

## Upper Paleocene-Early Eocene mollusks of Silveirinha (Figueira da Foz, West Central Portugal)

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### Abstract

**Key-words:** Upper Palaeocene, Gastropoda, Bivalvia, Silveirinha Formation, Portugal.

A collection of fossil gastropods and bivalves assembled at the Thanetian/Ypresian vertebrate site of Silveirinha (Figueira da Foz, West Central Portugal) is analysed from the point of view of systematics and palaeoecology. The diversity is scarce but the age and exceptional characteristics of the site are factors that substantiate a detailed study. The taxa identified are: *Bithynia soaresi* sp. nov., *Gyraulus antunesi* sp. nov., *Chlamys* sp. and *Cardiacea* gen. sp. indet. The prevailing of freshwater gastropods and the occurrence of 2 fragments of marine bivalves suggest a palaeoenvironmental setting that is in conformity with interpretations already established, which are based both in sedimentologic and vertebrate data. These interpretations point out the existence of a freshwater environment opened from time to time to marine influences, resulting from a palaeoatlantic coast placed some kilometres westwards.

### Resumo

**Palavras-chave:** Paleocénico superior, Gastropoda, Bivalvia, Areias e Argilas de Silveirinha.

Procede-se ao estudo sistemático e paleoecológico de uma colecção de moluscos gastrópodes e bivalves efectuada na jazida de Silveirinha (Formação das Areias e argilas de Silveirinha, de idade tanetiana a ipresiana), situada 13 km a Sul de Figueira da Foz, junto à EN109. O elenco sistemático é pouco diversificado, mas a particularidade da sua idade, contexto faunístico e ecológico, conferem-lhe um interesse óbvio dentro das faunas de moluscos cenozóicos de Portugal. Os taxa descritos são: *Bithynia soaresi* sp. nov., *Gyraulus antunesi* sp. nov., *Chlamys* sp. e *Cardiacea* gen. sp. indet. A dominância de gastrópodes de água doce, a par de 2 fragmentos rolados de bivalves pertencentes a famílias típicas de ambientes marinhos ou salobros, são aspectos que concordam com as sínteses paleoecológicas já existentes e fundamentadas na análise dos vertebrados e em dados sedimentológicos. Tais sínteses apontam para ambiente de natureza fluvial, sujeito a influências marinhas esporádicas.

### Introduction

During the last two decades the clay-pit of Silveirinha (fig. 1) has been recognized as one of the most notorious vertebrate sites for the continental Palaeogene of Western Europe. The first vertebrate remains were found in 1977, by R. Pena dos Reis, and studied by M. Telles Antunes (Reis *et al.*, 1981a, 1981b; Antunes & Russel, 1981; Antunes *et al.*, 1987). Ever since, the clay units of Silveirinha have been exhaustively sampled for

palaeontologic purposes, and became the main subject of many systematic and stratigraphic studies (see Antunes *et al.*, 1997, for exhaustive references).

With a few exceptions, all researches on palaeontology were focused with the description of vertebrate remains, many of them gathered by laboratorial washing and sieving of sediments. However, the same sediments also yielded shells and moulds of aquatic invertebrates, as well vegetal remains. First evidences about this fauna of small invertebrates were mentioned by M. Telles Antunes (*in*

Reis *et al.*, 1981a) and M. Telles Antunes & D. Russel (1981), as part of preliminary check-lists that pointed out the palaeontologic importance and diversity of this site.

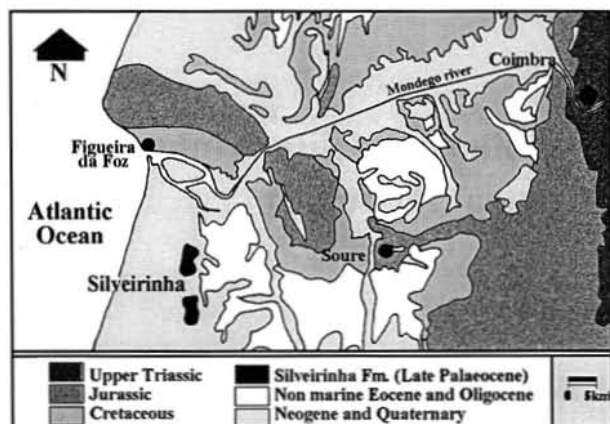


Figure 1 – Simplified map of Baixo Mondego with indication of the clay pit of Silveirinha.

The invertebrate fossils of Silveirinha are represented by a few species of aquatic gastropods, bivalves and ostracods. Nevertheless the scarce diversity of this fauna, especially when compared with the large number of vertebrates already known, the age and exceptional characteristics of the site are factors that substantiate a detailed study.

The present paper sets out to review the fossil molluscs of Silveirinha, with emphasis on systematic and palaeobiologic data.

### Geological setting

The fossiliferous units of Silveirinha outcrop near the national road EN109, about 13 Km southward the Mondego estuary and the coastal town of Figueira da Foz (West Central Portugal).

The abundant fossil remains were found within a succession of lenticular beds of calcilitic conglomerates, laminated and cross-bedded sandstones, and brownish-red clays (Reis, 1981; Reis *et al.*, 1981; Soares & Reis, 1982; Soares *et al.*, 1986). These siliciclastic units are articulated as positive elementary sequences dominated by pelitic facies, which are macroscopically analogous to the late Cretaceous continental sediments of Taveiro Formation (Antunes & Pais, 1978; Antunes, 1979; Reis, 1981).

The siliciclastic units of Silveirinha and adjacent outcrops are usually designated as Silveirinha Formation or Silveirinha Sands and Clays (=Areias e Argilas de Silveirinha *in* Soares & Reis, 1980, 1982; Reis *et al.*, 1981a, 1981b). Evidence from fossil vertebrates suggests that the Formation is of late Palaeocene and/or lower Eocene age (Antunes *in* Reis *et al.*, 1981a; Antunes & Russel, 1981; Antunes *et al.*, 1987, Antunes *et al.*, 1997, Estravis, 1992). These biostratigraphic data also corroborate that Silveirinha Formation is the most significant sedimentary record of Thanetian-Ypresian age outcropping in the onshore of the West Portuguese Margin.

From the point of view of the Meso-Cenozoic sedimentary evolution of this continental margin, the Silveirinha Formation can be considered as the onshore expression of a major tectono-sedimentary sequence, posterior to the well-known late Campanian-Maastrichtian events recorded by Taveiro and other contemporaneous formations (Cunha, 1992; Cunha & Reis, 1992, 1995; Reis, 1998). This early Palaeogene sequence (SLD6 *sensu* Cunha, 1992) is also documented in adjacent sectors of the continental platform, being thicker and dominated by carbonate facies (Boillot *et al.*, 1975).

### Systematic descriptions

The next systematic descriptions arise from a collection housed in the Earth Sciences Department of the New University of Lisbon and assembled under guidance of M. Telles Antunes.

The systematic analysis of Prosobranchia and Basommatophora were based, respectively, in the extensive monographs of W. Wenz (1938-44) and A. Zilch (1959-60). Bivalves were systematized after R. Moore (1969) and R. Abbott & K. Boss (1989).

Phylum MOLLUSCA Linné, 1758  
 Class GASTROPODA Cuvier, 1797  
 Subclass PROSOBRANCHIA Milne & Edwards, 1848  
 Order MESOGASTROPODA Thiele, 1925  
 Family Bithyniidae Gray, 1857  
 Genus *Bithynia* Leach, *in* Abel, 1818  
 [Type species: *Bithynia tentaculata* (Linné, 1758) ]

*Bithynia soaresi* sp. nov.  
 (Plate 1, figs. 1a-b, 2a-b, 3a-b, 5-12)

**Type material:** 3 incomplete shells and 365 calcareous opercula.

**Repository of specimens:** All specimens are housed in the collections of palaeontology of the Earth Sciences Department of the New University of Lisbon.

**Etymology:** The specific name is an homage to Prof. A. Ferreira Soares, author of fundamental ideas and contributions concerning the Meso-Cenozoic stratigraphy and palaeontology of the West Portuguese Basin.

**Description of the holotype:** Shell small and thin, ovoidly conical, with a minute protoconch and 4 convex whorls crossed by very fine growth-lines; aperture oval, with a slightly angled upper corner. Diameter: 3,4 mm; Height: 2,4 mm.

**Additional descriptions:** Both holotype and paratypes are incomplete shells and internal moulds, without the body whorl and the last part of the spire preserved. However, the real dimensions and the number of original whorls could be inferred after a comparison with the numerous calcareous opercula found together. These

opercula are rather thickened and oval, with a subtriangular upper corner. The external surface is sculptured with many concentric growth lines and lamellae. The maximal height and width measured are, respectively, of 5,0 mm and 3,8 mm. These dimensions are equivalent to mature specimens with estimated height of 12-14 mm and 5,5-6 whorls of coiling.

**Remarks:** Fossil members of the prosobranch family Bithyniidae occur in fluvial and lacustrine sediments since the beginning of Cenozoic (Zilch, 1960). The present species is, much probably, the older member of the genus recorded in Portugal.

Subclass PULMONATA Cuvier, 1817  
 Order BASOMMATOPHORA Schmidt, 1855  
 Family Planorbidae Rafinesque, 1815  
 Genus *Gyraulus* Charpentier, 1837  
 Subgenus *Gyraulus* s. str.  
 [Type species: *Gyraulus (Gyraulus) hispidus* (Draparnaud, 1805)]

*Gyraulus antunesi* sp. nov.  
 (Plate I, figs. 13a-b, 14-17)

**Type material:** Four fragments of shell and two internal moulds of a quarter of whorl.

**Repository of specimens:** All specimens are housed in the collections of palaeontology of the Earth Sciences Department of the New University of Lisbon.

**Etymology:** The specific name is an acknowledgement to Prof. M. Telles Antunes, who stimulated the studies of vertebrate palaeontology in Portugal and initiated two decades of palaeontologic researches at the site of Silveirinha.

**Description of the holotype:** Shell small, hyperstrophic, compressed and discoid, with slightly concave upper and lower surfaces. Apex submerged. Spire with 4 finely grooved round and convex whorls. The shape of the aperture is unknown. Diameter: 3,8 mm; Height: 1,1 mm.

**Additional descriptions:** The holotype is an incomplete shell, in which the body whorl and the aperture were not preserved. The type material also includes two internal moulds with a quarter of whorl each, suggesting that the whole shell of a mature specimen could have at least 5-6 whorls and 6 mm long. The remaining types are two minute fragments of spire, showing a submerged apex.

**Remarks:** Planorbidae is one of the most important and widespread family of freshwater gastropods. Recent and fossil species are characterized by discoid and frequently keeled sinistral shells, characteristic of fluvial and lacustrine facies from middle Jurassic to present time.

Among the oldest known occurrences of this family are the pavements of "*Planorbis*" found in the Late

Oxfordian carbonaceous facies of Cabo Mondego, in the Northern Sector of the Lusitanian Basin. Also in Portugal, other evidence is only documented from Cenozoic, mainly Neogenic, lacustrine deposits of Tagus Basin. The occurrence of *Gyraulus antunesi* in the Thanetian-Ypresian of Silveirinha is the older record of this family found in the Palaeogene of Portugal.

Comparisons with contemporaneous Planorbidae from foreign European countries are difficult at present time. *Gyraulus* and other related genera are characterized by morphologic convergence and strong resemblance between species. This difficulty is increased by a poor preservation of many fossil specimens, allowing no more than generalistic approaches.

Class BIVALVIA Linné, 1758  
 Subclass PTERIOMORPHIA Beurlen, 1944  
 Order PTERIOIDA Newell, 1965  
 Family Pectinidae Rafinesque, 1815  
 Genus *Chlamys* Röding, 1798  
 (Type species: *Chlamys islandicus* Müller, 1776)

*Chlamys* sp.  
 (Plate I, fig. 4)

**Material:** A fragment of valve with the shell sculpture partly preserved.

**Repository of specimens:** The specimen is housed in the collections of palaeontology of the Earth Sciences Department of the New University of Lisbon.

**Description:** Small fragment of an obliquely ovate and slightly convex valve, with four radial ribs and part of the ventral margin. The sculpture is composed of radial ribs, narrow and prominent, with rounded sections; the intercalated interspaces have just about the same width of the contiguous ribs, and are crossed by delicate growth-lines.

**Remarks:** This fragment shows elements of a typical sculpture of a Pectinidae from the *Chlamys* group. However, some other diagnostic features related with the auricles and the umbonal region couldn't be observed. As a result, the generic attribution of *Chlamys* is used here in a broad sense.

The same valve also shows traces of mechanical abrasion, suggesting a prolonged biostratonomical transport previous to sedimentation.

Subclass HETERODONTA Neumayr, 1884  
 Order VENEROIDA H. & A. Adams, 1857

*Cardiacea* gen. sp. indet.  
 (Plate I, fig. 18)

**Material:** A small fragment of valve with the shell sculpture preserved.

**Repository of specimens:** The specimen is housed in the collections of palaeontology of the Earth Sciences Department of the New University of Lisbon.

**Description:** Small fragment of valve with 6 mm long and 5 mm height. The original shell sculpture was preserved and consists of 4 radial ribs separated by narrow and deep interspaces. These ribs have subrectangular sections and are covered by 3-4 fine radial sulcus, and crossed by growth-lines.

**Remarks:** The style of sculpture observed resembles the ribbing of *Heterodonta* from the superfamily *Cardiacea*. However, the fragment is too small and incomplete to allow a more accurate determination.

### Palaeobiologic significance

The Bithyniidae are an interesting example of prosobranch gastropods adapted to freshwater environments. This family of operculated and ovoidly conical shells includes the common and widespread Palearctic *Bithynia tentaculata* (Linné, 1758), which is the best known modern European representative of this archaic group (Matos, 1993), with origins that back away, at least to the Palaeocene. Considering the ecologic adaptations of this and other modern related species, we can infer with a substantial degree of confidence that *Bithynia soaresi* was also a freshwater species, inhabitant of soft and organic rich bottoms of fluvial channels, ponds, marshes and inundated margins (fig. 2). This analysis is in conformity with the palaeobiologic and palaeobiogeographic interpretations already established for Silveirinha, which are based both in Vertebrate and sedimentologic data (Antunes *in Reis et al.*, 1981a; Antunes & Russel, 1981). The same kind of analogies can be made about *Gyraulus antunesi*. The Planorbidae are a typical group of freshwater

Basommatophora, common in lacustrine and alluvial environments since the middle Jurassic.

The presence of two abraded fragments of marine bivalves (*Chlamys* sp. and *Cardiacea* indet.) deserves a different explanation. Not excluding the possibility of these fragments being of reworked shells, its occurrence is more likely an indication of the proximity of littoral. The freshwater environment of Silveirinha was probably opened from time to time to marine influences, as the result of a palaeoatlantic coast placed some kilometres westwards. These marine influences were already noted after the identification of vertebrate species belonging to groups with brackish or marginal marine affinities (Antunes *in Reis et al.*, 1981a; Antunes & Russel, 1981).

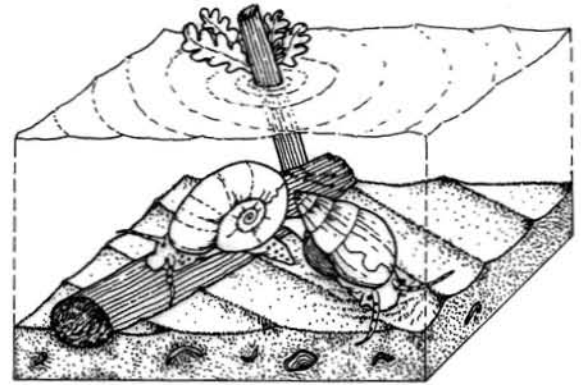


Fig. 2

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**Plate 1**

- 1a-b – *Bithynia soaresi* sp. nov. (x5). Paratype.  
2a-b – *Bithynia soaresi* sp. nov. (x5). Holotype.  
3a-b – *Bithynia soaresi* sp. nov. (x5). Paratype.  
4 – *Chlamys* sp. (x7). Fragment of valve with part of the ventral margin.  
5 – *Bithynia soaresi* sp. nov. (x4). External view of operculum.  
6 – *Bithynia soaresi* sp. nov. (x4). Internal view of operculum.  
7 – *Bithynia soaresi* sp. nov. (x4). External view of operculum.  
8 – *Bithynia soaresi* sp. nov. (x4). Internal view of operculum.  
9 – *Bithynia soaresi* sp. nov. (x4). Internal view of operculum.  
10 – *Bithynia soaresi* sp. nov. (x4). Internal view of operculum.  
11 – *Bithynia soaresi* sp. nov. (x4). External view of operculum.  
12 – *Bithynia soaresi* sp. nov. (x4). External view of operculum.  
13a-b – *Gyraulus antunesi* sp. nov. (x4). Holotype.  
14 – *Gyraulus antunesi* sp. nov. (x4). Fragment of whorl.  
15 – *Gyraulus antunesi* sp. nov. (x4). Fragment of whorl.  
16 – *Gyraulus antunesi* sp. nov. (x7). Fragment of spire showing the submerged apex.  
17 – *Gyraulus antunesi* sp. nov. (x7). Fragment of spire showing the submerged apex.  
18 – Cardicea gen. sp. indet. (x7). Fragment of valve.

PLATE 1

