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PALAEOECOLOGIC AND PALAEOBIOGEOGRAPHIC CHARACTER OF MIDDLE PLIOCENE NON-MARINE MOLLUSC FAUNAS FROM NORTH-WESTERN ITALY

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Abstract. Significant new records of rich Middle Pliocene non-marine mollusc assemblages from the Piedmont basin (North-western Italy) have led to an update of the systematic position of some taxa known since the end of the 19th century. The recorded molluscs come from deposits belonging to the San Martino unit in the "Villafranchian type-area" (Villafranca d'Asti) and to Cuneo and Alessandria districts. Vertebrate remains referred to the Middle Pliocene Triversa Faunal Unit (Mammal Neogene zone MN16a) are often associated with molluscs.

A detailed palaeoecologic and palaeobiogeographic picture of the Middle Pliocene aquatic and terrestrial mollusc faunas is outlined. The assemblages are characterised by a high degree of species diversity and by the dominance of land prosobranchs and pulmonates. The palaeoecologic character is related to the different sedimentary facies recognised in the lithostratigraphic units: hygrophilous land faunas in paleosols and dominant aquatic taxa in lacustrine-palustrine sediments. Thermophilous swampy and forest taxa point to warm-temperate and humid climate conditions.

A high number of extinct taxa and a high rate of endemism are underlined. A Mio-Pliocene Central-western European origin is noticed for many species. In the Middle Pliocene a spreading of some terrestrial species took place from North-western Italy towards Central Italy.

Some new extinct taxa, belonging to the families Aciculidae (*Renea* sp. 1) and Clausiliidae [*Monoptychia* (subgen. n.) sp. 1; *Neostyriaca* sp. 1; *Fusulus (Fusulus)* sp. 1], are identified.

Riassunto. Significativi recenti ritrovamenti di associazioni a molluschi continentali medio pliocenici del Piemonte hanno portato a una revisione tassonomica di numerose specie già note alla fine del 19° secolo permettendo un inquadramento paleoecologico e paleobiogeografico dell'insieme faunistico medio-pliocenico caratterizzante il settore nord-occidentale italiano. I ritrovamenti si riferiscono a depositi dell'Unità di San Martino nell'area di Villafranca d'Asti e a depositi delle province di Cuneo e di Alessandria in cui i molluschi sono associati a resti di vertebrati dell'Unità Faunistica di Triversa (Mammal Zone MN16a) riferibile al Pliocene medio. Le malacofaune, caratterizzate da un alto grado di diversità specifica, sono dominate da gasteropodi terrestri di ambiente forestale medio umido e di suoli idromorfi. Il carattere paleoambientale delle associazioni viene messo in relazione alla relativa litofacies: paleosuoli idromorfi o sedimenti lacustri. Specie termofile ed igrofile indicano condizioni climatiche umide e temperato-calde. L'analisi paleobiogeografica evidenzia una composizione eterogenea delle associazioni piemontesi con prevalenza di elementi endemici e taxa di origine miocenica centro-europea o del Pliocene inferiore e medio dell'Europa centro-occidentale. Durante il Pliocene medio alcune specie terrestri si diffondono nell'Italia centrale. Fra le numerose specie estinte sono individuati alcuni nuovi taxa appartenenti alle Fam. Aciculidae (*Renea* sp. 1) e Clausiliidae [*Monoptychia* (subgen. n.) sp. 1, *Neostyriaca* sp. 1, *Fusulus (Fusulus)* sp. 1].

Introduction

Since the end of the 19th century rich assemblages of significant freshwater and land molluscs were recorded by ancient Authors, such as F. Sacco and E. Sismonda, in the Pliocene sediments of the Piedmont basin from the "Villafranchian stage" type-area as defined by Pareto (1865) in the surroundings of Villafranca d'Asti. Similar faunas are also recorded outside this area nearby Fossano (Cuneo district) and Tassarolo (Alessandria district) (Fig. 1) (Sismonda 1851; Sacco 1884, 1885, 1886a, 1888, 1889-90). As for the record of Tertiary non-marine molluscs the Piedmont basin offers the main fossiliferous horizons of North-western Italy. A first general review of the land and freshwater molluscs considered by F. Sacco and E. Sismonda was made by Wenz (1923-30) and partly, in the last three decades, by many other researchers,

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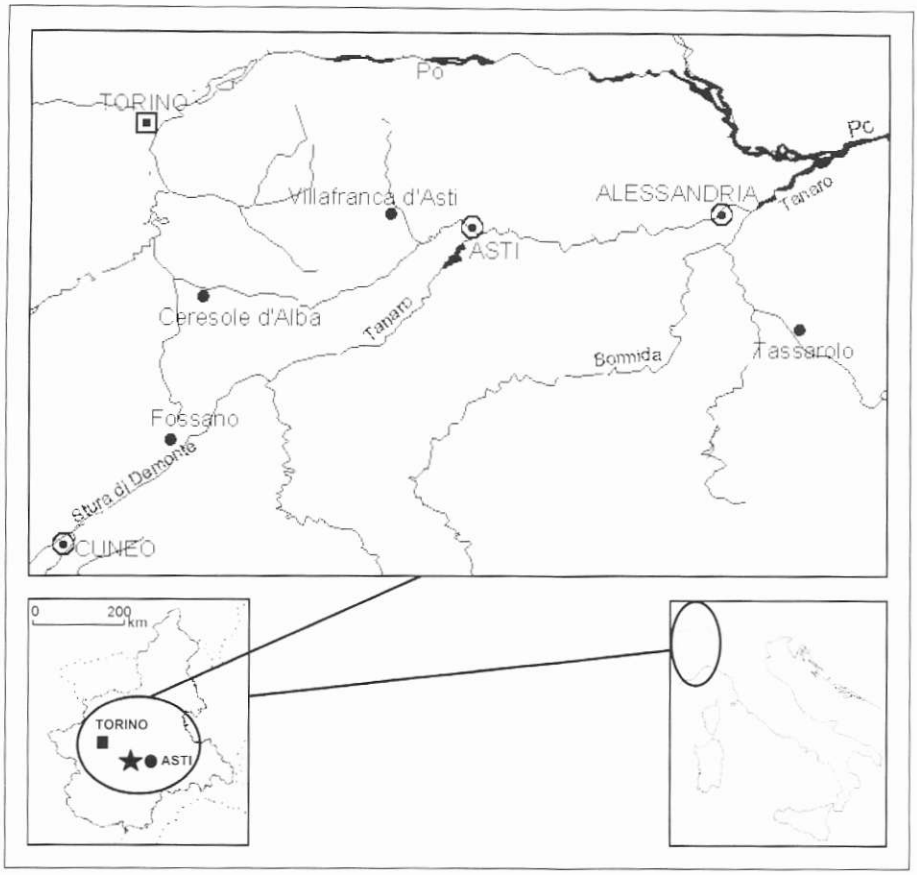

Fig. 1 - Location of the "Villafranchian type-area" (star) and the main fossiliferous sites out of it.

as Truc (1971a, 1972), Schlickum & Strauch (1979), Esu (1982), Manganelli et al. (1990), Esu & Girotti (1991), Esu et al. (1993), Ciangherotti et al. (1996), Ciangherotti (1997a), Ciangherotti et al. (1998), Manganelli & Giusti (2000a, b), Nordsieck (2000), even if many of the types described by Sacco were destroyed (Ferrero Mortara et al. 1984). Luckily the Piedmont mollusc documentation has been considerably increased by field researches carried on in the last decade by researchers of the University of Turin (Carraro 1996 and E. Martinetto) which led to the findings of new Pliocene fossiliferous outcrops rich in terrestrial and freshwater molluscs.

Vertebrate remains have been often recorded by ancient authors in the same sediments, "the Villafranchian type succession" proposed by Pareto, which yielded the molluscs. In the 20th century other field researches dug out many other micro- and macromammal remains (see Carraro 1996 cum refs.). The well-known Pliocene large mammals of remarkable stratigraphic interest from the Villafranchian type-area are assigned by Azzaroli (1977) to the Triversa Faunal Unit, at about 3 Ma (Middle Pliocene), corresponding to the lower Villafranchian Mammal Age, i.e. to the Mammal Neogene zone MN16 and more precisely to "MN16a" established by Mein (1990) (Fig. 2) since the Triversa faunas are considered the oldest Villafranchian faunas (Azzaroli 1983).

Therefore the rich autochthonous assemblages of non-marine molluscs from the same sediments yielding the vertebrates can be referred to the Middle Pliocene.

The aim of the present paper is to give a complete picture of the Pliocene non-marine mollusc fauna from North-western Italy and of its relationships with coeval assemblages from the rest of Italian peninsula and Europe. The palaeoecologic and palaeobiogeographic analysis of the newly-collected faunas, the taxonomic revision of Sacco's material and the better knowledge acquired in the last years about the Pliocene non-marine mollusc assemblages from other Italian sites (Esu et al. 1993, 2000; Ambrosetti et al. 1995; Ciangherotti et al. 1996; Ciangherotti 1997a, b; Nordsieck 2000) have been the ground for this paper.

The "Villafranchian stage" type-area: stratigraphic and palaeoenvironmental context

Recent stratigraphic studies by Basilici (1996) and Boano & Forno (1996a, b) of the wide "Villafranchian stage" type-area comprised in the Asti province allowed to recognise two outcropping lithostratigraphic units, Ferrere (lower-lying) and San Martino.

The Ferrere unit is made up of coarse sandy and silty sediments of delta front deposits interfingered with beach sediments. It rests in sedimentary continuity on littoral pre-villafranchian marine sediments ("Sabbie di Asti" p.p. Formation) very rich in foraminifers and marine molluscs of Early/Middle Pliocene age (latest Zanclean-earliest Piacenzian). Several mammal remains, mostly mastodons, as well as littoral marine molluscs are recorded in the Ferrere unit.

The San Martino unit is a widespread heterogeneous formation of a noticeable thickness (about 40 m) laid down into a deltaic plain in stratigraphic continuity on the Ferrere unit, testifying a gradual transition from coastal marine towards non-marine environment. It is made up of alternating plain-planar laminated silty-clayey sediments laid down in coastal swamps and sandy bodies resulting by fluvial channel infilling. In this environmental context many species of land and freshwater molluscs are recorded.

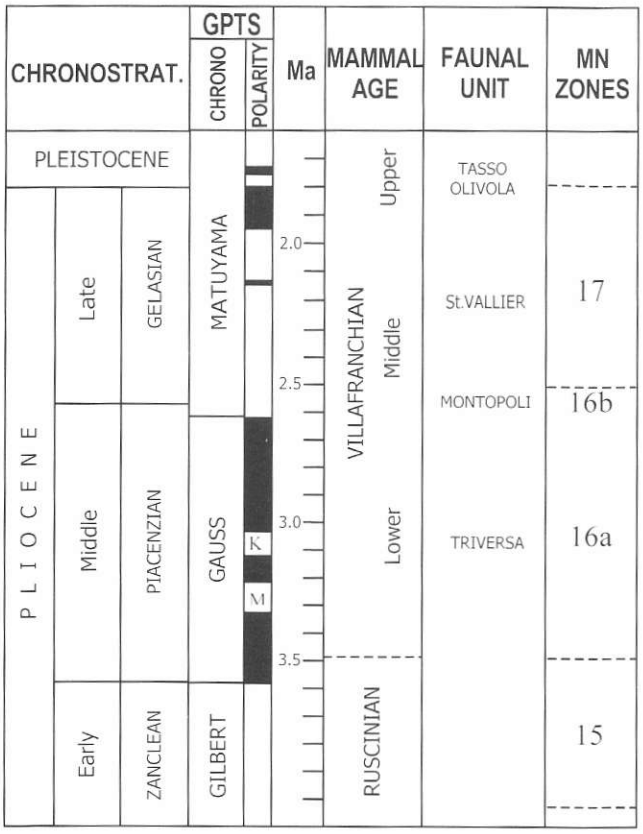

Fig. 2 - Chronostratigraphic relations of Mammal Ages, Faunal Units and European Mammal Neogene (MN) zones.

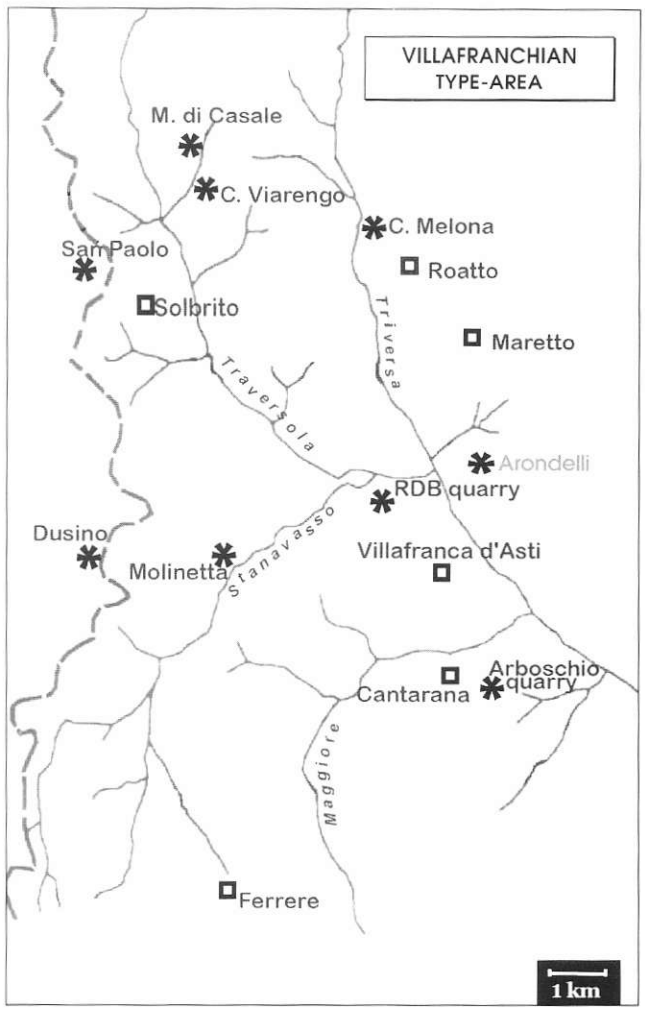

Fig. 3 - Main fossiliferous deposits of the San Martino unit in the "Villafranchian type-area".

Different sedimentary facies which give good palaeoenvironmental information, are recognised by Basilici (1996) in the San Martino unit to which the recorded mollusc assemblages will be related in this work:

- **lithofacies A**: sandy and gravelly sediments of delta channels without fossils;

- **lithofacies B**: lake and pond clayey sediments very rich in freshwater gastropods and bivalves, such as *Viviparus*, *Valvata*, *Planorbis*, *Pisidium*, of a low-energy freshwater environment and of maximum 10 m depth; many plant remains and ostracods are also recorded in these sediments;

- **lithofacies C**: coarse to fine sandy deposits of fluvial flood without fossil remains;

- **lithofacies D**: paleosols made up of clayey silt very rich in fossil remains. Two different types of paleosols have been distinguished: hydromorphous type (**lithofacies D1**) made up of silty clay, often rich in organic matter, yielding highly hygrophilous land gastropods, such as *Carychium*, *Vertigo*, *Oxyloma*, rodents and plant remains, as tree remains in life position, leafs and large roots; non hydromorphous type (**lithofacies D2**), with pedogenetic structures, formed in a well drained ground, in which no organic remains are recorded.

The very common passage from lithofacies D1 to lithofacies B occurring in the San Martino unit is often abrupt testifying a soil quick drowning (Basilici 1996). This environmental change is accompanied by a sharp diversification in the mollusc assemblages.

The rich palynological content and plant macro-remains recorded from the San Martino unit, mainly from hydromorphous soils and clayey sediments rich in organic matter, show the dominance of marshy and swampy floristic and arboreal elements, with a few tropical-subtropical taxa (Bertoldi 1996; Martinetto & Mai 1996).

The stratigraphic setting, the palaeontological and palynological content of the sediments and the magnetostratigraphy carried on the most complete succession of this unit (stratigraphic section at RDB quarry, Villafranca d'Asti) by different authors (Lindsay et al. 1980, 1997; Carraro 1996; Boano et al. 1999; Napoleone et al. 2003) permit to refer the San Martino unit to the Middle Pliocene, more precisely at 3.1-2.9 Ma of the Kaena/late Gauss chrons. A few remarkable Pliocene mammal remains belonging to the Triversa F.U., today stored in the Palaeontological Museum of Basel, were recovered by N. Masoero from RDB quarry (Hürzeler 1967; Azzaroli

Extinct species in Piedmont sites (Middle Pliocene)	Villafranca d'Asti area									Cuneo	AL
	RDB quarry	Arboschio quarry	Cascina Melona	Cascina Viarengo	Madonna di Casale	Dusino	Molinetta	San Paolo	Ceresole D'Alba	Fossano	Tassarolo
Hydrocena (H.) dubrueilliana									■		
Platyla cf. *callosa*							?		■		
Platyla klemmi							cf.				
Renea sp. 1	■						■		■		
Viviparus pollonerai	■	■	■	■				■	■	■	
Schuettemmericia lenoiri	■			■					■		
Emmericia pliocenica								■		■	
Carychium (C.) puisseguri							cf.				
Carychium (S.) pachychilum	■								■		
Carychium (S.) pseudotetrodon	■		■			cf.			■		
Physa meneghinii	■						■		■	■	
Lymnaea bucciniformis	■			■					■	■	
Cochlicopa laevissima									■		
Vertigo (V.) nouleti									■		
Vertigo globosa globosa										■	
Vertigo globosa tassaroliana										■	■
Negulus villafranchianus		■									■
Pagodulina bellardii									■	■	
Ferussacia pollonerai								■		■	
Ferussacia tassaroliana											■
Gastrocopta (A.) acuminata	■				■					■	
Gastrocopta (V.) moravica	■				■				■		
Leiostyla capellinii										■	■
Leiostyla gottschicki	■								■		
Argna proexcessiva											■
Argna spjeldnaesi									cf.		
Eostrobilops aloisii	■								■		
Eostrobilops patuliformis										■	
Janulus angustiumbilicatus	■							■		■	
Discus lateumbilicatus										■	
Discus pantanellii								■			
Retinella (R.) depressissima	■		■		■		■	■	■	■	■
Palaeoglandina lunensis	■										
Poiretia pseudoalgira										■	■
Nordsieckia fischeri									■		
Serrulella decemplicata										■	
Polloneria pliocenica					■		■		■	■	
Monoptychia (n. subg.) sp. 1									■		
Clausilia (C.) portisi										■	
Clausilia (C.) strauchiana subsp. 1									■		
Neostyriaca sp. 1									■		
Fusulus (F.) sp. 1									■		
Cochlodina (P.) prolaminata	■					cf.					■
Laminiplica villafranchiana	■							■			
Triptychia mastodontophila	■						■	■	■	■	
Drepanostoma planorbiforme										■	■
Drepanostoma plioauriculatum										■	■
Hygromia carinatissima	■						■	■	■	■	■
Eobania magnilabiata	■							■			
Schlickumia bottinii										■	

Tab. 1 - Extinct non-marine mollusc species from selected Middle Pliocene fossiliferous sites of Piedmont.

1977) and some teeth of *Anancus arvernenis* were found in the following years (Carraro 1996). Furthermore micromammal remains belonging to the rodent *Apodemus alsomyoides* have been found at RDB quarry in the last years (Ciangherotti 1997b; Kotsakis et al. 2003) supplying a further good element of correlation since this rodent was previously found by Michaux (1970) in Middle Pliocene sediments near Arondelli (see hereinafter). The rich micromammal fauna from Arondelli described by many Authors (Kotsakis et. al 2003) is placed correlative to the upper late Gauss chron (Napoleone et al. 2003).

Palaeoecology

Many fossiliferous Pliocene deposits belonging to the San Martino unit discovered in the Villafranca d'Asti area in the last years and the ones already known in literature were sampled in detail for mollusc analysis. The main fossiliferous sites are RDB quarry, Arboschio quarry, Arondelli, Cascina Melona, Cascina Viarengo, Madonna di Casale, San Paolo, Dusino and Molinetta (Fig. 3). In several outcrops mammal remains belonging to the Trivversa F.U. were found in assemblage with molluscs.

Outside the Villafranchian type-area a new fossiliferous non-marine deposit was discovered near Ceresole d'Alba (Cuneo) by P. Giuntelli. In the same area Sacco (1889-90) mentions non-marine mollusc-bearing deposits belonging to the "Villafranchian stage". Other significant localities, such as Fossano (Cuneo) and Tassarolo (Alessandria), are reported by Sacco in the same paper. Many fossiliferous sites are mapped by this author in topographical maps (1:25.000) stored in the Dipartimento di Scienze della Terra of the University of Turin (F. Sacco's archiv).

The Pliocene assemblages from the Villafranchian type-area and out of it mentioned by Sacco in numerous papers and the ones newly collected are listed with taxonomic revision in Tab. 1; only the extinct and revised species are reported because of the incomplete information on the extant species.

The detailed qualitative and quantitative palaeoecologic analysis of the mollusc assemblages from each deposit, based on the attribution of each species to a particular biotope, follows the classical palaeoecological method of Ložek (1964) in order to point out the life environment of the mollusc faunas and the strict relationship between the sedimentary facies and the type of assemblage. Only autochthonous assemblages are taken into account. For the old records mentioned by Sacco only qualitative analysis is possible.

The "Villafranchian type-area" sites

Villafranca d'Asti and San Paolo (Solbrito). Non-marine molluscs are reported by Sismonda (1851) and Sacco (1884, 1885, 1886b, 1889-90, 1897) from Pliocene alluvial deposits and yellow or green-gray marls cropping out in several sites in the Villafranchian type-area (Topographical maps Montafia 69-IV-IV and San Damiano 69-IV-III; 1:25.000, surveyed by F. Sacco). Several mastodon remains were found in reddish clayey marls overlying the mollusc-bearing layers. The San Paolo local mammal fauna

is tentatively placed correlative to the late Gauss chron at about 2.9 Ma by Napoleone et al. (2003). Lacustrine mollusc taxa pointing to oxygenated water body, such as *Viviparus pollonerai, Bithynia tentaculata, Emmericia pliocenica, Gyraulus albus* and land hygrophilous species of open-forest environment, such as *Retinella depressissima* and *Hygromia carinatissima*, characterise these sediments. Some extinct species belonging to deciduous forest taxa (Esu 1999), such as *Janulus, Discus, Laminifera, Eobania*, also occur. A prevalence of lithofacies B (ponds or small lakes) with surrounding open-woodland can be inferred.

RDB quarry (Villafranca d'Asti). Rich mollusc assemblages of land and freshwater gastropods and bivalves come from paleosols (lithofacies D) and alternating lacustrine sediments (lithofacies B) cropping out at RDB quarry (Esu 1982; Ciangherotti 1997b) where the San Martino unit is very well exposed. Along the sedimentary succession lithofacies A and C, both barren of molluscs, also occur. Many terrestrial hygrophilous elements come from the subfacies D1 (hydromorphous paleosols) which is very frequent in the section. Many extinct land and freshwater taxa, which reach the 50% of the total, occur. Several extant species, such as *Pomatias elegans, Valvata cristata, V. piscinalis, Lymnaea truncatula, Planorbis planorbis, Anisus spirorbis, Gyraulus albus, Planorbarius corneus, Acroloxus lacustris, Succinea oblonga, Truncatellina* cf. *callicratis, Vertigo angustior, Punctum pygmaeum, Discus rotundatus, Vitrea contracta, V. subrimata, Pisidium personatum*, are also present. The dominance of palustrine or hygrophilous land taxa, such as *Carychium, Vertigo, Leiostyla, Discus, Vitrea, Hygromia*, is noticed in the paleosols. The recorded assemblages point to alternating lacustrine and marshy environment. For the detailed quantitative analysis see Ciangherotti (1997b).

Arboschio quarry (Cantarana). Non-marine molluscs come from the upper part of the section in the front of the Arboschio quarry at 3.15 m (=level D -lithozone 4- in Pavia 1970) where the San Martino unit crops out overlying the Middle Pliocene marine sediments of the Ferrere unit. Vertebrate remains of the Triversa F.U. are also recorded (Pavia 1970). An assemblage of lacustrine and hygrophilous land gastropods, in which the aquatic prosobranchs *V. pollonerai* and *V. piscinalis* are dominant (80%), is recorded from non-marine silty marls and lacustrine clays referred to the lithofacies B. The land hygrophilous taxa, *Carychium* cf. *minimum* and *Negulus villafranchianus*, occur in low percentage (15% in total). Fragmentary Clausiliidae are also present. The molluscs point to shallow and slowly current water and a moist surrounding environment. Many leaf imprints are also recorded which show a swamp plant community with *Alnus* and *Taxodium* (Martinetto & Mai 1996).

Cascina Melona: well clay	Ecological class	No. specim.	% specim.	% ecological classes	
V. pollonerai	10SF	1	3,85	2W(s)	3,85
V. piscinalis	10SF	2	7,69	7M	7,69
C. (S.) pseudotetrodon	9P	1	3,85	9P	73,1
Carychium sp.	9P	16	61,54	10SF	11,5
L. truncatula	10SPPp	1	3,85	10SPPp	3,85
Oxyloma sp.	9P	2	7,69		
Vitrea sp.	7M	1	3,85		
R. (R.) depressissima	7M?	1	3,85		
Limax sp.	2W(s)	1	3,85		
		26			

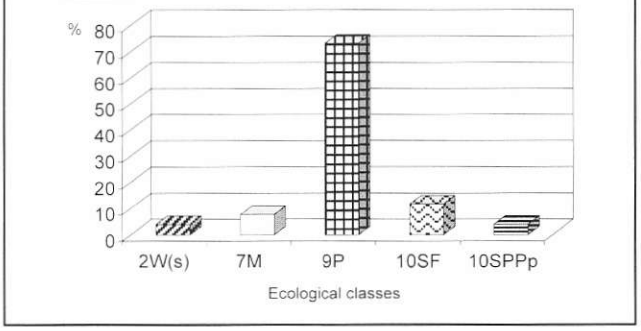

Fig. 4 - Ecological spectrum of the mollusc assemblage from lithofacies D1 at Cascina Melona (clay well). Ecological marks: 2W(s) - species living in open woods and scrubs, sometimes in open places; 7M - mesophilous species living in damp or dry places; 9P – strongly hygrophilous species living in marshes or in similar very damp to wet places; 10SF – aquatic species living in still or moving water; 10SPPp – aquatic species living either in still waters or in marshes and periodic marshes.

Arondelli (Scarassera). At the old quarry of Cascina Arondelli (today named Cascina Damasia), an old exposure yielded some molluscs and numerous micromammal remains.

The molluscs, recovered by M.D.A. Savage of the University of Berkley and collaborators, were referred by Truc (1971a: 119) to a generic Pliocene. No list is given by this author. In the same area a new stratigraphic section near Cascina San Martino, where the lithofacies B of the San Martino unit is well exposed (Basilici 1996), provided a poor mollusc assemblage composed of few lacustrine species, *V. pollonerai*, *P. corneus* and *Pisidium* sp., pointing to a shallow water body, such as a pond or a small lake.

Cascina Melona (Roatto). On the left bank of the Triversa river freshwater and terrestrial molluscs come from silty clays extracted from a 18 m deep well near the farm Cascina Melona North-west of Roatto. The recorded fauna (Fig. 4) composed mainly of marshy taxa (9P; 73,1%), such as *Carychium* and *Oxyloma*, characterises the hydromorphous paleosols (lithofacies D1). The presence of some aquatic elements of shallow water, such as *Valvata* and *Lymnaea*, testifies a very wet ground, that is

Cascina Melona: 5 m over *S. jeanvireti*	Ecological class	No. specim.	% specim.	% ecological classes	
V. pollonerai	10SF	2	1,79	10P	0,89
Pseudamnicola sp.	10SF	38	33,93	10S	2,68
V. cristata	10P	1	0,89	10SF	95,54
V. piscinalis	10SF	67	59,82	10	0,89
Planorbidae indet.	10	1	0,89		
A. lacustris	10S	3	2,68		
		112			

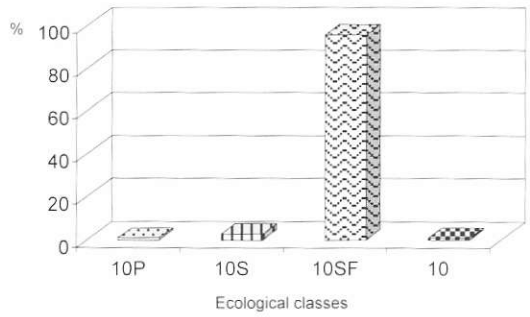

Fig. 5 - Ecological spectrum of the mollusc assemblage from lithofacies B at Cascina Melona (rhinoceros site). Ecological marks: 10P – aquatic species living in marshes and in shallow water rich in vegetation; 10S – aquatic species living in still water; 10SF – aquatic species living in still or moving water; 10 – aquatic species not identified.

a high level of water-table. The palaeocarpological analysis of these sediments is in accordance with the mollusc palaeoecology showing a high percentage of marshy herbaceous plants (Martinetto & Mai 1996).

Moreover freshwater molluscs were recorded from a sedimentary deposit cropping out about 150 m South of C. Melona, where rhinoceros remains referred to *Stephanorhinus jeanvireti* have been collected in the nineties (Campanino et al. 1994). The molluscs come from silty clays overlying the sandy level bearing the rhinoceros bones. The lithofacies B is very well represented by sedimentary evidences and by the dominance of molluscs (95,54%) requiring oxygenated water, such as *Pseudamnicola* sp. and *V. piscinalis* (Fig. 5).

Cascina Viarengo. A very rich non-marine mollusc assemblage comes from the deposit of the San Martino unit cropping out near Cascina Viarengo (North-west of Roatto) described in Boano & Forno (1996a). The mollusc assemblage coming from a clayey layer at about 1 m from the base of the described stratigraphic section is very rich in freshwater gastropods, such as *V. pollonerai, V. cristata, Schuettemmericia lenoiri, Lymnaea bucciniformis, L. peregra, P. planorbis, P. corneus, A. lacustris* and small-sized bivalves, such as *Sphaerium corneum* and *Pisidium* cf. *personatum*, characterising ponds or small lakes. The lithofacies B is recognised.

Madonna di Casale. A polytypic assemblage comes from non-marine deposits of the San Martino unit cropping out in a ploughed field at Madonna di Casale, North of Cascina Viarengo. Marshy species, belonging to *Carychium* sp., *L. truncatula, G. albus, Vertigo antivertigo*, are dominant (60%). Species of more or less humid open woodland, such as *P. elegans, D. rotundatus, R. depressissima, Gastrocopta (Albinula) acuminata, Gastrocopta (Vertigopsis) moravica*, also occur in lower percentage. The composition of this assemblage suggests a provenance from lithofacies D1.

Dusino. Sacco (1889-90) mentions the record of vertebrate remains, such as a nearly complete skeleton of rhinoceros, and land and freshwater molluscs at Dusino. Later on the rhinoceros was referred to *S. jeanvireti* (Campanino et al. 1994 cum refs.). New fossiliferous deposits discovered near Dusino cemetery in the last years yielded lower Villafranchian non-marine molluscs. It deals with marls belonging to lithofacies D1. The recorded mollusc fauna is composed by dominant marshy elements (9P; 47,92%), such as *Carychium* cf. *pseudotetrodon* and *V. antivertigo*, by woodland hygrophilous species, such as *Cochlodina* cf. *prolaminata* and *Helicodonta obvoluta* in lower percentage (6,25%) and by well represented small-sized bivalves, *Pisidium casertanum* (45,83%), living in various aquatic habitats. Very damp conditions of the soil where the molluscs lived are inferred in accordance with the recognised lithofacies.

Molinetta. Sacco (1889-90) describes rich fossiliferous deposits in the Stanavasso little valley at the foot of Case Traversole where a complete skeleton of mastodon was recovered. A significant polytypical mollusc fauna was also recorded by us from a cut of a hill on the left bank of Rio Stanavasso, at Molinetta. Many forest taxa of humid environment, such as *Acicula lineata, Platyla* spp., *Renea* sp.1, *Acanthinula aculeata, P. pygmaeum, D. rotundatus, Vitrinobrachium breve, V. subrimata, R. depressissima, H. carinatissima*, are dominant (57,66%). The sediments are attributed to the lithofacies D1. Some extinct taxa significant by a chronostratigraphic and palaeobiogeographic point of view (Tab. 2), such as *Renea* sp. 1 (a new species of the family Aciculidae under study by Ciangherotti & Esu), *Platyla* cf. *callosa* (?), *P.* cf. *klemmi, Carychium (Carychiella)* cf. *puisseguri* and *Triptychia mastodontophila*, occur.

The Middle Pliocene outcrops outside the "Villafranchian type-area"

Ceresole d'Alba (Cuneo). (Sacco 1886b, 1889-90, 1897). In the valley of the Ricciardo brook from Ponte della Madonna to the village of Ceresole d'Alba and in Scura valley, rich fossiliferous green-grey clayey marls recorded by F. Sacco (Topographical maps Monteu Roero 68-II-I and Sommariva Bosco 68-II-IV) are referred to

the "Villafranchian stage". Many lacustrine and terrestrial species were recognised among which *V. pollonerai* and *T. mastodontophila*, both extinct, are recorded by F. Sacco.

Ceresole d'Alba (Cuneo) (new site). A new fossiliferous deposit, from where polytypical non-marine assemblages have been sampled, was discovered along Rio Ricciardo nearby Ceresole d'Alba by P. Giuntelli. A first analysis of the recovered faunas carried out by Cianghe-rotti (1997a) and on the recorded Clausiliidae by Nordsieck (2000) has pointed out many extinct species with noteworthy palaeobiogeographic and stratigraphic interest (Tab. 2). The new species of the land genus *Renea* (*Renea* sp. 1) is common to the RDB quarry (Cianghe-rotti 1997b). Many extant terrestrial and freshwater taxa belonging to land prosobranchs (Aciculidae), land and aquatic pulmonates (Ellobiidae, Succineidae, Planorbidae, Vertiginidae, Zonitidae, Clausiliidae, Triptychiidae) and bivalves (Sphaeriidae) have been collected till now (studies in progress). The assemblages, coming from two distinct levels separated by an organic layer, show a different composition: dominant hygrophilous marshy and forest elements in the lower level, prevailing stagnant aquatic taxa of ponds or small lakes in the upper one. The ecological character of the first assemblage is in agreement with the damp environment of the hydromorphous paleosols recognised in the San Martino unit of the Villafranchian type-area, thus it is possible to ascribe the study deposit to lithofacies D1; the second assemblage, which shows the dominance of pond and lake species, can be ascribed to lithofacies B. The passage from lithofacies D1 to lithofacies B, which is common in the San Martino unit, as above said, must be noticed.

The composition of the mollusc assemblages from Ceresole permits to correlate them to the faunas recorded from the San Martino unit in the Villafranchian type-area (Tab. 1).

Fossano (Cuneo). Along the left bank of the Stura di Demonte river, in the Fossano district, proboscidean tusks and turtles were recovered by ancient authors from sandy alluvial Pliocene deposits. Rich assemblages of non-marine molluscs are described by Sacco in many papers (1884, 1885, 1886a, b, 1887b, 1889-90, 1897) from the lower-lying clayey marls outcropping nearby Fossano and from the downstream Villafranchian marls of Rio San Giacomo near Cascina Costamagna and Case del Porto (Topographical map Fossano 80-I-III). The following extant species are mentioned by Sacco (1886b; 1887b): *V. cristata, V. lessonae (=V. piscinalis), C. minimum, S. oblonga, Monacha cartusiana, Orcula dolium* and Planorbidae. Many extinct thermophilous forest elements, such as *Gastrocopta (Albinula), Leiostyla, Eostrobilops, Janulus, Triptychia, Schlickumia*, characterise the assemblages (Tab. 1). The recorded freshwater and land gastropods point to a marshy-swampy environment.

No new stratigraphic studies are available about this area, but the occurrence of significant species, such as *V. pollonerai, E. pliocenica, Pagodulina bellardii, G. (A.) acuminata, Janulus angustiumbilicatus, Polloneria pliocenica, T. mastodontophila*, common to Ceresole d'Alba and San Paolo (Solbrito), suggests a Middle Pliocene age for the Fossano deposits too.

Tassarolo (Alessandria). South of Novi Ligure near Tassarolo, at the confluence of Paré and Gavalusso valleys, and in Vaj and Riasco valleys (Topographical map Gavi 70-II-III), Sacco (1887a, 1888, 1889-90, 1897) describes fossiliferous Pliocene bluish marls very rich in molluscs alternating to gravelly deposits. Sacco gives a list of significant extinct taxa (Tab.1) in which only land hygrophilous elements are present with dominant woodland species. The extant species are represented by forest taxa of moist open woods such as *A. lineata, A. aculeata, V. breve*. The lithofacies D1 type could be inferred for the sediments yielding such molluscs. No recent stratigraphic revision of the non-marine deposits has been carried out in the Tassarolo district, nevertheless the occurrence of many extinct taxa common to the other considered Pliocene sites permits to correlate the Tassarolo assemblages to the study Middle Pliocene mollusc faunas from Piedmont.

Palaeobiogeography

Many significant species are common to the investigated Piedmont sites (Tab. 1) pointing to a wide distribution and a coeval presence of the recorded assemblages. In Tabs. 2 and 3 the stratigraphic and geographic range of each extinct species is given.

As a whole the Piedmont fauna is characterised by a quite high number of extinct taxa (about two-thirds of the total) which can reach more than 50% of the mollusc assemblage in a single site (for example at RDB quarry and at Ceresole d'Alba, new site). From a palaeobiogeographic point of view it is possible to distinguish different components in the Middle Pliocene Piedmont fauna:

a) a very low percentage (6%) of species of Miocene Central European origin. Three land prosobranchs, *Platyla* cf. *callosa, G. (A.) acuminata* and *L. gottschicki*, are the most archaic species (Tab. 2). The closely related *P. callosa* is known from the Early Miocene (Burdigalian) of Tuchoriće (Bohemia) (Boeters et al. 1989) referred to the Mammal zone MN 3 (Orleanian) (Esu 1999); *G. (A.) acuminata* is recorded from Middle Miocene deposits at Mörsingen (Baden-Württemberg, Germany), at Undorf (Bayern) (MN 5, Orleanian) and at Steinheim am Aalbuch (Germany) (MN 7/8, Astaracian) (Finger 1998; Esu 1999); the record of this species, under the name of *Pupa larteti*, from Middle Miocene deposits of Sansan, France, seems to be referred to MN 6; at least *L. gotts-*

MIOCENE			PLIOCENE			PLEI ST.	EXTINCT SPECIES	MIOCENE					PLIOCENE										PLEISTOCENE					
								EARLY	MIDDLE			LATE	EARLY	MIDDLE					LATE		LATE?		EARLY					
EARLY	MIDDLE	LATE	EARLY	MIDDLE	LATE	EARLY		Bohemia	France	Germany	Austria	France	France	Tuscany[2]	Piedmont[1]	Umbria[2]	Tuscany[2]	Sardinia	France	Germany	Umbria[2]	Tuscany[2] Latium[2]	France	Tuscany[2]	Umbria[2] Tuscany[2]	Latium[2]	Emilia[3]	Venetia[4]	France	Hungary
							H. (H.) dubrueilliana						*		*	*					*								
			cf.		cf.		*P. callosa*	*							cf.						cf.								
							P. klemmi						*		cf.					*									
							Renea sp. 1								E														
							V. pollonerai								*					*									
							S. lenoiri								*				*										
					?		*E. pliocenica*							*	*										*					
							C. (C.) puisseguri						*		*							*				*				
							C. (S.) pachychilum						*		cf.					*	*								
							C. (S.) pseudotetrodon						*		*	*			*	*	*								
							P. meneghinii								E														
							L. buccinifórmis								*					*					*		*		
							C. laevissima						*		*					*									
							V. (V.) nouleti						*		*														
							V. globosa globosa								E														
					?		*V. globosa tassaroliana*								E														
							N. villafranchianus								*	*	*	*				*			*		?			
							P. bellardii								E														
							F. pollonerai								E														
							F. tassaroliana								E	cf.													
							G. (A.) acuminata		*	*		*	*		*	*				*	*								
							G. (V.) moravica								*					*	*		*	*	*			*	*	*
							L. capellinii								E														
							L. gottschicki			*	*				*						*			*					
							A. proexcessiva								E														
							A. spjeldnaesi								cf.					*									
							E. aloisii								*	*					*								
							E. patuliformis								E														
							J. angustiumbilicatus								E														
							D. lateumbilicatus								E														
							D. pantanellii								E														
							R. (R.) depressissima								E														
					?		*P. lunensis*								cf.								*			?			
							P. pseudoalgira								E														
							N. fischeri						*		*					*									
							S. decemplicata								E														
							P. pliocenica								*					*									
							Monoptychia (subg.n.) sp.1								E														
							C. (C.) portisi								E														
							C.(C.)strauchiana subsp.1								E														
							Neostyriaca sp. 1								E														
							Fusulus (F.) sp.1								E														
							C. (P.) prolaminata								E														
							L. villafranchiana								E	cf.													
							T. mastodontophila								E														
							D. planorbiforme								E														
							D. pliocauriculatum								E														
							H. carinatissima						*		*														
							E. magnilabiata								E														
							S. bottinii								E														

E = endemic species 1 = North-West Italy; 2 = Central Italy; 3 = Northern Italy; 4 = North-East Italy

Tab. 2 - Stratigraphic and geographic range of the Middle Pliocene extinct non-marine molluscs from Piedmont.

chicki comes from the Middle Miocene deposits of Steinheim am Aalbuch and Hollabrun (Austria) (MN 7/8) (Esu 1999 cum refs.);

b) a good number of species (20%) recorded from the Early and Middle Pliocene deposits of Western Europe (Celleneuve, Hauterives and Vallée des Tilles, Cessey-sur-Tilles, Rhône basin, France), such as *H. (H.) dubrueilliana, P. klemmi, S. lenoiri, C. (C.) puisseguri, C. (S.) pachychilum, C. (S.) pseudotetrodon, C. laevissima, V. (V.) nouleti, N. fischeri, H. carinatissima* and the genera *Laminiplica, Monoptychia* and *Schlickumia* (Truc 1971a, b; 1972; Esu 1999; Nordsieck 2000).

Piedmont non endemic species: Italian distribution				*H.(H.) dubrueilliana*	*P. callosa*	*E. pliocenica*	*C. (C.) puisseguri*	*C.(S.) pachychilus*	*C.(S.)pseudotetrodon*	*L. bucciniformis*	*N. villafranchianus*	*G. (A.) acuminata*	*G. (V.) moravica*	*L. gottschicki*	*E. aloisii*	*P. lunensis*	*N. fischeri*	*P. pliocenica*	*L. villafranchiana*
PLEISTOCENE	EARLY	Steggio Basin	Steggio (V)										•						
			Crostolo (E)							•									
		Anghiari Basin	Fighille (T)										•						
			Lucca-Montecarlo-Vinci Basin (T)							•									
			Tiber Middle Valley													?			
		Tavernelle Basin	Pietrafitta (U)							•									
		Tiber Basin	Villa S.Faustino (U)				•												
	P/P		Sabina Valleys (L)								•					?			
PLIOCENE	LATE?	Lower Valdarno	Cerbaie Hills (T)								•		•	•					
	LATE		Ligurian Riviera													•			
			Poggio Mirteto (L)													•			
			Perugia (U)													•			
			Pieve Fosciana (T) Filattiera (T)													•			
			Magra Valley (T)													•			
		Tiber Basin	Toppetti quarry PNF (U)		cf.		•	•	•		•						•	•	
			Dunarobba Fossil Forest (U)	•				•	•		•	•	•	•	•			•	
	MIDDLE	Cedrino Basin	Nuraghe Su Casteddu (S)								•								
		W of Tiber Basin	Camorena (U)						•		•	•							
			Fabro (U)	•					•		•				•				
			Pesa Valley (T)			•	•		•		•								cf.
		Piedmont Basin	Various sites	•	cf.	•	•	cf.	•	•	•	•	•	•	•	•	•	•	•
	EARLY		Pesa Valley (T)			?													

U= Umbria T= Tuscany L= Latium S= Sardinia E= Emilia V= Venetia

Tab. 3 - Distribution of the extinct non-endemic Piedmont species in Italy.

Selected Piedmont genera	EUROPE									OUT OF EUROPE
	Paleocene	Eocene	Oligocene	Miocene			Pliocene			Pleistocene			Recent
				E	M	L	E	M	L	E	M	L	
Schuettemmericia													
Negulus										?			
Gastrocopta (Albinula)		?											
Gastrocopta (Vertigopsis)					?								
Eostrobilops													
Janulus													
Palaeoglandina													
Serrulella													
Nordsieckia													
Polloneria													
Laminiplica													
Neostyriaca													
Triptychia													
Schlickumia													

Tab. 4 - Chronostratigraphic range of selected genera recorded from Middle Pliocene Piedmont sites.

c) a small number of species (8%) known only from the Middle Pliocene of Central Europe (Frechen and Fortuna Rheinische Braunkohle, Germany, Schlickum & Strauch 1979), such as *V. pollonerai* (?), *L. bucciniformis*, *G. (V.) moravica* and *A. spjeldnaesi*;

d) a prevailing stock (66%) of endemic elements distributed in several Piedmont sites (Tab.1) and restricted to the Middle Pliocene.

Moreover the palaeobiogeographic analysis of the recorded taxa points out that during the Middle Pliocene the spreading of some terrestrial species, such as *H. (H.) dubrueilliana*, *P.* cf. *callosa*, *C. (C.) puisseguri*, *C. (S.) pachychilum*, *C. (S.) pseudotetrodon*, *N. villafranchianus*, *G. (A.) acuminata*, *G. (V.) moravica*, *L. gottschicki*, *E. aloisii*, *N. fischeri*, *P. pliocenica*, took place from North-western Italy towards Central Italy where they persisted until the Late Pliocene (Tabs. 2 and 3). Actually they are recorded from several Middle and Late Pliocene deposits of Tuscany, Umbria and Latium (Manganelli et al. 1990; Ambrosetti et al. 1995; Ciangherotti et al. 1996; Petronio et al. 2000-2002 and personal data).

Only a few species, such as *C. (C.) puisseguri*, *L. bucciniformis*, *N. villafranchianus* (?), *G. (V.) moravica* and *P. lunensis* (?), extend into the Early Pleistocene of Italy; *C. (C.) puisseguri* is also recorded from the Early Pleistocene of France and *G. (V.) moravica* from the Early Pleistocene of France, Hungary and Czech Republic (Ložek 1964; Krolopp 1983).

At genus or subgenus level the Piedmont assemblages are characterised by some archaic thermophilous land elements of prevailing Paleogene-Miocene European origin (Tab. 4). Several taxa, such as *Negulus*, *Gastrocopta (Albinula)*, *Leiostyla (Leiostyla)*, *Eostrobilops*, *Janulus*, *Palaeoglandina*, *Triptychia*, are distributed in various Oligocene non-marine deposits of Europe; a few are known since Paleocene, such as *Palaeoglandina*, or since Eocene, such as *Negulus*, *Gastrocopta (Albinula)* (?) and *Triptychia*; someone else, such as *Schuettemmericia*, *Gastrocopta (Vertigopsis)* (?), *Serrulella*, *Nordsieckia*, *Schlickumia*, is known since Miocene (Esu 1999, cum refs.); particularly the genus *Schlickumia* is confined to non-marine basins of South-western Europe (Spain, South-eastern France and North-western Italy) (Truc 1971b).

Most of these taxa, such as *Schuettemmericia*, *Nordsieckia*, *Polloneria*, *Laminiplica*, *Triptychia* and *Schlickumia*, died out in the Middle Pliocene, others survived out of Europe in other continents and at different latitudes, some in warmer regions: *Negulus* is living in Eastern Af-

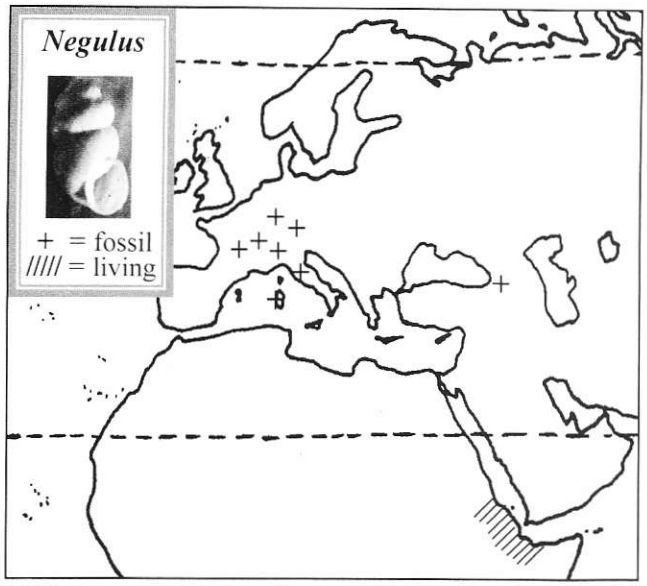

Fig. 6 - Distribution map of the genus *Negulus* Boettger.

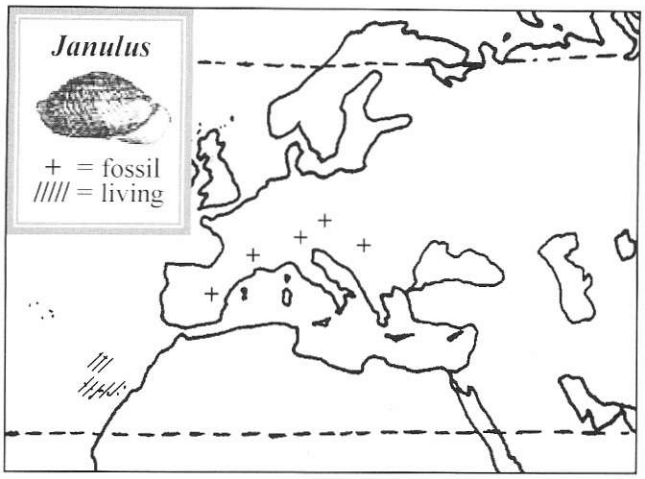

Fig. 8 - Distribution map of the genus *Janulus* Lowe.

rica (Ethiopia and Eritrea) (Fig.6); *Gastrocopta* (*Albinula*) is neartic (some species live in Mexico and Central-eastern United States); *Leiostyla* (*Leiostyla*) lives in Madeira, Canary Is., Azores, Algeria and sporadically in Western Europe as relict, *Eostrobilops* lives in Eastern Asia South of 40°N (Fig. 7), *Janulus* lives in Madeira and in Canary Is. (Fig. 8) (Esu 1999; Cameron & Cook 2001).

The palynological data given by Bonefille et al. (1987) for the Middle Pliocene (3.3-2.9 Ma) Hadar Formation in Ethiopia, where the genus *Negulus* is relict today, indicates that East Africa was wetter than at present; probably *Negulus* had a wider distribution in that time, even if fossil record of this genus are not known there.

Conclusions

The investigated Middle Pliocene sediments yielded large and well diversified mollusc faunas. Many families are often represented in the polytypical assemblages composed of land and freshwater taxa. At the main fossiliferous sites, RDB quarry and Ceresole d'Alba, over 24 families of prosobranchs, heterobranchs and pulmonates occur which points to favourable climatic conditions for the molluscs.

It is noteworthy that a high rate of extinct taxa (about two thirds of the total) occurs in the Piedmont faunas.

Diverse palaeobiological evidences can be noticed from the various depositional environments recognised in the investigated area. The assemblages sampled in deposits characterised by the lithofacies B are generally dominated by aquatic taxa represented by freshwater prosobranch, heterobranch and pulmonate gastropods, such as *Viviparus, Valvata, Gyraulus, Planorbarius, Lymnaea* and small bivalves of the genus *Pisidium*. In this facies land taxa are subordinate and represented only by highly hygrophilous pulmonates, such as *Oxyloma*, *Carychium* and *Succinea*, living in damp places near the bank of water body. The synecological analysis of the recorded species shows the occurrence of hypohaline and almost shallow water environments, like stagnant and very vegetated ponds or small lakes, which is in accordance with the sedimentological analysis.

The assemblages from lithofacies D1 are characterised by high percentage (or at least over 30%) of land taxa among which marshy elements, such as *Carychium*, dominate; this genus, often represented by more than one species, can reach the 80% of the mollusc assemblage. Other land elements, such as *Leiostyla, Succinea* and different species of *Vertigo*, which require damp or very damp conditions, often occur. Moreover in this lithofacies many taxa inhabiting more or less open, deciduous and moderately moist woodland, such as *Acanthinula, Discus, Punctum, Vitrea, Retinella*, prevail and the aquatic elements, which are represented by taxa inhabiting small ponds, such as *Physa* and different species of *Lymnaea*,

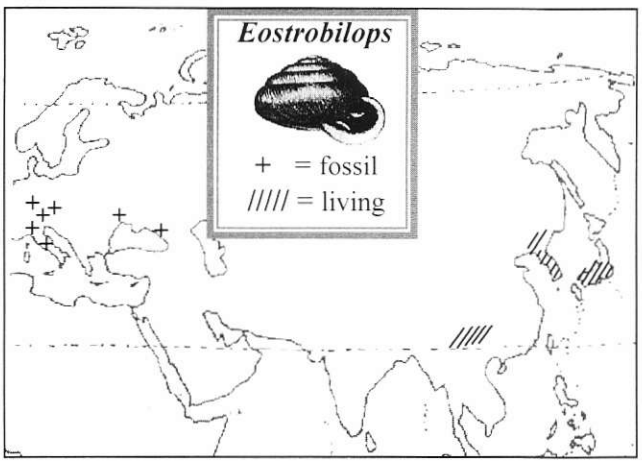

Fig. 7 - Distribution map of the genus *Eostrobilops* Pilsbry.

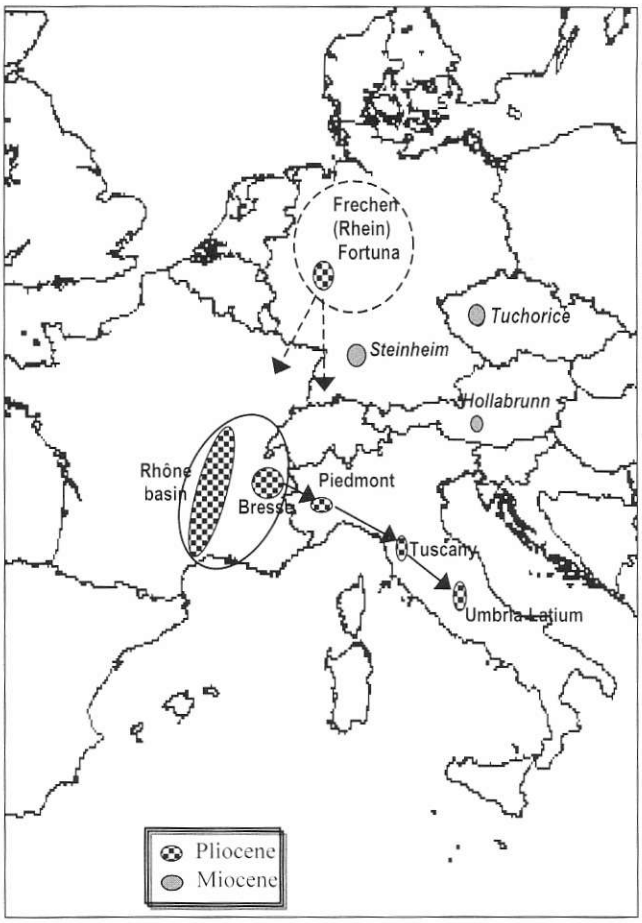

Fig. 9 - Geographical diffusion of Piedmont non-marine molluscs during the Middle Pliocene. Significant Miocene and Pliocene non-marine basins are pointed out.

are subordinate. Some prosobranchs and heterobranchs preferring more oxygenated water, such as *V. cristata*, *Schuettemmericia*, *Pseudamnicola*, occur locally testifying the supply of springs or streams. The recorded assemblages characterise a very damp or marshy environment, like hydromorphous soil to which the deposits of lithofacies D1 are referred.

Generally the palaeoecological analysis of the assemblages shows a dominance of highly hygrophilous land and marshy taxa.

The vegetation cover ought to be mainly arboreal in accordance to macrofloristic and palynological analyses which show the diffusion of the thermophilous *Taxodium* and *Glyptostrobus* arboreal taxa in that area (Bertoldi 1996; Martinetto & Mai 1996).

From a palaeoclimatic point of view the presence of many mollusc taxa whose modern relative live in tropical or subtropical areas and the richness and large diversity of the mollusc assemblages point to warmer conditions than present in agreement with the palynological evidence.

From a palaeobiogeographic point of view the Middle Pliocene non-marine mollusc fauna from Piedmont shows various elements which point to a Miocene (in lower percentage) and Early/Middle Pliocene origin from Central-Western Europe and a prevalent stock of endemic extinct species.

A spreading of some land species took place during the Middle Pliocene from North-western Italy towards Central Italy (Fig. 9) where they persisted till the end of the Pliocene, probably supported by a general diffusion of their favourable habitat along the Italian peninsula at the time span Middle-Late Pliocene: marshes and/or swampy subtropical forests, as it is testified by the occurrence of mollusc assemblages requiring similar environment in the Middle Pliocene deposits of Val di Pesa (Tuscany), Camorena (Umbria) and Fabro (Latium) and in the Upper Pliocene sediments of the Fossil Forest of Dunarobba (Umbria) (Ambrosetti et al. 1995; Petronio et al. 2000-2002). The high frequency of thermophilous and subtropical forest elements in these assemblages is indicative of a warm climate and of diffuse moist forest biotopes in the Piedmont basin and in Central Italy during the Middle Pliocene warm period and a part of the Late Pliocene.

The Pliocene fossiliferous non-marine sequence of the Fossil Forest of Dunarobba (Terni) representing the upper part of the Fosso Bianco Formation and the Ponte Naja Formation at Toppetti quarry (Todi) are believed to be Late Pliocene in age (Tab. 3) on the basis of vertebrate evidence, pollen analysis and magnetostratigraphy (Abbazzi et al. 1997; Pontini & Bertini 2000; Napoleone et al. 2003). The recorded mollusc assemblages from these two sites, especially the ones from Dunarobba (Ambrosetti et al. 1995; Petronio et al 2000-2002), show a certain similarity in the faunal composition with the Middle Pliocene Piedmont one mainly as for the extinct land species, nevertheless the higher percentage of the extant species in comparison with the extinct ones and the lack of several Piedmont land taxa characterising the Triversa fauna favor the attribution of the two considered sites of Central Italy to the Late Pliocene.

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Appendix -Taxonomic remarks

Tabs. 1 and 2 are drawn up taking into account recent systematic revisions of some Italian and foreign species:

Vertigo (Scarabella) fossanense Sacco (1885), *V. (S.) fossanensis* var. *quatuordentata* Sacco (1886), *V. (S.) capellinii* Sacco (1885), *V. (S.) capellinii* var. *ligustica* Sacco (1887), *Pupa larteti* Dupuy (1850), *P. dupuyi* Michaud (1855), *Gastrocopta (Vertigopsis) meijeri* Schlickum (1978), *G. (V.) dehmi* Schlickum & Strauch (1979).

V. (S.) fossanense, recorded from the type-locality of Fossano, is believed to be subspecies of *Gastrocopta (Albinula) acuminata* (Klein 1846) from the Middle Miocene of Mörsingen (Germany) by Wenz (1923-1930: 919, "*G. (A.) acuminata fossanensis*"). On the contrary, according to the revision of the European gastrocoptids by Manganelli & Giusti (2000a) *V. (S.) fossanense* must be considered junior synonym with *G. (A.) acuminata*.

Moreover the following taxa, *V. (S.) fossanensis* var. *quatuordentata* from Fossano, *P. larteti* from the Middle Miocene deposits of Sansan (France), *G. (A.) acuminata acuminata* (leg. G. Truc, SMF 274515/8, Senckenberg Museum Frankfurt) from the Late Miocene deposits of Mollon (France), *G. (A.) acuminata fossanensis* (SMF 248617/1; 274529/47; 274530/1) from the Middle Pliocene deposits of Frechen/Fortuna (Germany) and of Italy and *P. dupuyi* (SMF 274534/4) from the Early Pliocene deposits of Hauterives and Celleneuve (Rhône basin, France), are also believed junior synonyms with *G. (A.) acuminata* by Manganelli & Giusti (2000a). On the basis of these opinions and of our comparison of Italian material from Piedmont and Umbria with specimens of *Gastrocopta (Albinula)* stored in Senckenberg Museum of Frankfurt we agree with the two authors.

V. (S.) capellinii var. *ligustica* from Tassarolo is, in our opinion, synonymous with *V. (S.) capellinii* from Fossano due to their strong similarity and to their co-presence in the same deposits at Tassarolo. The shell character of *V. (S.) capellinii* allows to ascribe it to the genus *Leiostyla* (Manganelli et al. 1990). As the preserved Sacco's material in Museo Regionale di Scienze Naturali of Turin is very poor (Ferrero Mortara et al. 1984), a conspecificity between *L. capellinii* and *L. gottschicki* is difficult to state even if very probable.

G. (V.) dehmi from the Middle Pliocene of Frechen and Fortuna (Rheinischen Braunkohle, Germany) and from Plio-Pleistocene Italian deposits is believed to be junior synonym with *Gastrocopta (Vertigopsis) moravica* (Petrbok 1956) from the Early Pleistocene of Hungary (Tab. 2) by Manganelli & Giusti (2000a). *G. (V.) meijeri* from the Late Miocene of Hungary is also held (with doubt) by these authors conspecific with *G. (V.) moravica*. Indeed the specimens of *G. (V.) meijeri* stored in Senckenberg Museum (SMF 247131/1 holotypus, 274615/55) are very closely related to *G (V.) moravica*. In this case the stratigraphic range of *G.(V.) moravica* should extend from the Late Miocene to the Early Pleistocene.