvi, 11 scafopodi (cf. Tab. I). I maggiori approfondimenti tassonomici sono stati condotti sui gasteropodi. L'analisi critica dei taxa descritti nelle monografie storiche (cf. Bellardi e Sacco) ha portato a una forte riduzione del numero di specie realisticamente assegnabili ai depositi miocenici della Collina di Torino. A titolo di esempio, viene riportato il contingente tassonomico revisionato per la famiglia Nassariidae. Sono state analizzate le associazioni a molluschi di sei località, 3 per il Miocene inferiore (VC, VS, VB della Formazione di Termofourà), 3 per il Miocene medio (VA, VF, MC della Formazione di Baldissero). Il congiunto dei dati stratigrafici ha permesso di correlare le località fossilifere e di inquadrarle in sequenza cronostratigrafica: VC e VS nella parte media del Burdigaliano, Biozona N7a; VB alla sommità del Burdigaliano; VA e VF nel Langhiano inferiore, Biozona N8; MC nel Langhiano superiore, Biozona N9a.

L'analisi della diversità specifica delle successive associazioni mostra un trend di variazione tassonomica con valenza sia biocronologica che paleobiogeografica. VC, VS e VB presentano valori di somiglianza intorno all'80% che riflettono omogeneità nelle paleocomunità del Burdigaliano medio-superiore; elevata somiglianza si ha anche con le associazioni VA e VF del Langhiano inferiore. Per contro la diversità specifica di MC è ridotta e diminuisce il suo grado di somiglianza con VC, sebbene le due associazioni siano comparabili per quanto riguarda lo spettro dimensionale dei fossili, e quindi il grado di rappresentanza tassonomica sopraspecifica. La variazione in MC può essere vista come la conseguenza dell'evoluzione disgiunta delle paleocomunità mediterranea e indo-pacifica successiva all'interruzione dei reciproci collegamenti paleobiogeografici nel Langhiano. La modificazione delle associazioni dal Miocene inferiore al Miocene medio potrebbe essere relazionata al gradiente termico negativo conseguente all'interruzione della circolazione oceanica medio-equatoriale. Un trend paleobiocenotico simile si osserva in associazioni a gasteropodi del Miocene di altre località europee; confronti significativi in tale direzione vengono proposti con le associazioni del Miocene del Bacino di Aquitania e del Miocene medio della Paratetide.

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## Introduction

Fossils and geology of the Torino Hills have been repeatedly studied since the second half of the 19$^{th}$ century, with particular attention to the genesis of the conglomeratic levels that characterize the Lower and Middle Miocene formations (Gastaldi 1862; Sacco 1887; Virgilio 1895, 1896). Sacco (1889) described the lithologic and paleontologic characteristics of the Miocene succession of the Torino Hills and in the Monferrato region, and provided an exhaustive list of fossiliferous sites. The monumental monograph "I molluschi dei terreni terziari di Piemonte e Liguria" also dates back to the late 1800's; started by Bellardi (1872-1890) and completed by Sacco (1890-1904), it describes the very rich Miocene mollusc assemblages ("Elveziano dei Colli Torinesi") from well-know localities of the Torino Hills, such as Termofourà, Fontana dei Francesi, Valle Ceppi, Val Sanfrà, Rio Batteria (Val Salice), Sciolze, Monte dei Cappuccini, etc. The collection by the same name, held at the Geo-Palaeontological Museum of the Department of Earth Sciences of the Torino University, remains the largest collection of Cenozoic molluscs in Italy, and is the starting point for any research of Miocene and Pliocene taxa, thanks in part to the recent inventory of the entire material (Ferrero Mortara et al. 1982, 1984; Merlino 2007).

Since the early 1900's, researches on the fossil assemblages of the Torino Hills stagnated; the only contributions were by Bellini (1905), who tried to differentiate between the various assemblages on the basis of the different outcropping lithofacies, and Hall (1964), who revised Conids from the Piedmont Miocene.

Research on the mollusc assemblages of Torino Hills started again in the 1970's with numerous undergraduate theses (Boldrini 1999; Peola 2000; Porta 1973; Raso 1997; Vai 1995), with the work of Pavia (2000) and Zunino's PhD thesis (2007), which re-examined all the material from the above-mentioned theses and performed additional sampling in Valle Ceppi. The taxonomic revision led to a palaeontological and stratigraphical reassesment of the latter locality, combining, whenever possible, information from the literature with new field data. The results of this paper allow to provide a chronostratigraphic sequence of the assemblages analyzed and some notes on paleobiogeographical aspect.

## Geologic and Stratigraphic Setting

The Torino Hills, a stratigraphic-structural element of the Piedmont Tertiary Basin, is an asymmetric anticline (Gassino anticline) with an Eocene nucleus, formed by thick Cenozoic terrigenous successions (Eocene-Messinian) characterized by alternating pelitic and reworked arenaceous-conglomeratic sediments arising from dismantling of the emerging Alpine chain (Polino et al. 1991) (Fig. 1).

The succession of the Torino Hills (Fig. 2) starts with the Upper Eocene Gassino Formation, consisting of marl and clay from bathyal environments, with re-sedimented calcirudite intercalations. After the mainly terrigenous complex of the Ranzano Formation, the Antognola Formation dates back to the Late Oligocene-Aquitatian interval; it comprises alternating pelites, marls, sandstones, and conglomerates interpreted as fan-delta slope deposits with periodical re-sedimentation events (Bonci et al. 1990). It is overlaid by a marl formation aged to early-middle Burdigalian, known as "Lower Pteropod Marls".

The upper-middle Burdigalian Termofourà Formation, atop the Lower Pteropod Marls or directly over the Antognola Formation (Bonsignore et al. 1969), reflects deposition between the outer platform and the upper part of the continental slope. The Termofourà Fm. is often very rich in fossils (Valle Ceppi, Val Sanfrà, among other famous sites) and is made up of silty marl and siltstone, intercalated with serpentinite sandstone layers and conglomeratic lenses extending laterally for several kilometers, whose stacking can reach thicknesses of several hundred meters.

The overlying Langhian Baldissero Formation is made up of marls and planctonic foramifera pelites with sandstone-conglomeratic intercalations often rich in mollusc fossils, such as those from the famous Villa Forzano and Monte dei Cappuccini localities (Bonsignore et al. 1969). The remaining Miocene marine succession (the Serravallian Marne di Mincengo and the Tortonian-Messinian Marne di S. Agata Fossili formations) is closed by the Messinian "Gessoso-Solfifera" Formation (Bonsignore et al. 1969).

The "Helvetian" fossils reported by Bellardi (1872-1890) and Sacco (1890-1904) come mainly from the re-sedimented terrigenous levels of the Termofourà Formation, and secondarily from the Baldissero Formation. The Termofourà levels contain rich fossil assemblages, with typical shallow water biota such as hermatypic corals, orbitoid foraminifera, and conid gastropods, associated with deeper water taxa like certain species of Tonnidae and Turridae. The taphonomic analysis of mollusc shells reveals the presence, in the same level, of various degrees of shell wear and fragmentation, indicating material transport from different source areas towards the base of the continental slope, probably through submarine canyons (Clari et al. 1994; Pavia 2000; Zunino 2007).

## Material and Methods

The identification of the conspicous material from the recent palaeontological collections started with the subdivision of fossils into

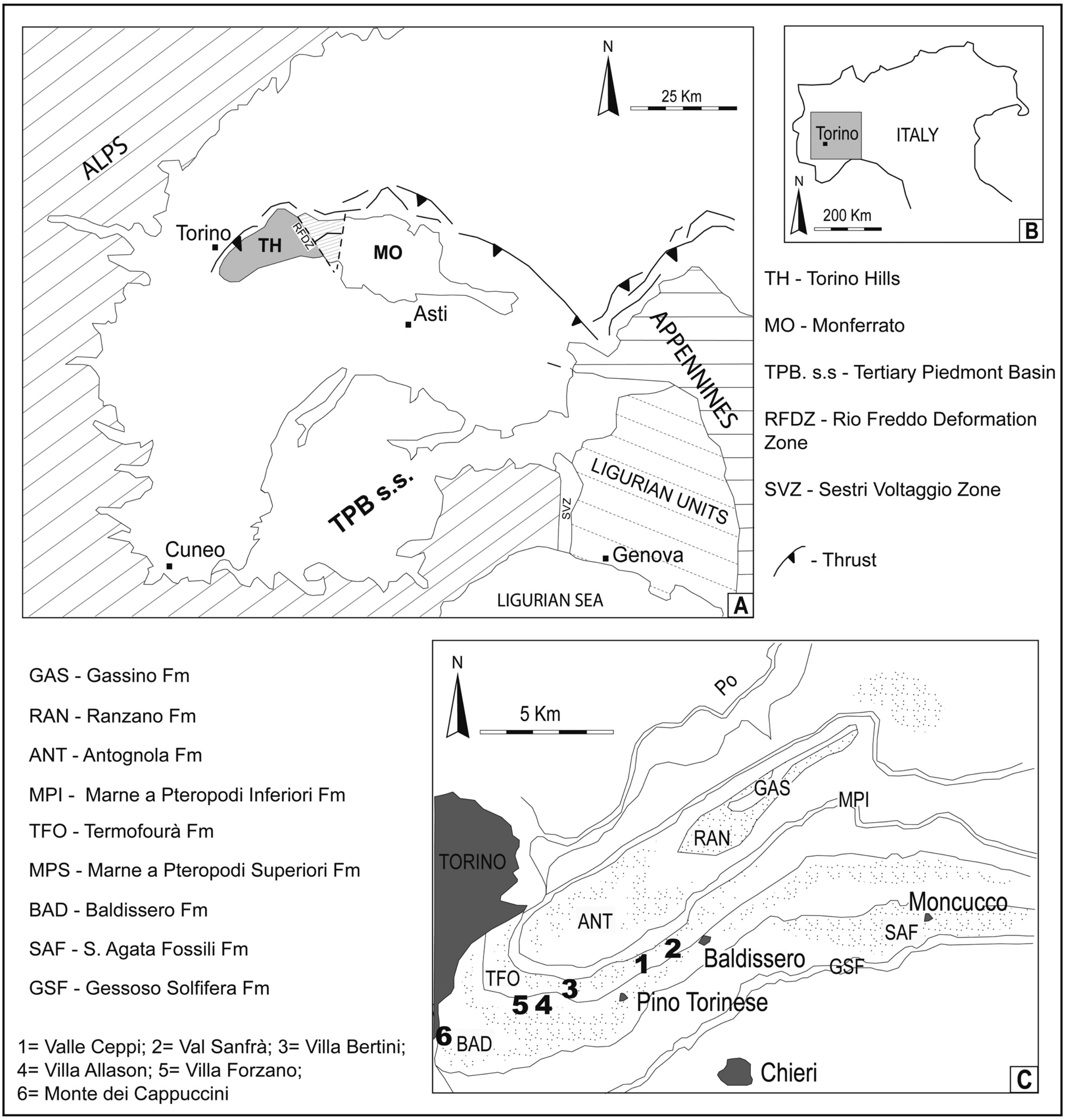


Fig. 1 - A. Structural sketch map of northwestern Italy (modified after Clari et al. 1994). B. Location of figure A. C. Geological sketch of Torino Hills. The distribution of conglomeratic levels is schematically shown by dot-pattern.

homogeneous groups according to structural and morphological elements of the shell; they were later compared with the illustrations and descriptions in Bellardi's (1873-1890) and Sacco's (1890-1904) monographs. The identification of specimens was limited to species, and does not reach subspecies or variety level. These preliminary identifications were confirmed or modified after direct comparisons with the type specimens in the Bellardi and Sacco collections (Ferrero Mortara et al. 1982, 1984; Merlino 2007). More than 18,000 mollusc specimens were analyzed from the Lower and Middle Miocene deposits of the Torino Hills; the collection includes 16,000 gastropod specimens belonging to 672 different species, and 1,700 bivalve specimens belonging to 115 species. The remaining 300 specimens are scaphopods belonging to 11 species (Tab. I).

Because of the limited number of specimens and the poor preservation state of bivalves, in parallel with their almost unchanged classification since Sacco's work (1890-1904) the research was focused on gastropods of which an in-depth revision of all the taxa represented in the Torino Hills Miocene deposits has been carried out.

Gastropods were identified mainly on the basis of the morphological characteristics of the teleoconch; nevertheless, the shape and size of the protoconch, when present, were considered the main diagnostic character for grouping closely-related forms. Unfortunately, in most cases the shells are bad preserved and the protoconch is missing, both in newly collected specimens and in those of the Bellardi and Sacco collections. Additionally, for many systematic groups, particularly those from the Lower Miocene, there are no reference works in the

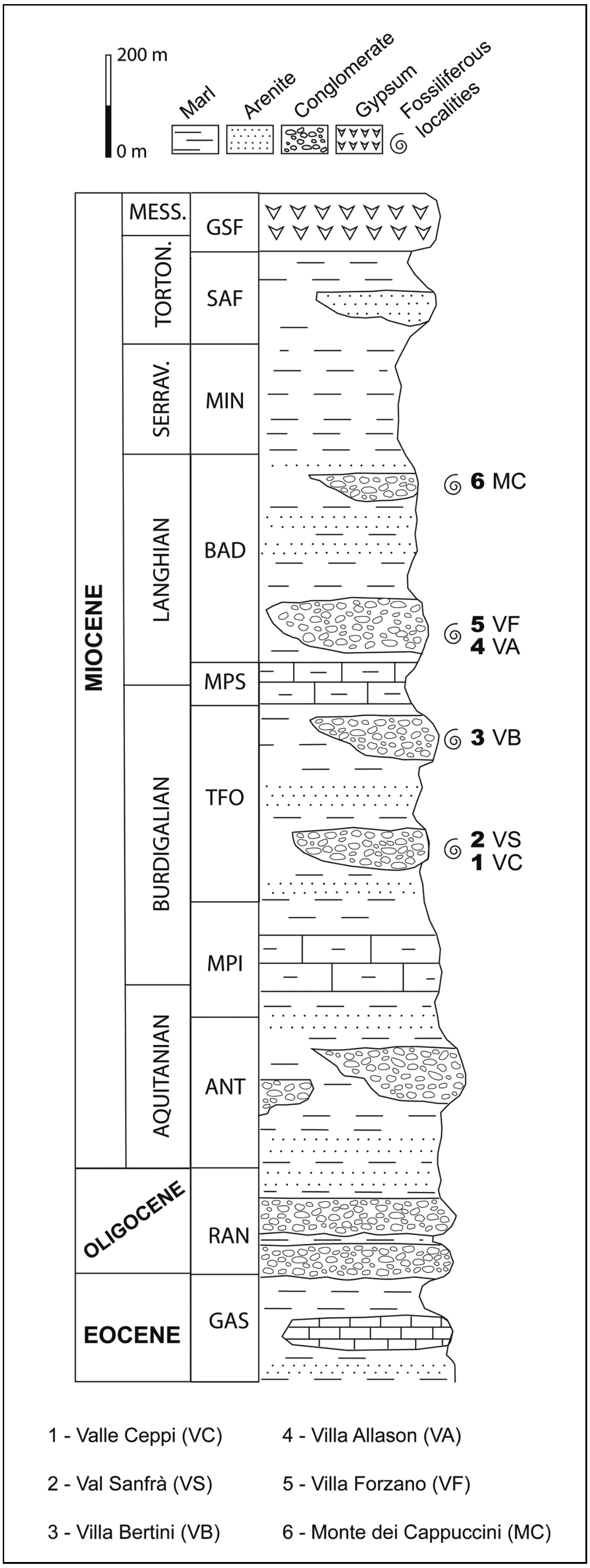


Fig. 2 - Stratigraphic log of western slope of Torino Hills. GAS: Gassino Fm.; RAN: Ranzano Fm.; ANT: Antognola Fm; MPI: Marne a Pteropodi Inferiori Fm.; TFO: Termofourà Fm.; MPS: Marne a Pteropodi Superiori Fm.; BAD: Baldissero Fm.; MIN: Marne di Mincengo; GSF: Gessoso-Solfifera Formation.

literature describing the use of larval morphology for specific identification.

Our approach to the Bellardi and Sacco collections was profoundly critical. During comparison with type specimens, we tried to find objective criteria for distinguishing the species defined by Bellardi and the varieties described by Sacco that would help us to lean towards one or the other approach. Finding characters that could be reliably used to differentiate the various forms was often impossible: with only one or two specimens in many type-series, and with the protoconch almost missing, it often proved difficult to unambiguously define taxa. This problem emerged for almost all of the groups we classified, and particularly for Cypraeidae, Naticidae, Nassariidae, Olividae, Mitridae, and Conidae, whose morphological characteristics, which are often quite similar within a single family, lead to confusion regarding specific identification. For many of these families, detailed systematic studies were consulted, albeit often dealing with species more recent that those we examined. These studies included: Bałuk (1975; 1995; 1997; 2003; 2006), Cossmann & Peyrot (1916-1919; 1922-1924), Davoli (1989, 1995, 2003), Friedberg (1923-1928), Glibert (1945; 1952a; 1952b; 1954), Harzhauser & Kowalke (2004), Hörnes (1851-1856), Hörnes & Auinger (1879), Kojumdgieva & Strachimirov (1960), Pavia (1976a; 1976b; 1980; 1991), Sorgenfrei (1958), Strausz (1966). Comparisons with the literature made it possible to evaluate the limits of intra-specific variability, and thus to conclude the specific identifications listed in Table I. Some of the species described by Bellardi were placed in synonymy on the base of taxa priority, and many of Sacco's varieties are considered insubstantial; on the other hand, in the presence of well-defined characteristics and a large enough number of specimens, some varieties have been elevated to subspecific or specific rank (Zunino 2007).

Nevertheless, it should be pointed out that: (1) the criteria described above require definitions of the limits of intra-specific variability; (2) these definitions would be established on the basis of specialized studies focussed on individual taxonomic groups.

These criteria can be exemplified in the revision adopted for Nassariidae, the results of which are described in Tab. II. Bellardi (1872-1890) and Sacco (1890-1904) recorded 83 species for the Lower and Middle Miocene of the Torino Hills, belonging to the following genera: *Nassa*, now *Nassarius* (79 species), *Cyllenina* (2 species) and *Cyllene* (1 species). The 50 varieties described by Sacco have not been taken into account in the revision, since they are based on only one or two, often poorly preserved specimens. Of the 79 species assigned to the genus *Nassarius*, 27 were lost during the World War II bombardments that destroyed part of the Geo-palaeontological Museum of the Torino University (Campanino & Pavia 2003); although they are described in the monograph, they are no longer present in the collection. Of the remaining 52 species, 35 are still considered valid (ICZN: artt. 11d, 23a, d), and 29 of them are only known from the Torino Hills. This high number of endemic species could be partly reduced after direct comparisons with species from the Aquitaine Basin and the Paratethys sea, but this check is out of the target of the present work.

The extensive collection of the recent material from Miocene Torino Hills is held at the Geo-palaeontological Museum of the Department of Earth Sciences of the Torino University. It is was organized according to the taxonomic order of Bouchet & Rocroi (2005), with some references to Moore (1960, 1969-1971), Skelton & Benton (1993), and Tracey et al. (1993). The fossils' catalogue numbers begin with the initials PU (Paleontologia Università), followed by a serial number; they are registered in an Access database following Pavia & Pavia (2004).

### Fossiliferous localities and molluscan assemblages

As previously mentioned, the revision was performed on both historical (Cantamessa, Forma, Rovasenda: all in the late 18th century) and recent collections (Bosso, De Marchi, Pavia, Sturani, Tropeano: in the second half of the 19th century; Zunino: 2004-2005) from the fossiferous localities of Valle Ceppi, Val Sanfrà, Villa Bertini, Villa Allason, Villa Forzano and Monte dei Cappuccini (Fig. 1C and Fig. 2). Molluscan assemblages collected in those levels are an important source of data on the diversity of the Miocene palaeofauna in northern Italy. In the following descriptions, we summarize the geological and geographic contexts of these localities, and the fossil assemblages collected therein. The full list of the species recorded in each locality is provided in Tab. I.

Due to the intense urban development in the Torino Hills over the last decades, some of the localities we analyzed are no longer accessible. Where deposits are still exposed, it was possible to sample fossiliferous levels, and in Valle Ceppi outcrops, to measure the stratigraphic section as well.

**Lower Miocene Localities**

Valle Ceppi

Valle Ceppi, located about 3 km east of the town of Pino Torinese, is a narrow valley cut by the Rio Civera; it includes numerous fossil outcrops (Fig. 3).

Valle Ceppi is rarely mentioned in the literature. Although indications on collecting localities are vague, the first, repeated references to Valle Ceppi are in Bellardi's (1872-1890) and Sacco's (1890-1904) monographs, were the locality is reported as one of the main sources of the fossils making up the so-called "Superga Fauna". Valle Ceppi's mollusc assemblages were the subject of Vai's (1995) undergraduate thesis. The re-examined fossil material belongs to different collections, in particular those of Cantamessa, Rovasenda, and Forma-Sacco. A significant portion of the material comes from the collections of Compagnoni-Sturani (1959-1961), Tropeano (1972), Pavia (1995-2001) and Pavia-Zunino (2004).

The Valle Ceppi section cuts through all the Miocene lithosomes of the south-eastern flank of the Gassino anticline; it was measured for the first time by Cerutti (1973) in his study on macroforaminifera, particularly miogypsinids, back when the conditions of the outcrops still made it possible to recognize a nearly continuous stratigraphic succession. The direction of the strata is nearly N 50° E with an average inclination of 35°. The succession is over 400 meters thick and is made up, in its lower portion, of the upper part of the Antognola Formation and the entire Pteropodi Inferiori Formation. The mid- and upper part of the succession, measured and described by Zunino (2007), refers to the Termofourà Formation where silt-clay levels alternate with coarse sands and conglomerates. The main stratigraphic section was measured along the axis of the Rio Civera Valley (tract 1 in Fig. 4 and 4A). A small complementary section was measured in a small left-side valley (tract 2 in Fig. 4 and 4A); its base was correlated geometrically with the conglomeratic layer at level 86 of the main section.

The micro-palaeontologic analyses, carried on the Termofourà Fm. allowed to attribute it to the mid-Burdigalian, Biozone N7a (Bicchi pers. com.; Zunino 2007). This is coherent with the data obtained through the analysis of miogypsinids: Cerutti (1973) and Novaretti et al. (1995) recognize an interval with *Miogypsina globulina, M. globulina-intermedia* and *M. negrii* which corresponds to Biozones N7a and the beginning of N7b.

Seven fossiliferous levels for mollusc assemblages have been sampled. The data obtained from these samples, along with data from previous collections (Vai 1995), total to 8,438 molluscs (Tab. I). On the whole, the assemblages are dominated by gastropods (7,236 specimens), followed by bivalves (1,118 specimens) and scaphopods (84 specimens). The most common gastropod families are Conidae (20 species), Turridae (18 species), Drilliidae (17 species), and Mitridae (18 species). The assemblages of the sampled layers are comparable as to the commonest families and with regards to medium and large gastropods (larger than 0.8 cm), despite the number of specimens is different among collections. They are no longer comparable with regards to micro-gastropods, since these are generally lacking in collection studied by Vai (1995).

With regards to bivalves, the new samplings produced a larger number of specimens (651 specimens) compared to Vai's collection from Valle Ceppi (347 specimens); it is worth noting that the latter have a higher number of species and families, while new collecting results in many specimens belonging to only a few families. Furthermore, these two samplings are not comparable since most of the newly-collected bivalves are small, and only a few specimens can be compared with the larger ones from previous collections.

Val Sanfrà

Val Sanfrà is the local name of a valley near the municipality of Baldissero Torinese, located immediately north of village (Fig. 5). Along the right bank of the Rio Baldissero, there are outcrops of the typical alternating pelites and conglomeratic sandstones of the Termofourà Formation, known as the "Val Sanfrà Strata" and attributed to the upper Burdigalian in the literature (Pavia 2000). The first record in the literature of fossil localities near Baldissero Torinese is by Sacco (1889), and subsequent studies were made by Bellini (1905), Chevalier (1961), and Hall (1964).

The Burdigalian strata of Val Sanfrà belong to Biozone N7a (Bicchi pers. comm.) and fossiliferous

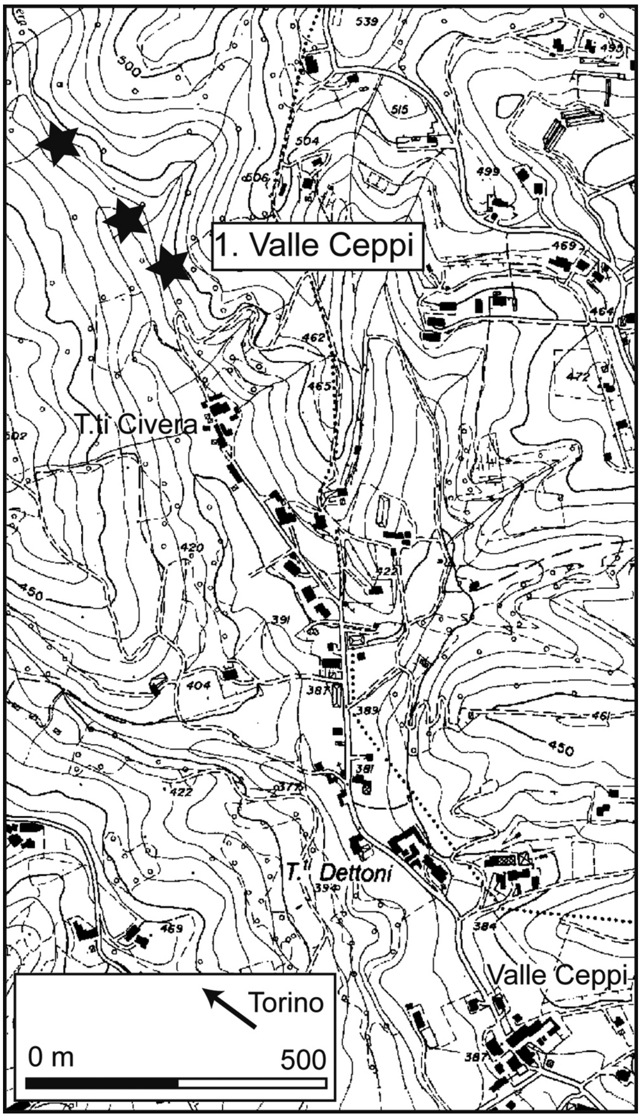


Fig. 3 - Location of Valle Ceppi fossiliferous outcrops. The black stars indicate sampled layers.

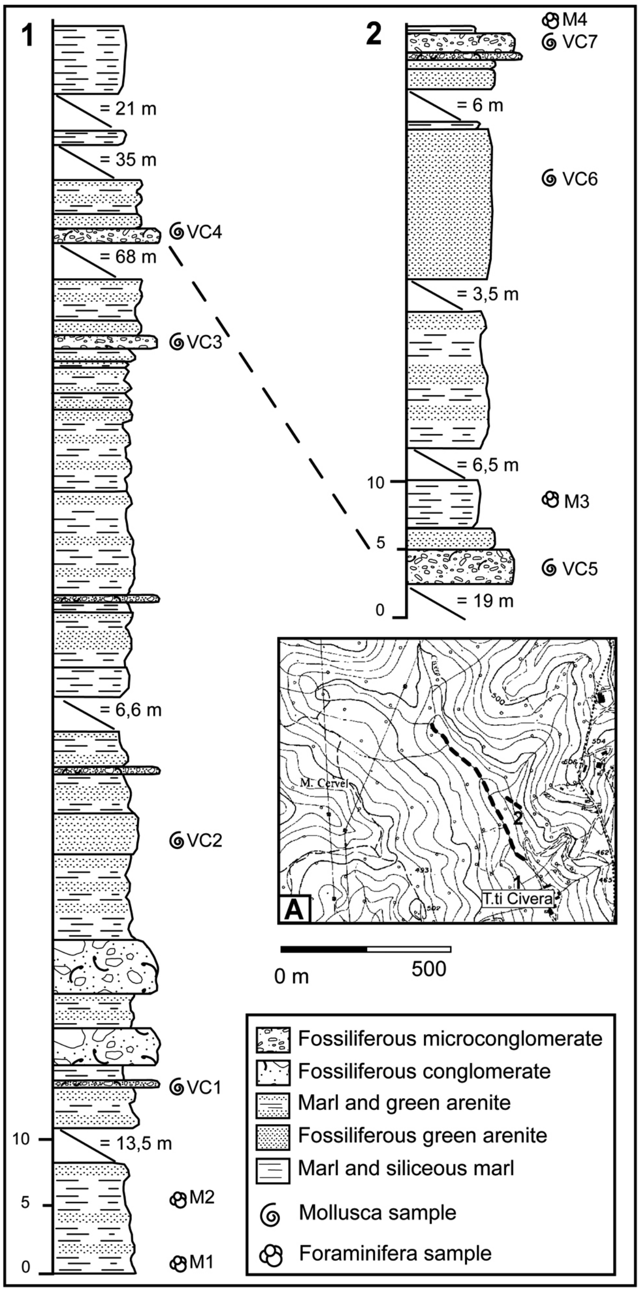


Fig. 4 - Stratigraphic log of Valle Ceppi. A. Topographical map of Valle Ceppi area indicating the main stratigraphic section along the axis of the Rio Civera Valley (tract 1) and a small complementary section in a side valley (tract 2).

outcrops have the same textural and structural characteristics as those of Valle Ceppi, with the same palaeontological content as well. Most of the analyzed material comes from the Cantamessa collection, which dates back to the second half of the 19th century and was re-ordered by Porta (1973). Additional material includes that collected by several field workers and studied in Boldrini's (1999) undergraduate thesis, numerous specimens collected in the 1980's by De Marchi-Pavia, and an important contribution from Carlo Bosso, a collaborator of the of Geo-palaeontological Museum of the Torino University.

The mollusc oryctocenosis is made up of 2,603 specimens (Tab. I). They are almost all gastropods (2,071 specimens), and in this case as well, the most species-rich family is Conidae (27 species) followed by Clavatulidae (14 species) and Mitridae (13 species). The Val Sanfrà fossils are bigger than those from other lower Miocene localities, and therefore cannot be easily compared with them; as to bivalves, this assemblage has the highest number of individuals and species.

Villa Bertini

The fossiliferous locality of Villa Bertini is located to the west of Valle Ceppi, near the type locality of Termofourà and nearby the road from the Eremo hill to the city of Torino, in the proximity of Villa Allason and Villa Forzano (Fig. 6). There are no clear references to Villa Bertini fossil deposits in the literature, except some generic mentions of the fossil assemblages "in the

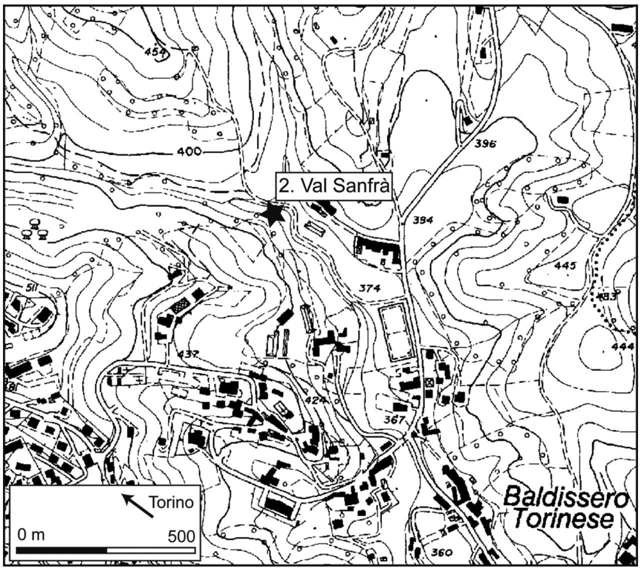


Fig. 5 - Location of Val Sanfrà fossiliferous outcrop indicate by black star.

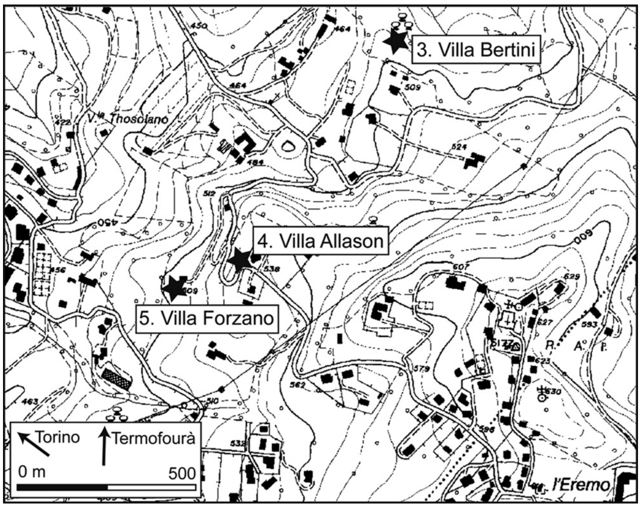


Fig. 6 - Location of Villa Bertini, Villa Allason and Villa Forzano fossiliferous outcrops indicate by black stars.

vicinity of Termofourà" (Bellini 1905). In the 1970's, a conglomeratic layer with a sandy-pelitic matrix and 1-cm-wide pebbles was exposed. The extensive fossil samples collected here were studied in Peola's (2000) undergraduate thesis. The fossiliferous deposit is presently inaccessible, and it was thus impossible to collect new samples for micro-palaeontologic analyses. On the basis of the data gathered by the surveys for Sheet 156 Torino Est of the Geological Map of Italy at 1:50000 (Festa et al. 2009a, 2009b), the Villa Bertini outcrop must be located at the topmost Termofourà Formation, which refers to the late Burdigalian.

The mollusc assemblage is represented by 330 specimens (Tab. I); 322 of them are gastropods, and the most species-rich families are once again Conidae (7 species) followed by Mitridae (6 species) and Olividae (5 species).

**Middle Miocene localities**

Villa Allason

Much like the other localities we describe, Villa Allason is also rarely mentioned in the literature: indeed, it is not mentioned in Bellardi's (1872-1890) and Sacco's (1890-1904) monographs, nor in Sacco's (1889) treatise, in which this locality was probably included in the broader "Torino Hills" area. Villa Allason is only briefly mentioned in Bellini (1905) and in Prever (1907).

The Villa Allason deposit (Fig. 6), located in Val Salice at the western end of the Gassino anticline, was sampled by G. Pavia in the 1980's; it is made up of a succession of several meters of sandy pelites and poorly cemented sandstone in layers of 30-50 cm. The material collected was studied along with that from Villa Bertini by Peola (2000). Unfortunately, this deposit is located on private property and is not accessible. Bonsignore et al. (1969) included the Villa Allason deposit in a re-sedimented sandstone-conglomerate horizon at the base of the Baldissero Formation. This level includes the last representatives of the genera *Miogypsina* and *Lepidociclyna*, which are always well-documented in the Torino Hills Lower Miocene succession (Bonsignore et al. 1969; Ferrero Mortara 1987). This data makes it possible to place the Villa Allason deposit in the basal part of the Baldissero Formation, which is attributed to the early Langhian (Biozone N8) on the basis of the presence of *Praeorbulina glomerosa curva* (Bonsignore et al. 1969).

Villa Allason fossil assemblage is made up of 568 specimens of small to medium-sized molluscs (Tab. I). In particular, there are 499 gastropods belonging to 109 species, 31 bivalve specimens belonging to 21 species and 7 scaphopods belonging to 2 species. The most species-rich gastropod families are Conidae (10 species), followed by Tonnidae, Buccinidae and Olividae (6 species each), by Naticidae, Ranellidae, Fascicolariidae and Muricidae (5 species each).

Villa Forzano (= Villa Cochis)

There is very little in the literature concerning Villa Forzano, located in the upper Val Salice, making a detailed description of the fossiliferous levels impossible (Fig. 6). Bellini (1905) and Prever (1907) report the presence of a great abundance of molluscs and associated corals, as well as miogypsinids; Prever (1907) believed that the Villa Forzano deposits are younger than those in Villa Allason and Termofourà, but older than the Monte dei Cappuccini and (sic!) Valle Ceppi deposits.

On the other hand, recent literature reports that the Villa Forzano deposit is of the same age as the Villa Allason deposit (Bonsignore et al. 1969), and thus belongs to the conglomeratic horizon at the base of the Baldissero Formation. The outcrop is presently covered,

TABLE I

| | | VC | VS | VB | VA | VF | MC |
|---|---|---|---|---|---|---|---|
| | **Class Gastropoda** | | | | | | |
| | **Family Patellidae** | | | | | | |
| 1 | *Patella* cf. *burdigalensis* | X | | | | | |
| 2 | *Patella coerulea* | X | | | | | |
| | **Family Fissurellidae** | | | | | | |
| 3 | *Fissurella costicillatissima* | | X | | | | |
| 4 | *Emarginula subclathrata* | X | | | | | |
| 5 | *Emarginula* sp. 1 | X | | | | | |
| 6 | *Emarginula* sp. 2 | X | | | | | |
| 7 | *Subemarginula prosculphilis* | X | | | | | |
| 8 | *Diodora italica* | X | | | | | |
| 9 | *Diodora graeca* | X | | | | | |
| | **Family Haliotidae** | | | | | | |
| 10 | *Haliotis tuberculatus* | X | | X | | | |
| | **Family Trochidae** | | | | | | |
| 11 | *Paroxystele amedei* | X | X | X | X | X | X |
| 12 | *Paroxystele rotellaris* | X | | | | | |
| 13 | *Gibbula laeviardens* | X | | | | | |
| 14 | *Gibbula adansoni* | X | | | | | |
| 15 | *Gibbula* cf. *subscalata* | X | | | | | |
| 16 | *Gibbula tauracuta* | X | X | | | | |
| 17 | *Gibbula* cf. *podhorcensis* | X | | | | | |
| 18 | *Gibbula* sp. 1 | X | | | | | |
| 19 | *Glomus monterosatoi* | X | X | | | | |
| 20 | *Monodonta quadrula* | X | | | | | |
| 21 | *Monodonta tauroparva* | X | | | | | |
| 22 | *Clanculus cruciatus* | | | | X | | |
| 23 | *Tectus rugosus* | X | | | | | |
| 24 | *Tectus vertex* | X | X | | | | |
| 25 | *Calliostoma scutiformis* | X | X | | | | |
| 26 | *Calliostoma* cf. *tauromiliare* | | X | | | | |
| 27 | *Calliostoma papilla* | X | | | | | |
| 28 | *Calliostoma* cf. *papilla* | X | | | | | |
| | **Family Solariellidae** | | | | | | |
| 29 | *Solariella* sp.1 | X | | | | | |
| | **Family Turbinidae** | | | | | | |
| 30 | *Astraea carinata* | X | X | | X | X | |
| 31 | *Astrea taurospeciosa* | | | | | | X |
| 32 | *Bolma proborsoni* | X | X | | | | |
| 33 | *Bolma subfimbriata* | X | | | | | |
| 34 | *Phorculellus tauroangulosus* | X | | | | | |
| 35 | *Homalopoma mamilla* | X | | | | | |
| 36 | *Leucorhynchia* cf. *zboroviensis* | X | | | | | |
| | **Family Phasianellidae** | | | | | | |
| 37 | *Tricolia pullus* | | | | | | X |
| 38 | *Tricolia* cf. *pullus* | X | | | | | |
| | **Family Cocculinidae** | | | | | | |
| 39 | *Cocculina adunca* | X | | | | | |
| | **Family Neritidae** | | | | | | |
| 40 | *Nerita asperata* | X | | | | | |
| 41 | *Nerita gigantea* | X | X | X | X | X | |
| 42 | *Nerita martiniana* | X | X | | X | | X |
| 43 | *Neritina picta* | X | | | | | |
| 44 | *Theodoxus hisingeri* | | X | | | | |
| 45 | *Theodoxus morellii* | | X | | | | |
| | **Family Cerithiidae** | | | | | | |
| 46 | *Cerithium crenatum* | X | | | | | |
| 47 | *Cerithium ocirrhoe* | X | | | | | |
| 48 | *Ptycocerithium pseudoelongatum* | | | X | | | |
| 49 | *Cerithium taurinum* | X | X | | | | |
| 50 | *Cerithium varicosum* | X | | | | | |
| 51 | *Cerithium vulgatum* | X | | | | X | |
| 52 | *Bittium reticulatum* | X | | | | | |
| 53 | *Bittium spina* | X | | | | | X |
| | **Family Diastomidae** | | | | | | |
| 54 | *Sandbergeria perpusilla* | X | | | | | |
| | **Family Litiopidae** | | | | | | |
| 55 | *Alaba costellata* | X | | | | | |
| | **Family Modulidae** | | | | | | |
| 56 | *Modulus basteroti* | X | | | | | |
| | **Family Planaxidae** | | | | | | |
| 57 | *Fossarus costatus* | X | | | | | |
| | **Family Potamididae** | | | | | | |
| 58 | *Trochocerithium turritum* | X | X | | | X | |
| | **Family Scaliolidae** | | | | | | |
| 59 | *Scaliola* cf. *semperi* | X | | | | | |
| | **Family Siliquaridae** | | | | | | |
| 60 | *Tenagodus anguinus* | X | | | | | |
| 61 | *Tenagodus obtusus* | X | | | | | |
| | **Family Turritellidae** | | | | | | |
| 62 | *Archimediella archimedis* | X | | | | | |
| 63 | *Archimediella miotaurina* | X | X | | | | X |
| 64 | *Peyrotia desmarestina* | X | X | | X | X | |
| 65 | *Haustator laevissima* | X | | | | | |
| 66 | *Peyrotia tauroperturrita* | X | X | X | | | |
| 67 | *Haustator tricincta* | X | | | | | |
| 68 | *Haustator turris* | X | X | | X | | |
| 69 | *Haustator vermicularis* | X | X | X | X | | X |
| 70 | *Turritella bellardii* | X | X | | | | X |
| 71 | *Turritella bicarinata* | X | X | | | | X |
| 72 | *Turritella spirata* | X | | | | | |
| 73 | *Turritella subangulata* | X | X | | | | X |
| 74 | *Turritella terebralis* | X | X | | | | |
| 75 | *Turritella tricarinata* | X | | | | | |
| 76 | *Protoma cathedralis* | X | X | | X | X | X |
| | **Family Calyptraeidae** | | | | | | |
| 77 | *Calyptraea chinensis* | X | | | | | |
| | **Family Capulidae** | | | | | | |
| 78 | *Capulus hungaricus* | X | | | | X | |
| 79 | *Capulus? barrandei* | X | | | | | |
| | **Family Cypraeidae** | | | | | | |
| 80 | *Jousseaumea grateloupi* | X | X | | | | |
| 81 | *Jousseaumea taurorotunda* | X | | | | | |
| 82 | *Trona lyncoides* | X | X | | | X | |
| 83 | *Zonarina amygdalum* | X | X | | | | |
| 84 | *Zonarina brochii* | X | X | | | X | |
| 85 | *Zonarina* cf. *brogniarti* | | X | | | | |
| 86 | *Zonarina decorticata* | X | X | | | | |
| 87 | *Zonarina haueri* | X | | | X | | |
| 88 | *Zonarina* cf. *orbignyana* | X | | | | | |
| 89 | *Zonarina annularia* | | X | | | | |
| 90 | *Zonarina pinguis* | X | X | X | | | |
| 91 | *Zonarina provincialis* | | X | | | | |
| 92 | *Zonarina subelongata* | X | X | | | | |
| 93 | *Schilderia taurovalis* | X | X | X | | X | |
| 94 | *Mandolina rhomboidalis* | X | X | X | | X | |
| 95 | *Cypraeorbis fabagina* | X | X | X | X | | X |
| | **Family Ovulidae** | | | | | | |
| 96 | *Apiocypraea subamygdalum* | X | | X | X | | |
| 97 | *Miolyncina prevostina* | X | | | | | |
| 98 | *Miolyncina tumida* | X | X | | | | |
| 99 | *Fossacypraea extusdentata* | | | | | X | |
| 100 | *Sphaerocypraea ovulina* | X | | | | X | |
| 101 | *Cypropterina duclosiana* | X | X | X | X | X | |
| | **Family Ficidae** | | | | | | |
| 102 | *Ficus conditus* | X | X | X | X | X | X |
| 103 | *Ficus geometra* | X | X | | | | X |
| 104 | *Ficopsis burdigalensis* | X | | | | | |
| | **Family Naticidae** | | | | | | |
| 105 | *Globularia compressa* | X | X | | | | X |
| 106 | *Pachycrommium scalaris* | X | | X | X | X | |
| 107 | *Euspira catena* | X | X | X | X | X | X |
| 108 | *Polinices miocolligens* | X | X | | | | |
| 109 | *Polinices proredemptus* | X | X | | X | | X |
| 110 | *Polinices submamillaris* | X | X | X | X | X | X |
| 111 | *Neverita josephinia* | X | X | X | X | | X |
| 112 | *Natica crassiuscula* | X | X | | | X | X |
| 113 | *Natica epiglottina* | X | X | | | X | X |
| 114 | *Natica taurina* | | | | | | X |
| 115 | *Natica dillwyni* | | | | | | X |
| 116 | *Eunaticina michaudi* | X | | | | | |
| 117 | *Sinum aquense* | | X | | | | |
| 118 | *Sinum sigaretoides* | | X | | | | |
| | **Family Rissoidae** | | | | | | |
| 119 | *Alvania cimex* | X | | | | | |
| 120 | *Alvania perregularis* | X | | | | | |
| 121 | *Alvania reticulata* | X | | | | | |
| 122 | *Alvania tauropraecedens* | X | | | | | |
| 123 | *Alvania venus parvotaurina* | X | | | | | |
| 124 | *Alvania venus transiens* | X | | | | | |
| 125 | *Alvania* cf. *brachia* | X | | | | | |
| 126 | *Alvania* cf. *tenuicostata* | X | | | | | |
| 127 | *Alvania* sp. 1 | X | | | | | |
| 128 | *Alvania* sp. 2 | X | | | | | |
| 129 | *Turboella acuticosta* | X | | | | | |
| 130 | *Rissoina decussata* | X | | | | | |
| 131 | *Rissoina pusilla* | X | | | | | |
| 132 | *Rissoina biocrassecincta* | X | | | | | |
| 133 | *Rissoina giuntelii* | X | | | | | |
| 134 | *Rissoina sturanii* | X | | | | | |
| 135 | *Zebina nerina* | X | | | | | |
| 136 | *Stosiscia planaxoides* | X | | | | | |
| | **Family Caecidae** | | | | | | |
| 137 | *Caecum trachea* | X | | | | | |
| 138 | *Caecum glabrum* | X | | | | | |
| | **Family Iravadiidae** | | | | | | |
| 139 | *Rhombostoma* sp. 1 | X | | | | | |
| | **Family Tornidae** | | | | | | |
| 140 | *Adeorbis miobicarinatus* | X | | | | | |

| | | VC | VS | VB | VA | VF | MC |
|---|---|---|---|---|---|---|---|
| 141 | *Rotellorbis plicatus* | X | | | | | |
| 142 | *Teinostoma woodi* | X | | | | | X |
| 143 | *Teinostoma cf. nanum* | X | | | | | |
| 144 | *Teinostoma* sp. 1 | X | | | | | |
| 145 | *Tornus* sp. 1 | X | | | | | |
| | **Family Tornidae** | | | | | | |
| 146 | *Georgesia terebellum* | X | | | | | |
| | **Family Strombidae** | | | | | | |
| 147 | *Dientomochilus decussatus* | X | | | | | |
| 148 | *Persististrombus bonellii* | X | X | X | X | X | X |
| 149 | *Sulcogladus collegnoi* | | X | | | | X |
| | **Family Aporrhaidae** | | | | | | |
| 150 | *Aporrhais pespelecani* | X | X | X | X | | X |
| 151 | *Aporrhais uttingeriana* | X | X | | | X | |
| | **Family Tonnidae** | | | | | | |
| 152 | *Eudolium subfasciatum* | X | X | | X | | |
| 153 | *Cypraecassis cypraeformis* | X | X | | | X | |
| 154 | *Cassis mammilaris* | | | | | | X |
| 155 | *Galeodea echinophora* | X | X | | | | X |
| 156 | *Galeodea miocristata* | | X | | | | |
| 157 | *Galeodea sconsioides* | X | X | | X | | |
| 158 | *Galeodea taurinensis* | X | X | X | X | X | |
| 159 | *Galeodea tauropomum* | X | | | | | |
| 160 | *Sconsia striatula* | | X | | | | |
| 161 | *Semicassis miolaevigata* | | X | | X | | X |
| 162 | *Semicassis saburon* | X | X | | | X | |
| 163 | *Semicassis subsulcosa* | X | | | | | |
| 164 | *Semicassis reticulata* | X | | | X | | X |
| 165 | *Semicassis variabilis* | X | X | X | X | X | |
| | **Family Bursidae** | | | | | | |
| 166 | *Bufonaria marginata* | X | X | | X | X | X |
| | **Family Personidae** | | | | | | |
| 167 | *Distorsio tortuosa* | X | X | X | | X | |
| | **Family Ranellidae** | | | | | | |
| 168 | *Gyrineum giganteum* | X | X | X | X | X | |
| 169 | *Gyrineum tuberosum* | X | | X | | X | |
| 170 | *Gyrineum elongatum* | X | | X | X | | |
| 171 | *Cymatium borsoni* | X | X | | | X | |
| 172 | *Cymatium* cf. *nodiferum* | | X | | | | |
| 173 | *Sassia appeninica* | X | X | X | X | | |
| 174 | *Sassia borsoni* | X | X | X | X | X | |
| 175 | *Sassia granosa* | X | X | X | X | | |
| 176 | *Sassia laevigata* | X | | | | | |
| 177 | *Sassia parvula* | X | | | | | |
| | **Family Hipponicidae** | | | | | | |
| 178 | *Hipponix sulcatus* | X | X | X | X | X | |
| | **Family Triviidae** | | | | | | |
| 179 | *Erato elongata* | X | | | | | |
| 180 | *Erato voluta* | X | | X | X | | |
| 181 | *Erato subcypreola* | X | | | X | | |
| 182 | *Erato transiens* | X | | | | | |
| 183 | *Trivia affinis* | X | X | | | | |
| 184 | *Trivia arctica* | X | X | | | | |
| | **Family Vermetidae** | | | | | | |
| 185 | *Serpulorbis arenaria* | X | | | | | |
| 186 | *Vermetus sulcovaricosus* | X | | | | | |
| 187 | *Vermetus triquetus* | X | | | | | |
| | **Family Xenophoridae** | | | | | | |
| 188 | *Xenophora deshayesi* | X | X | | X | X | X |
| 189 | *Xenophora postextensa* | X | | | | | |
| 190 | *Tugurium borsoni* | | X | | | | |
| | **Family Epitoniidae** | | | | | | |
| 191 | *Cirsotrema seguenzai* | X | | | | | |
| 192 | *Discoscala scaberrima* | X | | | | | |
| 193 | *Stenorhytis proglobosa* | X | | | | | |
| 194 | *Stenorhytis retusa* | X | X | | | | |
| | **Family Eulimidae** | | | | | | |
| 195 | *Melanella polita* | X | | | | | X |
| 196 | *Eulima subulata* | | | | | | X |
| 197 | *Niso eburnea* | X | | | | | |
| 198 | *Niso terebellum* | X | | | | | |
| 199 | *Niso tauroconica* | | | | | | X |
| 200 | *Polygireulima spina* | | | | | | X |
| | **Family Aclididae** | | | | | | |
| 201 | *Cima neglecta* | X | | | | | |
| | **Family Triphoridae** | | | | | | |
| 202 | *Monophorus* cf. *perversus* | X | | | | | |
| | **Family Cerithiopsidae** | | | | | | |
| 203 | *Cerithiella suprabicincta* | X | | | | | |
| 204 | *Cerithiella* cf. *bitorquata* | X | | | | | |
| 205 | ?*Cerithiella* sp. indet. | X | | | | | |
| 206 | *Cerithiopsis* cf. *tubercularis* | X | | | | | |
| 207 | *Cerithiopsis bilineata* | X | | | | | |
| 208 | *Cerithiopsis pusilla* | X | | | | | |
| 209 | *Cerithiopsis* sp. 1 | X | | | | | |

| | | VC | VS | VB | VA | VF | MC |
|---|---|---|---|---|---|---|---|
| 210 | *Cerithiopsis* sp. 2 | X | | | | | |
| 211 | *Seila trilineata* | X | | | | | |
| 212 | *Seila* cf. *trilineata* | X | | | | | |
| 213 | *Seila* sp. 1 | X | | | | | |
| | **Family Buccinidae** | | | | | | |
| 214 | *Exilioidea ordita* | X | | | | X | |
| 215 | *Euthria adunca* | X | X | X | X | | |
| 216 | *Euthria elongata* | | X | | | | |
| 217 | *Euthria longirostra* | | X | | X | | |
| 218 | *Euthria obesa* | X | | | | | |
| 219 | *Euthria abbreviata* | | | | | X | |
| 220 | *Euthria intermedia* | | | | | X | |
| 221 | *Neptunea glomoides* | X | X | | X | X | |
| 222 | *Phos citharella* | X | X | X | X | X | X |
| 223 | *Phos orditus* | X | | | | | |
| 224 | *Cantharus compressus* | X | | | | | |
| 225 | *Cantharus liratus* | X | | | X | | |
| 226 | *Cantharus magnicostatus* | X | | X | | | |
| 227 | *Cantharus multicostatus* | X | | | | | |
| 228 | *Cantharus rhombus* | | | X | X | | |
| 229 | *Cantharus varians* | X | | | | | |
| 230 | *Janiopsis labrosa* | X | | | | X | |
| 231 | *Janiopsis maxillosa* | X | X | | | | |
| 232 | *Pisania inflata* | X | | | | | |
| | **Family Colubrariidae** | | | | | | |
| 233 | *Colubraria deshayesi* | X | | | | | |
| 234 | *Colubraria reticulata* | X | | | | | |
| 235 | *Metula reticulata* | X | | | | | X |
| 236 | *Metula recta* | | | | X | | |
| | **Family Columbellidae** | | | | | | |
| 237 | *Alia curta* | X | | X | X | | |
| 238 | *Columbella galbina* | | | | | | X |
| 239 | *Columbella borsoni* | X | | | | | |
| 240 | *Columbella scalaris* | X | | | | | |
| 241 | *Columbella taurinensis* | | | | | X | |
| 242 | *Columbellopsis inedita* | | | | | | X |
| 243 | *Mitrella adjecta* | X | | | | | |
| 244 | *Mitrella crassilabris* | X | | | X | X | |
| 245 | *Mitrella inflata* | X | | | | | |
| 246 | *Mitrella neglecta* | X | X | | | | X |
| 247 | *Mitrella turgida* | | X | | | | |
| 248 | *Pyrene klipsteini* | | X | | | | |
| 249 | *Pyrene* cf. *carinata* | X | | | | | |
| 250 | *Pyrene* cf. *semicaudata* | X | | | | | |
| 251 | *Anachis parva* | X | | | | | |
| 252 | *Anachis procorrugata* | X | | | | | |
| 253 | *Anachis turrita* | X | | | | | X |
| 254 | *Anachis terebralis* | X | | | | | |
| 255 | *Anachis* cf. *recticostata* | X | | | | | |
| | **Family Fasciolariidae** | | | | | | |
| 256 | *Fasciolaria tarbelliana* | | X | | | | |
| 257 | *Fusinus multiliratus* | X | | X | X | | |
| 258 | *Fusinus pustulatus* | X | | | | X | X |
| 259 | *Fusinus sismondai* | X | | | | | |
| 260 | *Fusus semirugosus* | | | | | X | X |
| 261 | *Fusus inaequicostatus* | | | | | | X |
| 262 | *Fusus subcostatus* | X | | | | | |
| 263 | *Fusus villai* | X | | | | | |
| 264 | *Euthriofusus burdigalensis* | X | | | | | |
| 265 | *Latirus carinatus* | X | | | X | | |
| 266 | *Latirus crassus* | X | X | | X | | |
| 267 | *Latirus cepporum* | X | | | | | |
| 268 | *Latirus lynchi* | X | | | X | | |
| 269 | *Latirus lyncoides* | | | | | X | |
| 270 | *Latirus pinensis* | X | X | | | X | X |
| 271 | *Latirus productus* | | X | | | | |
| 272 | *Latirus subcostatus* | X | | | | | |
| 273 | *Latirus taurinus* | X | X | | | | |
| 274 | *Leucozonia turbinata* | X | | | | | |
| 275 | *Peristernia exornata* | X | | | | | |
| 276 | *Pseudolatirus concinnus* | X | | | X | | |
| | **Family Nassariidae** | | | | | | |
| 277 | *Nassarius badensis* | X | | X | | X | X |
| 278 | *Nassarius basteroti* | X | | | | | |
| 279 | *Nassarius bowerbanki* | | X | | | | |
| 280 | *Nassarius clathurellus* | | X | | | | |
| 281 | *Nassarius cocconii* | | X | | | | |
| 282 | *Nassarius collegni* | X | X | | X | | |
| 283 | *Nassarius connectens* | | | | | | X |
| 284 | *Nassarius* cf. *coppii* | | | | | | X |
| 285 | *Nassarius curvicostatus* | X | | | | | |
| 286 | *Nassarius depromptus* | X | | | | | |
| 287 | *Nassarius* cf. *diversus* | X | | | | | X |
| 288 | *Nassarius exiguus* | X | | | | X | |
| 289 | *Nassarius familiaris* | X | | | | | |

| | | VC | VS | VB | VA | VF | MC |
|---|---|---|---|---|---|---|---|
| 290 | *Nassarius inaequalis* | | | | | | X |
| 291 | *Nassarius incertus* | X | X | | X | | |
| 292 | *Nassarius intercisus* | X | | | | | |
| 293 | *Nassarius perpulchrus* | X | | | | | |
| 294 | *Nassarius semirugosus* | X | X | | | | |
| 295 | *Nassarius serraticosta* | X | | | | | |
| 296 | *Nassarius speciosus* | | X | | | | X |
| 297 | *Nassarius subcaudatus* | | | | | | X |
| 298 | *Nassarius subesulcatus* | | X | | | | |
| 299 | *Nassarius sublaevigatus* | X | X | | X | X | X |
| 300 | *Nassarius subquadrangularis* | | X | | | | X |
| 301 | *Nassarius tessellatus* | X | | X | | | X |
| 302 | *Nassarius* cf. *macrodon* | X | | | | | |
| 303 | *Nassarius striatulus* | | | | | | X |
| 304 | *Duplicata haueri* | X | | | | | |
| 305 | *Duplicata ovulata* | X | | | | | |
| 306 | *Duplicata sismondai* | X | | | | | |
| 307 | *Duplicata* sp. | X | | | | | |
| | **Family Melongenidae** | | | | | | |
| 308 | *Pugilina crassicostata* | X | | | | | |
| 309 | *Pugilina acutissima* | X | | | | | |
| | **Family Muricidae** | | | | | | |
| 310 | *Chicoreus michelotti* | X | | | | | |
| 311 | *Chicoreus striaeformis* | | X | | | | |
| 312 | *Chicoreus sedgwicki* | X | | | | | |
| 313 | *Hexaplex subasperrima* | X | X | | X | | X |
| 314 | *Murex aquitanicus* | | | | X | | |
| 315 | *Murex citimus* | | | | | | X |
| 316 | *Murex longus* | X | | X | | | |
| 317 | *Murex pustulatus* | | | | | | X |
| 318 | *Murex renieri* | X | | | | | |
| 319 | *Murex pseudophyllopterus* | X | | | | | |
| 320 | *Murex taurinensis* | X | | | | | |
| 321 | *Coralliophila recurvicauda* | X | | | | | |
| 322 | *Coralliophila brevispira* | X | | | | | |
| 323 | *Orania granifera* | X | | | | | |
| 324 | *Oraria intercisa* | X | | | | | X |
| 325 | *Haustellum partschi* | X | X | | | | |
| 326 | *Haustellum sismondai* | X | X | X | | | X |
| 327 | *Ocenebra dufrenoyi* | X | | | | | |
| 328 | *Ocenebra lassaignei* | X | | | | | |
| 329 | *Ocenebra pustulata* | X | | | | | |
| 330 | *Ocenebra* cf. *danconai* | X | | | | | |
| 331 | *Purpura elongata* | X | | | | | |
| 332 | *Thais arata* | X | | X | X | | |
| 333 | *Thais haemastomoides* | X | | | X | | |
| 334 | *Thais inaequicostata* | X | X | | | X | |
| 335 | *Thais parvula* | | | | | X | |
| 336 | *Thais reflexa* | | X | | | | |
| 337 | *Thais tuberculata* | X | | | X | | |
| 338 | *Thais calcarata* | X | | | | | |
| 339 | *Vitularia linguabovis* | X | | | | | |
| 340 | *Trophon bredai* | X | | | | | |
| 341 | *Typhis fistulosus* | | | | | | X |
| 342 | *Typhis sowerby* | | X | | | | |
| | **Family Babylonidae** | | | | | | |
| 343 | *Babilonia eburnoides* | X | X | | | X | X |
| | **Family Costellariidae** | | | | | | |
| 344 | *Vexillum avellanum* | X | | | | | |
| 345 | *Vexillum turritum* | X | | | | | |
| 346 | *Vexillum* cf. *ornatum* | X | | | | | |
| 347 | *Vexillum subglobosum* | X | | | | | |
| 348 | *Vexillum analoga* | | X | | | | |
| 349 | *Vexillum attiguum* | X | | | | | |
| 350 | *Vexillum borsoni* | X | | | | | |
| 351 | *Vexillum canaliculatum* | X | | | | | |
| 352 | *Vexillum consanguineum* | X | | | | | |
| 353 | *Vexillum cincta* | | | | | | X |
| 354 | *Vexillum* cf. *cincta* | | X | | | | |
| 355 | *Vexillum* cf. *crebricostatum* | X | | | | | |
| 356 | *Vexillum decipiens* | X | | | | | |
| 357 | *Vexillum minuta* | X | | | | | |
| 358 | *Vexillum notabilis* | X | | | | | |
| 359 | *Vexillum pluricostatum* | X | | | | | |
| 360 | *Vexillum rectiplicata* | | | | X | | |
| 361 | *Vexillum similis* | X | | | | | |
| 362 | *Vexillum subglobosum* | X | | | | | |
| 363 | *Vexillum* sp. 1 | X | | | | | |
| | **Family Harpidae** | | | | | | |
| 364 | *Morum cytharum* | X | X | | X | X | |
| 365 | *Morum verrucosum* | X | X | | | | |
| | **Family Marginellidae** | | | | | | |
| 366 | *Gibberulina philippi* | X | | | | | |
| 367 | *Glabella borsoni* | X | X | | | | X |
| 368 | *Glabella excavata* | X | | | X | | X |
| 369 | *Glabella longa* | X | X | | X | | |
| 370 | *Glabella taurinensis* | X | X | X | | | X |
| 371 | *Marginella* cf. *marginata* | | | | | | X |
| 372 | *Marginella subovulata* | X | | | X | | X |
| 373 | *Persicula sabatica* | X | | | | | |
| 374 | *Volvarina elongata* | X | | | | | |
| 375 | *Volvarina parvula* | X | | | | | |
| | **Family Mitridae** | | | | | | |
| 376 | *Mitra absona* | | X | | | | |
| 377 | *Mitra admissa* | | X | | | | |
| 378 | *Mitra acuta* | X | | X | | | |
| 379 | *Mitra afficta* | X | | | | | |
| 380 | *Mitra arata* | | | | | X | |
| 381 | *Mitra* cf. *arata* | X | | | | | |
| 382 | *Mitra arva* | | | | X | | |
| 383 | *Mitra biformis* | X | X | | | | |
| 384 | *Mitra brevispira* | | | | | | |
| 385 | *Mitra cepporum* | | X | | | | |
| 386 | *Mitra* cf. *contorta* | X | | | | | |
| 387 | *Mitra cognatella* | | X | | | | |
| 388 | *Mitra cohibita* | X | | | | | |
| 389 | *Mitra compressa* | X | X | | | | |
| 390 | *Mitra confundenda* | | X | | | | |
| 391 | *Mitra defossa* | | X | | | | |
| 392 | *Mitra dolium* | X | | | | | |
| 393 | *Mitra graviuscula* | X | X | X | X | | |
| 394 | *Mitra indistinta* | X | | | | | |
| 395 | *Mitra intermissa* | | | X | | | |
| 396 | *Mitra megaspira* | | X | | | | |
| 397 | *Mitra neglecta* | X | | X | | | |
| 398 | *Mitra observabilis* | X | X | X | | | |
| 399 | *Mitra ponderosa* | X | | | | | |
| 400 | *Mitra proxima* | X | | | | | |
| 401 | *Mitra semiarata* | X | | | X | | |
| 402 | *Mitra sismondae* | | | | | X | |
| 403 | *Mitra subangulata* | X | | | | | |
| 404 | *Mitra subuliformis* | X | | X | | | |
| 405 | *Mitra subumbilicata* | X | | | X | X | |
| 406 | *Mitra suturalis* | | X | | | | |
| 407 | *Mitra taeniolata* | X | | | | | |
| 408 | *Mitra* cf. *turbinata* | X | | | | | |
| 409 | *Micromitra taurina* | X | | | | | |
| | **Family Turbinellidae** | | | | | | |
| 410 | *Tudicla rusticula* | X | X | | | | |
| | **Family Volutidae** | | | | | | |
| 411 | *Lyria magorum* | | X | | X | | |
| 412 | *Lyria picturata* | X | X | X | X | X | |
| 413 | *Athleta ficulina* | X | X | | | X | |
| | **Family Olividae** | | | | | | |
| 414 | *Oliva bellardi* | X | | | | | |
| 415 | *Oliva clavula* | X | | | | | |
| 416 | *Oliva picholina* | X | | X | X | X | |
| 417 | *Oliva cylindracea* | X | X | X | X | X | X |
| 418 | *Oliva ceppiensis* | X | | | | | |
| 419 | *Oliva dufresnei* | X | X | X | X | | |
| 420 | *Oliva longispira* | X | X | | X | X | |
| 421 | *Oliva malthata* | | X | | | | |
| 422 | *Ancilla pusilla* | X | | | | | |
| 423 | *Ancilla subcanalifera* | X | X | | X | | |
| 424 | *Ancilla obsoleta* | X | | | | | |
| 425 | *Ancilla sismondiana* | X | X | X | | | |
| 426 | *Ancilla sowerbyi* | | X | | | X | |
| 427 | *Ancilla suturalis* | | | | | X | |
| 428 | *Amalda glandiformis* | X | X | X | X | | X |
| 429 | *Amalda patula* | X | | | | X | X |
| | **Family Olivellidae** | | | | | | |
| 430 | *Olivella longispira* | X | | | | | |
| 431 | *Olivella obliquata* | X | X | | | | |
| 432 | *Olivella brevis* | | X | | | | |
| 433 | *Olivella clavula* | | X | | X | | |
| 434 | *Olivella ventrosa* | X | X | | X | | |
| | **Family Conidae** | | | | | | |
| 435 | *Conus aquensis* | X | X | | | X | |
| 436 | *Conus antidiluvianus* | X | X | | | | |
| 437 | *Conus antiquus* | X | X | X | X | X | |
| 438 | *Conus avellana* | | X | | | | |
| 439 | *Conus basteroti* | X | X | | | X | |
| 440 | *Conus belus* | | X | | | X | X |
| 441 | *Conus* cf. *berghausi* | | X | | X | | |
| 442 | *Conus bitorosus* | X | X | X | X | X | |
| 443 | *Conus bredai* | | X | | | | |
| 444 | *Conus brocchii* | X | X | X | X | X | |
| 445 | *Conus canaliculatus* | X | X | | | X | |
| 446 | *Conus clavatulus* | | X | | | | |
| 447 | *Conus conoponderosus* | | | | X | | |

| | | VC | VS | VB | VA | VF | MC |
|---|---|---|---|---|---|---|---|
| 448 | *Conus dujardinii* | X | | | | | X |
| 449 | *Conus elongatus* | X | X | X | | | |
| 450 | *Conus gastaldii* | | X | | | | |
| 451 | *Conus gastriculus* | | | | | X | |
| 452 | *Conus granulari* | X | | | | | X |
| 453 | *Conus marii* | X | X | | | | |
| 454 | *Conus mercatii* | | | | | | X |
| 455 | *Conus montisclavus* | X | X | | | | |
| 456 | *Conus mucronatolaevis* | X | X | X | X | | |
| 457 | *Conus obesus* | | | | | X | |
| 458 | *Conus oblongoturbinatus* | X | X | | | | X |
| 459 | *Conus parvecatenatus* | X | | X | X | X | |
| 460 | *Conus parvicaudatus* | | X | | | | |
| 461 | *Conus pelagicus* | X | X | | | X | |
| 462 | *Conus ponderosulcatus* | | X | | | | |
| 463 | *Conus ponderosus* | X | X | X | X | X | X |
| 464 | *Conus puschi* | X | X | | | | |
| 465 | *Conus raristriatus* | | X | | | | |
| 466 | *Conus striatulus* | X | | | | | X |
| 467 | *Conus taurinensis* | X | X | | X | | |
| 468 | *Bathytoma cataphracta* | X | X | | X | X | |
| 469 | *Borsonia prima* | X | | | | | |
| 470 | *Clathurella detruncata* | X | | | | | |
| 471 | *Cythara rugulosa* | X | | | | | |
| 472 | *Cythara subcilindrata* | X | | | | | |
| 473 | *Cythara longa* | | | | | | X |
| 474 | *Mangelia* sp. 1 | X | | | | | |
| 475 | *Mangelia* sp. 2 | X | | | | | |
| 476 | *Neogulares* aff. *spininiferus* | | | | | | X |
| 477 | *Neogulares* sp. indet. | X | | | | | |
| 478 | *Raphitoma* sp. indet. | X | | | | | |
| 479 | *Teretia* sp. 1 | X | | | | | |
| 480 | *Pleurotomides* cf. *simplex* | X | | | | | |
| 481 | *Pleurotomides* sp. 1 | X | | | | | |
| 482 | *Pleurotomides* sp. 2 | X | | | | | |
| | **Family Clavatulidae** | | | | | | |
| 483 | *Clavatula asperulata* | X | X | | X | | |
| 484 | *Clavatula concatenata* | | X | | | | X |
| 485 | *Clavatula consimilis* | X | X | | | | |
| 486 | *Clavatula defrancei* | X | | | | | |
| 487 | *Clavatula excavata* | | | | | X | |
| 488 | *Clavatula evae* | X | | | | | |
| 489 | *Clavatula heros* | | X | | | | X |
| 490 | *Clavatula geniculata* | X | | | | | |
| 491 | *Clavatula gothica* | | X | | | X | |
| 492 | *Clavatula nodosa* | X | | | X | X | |
| 493 | *Clavatula* cf. *pretiosa* | X | | | | | |
| 494 | *Clavatula semimarginata* | | X | | | | |
| 495 | *Clavatula taurinensis* | X | | | | | |
| 496 | *Clavatula turriculata* | | X | | | | X |
| 497 | *Genota ramosa* | X | X | X | X | X | X |
| 498 | *Genota hirsuta* | X | | | | | |
| 499 | *Genota laevis* | X | X | | X | | |
| 500 | *Pseudotoma bonellii* | X | | | | | X |
| 501 | *Pseudotoma precedens* | | X | | | | X |
| 502 | *Pseudotoma striolata* | X | | | | | |
| 503 | *Perrona jouanneti* | X | | | | | X |
| 504 | *Perrona pedemontana* | | X | | | | |
| 505 | *Perrona semimarginata* | | X | | | | |
| | **Family Drilliidae** | | | | | | |
| 506 | *Asthenotoma* cf. *mirabilis* | X | | | | | |
| 507 | *Asthenotoma* cf. *festiva* | X | | | | | |
| 508 | *Cerodrillia soror* | X | | | | | |
| 509 | *Clavus pustulatus* | X | | | | | |
| 510 | *Clavus obtusangulus* | X | | | | | X |
| 511 | *Turrisclavus* aff. *harpula* | | | | | | X |
| 512 | *Nitidiclavus maitrejus* | | | | | | X |
| 513 | *Crassopleura sigmoidea* | X | | | | | X |
| 514 | *Drillia brongniarti* | X | | | | | |
| 515 | *Drillia crebricosta* | X | | | X | | |
| 516 | *Drillia fratercula* | X | | | | | |
| 517 | *Drillia michelotti* | X | | | | | |
| 518 | *Drillia perrara* | X | | | | | |
| 519 | *Drillia raricosta* | X | X | X | X | | X |
| 520 | *Drillia sejungenda* | X | | | X | | |
| 521 | *Drillia semisulcata* | X | | | | | |
| 522 | *Drillia seiuncta* | X | | | | | |
| 523 | *Drillia serratula* | | | | | | X |
| 524 | *Drillia spinescens* | X | | | | | X |
| 525 | *Drillia sulciensis* | | | | | | X |
| 526 | *Drillia terebra* | X | | | | | |
| 527 | *Drillia unifilosa* | X | | | | | |
| 528 | *Haedrapleura pseudosigmoidea* | X | | | | | X |
| 529 | *Haedrapleura septangularis* | | | | | | X |
| 530 | *Haedropleura* sp. 1 | X | | | | | |

| | | VC | VS | VB | VA | VF | MC |
|---|---|---|---|---|---|---|---|
| 531 | *Drilliola crispata* | | | | | | X |
| 532 | *Microdrillia* sp. 1 | X | | | | | |
| 533 | *Paradrilliola bifidosa* | X | | | | | |
| 534 | *Stenodrillia bellardii* | | | | | | X |
| | **Family Terebridae** | | | | | | |
| 535 | *Hastula subcinerea* | X | X | | | | |
| 536 | *Hastula striata* | X | | | | | |
| 537 | *Hastula* cf. *striata* | X | | | | | |
| 538 | *Terebra acuminata* | X | X | | X | | X |
| 539 | *Terebra neglecta* | X | X | | | | X |
| 540 | *Terebra subulocacellense* | X | X | | | | |
| 541 | *Terebra subulatoidea* | X | X | X | | | |
| 542 | *Terebra subtessellata* | X | X | X | X | | X |
| 543 | *Terebra basteroti* | X | X | | X | X | X |
| 544 | *Terebra hoernesi* | X | | X | | | |
| 545 | *Terebra exbistriata* | X | | | | | |
| 546 | *Terebra* cf. *atorquatum* | | | | | | X |
| 547 | *Terebra terebrina* | | | | | | X |
| 548 | *Subula fuscata* | X | X | X | | X | |
| 549 | *Subula plicaria* | X | X | X | | X | X |
| | **Family Turridae** | | | | | | |
| 550 | *Turricula dimidiata* | X | | | | | X |
| 551 | *Turricula lamarcki* | | | | | | X |
| 552 | *Turricula kossuthii* | X | X | | | | |
| 553 | *Turris cypris* | X | | | | | |
| 554 | *Turris* cf. *cypris* | X | | | | | |
| 555 | *Turris vermicularis* | | | | | X | |
| 556 | *Gemmula denticula* | X | | | | | X |
| 557 | *Gemmala desita* | X | | | | | |
| 558 | *Gemmula rotata* | X | X | | | X | |
| 559 | *Gemmula spiralis* | | | | | X | X |
| 560 | *Gemmula stricta* | X | | | X | | |
| 561 | *Gemmula subcoronata* | X | X | | | X | X |
| 562 | *Surcula avia* | | | | | | X |
| 563 | *Surcula bardini* | X | | | | | |
| 564 | *Surcula chinensis* | X | X | | | | |
| 565 | *Surcula destefanii* | X | | | | | |
| 566 | *Surcula diademata* | X | | | | | |
| 567 | *Surcula intermedia* | X | | | | X | |
| 568 | *Surcula perlonga* | X | | | | | |
| 569 | *Surcula sismondiana* | X | | | | | |
| 570 | *Surcula striatula* | | X | | | | |
| 571 | *Pleurotoma archimedis* | X | | | | X | |
| 572 | *Pleurotoma citima* | X | X | X | | | X |
| 573 | *Pleurotoma coronifera* | | | | | X | |
| 574 | *Pleurotoma decorata* | X | | | | | |
| 575 | *Pleurotoma denticula* | X | | | | | |
| 576 | *Pleurotoma flammulata* | X | | | | | |
| 577 | *Pleurotoma multistriata* | X | | | X | | |
| 578 | *Pleurotoma obsoleta* | | | | | | X |
| 579 | *Pleurotoma pinguis* | X | | X | | | |
| 580 | *Pleurotoma sororcula* | X | | X | X | | |
| 581 | *Pleurotoma stricta* | X | | | | | |
| 582 | *Pleurotoma subnuda* | X | | | | | |
| 583 | *Pleurotoma trifasciata* | X | | | | | |
| 584 | *Roualtia bicoronata* | X | | | | | |
| 585 | *Crassispira semisulcata* | X | | | | | |
| 586 | *Bela* cf. *vulpecula* | X | | | | | |
| 587 | *Bela* aff. *scalariformis* | | | | | | X |
| 588 | *Bela* sp. 1 | X | | | | | |
| | **Family Cancellariidae** | | | | | | |
| 589 | *Bonellitia* cf. *bonelli* | | | | | | X |
| 590 | *Bonellitia evulsa* | X | | | X | | |
| 591 | *Bonellitia serrata* | X | | | | X | |
| 592 | *Cancellaria contorta* | X | X | | | | |
| 593 | *Cancellaria* cf. *contorta* | X | | | | | |
| 594 | *Cancellaria dertonensis* | X | X | | | | |
| 595 | *Gulia geslini* | X | | | | | |
| 596 | *Narona dufourii* | X | | | | | |
| 597 | *Narona lyrata* | | X | | | | X |
| 598 | *Sveltia taurina* | X | | | | | |
| 599 | *Trigonostoma ampullaceum* | | X | | X | | |
| 600 | *Trigonostoma michelinii* | X | | | | | |
| 601 | *Trigonostoma taurocrassa* | | X | | | | |
| 602 | *Trigonostoma taurolaevigata* | | | | X | | |
| 603 | *Trigonostoma acutangula* | X | | | | | |
| 604 | *Trigonostoma trochleare* | X | | | | X | |
| 605 | *Admete dregeri* | X | | | | | X |
| 606 | *Admete* cf. *dregeri* | X | | | | | |
| | **Family Acteonidae** | | | | | | |
| 607 | *Acteon pinguis* | X | | | | | |
| 608 | *Acteon punctulatu* | X | | | | | |
| 609 | *Acteon semistriatus* | X | | | | | |
| 610 | *Acteon* cf. *tornantilis* | X | | | | | |
| 611 | *Crenilabrum pedemontanum* | X | | | | | |

| | | VC | VS | VB | VA | VF | MC |
|---|---|---|---|---|---|---|---|
| | **Family Architectonicidae** | | | | | | |
| 612 | *Architectonica caracollata* | X | X | | X | | X |
| 613 | *Architectonica caracollosimplex* | X | | | | X | |
| 614 | *Architectonica depressomonilifera* | X | | | | | |
| 615 | *Architectonica planulata* | X | | | | | |
| 616 | *Architectonica prosemisquamosa* | X | | | | | X |
| 617 | *Architectonica* cf. *prosemisquamosa* | X | | | | | |
| 618 | *Architectonica* cf. *simplex* | X | | | | | |
| 619 | *Granosolarium deshayesi* | X | | | | | |
| 620 | *Philippia subconoidea* | X | | | | | |
| 621 | *Heliacus albertini* | | | | | | X |
| 622 | *Heliacus* cf. *faustae* | X | | | | | |
| | **Family Mathildidae** | | | | | | |
| 623 | *Gagania miocenica* | | | | | X | |
| 624 | *Gegania sulcata* | X | | | | | |
| 625 | *Mathilda granosa* | X | | | | | |
| 626 | *Mathilda praeclara* | X | | | | | |
| 627 | *Mathilda* sp. 1 | X | | | | | |
| | **Family Pyramidellidae** | | | | | | |
| 628 | *Menesto* cf. *peculiaris* | X | | | | | |
| 629 | *Pyramidella grateloupi* | X | | | | | |
| 630 | *Pyramidella plicosa* | X | | | | | |
| 631 | *Pyramidella* aff. *unisulcata* | X | | | | | |
| 632 | *Chrysallida pigmaea* | X | | | | | |
| 633 | *Chrysallida* sp. 1 | X | | | | | |
| 634 | *Odostomia perstricta* | | | | | | X |
| 635 | *Odostomia* sp. 1 | X | | | | | |
| 636 | *Odostomia* sp. 2 | X | | | | | |
| 637 | *Odostomia* sp. 3 | X | | | | | |
| 638 | *Odostomia* sp. 4 | X | | | | | |
| 639 | *Odostomia* sp. 5 | X | | | | | |
| 640 | *Odostomia* sp. 6 | X | | | | | |
| 641 | *Syrnola subumbilicata* | | | | | | X |
| 642 | *Syrnola* sp. 1 | X | | | | | |
| 643 | *Syrnola* sp. 2 | X | | | | | |
| 644 | *Eulimella affinis* | | | | | | X |
| 645 | *Eulimella subumbilicata* | X | | | | | |
| 646 | *Eulimella* cf. *taurinensis* | | | | | | |
| 647 | *Turbonilla costellatoides* | | | | | | X |
| 648 | *Turbonilla* cf. *pseudocostellata* | X | | | | | |
| 649 | *Turbonilla pusilla* | X | | | | | |
| 650 | *Turbonilla* cf. *pusilla* | X | | | | | |
| 651 | *Turbonilla* cf. *rufa* | X | | | | | |
| 652 | *Turbonilla* sp. 1 | X | | | | | |
| 653 | *Turbonilla* sp. 2 | X | | | | | |
| 654 | *Turbonilla* sp. 3 | X | | | | | |
| | **Family Ringiculidae** | | | | | | |
| 655 | *Ringicula auriculata* | X | X | X | X | | X |
| 656 | *Ringicula bonelli* | X | X | X | X | X | X |
| 657 | *Ringicula* cf. *sandbergeri* | X | | | | | |
| | **Family Hamenoeidae** | | | | | | |
| 658 | *Haminoea hydatis* | X | | | | | |
| 659 | *Weinkauffia* sp. indet. | X | | | | | |
| | **Family Cylichnidae** | | | | | | |
| 660 | *Cylichna cylindracea* | X | | | | | |
| 661 | *Roxania burdigalensis* | X | | | | | |
| 662 | *Roxania utriculus* | X | | | | | |
| 663 | *Scaphander grateloupi* | X | | | | | |
| 664 | *Scaphander* cf. *lignarius* | X | | | | | |
| 665 | *Tornantina lajonkaireana* | X | | | | | |
| 666 | *Volvulella* cf. *acuminata* | X | | | | | |
| | **Family Retusidae** | | | | | | |
| 667 | *Pseudoavena tauroglandula* | X | | | | | |
| 668 | *Retusa elongata* | X | | X | X | | |
| 669 | *Retusa testiculina* | X | X | | | | |
| | **Family Siphonariidae** | | | | | | |
| 670 | *Siphonaria polygona* | X | | | | | |
| 671 | *Williamia gussoni* | X | | | | | |
| | **Class Bivalvia** | | | | | | |
| | **Family Nuculidae** | | | | | | |
| 672 | *Nucula nucleus* | X | X | | X | | |
| 673 | *Nucula placentina* | X | X | | X | | |
| | **Family Yoldiidae** | | | | | | |
| 674 | *Yoldia nitida* | X | | | | | |
| | **Family Nuculanidae** | | | | | | |
| 675 | *Nuculana commutata* | X | | | | | X |
| | **Family Arcidae** | | | | | | |
| 676 | *Arca* cf. *biangula* | X | X | | | | |
| 677 | *Arca imbricata* | | X | | X | | |
| 678 | *Arca noae* | X | X | | | | |
| 679 | *Arca tauroclathrata* | X | | | X | | |
| 680 | *Arca tetragona* | X | X | | | | |
| 681 | *Anadara fichteli* | X | X | | | | |
| 682 | *Anadara diluvii* | X | | | | | |
| 683 | *Andara turonensis* | | X | | | | |
| 684 | *Barbatia barbata* | X | X | X | X | | |
| 685 | *Barbatia candida* | X | | | | | |
| 686 | *Barbatia clathrata* | X | | | | | |
| 687 | *Barbatia nodulosa* | X | X | | X | | |
| 688 | *Barbatia tauroclatthrata* | X | | | | | |
| | **Family Noetiidae** | | | | | | |
| 689 | *Striarca lactea* | X | | | | | |
| | **Family Limopsidae** | | | | | | |
| 690 | *Limopsis aurita* | X | X | | | | |
| | **Family Glycymerididae** | | | | | | |
| 691 | *Glycymeris inflata* | X | X | | | | |
| 692 | *Glycymeris insubrica* | | X | | | | |
| 693 | *Glycymeris pilosa* | X | X | | X | | |
| 694 | *Glycymeri* gr. *pilosa* | X | X | | | | |
| | **Family Mytilidae** | | | | | | |
| 695 | *Lithophaga lithophaga* | X | | | | | |
| | **Family Malleidae** | | | | | | |
| 696 | *Ostreinella neglecta* | X | X | | | | |
| | **Family Pinnidae** | | | | | | |
| 697 | *Pinna* cf. *nobilis* | X | | | | | |
| | **Family Ostreidae** | | | | | | |
| 698 | *Cubitostrea frondosa* | X | | | | | |
| 699 | *Gryphaeostrea miotauriniensis* | X | | | | | |
| 700 | *Lopha plicatula* | X | X | | | | |
| 701 | *Lopha proplicatula* | | X | | | | |
| 702 | *Neopycnodonte cochlear* | X | X | | | | |
| 703 | *Ostrea edulis* | X | X | | | | |
| 704 | *Ostrea* aff. *edulis* | X | | | | | |
| 705 | *Ostrea gingensis* | X | X | | | | |
| | **Family Pectinidae** | | | | | | |
| 706 | *Chlamys gloriamaris* | X | | | X | | |
| 707 | *Chlamys harveri* | X | | | | | |
| 708 | *Chlamys* cf. *tauroperstriata* | X | X | | | | |
| 709 | *Chlamys tournali* | | X | | | | |
| 710 | *Aequipecten harveri* | | X | | | | |
| 711 | *Aequipecten northamptoni* | X | | | | | |
| 712 | *Aequipecten opercularis* | X | | | | | |
| 713 | *Pecten beudanti* | | X | | | | |
| 714 | *Pecten burdigalensis* | X | | | | | |
| 715 | *Pecten cristatocostatus* | | X | | | | |
| 716 | *Pecten grayi* | | X | | X | | |
| 717 | *Pecten* cf. *paulensis* | | X | | | | |
| | **Family Spondyliidae** | | | | | | |
| 718 | *Spondylus concentricus* | X | | | | | |
| 719 | *Spondylus* cf. *concentricus* | X | | | | | |
| 720 | *Spondylus gaederopus* | X | X | | X | | |
| | **Family Radulidae** | | | | | | |
| 721 | *Radula lima* | | X | | X | | |
| | **Family Anomidae** | | | | | | |
| 722 | *Anomia ephippium* | X | X | | | | |
| 723 | *Pododesmus* aff. *patelliformis* | X | | | | | |
| 724 | *Pododesmus tauraculeatu* | X | | | | | |
| | **Family Limidae** | | | | | | |
| 725 | *Limea strigillata* | X | | | | | X |
| | **Family Lucinidae** | | | | | | |
| 726 | *Lucina barrandei* | | X | | | | |
| 727 | *Lucina globulosa* | | X | | | | |
| 728 | *Lucina michelotti* | X | X | | | | |
| 729 | *Lucina perusiana* | | | X | | | |
| 730 | *Ctena reticulata* | X | | | | | |
| 731 | *Linga agassizi* | X | | X | | | X |
| 732 | *Lucinoma borealis* | X | | | X | | |
| 733 | *Megaxinus bellardianus* | X | X | | | | |
| 734 | *Megaxinus incrassatus* | X | | | | | |
| 735 | *Myrtea spinifera* | X | | | | | X |
| 736 | *Myrtea taurina* | X | | | | | |
| 737 | *Gonimyrtea meneghini* | X | | | | | |
| | **Family Thyasiridae** | | | | | | |
| 738 | *Cryptodon flexuosus* | X | | | | | |
| | **Family Ungulinidae** | | | | | | |
| 739 | *Felaniella trigonula* | X | | | | | |
| | **Family Carditidae** | | | | | | |
| 740 | *Cardita calyculata* | X | | | | | |
| 741 | *Cardita crassa* | X | | | | | |
| 742 | *Cardita squamulosa* | | | | X | | |
| 743 | *Cardites antiquatus* | X | | X | X | | |
| 744 | *Cardites* cf. *antiquatus* | X | | | | | |
| 745 | *Cardites edulinum* | | | | X | | |
| 746 | *Cardites pinnula* | X | X | | | | |
| 747 | *Cardites* (?) *taurelongatus* | X | | | | | |
| 748 | *Glans aculeata* | X | X | X | X | | |
| 749 | *Miodontiscus scalaris* | X | | | | | |
| | **Family Chamidae** | | | | | | |
| 750 | *Chama benoisti* | X | | | | | |
| 751 | *Chama gamella* | | X | X | | | |

| | | VC | VS | VB | VA | VF | MC |
|---|---|---|---|---|---|---|---|
| 752 | *Chama gryphoides* | X | | | | | |
| 753 | *Pseudochama gryphina* | X | | | | | |
| | **Family Astartidae** | | | | | | |
| 754 | *Astarate solidula* | X | | | | | |
| | **Family Cardiidae** | | | | | | |
| 755 | *Cardium burdigalinum* | X | | | | | |
| 756 | *Cardium taurinum* | X | | | | | |
| 757 | *Discors discrepans* | X | | | | | |
| 758 | *Cerastoderma michelotti* | X | X | | | | |
| 759 | *Trachycardium multicostatum* | X | | | | | |
| | **Family Mesodesmatidae** | | | | | | |
| 760 | *Ervilia castanea* | | X | | | | X |
| 761 | *Ervilia nitens* | X | | | | | |
| | **Family Glossidae** | | | | | | |
| 762 | *Glossus cytheroides* | X | | | | | |
| 763 | *Meiocardia deshayesi* | X | | | | | |
| | **Family Veneridae** | | | | | | |
| 764 | *Callista italica* | X | | | | | |
| 765 | *Callista* aff. *italica* | X | | | | | |
| 766 | *Callista chione* | X | X | | | | |
| 767 | *Callista* cf. *chione* | X | | | | | X |
| 768 | *Callista erycina* | X | | | | | |
| 769 | *Callista erycinoides* | X | | | | | |
| 770 | *Callista pedemontana* | X | X | | X | | |
| 771 | *Callista taurorugosa* | X | | | | | |
| 772 | *Clausinella basteroti* | | X | | | | |
| 773 | *Clausinella fasciata* | X | | | | | |
| 774 | *Clausinella taurotrigona* | | X | | | | |
| 775 | *"Omphaloclathrum" aglauare* | | X | | | | |
| 776 | *Pelecyora gigas* | X | X | | | | |
| 777 | *Timoclea ovata* | X | | | | | |
| 778 | *Venus* cf. *libellus* | X | | | | | |
| 779 | *Venus multilamella* | X | X | | X | | |
| | **Family Hiatellidae** | | | | | | |
| 780 | *Hiatella* aff. *arctica* | X | | | | | |
| | **Family Corbulidae** | | | | | | |
| 781 | *Corbula carinata* | X | X | | | | X |
| 782 | *Corbula cocconii* | X | | | | | |
| 783 | *Corbula gibba* | X | | | | | X |
| | **Family Teredenidae** | | | | | | |
| 784 | *Nototeredo norvegica* | X | X | | X | | |
| | **Family Verticordiidae** | | | | | | |
| 785 | *Pecchiolina argentea* | X | X | | X | | |
| | **Class Scaphopoda** | | | | | | |
| | **Family Dentaliidae** | | | | | | |
| 786 | *Antalis badense* | X | X | | | | |
| 787 | *Antalis* cf. *badense* | X | | | | | |
| 788 | *Antalis bouei* | X | X | X | | | X |
| 789 | *Antalis miocaenicum* | | X | | | | X |
| 790 | *Antalis miopseudoentalis* | X | X | | | | |
| 791 | *Antalis taurocostatum* | X | | | | | |
| 792 | *Antalis tauroperstriatum* | X | | | | | |
| 793 | *Antalis vulgaris* | X | | | X | | |
| 794 | *Dentalium michelotti* | X | | | | | X |
| 795 | *Fissidentalium tauroasperum* | X | X | | X | | X |
| 796 | *Fissidentalium taurostriatum* | X | X | | | | X |

Tab. I - Lower and Middle Miocene mollusc taxonomic list of selected fossiliferous localities of Torino Hills. VC: Valle Ceppi; VS: Val Sanfrà; VB: Villa Bertini; VA: Villa Allason; VF: Villa Forzano; MC: Monte dei Cappuccini.

and the material studied comes from the Cantamessa collection.

The Villa Forzano fossil assemblage is made up of 968 specimens of medium-size and large molluscs (Tab. I); these include 908 gastropod specimens belonging to 107 species, 30 bivalves belonging to 10 species and 3 scaphopods belonging to one species. The most species-rich gastropod families are Conidae (10 species), followed by Tonnidae, Buccinidae and Olividae (6 species each), by Naticidae, Ranellidae, Fascicolariidae and Muricidae (5 species each).

The Villa Forzano assemblage is mainly constituted by mid- to large sized specimens, most of which are absent at Villa Allason; indeed, of the 101 species of gastropods recorded at Villa Forzano, only 41 have been recorded at Villa Allason as well. In large part, this is due to the significant difference in the sizes of the fossils found in the two assemblages.

Monte dei Cappuccini

The Monte dei Cappuccini, located on the north-western slope of the Torino Hills, is 284 meters high. It overlooks the right bank of the Po River, and stands apart from the main Torino Hills.

The toponym "Monte dei Cappuccini" appears in Bellardi's (1872-1890) and Sacco's (1890-1904) monographs, alternating with the more generic "Torino Hills". Audenino (1897), in his study on the Monte dei Cappuccini pteropods, briefly described the stratigraphic succession, made up of a conglomeratic base horizon followed by greyish sandstone and pteropod-rich marls. Bellini (1905) and Prever (1907) reported a long list of fossils from the Monte dei Cappuccini.

Bonsignore et al. (1969) reports that the abundant "fauna of the Monte dei Cappuccini" comes from alternating clayish siltstone, sands and conglomerates with a thickness of about 50-80 metres, rich in cephalopods of the genus *Aturia* and pteropods. It is located about 50-80 meters above Villa Allason – Villa Forzano sandstone-conglomeratic level. Planctonic foramifera, with the appearance of *Orbulina suturalis* at the lower level, date the outcrop to the Late Langhian (Biozone N9a). The Monte dei Cappucini is now part of Torino urban area, and is almost covered by buildings that prevent the possibility of any field verification of the data discussed here.

The examined mollusc specimens come from the collection of Ernesto Forma, a technician at the Geo-palaeontological Museum of Torino who worked with Bellardi and Sacco. At the end of the 19th century, most of the collection, which was bequeathed to the Museum, became part of the Bellardi and Sacco collection and was inventoried by Ferrero Mortara et al. (1982, 1984). The material described here comes from a remained part of the Forma collection added to the Bellardi and Sacco collection, and was re-ordered by Raso (1997).

Monte dei Cappuccini fossil assemblage is made up of 2,227 mollusc specimens (Tab. I). We revised 2,148 gastropod specimens belonging to 118 species, 76 bivalves belonging to 14 species, and 3 scaphopods belonging to 3 species. The most species-rich gastropod families are Conidae and Nassariidae (10 species each), followed by Turridae (9 species), Naticidae (8 species) and Turritellidae (6 species).

Most significant species are illustrated in Plates 1 and 2.

| | Bellardi (1882) | Zunino (2007) |
|---|---|---|
| □ | *Na. arata* Bellardi, 1882 | *Ns. aratus* Bellardi, 1882 |
| □ | *Na. atlantica* (Mayer in Bronn, 1860) | *Ns. atlanticus* (Mayer in Bronn, 1860) |
| | *Na. badensis* (Hörnes, 1852) | *Ns. badensis* (Hörnes, 1852) |
| □ | *Na. badensis* (Hörnes, 1852) | *Ns. exiguus* (Brocchi, 1814) |
| □ | *Na. exigua* (Brocchi, 1814) | *Ns. exiguus* (Brocchi, 1814) |
| ○ | *Na. basteroti* Michelotti | *Ns. basteroti* Michelotti |
| □ | *Na. bivonai* Bellardi, 1882 | *Ns. bivonai* Bellardi, 1882 |
| | *Na. bowerbanki* Michelotti, 1847 | *Ns. bowerbanki* Michelotti, 1847 |
| □ | *Na. turgidula* Bellardi, 1882 | *Ns. bowerbanki* Michelotti, 1847 |
| □ | *Na. brevis* Bellardi, 1882 | *Ns. brevis* Bellardi, 1882 |
| □ | *Na. cepporum* Bellardi, 1882 | *Ns. cepporum* Bellardi, 1882 |
| □ | *Na. angusta* Bellardi, 1882 | *Ns. cepporum* Bellardi, 1882 |
| | *Na. clathurella* Bellardi, 1882 | *Ns. clathurellus* Bellardi, 1882 |
| | *Na. cocconii* Bellardi, 1882 | *Ns. cocconii* Bellardi, 1882 |
| □ | *Na. proavia* Bellardi, 1882 | *Ns. cocconii* Bellardi, 1882 |
| | *Na. collegni* Bellardi, 1882 | *Ns. collegni* Bellardi, 1882 |
| | *Na. connectens* Bellardi, 1882 | *Ns. connectens* Bellardi, 1882 |
| ○ | *Na. coppii* Bellardi, 1882 | *Ns.* cf. *coppii* Bellardi, 1882 |
| | *Na. curvicostata* Bellardi, 1882 | *Ns. curvicostatus* Bellardi, 1882 |
| □ | *Na. calcarai* Bellardi, 1882 | *Ns. curvicostatus* Bellardi, 1882 |
| | *Na. deprompta* Bellardi, 1882 | *Ns. depromptus* Bellardi, 1882 |
| | *Na. exigua* (Brocchi) | *Ns. exiguus* (Brocchi) |
| □ | *Na. difficilis* Bellardi, 1882 | *Ns. difficilis* Bellardi, 1882 |
| | *Na. diversa* Bellardi, 1882 | *Ns. diversus* Bellardi, 1882 |
| □ | *Na. sobrina* Bellardi, 1882 | *Ns. diversus* Bellardi, 1882 |
| □ | *Na. familiaris* (Mayer in Bellardi, 1882) | *Ns. familiaris* (Mayer in Bellardi, 1882) |
| □ | *Na. flexicostata* Bellardi, 1882 | *Ns. flexicostatus* Bellardi, 1882 |
| □ | *Na. omissa* Bellardi, 1882 | *Ns. flexicostatus* Bellardi, 1882 |
| | *Na. inaequalis* Bellardi, 1882 | *Ns. inaequalis* Bellardi, 1882 |
| | *Na. incerta* Bellardi, 1882 | *Ns. incertus* Bellardi, 1882 |
| □ | *Na. pectita* Bellardi, 1882 | *Ns. incertus* Bellardi, 1882 |
| | *Na. intercisa* (Michelotti, 1840) | *Ns. intercisus* (Michelotti, 1840) |
| □ | *Na. cincta* Bellardi, 1882 | *Ns. intercisus* (Michelotti, 1840) |
| □ | *Na. renieri* Bellardi, 1882 | *Ns. intercisus* (Michelotti, 1840) |
| □ | *Na. magnicostata* Bellardi, 1882 | *Ns. intercisus* (Michelotti, 1840) |
| □ | *Na. isseli* Bellardi, 1882 | *Ns. isseli* Bellardi, 1882 |
| | *Na. auingeri* (Hoernes) | *Ns. macrodon auingeri* (Hörnes & Auinger) |
| □ | *Na. pauli* Hörnes, 1875 | *Ns. pauli* (Hörnes, 1875) |
| | *Na. perpulchra* Bellardi, 1882 | *Ns. perpulchrus* Bellardi, 1882 |
| | *Na. semirugosa* Bellardi, 1882 | *Ns. semirugosus* Bellardi, 1882 |
| □ | *Na. albucianensis* Bellardi | *Ns. semirugosus* Bellardi, 1882 |
| □ | *Na. pupoides* Bellardi, 1882 | *Ns. semirugosus* Bellardi, 1882 |
| | *Na. serraticosta* (Bronn, 1831) | *Ns. serraticosta* (Bronn, 1831) |
| □ | *Na. soror* Bellardi, 1882 | *Ns. soror* Bellardi, 1882 |
| | *Na. speciosa* Bellardi, 1882 | *Ns. speciosus* Bellardi, 1882 |
| | *Na. restitutensis* (Fontannes, 1879) | *Ns. striatulus* (Eichwald, 1829) |
| ○ | *Na. subcaudata* Bellardi, 1882 | *Ns. subcaudatus* Bellardi, 1882 |
| | *Na. subesulcata* Bellardi, 1882 | *Ns. subesulcatus* Bellardi, 1882 |
| | *Na. sublaevigata* Bellardi, 1882 | *Ns. sublaevigatus* Bellardi, 1882 |
| □ | *Na. taurinorum* Bellardi, 1882 | *Ns. sublaevigatus* Bellardi, 1882 |
| | *Na. subquadrangularis* Michelotti | *Ns. subquadrangularis* Michelotti |
| | *Na. tessellata* (Michelotti, 1840) | *Ns. tessellatus* (Michelotti, 1840) |
| □ | *Na. tumida* (Eichwald, 1830) | *Ns. tumidus* (Eichwald, 1830) |
| □ | *Na. woodi* Bellardi, 1882 | *Ns. woodi* Bellardi, 1882 |
| □ | *CY. desnoyersi* (Basterot) | *CY. desnoyersi* (Basterot) |
| □ | *Cy. pleurotomoides* Bellardi, 1882 | *Do. pleurotomoides* Bellardi, 1882 |
| □ | *Na. veneris* (Faujas, 1817) | *Do. veneris* (Faujas, 1817) |
| ○ | | *Duplicata* sp. |
| | *Do. haueri* (Michelotti, 1847) | *Du. haueri* (Michelotti, 1847) |
| □ | *Na. cyllenoides* Sacco, 1890 | *Du. haueri* (Michelotti, 1847) |
| | *Cy. ovulata* Bellardi, 1882 | *Du. ovulata* Bellardi, 1882 |
| □ | *Na. rustica* Bellardi, 1882 | *Du. rustica* Bellardi, 1882 |
| | *Du. sismondai* (Bellardi, 1882) | *Du. sismondai* (Bellardi, 1882) |

Tab. II - Taxonomic revision of family Nassariidae in Bellardi & Sacco collection according to Zunino (2007). ○ = specimens absent in Bellardi & Sacco collection. The samples are described in their Monography but at the moment are not available; □= the specimens are present only in Bellardi & Sacco collection but not in the new collection examined in Zunino (2007). *Na.*= *Nassa* Lamarck, 1779; *Ns.*= *Nassarius* Dumeril, 1806; *CY.*= *Cyllene* Gray in Griffith & Pigeon, 1834; *Cy.*= *Cyllenina* Bellardi, 1882; *Do.*= *Dorsanum* Gray, 1847.
The specimens *N. asperata*, *N. atilis*, *N. baldisserensis*, *N. brusinae*, *N. clavatula*, *N. cognata*, *N. crispa*, *N. fischeri*, *N. impar*, *N. jeffresi*, *N. pachygaster*, *N. obesa*, *N. peregrina*, *N. pereirae*, *N. perrara*, *N. rovasendae*, *N. semicostulata*, *N. simulans*, *N. subreticulata*, *N. tomentosa*, *N. tracta*, *N. turbinata*, *N. turricula*, *N. divisa* are not present in the Bellardi & Sacco collection anymore and are not revised in Zunino (2007).

**Discussion**

Comparison among molluscs assemblages

On the basis of what has been described above, the fossiliferous localities of the Torino Hills can be compared under two different aspects. One is the stratigraphic aspect: an analysis of the available cartography (Festa et al. 2009a) shows that in the Valle Ceppi-Val Sanfrà sector there is a single, thick lithosome of coarse-matrix terrigenous deposits, which splits into multiple distinct bodies in the westernmost quadrants of the Hills (Val Salice). On the other hand, the Villa Bertini deposits apparently belong to a sandstone-conglomeratic body overlaying the Valle Ceppi-Val Sanfrà lithosome and its lateral equivalents, and thus it lies at the topmost Termofourà Formation. Although it was possible to date the pelitic levels of Val Sanfrà with planctonic foraminifera to the middle Burdigalian (Biozone N7a), exactly like the Valle Ceppi fossiliferous deposits, no biostratigraphic information is available for the Villa Bertini levels. Nevertheless, the conglomeratic layer containing the Villa Bertini fossil assemblage can be referred to the late Burdigalian, since it lies just below the so-called "Upper Pteropod Marls" lithosome assigned to the Burdigalian-Langhian transition in the literature (Bonsignore et al. 1969). The chronostratigraphy of the Villa Allason, Villa Forzano, and Monte dei Cappuccini fossil deposits is more precisely defined within the Baldissero Formation (Bonsignore et al. 1969); the first two can be referred to as early Langhian, and the third to late Langhian.

Fig. 2 shows the stratigraphic relationships between the various Miocene localities: the fossiliferous conglomeratic bodies are organized in chronostratigraphic order on the basis of data extrapolated from the literature and recently collected in the field (Bonsignore et al. 1969; Zunino 2007; Festa et al. 2009a, 2009b) as described in the preceding paragraphs. The composite section of Fig. 2 shows the distribution of the fossil assemblages obtained in the analyzed localities, from the middle Burdigalian to the upper Langhian. The relative continuity of taphonomic record thus assumes a valid instrument for evaluating the paleobiological evolution of Middle Miocene mollusc faunas of the Piedmont Tertiary Basin.

The second aspect regards to comparison among the different fossils assemblages, pointing attention to gastropods which show the highest abundance and biodiversity among molluscs. The low homogeneity of mollusc assemblages from Torino Hills, particularly concerning the deposit genesis, size differences of fossils, number of specimens, samplings, do not allow employment of any similarity index (e.g. Sorensen Index). The percent values here indicated for each fossiliferous locality just quantify the weight of common species reported to the Valle Ceppi assemblages, that is regarded in this context as the reference datum. With regards to Lower Miocene, an analysis of the number of gastropod species shared by all three localities shows a high degree of similarity, around 75-80%. Indeed, of the 211 species recorded in the Val Sanfrà deposits, 147 (70%) are shared with Valle Ceppi; this is a very high degree of similarity considering that many of Valle Ceppi's medium-small sized species are absent from Val Sanfrà. Furthermore, of the 72 gastropod species identified at Villa Bertini, as many as 70 (95%) are shared with Valle Ceppi: in this case, however, the low number of species recorded at Villa Bertini affects the comparison.

The situation changes significantly if we compare Valle Ceppi with Middle Miocene localities. The mollusc assemblages of Villa Allason-Villa Forzano and Monte dei Cappuccini show lower species diversity in all gastropod families, but particularly in three highly thermophilous families such as Cypreidae, Olividae and Conidae, especially for the upper Langhian of Monte dei Cappuccini. Nevertheless, considering taxa shared by the different oryctocenoses, 85% of the 108 species recorded at Villa Allason and 74% of the 101 species recorded at Villa Forzano are also found in Valle Ceppi. Turning to Monte dei Cappuccini, out of 127 total species only 62 (49%) are shared with Valle Ceppi; in this case, such a low value is highly significant given that most of Monte dei Cappucini's gastropods are medium-small, and thus easily comparable to those of Valle Ceppi.

In summary, there is a high degree of similarity between the Burdigalian and the lower Langhian oryctocenoses, whereas similarity with the upper Langhian assemblages decreases significantly. These differences can be attributed to the genesis of the fossiliferous deposits created by instantaneous, catastrophic events such as debris-flows and turbidity currents, which make the paleontological record unique and casual. These events imply that the taphogenic remains were selected based on size, morphology, structure during pre-burial transportation and re-sedimentation. Furthermore, the uneven degree of sampling of the various fossiliferous records, caused by the different degrees of rock cementation, led to further fossil selection and loss of information on the original assemblage.

Palaeobiogeographic constraints

Taxonomic discrepancies also attest changes in the original assemblages as a reflection of the interrupted marine connections between Mediterranean areas and eastern Tethys, dated to the Burdigalian-Langhian transition (Adams et al. 1983; Harzhauser et al. 2007; Meulenkamp & Sissing 2003; Robba 1986; Rögl & Steininger 1984). This important geological phenomenon, driven by the collision of the Arabian and Eurasian plates in their mid-eastern section, led to the definitive separation of mollusc communities, and the different evolution of their populations in the new Proto-Mediterranean and Indo-Pacific bio-provinces, and also caused the differentiation of Lower towards Middle Miocene assemblages in the area of the Torino Hills. Indeed, the fall in the number of species could be related to the drop in surface water temperature, from an estimated 26-22ºC for the Eocene-Oligocene to 18ºC in the Middle Miocene, due to the interruption of circum-equatorial oceanic circulation (Adams et al. 1983; Berggren & Hollister 1977; Davoli 1989; Harzhauser et al. 2002; Meulenkamp & Sissingh 2003; Robba 1986; Rögl 1998; Rögl & Steininger 1984; Valentine 1984).

*Western France Burdigalian:* assemblages from the westernmost part of the Tethys are generally rather homogeneous; the number of species shared by the Torino Hills and other fossiliferous sites of the same age is very high for the Aquitaine Basin in France (Cossmann & Peyrot 1916-1919, 1922-1924; Harzhauser et al. 2002); the number of shared species decreases as one moves eastwards, where taxa from the Tethys decrease while Indo-Pacific taxa increase greatly. At the family level, there is a high degree of homogeneity within Melongenidae, Cerithiidae, Strombidae, and Naticidae, whereas Conidae and Turridae show a high degree of differentiation (Brebion 1974; Harzhauser et al. 2002). With regards to species richness, Harzhauser et al. (2002) report low diversity in the eastern Mediterranean – about 50-60 species – compared to higher diversity in western assemblages. Bellardi (1872-1890) and Sacco (1890-1904) described over 980 for the Piedmont Tertiary Basin, of which 650 have been recorded from the Torino Hills. These differences are probably due to the lack of detailed studies on these areas, and uneven sampling of fossiliferous levels. The fossil assemblages of south-western France are also species-rich: Cossmann & Peyrot (1916-1919, 1922-1924) described 495 species for the Aquitanian and over 680 for the Burdigalian (Brebion 1974; Harzhauser et al. 2002). With regards to the Aquitaine basin, in spite of its being a peri-Tethyan gulf with Atlantic influence (Cavelier et al. 1993), the typical Lower Miocene species have strong Tethyan pattern. Taxa well-represented on the Torino Hills are also common in the famous outcrops at Bernachon, Ariey, and Pont-Pourquey, including: *Haustator desmarestinus, Turritella terebralis, Protoma cathedralis, Modulus basteroti, Mandolina rhomboidalis, Globularia compressa, Tudicla rusticula, Pachycrommium scalaris, Dorsanum veneris, Conus basteroti, Perrona semimarginata*. The percentage of species shared by these assemblages is certainly very high for the Lower Miocene. Since many taxa thought to be endemic to one or the other oryctocenosis may prove to be synonyms, should the revision of the Torino Burdigalian described above be widely accepted with its significant reduction in the number of valid species.

Middle Miocene assemblages in the Aquitaine Basin have fewer species (about 400), with the disappearance of many Burdigalian genera and the high species turnover. Only a few Burdigalian taxa continue to be represented, including *Modulus, Cypraecassis, Cassis, Thais, Olivella* and some Cypraeidae, thus confirming the turnover of assemblages which characterizes the Middle Miocene on the Torino Hills (Brebion 1974).

*Paratethyan Langhian:* comparisons become simpler with the gastropod assemblages of the Paratethys, a paleobiogeographic unit distinct from the Tethys, whose history begins around the Eocene-Oligocene limit and ends with the Pliocene. It is characterized by periods of total or partial isolation, with high degrees of endemism, and periods of communication with the Boreal, Indo-Pacific, and especially Mediterranean bio-provinces (Papp et al. 1974; Seneš & Marinescu 1974; Harzhauser et al. 2003). The first period of isolation of the Paratethys was during the Oligocene; it culminated in the explosion and rapid diversification of brackish water endemic bivalves (Rögl 1998; Harzhauser et al. 2002), whereas gastropods show a reduced endemism with brackish water genera distributed in the western Tethys as well (Harzhauser et al. 2003). During Lower and Middle Miocene, Mediterranean and Paratethys were reconnected following the extensive marine transgression caused by the climatic optimum (Harzhauser et al. 2002). Harhauser et al. (2003) studied their faunistic exchange and identified two different periods of communication. The first one coincided with the late Burdigalian (Karpatian), and was characterized by assemblages with strong Mediterranean characteristics, which were well documented in the Korneuburg Basin; the second period dates to the Langhian (Badenian) with species-rich assemblages, especially within Cypraeidae, Turridae, Nassaridae, Muricidae, with typical Tethyan taxa such as: *Cerithium procrenatum, Cypraecassis cypraeformis, Bursa nodosa, Sassia apenninica, Charonia nodifera, Muricopsis cristatus.*

In general, the Badenian high number of species is related to massive immigration from the Mediterranean, highlighted by the fact that over 70% of species are shared by the Mediterranean and Central Paratethys. These mollusc assemblages were originally studied by Hörnes (1851-1856) from Austria, Friedberg (1923-1928) from Poland, and Zilch (1934) and Strausz (1966) from Hungary, with recent revisions by Harzhauser (2003), Harzhauser et al. (2002, 2003), Harzhauser & Kowalke (2004). Affinities with Italian species are quite evident in the fossiliferous locality of Korytnica, near Krakow; within the broad gulf of the central Paratethys located between what is now south-central Poland and the Carpathians. The fossiliferous deposits of Korytnica, studied in detail by Bałuk (1975, 1995, 1997, 2003, 2006), are correlated with the Langhian-Serravallian interval in the Mediterranean, and with the lower Badenian in the Vienna Basin (Pavia 1991; Harzhauser et al. 2003; Bałuk 2006). Korytnica gastropod assemblages include 604 species (Bałuk 2006), with both small and large specimens of some species that are also found in the Lower and Middle Miocene deposits of Torino Hills. A total of 92 species are shared by these localities, including: *Zonarina amygdalum, Z. brochii, Schilderia taurovalis, Ficus conditus, Neverita josephinia, Cypraecassis cypraeformis, Hipponix sulcatus, Euthria adunca, Oliva dufresnei, Amalda glandiformis, Conus dujardinii, C. elongatus, Genota ramosa, Pseudotoma bonellii, Subula plicaria, Architectonica caracollata*. There is a high degree of similarity between small species, which so far have only been found in Valle Ceppi, and in particular for Rissoidae (*Alvania perregularis, A.* cf. *brachia, A.* cf. *tenuiscostata, Rissoina decussata*) and Cerithiopsidae (*Cerithiopsis* cf. *tubercularis, C. bilineata, C. pusilla*). Other families, such as Nassariidae and Turridae, show marked diversification, albeit with some shared species, such as *Nassarius serraticosta* or *Turricula dimidiata*. As we have said before, such diversity needs to be verified and confirmed.

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PLATE I

1 - *Paroxystele amedei* (Brogniart, 1823), Middle Burdigalian, Valle Ceppi (PU108785);

2 - *Cerithium ocirrhoe* (d'Orbigny, 1852), Middle Burdigalian, Valle Ceppi (PU108786);

3 - *Protoma cathedralis* (Brongniart, 1856), Middle Burdigalian, Valle Ceppi (PU108003);

4 - *Zonarina brocchii* (Mylius, 1628), Middle Burdigalian, Valle Ceppi (PU108787);

5 - *Globularia compressa* (Basterot, 1825), Middle Burdigalian, Val Sanfrà (PU107631);

6 - *Euspira catena* (Da Costa, 1778), Middle Burdigalian, Val Sanfrà (PU107636);

7 - *Polinices proredemptus* Sacco, 1891, Middle Burdigalian, Val Sanfrà (PU107628);

8 - *Persististrombus bonellii* (Brongniart, 1823), Middle Burdigalian, Valle Ceppi (PU108784);

9 - *Aporrhais uttingeriana* (Risso, 1826), Middle Burdigalian, Valle Ceppi (PU108788);

10 - *Aporrhais pespelecani* (Linneo, 1758), Middle Burdigalian, Valle Ceppi (PU108789);

11 - *Gyrineum elongatum* (Bellardi & Michelotti, 1840), Middle Burdigalian, Valle Ceppi PU107077);

12 - *Janiopsis maxillosa* (Bellardi & Michelotti, 1840, Bonelli m.s.), Middle Burdigalian, Valle Ceppi (PU108790);

13 - *Genota laevis* (Bellardi, 1847), Middle Burdigalian, Valle Ceppi (PU108791);

14 - *Nassarius intercisus* (Michelotti, 1840, Gené m.s.), Middle Burdigalian, Valle Ceppi (PU107039);

15 - *Nassarius badensis* (Hörnes, 1852), Middle Burdigalian, Valle Ceppi (PU25323);

16 - *Nassarius subquadrangularis* (Michelotti, 1847), Middle Burdigalian, Val Sanfrà (PU23700);

17 - *Oliva cylindracea* Borson, 1825, Middle Burdigalian, Valle Ceppi (PU108792);

18 - *Oliva dufresnei* (Basterot, 1825), Middle Burdigalian, Valle Ceppi (PU108793);

19 - *Ancilla sismondana* Bellardi, 1882, Middle Burdigalian, Valle Ceppi (PU108794);

20 - *Amalda glandiformis* (Lamarck, 1810), Middle Burdigalian, Valle Ceppi (PU108795).

PLATE II

1 - *Conus brochii* Bronn, 1828, Middle Burdigalian, Valle Ceppi (PU108796);

2 - *Bathytoma cataphracta* (Brocchi, 1814), Middle Burdigalian, Valle Ceppi (PU107087);

3 - *Gemmula subcoronata* Bellardi & Michelotti, 1840, Middle Burdigalian, Valle Ceppi (PU108797);

4 - *Pseudotoma bonellii* (Bellardi, 1847), Middle Burdigalian, Valle Ceppi (PU108060);

5 - *Clavatula taurinensis* (Mayer, 1873), Middle Burdigalian, Valle Ceppi (PU108058);

6 - *Gemmula rotata* (Brocchi, 1814), Middle Burdigalian, Valle Ceppi (PU108798);

7 - *Murex citimus* Bellardi, 1872, Langhian, Monte Cappuccini (PU25691);

8 - *Nassarius subcaudatus* (Bellardi, 1882), Langhian, Monte Cappuccini (PU25718);

9 - *Terebra (Fusoterebra) terebrina* (Bellardi & Michelotti, 1840, Bonelli m.s.), Late Langhian, Monte Cappuccini (PU25792);

10 - *Columbellopsis inedita* (Bellardi, 1890), Late Langhian, Monte Cappuccini (PU25699);

11 - *Stenodrillia bellardi* (Desmoulins, 1842), Late Langhian, Monte Cappuccini (PU25751);

12 - *Barbatia (Acar) nodulosa* (Muller, 1776), Early Langhian, Villa Allason (PU107090);

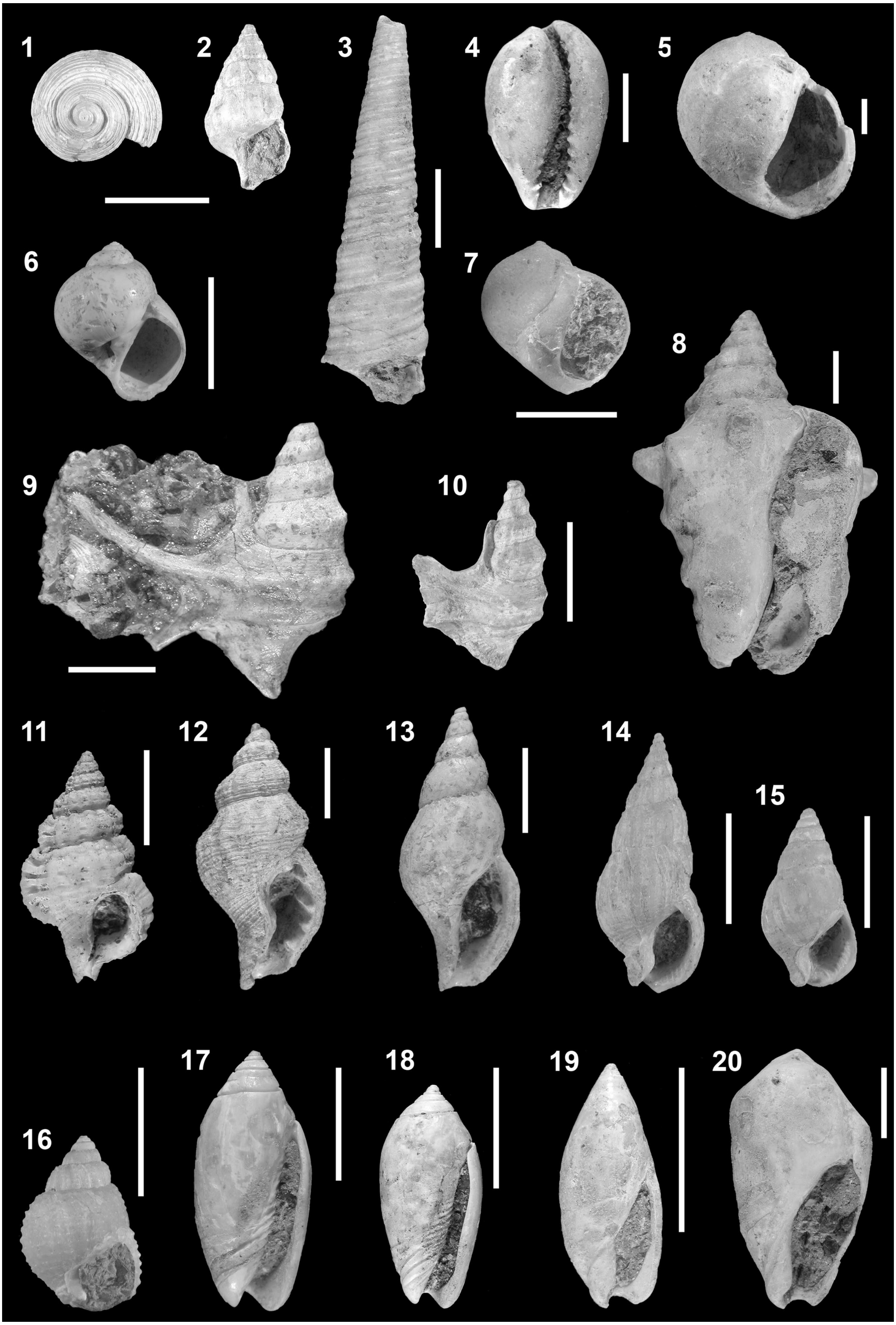
13 - *Glycymeris pilosa* (Linneo, 1758), Early Langhian, Villa Allason (PU107091);

14 - *Glans aculeata* (Michelotti, 1839), Late Burdigalian, Villa Bertini (PU107706);

15 - *Radula lima* Linnaeus, 1758, Middle Burdigalian, Val Sanfrà (PU107688);

16 - *Callista italica* Defrance, 1815, Middle Burdigalian, Valle Ceppi (PU25860);

17 - *Venus multilamella* Lamarck, 1818, Langhian, Villa Allason (PU107727).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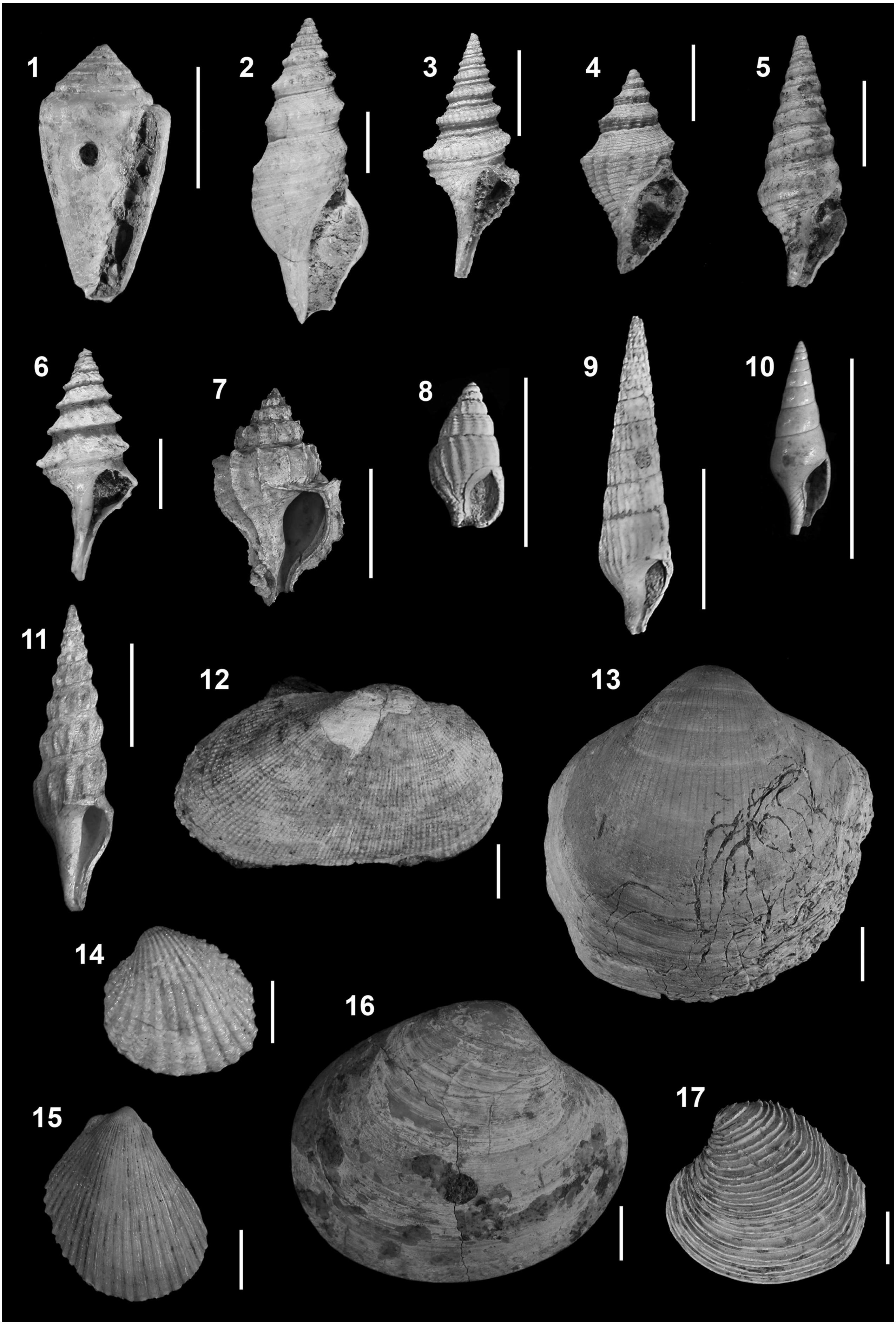
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