*Acta Geologica Polonica*, Vol. 56 (2006), No. 1, pp. 67-88

# Latest Albian (Vraconian) brachiopod fauna from North Dobrogea (Romania): taxonomy, palaeoecology and palaeobiogeography

EUGEN GRĂDINARU[1], AURELIA BĂRBULESCU[1] & ELLIS FREDERIC OWEN[2]

[1]*Department of Geology and Palaeontology, Faculty of Geology and Geophysics, University of Bucharest, Bd. Bălcescu Nicolae 1, RO-010041 Bucharest, Romania. E-mail: egradin@geo.edu.ro*

[2]*Department of Palaeontology, The Natural History Museum, Cromwell Road, London SW7 5BD, Great Britain.*

ABSTRACT:

GRĂDINARU, E., BĂRBULESCU, A. & OWEN, E.F. 2006. Latest Albian (Vraconian) brachiopod fauna from North Dobrogea (Romania): taxonomy, palaeoecology and palaeobiogeography. *Acta Geologica Polonica*, **56** (1), 67-88. Warszawa.

The latest Albian (Vraconian) brachiopod fauna from Enisala, in North Dobrogea, includes representatives of rhynchonellids and terebratulids. The rhynchonellids are scarce, representing two families, Cyclothyrididae and Tetrarhynchiidae. The Cyclothyrididae with the subfamily Cyclothyridinae, and the Tetrarhynchiidae with the subfamily Cretirhynchiinae, are represented by rare specimens of ? *Cyclothyris* sp. and *Burrirhynchia* cf. *sigma* (SCHLOENBACH, 1867), respectively. The terebratulids are very abundant and include representatives of several families, as follows: Sellithyrididae, Capillithyrididae, Cancellothyrididae and Terebrataliidae. The Sellithyrididae, which make up the bulk of the assemblage, are represented by two subfamilies: Sellithyridinae with *Sellithyris upwarnesis* (WALKER, 1870), *Boubeithyris boubei* (D'ARCHIAC, 1847) and *Ovatathyris* cf. *potternensis* OWEN, 1988, and Nerthebrochinae with *Harmatosia crassa* (D'ARCHIAC, 1847). The Capillithyrididae are represented by the subfamily Capillithyridinae with *Capillithyris capillata* (D'ARCHIAC, 1847). The Cancellothyrididae are represented by the subfamily Cancellothyridinae with numerous specimens of *Terebratulina protostriatula* OWEN, 1988. The Terebrataliidae are represented by the subfamily Gemmarculinae with scarce specimens of *Gemmarcula canaliculata* (ROEMER, 1840) and *Gemmarcula* sp.

The abundance and diversity of the terebratulids in the brachiopod assemblage from Enisala was related to favourable environmental conditions connected with the onset of the marine transgression on North Dobrogea during the latest Albian.

There is a marked stratigraphic lag with some species which in North Dobrogea occur in the latest Albian appearing in the Early Cenomanian in Central and Western Europe. This suggests that North Dobrogea was located on the main route of the westward migration of the mid-Cretaceous brachiopod faunas.

**Key words:** Brachiopods, Latest Albian (Vraconian), Cretaceous, Romania.

## INTRODUCTION

North Dobrogea is a region situated in the south-eastern part of Romania, on the western shore of the Black Sea. In this region, Cretaceous brachiopods are known from a single locality near Enisala village, on the north-eastern margin of the Babadag Basin (Text-fig. 1). Brachiopod-bearing strata crop out on the south-western side of the hill with the ruins of the Heraclea Citadel. The age of this previously undescribed brachiopod fauna has been the subject of some controversy.

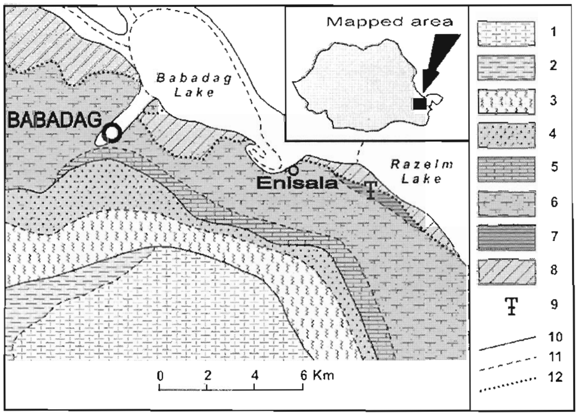


Fig. 1. Geological map of the eastern part of the Babadag Basin (North Dobrogea, Romania), redrawn and modified from SZASZ & ION (1988). **Dolojman Formation**: 1 and 2 - Coniacian (Jurilofca and Caugagia Members), 3 and 4 – Turonian (Harada and Jidini Members); **Iancila Formation**: 5 and 6 – Cenomanian (Golovița and Babadag Members); 7 – Vraconian (Enisala Member); 8 – Pre-Cretaceous basement; 9 – Fossiliferous site; 10 – normal lithological boundary; 11 – diachronous lithological boundary; 12 - unconformity

Extensive sampling made during the last years by one of us (EG) in the locality allowed the recovery of rich bivalve and brachiopod faunas.

The brachiopod fauna from Enisala includes a number of new taxa for the Dobrogea area, and for Romania.

The occurrence of the ammonite genus *Lepthoplites* in the brachiopod-bearing strata establishes a latest Albian (Vraconian) age for the basal deposits of the Babadag Basin (GRĂDINARU 2004), and allows accurate determination of the stratigraphic position of the brachiopod fauna from Enisala.

Geographically, the Vraconian brachiopod fauna from Enisala is of major importance for the palaeobiogeography of the mid-Cretaceous brachiopod faunas in Europe. North Dobrogea was a bridge between the Crimean and Caucasian regions, on the one side, and the Central and Western Europe, on the other, and fills a gap in the knowledge of the geographic distribution of mid-Cretaceous brachiopods.

## PREVIOUS DATA

The first mentions of brachiopods at Enisala are to be found in the old monographs of PETERS (1867) and ANASTASIU (1898), who assigned them a Middle Jurassic age.

Later, POMPECKJ (1897) and SIMIONESCU (1910) argued for a Cenomanian age for the brachiopod-bearing limestones from Enisala. SIMIONESCU (1914) recognized two distinct series in the sedimentary fill of the Babdag Basin, the lower one named 'Iancila Series', for the Cenomanian deposits, and the upper one named 'Dolojman Series', for the Turonian-Senonian deposits. The brachiopod-bearing strata from Enisala were located to the 'Iancila Series'. Subsequently, SIMIONESCU (1927), MACOVEI & ATANASIU (1934) and MIRĂUȚĂ & MIRĂUȚĂ (1964) accepted a Cenomanian age of the basal deposits of the Babadag Basin.

MUTIHAC & *al.* (1972) claimed a Late Aptian-Albian age for the brachiopod-bearing limestones from Enisala, based only on generic assignments of poorly preserved specimens of brachiopods, and from the study of the bryozoans, calcareous algae and foraminifera. More recently, DRAGASTAN (in BĂNCILĂ & *al.* 1997) reconsidered the biostratigraphic significance of the bryozoans, calcareous algae and the foraminifera from this locality and assigned a Late Albian age for the Enisala Limestone.

PATRULIUS (1974) emphasized that brachiopods similar to those from Enisala occurred in the East Carpathians in the Vraconian-Cenomanian time interval, and reckoned that the brachiopod-bearing strata from Enisala are not older than the Late Albian.

SZASZ & ION (1988) formally described the brachiopod-bearing strata from Enisala as a distinct member in the Iancila Formation, named Enisala Member. These authors agreed to an Early Cenomanian (*pro parte*) age, eventually also Vraconian, for the Enisala Member, having in view that the conformably overlying Babadag Member yielded belemnites, inoceramids and foraminifera of Early (*pro parte*) and Middle Cenomanian age.

BUCUR & BALTREȘ (2002) assigned an Early Cenomanian age, based on the study of foraminifera and red calcareous algae, to the bioclastic limestones from the basal part of the sedimentary fill cored in two wells drilled in the north-eastern part of the Babadag Basin.

In conclusion, the age of the Enisala Limestone and its brachiopod fauna was widely disputed. While most authors supported a Cenomanian or an Early Cenomanian age, eventually including also the Vraconian, a few agreed that the Enisala Limestone might be of Late Albian age.

## GEOLOGIC AND STRATIGRAPHIC DATA

The Enisala Member, situated in the basal part of the Iancila Formation, unconformably overlies the Triassic Wetterstein-type thick-bedded grayish limestones which crop out mainly in the hill bellow the ruins of the Heraclea Citadel (Text-fig. 2). Here, on the south-western side of the hill, the Enisala Member is

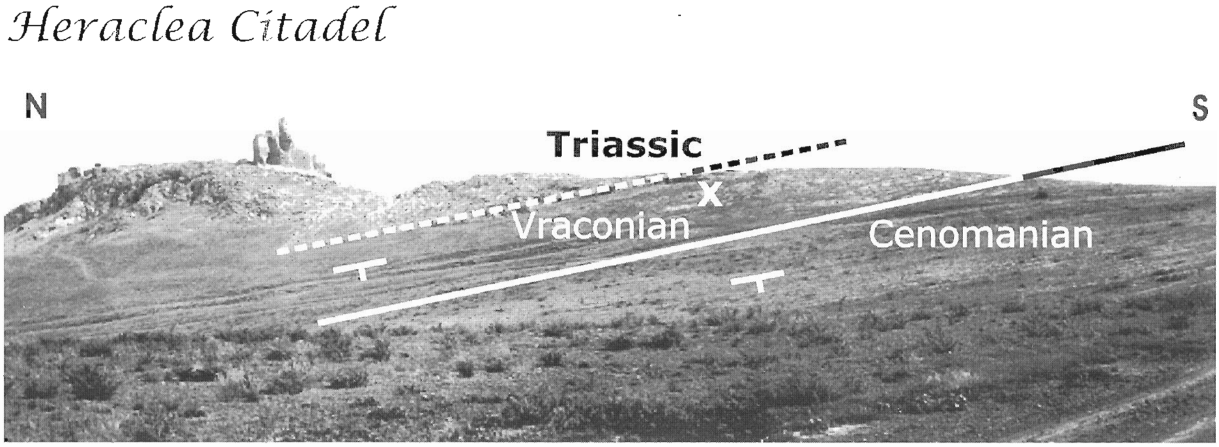


Fig. 2. Panoramic view of the western side of the Heraclea Hill at Enisala (North Dobrogea, Romania), showing the stratigraphic relationships of the latest Albian Enisala Member; X – occurrence point of the described brachiopod fauna

estimated to be less than 20 meters thick. It is made up of whitish or rosy, massive, poorly bedded bioclastic limestones. Microfacially, the limestones are coarse-grained grainstones to packstones, made up mainly of bryozoan, red calcareous algae, echinoid debris and molluscan shell fragments. The macrofossils are represented mainly by bivalves, among which the oysters are the most abundant group, and by brachiopods, which in some levels are the most common fossils. Only a few specimens of echinoids, and rare ammonites and fish teeth, were recovered.

The massive bioclastic limestones of the Enisala Member grade upwards to the well-bedded quartz-rich crinoidal calcarenites of the overlying Babadag Member in the Iancila Formation, which represent the typical facies of the Cenomanian in the Babadag Basin.

The recovery of the first ammonite specimen from the brachiopod-bearing strata, which is ascribed to the genus *Lepthoplites* (Grâdinaru 2004), clarifies the age of the Enisala Member. In Western Europe *Lepthoplites* occurs mainly in the *Stoliczkaia* (*S.*) *dispar* Zone of the topmost Albian (Owen 1989; López-Horgue & *al.* 1999; Wiedmann & Owen 2001). At the colloquium on the Lower Cretaceous in Lyon in 1963 this zone was considered as the equivalent of the Vraconian (Collignon 1965). The discussions regarding the chronostratigraphic status of the Vraconian, considered as a substage at the top of the Albian by Breistroffer (1936, 1940), are resumed in recent publications (Gale & *al.* 1996; Marcinowski & *al.* 1996; Amédro 2002; Hancock 2003). In Romania, both in the Carpathians and in North Dobrogea, the Vraconian sedimentation marked the onset of the marine transgression.

## MATERIAL, PRESERVATION AND TAXONOMIC COMPOSITION OF THE STUDIED BRACHIOPOD FAUNA

In the brachiopod material from Enisala, which includes more than 214 complete specimens, several taxonomic groups are represented by numerous specimens at different stages of ontogenetic development, and which show pronounced intraspecific morphologies. In addition to the complete specimens, there are numerous incomplete specimens damaged by crushing during extraction from the host rock.

The preservation of the brachiopod material is variable for the different taxa, being dependent on their ontogenetic development, sizes, etc. Only a few specimens with separated shells were found. During the extraction of the brachiopods from the host rock, some parts of their shells, either the umbo or the anterior margin, were damaged. Also, most brachiopods have decorticated shells. However, many specimens show areas on which the fine details of ornamentation or its inner structure are visible. Few specimens naturally released by weathering of the rock preserve shell ornamentation.

The frequency, distribution and position of the specimens in the rock was investigated. In some strata the specimens are abundant, sometimes closely packed, but in other strata there are only a few specimens. There is no sorting of the specimens by their sizes or ontogenetic development with young specimens and gerontic specimens found together. No sorting either by distinct taxa or by a preferred position was observed. Many specimens were buried with their shells either partially or completely void of sediment, showing no crushing. The interiors of some hollow shells are filled with calcite crystals, looking like mini-geodes. For the shells filled with sediment, a graded structure can frequently be observed. The coarser sediment is followed by finer sediment and finally by sparry calcite. Similar filling aspects were described for Cretaceous brachiopods from Algeria, France and Spain by GASPARD (1988, 1996).

The Vraconian brachiopod fauna from Enisala, listed in taxonomic order, is as follows:

RHYNCHONELLIDA (Order)
**Cyclothyrididae** (Family)
Cyclothyridinae (Subfamily)
? *Cyclothyris* sp.
**Tetrarhynchiidae** (Family)
Cretirhynchiinae (Subfamily)
*Burrirhynchia* cf. *sigma* (SCHLOENBACH, 1867)
TEREBRATULIDA (Order)
**Sellithyrididae** (Family)
Sellithyridinae (Subfamily)
*Sellithyris upwarnensis* (WALKER, 1870)
*Boubeithyris boubei* (D'ARCHIAC, 1847)
*Ovatathyris* cf. *potternensis* OWEN, 1988
Nerthebrochinae (Subfamily)
*Harmatosia crassa* (D'ARCHIAC, 1847)
**Capillithyrididae** (Family)
Capillithyridinae (Subfamily)
*Capillithyris capillata* D'ARCHIAC, 1847)
**Cancellothyrididae** (Family)
Cancellothyridinae (Subfamily)
*Terebratulina protostriatula* OWEN, 1988
**Terebrataliidae** (Family)
Gemmarculinae (Subfamily)
*Gemmarcula canaliculata* (ROEMER, 1840)
*Gemmarcula* sp.

As shown in Text-fig. 3, the Vraconian brachiopod fauna from Enisala includes representatives of Rhynchonellida and Terebratulida, representing 6.5 % and 93.5 % of the assemblage, respectively.

The rhynchonellids are rare, with two families, Cyclothyrididae and Tetrarhynchiidae, making up 4.5 % and 1.3 % of the assemblage, respectively. Cyclothyrididae (subfamily Cyclothyridinae) and Tetrarhynchiidae (subfamily Cretirhynchiinae) are represented by rare specimens of ? *Cyclothyris* sp. and *Burrirhynchia* cf. *sigma* (SCHLOENBACH, 1867), respectively.

In contrast, terebratulids are abundant, and include representatives of several families, as follows: Sellithyrididae, Capillithyrididae, Cancellothyrididae and Terebrataliidae. The Sellithyrididae, which make up 40 % of the assemblage are represented by two subfamilies: Sellithyridinae with *Sellithyris upwarnensis* (WALKER, 1870), *Boubeithyris boubei* (D'ARCHIAC, 1847), and *Ovatathyris* cf. *potternensis* OWEN, 1988, and Nerthebrochinae with *Harmatosia crassa* (D'ARCHIAC, 1847). The Capillithyrididae, making up 11 % of the assemblage, are represented by subfamily Capillithyridinae with *Capillithyris capillata* (D'ARCHIAC, 1847). The Cancellothyrididae, 34 % of the assemblage, are represented by the subfamily Cancellothyridinae, with numerous specimens of *Terebratulina protostriatula* OWEN, 1988. The Terebrataliidae, forming 9 % of the assemblage, are represented by the subfamily Gemmarculinae with scarce specimens of *Gemmarcula canaliculata* (ROEMER, 1840) and *Gemmarcula* sp.

Taxonomically, Sellithyrididae, which are represented by four genera, are the main group in the brachiopod fauna studied. The Cyclothyrididae are represented by two genera while Capillithyrididae, Cancello-

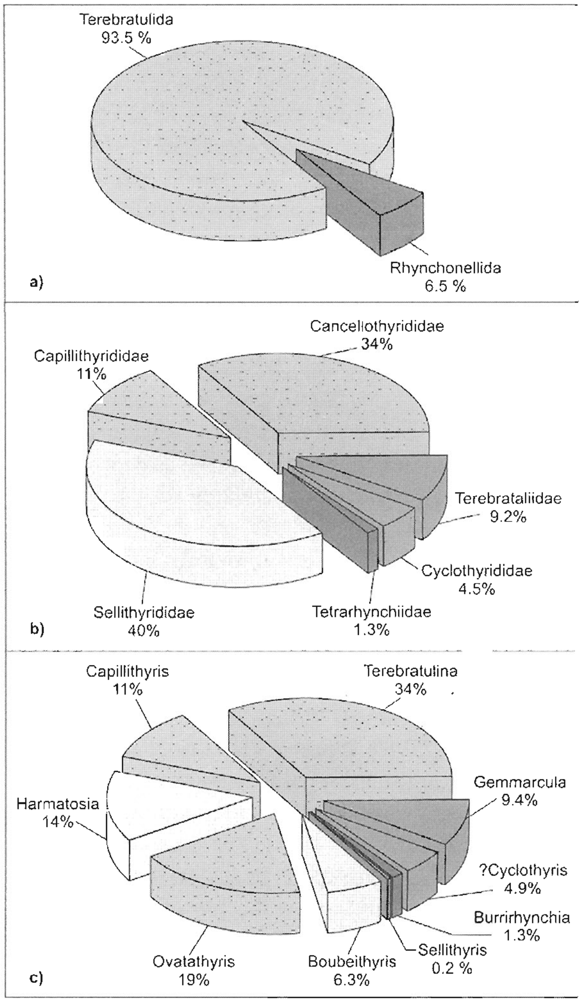


Fig. 3. Taxonomic diversity and abundance of the latest Albian brachiopod fauna from Enisala (North Dobrogea, Romania), by orders (a), families (b) and genera (c)

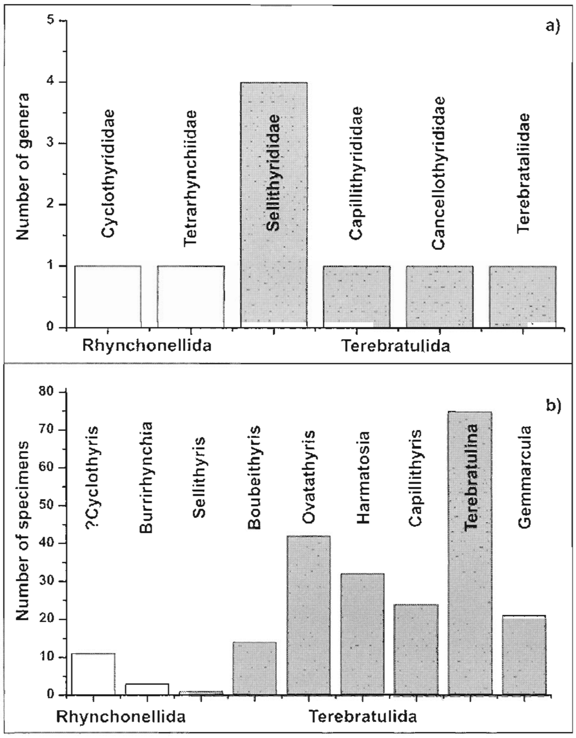


Fig. 4. Histograms showing the abundance of genera by families (a) and number of specimens by genera (b) in the latest Albian brachiopod fauna from Enisala (North Dobrogea, Romania)

thyrididae and Terebrataliidae are each represented by one genus.

Numerically (Text-figs 3-4), *Terebratulina* with 34 % is the most abundant taxon. It is followed by *Ovatathyris* (19 %), *Harmatosia* (14 %), and *Capillithyris* (11 %), from the Sellithyrididae. Other genera, such as *Gemmarcula* from the Terebrataliidae, *Boubeithyris* from the Sellithyrididae, ? *Cyclothyris* and *Burrirhynchia* from the Cyclothyrididae, and *Sellithyris* from the Sellithyrididae, have a decreasingly smaller number of specimens.

## PALAEOECOLOGY

The marine transgression which covered North Dobrogea during the latest Albian, although not regionally extensive, gave rise to favourable environmental conditions, which allowed the settlement and development of a very diversified marine benthic life in some areas, as illustrated now in the Enisala region. The rich assemblage of calcareous red algae and cyclostomate bryozoans, which are among the most important contributors to the calcareous sediment, flourished in calm and shallow waters, no more than 25-30 m in depth (DRAGASTAN in MUTIHAC & *al.* 1972). The sea bottom was inhabited by a rich benthic macrofauna including serpulids, bivalves, articulated brachiopods and echinoderms. The oysters, which are known as a high opportunist bivalve group during the marine transgressions, were by far the most dominant group in the benthic macrofauna, in abundance and diversity. The sea bottom, paved with abundant coarser biogenic detritus, was also populated by a rich brachiopod fauna. Besides the robust terebratulids (*Ovatathyris*, *Harmatosia*), which dominated the brachiopod assemblage and may have been detached from the substrate in maturity, the terebratulinids, with small-sized, thin and finely-ornamented shells, had a permanently sessile life-style attached to other biogenic remains.

It is known that the brachiopods are sensitive to the nature of the substratum. Every type of lithology supported a dominant brachiopod community to which some species with a long range and adapted to various ecologies were associated (AGER 1965; OWEN 1988). The terrigenous sediments that were favourable for rhynchonellids, were not well tolerated by the terebratulids which preferred the calcareous and marly or chalky sediments. This is well illustrated by the rhynchonellid-rich brachiopod assemblages from the Cracow region, in Poland (POPIEL-BARCZYK 1972, 1977), which settled in a terrigenous environment. In North Dobrogea, the terebratulids, which were the dominant group in the latest Albian brachiopod fauna from Enisala, disappeared during the Early Cenomanian due to lithofacies changes. The Early Cenomanian Babadag Member of the Iancila Formation consists exclusively of quartz-rich crinoidal calcarenites. At the onset of the Late Cretaceous, by widening and deepening of the sea, the brachiopods were replaced by other groups of macrofauna, the ammonoids and the inoceramids, much better adapted to the new environmental conditions.

## PALAEOBIOGEOGRAPHY

In the Dobrogea area, as a whole, any representatives of the Vraconian brachiopod fauna from North Dobrogea are also found in South Dobrogea, where numerous Early and Late Cretaceous brachiopods have been investigated (BĂRBULESCU & *al.* 1975, 1979; NEAGU & BĂRBULESCU 1979; BĂRBULESCU & NEAGU 1988). It proves that important palaeogeographic modifications happened during the mid-Cretaceous in the western part of the Black Sea, including also the Dobrogea area, which controlled the distribution and pattern of sedimentary environments and the associated biotic communities.

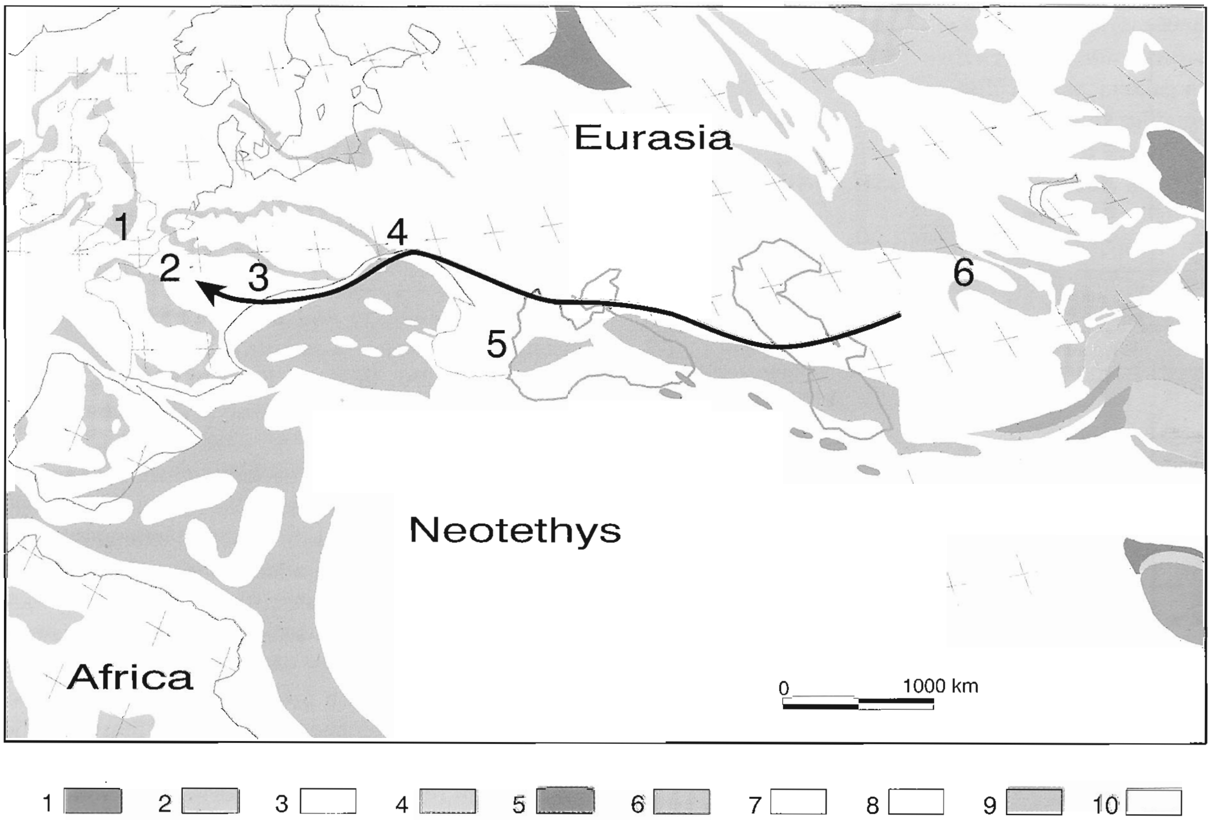


Fig. 5. Palaeogeographic map of the Late Albian (redrawn and simplified from GOLONKA 2004) showing the main occurrences of species represented in the Vraconian brachiopod fauna from Enisala, and the inferred route for the dispersal of some of the Mid-Cretaceous brachiopods, as discussed in the text of paper. 1 – South Great Britain; 2 – Belgium (Tourtia of Tournai) and France (Normandy); 3 – South Germany; 4 – Poland (Cracow and Annopol regions) and Ukraine (Podolia region); 5 – Romania (North Dobrogea); 6 – Central Asia (Gissar Ridge); 1 – "Mountains"/Highlands (active tectonically); 2 – Topographic highs (inactive tectonically); 3 – Topographic medium-low (inactive tectonically, non-depositional); 4 – Terrestrial undifferentiated; 5 – Fluvio-lacustrine; 6 – Coastal, transitional, marginal marine; 7 – Shallow marine, shelf; 8 – Slope; 9 – Deep ocean basin with sediments (continental, transitional, or oceanic crust); 10 – Deep ocean basin with little to no sediments (primarily oceanic crust)

| Location | Local stratigraphic range | | | | | | | | | | | | | | | | | | Regional stratigraphic range | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | South Britain | | North France | | Belgium (Tournai) | | North Germany | | South Germany | | Poland | | Ukraine | | Gissar Ridge | | West Europe | | Central Europe | | Central Asia | |
| Taxons / Age | Vr | $C_1$ | Vr | $C_1$ | Vr | $C_1$ | Vr | $C_1$ | Vr | $C_1$ | Vr | $C_1$ | Vr | $C_1$ | Vr | $C_1$ | Vr | $C_1$ | Vr | $C_1$ | Vr | $C_1$ |
| *Burrirhynchia* cf. *sigma* | | | | | | | | | | | | | | | | | | | | | | |
| *Boubeithyris boubei* | | | | | | | | | | | | | | | | | | | | | | |
| *Ovatathyris* cf. *potternensis* | | | | | | | | | | | | | | | | | | | | | | |
| *Harmatosia crassa* | | | | | | | | | | | | | | | | | | | | | | |
| *Capillithyris capillata* | | | | | | | | | | | | | | | | | | | | | | |
| *Terebratulina protostriatula* | | | | | | | | | | | | | | | | | | | | | | |
| *Gemmarcula canaliculata* | | | | | | | | | | | | | | | | | | | | | | |

Table 1. Stratigraphic range and geographic distribution of the most representative brachiopod species from Enisala (North Dobrogea, Romania). Vr – Vraconian (uppermost Albian); $C_1$ - Lower Cenomanian

With regard to the occurrence of some brachiopod species in the Vraconian deposits from North Dobrogea, there appears to be an appreciable stratigraphic lag in comparison with faunas from Central and Western Europe. In the brachiopod assemblage from Enisala some species occur almost exclusively in the basal Cenomanian from some regions in Central and Western Europe (Tab. 1). The species that also occur in the Albian, such as *Boubeithyris boubei* (D'ARCHIAC, 1847) and *Capillithyris capillata* (D'ARCHIAC, 1847), belong to genera that show an extended stratigraphic range and wider geographic distribution.

The geographic distribution of the species identified in the Vraconian brachiopod fauna from Enisala is markedly uneven. Most of the brachiopod species are described from Western Europe, whilst in Central Europe, only *Capillithyris capillata* (D'ARCHIAC, 1847) and *Boubeithyris sigma* (D'ARCHIAC, 1847) are recorded from southern Poland and Podolia (Ukraine).

The stratigraphic lag and the uneven geographic distribution of some brachiopod species from Enisala, as compared with their occurrence in Western and Central Europe, can be related to the major palaeogeographic events that took place during the Late Albian-Early Cenomanian time. The mid-Cretaceous transgressing sea determined the migration and the re-establishment of the brachiopod faunas especially during the Cenomanian, as already shown by MIDDLEMISS (1981, 1984 a-b), OWEN (1978, 1988) and GASPARD (1997).

The brachiopods from North Dobrogea demonstrate that many species, which are known in Western Europe in the Early Cenomanian, occurred earlier in Eastern Europe. For instance, the species *Harmatosia crassa* (D'ARCHIAC, 1847), which occurs in Central Asia (Gissar Ridge) in the Late Albian, in North Dobrogea occurs in the latest Albian, whilst in Western Europe (Belgium and Germany) the same species occurs only in the Early Cenomanian. Following the specimen count made by MICHALIK (1992), *Harmatosia crassa* (D'ARCHIAC, 1847) comprises more than 90 % of the Late Albian brachiopod fauna from Gissar Ridge described by LOBACHEVA (1983). The same species is important in North Dobrogea, making up 14 % of the fauna (Text-fig. 3).

It clearly demonstrates that North Dobrogea was located on the main migration route of the mid-Cretaceous brachiopod faunas, from Central Asia to Western Europe (Text-fig. 5). It fits well the palaeobiogeographic maps drawn up by MICHALIK (1992). Both the very long migration route and the short life-time of the brachiopod larvae could explain the much earlier stratigraphic occurrence of the brachiopods identified in North Dobrogea (latest Albian), as compared with their occurrences in Western Europe (Early Cenomanian).

The mid-Cretaceous sea that extended from southern Central Asia across Eastern and Central Europe towards Western Europe created diversified environments, which favoured the brachiopod migration and speciation and thus controlled the stratigraphic and geographic distribution of the mid-Cretaceous brachiopods.

## BRACHIOPOD SYSTEMATICS AND CONVENTIONS

The two volumes of Part H. Brachiopoda in MOORE's edition of the Treatise on Invertebrate Paleontology, published by WILLIAMS & *al.* (1965), have been for a long time the basic reference for brachiopod systematics. The huge amount of new data, which started to accumulate just after the printing of MOORE's 1965 edition, required the revision of the systematics of the group. Consequently, in KAESLER's edition of the Treatise on Invertebrate Paleontology, no less than six volumes are scheduled to revise the brachiopod systematics. Four volumes are already published and the other two are in press.

For the Rhynchonellida we refer to volume 4 (SAVAGE & *al.* 2002), while for the Terebratulida we have benefitted of the revised systematics in the volume 5 (LEE & *al.* 2006), which is in press (D.E. LEE & T.N. SMIRNOVA for the superfamily Terebratuloidea; D.E. LEE, T.N. SMIRNOVA & SUN DONG-LI for the superfamily Cancellothyridoidea; D.I. MACKINNON & D.E. LEE for the superfamily Laqueoidea). For the supra-ordinal classification of the Brachiopoda, the classifications given by WILLIAMS & *al.* (1996) and MANCEÑIDO & OWEN (2001) are herein followed.

In describing the shell morphology and internal characters, the morphological and anatomical terms applied to brachiopods given by WILLIAMS & *al.* (1997) and WILLIAMS & BRUNTON (1997) are used.

**Location of specimens**: The following abbreviation is used to indicate the repository of specimens mentioned in the text: LPB.III.B. – Laboratory of Paleontology, University of Bucharest, Catalogue Romania – Brachiopoda.

**Other abbreviations**: L – length of shell; W – width of shell; T – thickness of shell; W/L – width/length ratio; T/L – thickness/length ratio. All dimensions are given in millimetres. Nearly all measurements are approximate owing to poor preservation of the material.

SYSTEMATIC PALAEONTOLOGY

Order Rhynchonellida KUHN, 1949
Superfamily Hemithiridoidea RZHONSNITSKAYA, 1956
Family Cyclothyrididae MAKRIDIN, 1955
Subfamily Cyclothyridinae MAKRIDIN, 1955
Genus *Cyclothyris* M'COY, 1844

TYPE SPECIES: *Terebratula latissima* J. de C. SOWERBY, 1840

? *Cyclothyris* sp.
(Pl. 1, Fig. 1; Text-fig. 6)

MATERIAL: Eleven specimens (LPB.III.B.0289), in various state of preservation.

DIMENSIONS (in mm):

| Specimen | L | W | W/L | T | T/L |
|---|---|---|---|---|---|
| LPB.III.B.0289/1 | 12.8 | 14.5 | 1.13 | 8.6 | 0.67 |
| " 0289/2 | 15.5 | 15.8 | 1.01 | 10.5 | 0.67 |
| " 0289/3 | 16.0 | 16.3 | 1.01 | 10.8 | 0.67 |
| " 0289/4 | 16.3 | 17.2 | 1.05 | 11.0 | 0.67 |
| " 0289/5 | 17.2 | 18.0 | 1.05 | 11.5 | 0.66 |

EXTERNAL CHARACTERS: Shell slightly broader than long, biconvex, with short massive umbo. Beak suberect, pointed; small foramen, deltidial plates conjunct. Anterior commissure uniplicate, symmetrical. Dorsal valve convex, median fold moderately developed. The ornament is composed of numerous finely rounded costae, rarely interrupted by growth lines. Some of the costae are bifurcated but discernible only on the well-preserved specimens.

INTERNAL CHARACTERS: The low and slender dental lamellae are nearly parallel and persistent (Text-fig. 6, sect. 0.7-3.4). The hinge-teeth are thick, quadrate and deep, nearly vertically inserted. The hinge-plates are slender, gently arched ventrally. Well defined inner and outer socket-ridge. The median septum is very short and does not support the hinge

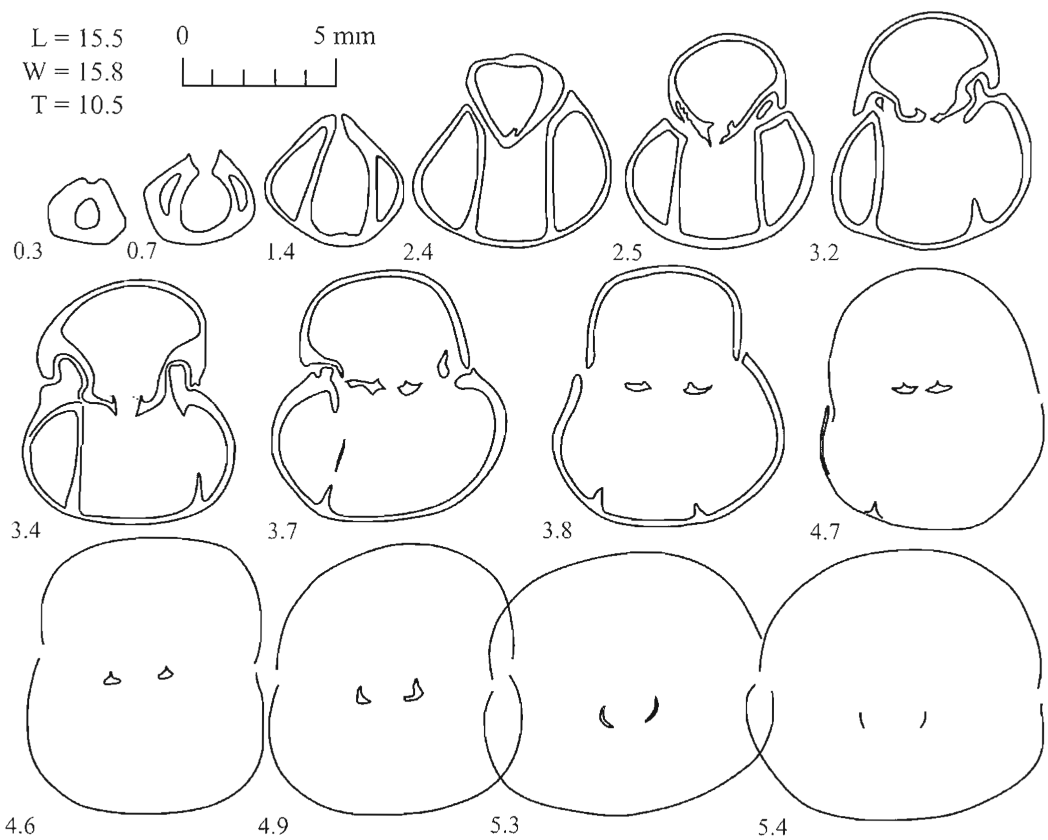


Fig. 6. Transverse serial sections through the umbo of ? *Cyclothyris* sp., LPB.IIIB.0289/2: L, 15.5 mm; W, 15.8 mm; T, 10.5 mm. Distance from the ventral umbo given in mm

plates. Canaliform crura originate from the distal parts of the hinge plates and each is terminated in a Y-shaped fork.

REMARKS: By its external characters our specimens are similar to *Cyclothyris* M'COY, 1844, however the internal characters are different. The small number of poorly preserved specimens does not permit adequate investigation of the internal characters. In correspondence, Dr. Svetlana LOBACHEVA suggested that these specimens could be referred to a new genus of Cyclothyrididae with slim subparallel dental lamellae and with characteristic construction of sharpened hinge plates. In her opinion, the diagram of the transverse serial sections of our specimens is near to the diagram of '*Cyclothyris*' *globata* (ARNAUD, 1877) (non *Cyclothyris*) in the paper of MOTCHUROVA-DEKOVA (1995).

OCCURRENCE: *Cyclothyris* has been mentioned from the Aptian-Maastrichtian across Europe (OWEN 1962; BILINKEVICH & POPIEL-BARCZYK 1979; MOTCHUROVA-DEKOVA 1995; BITNER & MOTCHUROVA-DEKOVA 2005). The specimens from North Dobrogea assigned to ? *Cyclothyris* are from the latest Albian Enisala Member of the Iancila Formation.

Family Tetrarhynchiidae AGER, 1965
Subfamily Cretirhynchiinae KATS, 1974

Genus *Burrirhynchia* OWEN, 1962
TYPE SPECIES: *Rhynchonella leightonensis* LAMPLUGH & WALKER, 1903

*Burrirhynchia* cf. *sigma* (SCHLOENBACH, 1867)
(Pl. 1, Fig. 2; Text-fig. 7)

1969. *Rhynchonella sigma* SCHLOENBACH; PANOW, p. 578, pl. 110, fig. 2.
1974. *Lepidorynchia sigma* (SCHLOENBACH); MARCINOWSKI, p. 123, pl. 20, fig. 7.
1977. *Burrirhynchia sigma* (SCHLOENBACH); POPIEL-BARCZYK, p. 43, pl. 4, figs 6-8, figs 16-17.
1988. *Burrirhynchia* cf. *sigma* (SCHLOENBACH); OWEN, p. 83, pl. I, figs 25-27.

MATERIAL: Three specimens (LPB.III.B.0297), medium sized, undeformed, nearly complete.

DIMENSIONS (in mm):

| Specimen | L | W | W/L | T | T/L |
|---|---|---|---|---|---|
| LPB.III.B.0297/1 | 14.0 | 12.8 | 0.91 | 11.0 | 0.78 |

EXTERNAL CHARACTERS: Shell dorsibiconvex, of medium size, pentagonal in outline, widest near anterior margin, at 0.56 its length. Umbo narrows posteriorly, beak slightly incurved. Pedicle foramen round and small, hypothyrid, deltidial plates disjunct.

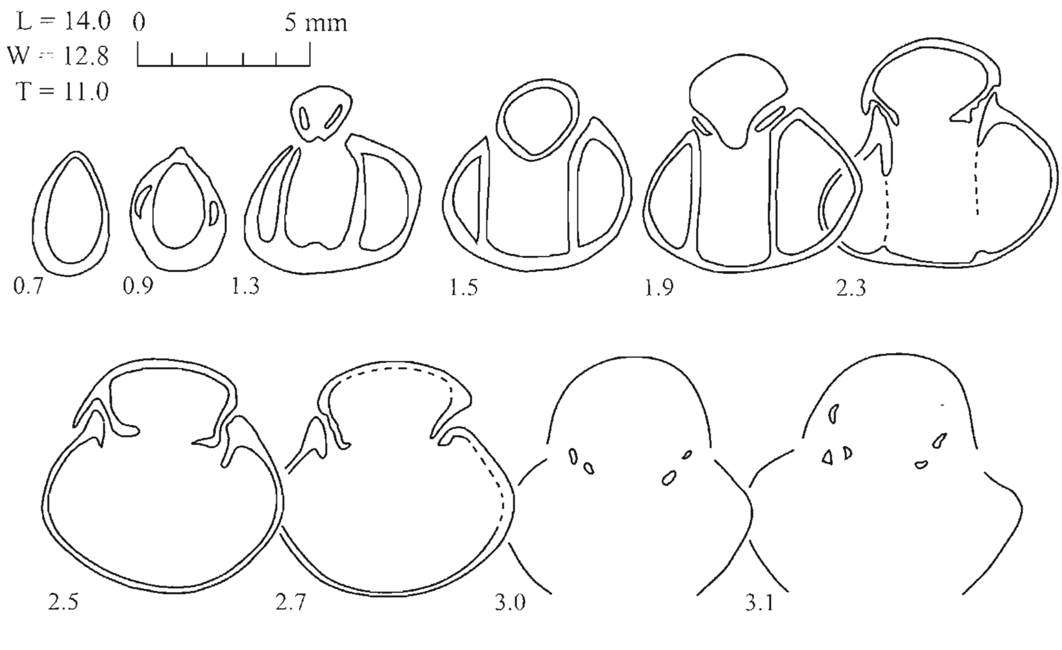


Fig. 7. Transverse serial sections through the umbo of *Burrirhynchia* cf. *sigma* (SCHLOENBACH) figured on Pl. 1, Fig. 2, LPB.IIIB.0297/1: L, 14.00 mm; W, 12.8 mm; T, 11.0 mm. Distance from the ventral umbo given in mm

Interarea long, distinctly concave. Lateral commissure, viewed in profile, has a zigzag fashion. Anterior commissure with sulciplicate sigmoidal aspect. There is a tendency to an accentuated asymmetry of the anterior commissure. The shell has an ornament of 31 to 32 fine and rounded costae on each valve. Dichotomous costae are very rare. Owing to the poor preservation of the shell, the characteristic lamellar growth-lines are not visible.

INTERNAL CHARACTERS: As shown in Text-fig. 7, the dental plates are thin and parallel to each other. Hinge plate narrow, slightly concave in the posterior part, dental socket slightly crenulated, hinge-teeth moderately developed, median septum low, rudimentary.

REMARKS: The specimen from Enisala resembles those from the Albian-Cenomanian of Poland, but the latter ones are subtriangular in outline, with a rounded anterior margin, umbo more elongated and the maximum width about midlength. By its pentagonal outline, the maximum width near the anterior margin, round foramen and anterior zigzag-shaped sulciplicate commissure, our figured specimen is much nearer to *Burrirhynchia sigma* (SCHLOENBACH, 1867) figured by POPIEL-BARCZYK (1977, p. 43, pl. 4, figs 6-8 and figs 16-17). *B. leightonensis* (LAMPLUGH & WALKER, 1903) from the Lower Albian of England, figured by OWEN (1988, pl. 1, figs 28-30) has a much finer costation and the width exceeds the length. *B. devoniana* OWEN, 1988, from England (OWEN 1988, p. 89, pl. 1, figs 22-24) has comparatively fewer costae, 20-25, more deeply incised ribs, and a trapezoidal and high linguiform extension.

OCCURRENCE: *Burrirhynchia sigma* has a wide geographic distribution in Europe. In Western Europe this species occurs in the Lower Cenomanian of South Germany, Belgium and France. In Central Europe this species is common in the Lower Cenomanian of Poland (POPIEL-BARCZYK 1977).

Order Terebratulida WAAGEN, 1883
Suborder Terebratulidina WAAGEN, 1883
Superfamily Terebratuloidea GRAY, 1840
Family Sellithyrididae MUIR-WOOD, 1965
Subfamily Sellithyridinae MUIR-WOOD, 1965
Genus *Sellithyris* MIDDLEMISS, 1959
TYPE SPECIES: *Terebratula sella* J. de C. SOWERBY, 1823

*Sellithyris upwarnensis* (WALKER, 1870)
(Pl. 1, Fig. 3)

1959. *Sellithyris upwarnensis* (WALKER); MIDDLEMISS, p. 118, pl. 16, fig. 7.
1988. *Sellithyris upwarnensis* (WALKER); GASPARD, p. 105, pl. 3, figs 1-6.

MATERIAL: A single specimen (LPB.III.B.0363), nearly complete.

DIMENSIONS (in mm):

| Specimen | L | W | W/L | T | T/L |
|---|---|---|---|---|---|
| LPB.III.B.0363/1 | 27.7 | 22.7 | 0.83 | 18.2 | 0.66 |

EXTERNAL CHARACTERS: Small shell (length less than 30 mm), globulose in shape (thickness about 0.64 of length), rhomboidal ventral profile, maximum wide slightly anterior mid line. P/A ratio 1.5, maximum convexity of ventral valve near the umbo, of dorsal valve about the mid line. Umbo short, straight, beak ridges round, foramen mesothyrid, symphytium short, bordered. Anterior commissure very characteristic: lateral sinusses are abrupt, angular and deep; long median sinus angular and deep; lateral plica angular, the median plica of ventral valve are long and angulate (Pl. 1, Figs 3 a-b, d).

REMARKS: The sharpness of the plicae of the anterior commissure combined with gently rounded large lateral sinuses is a notable feature of *Sellithyris upwarnensis*. This species differs from *Sellithyris sella* (J. de C. SOWERBY, 1823) in being markedly thicker in relation to length, by having a median sinus much larger than the lateral sinusses and much less rounded appearance.

OCCURRENCE: Described from Lower Greensand at Upware and Brickhill (England). Mentioned at Corbières (France).

Genus *Boubeithyris* COX & MIDDLEMISS, 1978
TYPE SPECIES: *Terebratula boubei* D'ARCHIAC, 1847

*Boubeithyris boubei* (D'ARCHIAC, 1847)
(Pl. 1, Figs 4-6)

1847. *Terebratula boubei* nov. sp.; D'ARCHIAC, p. 320, pl. 19, fig. 11.
1978. *Boubeithyris boubei* D'ARCHIAC; COX & MIDDLEMISS, p. 419, pl. 40, figs 1-4; text-fig. 4.
1988. *Boubeithyris boubei* D'ARCHIAC; OWEN, p. 112, pl. 7, figs 4-9.

MATERIAL: Fourteen complete specimens (LPB.III.B.0296) were recovered in the limestones from Enisala.

DIMENSIONS (in mm):

| Specimen | L | W | W/L | T | T/L |
|---|---|---|---|---|---|
| LPB.III.B.0296/1 | 22.2 | 17.0 | 0.76 | 12.2 | 0.54 |
| " 0296/2 | 24.0 | 18.4 | 0.77 | 14.5 | 0.60 |

EXTERNAL CHARACTERS: Oval-pentagonal outline, narrow suberect umbo and well defined sharp beak ridges. The shells are moderately large; foramen circular; symphytium short, not well exposed. Maximum width mid-shell. The anterior margin of the shell is rounded (small specimen, Pl. 1, Fig. 4) or nearly straight (Pl. 1, Fig. 5). The anterior commissure is sulciplicate, the plicae are close set (Pl. 1, Fig. 5), relatively narrow and rounded, resembling the figure presented by OWEN (1988, pl. 7, figs 7-9). The immature individuals have incipiently sulciplicate commissures. The folds of dorsal valve are confined to the anterior third of valve (Pl. 1, Figs 5-6).

REMARKS: The specimens from Enisala are of small size, but close to the W/L and T/L ratio of the specimens figured by OWEN (1988, pl. 7, figs 4-9) from the Lower Cenomanian of Le Havre, in Normandy, and the Tourtia of Tournai, Belgium. As compared to the holotype figured by D'ARCHIAC (1847, pl. 19, fig. 11), the specimens from Enisala are less thick.

OCCURRENCE: Lower Cenomanian from the Tourtia of Tournai, in Belgium; Lower Albian-Cenomanian in United Kingdom (Shenley Limestones of Leighton Buzzard, Bedfordshire), Lower Cenomanian from Le Havre, Normandy.

Genus *Ovatathyris* OWEN, 1988

TYPE SPECIES: *Terebratula ovata* J. SOWERBY, 1812

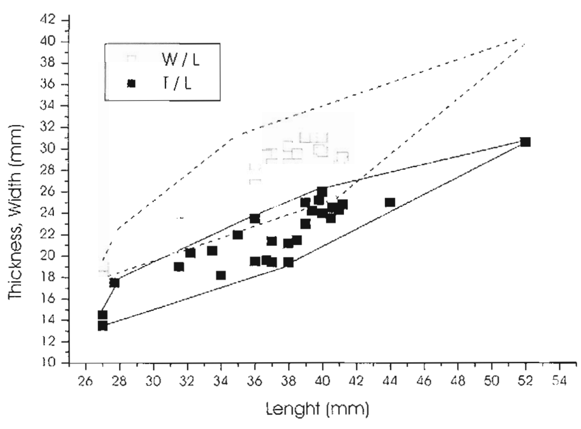


Fig. 8. Intraspecific variation in *Ovatathyris* cf. *potternensis* OWEN. Scatter diagram plotting width/length and thickness/length

*Ovatathyris* cf. *potternensis* OWEN, 1988

(Pl. 1, Figs 7-9; Pl. 2, Figs 1-6; Pl. 3, Fig. 1; Text-figs 8-10)

1847. *Terebratula squamosa* MANTELL; DAVIDSON & MORRIS, p. 254, pl. 18, figs 8 a-b.

1988. *Ovatathyris potternensis* sp. nov.; OWEN, p. 109, text-fig. 16, pl. 7, figs 10-18, pl. 25, figs 1-2.

MATERIAL: Forty-two specimens and numerous fragments (LPB.III.B.0290).

DIMENSIONS (in mm):

| Specimen | L | W | W/L | T | T/L |
|---|---|---|---|---|---|
| LPB.III.B.0290/1 | 33.5 | 24.4 | 0.72 | 20.5 | 0.60 |
| " 0290/2 | 34.9 | 26.6 | 0.76 | 18.6 | 0.53 |
| " 0290/3 | 37.0 | 28.2 | 0.76 | 19.7 | 0.69 |
| " 0290/4 | 38.5 | 29.6 | 0.76 | 21.6 | 0.56 |
| " 0290/5 | 39.2 | 31.2 | 0.87 | 26.5 | 0.67 |
| " 0290/6 | 39.3 | 28.5 | 0.72 | 24.3 | 0.61 |
| " 0290/7 | 39.8 | 30.3 | 0.77 | 25.2 | 0.63 |
| " 0290/8 | 40.4 | 28.6 | 0.70 | 24.7 | 0.61 |
| " 0290/9 | 40.6 | 25.2 | 0.62 | 23.6 | 0.55 |
| " 0290/10 | 41.0 | 28.7 | 0.70 | 24.2 | 0.59 |
| " 0290/11 | 50.2 | 41.0 | 0.81 | 31.2 | 0.62 |

EXTERNAL CHARACTERS: Biconvex shell, robust, commonly obese; fully mature and gerontic individuals may be larger (over 30 mm long). Outline pentagonal-oval to regularly oval (Text-fig. 8). Short, massive, suberect umbo with beak ridges well-defined. Interarea triangular, short pentagonal symphytium with slightly concave base. Mesothyrid or rarely submesothyrid foramen, usually relatively large, circular, with the margin rarely preserved. The maximum width of the shell is just posteriorly to the middle of shell, or little more posteriorly placed. The anterior commissure is usually sulciplicate to paraplicate. The folding shows a wide range of development, usually being confined to the anterior third of the dorsal valve. The ventral valve may be gently folded or may not show any folding. A shallow sulcus starts about mid length, or little below, on dorsal valve and deepens and widens anteriorly, bordered by rounded carina. Owing to the poor state of preservation, the rugose ornament of concentric growth lines and the spinules are visible only on small well-preserved shell surfaces of some specimens.

INTERNAL CHARACTERS: Transverse serial sections through two large specimens (Text-figs 9-10) display a well developed pedicle collar, a wide symphytium and a cardinal process with well developed muscle attachment area. The high cardinal process encloses long and slen-

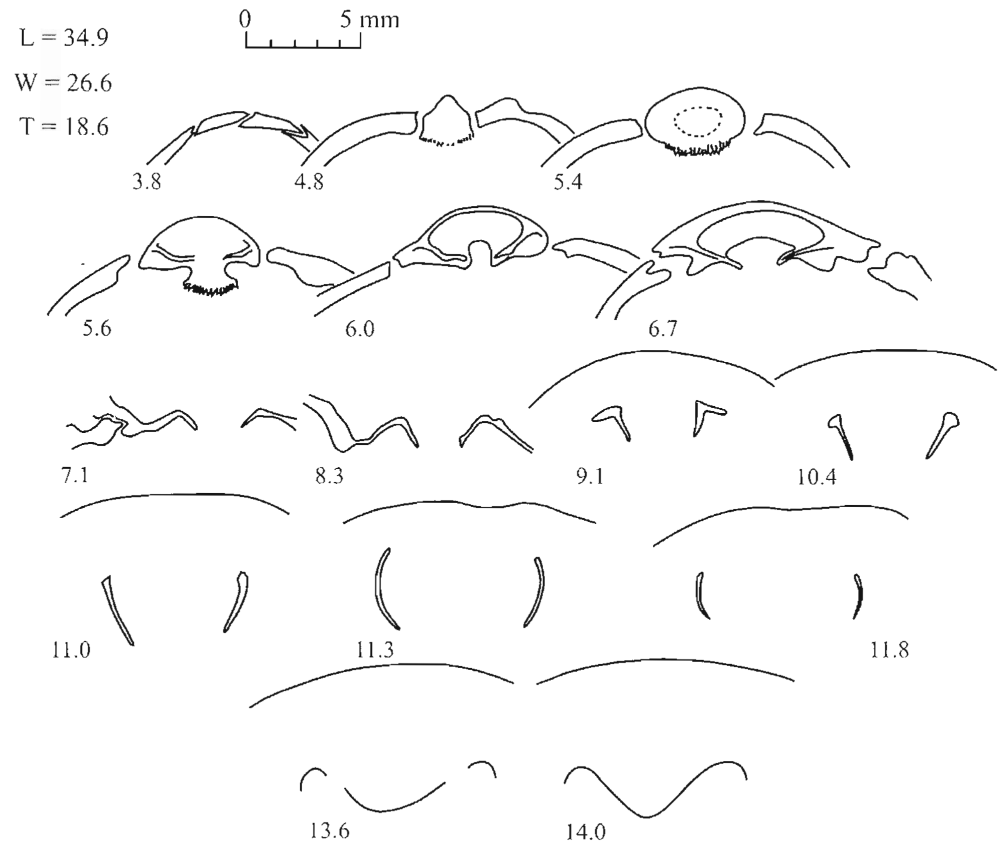


Fig. 9. Transverse serial sections through the umbo of *Ovatathyris* cf. *potternensis* OWEN, LPB.IIIB.0290/2: L, 34.9 mm; W, 26.6 mm; T, 18.6 mm. Distance from the ventral umbo given in mm

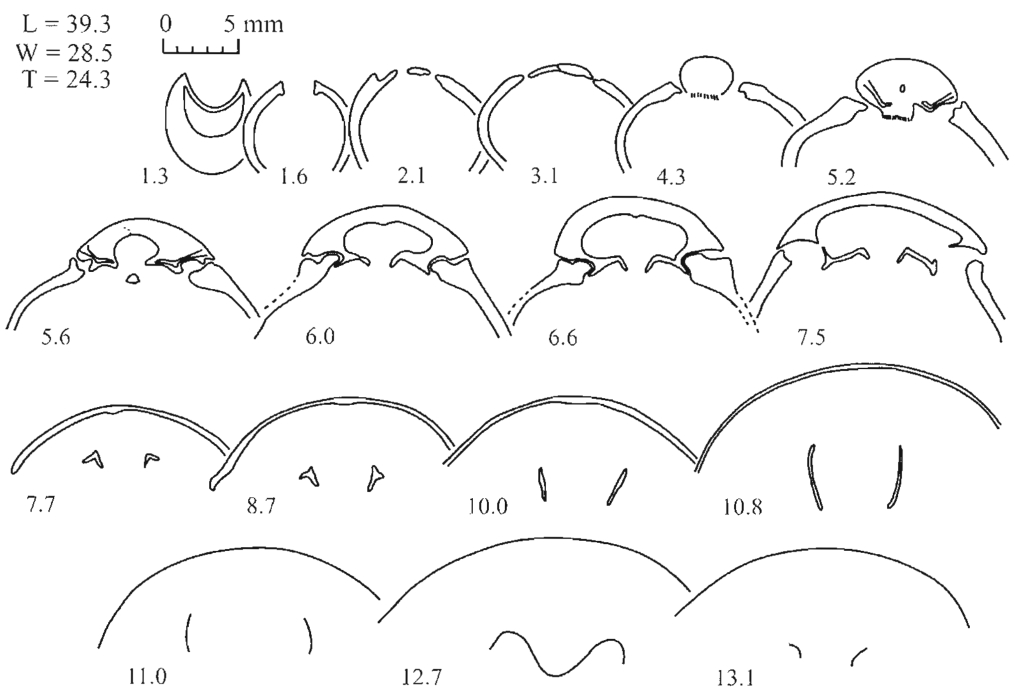


Fig. 10. Transverse serial sections through the umbo of *Ovatathyris* cf. *potternensis* OWEN, LPB.IIIB.0290/6: L, 39.3 mm; W, 28.5 mm; T. 24.3 mm. Distance from the ventral umbo given in mm

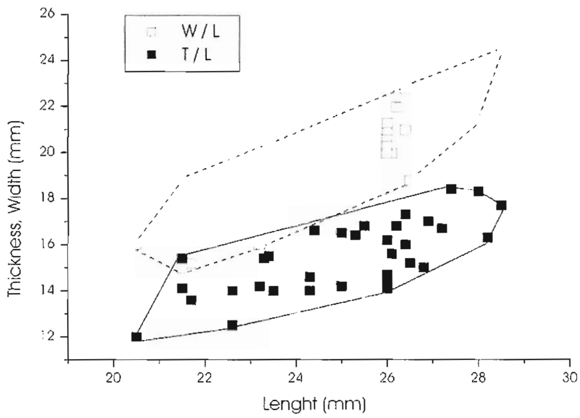


Fig. 11. Intraspecific variation in *Harmatosia crassa* (D'ARCHIAC). Scatter diagram plotting width/length and thickness/length

der initial hinge plates with high crural bases attached at an acute angle to slightly concave hinge plates. The massive and thick hinge teeth with large bases fix into relatively shallow rounded sockets. The inner socket ridges are strong, the outer socket ridge is very weak. Crural processes are long, slender and inwardly curving. The descending branches of the brachial loop have a broad, high-arched transverse band.

REMARKS: Measurement of 35 specimens reveals that in many cases there is considerable variation in size, convexity and plication. In addition, no specimen reveals a tendency to be less biplicate than in *O. potternensis* (OWEN, 1988) from the United Kingdom and the anterior commisssure is frequently more or less asymmetrical. From the congeneric species *O. ovata* (J. SOWERBY, 1812), *Ovatathyris* cf. *potternensis* can be distinguished by its consistently acute biconvexity and its rugose shell ornament. *Ovatathyris* cf. *potternensis* differs internally from *O. ovata* (J. SOWERBY, 1812) and *O. potternensis* (OWEN, 1988) which have a low, flat cardinal process, acutely ventrally concave hinge plates and strong inner and outer socket ridges. From other species of Terebratulidae (*Ornatothyris*, *Boubeithyris*), *Ovatathyris* cf. *potternensis* can be distinguished by its internal characters: angular shape of hinge-plates and high arched transverse band of the brachial loop.

OCCURRENCE: *Ovatathyris potternensis* (OWEN, 1988) occurs in the Lower Cenomanian in the southern British Isles: Upper Greensand from Potterne, Wiltshire and Glauconitic Marl of Compton Bay, Isle of Wight.

Subfamily Nerthebrochinae COOPER, 1983
Genus *Harmatosia* COOPER, 1983
TYPE SPECIES: *Terebratula crassa* D'ARCHIAC, 1847

*Harmatosia crassa* (D'ARCHIAC, 1847)
(Pl. 2, Figs 7-8; Pl. 3, Figs 2-4; Text-figs 11-13)

1847. *Terebratula crassa* nov. sp.; D'ARCHIAC, p. 318, pl. 18, figs 8-9.

1983. *Harmatosia crassa* (D'ARCHIAC); COOPER, p. 196, pl. 19, figs 13-22, pl. 29, figs 8-11; pl. 67, figs 5, 10-11.

1983. *Sellithyris crassa* (D'ARCHIAC); LOBACHEVA, p. 105, pl. 1, figs 10-15; text-fig. 2.

1988. *Harmatosia crassa* (D'ARCHIAC); OWEN, p. 127, pl. 6, figs 4-6.

MATERIAL: Twenty-two complete and ten incomplete specimens (LPB.III.B.0292).

DIMENSIONS (in mm):

| Specimen | L | W | W/L | T | T/L |
|---|---|---|---|---|---|
| LPB.III.B.0292/1 | 20.6 | 16.8 | 0.81 | 14.3 | 0.69 |
| " 0292/2 | 22.6 | 20.3 | 0.80 | 15.4 | 0.69 |
| " 0292/4 | 23.4 | 20.3 | 0.86 | 15.0 | 0.64 |
| " 0292/5 | 24.3 | 20.0 | 0.78 | 16.3 | 0.64 |
| " 0292/6 | 27.2 | 22.5 | 0.81 | 17.7 | 0.61 |
| " 0292/7 | 28.8 | 24.4 | 0.85 | 17.5 | 0.60 |

EXTERNAL CHARACTERS: Short shell acutely convex. The outline is from pentagonal to subpentagonal (Text-fig. 11), with anterior margin large, rounded (Pl. 3, Fig. 4) or straight (Pl. 2, Fig. 8; Pl. 3, Figs 2-3). Large and short umbo with relatively long beak, suberect; foramen small to large, circular, submesothyrid, symphytium large. Long beak-ridge well defined, interarea extensive, concave. Maximum width of shell is at the middle of the valve length. Lateral commissure curved toward ventral valve. Two rounded folds originate at about half the valve length; between these folds there is a shallow dorsal sulcus. Ventral valve has a median carina in the posterior half. Anterior commissure is more or less paraplicate.

INTERNAL CHARACTERS: Owing to the rock hardness the internal structure of the specimens from Enisala cannot be dissected and thus cannot be compared with that of the specimens prepared by COOPER (1983). Instead, we prepared transverse serial sections which show the pattern of the internal morphology (Text-figs 12-13).

A pedicle collar is present. The well-developed cardinal process encloses the initially concave hinge plates. The hinge plates are wide, concave, slender, and are more or less curving in a posterior direction. These are poorly differentiated from the laterally deflected inner socket ridges. The long, strong, nearly vertical hinge teeth are deeply inserted in the brachial valve sockets.

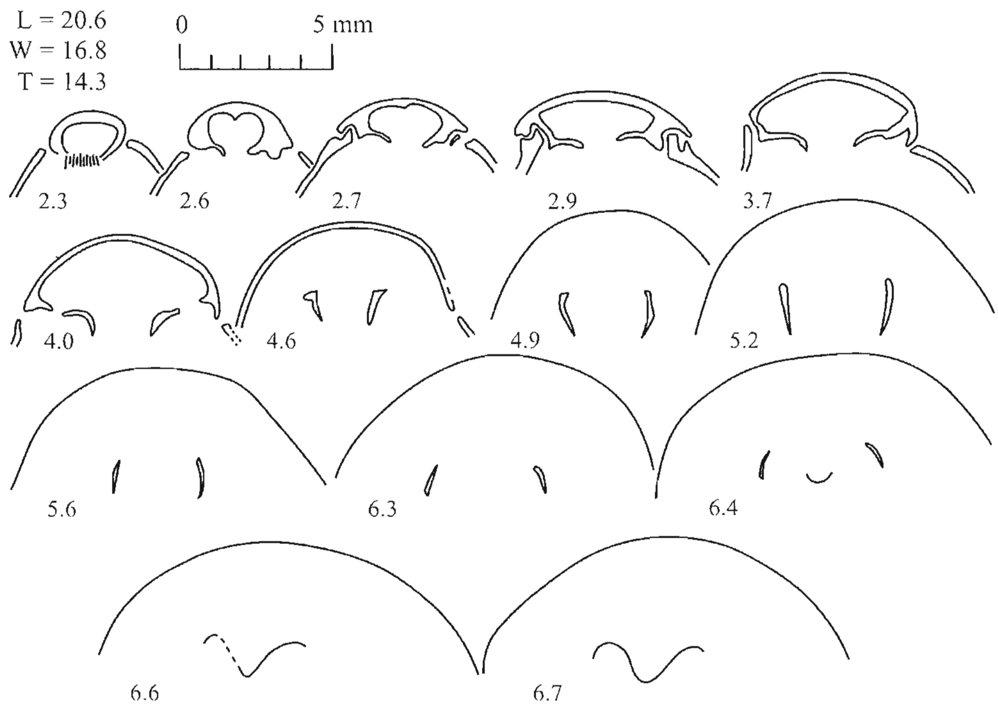


Fig. 12. Transverse serial section through the umbo of *Harmatosia crassa* (D'ARCHIAC), LPB.IIIB.0292/1: L, 20.6 mm; W, 16.8 mm; T, 14.3 mm. Distance from the ventral umbo given in mm

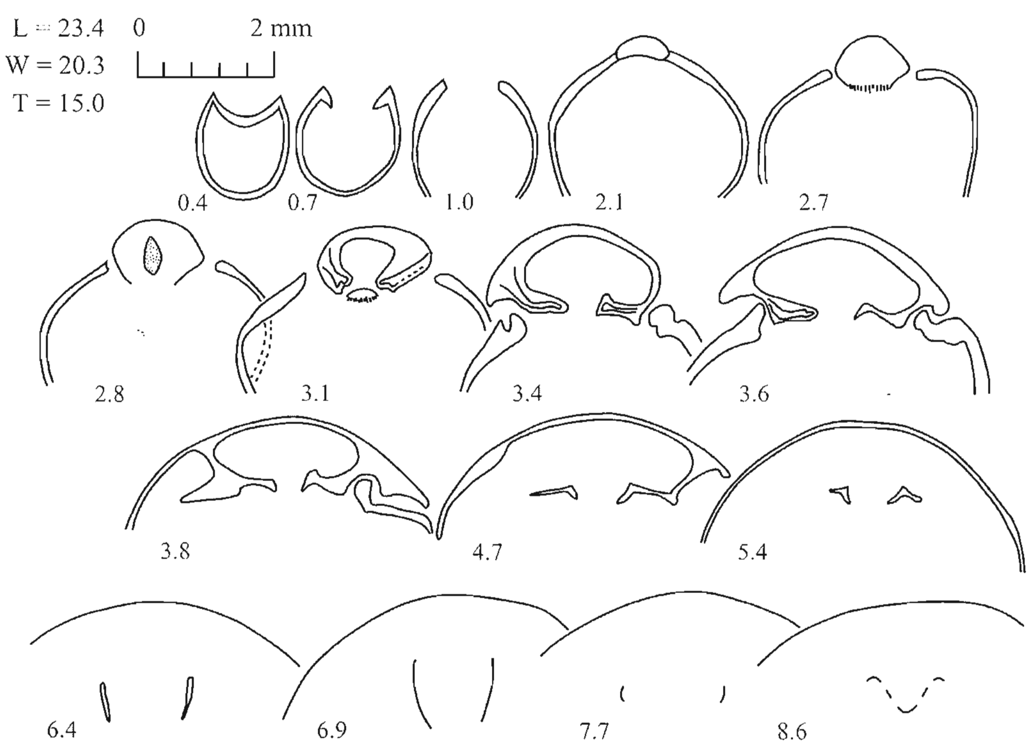


Fig. 13. Transverse serial section through the umbo of *Harmatosia crassa* (D'ARCHIAC), LPB.IIIB.0292/4: L, 23.4 mm; W, 20.3 mm; T, 15.0 mm. Distance from the ventral umbo given in mm

The crural processes are long and slender curving toward one another. The transverse band of the brachial loop is highly arched.

REMARKS: D'ARCHIAC (1847) separated a much larger variant with less convex ventral valve and with folding less pronounced. This variant is present also in our material.

By their external morphology, the Enisala specimens of *Harmatosia crassa* (D'ARCHIAC, 1847) are very close to those described by LOBACHEVA (1983) as *Sellithyris crassa* from the Late Albian of Gissar Ridge. In North Dobrogea there are also the two morphs recognized by LOBACHEVA (1983), but the wider morph occurs more frequently.

By their internal characters, the specimens from North Dobrogea are also similar to those described by LOBACHEVA (1983) as *Sellithyris crassa* (D'ARCHIAC, 1847). Mainly, the aspects of the hinge plates, the size of crura and cardinal processes, the shape and size of transverse band are similar. We emphasize however that the crural processes are less straight and a little thicker toward the posterior extremity, by comparison with the specimens from North Dobrogea.

OCCURRENCE: Described from the Lower Cenomanian of Tourtia in Tournai, Belgium. Mentioned also from Germany by COOPER (1983). Described as *Sellithyris crassa* (D'ARCHIAC, 1847), specimens referable to those of Tourtia of Tournai, were also identified in Central Asia (Gissar Ridge).

Family Capillithyrididae COOPER, 1983
Subfamily Capillithyridinae COOPER, 1983
Genus *Capillithyris* KATZ, 1974
TYPE SPECIES: *Terebratula capillata* D'ARCHIAC, 1847

*Capillithyris capillata* (D'ARCHIAC, 1847)
(Pl. 3, Figs 5-7; Pl. 4, Figs 1-3; Text-figs 14-15)

1847. *Terebratula capillata* nov.sp.; D'ARCHIAC, p. 323, pl. 20, figs 1-3.
1972. *Platythyris capillata* (D'ARCHIAC); POPIEL-BARCZYK, p. 142, pl. 2, fig 8, pl. 4, fig. 1, text-fig.12.
1978. *Platythyris capillata* (D'ARCHIAC); COX & MIDDLEMISS, p. 432, pl. 41, fig. 6, pl. 42, figs 1-2, text-fig. 10.
1979. *Capillithyris capillata* (D'ARCHIAC); BILINKEVICH & POPIEL-BARCZYK, p. 10, pl. 1, figs 1-5, text-figs 4-5.
1997. *Capillithyris capillata* (D'ARCHIAC); GASPARD, p. 152, pl. 2, fig. 8.

MATERIAL: Twenty-four specimens (LPB.III.B.0293), most internal moulds, with the ornament only occasionally preserved.

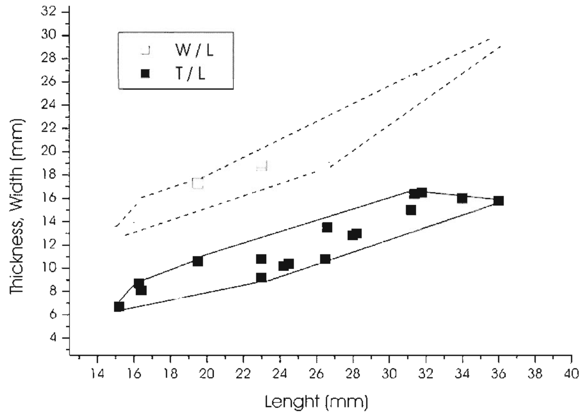


Fig. 14. Intraspecific variation in *Capillithyris capillata* (D'ARCHIAC). Scatter diagram plotting the relationship of width/length and thickness/length

DIMENSIONS (in mm):

| Specimen | L | W | W/L | T | T/L |
|---|---|---|---|---|---|
| LPB.III.B.0293/1 | 23.9 | 20.2 | 0.84 | 9.2 | 0.55 |
| " 0293/2 | 24.7 | 19.9 | 0.80 | 10.9 | 0.44 |
| " 0293/3 | 26.0 | 20.8 | 0.80 | 12.3 | 0.47 |
| " 0293/4 | 28.3 | 22.2 | 0.78 | 12.6 | 0.44 |
| " 0293/5 | 31.4 | 25.7 | 0.82 | 15.0 | 0.47 |
| " 0293/6 | 32.4 | 26.4 | 0.81 | 17.3 | 0.53 |
| " 0293/7 | 34.2 | 26.9 | 0.78 | 15.3 | 0.44 |

REMARKS: COX & MIDDLEMISS (1978, p. 432) and MIDDLEMISS (1978) described this species within the genus *Platythyris*. BILINKEVICH & POPIEL-BARCZYK (1979, p. 10) assigned the species *T. capillata* D'ARCHIAC, 1847, to the genus *Capillithyris* KATZ, 1974, and gave an emended diagnosis for the genus and the species. Our material includes specimens in various ontogenetic stages (Text-fig. 14). In the young stage the contours of the valves are circular and fairly depressed (Pl. 3, Figs 5-7). Over 16 mm in length the specimens have a circular-oval outline (Pl. 4, Figs 1-3), a rectimarginate, uniplicate or slightly sulciplicate anterior commissure and vertical or nearly vertical lateral commissure. Umbo suberect, foramen large, circular, mesothyridid, symphytium short. The characteristic ornament has concentric growth lines and fine radiating lines (capillae). *Capillithyris capillata* (D'ARCHIAC) differs from *Capillithyris podolica* (ZARĘCZNY, 1874) in the type of anterior commissure which is rectimarginate or uniplicate, devoid of sulcus.

The internal characters presented in Text-fig. 15 are typical for the species *Capillithyris capillata* (D'ARCHIAC).

OCCURRENCE: Basal part of Cenomanian in Tourtia of Tournai, Belgium; Cenomanian of Essen and Dresden,

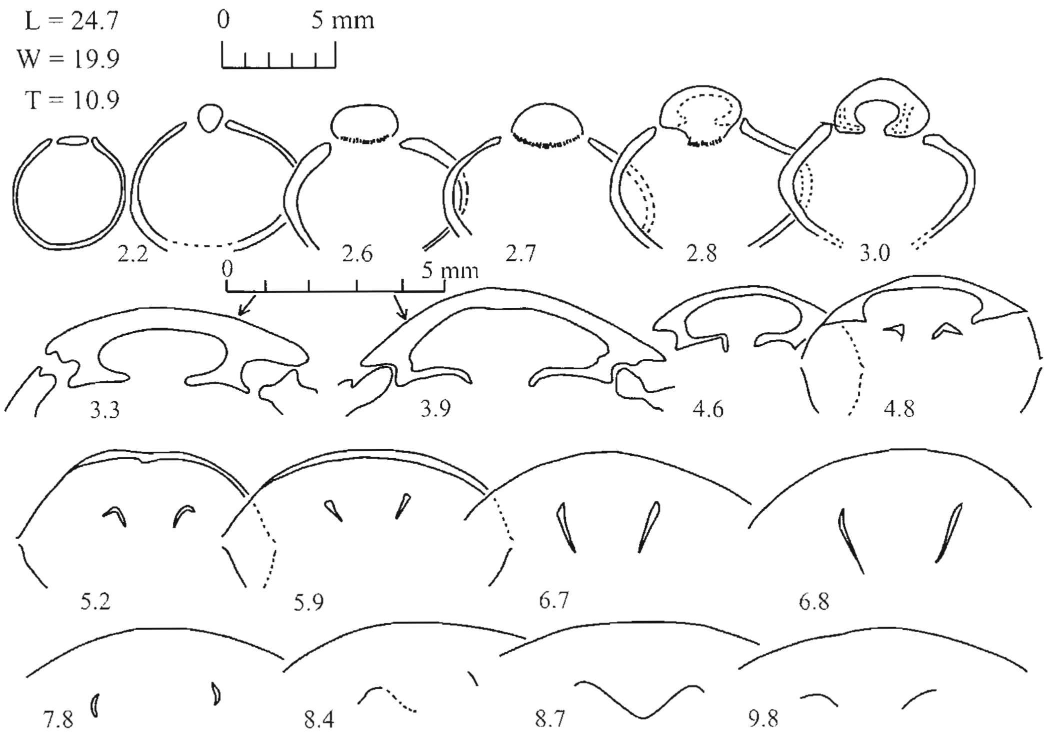


Fig. 15. Transverse serial section through the umbo of *Capillithyris capillata* (D'ARCHIAC), LPB.IIIB.0293/2: L, 24.7 mm; W, 19.9 mm, T, 10.9 mm. Distance from the ventral umbo given in mm

Germany; Shenley Limestone (Lower Albian) in Britain. In Central Europe, *Capillithyris capillata* (D'ARCHIAC, 1847) occurs in Cracow region (Poland) and Podolia (Ukraine).

Superfamily Cancellothyridoidea COOPER, 1973
Family Cancellothyrididae THOMSON, 1926
Subfamily Cancellothyridinae THOMSON, 1926
Genus *Terebratulina* D'ORBIGNY, 1847
TYPE SPECIES: *Anomia retusa* LINNAEUS, 1758

*Terebratulina protostriatula* OWEN, 1988
(Pl. 4, Figs. 4-6; Text-figs 16-17)

1826. *Terebratulina striatula* sp. nov.; J. de C. SOWERBY, p. 69, pl. 536, figs 3-4 (non MANTELL).
1852. *Terebratula striata*, sensu WAHLENBERG; DAVIDSON, pl. 2, figs 25, 27, 28.
1988. *Terebratulina protostriatula* sp. nov.; OWEN, p. 150, pl. 5, figs 1-6, 13-15; pl. 20, figs 1-2.
1997. *Terebratulina protostriatula* OWEN; GASPARD, p. 154, pl. 2, fig. 11.

MATERIAL: Seventy-five specimens of various sizes (LPB.III.B.0291), almost all complete, with partially preserved ornament.

DIMENSIONS (in mm):

| Specimen | L | W | W/L | T | T/L |
|---|---|---|---|---|---|
| LPB.III.B.0291/1 | 18.0 | 13.3 | 0.73 | 6.6 | 0.36 |
| " 0291/2 | 18.0 | 13.6 | 0.75 | 7.1 | 0.37 |
| " 0291/3 | 20.0 | 14.5 | 0.72 | 7.5 | 0.30 |
| " 0291/4 | 21.0 | 15.2 | 0.72 | 7.1 | 0.46 |

DESCRIPTION: All specimens are internal moulds with very few areas of preserved shell. The posterior region of shell is angular and the anterior rounded. A shallow ventral median sulcus extends from the umbonal region. The umbo is slightly produced. The nodulose ornament in the umbonal region is not preserved. The surface ornament consists of dense fine costellae. Variation occurs in the outline of the shell (Text-fig. 16), with a tendency towards a more spatulate outline, and in the density of costation. The internal characters presented in Text-fig. 17 are comparable with those for the genus *Terebratulina* D'ORBIGNY, 1847.

REMARKS: OWEN (1988, p. 151) stated that *Terebratulina protostriatula* OWEN, 1988, differs from *T. striatula* (MANTELL) from the Upper Chalk (Coniacian) which has transversally angular longitudinal

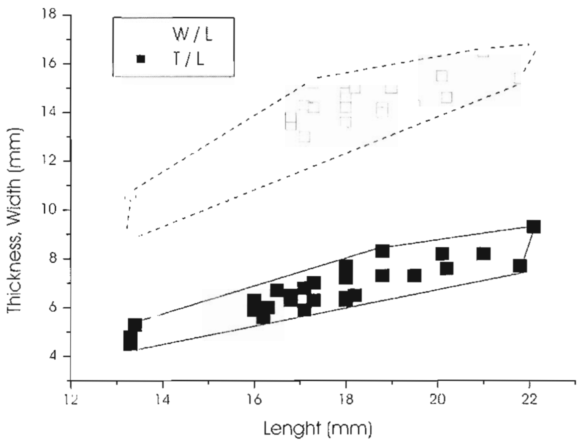


Fig. 16. Intraspecific variation in *Terebratulina protostriatula* OWEN. Scatter diagram plotting width/length and thickness/length

costellae. Photomicrographs given by OWEN (1988, pl. 20, figs 1-2) show that *T. protostriatula*, which is the forerunner of *T. striatula*, has quadrate costellae and an umbonal region with nodulose ornament.

OCCURRENCE: Numerous specimens from the Lower Cenomanian (Lower Chalk, Chalk Marl, Glauconitic Marl, Upper Greensand etc.) from Devon, Dover, Kent, Sussex, Isle of Wight and other localities in Great Britain. In France this species is known from Le Havre, Cap Blanc Nez and Boulonnais. In the Tourtia of Tournai, Belgium, *Terebratulina protostriatula* OWEN, 1988, is rare.

Suborder Terebratellidina MUIR-WOOD, 1955
Superfamily Laqueoidea THOMSON, 1927
Family Terebrataliidae RICHARDSON, 1975
Subfamily Gemmarculinae ELLIOTT, 1947
Genus *Gemmarcula* ELLIOTT, 1947
(= *Trifidarcula* ELLIOTT, 1959)
TYPE SPECIES: *Gemmarcula aurea* ELLIOTT, 1947

*Gemmarcula canaliculata* (ROEMER, 1840)
(Pl. 4, Figs 7-8)

1847. *Terebratula canaliculata* ROEMER; D'ARCHIAC, p. 331, pl. 7, fig. 12, pl. 21, figs 15 a-e.
1977. *Gemmarcula canaliculata* (ROEMER); OWEN, p. 217, text-fig. 6.

MATERIAL: Six specimens (LPB.III.B.0295), four complete and one ventral valve.

DIMENSIONS (in mm):

| Specimen | L | W | W/L | T | T/L |
|---|---|---|---|---|---|
| LPB.III.B.0295/1 | 11.3 | 9.8 | 0.86 | 6.2 | 0.54 |
| " 0295/2 | 12.1 | 10.0 | 0.82 | 7.0 | 0.57 |
| " 0295/3 | 14.5 | 12.6 | 0.87 | - | - |

DESCRIPTION: Small shell with semicircular dorsal valve, slightly convex in the posterior half of valve; posterior margin straight; dorsal umbo short, less prominent. Ventral valve rounded anteriorly, with large triangular

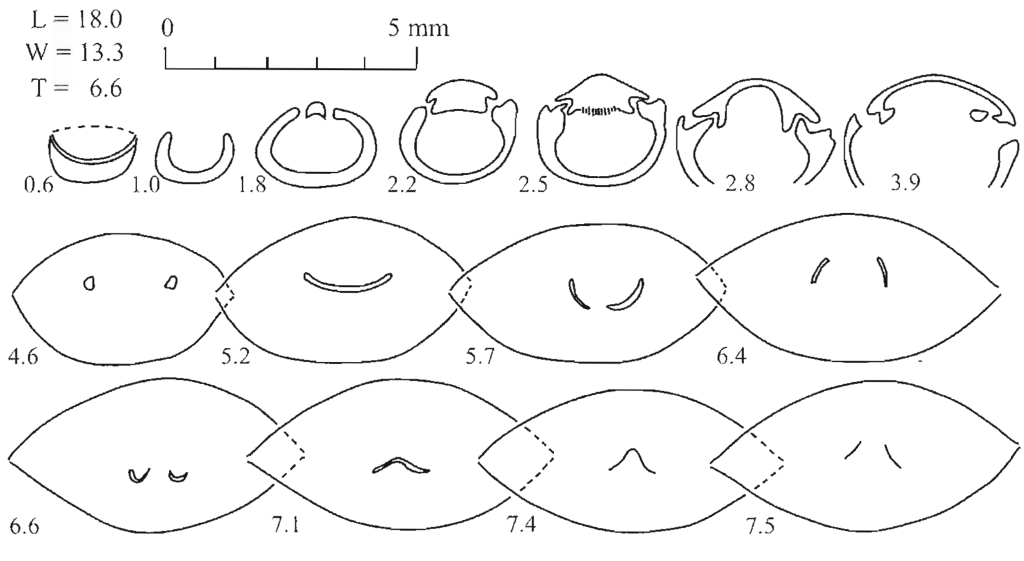


Fig. 17. Transverse serial sections through the umbo of *Terebratulina protostriatula* OWEN, LPB.IIIB.0291/1: L, 18.0 mm; W, 13.3 mm; T, 6.6 mm. Distance from the ventral umbo given in mm

umbo, equal to nearly half of shell area. Small circular foramen, slightly convex long deltidium, conjunct deltidial plates well exposed. The ventral umbo is triangular, broad and produced, with sharp beak ridges bordering an extensive interarea. A faint dorsal fold and fairly well marked ventral sulcus originate from the extreme posterior end of the umbo and widen anteriorly; the peduncular sulcus is bordered by two prominent costae. Anterior commissure is biplicate. Shell ornament of 15-17 rounded radiating costae with marginal bifurcations.

REMARKS: D'ARCHIAC's (1847) description was accompanied by an illustration of the external view of the shell and of the interior of a brachial valve. The remarkable long umbo and shell ornament is comparable to our material. Owing to a small number of specimens and their poor state of preservation the internal characters were not investigated.

OCCURRENCE: *Gemmarcula canaliculata* (ROEMER, 1840) occurs in Belgium (Sables de Gussignies and Tourtia-Cenomanian) and Germany (Hils Conglomerat-Cenomanian). Range: Lower Cenomanian.

*Gemmarcula* sp.
(Pl. 4, Figs 9-13; Text-fig. 18)

MATERIAL: Fifteen specimens (LPB.III.B.0296) in diverse ontogenetic stages.

DIMENSIONS (in mm):

| Specimen | L | W | W/L | T | T/L |
|---|---|---|---|---|---|
| LPB.III.B.0296/2 | 18.0 | 15.6 | 0.83 | 10.3 | 0.57 |
| " 0296/3 | 25.5 | 20.2 | 0.79 | 14.5 | 0.56 |
| " 0296/4 | 25.8 | 19.7 | 0.76 | 13.1 | 0.50 |
| " 0296/5 | 26.0 | 19.5 | 0.85 | 13.8 | 0.53 |
| " 0296/6 | 28.0 | 21.2 | 0.75 | 13.4 | 0.47 |

EXTERNAL CHARACTERS: Small to large, elongate-oval or elongate-pentagonal outline in adult and gerontic stages. The umbo of the ventral valve is broadly triangular and produced, near 1/3 of valve length, with a slightly incurved beak. Sharply defined beak ridges that border a wide, slightly concave, extensive interarea; foramen moderately large, circular, conjunct deltidial plates well exposed and slightly convex. The hinge line is straight and

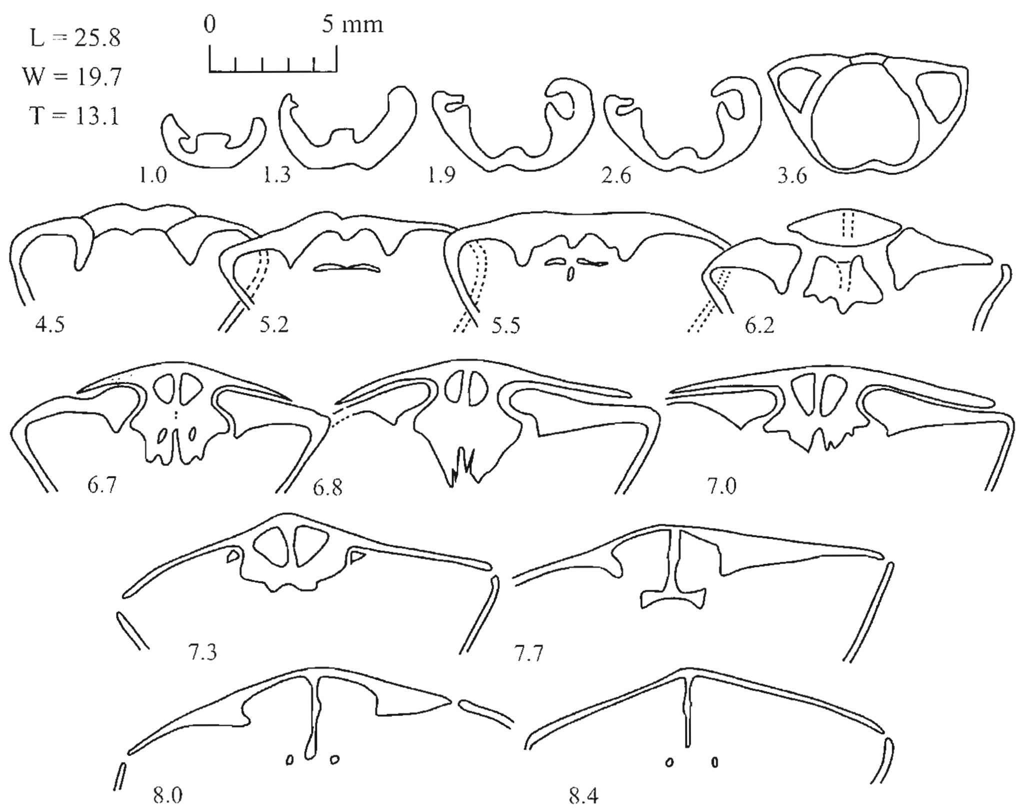


Fig. 18. Transverse serial sections through the umbo of *Gemmarcula* sp., LPB.IIIB.0296/4: L, 25.8 mm; W, 19.7 mm, T, 13.1 mm. Distance from the ventral umbo given in mm

a little narrower than the width of the shell. Unequally convex shell: the ventral valve is much more convex than the dorsal valve, maximum convexity is in the middle of the valve's length. The ventral valve has pronounced median carinae, without a ventral sulcus in the umbonal region. There is no ventral sulcus or dorsal fold, the anterior commissure is consequently rectimarginate. Exceptionally, a gerontic specimen (27.2 mm length, 24.5 mm width) has a slight ventral sulcus. The frontal commissure in gerontic stage has a thickened margin, as seen in Pl. 4, Figs 11-12. The shell surface is ornamented with 40-55 costellae. They bifurcate frequently.

Among the specimens assigned herein to *Gemmarcula* sp. one can recognize the presence of two morphs which at a comparable size have a distinct external morphology. The first morph, including the specimens illustrated on Pl. 4, Figs 10 and 13, shows a much thinner and more rounded frontal part than the second morph, to which the specimens illustrated on Pl. 4, Figs 11 and 12 are referred. Further study of an additional material will demonstrate if the two morphs are distinct species.

INTERNAL CHARACTERS: As seen in transverse serial sections (Text-fig. 18) the dental lamellae are divergent and the cardinalia is thickened; the highly developed cardinal process and high supporting median septum are similar to *Gemmarcula menardi* (LAMARCK, 1819) and *Gemmarcula canaliculata* (ROEMER, 1840) figured by OWEN (1977, text-figs 5-6).

REMARKS: The main difference between *Gemmarcula* sp. and *Gemmarcula canaliculata* (ROEMER, 1840) from Enisala, is in its more elongate anterior tapering of valves and the absence of a ventral sulcus.

OCCURRENCE: From the latest Albian (Vraconian) Enisala Member of the Iancila Formation.

## COMMENTS AND CONCLUDING REMARKS

The latest Albian (Vraconian) brachiopods from Enisala, in North Dobrogea, described in the present paper, are recorded for the first time from the area of the Carpathian foreland in Romania. Generally, brachiopod faunas of Vraconian age are poorly represented in the European shallow-water deposits.

The occurrence of the ammonite genus *Lepthoplites* (GRĂDINARU 2004), in the brachiopod-bearing strata, allows us to define accurately both the age of the brachiopod fauna from Enisala and of the base of sedimentary fill of the Babadag Basin (Text-fig. 19). It demonstrates that the onset of the Mid-Cretaceous marine transgression is placed in latest Albian time in the area of the North Dobrogea which is located immediately west of the Black Sea. Late Albian deposits, well documented with ammonite and inoceramids faunas, were drilled on the eastern offshore prolongation of the Babadag Basin in the western continental shelf of the Black Sea (BĂNCILĂ *& al.* 1997). These data indicate a progressive westward marine transgression from offshore to the onland areas of the Babadag Basin. It fits well into the Aptian-Albian palaeogeography of the European margin of Tethys (DERCOURT *& al.* 1990; GÖRÜR 1991).

| STAGES Substages | | | ZONES Subzones | | Ammonite and brachiopod taxa |
|---|---|---|---|---|---|
| CENOMANIAN | | | | | |
| ALBIAN | Upper | Vraconian | *Stoliczkaia (S.) dispar* | *Arrhaphoceras (Praeschloenbachia) briacensis* | ***Lepthoplites enisalaensis***<br>**? *Cyclothyris* sp.**<br>***Burrirhynchia* cf. *sigma***<br>***Sellithyris upwarnensis***<br>***Boubeithyris boubei***<br>***Ovatathyris* cf. *potternensis***<br>***Harmatosia crassa***<br>***Capillithyris capillata***<br>***Terebratulina protostriatula***<br>***Gemmarcula canaliculata***<br>***Gemmarcula* sp.** |
| | | | | *Mortoniceras (Durnovarites) perinflatum* | |
| | | | | *Mortoniceras (Mortoniceras) rostratum* | |
| | | | ***Mortoniceras (M.) inflatum*** | | |

Fig. 19. Chronostratigraphic scale and ammonite zones and subzones for the Upper Albian in the European faunal province (OWEN 1999), and the stratigraphic position of the brachiopod fauna from Enisala (North Dobrogea, Romania) in the Enisala Member (Vraconian, uppermost Albian) of the Iancila Formation

During the Cenomanian the marine transgression extended over very large areas of stable Europe (PHILIP & FLOQUET 2000). This provided favourable facies conditions for re-establishment and flourishing of the brachiopod faunas (AGER 1965; MIDDLEMISS 1981, 1984 a-b; OWEN 1978, 1988; GASPARD 1997). The Cenomanian brachiopod faunas are commonly known along the southern margin of the north European epicontinental sea from south Great Britain, north France, Belgium, Germany, Poland, Ukraine to Romania and Bulgaria.

The latest Albian brachiopod fauna from Enisala is of major importance for the palaeobiogeography of the Mid-Cretaceous brachiopod faunas in the European area. North Dobrogea as a bridging area between the Crimean and Caucasian regions, on the one side, and the Central and Western European regions, on the other, fills a gap in the previously known geographic distribution of the Mid-Cretaceous brachiopod faunas in Europe.

**Acknowledgements.**

The authors offer many thanks to Dr. Daphne E. LEE (Department of Geology, University of Otago, New Zealand) who provided us the new systematics for Terebratulida adopted in the volume 5 of KAESLER's edition of the Treatise on Invertebrate Paleontology, Part H. Brachiopoda, which is in press, and for a careful review and linguistic improvement of the final version of this paper. Dr. Svetlana LOBACHEVA (VSEGEI, St.Petersburg) is greatfully acknowledged for her comments and suggestions regarding the taxonomy of the specimens assigned herein to ? *Cyclothyris* sp. We thank also Dr. Jan GOLONKA (Institute of Geological Sciences, Jagellonian University, Cracow) who kindly provided us with a palaeogeographic map for the Late Albian. Sincere thanks are due to Dr. Maria Aleksandra BITNER (Institute of Paleobiology, Warsaw) and also to an anonymous reviewer for their critical review and constructive comments on the manuscript. Thanks are extended to Dr. Michael R. SANDY (Department of Geology, University of Dayton, Ohio) who helped improve the quality of the paper. Victor BARBU (Department of Geology and Paleontology, University of Bucharest) is acknowledged for computer processing of some of the text-figures.

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*Manuscript submitted: 20th January 2005*
*Revised version accepted: 20th October 2005*

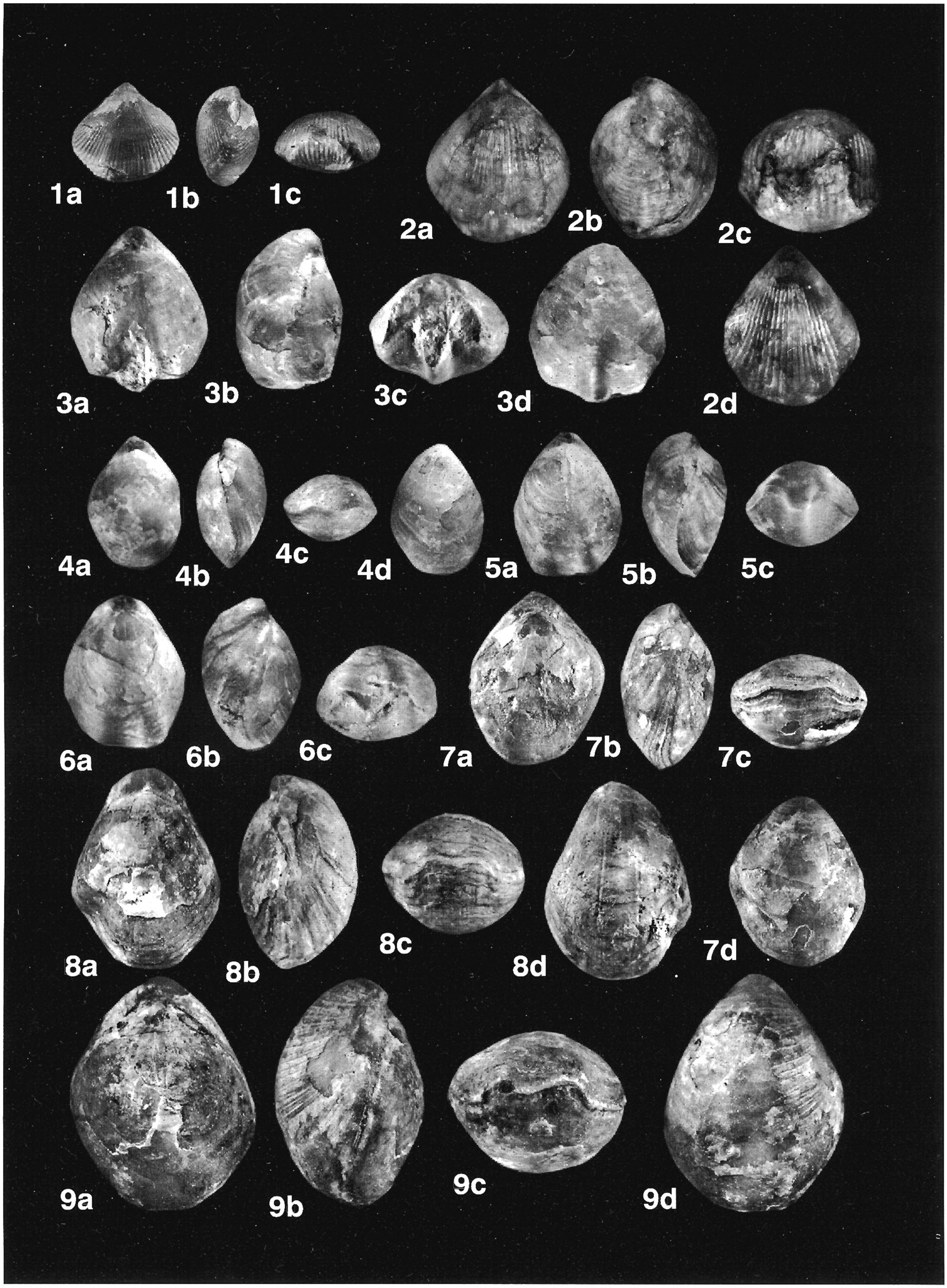
PLATES 1-4

# PLATE 1

All specimens are from the uppermost Albian of the Iancila Formation (Enisala Member) of Enisala (North Dobrogea, Romania)

**1** – ? *Cyclothyris* sp., LPB.III.B.0289/5, all × 1.
**2** – *Burrirhynchia* cf. *sigma* (SCHLOENBACH), LPB.III.B.0297/1, all × 2.
**3** – *Sellithyris upwarnensis* (WALKER), LPB.III.B.0363/1, all × 1.
**4-6** – *Boubeithyris boubei* (D'ARCHIAC), 4 – LPB.III.B.0296/1, 5 – LPB.III.B.0296/2, 6 – LPB.III.B.0296/3; all × 1.
**7-9** – *Ovatathyris potternensis* OWEN, 7 – LPB.III.B.0290/12, 8 – LPB.III.B.0290/1, 9 – LPB.III.B.0290/7; all × 1.

a – dorsal, b – lateral, c – anterior, and d – ventral views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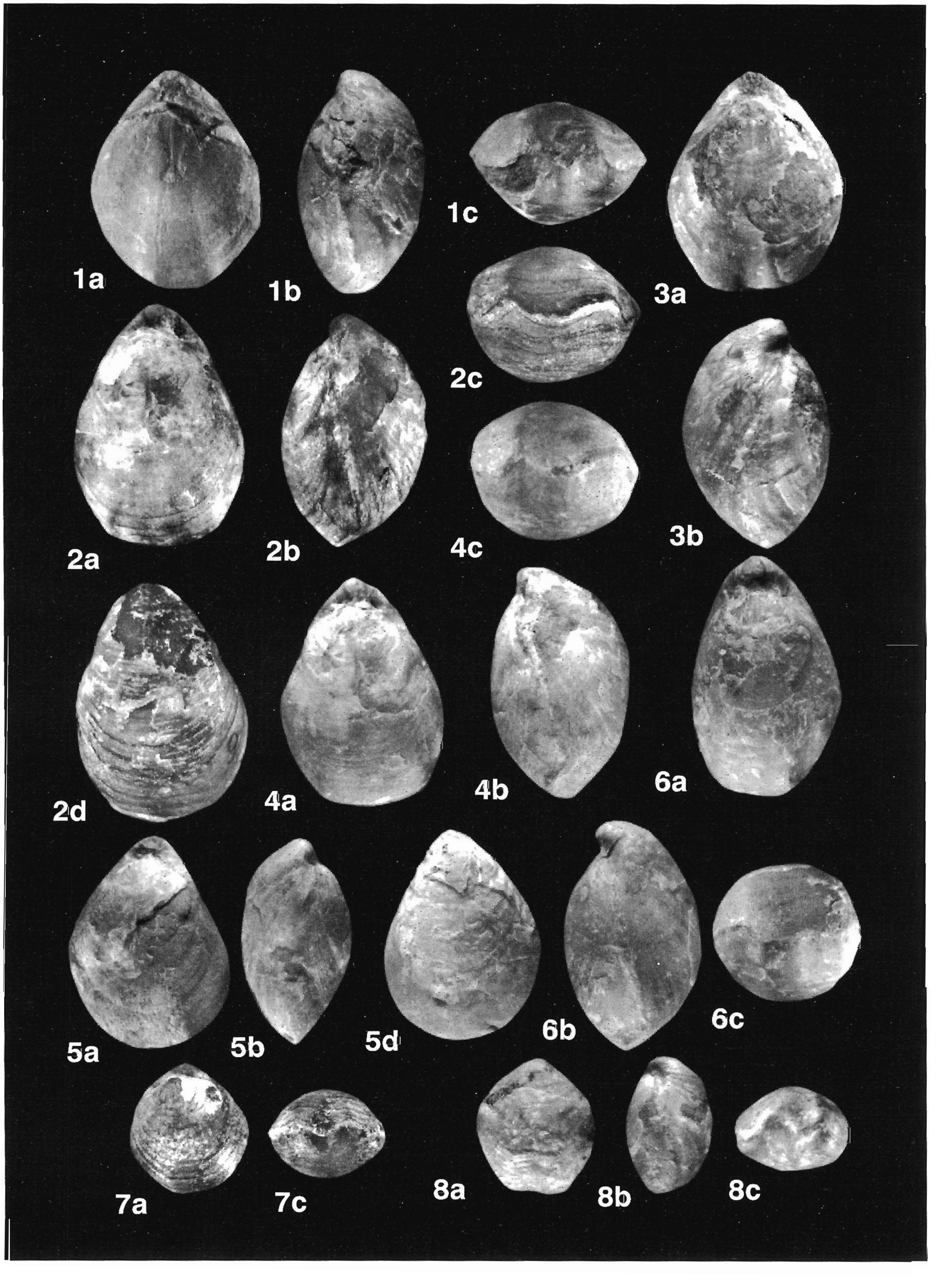
## PLATE 2

All specimens are from the uppermost Albian of the Iancila Formation (Enisala Member) of Enisala (North Dobrogea, Romania)

**1-6** – *Ovatathyris potternensis* Owen, 1 – LPB.III.B.0290/4, 2 – LPB.III.B.0290/9, 3 - LPB.III.B.0290/5, 4 – LPB.III.B.0290/13; 5 – LPB.III.B.0290/3; 6 - LPB.III.B.0290/10; all × 1.
**7-8** – *Harmatosia crassa* (d'Archiac), 7 – LPB.III.B.0292/3; 8 – LPB.III.B.0292/5; all × 1.

a – dorsal, b – lateral, c – anterior, and d – ventral views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7c
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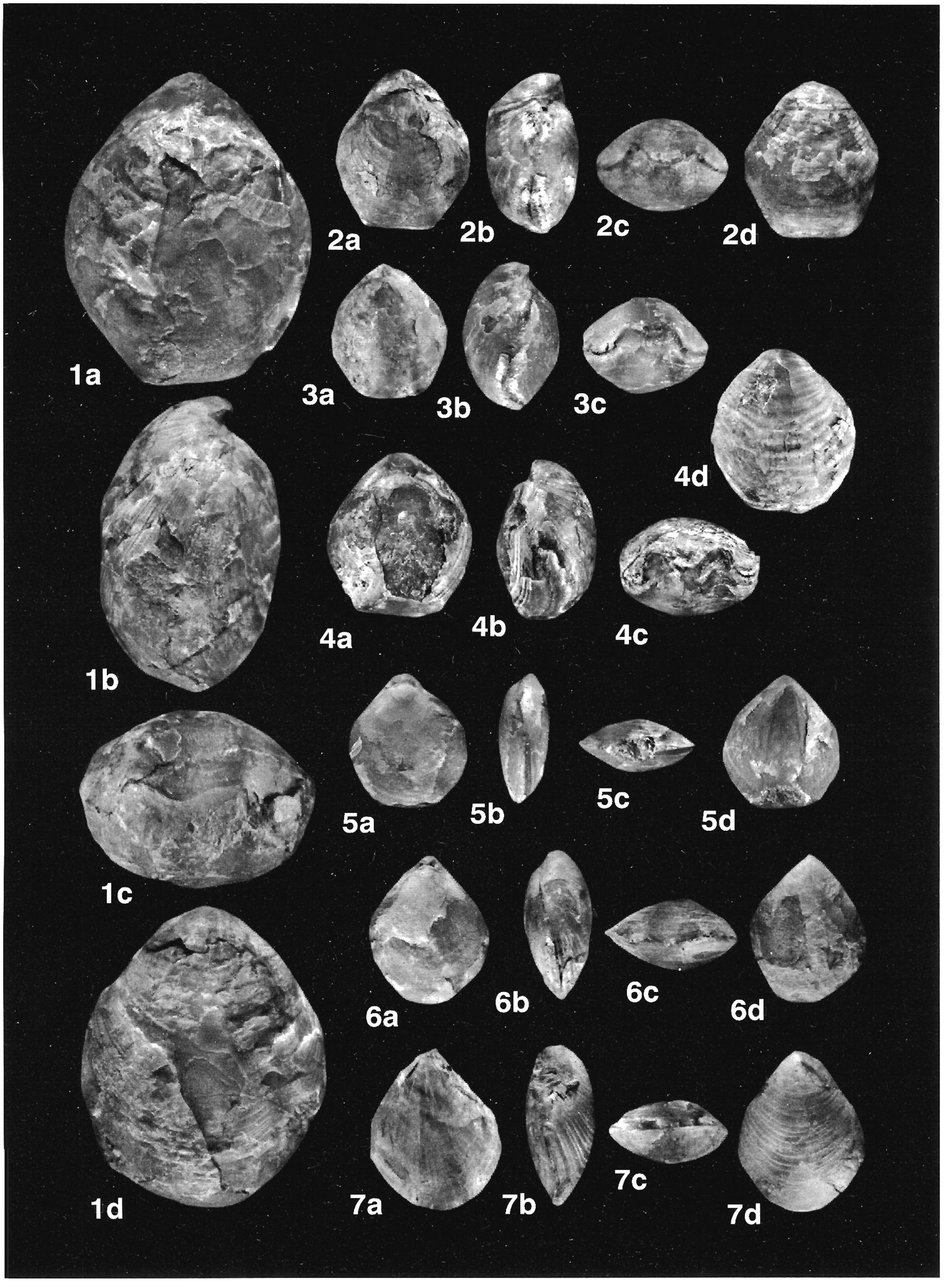
8b
8c

# PLATE 3

All specimens are from the uppermost Albian of the Iancila Formation (Enisala Member) of Enisala (North Dobrogea, Romania)

**1** – *Ovatathyris potternensis* OWEN, LPB.III.0290/11; all × 1.
**2-4** – *Harmatosia crassa* (D'ARCHIAC), 2 – LPB.III.B.0292/2, 3 – LPB.III.B.0292/6, 4 - LPB.III.B.0292/7; all × 1.
**5-7** – *Capillithyris capillata* (D'ARCHIAC), 5 – LPB.III.B.0293/8, 6 – LPB.III.B.0293/12, 7 – LPB.III.B.0293/14; all × 1.

a – dorsal, b – lateral, c – anterior, and d – ventral views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7b
7c
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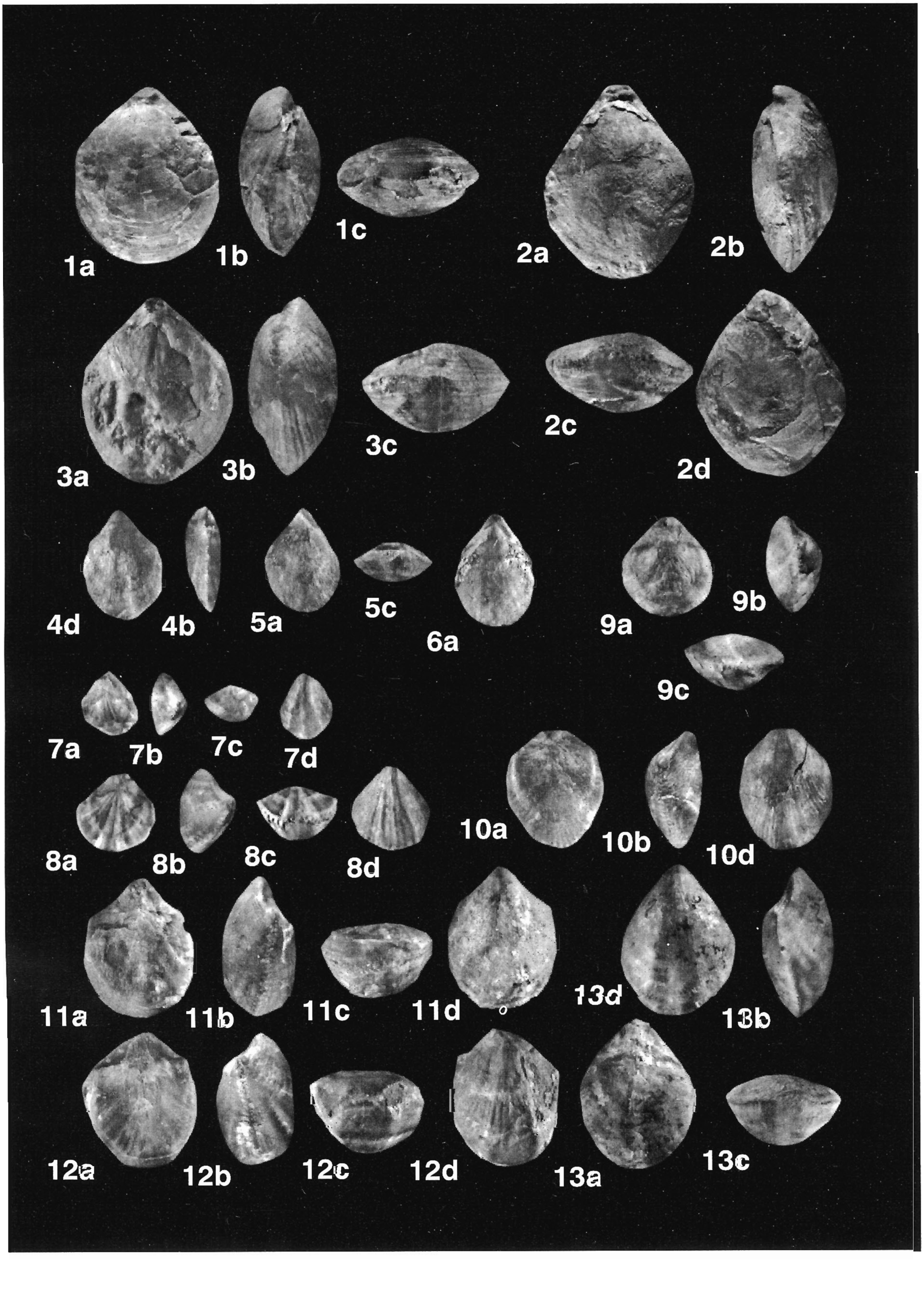
# PLATE 4

All specimens are from the uppermost Albian of the Iancila Formation (Enisala Member) of Enisala (North Dobrogea, Romania)

**1-3** – *Capillithyris capillata* (D'ARCHIAC), 1 – LPB.III.B.0293/15, 2 – LPB.III.B.0293/17, 3 – LPB.III.B.0293/16; all × 1.
**4-6** – *Terebratulina protostriatula* OWEN, 4 – LPB.III.B.0291/2, 5 – LPB.III.B.0291/3, 6 – LPB.III.B.0291/4; all × 1.
**7-8** – *Gemmarcula canaliculata* (D'ARCHIAC), 7 – LPB.III.B.0295/2, 8 – LPB.III.B.0295/4; all × 1.
**9-13** – *Gemmarcula* sp., 9 - LPB.III.B.0296/2, 10 – LPB.III.B.0296/7, 11 – LPB.III.B.0296/8, 12 – LPB.III.B.0296/3, 13 - LPB.III.B.0296/6; all × 1.

a – dorsal, b – lateral, c – anterior, and d – ventral views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