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Bithynia abbatiae n. sp. (Caenogastropoda) from the Lower Pliocene of the Pesa River Valley (Tuscany, central Italy) and palaeobiogeographical remarks

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KEY WORDS - Freshwater gastropods, Bithyniidae, Systematics, Early Pliocene, Tuscany, central Italy.

ABSTRACT - A new extinct freshwater gastropod species, Bithynia abbatiae *n. sp., representative of the Family Bithyniidae (Caenogastropoda, Truncatelloidea), is described. It was recorded from lacustrine-palustrine layers of the stratigraphical section Sambuca Nord, near the Sambuca village in the Pesa Valley, sub-basin of the adjacent Valdelsa Basin (Tuscany, central Italy). These deposits are rich in non-marine molluscs and ostracods. Stratigraphical correlations and palaeontological data (mammals and microfossils) of the Valdelsa Basin indicate an Early Pliocene age for the analysed deposits, supported also by the eastern affinity of the recorded molluscs and ostracods.*

RIASSUNTO - [*Bithynia abbatiae* n. sp. (Caenogastropoda) del Pliocene Inferiore della Val di Pesa, Toscana, Italia centrale] - *Viene descritta una nuova specie di gasteropode di acqua dolce,* Bithynia abbatiae *n. sp., rappresentante della Famiglia Bithyniidae (Caenogastropoda, Truncatelloidea), rinvenuta negli strati lacustro-palustri di Sambuca Nord, presso il borgo di Sambuca, nel bacino della Val di Pesa, sub-bacino dell'adiacente bacino della Valdelsa (Toscana). Tali depositi si sono rivelati ricchi in associazioni a molluschi e ostracodi continentali. Correlazioni stratigrafiche e dati paleontologici riguardanti mammiferi e microfossili del Bacino della Valdelsa e le affinità orientali dei molluschi e degli ostracodi rinvenuti indicano un'età pliocenica inferiore per tali depositi.*

INTRODUCTION

Located in Tuscany (central Italy) on the western side of the Northern Apennines, the Elsa and the Pesa rivers, oriented SE-NW, are left tributaries of the lower course of the Arno River. The Pesa Valley is filled up with stratigraphic units considered as belonging to a sub-basin of the NW-SE oriented Valdelsa Basin separated from it by the Montespertoli-Tavarnelle high. In turn, the Pesa sub-basin is bordered to E by the Albano-Chianti Mounts (Benvenuti et al., 2014). The Valdelsa Basin includes up to 2000 m of fluvio-deltaic and shallow-marine deposits, which where subdivided into seven unconformity-bounded lithostratigraphic units (synthems), ranging from Late Messinian to Quaternary (Benvenuti et al., 2014). The lowermost unit (synthem S1) (Fig. 1), mainly exposed in the SE portion of the Valdelsa Basin (Strolla Creek valley), is represented by gravelly-sandy and muddy lithofacies with occasional vertebrates and land snails at the base. On the upper part, it consists of mudstones with microfossils, molluscs, fishes and cetaceans proper to open marine, inner shelf environment. Based on mammal remains and microfossil content, synthem S1 is referred to the latest Messinian-Early Zanclean age (Benvenuti et al., 2014, and references therein). In the central-eastern margin of the Pesa sub-basin, around the Sambuca village (Tavarnelle Val di Pesa), Synthem S1 is composed of sands and mudstones including thin lignite seams. Abundant freshwater gastropods (among which the new species described in this paper) and ostracods, characterizing prevalent palustrine-lacustrine conditions with sandy supply from small deltas, were recorded from these deposits (Benvenuti & Degli Innocenti, 2001; Benvenuti et al., 2014). Stratigraphical and palaeontological analyses (molluscs and ostracods) support an Early Pliocene age (Zanclean) for these deposits (Benvenuti & Degli Innocenti, 2001; Medici et al., 2011; Benvenuti et al., 2014; Esu & Girotti, 2016).

MATERIAL AND METHODS

In the Pesa sub-basin, three fossiliferous deposits of the Sambuca area (Sambuca Briglia, Sambuca Nord and Sambuca Lago Piccolo), stratigraphically overlapping (Medici et al., 2011), were sampled for molluscan analysis. The three deposits, consisting of fluvio-lacustrine sand and lignite-bearing mudstone, belong to the synthem S1 referred to the lowermost Pliocene (Zanclean) (Benvenuti et al., 2014).

The new gastropod species was recovered from the Lower Pliocene clayey sands of the stratigraphical section Sambuca Nord (synthem S1), located a few kilometres north of the Sambuca village (43°35'13"N, 11°13'47"E) (Medici et al., 2011; Benvenuti et al., 2014). Sambuca Nord is a composite section about 4 m thick, in which sandy gravels and clayey sands alternate. The molluscan fauna was collected from three clayey layers: SBN1, SBN2, and SBN3, from bottom to top (described in Medici et al., 2011). Here, 124 specimens and 154 opercula of the new species were found. The studied material is stored at the Museo Universitario di Scienze della Terra dell'Università Sapienza di Roma (collection Esu-Girotti, MPUR7).

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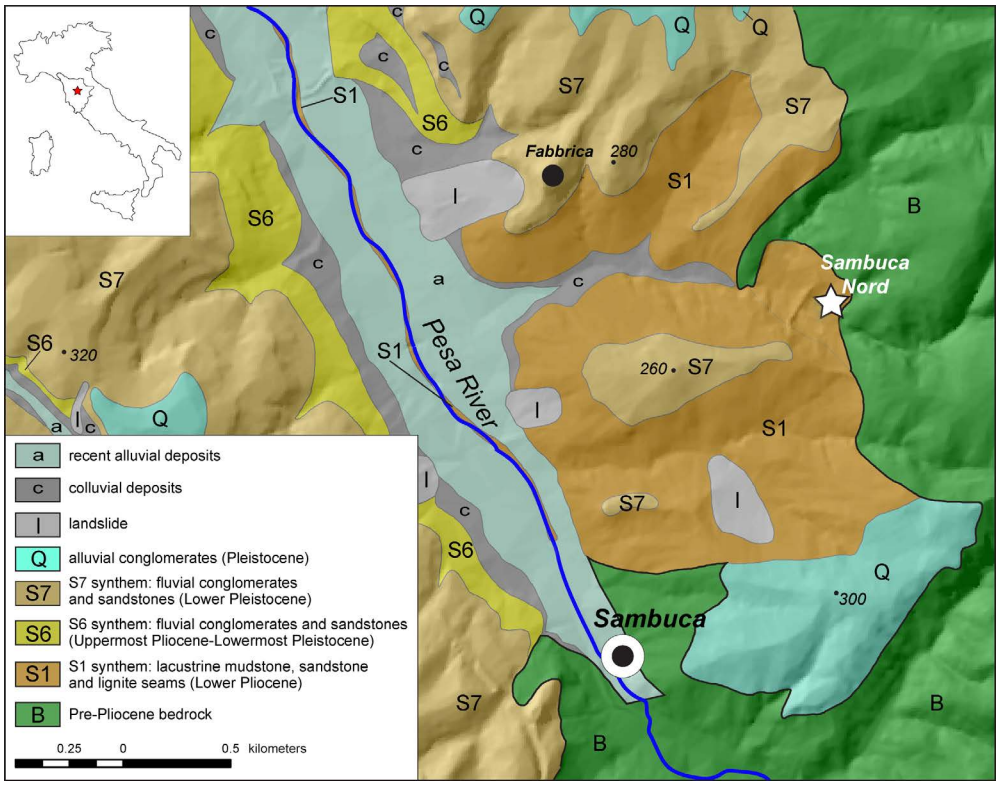


Fig. 1 - (Color online) Schematic geological map with the location of the sampled site, the Sanbuca Nord section, Tuscany (Italy) (by M. Benvenuti).

SYSTEMATIC PALAEONTOLOGY

Class Gastropoda Cuvier, 1795
Subclass Caenogastropoda Cox, 1960
Order Littorinimorpha Golikov & Starobogatov, 1975
Superfamily Truncatelloidea Gray, 1840
Family Bithyniidae Gray, 1857

Genus *Bithynia* Leach, 1818 in Abel, 1818
Type species *Helix tentaculata* Linnaeus, 1758, Recent, Europe.

Bithynia abbatiae Esu & Girotti n. sp.
(Pl. 1, figs 1-7)

Derivatio nominis - From the nearby historic abbey, Badia (in Latin abbatia) of St. Michele Arcangelo, at Passignano (Tavarnelle Val di Pesa, Province of Florence), East of Sambuca village.

Locus typicus and stratum typicum - Sambuca Nord section (43°35'13"N, 11°13'47"E), in the Pesa River Valley (Tuscany, Italy), Lower Pliocene clayey levels of synthem S1 (sensu Benvenuti et al., 2014).

Type material - Holotype (MPUR7-3964), from the SBN3 clayey layer of the Sambuca Nord section (Tuscany, Italy); Paratypes, MPUR7-4117/3 + 1 operculum.

Additional material - SBN1, 38 specimens + 7 opercula (MPUR7-3966); SBN2, 43 specimens + 56 opercula (MPUR7-3965); SBN3, 39 specimens + 90 opercula (MPUR7-4118).

EXPLANATION OF PLATE 1

Bithynia abbatiae n. sp., from the Sanbuca Nord section (Tuscany, Italy).

Fig. 1 - Holotype MPUR7-3964; frontal (a), lateral (b) and posterior (c) view; SBN3.

Fig. 2 - Paratype MPUR7-4117/3; frontal (a), lateral (b) and posterior (c) view; SBN3.

Fig. 3 - Paratype MPUR7-4117/3; frontal (a), lateral (b) and posterior (c) view; SBN3.

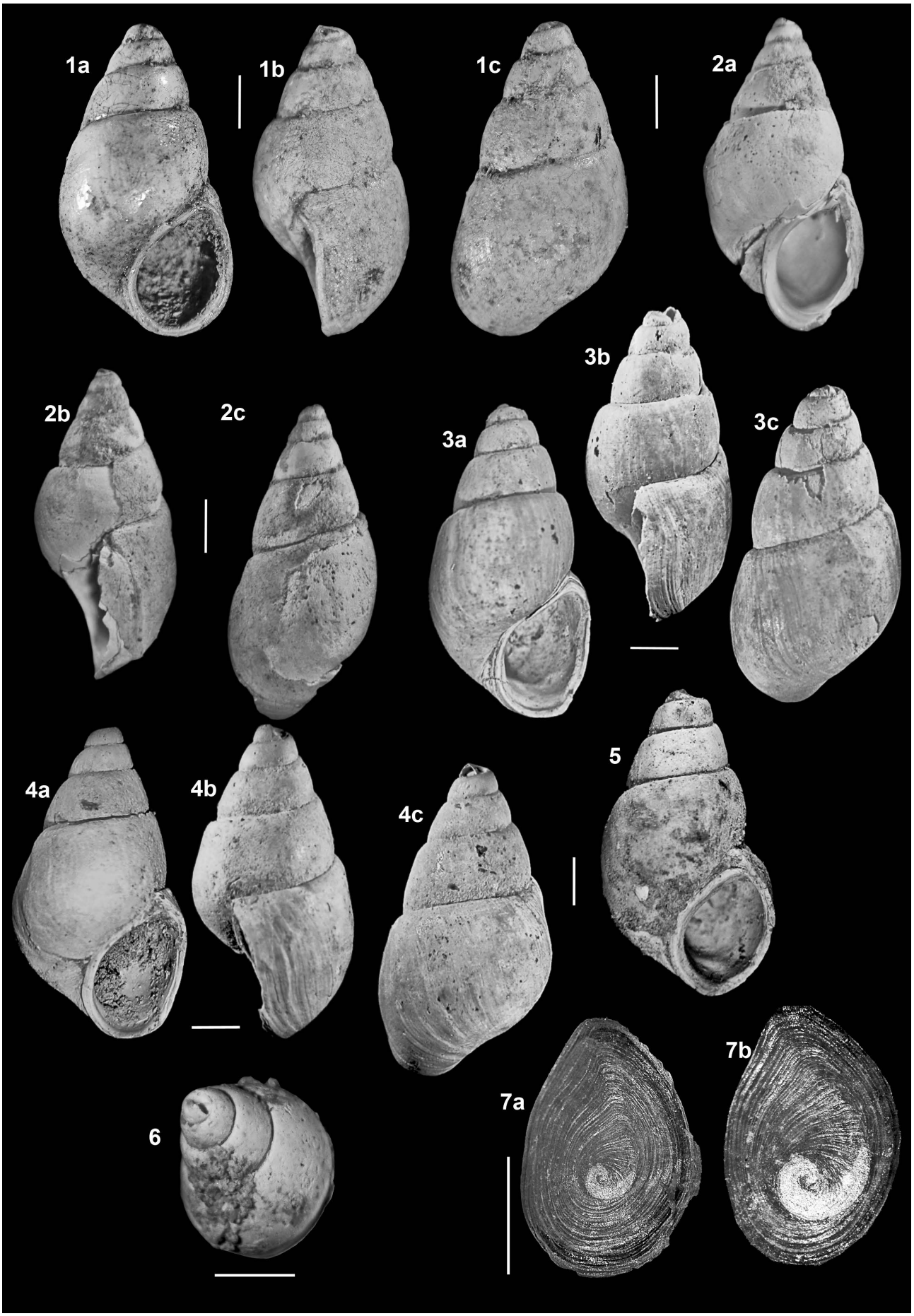
Fig. 4 - MPUR7-4145/3; frontal (a), lateral (b) and posterior (c) view; SBN2.

Fig. 5 - MPUR7-4145/3; frontal view; SBN2.

Fig. 6 - MPUR7-4145/3; first whorls; SBN2.

Fig. 7 - MPUR7-4117/3; operculum (a), detail of nucleus (b); SBN3.

All scale bars correspond to 2 mm.


1a
1b
1c
2a
2b
2c
3a
3b
3c
4a
4b
4c
5
6
7a
7b

Age - The new species is known only from the Early Pliocene of Tuscany.

Diagnosis - Conical and high-spired shell; six nearly flattened whorls; aperture ovate, adapically slightly angulate. Imperforate.

Description - Shell medium-sized, solid, conical-elongate to drop shaped, with six nearly flattened and often slightly stepped whorls, regularly growing; the last high 2/3 of total height. Suture incised, linear. Apex mainly corroded, apical part acute when preserved. Aperture ovate, slightly angulate adapically, peristome slightly thickened in the adapical part and at the columellar side; in lateral view, the outer lip is sinuous. Shell surface with very fine growth lines, becoming progressively thicker and more evident on the last whorl near the aperture. Operculum with small, paucispiral, central nucleus followed by concentric striae. Shell imperforate.

Dimensions - Holotype: H = 12 mm, W = 6.5 mm. Maximum dimensions observed: up to 13 mm high and 7.5 mm wide, in specimens with 4 whorls and truncated apex (Pl. 1, Fig. 4).

Remarks - The morphology of the numerous specimens and opercula recorded from the type locality allows attributing them to the genus *Bithynia* Leach in Abel, 1818. The fossil assemblages from the three SBN layers show a certain degree of variability, varying from conical to drop shaped shell, and stepped whorls in most specimens. Size is quite constant, most apices are corroded and regenerated. Among the 124 specimens recorded from the three layers, only a few bear the apical part nearly complete (Pl. 1, Fig. 6). The extinct species of *Bithynia* recorded for Italy are poorly known and locally spread (De Stefani, 1876-1880; Wenz, 1928; Esu & Girotti, 2016). Among these, *Bithynia jurinaci* Brusina, 1884, originally described from the middle Miocene of Miočić, SE Croatia, was also recorded in the Early Pliocene of the Valdelsa Basin (Pesa Valley, Sambuca area) (Esu & Girotti, 2016). Comparisons with *B. jurinaci* of Brusina's collection stored at the Croatian Natural History Museum of Zagreb (Inv. N. 3853-1493, from Miočić) (see Neubauer et al., 2015 about the invalidity of the neotype), and at Senckenberg Museum of Frankfurt (SMF 242009/72, from Miočić, ex Brusina, coll. O. Boettger), showed clear differences from *B. abbatiae* n. sp. The Croatian specimens have a smaller size (H = 7 - 10 mm; W = 4.5 - 6 mm), more globose shell, convex whorls, the last large and inflated, and protoconch particularly prominent. Similarly the specimens of *B. jurinaci* from Sambuca area are clearly different from *B. abbatiae* n. sp. in size and shell shape. *Bithynia bronni* D'Ancona in Cocchi, 1867, from the lower Early Pleistocene of the upper Valdarno Basin (Tuscany, central Italy), differs from *B. abbatiae* n. sp. in having a more ovate shell with fast growing whorls, the last large, inflated, surface malleated and aperture round-ovate (De Stefani, 1880: p. 103, pl. 3, fig. 6). Original material of this species along with several specimens from Montecarlo Valdarno is available at the Museo di Storia Naturale di Firenze, Geologia e Paleontologia (MSNUFI-IGF 2720E, old collection, with red label "*Bythinia bronni*"). Opercula of *B. bronni* recorded by the authors from the type locality show a well-developed nucleus with evident paucispiral striae, which together with the characters of the shells suggest classification of *B. bronni* in the genus *Neumayria* De Stefani, 1877. Indeed *Neumayria* distinguishes from *Bithynia* in its stronger shell, thickened and redoubled peristome, and in having the operculum with subcentral and subspiral nucleus (Herbich & Neumayr, 1875; De Stefani, 1877). Numerous fossil species of *Bithynia* have been described for the Neogene of central-eastern Europe (Rolle, 1860; Neumayr in Neumayr & Paul, 1875; Fuchs, 1877; Brusina, 1902; Jekelius, 1932; Wenz, 1942). Among these, besides the mentioned *B. jurinaci*, species similar in shape to *B. abbatiae* n. sp. are *Bithynia ungeri* (Rolle, 1860) from the Plio-Pleistocene of Šoštanj (Lower Styria, Slovenia) and *Bithynia pilari* Neumayr in Neumayr & Paul, 1875 from the Pliocene of Romania. *B. ungeri* differs from the new species in its smaller size and wider conical shape, the whorls being more convex, the apical ones more turreted, the last more inflated and the aperture more roundish. *B. pilari*, which was also illustrated by Wenz (1942, pl. 17, figs 260-267), differs from the new species in its larger size, the lower spire and the last whorl being slightly depressed laterally. Among the extant species of *Bithynia*, two live in Italy, *B. leachii* (Sheppard, 1823) and *B. tentaculata* (Linnaeus, 1758). Both have been documented from Neogene and Quaternary deposits of Europe (including Italy) (Ložek, 1964; Esu & Girotti, 1975; Glöer, 2002). *B. tentaculata* differs from *B. abbatiae* n. sp. in having a more globose shell, lower spire, wider apical angle, more convex whorls, and smaller size; *B. leachii* differs in its smaller size, strongly convex whorls and rounded aperture. The other known Recent European species of *Bithynia*, the Greek *B. graeca* Westerlund in Westerlund & Blanc, 1879 and the central-eastern European *B. transsilvanica* (Bielz, 1853) (cf. Welter-Schultes, 2012) clearly differ from *B. abbatiae* n. sp. as well. *B. graeca* distinguishes from it in its more turreted and densely striated shell, more convex whorls and open umbilicus, *B. transsilvanica* in its strongly convex whorls, the last more inflated and deeper suture.

DISCUSSION

The recorded molluscan assemblages from the Pesa sub-basin are composed of prevailing aquatic extinct gastropods of oligohaline environment. They have been partially object of a previous study by Esu & Girotti (2016). At least fourteen extinct freshwater gastropods belonging to Caenogastropoda, Heterobranchia and Pulmonata were recorded: *Melanopsis* cf. *nodosa* Férussac, 1822, *Bithynia abbatiae* n. sp., *B. jurinaci, Choerina* sp., *Emmericia cauponia* Esu & Girotti in Esu et al., 2001, "*Marticia" pauli* (Fuchs, 1877), *Prososthenia pantanellii* Brusina, 1884, *Prososthenia pesae* Esu & Girotti, 2016, *Prososthenia sambuci* Esu & Girotti, 2016, *Pyrgula capellinii* Wenz, 1919, *Pyrgula subdola* Esu & Girotti, 2016, *Pyrgula vinearum* Esu & Girotti, 2016, *Corymbina elegans* (Cantraine, 1841), and *Valvata* sp. At Sambuca Nord, extinct species of Hydrobiidae, such as *P. capellinii* and *P. subdola*, and Lymnaeidae, such as *C. elegans*, accompany *B. abbatiae* n. sp. in the clayey layers.

Among these, *P. capellinii* and *P. subdola* are endemic to Tuscany, whereas *C. elegans* is an element typical of the Pliocene and late Early Pleistocene of Greece and Turkey (Esu & Girotti, 2015). Other eastern taxa also occur in the Early Pliocene of the Sambuca area, such as *B. jurinaci* known from the Miocene of Croatia (Neubauer et al., 2013), and "*M.*" *pauli* (= *Goniochilus pauli*, following Willmann, 1981) from the Pliocene and Early Pleistocene of Greece (Fuchs, 1877; Willmann, 1981). The affinity of molluscs and ostracods from the Sambuca area with coeval faunas from eastern Europe (Medici et al., 2011; Esu & Girotti, 2016), together with stratigraphical data (Benvenuti et al. 2014), support an Early Pliocene age for the Sambuca Nord deposits. *Prososthenia* Neumayr, 1869, *Pyrgula* De Cristofori & Jan, 1832 and *Corymbina* Bukowski, 1892 are the most represented genera in these molluscan assemblages, whose species, together with species of other genera, are unevenly spread in the studied sites. This is probably due to the particular sedimentary dynamics influenced by tectonics and eustatic sea-level fluctuations of the Pesa Valley Basin (Benvenuti et al., 2014). Palustrine-lacustrine environment receiving sandy inflows from small deltas may explain the different faunal composition, rather than chronological implications.

The Valdelsa Basin, together with the Pesa Valley Basin, belongs to a wider palaeogeographic domain, which is spread over a wide area west of the central-northern Apennine and geologically known as "Tuscan Neoauthochtonous Cycle" (TNC), Tortonian up to Early Pleistocene in age (Bossio et al., 1993; Martini & Sagri, 1993). This consists of a succession of non-marine basins being progressively younger from the Tyrrhenian margin to the western foot of the Apennine arch, which acted as physical threshold isolating through time these basins and preventing important contaminations by external taxa. Nevertheless, the occurrence of some eastern genera, such as *Emmericia* Brusina, 1870, *Odontohydrobia* Pavlović, 1927, *Socenia* Jekelius, 1944, *Prososthenia*, *Pyrgula*, and *Orygoceras* Brusina, 1882, typical of the Miocene of eastern Europe (e.g., Pannonian and Dinaride basins) (Harzhauser et al., 2002 and references therein; Neubauer et al., 2015), are recorded from the Late Miocene basins of TNC. Active dispersion can be envisaged for these genera by possible connections between the Paratethyan domain and the Proto-Mediterranean during the Late Miocene. Most of them are represented in the TNC basins by endemic species (Esu & Girotti, 2015a), whose ancestors are not identified. Similarly, during the Early Pliocene, the TNC basins hosted eastern genera (*Choerina*, *Marticia* Brusina, 1897, *Corymbina*) showing strong affinity with southeastern European fauna (Esu & Girotti, 2015b), besides the genera already occurring in the Miocene. A strong endemic character of the species from the Sambuca area is recognized, which is explained by the geographical isolation of these non-marine basins during the lowermost Pliocene. The dispersal way of eastern taxa (genera and species) recorded from the lower Pliocene deposits is unknown so far: it is possible to argue a passive dispersal (?birds, cf. van Leeuwen, 2012) for some species, or unidentified non-marine hydrological connections. Indeed, these taxa are not documented in the upper Messinian "Lago-mare" assemblages widely spread in the Mediterranean area (Esu, 2007).

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REFERENCES

Abel C. (1818). Narrative of a journey in the interior of China, and of a voyage to and from that country, in the years 1816 and 1817. 16+420 pp. Longman, Hurst, Rees, Orme & Brown, London.

Benvenuti M. & Degli Innocenti D. (2001). The Pliocene deposits in the Central-Eastern Valdelsa Basin (Florence, Italy), revised through facies analysis and unconformity-bounded stratigraphic units. *Rivista Italiana di Paleontologia e Stratigrafia*, 107: 265-286.

Benvenuti M., Del Conte S., Scarselli N. & Dominici S. (2014). Hinterland basin development and infilling through tectonic and eustatic processes: latest Messinian-Gelasian Valdelsa Basin, Northern Apennines, Italy. *Basin Research*, 26: 387-402.

Bielz E.A. (1853). Beitrag zur Kenntniss der siebenbürgischen Land- und Süsswassermollusken. *Verhandlungen und Mittheilungen des Siebenbürgischen Vereins für Naturwissenschaften in Hermannstadt*, 4: 113-124, 162-165.

Bossio A., Costantini A., Lazzarotto A., Liotta D., Mazzanti R., Mazzei R., Salvatorini G. & Sandrelli F. (1993). Rassegna delle conoscenze sulla stratigrafia del Neoautoctono toscano. *Memorie della Società Geologica Italiana*, 49: 17-89.

Brusina S. (1870). Monographie der Gattungen *Emmericia* und *Fossarulus*. *Verhandlungen der Kaiserlich-königlichen Zoologisch-botanischen Gesellschaft in Wien*, 20: 925-938.

Brusina S. (1882). *Orygoceras*. Eine neue Gasteropodengattung der Melanopsiden-Mergel Dalmatiens. *Beiträge zur Paläontologie Österreich-Ungarns und des Orients*, 2: 33-46.

Brusina S. (1884). Die Neritodonta Dalmatiens und Slavoniens nebst allerlei Malakologischen Bemerkungen. *Jahrbücher der Deutschen Malakozoologischen Gesellschaft*, 11: 17-120.

Brusina S. (1897). Matériaux pour la faune malacologique néogène de la Dalmatie, de la Croatie et de la Slavonie avec des espèces de la Bosnie, de l'Herzégovine et de la Serbie. *Djela Jugoslavenske Akademije Znanosti i Umjetnosti*, 18: I-XXI, 1-43.

Brusina S. (1902). Iconographia Molluscorum Fossilium in tellure tertiaria Hungariae, Croatiae, Slavoniae, Dalmatiae, Bosniae, Herzegovinae, Serbiae and Bulgariae inventorum. 30 plates, I-X pp. Officina Soc. Typographicae, Agram.

Bukowski G. v. (1892). Notiz über die Molluskenfauna der levantinischen Bildungen der Insel Rhodus. *Anzeiger der Österreichischen Akademie der Wissenschaften, mathematisch-naturwissenschaftliche Klasse*, 29: 247-250.

Cantraine F. (1841). Malacologie méditerranéenne et littorale. Nouveaux *Mémoires de l'Académie Royale des Sciences et Belles-Lettres de Bruxelles*, 13: 1-173.

Cocchi I. (1867). L'uomo fossile nell'Italia centrale. *Memorie della Società Italiana di Scienze Naturali*, 2: 3-80.

Cox L.R. (1960). Supplement Paleozoic and some Mesozoic Caenogastropoda and Opisthobranchia. *In* Moore R.C. (ed.), Treatise on Invertebrate Paleontology. Part I, Mollusca 1. The Geological Society of America and University of Kansas Press, Lawrence: *I*310-*I*324.

Cuvier G. (1795). Second Mémoire sur l'organisation et les rapports des animaux à sang blanc, dans lequel on traite de la structure des Mollusques et de leur division en ordre. *Magasin*

Encyclopédique ou Journal des Sciences, des Lettres et des Arts, 2: 433-449.
De Cristofori J. & Jan G. (1832). Catalogus in IV sectiones divisus rerum naturalium in museo exstantium. Sectio II, pars 1 (Mantissa): 1-4.
De Stefani C. (1876-1880). Molluschi continentali, fino ad ora notati in Italia nei terreni pliocenici, ed ordinamento di questi ultimi. *Atti della Società Toscana di Scienze Naturali in Pisa, Memorie*, 2 (1876): 130-174; 3 (1877): 274-325; 5 (1880): 9-108.
Esu D. (2007). Latest Messinian "Lago-Mare" Lymnocardiinae from Italy: Close relations with the Pontian fauna from the Dacic basin. *Geobios*, 40: 291-302.
Esu D. & Girotti O. (1975). La malacofauna continentale del Plio-Pleistocene dell'Italia centrale. I. Paleontologia. *Geologica Romana*, 13 (1974): 203-294.
Esu D. & Girotti O. (2015a). A contribution to the knowledge of Late Miocene freshwater hydrobiids from Tuscany (Central Italy) (Gastropoda Prosobranchia: Rissooidea). *Archiv für Molluskenkunde*, 144: 139-147.
Esu D. & Girotti O. (2015b). The late Early Pleistocene non-marine molluscan fauna from the Synania Formation (Achaia, Greece), with description of nine new species (Mollusca: Gastropoda). *Archiv für Molluskenkunde*, 144: 65-81.
Esu D. & Girotti O. (2016). New Plio-Pleistocene freshwater gastropods from Tuscany and Umbria, with comments about confined Neogene-Quaternary basins of Central Italy (Gastropoda: Viviparidae, Hydrobiidae). *Archiv für Molluskenkunde*, 145: 7-22.
Esu D., Girotti O. & Truc G. (2001). New data on fossil Emmericiinae from Italy and France (Gastropoda: Prosobranchia: Emmericiidae). *Archiv für Molluskenkunde*, 129: 123-143.
Férussac A.E.J.P.J.F. d'Audebard de [continued by Deshayes G.P.P.] (1819-1851). Histoire naturelle générale et particulière des mollusques terrestres et fluviatiles tant des espèces que l'on trouve aujourd'hui vivantes, que des dépouilles fossiles de celles qui n'existent plus; classés d'après les caractères essentiels que présentent ces animaux et leurs coquilles, 2 vols. Baillière, Paris.
Fuchs T. (1877). Studien über die jüngeren Tertiärbildungen Griechenlandes. *Denkschriften der Kaiserlichen Akademie der Wissenschaften mathematisch-naturwissenschaftliche Classe*, 37: 1-42.
Glöer P. (2002). Die Süßwassergastropoden Nord- und Mitteleuropas. *Die Tierwelt Deutschlands*, 73. 327 pp. ConchBooks, Hackenheim.
Golikov A.N. & Starobogatov Y.I. (1975). Systematics of prosobranch gastropods. *Malacologia*, 15: 185-232.
Gray J.E. (1840). Shells of molluscous animals. *In* Synopsis of the contents of the British Museum. G. Woodfall, London: 105-152.
Gray J.E. (1857). Guide to the systematic distribution of Mollusca in the British Museum, 1. 1-12 + 230 pp. Taylor & Francis, London.
Harzhauser M., Kowalke T. & Mandic O. (2002). Late Miocene (Pannonian) Gastropods of Lake Pannon with special emphasis on early Ontogenetic development. *Annalen des Naturhistorischen Museums Wien*, 103A: 75-141.
Herbich F. & Neumayr M. (1875). Beiträge zur Kenntniss fossiler Binnenfaunen. VII. Die Süsswasserablagerungen im südöstlichen Siebenbürgen. *Jahrbuch der Kaiserlich-königlichen Geologischen Reichsanstalt*, 25: 401-431.
Jekelius E. (1932). Fauna Neogenă a României. Die Molluskenfauna der dazischen Stufe des Beckens von Braşov. *Memoriile Institutului geologic al României*, 2: 1-118.
Jekelius E. (1944). Sarmat und Pont von Soceni. *Memoriile Institutului geologic al României*, 5: 1-167.
Linnaeus C. (1758). Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis locis. 1. 824 pp. Laurentius Salvius, Holmiae.
Ložek V. (1964). Quartärmollusken der Tschechoslowakei. *Rozpravy Ustredniho Ustavu Geologického,* 31: 1-368.
Martini I.P. & Sagri M. (1993). Tectono-sedimentary characteristics of Late Miocene-Quaternary extensional basins of the Northern Apennines, Italy. *Earth-Science Reviews*, 34: 197-233.
Medici M.C., Ceci E. & Gliozzi E. (2011). Early Pliocene brackish and freshwater ostracoda from the Valdelsa Basin (Tuscany, central Italy). *Rivista Italiana di Paleontologia e Stratigrafia*, 117: 473-500.
Neubauer T.A., Mandic O. & Harzhauser M. (2013). The Middle Miocene freshwater mollusk fauna of Lake Gacko (SE Bosnia and Herzegovina): taxonomic revision and paleoenvironmental analysis. *Fossil Record*, 16: 77-96.
Neubauer T.A., Mandic O. & Harzhauser M. (2015). The freshwater mollusk fauna of the Middle Miocene Lake Drniš (Dinaride Lake System, Croatia): a taxonomic and systematic revision. *Austrian Journal of Earth Sciences*, 108/2: 15-67.
Neumayr M. (1869). Beiträge zur Kenntniss fossiler Binnenfaunen. *Jahrbuch der Kaiserlich-königlichen Geologischen Reichsanstalt*, 19: 355-382.
Neumayr M. & Paul C.M. (1875). Die Congerien- und Paludinenschichten Slavoniens und deren Faunen. *Abhandlungen der Kaiserlich-königlichen Geologischen Reichsanstalt*, 7: 1-111.
Pavlović P.S. (1927). Donjopontiski mekušci iz okoline Beograda (s naročitim obzirom na fosilnu faunu okoline sela Vrčina). *Sprska Akademija nauka, posebna izdanja*, 66: 1-121.
Rolle F. (1860). Die Lignit-Ablagerung des Beckens von Schönstein in Unter-Steiermark und ihre Fossilien. *Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften, mathematisch-naturwissenschaftliche Classe,* 41: 7-46.
Sheppard R. (1823). Descriptions of seven new British land and fresh-water shells, with observations upon many other species, including a list of such as have been found in the county of Suffolk. *Transactions of the Linnean Society of London*, 14: 148-170.
van Leeuwen C.H.A., van der Velde G., van Lith B. & Klaassen M. (2012). Experimental quantification of long distance dispersal potential of aquatic snails in the gut of migratory birds. *PLoS One*, 7: e32292.
Welter-Schultes F.W. (2012). European non-marine molluscs, a guide for species identification. 679 pp. Planet Poster Editions, Göttingen.
Wenz W. (1919). Zur Nomenklatur tertiärer Land- und Süßwassergastropoden. I. *Nachrichtsblatt der Deutschen Malakozoologischen Gesellschaft*, 51: 68-76.
Wenz W. (1923-1930). Fossilium Catalogus. I: Animalia. Gastropoda Extramarina Tertiaria. 1-3387 pp. Junk, Berlin.
Wenz W. (1942). Die Mollusken des Pliozäns der rumänischen Erdöl-Gebiete. *Senckenbergiana*, 24: 1-293.
Westerlund C.A. & Blanc H. (1879). Aperçu sur la faune malacologique de la Grèce inclus l'Epire et la Thessalie. Coquilles extramarines. 161 pp. Tornese, Naples.
Willmann R. (1981). Evolution, Systematik und stratigraphische Bedeutung der neogenen Süßwassergastropoden von Rhodos und Kos/Ägäis. *Palaeontographica*, Abt. A, 174: 10-235.

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