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CLASTS OF UPPERMOST ALBIAN (VRACONIAN) LIMESTONE IN THE EOCENE CUCCURU 'E FLORES CONGLOMERATE OF THE M. ALBO MASSIF (EASTERN SARDINIA)

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Abstract. Rare clasts of richly fossiliferous uppermost Albian (Vraconian *auctt.*) glauconitic and phosphatic, ammonite-bearing limestone have been found in the Eocene Cuccuru 'e Flores Conglomerate in the area of M. Albo massif (eastern Sardinia). The limestone is wholly comparable in facies and fossil assemblage to the classical outcrop known in the Orosei area. The fossil content includes also brachiopods and abundant planktonic foraminifers of the *Thalmanninella* (formerly *Rotalipora*) *appenninica* Zone. In the palaeontological part the brachiopods *Orbirhynchia parkinsoni* and *Capillithyris capillata* are described and discussed. Vraconian highly condensed deposits, characterized by basal erosional gaps of variable importance, have particular relevance, being known to be widely distributed in the northern Tethyan margin with common characteristics, such as authigenic glauconite, phosphatic nodules and a rich outer-shelf fauna.

Riassunto. Rari clasti di un calcare glauconitico e fosfatico ricco di ammoniti dell'Albiano terminale (Vraconiano *auctt.*) sono stati ritrovati nella formazione eocenica del Conglomerato di Cuccuru 'e Flores nel massiccio del Monte Albo (Sardegna orientale). Il calcare presenta facies e faune del tutto simili a quelle del classico affioramento noto nell'area di Orosei. Il contenuto fossilifero comprende anche brachiopodi e foraminiferi planctonici della Zona a *Thalmanninella* (ex *Rotalipora*) *appenninica*. Nella parte paleontologica i brachiopodi *Orbirhynchia parkinsoni* e *Capillithyris capillata* vengono descritti e discussi. Depositi vraconiani altamente condensati, caratterizzati da lacune basali di varia importanza, hanno un significato paleogeografico particolare, essendo largamente diffusi in corrispondenza del margine settentrionale della Tetide con caratteristiche comuni, quali presenza di glauconite autigena, noduli fosfatici e una ricca fauna di piattaforma esterna.

Introduction (I. Dieni & F. Massari)

Clasts of syntectonic conglomerates derived from the cannibalization of formerly outcropping formations no longer existing today are useful for the reconstruction of the original stratigraphic succession. They provide in addition useful clues to the palaeogeography and palaeostructural setting at the time of deposition and progressive unroofing process. The study of the clasts of the Eocene Cuccuru 'e Flores Conglomerate, forming syntectonic debris aprons lining fault scarps generated by the Pyrenean tectonics in eastern Sardinia, proved to be useful for the reconstruction of the original Mesozoic to Palaeogene succession existing before its large-scale denudation. The purpose of this paper, in particular, is to document the presence of rare limestone clasts with a palaeontological assemblage typical of the uppermost Albian (Vraconian in the French usage or Vraconnian following Amédro, 2002) in the conglomerate cropping out at the toe of the Monte Albo massif near the village of Siniscola. As the youngest term of the local Cretaceous succession is represented by lower Hauterivian limestones, the finding of Vraconian glauconitic limestone clasts in the conglomerate documents the former presence in the local sedimentary cover of this stratigraphic interval, so far known in Sardinia only in an areally very restricted outcrop located near Orosei (Dieni & Massari 1965; Wiedmann & Dieni 1968) (Fig. 1).

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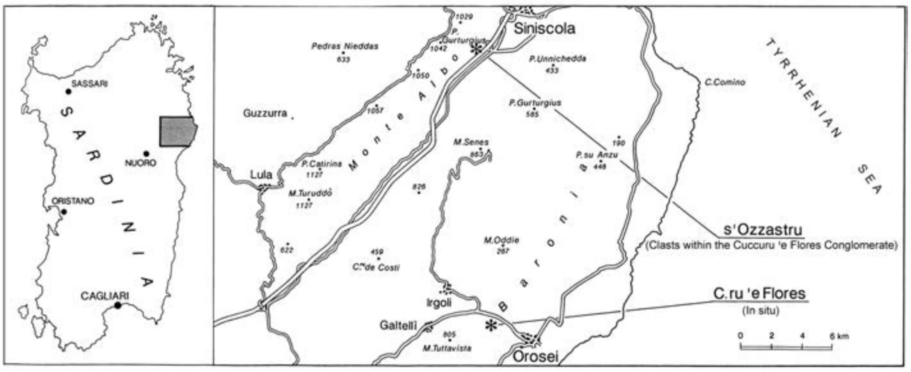


Fig. 1 - Sardinian sites in which uppermost Albian (Vraconian) limestones are so far known.

The Cuccuru 'e Flores Conglomerate: general characteristics and tectonic setting (I. Dieni & F. Massari)

The Cuccuru 'e Flores Conglomerate (CFC), cropping out in eastern Sardinia (Baronie and Supramonte areas between Oliena and Dorgali), is a polymictic rudite, locally exceeding 200 metres in thickness, forming elongate, syntectonic debris aprons lining scarps linked with the major Cenozoic faults (Dieni & Massari 1966; Carmignani et al. 2001; Dieni et al. 2008 and references therein). It unconformably lies on a deformed substrate of Middle Jurassic to Lower Eocene formations, locally with angular basal discordance and, in places, on the Palaeozoic basement intruded by granitoid bodies and related dykes.

The northernmost outcrops of the formation are located on the hills between the villages of Siniscola and La Caletta. Southwards, the CFC is present on the hills east of the Monte Tuttavista, near Orosei (type area of the formation; Dieni & Massari 1966), and in the carbonate massif known as Supramonte of Oliena and Dorgali (see Dieni et al. 2008, fig. 1).

Most of the deposits consist of breccias, ranging from chaotically accumulated to regularly stratified, with locally occurring interbedded sandstones. Among the rudites, clast-supported, tightly cemented types predominate, with smaller amounts of mudstones and pebbly/cobbly mudstones emplaced by cohesive debris flows (Panatta area on the eastern slope of Cuccuru 'e Flores, west of Orosei).

The composition is variable from place to place, as the clasts mostly reflect the nearby terms of the local succession, from the Palaeozoic substrate to upper Cuisian (Shallow Benthic Zone SBZ 12 of Serra-Kiel et al. 1998) nummulitic limestones (Dieni & Massari 1966; Dieni et al. 2008, and references therein). The rudites contain a wide range of lithologies of the Palaeozoic basement (phyllites, micaschists, para- and orthogneiss, quartzites, granites and related dykes) and the Middle Jurassic to Lower Eocene cover, including Bathonian-Kimmeridgian dolostones (Dorgali Dolostone), Middle Jurassic – lowermost Cretaceous limestones (S'Adde Limestone and Monte Bardia Limestone), Lower and Upper Cretaceous limestones, cherty limestones and marls, phosphatised and glauconitised Gargasian, Clansayesian and Vraconian hard-grounds (respectively corresponding to the middle Aptian, upper Aptian and uppermost Albian. We refer to the French usage due to the close affinity between the Cretaceous successions and faunas of Sardinia and southern France). Also it contains Palaeocene (Danian to Thanetian) and Lower Eocene limestones with larger foraminifers and hybrid arenites (Dieni et al. 2008 and references therein).

The matrix of conglomerates commonly contains reworked microfossils including foraminifers and various types of bioclasts. The youngest reworked fossils are Cuisian nummulites (particularly reported in the Orosei and Oliena Supramonte areas), locally associated with clasts of Cuisian nummulitic limestones, allowing to place an upper age limit for the formation.

For a better age constraint, a number of samples from the mudstone interbeds of the CFC west of Orosei (eastern slope of Cuccuru 'e Flores, Panatta area) have been treated for palynological analysis (Dieni et al. 2008). Although the palynofloras do not allow high resolution in their chronostratigraphic assignment, the available data support an early middle Lutetian age, which is younger than the ages of the reworked marine microfossils found in the matrix of the CFC (Dieni et al. 2008).

Although the composition generally reflects the lithology of nearby cropping out formations, the rudites also contain clasts of lithologies and ages having no counterparts in the surrounding area, thus providing important clues to the original stratigraphic succession, as well as local palaeogeography, especially in Palaeocene times, as formations of this age are now completely lacking in eastern Sardinia. The compositional analysis provides also important hints to the palaeostructural setting. Striking differences in lithology and facies between clasts and nearby outcropping coeval formations highlight a complex palaeogeography and imply significant synsedimentary tectonics. For instance, at Sovana (near Lanaittu, Supramonte of Oliena) the CFC contains clasts of Campanian and Maastrichtian shallowwater rudist limestones, of which the age-equivalent outcropping units in nearby areas are hemipelagic black marls with sparse turbidite sandstone layers (Busulini et al. 1984).

The vertical changes in rudite composition provide useful clues to the progressive unroofing process. In fact, the ongoing denudation process commonly produced an inverted succession of lithologies with respect to the inferred local stratigraphy.

Clast composition suggests denudation of a very rugged topography resulting from a phase of considerable rejuvenation of the relief thought to result from severe tectonic movements (Dieni et al. 2008 and references therein). An Eocene phase of tectonic structuration accompanied by a strike-slip regime, supposedly coeval with that affecting Corsica during the collisional phase, has been identified in Sardinia by Chabrier (1970), Chabrier & Mascle (1975, 1984), Dieni et al. (1979), Letouzey et al. (1982), Cherchi & Montadert (1984), Barca & Costamagna (1997) and Lecca et al. (1997). It was interpreted as the regional expression of a major deformation event of the European margin as a response to the thrusting which affected the Alpine and Pyreneo-Provençal chains during the Eocene. The lack of marine Lutetian and younger elements in the conglomerate indirectly supports the Middle Eocene age of the Pyrenean tectonic phase in Sardinia, to which the deposition of the CFC is linked (Zattin et al. 2008).

The Cuccuru 'e Flores Conglomerate of the Monte Albo massif (I. Dieni & F. Massari)

The local succession cropping out in the Monte Albo massif and forming the substrate of the conglomerate includes a basal dolomitic complex of Bathonian age (Dorgali Dolostone), followed by distinctly bedded Callovian-Kimmeridgian micritic limestones with ammonites and cherty levels (S'Adde Limestone), and a thick carbonate complex (grainstones, rudstones and algal bindstones) of Tithonian to Berriasian age (M. Bardia Limestone). The youngest term of the local Cretaceous succession is represented by lower Hauterivian limestones.

The CFC rudites in the study area (s'Ozzastru quarry of the cement factory near Siniscola; Fig. 1) line an important NE-trending fault at the toe of the Mesozoic massif of the Monte Albo (see Dieni et al. 2008, fig. 1 and fig. 4 for a detailed stratigraphic log).

Sedimentological features of the conglomerates include a-axis imbrication, ubiquitous inverse, normal and oscillation grading, and local occurrence of slumped beds. These characteristics indicate that the deposits were laid down by high-concentration gravity flows in a subaqueous environment, on high-gradient slopes bounding uplifting blocks. Sandy layers interbedded with the conglomerates are characterized by relatively common bioturbation. A marine depositional environment is indicated by the ichnofossil association, especially *Scolicia*, a trace currently attributed to irregular echinoids (Dieni et al. 2008). The local depositional area was probably an embayed basin surrounded by emerged fault-bounded ridges. Rapid dismantling of the ridges generated coarse-textured sediment, which was accumulated at their toe by means of sediment gravity flows. Very rapid lateral changes in composition support a setting characterized by aprons of laterally interfingering debris cones at the toe of active tectonic scarps.

The clasts of Vraconian limestone (I. Dieni & F. Massari)

The rare clasts of Vraconian limestone occurring in the conglomerate at the s'Ozzastru quarry, have been found in the lowermost coarsest part of the formation. Among them, a glauconitic and phosphatic brown limestone cobble (20x18x13 cm) (Fig. 2) yielded a rich palaeontological assemblage (micro- and macrofauna). The finding is highly interesting for the inferences concerning the original stratigraphic succession prior to the drastic denudation which accompanied the formation of the conglomerate. The facies and lithological features are wholly comparable to those reported for the Vraconian horizon occurring in an isolated and areally very restricted outcrop in the Panatta area near Orosei (Dieni & Massari 1965; Wiedmann & Dieni 1968; Fig. 1). Here the horizon overlies, with basal angular discordance, a relatively complete Lower Cretaceous succession composed of a number of upward-shoaling sequences commonly capped by fossiliferous glauconitic and phosphatic hardgrounds (Dieni & Massari 1965). This succession is overlain, by means of an erosional and angular unconformity, by a highly condensed conglomeratic limestone horizon of late Albian age (Vraconian), crowded with ammonites and intraformational glauconitic and phosphatic clasts, and locally underlain by a transgressive encrinitic facies (Dieni & Massari 1965; Wiedmann & Dieni 1968).

Thin-section analysis reveals that the brown Vraconian limestone from s'Ozzastru quarry is a biomicrite rich in corroded, mineralized, encrusted and bored intraclasts (Fig. 2), associated with lithoclasts of older (?) Lower Cretaceous formations. Clasts are commonly composite, i.e. incorporating other clasts at their interior. Mineralization occurs essentially as glauconite and phosphate replacement and encrustation of clasts and, to a lesser extent, replacement of carbonate matrix and skeletal grains, among which ammonites, commonly occurring as fragments.

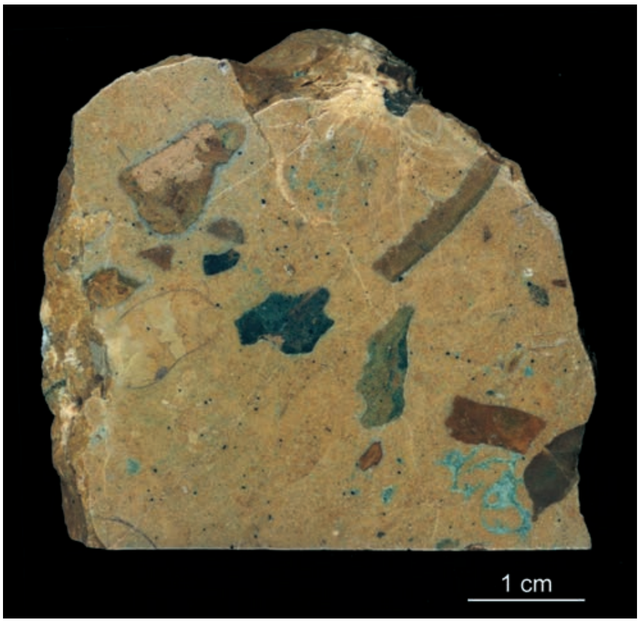


Fig. 2 - Polished cut of the Vraconian limestone cobble included in the Cuccuru 'e Flores Conglomerate at s'Ozzastru quarry, near the village of Siniscola. The brown matrix contains dark-green glauconitised and brown phosphatised clasts. Glauconite is also present as replacement haloes on the margins of some clasts (upper left), as well as bluish green irregular patches (lower right) and sparse grains. A fragment of hard-ground crust (upper right) and a tangential section of a small ammonite (centre left) may be observed.

XRPD analysis has been carried out on a portion of the matrix and on a phosphatized clast. The matrix is composed essentially of calcite with goethite and quartz in traces. The phosphatised clast is composed of apatite (probably carbonate apatite), calcite, goethite in minor amount and quartz in traces.

Glauconite occurs either as replacement product, or as isolated grains with commonly lobate contours, or as infilling of foraminiferal chambers. Intraclasts show varying degrees of phosphatisation and glauconitisation and generally show irregular and commonly angular contours. They appear to be eroded and resedimented pieces of hardgrounds. The intraclasts, as well as skeletal remains and planktonic foraminifers, may show peripheral microborings, sometimes themselves truncated, and appear commonly coated by phosphate stromatolites occurring both as external crusts and as cavity-dwelling endostromatolites. The stromatolites show a rhythmic growth pattern of alternating phosphate, carbonate and iron hydroxide laminae, with fine particles trapped and bound between the laminae during the growth. The crusts enveloping clasts appear locally truncated, and isolated fragments of crusts appear also as clasts, indicating repeated phases of microbial encrustation, brecciation and redeposition. The rock may be defined as a conglomeratic hardground formed in conditions of extreme stratigraphic condensation, as a result of processes of sedimentation, cementation, brecciation, encrustation, boring and mineralization of the clasts and renewed sedimentation, repeated many times and recording a complex early diagenetic history (Fig. 2).

Macrofossils are abundant and commonly fragmented. Among the ammonites the following taxa, also reported in the Orosei area (Wiedmann & Dieni 1968), have been identified:

Lechites gaudini (Pictet & Campiche, 1861)
Ostlingoceras puzosianum (d'Orbigny, 1842)
Mariella (*M.*) *bergeri* (Brongniart, 1822)
Desmoceras (*D.*) *latidorsatum* (Michelin, 1838).

The first three species are markers of the "upper Vraconnian" *sensu* Amédro (2002).

Echinoids are represented by *Conulus castanea* (Brongniart, 1822) and brachiopods by *Orbirhynchia parkinsoni* Owen, 1960 and *Capillithyris capillata* (d'Archiac, 1847), both described in the palaeontological part.

The following species of planktonic foraminifers have been determined (Pl. 1):

Favusella washitensis (Carsey, 1926)
Globigerinelloides bentonensis (Morrow, 1934)
Globigerinelloides pulchellus (Todd & Low, 1964)
Hedbergella delrioensis (Carsey, 1926)
Hedbergella cf. *planispira* (Tappan, 1940)
Hedbergella rischi Moullade, 1974
Hedbergella sp.
Heterohelix moremani (Cushman, 1938)
Paracostellagerina praelibyca (Petrizzo & Huber, 2006)
Planomalina buxtorfi (Gandolfi, 1942)
Planomalina praebuxtorfi Wonders, 1975
Pseudothalmanninella ticinensis (Gandolfi, 1942)
Pseudothalmanninella ex gr. *subticinensis* (Gandolfi, 1957)
Thalmanninella appenninica (Renz, 1936)
Thalmanninella balernaensis (Gandolfi, 1957)
Thalmanninella praebalernaensis (Sigal, 1969)
Ticinella cf. *madecassiana* Sigal, 1966

The assemblage indicates the *Thalmanninella* (formerly *Rotalipora*) *appenninica* Zone, referred by Premoli Silva & Verga (2004) to the "latest Albian".

Among the benthonic foraminifers, patellinids with the typical calcitic monocrystalline structure (= "*Campanulina carpatica* Mišik, 1973") are present. Calcareous cysts of dinoflagellates are represented by *Pithonella ovalis* (Kaufmann, 1865), *Pithonella sphaerica* (Kaufmann, 1865), particularly common, and *Pithonella trejoi* Bonet, 1956.

Palaeogeographical remarks (I. Dieni & F. Massari)

The unconformity, in addition of representing the response of a generalized sea-level lowstand (Amédro 2002), is a clear indication of mid-Cretaceous tectonic activity. This event is recorded in the Nurra (north-western Sardinia) by gentle folding accompanied by a general emergence episode marked by bauxites and lacustrine deposits (Cocco & Pecorini 1959; Pecorini 1965; Cherchi & Trémolières 1984; Masse & Allemann 1982 among others) and in eastern Sardinia by tilting of the underlying Jurassic-Cretaceous succession in the Orosei area. The smaller stratigraphic gap in this area allows placing this tectonics between the early and late Albian (Dieni & Massari 1987).

It is known that upper Albian highly condensed deposits, characterized by basal erosional gaps of variable importance, are widely distributed in the northern Tethyan margin (e.g. Delamette 1988) and display common characteristics such as authigenic glauconite, phosphatic nodules and a rich outer-shelf fauna. This author suggested that a common factor, inferred to be represented by strong, outer-shelf bottom currents linked to the oceanic circulation (the Tethyan current), controlled the environmental setting by causing erosion, hiatuses, gravel pavements and highly condensed sedimentation with development of authigenic glauconite and phosphate nodules.

The finding in the s'Ozzastru quarry of Vraconian glauconitic limestones in the CFC documents the original presence of this stratigraphic interval in the local sedimentary cover of this area, with lithological and faunal characteristics wholly comparable to those known near Orosei.

Systematic palaeontology (I. Dieni & V. Radulović)

The studied specimens are housed in the Museum of Geology and Palaeontology of the Padova University (MGP).

Phylum **Brachiopoda** Duméril, 1806

Order **Rhynchonellida** Kuhn, 1949

Family Basiliolidae Cooper, 1959

Genus *Orbirhynchia* Pettitt, 1954

Orbirhynchia parkinsoni Owen, 1960

Pl. 1, figs 25a, b

v + 1960 *Orbirhynchia parkinsoni* sp. nov. – Owen, p. 250, pl. 5, figs 2a-c; text-fig. 1.

v 1975 *Orbirhynchia parkinsoni* Owen – Dieni & Owen in Dieni, Middlemiss & Owen, p. 210, pl. 38, figs 10, 11 (see for extensive synonymy list).

1977 *Orbirhynchia parkinsoni* Owen – Popiel-Barczyk, p. 32, pl. 2, figs 1-6; text-figs 5-8.

non 1979 *Orbirhynchia parkinsoni* Owen – Bitner & Pisera, p. 70, pl. 1, fig. 2.

v non 1996 *Orbirhynchia parkinsoni parkinsoni* Owen – Motchurova-Dekova, p. 187 (= *O. oweni* Radulović & Radulović, 2002?).

2002 *Orbirhynchia parkinsoni* Owen – Sulser & Friebe, p. 417, figs 3, 4.

Description. A single well preserved, acutely convex and faintly asymmetric dorsal valve (MGP 30811), 18.6 mm long and 22.0 mm wide, has transversally oval outline, greatest width at mid-valve, and is ornamented with about 32 sharp radiating costae which become much stronger towards the anterior margin; 7 of them are much more pronounced on the almost imperceptible median fold developed anteriorly. Growth lines are marked. The anterior commissure has a low, broadly arcuate plication corresponding to the dorsal fold which would have accommodated the linguiform extension of the ventral valve.

Remarks. The external features of the Sardinian specimen agree well with figures of previous authors, especially those of the holotype (Owen 1960, pl. 5, figs 2 a-c).

Based solely on external morphology, Jacob & Fallot (1913) described four varieties of "*Rhynchonella sulcata* (Parkinson) Davidson" from the Albian of south-eastern France. Dieni & Owen (in Dieni, Middlemiss & Owen 1975), Owen (in Middlemiss & Owen 1980), Calzada (in Gómez & Calzada 1993) and Motchurova-Dekova (1996) believed that the two of the four varieties mentioned above are subspecies of *O. parkinsoni.* The type material of these taxa has not yet been studied, so their generic assignment is still uncertain. Externally, "*O. parkinsoni rencurelensis*" differs from *O. parkinsoni* by its smaller number of costae and much less convex valves, whereas "*O. parkinsoni paludensis*" possesses almost heart-shaped outline, greatest width situated at or near the hinge line, and more numerous and finer costae. The other two varieties were not quoted after Jacob & Fallot (1913) introduced them. "*Rhynchonella sulcata* var. *paucicostata*" differs from the described species by its subpentagonal outline and fewer costae, whereas "*Rhynchonella sulcata* var. *salazacensis*" has triangular outline and greatest width on anterior end. In our opinion the four "varieties" very probably belong all to separate taxa.

Without data on its internal characters, Bitner & Pisera (1979) described and figured as *Orbirhynchia parkinsoni* a rhynchonellid from the lower Maastrichtian of eastern Poland (Mielnik) which, apart from its very different chronostratigraphic position, differs from the holotype in having much fewer, coarser costae (19 instead of 30-32).

Calzada (in Gómez & Calzada 1993) erected the species *Orbirhynchia irenae* from the lower Albian of Gorbea (northern Spain) which differs from *O. parkinsoni* for its smaller size, subpentagonal to triangular outline, subtrapezoidal and asymmetric uniplication, and more numerous fine and rounded costae.

The Cenomanian representatives of *Orbirhynchia* of north-eastern Bulgaria determined as *O. parkinsoni parkinsoni* by Motchurova-Dekova (1996, not figured) differ from this taxon. They are smaller than the type described by Owen (1960) [the values of length, width and thickness of the largest specimen (National Museum of Natural History, Sofia, I-309) are respectively 17.0 mm, 18.6 mm and 11.2 mm], have a much smaller number of costae (22-23 instead of 32-33) and almost always present a more or less pronounced asymmetry of the anterior commissure. For these reasons they seem referable to a species of *Orbirhynchia* different from *parkinsoni*. Judging from their asymmetric shell part, the Bulgarian specimens most probably belong to *Orbirhynchia oweni* Radulović & Radulović (in Rabrenović et al. 2002), known from the lowermost middle Cenomanian of eastern Serbia. *O. oweni* differs from *O. parkinsoni* by its facultative asymmetry of the shell and in having fewer and coarser costae (24-28 instead of 30-32).

Recently, Motchurova-Dekova et al. (2009) introduced the species *Orbirhynchia nadiae* from the lower Aptian of the Gargano Promontory (southern Italy); this taxon differs from *O. parkinsoni* in having generally greater number of rounded costae (22-38 instead of 30-32) and anterior commissure displaying facultative asymmetry.

Although the genus *Orbirhynchia* has a relatively wide stratigraphic range, from the lower Aptian to the lower Maastrichtian (Motchurova-Dekova et al. 2009), the largest number of species is known from the Cenomanian-Turonian interval (Monks & Owen 2000). Stratigraphically very important for the lower Cenomanian of Europe (*Acanthoceras rothomagense* Zone) is *O. mantelliana* (J. de C. Sowerby, 1826), which differs from *O. parkinsoni* in having fewer but coarser costae (see Owen 1988, and Inesta & Calzada 1996, with references therein).

Occurrence. Upper Albian of England (Cambridge District, Isle of Wight, Hunstanton Cliff), Spain, SE France (Dept. Isère, Savoie), ?western Switzerland, western Austria (Voralberg), southern Poland (Tatra Mts); Vraconian (*Thalmanninella appenninica* Zone) of eastern Sardinia; lower Cenomanian of Poland (surroundings of Cracow and Annopol).

Order **Terebratulida** Waagen, 1883
Family Capillithyrididae Cooper, 1983
Genus *Capillithyris* Katz, 1974

Capillithyris capillata (d'Archiac, 1847)
Pl. 1, fig. 26

+ 1847 *Terebratula capillata* nov. sp. – d'Archiac, p. 323, pl. 20, figs 1-3.

non 1852 *Terebratula capillata* d'Archiac – Davidson, p. 46, pl. 5, fig. 12 [= *Capillithyris diversa rubicunda* (Cox & Middlemiss, 1978)].

non 1874 *Terebratula capillata* d'Archiac – Davidson, p. 33, pl. 17, fig. 2 [= *Capillithyris diversa rubicunda* (Cox & Middlemiss, 1978)].

non 1903 *Terebratula capillata* d'Archiac – Lamplugh & Walker, p. 249, pl. 16, figs 1-6 [= *Capillithyris diversa* (Cox & Middlemiss, 1978)].

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.

p 1979 *Capillithyris capillata* (d' Archiac) – Bilinkevich & Popiel-Barczyk, p. 10, text-fig. 5, pl. 1, figs 1, 2, 5 [non text-fig. 4 and pl. 1, figs 3, 4 = *Capillithyris diversa* (Cox & Middlemiss, 1978)].

1983 *Capillithyris capillata* (d'Archiac) – Cooper, p. 179, pl. 23, figs 12-18; pl. 66, figs 16, 17.

1984 *Capillithyris capillata* (d'Archiac) – Popiel-Barczyk, p. 353, pl. 150, fig. 9.

1988 *Capillithyris capillata* (d'Archiac) – Owen, p. 80, pl. 18, figs 1-3.

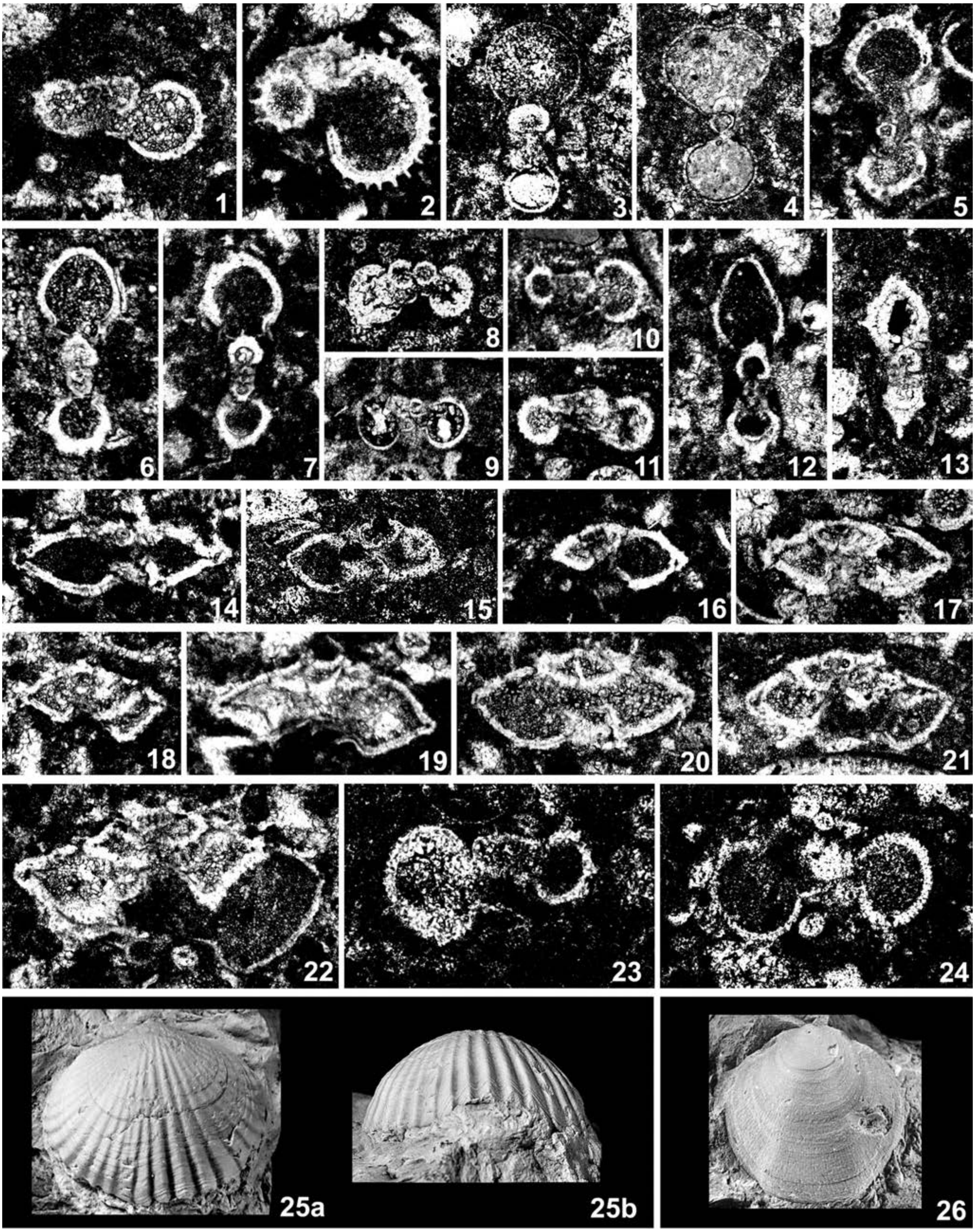
1997 *Capillithyris capillata* (d'Archiac) – Gaspard, p. 152, pl. 2, fig. 8.

2006 *Capillithyris capillata* (d'Archiac) – Gradinaru et al., p. 81, pl. 3, figs 5-7; pl. 4, figs 1-3; text-figs 14, 15.

Description. One slightly convex dorsal valve (MGP 30812), 12.7 mm long and 13.3 mm wide, has

PLATE 1

Fig. 1 - *Paracostellagerina praelibyca* (Petrizzo & Huber, 2006);
Fig. 2 - *Favusella washitensis* (Carsey, 1926);
Figs 3, 4 - *Globigerinelloides bentonensis* (Morrow, 1934);
Fig. 5 - *Globigerinelloides* cf. *bentonensis* (Morrow, 1934);
Figs 6, 7 - *Globigerinelloides pulchellus* (Todd & Low, 1964);
Figs 8, 9 - *Hedbergella delrioensis* (Carsey, 1926);
Figs 10, 11 - *Hedbergella* cf. *planispira* (Tappan, 1940);
Fig. 12 - *Planomalina praebuxtorfi* Wonders, 1975;
Figs 13 - *Planomalina buxtorfi* (Gandolfi, 1942);
Fig. 14 - *Thalmanninella appenninica* (Renz, 1936);
Fig. 15 - *Thalmanninella praebalernaensis* (Sigal, 1969);
Figs 16, 17 - *Thalmanninella balernaensis* (Gandolfi, 1957);
Fig. 18 - *Thalmanninella* sp. aff. *Th. brotzeni* Sigal, 1948;
Figs 19-21 - *Pseudothalmanninella ticinensis* (Gandolfi, 1942);
Fig. 22 - *Thalmanninella* cf. *gandolfii* (Luterbacher & Premoli Silva, 1962);
Fig. 23 - *Hedbergella rischi* Moullade, 1974;
Fig. 24 - *Ticinella* cf. *madecassiana* Sigal, 1966;
Figs 25 a, b - *Orbirhynchia parkinsoni* Owen, 1960; dorsal valve, whitened; MGP 30811;
Fig. 26 - *Capillithyris capillata* (d'Archiac, 1847); dorsal valve, whitened; MGP 30812.
Magnification: figs 1-7, 9-22, 24 = 100x; figs 8, 23 = 160 x; figs 25 a,b = 1.5x; fig. 26 = 2x.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the external characters typical of *Capillithyris capillata*, such as subcircular-pentagonal outline with two faint carinae originating from the umbonal region and radiating anteriorly, and surface covered by fine capilli (about 5-6 capilli per mm near the anterior margin) crossed by 10-12 well marked growth lines [for a correct use of the Latin language, to indicate fine radiating ribs more than 25 per 10 mm on outer surface of shell (= capillate ornament, capilliform ornamentation) we adopt here the term *capillus*, m. = hair (plural *capilli*) instead of *capilla* (pl. *capillae*), originally proposed by Muir-Wood (1965, p. 776)].

Remarks. This species was originally described from the Tourtia deposits of Tournai in Belgium. There are different opinions concerning the age of these sediments, but up to now their precise stratigraphic position remains uncertain (see Polvèche 1957). Marlière (1939, p. 339) stated that Tourtia is Cenomanian in age (early and middle Cenomanian). According to Owen (1970, p. 56) the stratigraphic level of Tourtia deposits comprises condensed upper Albian and Cenomanian, and according to Gaspard (1997, p. 152) and Robaszynski et al. (2002, p. 125) the age is early Cenomanian.

Lamplugh & Walker (1903, p. 249, pl.16, figs 1-6) described under the name *Terebratula capillata* forms from the lower Albian Shenley Limestone of Bedfordshire and the upper Albian Red Chalk of Norfolk (England) and indicated a close resemblance to the Belgian type material, also as far as the matrix of the specimens was concerned. Based on minor differences, in shape of the anterior commissure and cardinal process, width of the loop and hinge plates, Cox & Middlemiss (1978) believed that the English specimens earlier referred to *Terebratula capillata* ought to be assigned to their new lower Albian species *Platythyris diversa* and upper Albian subspecies *P. diversa rubicunda*, for which Cooper (1983) erected the genus *Capillarina* (having *Platythyris diversa* Cox & Middlemiss as type species), considered by Lee & Smirnova (in Lee et al. 2006, p. 2071) as junior synonym of *Capillithyris* Katz, 1974.

Except that it is stratigraphically younger, *Capillithyris capillata* differs from *C. diversa* (Cox & Middlemiss, 1978) in having rectimarginate to sulciplicate anterior commissure, larger cardinal process, wider loop with a narrower transverse band, and greater loop angle. *C. diversa rubicunda* is distinguishable from the latter by its oval outline and much more convex valves. Davidson (1874) and Cooper (1983) suggested that perhaps the specimens from the Red Chalk of Hunstanton (= *C. diversa rubicunda*) may constitute a separate species.

Occurrence. Uppermost Albian (Vraconian) of eastern Sardinia; lower Cenomanian (?) of Belgium (Tourtia, Tournai) and Germany; lower Cenomanian of Russia (Donbass, Crimea); Cenomanian of Poland (environs of Cracow and Annopol).

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