



Staurodon cianfanellianus n. sp. (Gastropoda Pulmonata), a new nesopupine vertiginid snail from the Middle-Late Pliocene Fossil Forest of Dunarobba (central Italy)

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KEY WORDS - *Staurodon*, *Taxonomy*, *Palaeontology*, *Neogene*, *Italy*.

ABSTRACT - Many shells of an enigmatic vertiginid snail were collected from the Middle-Late Pliocene Fossil Forest of Dunarobba (central Italy). The structure of their apertural barrier (an angular lamella joined to the upper vertex of the peristome) matches that of species traditionally assigned to the nesopupines and among them recalls the monospecific Madeiran genus *Staurodon*. They are therefore assigned to a new species of this genus, *S. cianfanellianus*, although there is awareness that its classification is somewhat tentative due to taxonomic and systematic uncertainty and frequent character homoplasy in this group of land snails. If correct, this is the first finding of a nesopupine vertiginid in the European Pliocene, since members of this subfamily, currently distributed in tropical regions, are only known in the western Palaearctic from the Late Oligocene to the early Late Miocene.

RIASSUNTO - [*Staurodon cianfanellianus* n. sp. (Gastropoda Pulmonata Vertiginidae), un nuovo vertiginide nesopupino dalla Foresta Fossile di Dunarobba (Pliocene medio-superiore, Italia centrale)] - Conchiglie di una specie inedita riferibile alla famiglia Vertiginidae, raccolte nelle argille plioceniche della Foresta Fossile di Dunarobba (Avigliano Umbro, Terni), presentano caratteri della barriera aperturale (lamella angolare unita al vertice superiore del peristoma) che sembrano indicarne l'affinità con gruppi di specie tradizionalmente assegnate alla sottofamiglia Nesopupinae, in particolare con il genere monospecifico *Staurodon*, vivente a Madeira. È, quindi, a questo genere che la nuova specie - *S. cianfanellianus* - è stata assegnata, pur nella consapevolezza che tale inquadramento rimane dubitativo a causa delle molte incertezze sulla tassonomia e sulla sistematica dei vertiginidi. La sottofamiglia Nesopupinae è attualmente diffusa nelle regioni tropicali di tutto il mondo. Entità fossili, datate dall'Oligocene superiore al Miocene superiore, sono note anche per località del Paleartico occidentale. Se l'inquadramento sistematico della nuova specie è corretto, la presente segnalazione è la prima per questa sottofamiglia nel Pliocene europeo.

INTRODUCTION

The finding of the Pliocene Fossil Forest of Dunarobba was one of the most exceptional palaeontological events in Italy in the 20th century. The forest consists of about fifty large trunks (2-8 m in circumference and up to 10 m in height), almost in life upright position, attributed to *Taxodioxylon gypsaceum*, as classified on the basis of the wood structure (Biondi & Brugiapaglia, 1991) and to *Glyptostrobus europaeus* on the basis of cones and seeds found in the sediment (Martinetto, 1994). Both are Tertiary taxodiaceous species of swamp environments and humid warm-temperate climates (Ambrosetti et al., 1995).

A rich fossil snail assemblage consisting of about twenty species, some of great palaeontological and biogeographical interest, was collected in the clay encrusting the trunks (Manganelli et al., 1989, 1990; Esu & Girotti, 1991; Esu et al., 1993; Ambrosetti et al., 1995; Manganelli & Giusti, 2000). Only five species have been investigated in detail: *Eostrobilops aloisii* Manganelli, Delle Cave & Giusti, 1989, *Leiostylia* cf. *gottschicki* (Wenz, 1922), *Lauria* cf. *cylindracea* (Da Costa, 1778), *Gastrocopta* (*Albinula*) *acuminata* (Klein, 1846) and *G. (Vertigopsis) moravica* (Petrbok, 1959) (Manganelli et al., 1989, 1990; Manganelli & Giusti, 2000). This

contribution concerns a new species of the nesopupine vertiginid *Staurodon* Lowe, 1852, a genus never previously found outside Madeira. This species was preliminarily reported as *Truncatellina* n. sp. by Gliozzi et al. (1997).

DESCRIPTION OF THE SPECIES

Staurodon cianfanellianus n. sp.
Pl. 1, figs. 1-11

Diagnosis - A species of nesopupine vertiginid *Staurodon* (?) differing from Recent Madeiran *S. seminulum* by virtue of its more elongate shape, its lower, more robust lamellae and plicae, its longer angular lamella (only a tooth-like lamella joined to upper vertex of peristome in *S. seminulum*) and its more reflexed peristome.

Description - Shell (Pl. 1, figs. 1-10) dextral, very small in size, cylindrical to ovate-cylindrical in shape with about four to five moderately convex whorls separated by deep sutures; last whorl about half shell height; umbilicus small, slit-like; aperture square, about one third of shell height, with thick parietal callus and five lamellae

and plicae: very short angular lamella, starting near outer end of parietal lamella and ending tooth-like joined to upper vertex of peristome; short, straight, high parietal lamella; tooth-like columellar lamella; two very short palatal plicae; peristome thick, well reflexed; protoconch finely malleated; teleoconch with strong but rather irregular prosocline ribs, intersected by very irregular spiral grooves more evident in upper portion of whorls.

Dimensions (n: 20) - Shell height: 1.95 ± 0.07 mm; shell width: 1.01 ± 0.04 mm; aperture height: 0.70 ± 0.04 mm; aperture width: 0.65 ± 0.02 mm.

Type locality and horizon - "Fossil Forest of Dunarobba", in massive Middle-Upper Pliocene clay encrusting the Trunk 15V. Fornace Briziarelli, Dunarobba, (Avigliano Umbro, Terni; Sheet 130 of the Geological Map of Italy).

Type material - Holotype (Pl. 1, fig. 2), G. Manganelli & L. Delle Cave leg. 22.2.1988 (Giusti & Manganelli collection, Dipartimento di Scienze Ambientali, University of Siena, no. 36931); 115 paratypes (55 whole shells and 60 fragmented shells), G. Manganelli & L. Delle Cave leg. 22.2.1988 (Giusti & Manganelli collection, Dipartimento di Scienze Ambientali, University of Siena, no. 36932); 51 paratypes (whole shells), F. Giusti, G. Manganelli & L. Delle Cave leg. 5.5.1990 (Giusti & Manganelli collection, Dipartimento di Scienze Ambientali, University of Siena, no. 36933); 19 paratypes (whole shells, Esu & Girotti collection, Palaeontological Museum of University "La Sapienza" of Rome, MPUR7 nos. 1283/1-1284/1-1285/1-1286/1-1288/15).

Derivation of name - The new species is named after Simone Cianfanelli of the Museo di Storia Naturale, Florence University (Italy), as a token of friendship and esteem for his many and important contributions to the study of non-marine molluscs.

Remarks - Among pupilloidean vertiginid snails, the new species shows evident similarity in shell shape to the species of *Truncatellina* Lowe, 1852 (type species: *Pupa linearis* Lowe, 1852). However, no species of the Palaearctic and Afrotropical *Truncatellina* have similar apertural barrier structure, especially the angular lamella joined to the upper vertex of the peristome and the two palatal plicae. Indeed *Truncatellina* species have up to three denticles (one parietal, one columellar and one deep-set palatal) (Pilsbry, 1920a, b; Zilch, 1959; Pokryszko, 1990).

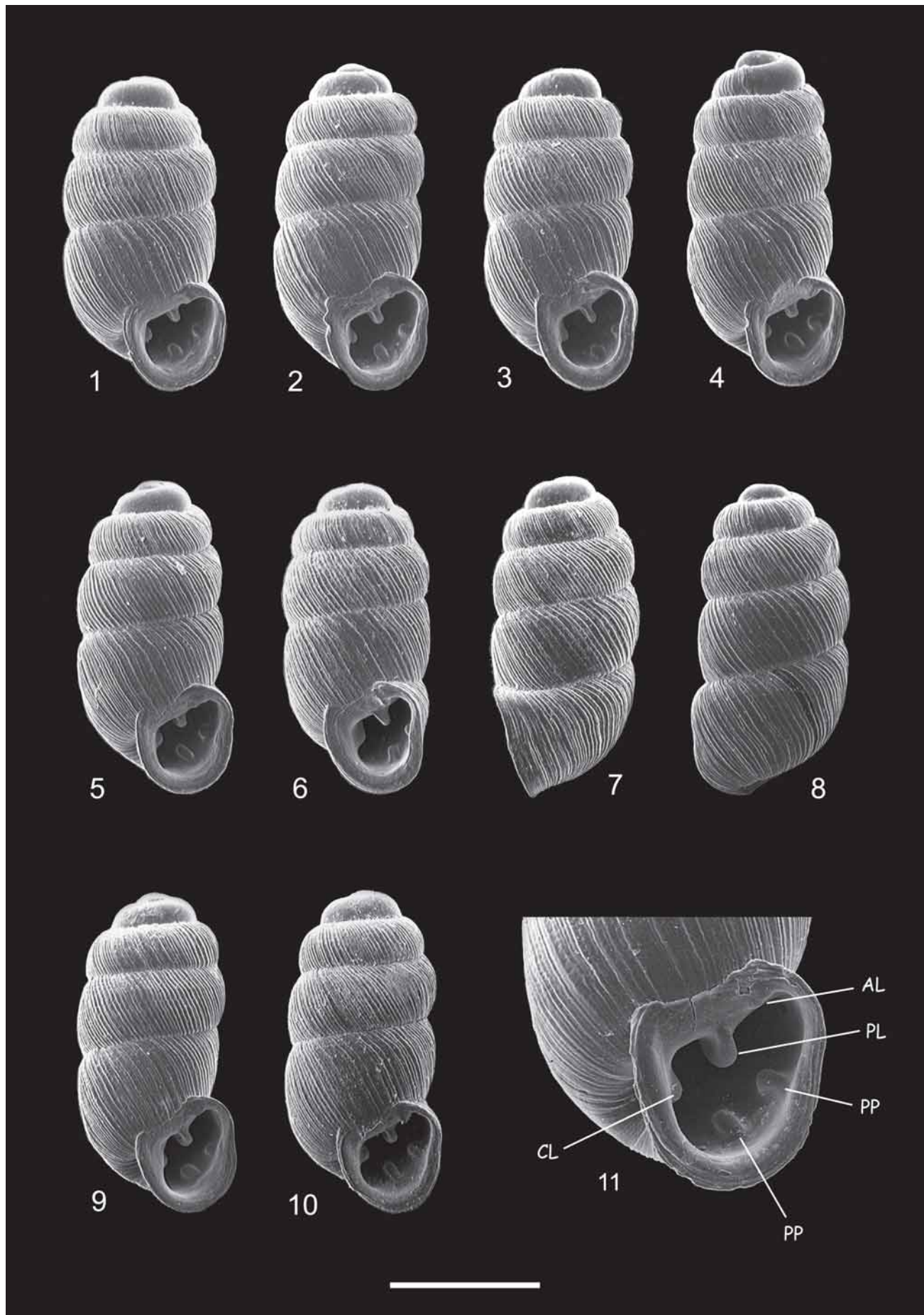
In shell shape and structure of the apertural barrier, the new species also recalls certain forms of the aberrant Nearctic vertiginid *Vertigo californica* (Rowell, 1861) but it is again distinguished by the angular lamella joined to the upper vertex of the peristome. In all species of *Vertigo* Müller, 1773 (type species: *Vertigo pusilla* Müller, 1774), including *V. californica*, the angular lamella is absent, or, if present, it does not reach the upper vertex of the peristome (Pilsbry & Cooke, 1919a: 70; Pilsbry, 1948: 943). The structure of the apertural barrier (with an angular lamella joined to the upper vertex of the peristome) of the new species matches that of vertiginids traditionally assigned to the subfamily Nesopupinae Steenberg, 1925 (type genus: *Nesopupa* Pilsbry, 1900) (cf. Zilch, 1959). This subfamily is an assemblage of about twenty genus-group taxa, the monophyly and inclusion in the vertiginids of which have been questioned (Pokryszko, 1990: 137-138). As currently conceived (differences exist in the taxa included, cf. Pilsbry, 1935; Zilch, 1959; Schileyko, 1998), the nesopupines include minute, diverse, mainly tropical and subtropical, almost cosmopolitan (only absent from mainland Palaearctic), vertiginid land snails. Those that are anatomically known have some features in common (penis with penial appendix and penial retractor branched; Pilsbry, 1935: xi; 1948: 1006; Baker, 1935: 192). Among them, the genus that best recalls the new species from Dunarobba is the monospecific Madeiran *Staurodon* Lowe, 1852 (type species: *Pupa saxicola* Lowe, 1852; *P. saxicola*, a junior primary homonym, was replaced by *P. seminulum* Lowe, 1852). We therefore assigned the new species to *Staurodon* on the basis of its overall similarity to the Madeiran species in shell and apertural armature structure. *S. cianfanellianus* differs from the Recent species by virtue of its more elongate shape, its lower, more robust lamellae and plicae, its longer angular lamella (only a tooth-like lamella joined to upper vertex of peristome in *S. seminulum*) and its more reflexed peristome. We are aware that inclusion of the new species in *Staurodon* is tentative due to taxonomic and systematic uncertainty and frequent character homoplasy in this group of land snails (Pokryszko, 1994). However, besides being the nesopupine morphologically most similar to the Dunarobba species, *Staurodon* is also the closest geographically.

Despite these uncertainties, the finding of a nesopupine vertiginid in the European Pliocene is very interesting. In the western Palaearctic, fossil nesopupines, allegedly related to the Indomalayan *Indopupa* Pilsbry & Cooke, 1920 (type species: *Pupa filosa* Theobald & Stolicka, 1872), are only known from

EXPLANATION OF PLATE 1

figs. 1-11 - *Staurodon cianfanellianus* n. sp.; Shells from trunk 15V of Middle-Late Pliocene Fossil Forest of Dunarobba.

- 1 - Holotype (Giusti & Manganelli collection, Dipartimento di Scienze Ambientali, University of Siena, no. 36931). Scale bar = 1 mm.
- 2-10 - Paratypes (Giusti & Manganelli collection, Dipartimento di Scienze Ambientali, University of Siena, no. 36932). Scale bar = 1 mm.
- 11 - Paratype, detail of aperture (Giusti & Manganelli collection, Dipartimento di Scienze Ambientali, University of Siena, no. 36932). Acronyms: AL angular lamella, CL columellar lamella, PL parietal lamella, PP palatal plica. Scale bar = 0.5 mm.



the Late Oligocene to the early Late Miocene: *Nesopupa blumi* (Boettger, 1884) and *Nesopupa trigonostoma* (Sandberger, 1863) (Pilsbry & Cooke, 1920; Wenz, 1923). Two other European fossil species were assigned to *Nesopupa*: *Pupa priscilla* Paladilhe, 1875 and *Vertigo minor* Boettger, 1870 (Pilsbry & Cooke, 1920; Stworzewicz, 1999), but the former is actually a species of *Leiostyla* Lowe, 1852 (type species: *Pupa vincta* Lowe, 1852) (Pupillidae) (Wenz, 1923) and the other could be a species of *Vertigo*. Stworzewicz (1999) assigned it to *Nesopupa* on the basis of teleoconch whorl sculpture (pitted-granulated sculpture associated with prosocline riblets), but aperture features bear a striking resemblance to those of *Vertigo antivertigo* Müller, 1774 (aperture heart-like with deep palatal scar; high rib bordering the columellar and palatal margins of the aperture internally).

The relationships of *Staurodon* are obscure. The only significant notions are from H.A. Pilsbry's classical monograph on pupilloidean snails in the Manual of Conchology (cf. Pilsbry & Cooke, 1919b: 224; 1920: 225-226). He assigned this genus to the family Vertiginidae, placing it after some Tertiary genera of doubtful affinities, such as *Glandicula* Sandberger, 1874, *Enneopupa* Boettger, 1889, and *Pseudelix* Boettger, 1889, and before the recent Hawaiian *Lyropupa* Pilsbry, 1900. Pilsbry also surmised that some of its characters ("emergence of the angular lamella and its union with the outer lip") could be ancestral since they were found in the Vertigininae and other subfamilies, such as the Gastrocoptinae, whereas another character, "the strong parietal callus" was "doubtless a later development", shared by many snails of arid regions. Pilsbry concluded that "the genus has probably existed on Madeira since the early Tertiary, as it appears to have no near relatives in the European series from the Oligocene on".

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REFERENCES

- Ambrosetti P., Basilici G., Ciangherotti A.D., Codipietro G., Corona E., Esu D., Girotti O., Lo Monaco A., Meneghini M., Paganelli A. & Romagnoli M. (1995). La Foresta Fossile di Dunarobba (Terni, Umbria, Italia centrale): contesto litostratigrafico, sedimentologico, palinologico, dendrocronologico e paleomalacologico. *Il Quaternario*, 8: 465-508.
- Baker H.B. (1935). Review of the anatomy of Pupillidae and related groups. In Tryon G.W. & Pilsbry H.A., Manual of Conchology, structural and systematical, with the illustrations of the species. Second series: Pulmonata, 28 (112): 191-209, Pls. 26-31.
- Biondi E. & Brugiapaglia E. (1991). *Taxodioxylon gypsaceum* in the fossil forest of Dunarobba (Umbria, central Italy). *Flora Mediterranea*, 1: 111-120.
- Esu D. & Girotti O. (1991). Late Pliocene and Pleistocene assemblages of continental molluscs in Italy. A survey. *Il Quaternario*, 4: 137-150.
- Esu D., Girotti O. & Kotsakis T. (1993). Palaeobiogeographical observations on Villafranchian continental molluscs of Italy. In Janssen A.W. & Janssen R. (eds.), Proceedings of the symposium "Molluscan Palaeontology" (11th International Malacological Congress, Siena, Italy, 30th August - 5th September 1992). *Scripta Geologica*, Special Issue 2: 101-119.
- Gliozzi E., Abbazzi L., Argenti P., Azzaroli A., Caloi L., Capasso Barbato L., Di Stefano G., Esu D., Ficarelli G., Girotti O., Kotsakis T., Masini F., Mazza P., Mezzabotta C., Palombo M.R., Petronio C., Rook L., Sala B., Sardella R., Zanalda E. & Torre D. (1997) Biochronology of selected mammals, molluscs and ostracods from the Middle Pliocene to the Late Pleistocene in Italy. The state of the art. *Rivista Italiana di Paleontologia e Stratigrafia*, 103: 369-388.
- Manganelli G., Delle Cave L. & Giusti F. (1989). Notulae Malacologicae, XLIV. Strobilopsidae (Gastropoda, Pulmonata), a family new to the Villafranchian land snail fauna of Apenninic Italy. *Basteria*, 52: 3-13.
- Manganelli G. & Giusti F. (2000). The gastrocoptids of the Fossil Forest of Dunarobba (central Italy) and a preliminary revision of the European Tertiary nominal species of *Albinula* and *Vertigopsis* (Gastropoda Pulmonata: Gastrocoptidae). *Bollettino della Società Paleontologica Italiana*, 39 (1): 55-82.
- Manganelli G., Giusti F. & Delle Cave L. (1990). Notulae Malacologicae, XLVII. Lauriinae (Gastropoda: Pulmonata, Orculidae/Pupillidae) from the Villafranchian of the peninsular Italy. *Basteria*, 53: 87-103.
- Martinetto E. (1994). Paleocarpology and the "in situ" ancient plant communities of a few Italian Pliocene fossil forests. In Matteucci R., Carboni M.G. & Pignatti J.S. (eds.), Studies on ecology and palaeoecology of benthic communities. *Bollettino della Società Paleontologica Italiana*, Special Volume, 2: 189-196.
- Pilsbry H.A. (1920a, b). [Family Pupillidae (Vertigininae, Pupillinae).] In Tryon G.W. & Pilsbry H.A., Manual of Conchology, structural and systematical, with the illustrations of the species. Second series: Pulmonata, 26 (101): 1-64, Pls. 1-8 (1920a), 26 (102): 65-128, Pls. 9-13 (1920b).
- Pilsbry H.A. (1935). Geographic distribution of Pupillidae, Strobilopsidae, Valloniidae and Pleurodiscidae. In Tryon G.W. & Pilsbry H.A., Manual of Conchology, structural and systematical, with the illustrations of the species. Second series: Pulmonata, 28 (112): 161-190, 210-226, Pls. 24-25, 29-31.
- Pilsbry H.A. (1948). Land Mollusca of North America (north of Mexico). *Monograph / The Academy of Natural Sciences of Philadelphia*, 3 (2, 2nd part): i-XLVII + 521-1113.
- Pilsbry H.A. & Cooke C.M. Jr. (1919a, b-1920). [Family Pupillidae (Gastrocoptinae, Vertigininae).] In Tryon G.W. & Pilsbry H.A., Manual of Conchology, structural and systematical, with the illustrations of the species. Second series: Pulmonata, 25 (98): 65-144, Pls. 6-10 (1919a), 25 (99): 145-224, Pls. 11-18 (1919b), 25 (100): 225-404, i-ix, Pls. 19-34 (1920).
- Pokryszko B.M. (1990). The Vertiginidae of Poland (Gastropoda: Pulmonata: Pupilloidea) - a systematic monograph. *Annales Zoologici*, 43: 133-257.
- Pokryszko B.M. (1994). On the mono(?)phyly and classification of the Orthurethra/Pupilloidea (Gastropoda: Pulmonata: Stylommatophora). *Genus*, 5 (4): 371-390.
- Schileyko A.A. (1998). Treatise on recent terrestrial Pulmonate molluscs. Part 2. Gastrocoptidae, Hypselostomatidae, Vertiginidae, Truncatellinidae, Pachnodidae, Enidae, Sagdidae. *Ruthenica*, Supplement 2: 129-261.
- Stworzewicz E. (1999). Miocene land snails from Belchatów (central Poland). IV.: Pupilloidea (Gastropoda Pulmonata). Systematic, biostratigraphic and palaeoecological studies. *Folia Malacologica*, 7 (3): 133-170.
- Wenz W. (1923). Gastropoda extramarina tertiaria. In Diener C. (ed.), Fossilium Catalogus, I (17-23): 1-1862.
- Zilch A. (1959). Gastropoda. Euthyneura. In Schindewolf O.H. (ed.), Handbuch der Paläozoologie 6 (2, 2nd part): i-xii + 1-200.

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