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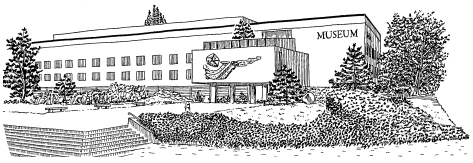

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Ammonite assemblages and biostratigraphy at the Lower to Upper Bajocian boundary in the Digne area (SE France). Implications for the definition of the Late Bajocian GSSP

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Abstract
The succession of the middle part of the "Marno-calcaires à *Cancellophycus*" Formation, typical of the French Subalpine Basin and cropping out in the area south of Digne, and its ammonite assemblages have been revised with the double aim of providing an updated biostratigraphic scheme for the succession of uppermost Humphriesianum Zone (Blagdeni Subzone) to lower Niortense Zone (Banksii and Polygyralis subzones), and of describing the evolutionary trend of the dimorphic couple *Caumontisphinctes-Infraparkinsonia* which is fundamental for defining the GSSP of the late Bajocian Substage. Three sections (Ravin du Feston, RF, Les Dourbes, LD, Ravin de la Coueste, RC) were sampled in 2011 and the newly collected material was added to the stock of specimens already present in the collection of the University of Torino. Field and laboratory data concur to indicate that the ammonite composite moulds belong to a single taphorecord and are classified as resedimented elements that, before burial, were repeatedly transferred to the bottom before burial by currents flowing down from platform sectors of the Subalpine Basin. Taxonomic details are provided for each biostratigraphic unit allowing the subdivision of the Blagdeni Subzone in three biohorizons (*Dubium, Coronatum* and *Festonensis*) and the subdivision of the Banksii Subzone in two biohorizons (*Diniensis* and *Nodatus*). The FO of pertinent index-species is defined for each subzone and biohorizon. Selected taxa with [M] and [m] counterparts are described in details with *Infraparkinsonia pierae* n. sp. Results concern different topics: shell architecture and morphology can be considered as valid parameters to support the origin of *Caumontisphinctes* (*C. garnieri*) from *Phaulostephanus*; the records of scattered specimens of *Phaulostephanus*, *Subcollina*, *Patrulia* and *Torrensia* reflect discontinuous connections and two-ways dispersion, correlated to the early-Bajocian sea-level rise, between the East Pacific Subrealm and the Tethyan Realm, via Central Atlantic. Therefore, the Ravin de la Coueste is quite suitable to be proposed as the late Bajocian GSSP, at bed RC-281.

Keywords
Ammonitida, *Caumontisphinctes*, *Leptosphinctes*, biostratigraphy, Humphriesianum-Niortense zones, Middle Jurassic, Hispanic Corridor, GSSP.

I. INTRODUCTION

The Jurassic successions of the Subalpine Basin (south-eastern France) are known since the 18th century for their ammonite records, with particular reference to those from the Aalenian-Bathonian "Marno-calcaires à *Cancellophycus*" Formation (d'Orbigny, 1849-52; Garnier, 1872; Haug, 1891; Arkell, 1956; Sturani, 1967; Caloo, 1971; Pavia, 1973, 1983a, b; Torrens, 1987; Innocenti *et al*., 1990).
Several recent papers focused on the upper Bajocian to lower Bathonian ammonite assemblages (Fernández-López, 2007; Fernández-López *et al*., 2007, 2009a; Pavia *et al*., 2008) in order to define the basal boundary stratotype (GSSP) of the Bathonian Stage that I.U.G.S ratified in July 2008 (Fernández-López *et al*., 2009b; Olivero *et al*., 2010). The present paper, which is complementary to the above mentioned ones, deals with the lower to upper Bajocian transition in the Digne area, where the ammonite turnover and evolutionary radiation correlated with sea-level changes can be recorded (Sandoval *et al*. 2001; O'Dogherty *et al*., 2006; Moyne & Neige, 2007), and with the onset of typical upper Bajocian taxa of Ammonitida, in particular the subfamilies Cadomitinae and Leptosphinctinae. The wide interest of these successions is primarily due to (1) their thick sedimentary sequences, (2) continuous ammonite record and favourable exposures useful to document ammonite evolutionary lineages, (3) possibility to produce reference biostratigraphy due to co-occurrence of biota pertaining to different Tethyan palaeobioprovinces, and finally, (4) central position within the Tethyan Realm with high correlation potential with mid-Jurassic of East Pacific Realm via Central Atlantic (Hillebrandt *et al.,* 1992; Pavia, 2000; Moyne & Neige, 2007; Fernández-López & Chong Diaz, 2011).
The aim of this paper is to produce a biostratigraphic scheme, thus updating the results of previous papers by

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the senior author (PAVIA, 1973, 1983a, b), which were focused on the lower to upper Bajocian boundary, i.e. between the European Standard Humphriesianum and Niortense zones, and to document the evolutionary trend of selected Ammonitida, such as the dimorphic couple *Caumontisphinctes-Infraparkinsonia* that is fundamental for defining the GSSP of the Late Bajocian Substage (DIETL & PAVIA, 1984).

II. GEOLOGICAL SETTING AND SECTIONS

Three sections have been studied in detail: Ravin du Feston (RF) and Les Dourbes (LD) in the administrative district of Digne, Ravin de la Coueste (RC) in the administrative district of Chaudon-Norante (Fig. 1). Their common lithostratigraphic succession represents the middle part of the "Marno-calcaires à *Cancellophycus*" Formation (GRACIANSKY *et al*., 1982).

The studied area is located in the French Subalpine Basin (FSB) corresponding to a gulf in the north-western margin of the Tethyan Ocean (FERNÁNDEZ-LÓPEZ *et al*., 2009a, b, and references therein) whose central part reached a depth of 700-800 metres during mid-Jurassic time (FERRY, 1990). The region was a transitional area between the epicontinental sea of the Paris Basin

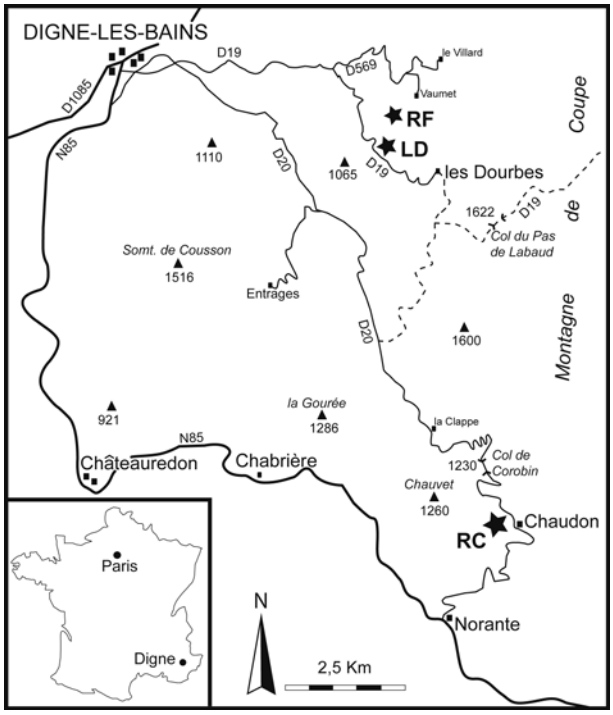

Fig. 1: Geographical location of the investigated sections RF (Ravin du Feston), LD (Les Dourbes), RC (Ravin de la Coueste).

Fig. 2: The lithostratigraphic succession of the Marno-calcaires à *Cancellophycus* Formation in the Ravin du Feston section, spanning the Humphriesianum to Garantiana zones. Bed RF-113 marks the base of the Niortense Zone.

(referable to the Northwest European Bioprovince) and the Piedmont oceanic domain (referable to the Mediterranean Bioprovince).

The lithostratigraphic succession consists of a cyclic limestone-marl alternation (Figs. 2, 3). Petrographically and in terms of biofacies, limestones are relatively uniform calcisphere-rich mudstones to radiolarian wackestones, and, in some cases *Bositra buchi* packstones, with common ammonoids, scarce nautiloids and siliceous sponges (spicules), rare brachiopods, bivalves (other than *B. buchi*), gastropods, ostracods and benthic foraminifers (PAVIA, 1983a). Marls show a calcisphere-mudstone texture and contain bivalves (*Bositra buchi*) and cephalopods with prevailing ammonoids and scarce belemnites. Bioturbation textures are very frequent, almost homogeneously distributed in the studied part of the succession: they refer to soft ground structures with widespread and typical *Zoophycos* traces (OLIVERO, 1994, 2003).

According to the cited literature, the "Marno-calcaires à *Cancellophycus*" Formation is interpreted as developed in hemipelagic conditions on the continental slope of the FSB. The bed-scale marl-limestone alternation is of primary origin, although enhanced by diagenetic redistribution of carbonate and compaction. Lithological differentiation between marly and limestone beds reflects alternating carbonate supplies from the platform.

Sedimentological data and sequence-stratigraphy interpretations of the Jurassic deposits of the FSB were discussed by several authors including GRACIANSKY *et al*. (1993, 1998), FERRY & MANGOLD (1995), HARDENBOL *et al*. (1998), JACQUIN *et al*. (1998). All these authors considered the deposition of the "Marno-calcaires à *Cancellophycus*" Formation as developed during the deepening and more subsiding phase of the mid-Jurassic 2nd order cycle. The onset of a transgressive system tract with first flooding surface has been detected in the uppermost horizons of the lower Bajocian; this event is coincident with the decrease of carbonate input registered in the upper Bajocian of the whole southern FSB. Such a lithological variation overlaps a significant reduction of thickness between the Ravin du Feston and the Ravin de la Coueste sections (from 370 to 250 metres according to PAVIA, 1983a), passing southwards from the distal to the proximal part of the FSB slope, i.e. approaching the southern margin of the FSB towards the Provence Platform (see PAVIA, 1984; OLIVERO, 2003).

Fig. 3: Detail of the limestone-marl alternation at the Ravin de la Coueste section. The sharp lower boundary and the gradual upper one of bed RC-275 suggest deposition from some kind of gravity flows.

The three successions described and correlated herein are parts of the complete sections documented by PAVIA (1973, 1983a). LD and RC sections are respectively 1,2 km and 9,6 km far from RF section (Fig. 1). It is thus worth noting that, similarly to the mentioned reduction in thickness, the studied chronostratigraphic interval is recorded in LD and in RC sections at 83% and 65% respectively compared with RF section. General information on these sections is described as follows:

RAVIN DU FESTON (RF: mark 4 on fossils) - Fig. 2 - The section is exposed in a small canyon on the right side of the Ravin du Feston, just southwards "la Condamine" farm. The coordinates of the lower to upper Bajocian boundary are: 44° 04' 52" N, 6° 17' 50" E, altitude 835 m. OLIVERO & MATTIOLI (2008) shortly illustrated the whole Bajocian succession in the frame of calcareous nannofossil biostratigraphic characterisation. The lithostratigraphic interval sampled for the present paper (23 m) encompasses beds 89-125. Ammonite occurrences are integrated with those of the LD and RC sections in the composite biostratigraphic log of Fig. 4.

LES DOURBES (LD: mark 3 on fossils) - Fig. 5 - The section crops out just by the side of the road from the town of Digne to the village of Les Dourbes. The coordinates of the lower to upper Bajocian boundary are: 44° 04' 19" N, 6° 17' 46" E, altitude 859 m. The section was mentioned by PAVIA (1973, 1983a) as supplementary information of the RF section. The lithostratigraphic interval sampled for the present paper (19 m) encompasses beds 63-129. Ammonite occurrences are integrated with those of RF and RC in the composite biostratigraphic log of Fig. 4.

RAVIN DE LA COUESTE (RC: mark 5 on fossils) - Fig. 6 - The section is exposed along the Ravin de la Coueste in the area of the village of Chaudon. The coordinates of the lower to upper Bajocian boundary, about 500 metres upstream from the bridge on the road Chaudon-Norante, are: 43° 59' 36" N, 6° 19' 34" E, altitude 946 m. The lithostratigraphic interval sampled for the present paper (15 m) encompasses beds 313-261. Ammonite occurrences are integrated with those of LD and RF sections in the composite biostratigraphic log of Fig. 4.

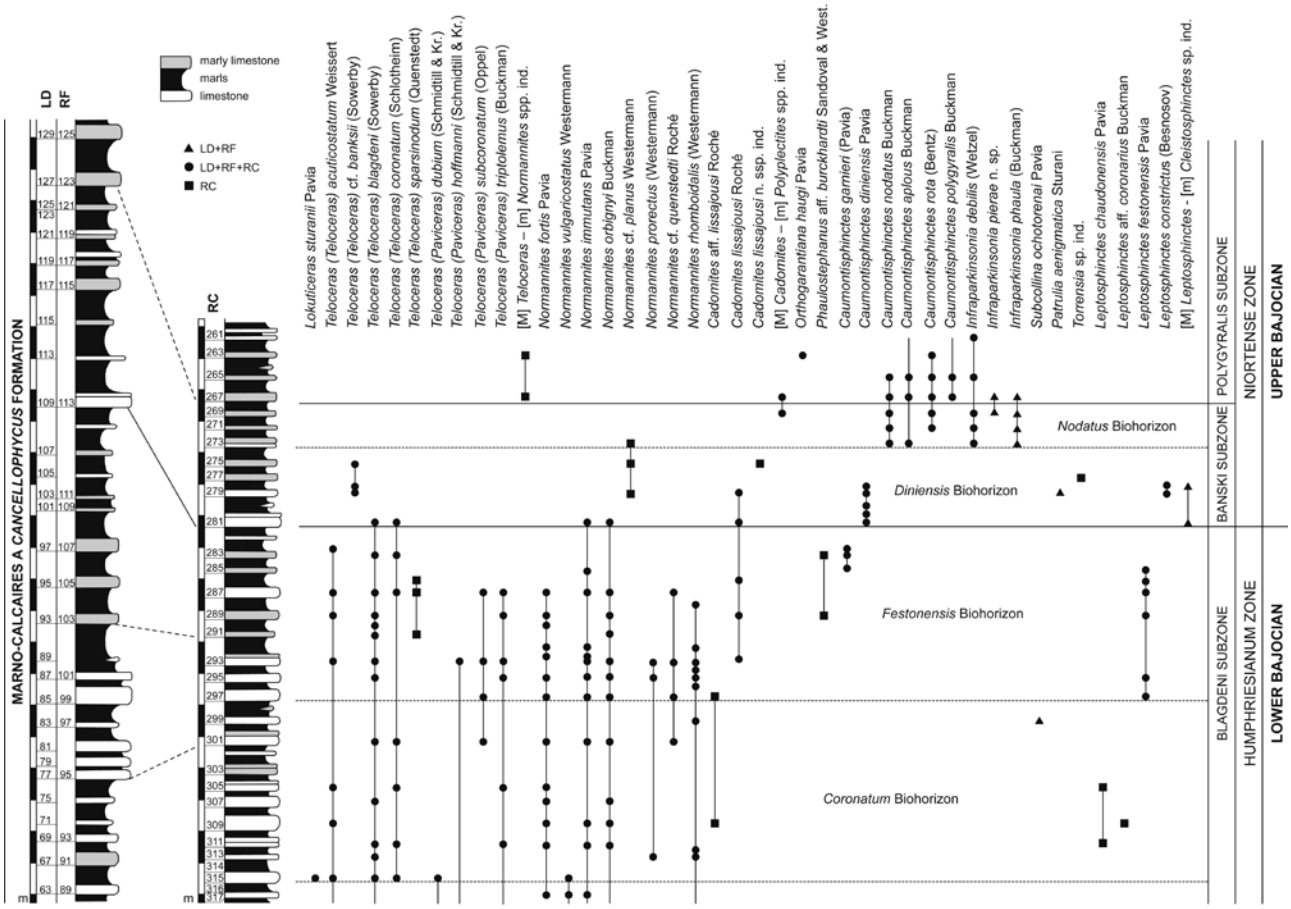

Fig. 4: Composite succession and biochronostratigraphic data at the lower to upper Bajocian transition based on the Ravin du Feston (RF), Les Dourbes (LD) and Ravin de la Coueste (RC) sections, restricted to Stephanoceratidae, Leptosphinctinae and connected taxa.

Fig. 5: The lithostratigraphic succession at the transition from lower to upper Bajocian in the Les Dourbes section. Bed LD-109 marks the base of the Niortense Zone.

III. AMMONITE ASSEMBLAGES

Ammonites are by far the most common and, in some cases, the only macrofossils of the Bajocian succession of the Digne area, with the exception of *Zoophycos* traces. Fossils are always rare in the deposits, except in beds LD-109, LD-125, RC-297, RC-293, RC-287, RC-281, and RC-267. In most cases fossils occur on the upper surface of the layers, generally lying subhorizontal; most rarely fossils have been observed deposited inside the bed lying without any preferential orientation. A detailed taphonomic analysis is beyond of the scope of this paper, nevertheless some taphonomic notes could be useful to interpret the genesis of the ammonite assemblages encountered in the studied set of beds. In ammonites, large specimens of Lytoceratidae (up to 40-70 cm in diameter) and Stephanoceratidae (genus *Teloceras* up

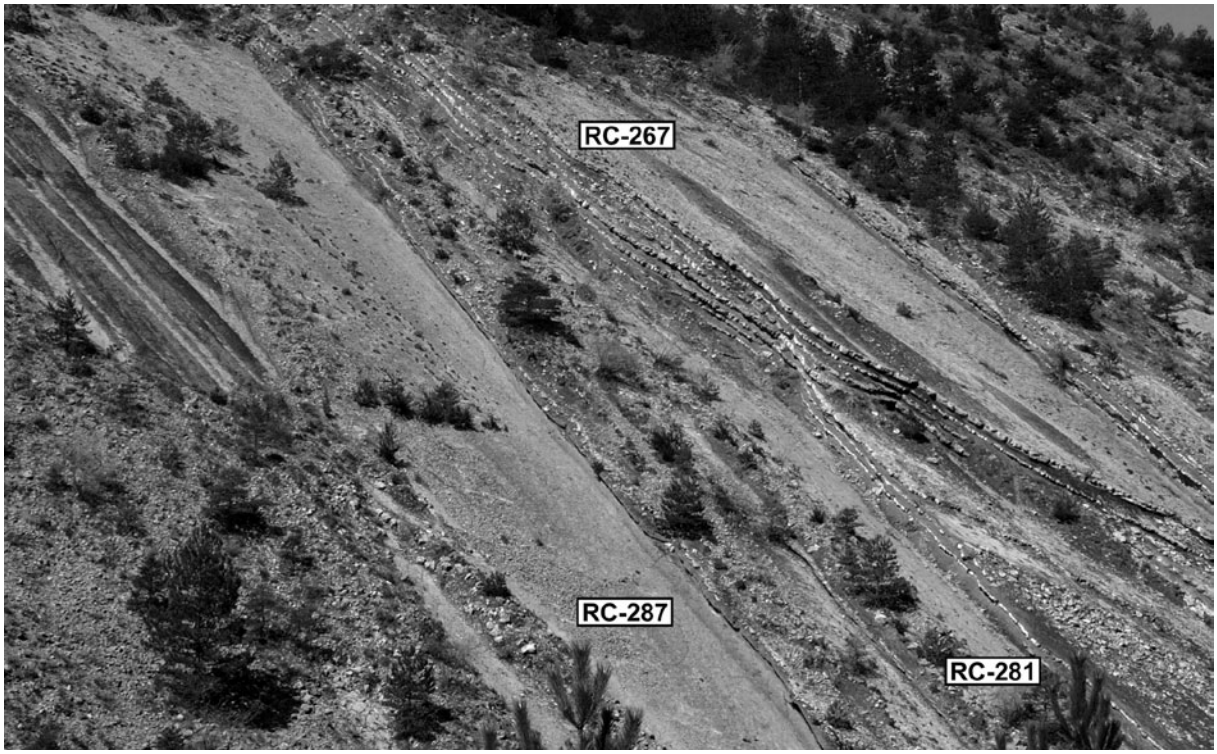

Fig. 6: The lithostratigraphic succession at the transition from lower to upper Bajocian in the Ravin de la Coueste. Bed RC-281 marks the base of the Niortense Zone.

to 30 cm in diameter: Fig. 7) occasionally show traces of intrathalamous (limited to the bodychamber) and extrathalamous encrusting: both cases may be interpreted as the product of necroplanktic floating/drifting before sinking and taphonic production on the deposition bottom.

All ammonoid fossils display a more or less complete infill of the sedimentary matrix. They are regularly preserved as composite moulds in which the original aragonitic shell is thinned or totally dissolved, whereas a carbonaceous film derived from reduction of the periostracum allows the external mould to engrave the not-yet lithified internal mould (SEILACHER *et al*., 1976; PAVIA, 1983a). Such a fossildiagenesis is the rule for lower and most part of upper Bajocian, whereas different types of preservation characterize ammonites of topmost Bajocian as well as of lower Bathonian (FERNÁNDEZ-LÓPEZ, 2007). Small pyrite internal moulds of the innermost whorls or pyritic portions of the whorl occur mainly in marly layers, reflecting dysaerobic conditions of the depositional environment.

Sedimentary infill of ammonoid shells is generally massive, though the nuclei usually are not observable because of the complete dissolution of the thin aragonitic test walls. In most cases it is difficult to estimate the degree of sediment infilling, as all the fossils record diagenetic compaction due to sediment loading, which is more effective in marly beds where horizontal moulds may be reduced to a few millimetres. Deformation is thus

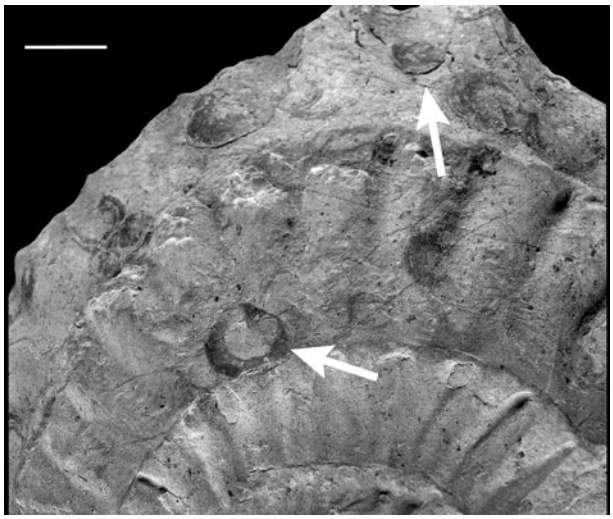

Fig. 7: External mould of *Teloceras* cf. *blagdeni* (SOWERBY) from bed RC-289 (PU112619). Note the extrathalamous encrusting by pseudoplankic juvenile oysters (arrows). Scale bar, 1 cm.

the rule, since it affects fossils in any position: lateral, symmetrical compression in horizontal fossils and dorso-ventral depression in shells vertically deposited (Fig. 8). Both fragmented parts of the whorl and complete specimens, frequently with apertural lappets or tubular peristome on the bodychamber, are mixed within each fossil assemblage. As far as the state of fossil

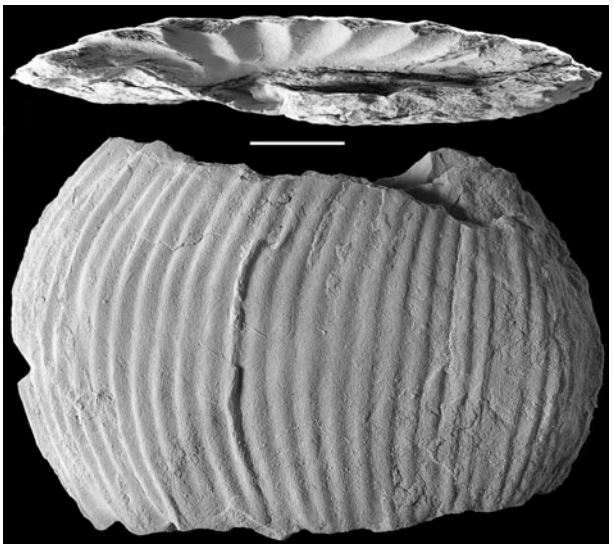

Fig. 8: Composite mould of *Teloceras* sp. from bed RC-279 (PU112620). The fossil is deformed by ventro-dorsal compression due to sedimentary loading. Scale bar, 2 cm.

preservation is concerned (*sensu* FERNÁNDEZ-LÓPEZ, 1991, 1995; PAVIA & MARTIRE, 1997), neither evidences of taphonomic accumulation, i.e. fossils lying on the place of taphogenic production at the depositional bottom without transport before burial, nor traces of abrasion and other taphonomic alteration of ammonite moulds that would reflect the presence of reelaborated fossils, have been detected. In other words, all ammonoids are to be classified as resedimented elements transferred on the bottom before burial, and belonging to a single taphorecord directly reflecting the time deposition of the beds.

The palaeobiogeographic pattern of the Bajocian ammonoid fossil-assemblages within the whole "Marno-calcaires à *Cancellophycus*" Formation is defined by the high proportion (more than 30%) of Phylloceratida and Lytoceratida which are typical of the Mediterranean Province reflecting the persistence of open seaways and pelagic cephalopod communities. Other significant components of the assemblages at the transition from lower to upper Bajocian belong to Ammonitida, and in particular to Stephanoceratidae and Perisphinctidae (namely Leptosphinctinae) that testify the existence of shallow-water areas roughly corresponding to the Provence Platform (OLIVERO, 1994, 2003). Such a hypothesis is supported by the progressive shift of ammonoid composition toward a major frequency of Ammonitida from RF to RC sections, approaching the southern SFB margin. Furthermore, in some sets of beds, ammonoid assemblages show non-homogeneous taxonomic record. This situation is particularly evident in the RC section (Fig. 4), where beds RC-287 and RC-281 respectively are rich in specimens of *Leptosphinctes festonensis* PAVIA and *Caumontisphinctes diniensis* PAVIA, which tend to become exclusive of each bed. Such a discontinuous record could be explained considering supplies of taphonic entities (ammonoid shells) from different sectors of the platform.

IV. BIOSTRATIGRAPHY

The taxonomic record and the biostratigraphy of the Feston and Chaudon successions were discussed in detail by PAVIA (1973, 1983a, 2000). However, because of the necessity of a better characterization of the fossil assemblages at the transition between lower and upper Bajocian, two new field researches on the RF, LD and RC sections have been carried out in April and May 2011. More than 300 ammonites have been collected. The new samplings provided new information, which allowed us to define the taxonomic character of the basal upper Bajocian. More precisely, based on the new available data, it has been possible to better determine (1) the late persistence of the early Bajocian Stephanoceratinae, (2) the onset of late Bajocian ammonite taxa, such as the earliest occurrence of the stephanoceratid Cadomitinae and the perisphinctid Leptosphinctinae, (3) the stratigraphic range and the evolutionary lineage of the dimorphic genus *Caumontisphinctes* which appears to be the most significant marker for the base of the upper Bajocian, namely the Banksii and Polygyralis subzones of the Niortense Zone.

New and previously detected data have been assembled in the composite biostratigraphic log of Fig. 4. We limited the graphic representation to Stephanoceratinae, Cadomitinae, Leptosphinctinae, and connected taxa (e.g. *Caumontisphinctes*) as they are the most useful and significant signals for biostratigraphic definition; for other taxa see PAVIA (1973 and 1983a). The correlation of the three sections (Fig. 4) has been based on lithostratigraphic equivalences and on the first occurrences of significant taxa. In this respect, it is worth noting the perfect correlation of beds RF-113, LD-109, RC-281 that are formed by two equivalent layers and deliver a comparable abundance of *Caumontisphinctes diniensis*.

As far as the biostratigraphic scheme is concerned, we refer to the Standard Zonation accepted for the Bajocian Stage (CALLOMON & COPE, 1996; RIOULT *et al*., 1997; SANDOVAL *et al*., 2001). On the base of the stratigraphic range of significant taxa, it has been possible to distinguish different biohorizons: this term is here used as a synonym of the "faunal horizon" discussed by PAGE (1995). The biostratigraphic units are described referring to the Ravin de la Coueste section.

Lower Bajocian, *Stephanoceras humphriesianum* Zone (Oppel, 1856)

***Teloceras blagdeni* Subzone (Spath, 1936) –** The distribution of the macroconch genus *Teloceras* and its dimorphic counterpart *Normannites* characterizes the subzone. The basal boundary of the subzone is fixed (Pavia, 1983a) by the FO of *T.* (*Teloceras*) *acusticostatum* that ranges through the subzone side by side to the congeneric subgenus *Paviceras* (Gauthier *et al*., 1996). Among them, *T.* (*Paviceras*) *dubium* marks the *Dubium* Biohorizon defined at the basal Blagdeni Subzone by Pavia (1983a; Rioult *et al*., 1997).

The middle and upper parts of the Blagdeni Subzone were distinct as "orizzonte a Coronatum" by Pavia (1983a). The new material shows a more diversified ammonite distribution, so that two successive biohorizons may be described.

- *Coronatum* Biohorizon (emended: Illies, 1956; Gabilly *et al*., 1971): beds RC-315 to RC-298. The biohorizon was confirmed by Rioult *et al*. (1997) for the European Bajocian. In the Digne sections the *Coronatum* Biohorizon ranges over the middle part of the subzone and is defined by the FO of *Teloceras* (*T.*) *coronatum* at bed RC-315. Significant bioevents are: (1) the FO of true perisphinctids with *Leptosphinctes chaudonensis* and *Leptosphinctes* cf. *coronarius*; (2) the confirmed occurrence of *Subcollina ochotorenai* (Pavia, 2000); (3) the onset of the genus *Cadomites* with *C*. aff. *lissajousi* that represents the oldest record of the genus *Cadomites*, derived from the stephanoceratid *Lokuticeras* of the lower Blagdeni Subzone (cf. Galácz, 1994) and still present at the base of the *Coronatum* Biohorizon with *L. sturanii*.
- *Festonensis* Biohorizon (new): beds RC-297 to RC-282 in the reference section. It corresponds to the upper part of the Blagdeni Subzone and is defined by the First Occurrence (FO) of *Leptosphinctes festonensis* at bed RC-297. New and significant events, compared with 1973 data, are: (1) the presence of the dimorphic *Phaulostephanus* aff. *burckhardti* (RC-289 and RC-283) just below the FO of the genus *Caumontisphinctes* whose first representative is *C. garnieri* limited to the topmost *Festonensis* Biohorizon; (2) the identification of the microconch partners of both *L. festonensis* and *C. garnieri*. Up to date, the *Festonensis* Biohorizon has never been recognized elsewhere, although the index species was cited in different Tethyan Bajocian outcrops referred to the Mediterranean province (Hungary: Galácz, accepted), the Submediterranean province (Iberian Range: Fernández-López, 1985) and the northeastern Tethyan border (Besnosov & Mitta, 1998). In Southern Germany, within the Blagdeni Subzone, Illies (1956) described beds with *Teloceras multinodum* (here regarded as morphotype of *T. blagdeni*) which were placed above beds with *T. coronatum* (V. Dietze, pers. comm.); it is difficult to state if Illies' beds might correspond to the *Festonensis* Biohorizon, or to the lowermost Niortense Zone (see below).

Upper Bajocian, *Strenoceras niortense* Zone (Buckman, 1893; Arkell, 1933)

***Teloceras banksii* Subzone (Buckman, 1910; Sturani, 1971) –** The FO of *Caumontisphinctes diniensis* is confirmed to mark the basal boundary of the subzone as formerly proposed by Pavia (1973) and Dietl & Pavia (1984). The index-species ranges through the lower part of the subzone, whereas its possible descendant *C. nodatus* marks the upper part of the subzone. Recurrent presence of late Stephanoceratidae (*Teloceras* and *Normannites*) also characterizes the subzone. The record of *Patrulia aenigmatica* from RF section (Pavia, 1973) did not obtain confirmation and supplementary information for this taxon would be therefore expected from other upper Bajocian outcrops, e.g. those found in Normandy where comparable ammonites are known (L. Maerten, pers. comm.). New and significant events, compared with 1973 data, are:

(1) Identification of the microconch partners of different species of *Caumontisphinctes* assigned to specific taxa of the genus *Infraparkinsonia* or joined to the macroconch equivalents, such as in *C. garnieri* and *C. diniensis*;

(2) Reduction of effective occurrence of *C. aplous* (most specimens of *C. aplous aplous* in Pavia, 1973, are here assigned to *C. nodatus*); the species with its likely microconch counterpart *I. pierae* n. sp. occurs frequently in the upper Banksii Subzone and in the lower Polygyralis Subzone;

(3) Identification of *Teloceras* (*T.) banksii* whose presence aligns the ammonoid assemblages of the Digne area to those of the Submediterranean and NW European provinces.

The overall distribution of the genus *Caumontisphinctes* suggests proposition of two biohorizons clearly distinguishable in the Ravin de la Coueste section:

- *Diniensis* Biohorizon (Dietl & Pavia, 1984): beds RC-281 to RC-272. This biohorizon is characterized by the last representatives of *Teloceras* (*T.) coronatum* and *Teloceras* (*T.) blagdeni* (comprising the morphotype *multinodum*: Fig. 9), *Normannites immutans* and *N. orbignyi*, *Cadomites lissajousi* and *C. lissajousi* n. ssp., scattered *Leptosphinctes* and its microconch counterpart *Cleistosphinctes*.

  Dietl & Pavia (1984) stated that the ammonite assemblages from the Submediterranean (Southern Germany: Dietl, 1980a) and the NW European provinces (Dorset: Parsons, 1976) also represent this biohorizon. Nevertheless successions in both areas suffer taphonomic condensations mixing together in the same level *Caumontisphinctes garnieri* and *C. aplous* which lie in Digne respectively below and

Fig. 9: External mould of *Teloceras blagdeni* (SOWERBY) morphotype *multinodum* (QUENSTEDT) on the upper surface of bed RC-281. Arrow indicates a damaged mould of *Caumontisphinctes diniensis* PAVIA.

above the range of *C. diniensis* respectively. Data from the Iberian Range (FERNÁNDEZ-LÓPEZ, 1985) and from the northeastern Tethyan border (BESNOSOV & MITTA, 1998) could also be added. The *Diniensis* Biohorizon corresponds to the "*Teloceras banksii* faunal horizon" proposed by CALLOMON & CHANDLER (1990) for Southern England; the continuous succession of Digne, without any taphonomic condensation, and DIETL & PAVIA's proposition (1984) get priority to the *Diniensis* Biohorizon upon the English synonym.

- *Nodatus* Biohorizon (new): beds RC-273 to RC-268. Informally suggested by RIOULT *et al*. (1997) for the European Bajocian, this biohorizon is based on the onset of the dimorphic couple *Caumontisphinctes nodatus* (mostly ex-*C. aplous* in PAVIA, 1973) and *Infraparkinsonia debilis*. Further taxa make first occurrence: *C. aplous* and *C. rota* with their possible microconch counterparts, respectively *I. pierae* n. sp. and *I. phaula*. Additional members of the *Nodatus* Biohorizon are specimens of *Cadomites* and *Polyplectites*, which anticipate the more classic Cadomitinae of the middle and upper Niortense Zone. At present, any comparison with other Bajocian outcrops elsewhere may be assured. The sole reference might be with the "*Caumontisphinctes aplous* faunal horizon" proposed by CALLOMON & COPE (1995) in Southern England; the authors did not provide any peculiar list of taxa therefore the value of this British "faunal horizon" derives by its stratigraphic position at the upper part of the Banksii Subzone just below the Polygyralis Subzone.

***Caumontisphinctes polygyralis* Subzone (PAVIA & STURANI, 1968; PAVIA, 1973) –** The FO of *Caumontisphinctes polygyralis* is confirmed to mark the basal boundary of the subzone, as formerly proposed by PAVIA (1973) and confirmed by RIOULT *et al*. (1997) for the European Bajocian. The remaining *Caumontisphinctes-Infraparkinsonia* assemblage of the lower part of the subzone includes the same species encountered in the *Nodatus* Biohorizon. The assemblage changes upwards, in the upper part of the subzone with the occurrence of the couple *C. bifurcus* - *I. inferior*, namely from bed RC-257 of the reference section (PAVIA, 1973). A significant datum is the first occurrence of *Orthogarantiana haugi* at bed RC-263 giving start to the development of the subfamily Garantianinae. Worth to note is the presence of *Teloceras* sp. slightly above the base of the subzone (Fig. 10) and unexpectedly extending the latest distribution of Stephanoceratinae upwards in the Niortense Subzone.

Fig. 10: External mould of the ventral side of *Teloceras* sp. on the upper surface of bed RC-263. This fossil is the youngest record of Stephanoceratinae so-far known in the late Bajocian.

V. TAXONOMIC NOTES

All the fossil material from the Middle Jurassic of the Alpes-de-Haute-Provence country is currently assembled in two collections housed at the Museo di Geologia e Paleontologia of the Dipartimento di Scienze della Terra of the University of Torino (code PU). The first collection deals with Bajocian ammonites, the second concerns Bathonian material (PAVIA *et al*., 2008). The lower and upper Bajocian collection consists of specimens described in previous papers (PAVIA, 1973, 1983a, 1983b, 2000) and it is presently enriched with material sampled in 2011 from Feston and Chaudon sectors.

Taxonomic descriptions and remarks deal with the dimorphic couple *Caumontisphinctes* [M] and *Infraparkinsonia* [m], which is crucial for bio-

chronostratigraphic correlations of the lowermost late Bajocian. After the original identification by PAVIA (1973), these taxa have been profoundly revised after their comparison with BUCKMAN's types, and considering DIETL's monograph (1980a). Moreover, the dimorphic taxon *Phaulostephanus* aff. *burckhardti* is also described since this taxon may be regarded as the direct ancestor of *Caumontisphinctes-Infraparkinsonia*. Finally, notes are devoted to some Leptosphinctinae in order to better document their monospecific occurrence in beds just below and above the lower to upper Bajocian boundary in the Digne district.

Order Ammonitida HYATT, 1889
Superfamily Stephanocerataceae NEUMAYR, 1875
Family Stephanoceratidae NEUMAYR, 1875
Subfamily Stephanoceratinae NEUMAYR, 1875
Genus *Phaulostephanus* BUCKMAN, 1927 [M] & [m]
Type-species: *Phaulostephanus paululus* BUCKMAN, 1927.

Remarks: SANDOVAL & WESTERMANN (1986) specified the characteristics of the taxon after the revisions of PAVIA (1983a) and FERNÁNDEZ-LÓPEZ (1985). Peculiar elements are: serpenticone shells with open umbilicus and subcircular to subquadratic whorl-sections; sharp and slightly sinuous ribs with mid-flank, more or less developed tubercles and secondaries prominent on the venter; septal suture intermediate between Stephanoceratinae and Leptosphinctinae. Microconchs show spatulate lateral lappets without pre-apertural constriction.

In the Digne sections (PAVIA, 1983a) the dimorphic genus *Phaulostephanus* is represented by five taxa distributed at different levels within the Humphriesianum Zone: *P. paululus* BUCKMAN and *P*. aff. *paululus* BUCKMAN in the Romani Subzone, *P. diniensis* PAVIA [M + m] in the middle part of the Humphriesianum Subzone, *Phaulostephanus* n. sp. in the lowermost Blagdeni Subzone, and *Phaulostephanus* aff. *burckhardti* SANDOVAL & WESTERMANN [M + m] sampled at the top of the Blagdeni Subzone.

Apart from SE France, macroconch *Phaulostephanus* have been recorded from the lower Humphriesianum Zone, Romani Subzone of England (BUCKMAN, 1927 in BUCKMAN, 1909-30; PARSONS, 1976) and Portugal (RUGET-PERROT, 1961), the Humphriesianum Zone of Iberian Range (FERNÁNDEZ-LÓPEZ, 1985), the transition of lower to upper Bajocian in Mexico (SANDOVAL & WESTERMANN, 1986). The latter authors cited the couple [M] *Parabigotites crassicostatus* IMLAY (1962) and [m] "*Normannites*" *kialagvikensis* IMLAY (1964), from the Pacific Crassicostatus Zone, as the possible origin of *Phaulostephanus*. The first evolutionary step of *Phaulostephanus* is thought to be represented by *P. mowichense* (IMLAY) and *P.* (?) *oregonense* IMLAY from a level of eastern Oregon (IMLAY, 1973) referred to as intermediate between the European Sauzei and Humphriesianum zones (WESTERMANN & RICCARDI, 1979).

***Phaulostephanus* aff. *burckhardti* SANDOVAL & WESTERMANN, 1986 [M] & [m]**
Pl. I, figs. 1, 2

Material: Two poorly preserved specimens represent the taxon, both from the Ravin de la Coueste section: a macroconch from bed RC-289 (PU112401), a microconch from bed RC-283 (PU112402).

Remarks: The macroconch specimen (Pl. I, fig. 1) differs from the *P. burckhardti* type-series (SANDOVAL & WESTERMANN, 1986, p. 1255) by narrower whorls and more open umbilicus; ribbing is also sharper in the inner whorls. The microconch specimen (Pl. I, fig. 2) is almost adult due to ribbing modification with simple and denser ribs in the last whorl portion; in comparison with the [M], this fragmentary [m] shows a very open umbilicus and even sharper ornamentation.

?Family Stephanoceratidae NEUMAYR, 1875
Genus [M] *Caumontisphinctes* BUCKMAN, 1920
Type-species: *Caumontisphinctes polygyralis* BUCKMAN, 1920.
Genus [m] *Infraparkinsonia* WESTERMANN, 1956
Type-species: *Parkinsonia inferior* BENTZ, 1924.

Remarks : The dimorphic couple *Caumontisphinctes-Infraparkinsonia* is well known in the Niortense Zone of Tethyan Realm with several species described in literature. Palaeobiogeographic distribution is so far limited to the Tethyan Realm, from the West Tethyan Subrealm to the northeastern Tethyan border. The presumed extension to the West Pacific Realm is far to be confirmed despite positive information is provided by WESTERMANN (1981, p. 475) and SUKAMTO & WESTERMANN (1992, p. 185): actually "*L.* (?*Caumontisphinctes*)" aff. *engleri* (FREBOLD) from the upper Bajocian of Sula Islands (HILLEBRANDT *et al*., 1992, p. 259, pl. 66, fig. 6) is a *Leptosphinctes* due to segmental growth of the shell.

As for taxonomy, neither morphologic characters nor biostratigraphy are clearly defined mainly due to taphonomic condensations in NW European successions (PARSONS, 1976; RIOULT, 1964; PAVIA, 1994; CALLOMON & COPE, 1995; PAVIA & MARTIRE, 2009) and Submediterranean Provinces (e.g. DIETL, 1980a), to poor fossil preservation in the SE France sections (PAVIA, 1973, 1983a), to scarcity of fossil assemblages as those of Venetian Alps (STURANI, 1971), and to lack of details in more or less continuous biostratigraphic successions such as those of Feuguerolles in Normandy (GAUTHIER *et al*., 1996), Iberian Range (FERNÁNDEZ-LÓPEZ, 1985) and Caucasus (e.g. BESNOSOV & MITTA, 1998). For this reason we are forced to describe once again the taxa encountered in the successions of Digne area, which were partly misidentified by PAVIA in 1973.

In general, *Caumontisphinctes* and *Infraparkinsonia* show small to medium-sized, serpenticone to platycone shells with sharp ribbing; ribs are usually bifurcate, rarely simple with pointed to obsolete tubercles at the bifurcation point; secondaries are interrupted on the venter and more or less displaced on both sides of a mid-ventral smooth band. The septal suture is simple, with a large and bifid 2nd lateral saddle, whereas the suspensive lobe shows shortly retracted auxiliary elements on the umbilical seam; it greatly resembles that of *Phaulostephanus burckhardti* (SANDOVAL & WESTERMANN, 1986, text-fig. 29). Adult macroconchs show occasional constrictions on the bodychamber where the simple peristome is ventrally projected without pre-apertural constriction. Microconchs do not display any constriction on the bodychamber, and the peristome is enlarged in spatulate lappets.

Caumontisphinctes garnieri (PAVIA, 1973) [M] & [m]
Pl. I, figs. 3-5

v 1969. *Caumontisphinctes aplous* n. ssp. - PAVIA, p. 147, text-fig. 4.
v 1973. *Leptosphinctes* (*L.*) *garnieri* PAVIA, p. 127 (pars), tab. 2, pl. 25, fig. 2 (paratype), pl. 25, fig. 3 and pl. 26, fig. 4 (holotype).
non 1973. *Leptosphinctes* (*L.*) *garnieri* PAVIA, p. 127 (pars), tab. 1 (= *C. diniensis*).
1980. *Caumontisphinctes* (*Caumontisphinctes*) *garnieri* (PAVIA). - DIETL, 1980a, p. 8, text-figs. 2a, 3a, pl. 1, figs. 1-4.
1984. ?*Caumontisphinctes garnieri* (PAVIA). - DIETL & PAVIA, p. 328, 331.

Material: The type-series consists of 5 [M] syntypes, 4 from bed RC-283 (PU 112403-112406), 1 from bed RC-282 (PU112407). The holotype is numbered PU112403, the figured paratype is numbered PU112404.
2011 sampling has provided 6 additional specimens: 3 [M] topotypes from bed RC-283 (PU 112408-112410), 1 [M] specimen from bed LD-105 (PU112411), 2 [m] specimens from beds RC-285 (PU112412) and LD-107 (PU112413).
Diagnosis: An emended diagnosis is necessary in absence of the original one:
Macroconchs with subquadratic whorl section (W/H: 1.08), slightly arched flanks and rounded venter; ribbing gently projected; strong primary ribs (31-35 on ca. 45 mm diameter measured at the end of the adult phragmocone); bifurcation at the outer third of the flank without tubercles; two secondaries per primary with single ribs each three-four bifurcations; secondaries discontinuously interrupted by a smooth ventral band and irregularly displaced. Microconchs more evolute, with stronger ribbing.
Remarks: PAVIA's description gives a detailed account of the species characteristics. DIETL (1980a) demonstrated the necessity to transfer the taxon to *Caumontisphinctes* due to the inconsistence of constrictions as diagnostic parameter, whereas the interruption and the slight displacement of the secondary ribs on the venter are effective in inner whorls and suture-line is *Caumontisphinctes*-like (DIETL, 1980a, text-fig. 3a). The newly collected [M] specimens confirm these characteristics and give evidence of a clear morphological variability in umbilicus aperture correlated to stronger ornamentation. Microconchs of *C. garnieri* are here described for the first time; the largest microconch specimen (Pl. I, fig. 3) does not preserve the peristome, but it is adult because of typical pre-apertural modifications with dense and prevalent single ribs.
At present, the species is recorded only from the uppermost Blagdeni Subzone of SE France, and from the slightly condensed fossil assemblages of the lower Niortense Zone of S Germany.

Caumontisphinctes diniensis PAVIA, 1973 [M] & [m]
Pl. I, figs. 6-9, 11; Figs. 11a, b

v 1969. *Caumontisphinctes aplous* BUCKMAN. - PAVIA, p. 448 (pars).
v 1973. *Caumontisphinctes aplous diniensis* PAVIA, p. 115, pl. 21, fig. 2, fig. 5 (holotype).
v 1973. *Leptosphinctes* (*L.*) *garnieri* PAVIA, p. 127 (pars), tab. 1.
v 1973. *C.* (*Infraparkinsonia*) *debilis* (WETZEL). - PAVIA, p. 127 (pars), tab. 1.
1976. *Caumontisphinctes (C.) diniensis* PAVIA. - PARSONS, p. 130.
1980. *Caumontisphinctes* (*Caumontisphinctes*) *diniensis* PAVIA. - DIETL, 1980a, p. 8, text-figs. 2b, 3b, pl. 1, figs. 6-8.
1984. *Caumontisphinctes diniensis* (PAVIA). - DIETL & PAVIA, p. 328, 331.
? 1985. *Caumontisphinctes* cf. *diniensis* PAVIA. - FERNÁNDEZ-LÓPEZ, p. 404, pl. 42, fig. 5.
1990. *Caumontisphinctes diniensis* PAVIA. - CALLOMON & CHANDLER, p. 100.
non 1998. *Caumontisphinctes* (*Caumontisphinctes*) *diniensis* PAVIA. - BESNOSOV & MITTA, p. 27, pl. 16, fig. 6-8. (= *C. nodatus*)

Material: The type-series consists of 22 [M] syntypes, 21 from bed RC-281 (PU112414-112434), 1 from bed LD-109 (PU112435). The holotype is numbered PU112414, the figured paratype is numbered PU112415.
Further specimens from LD-109, erroneously assigned in Pavia' paper, are added herein: [M] PU112436 as *L. garnieri* and [m] PU112437 as *I. debilis*.
Recent samplings provided 49 new specimens: 25 [M] topotypes from bed RC-281 (PU112438-112462), 21 [M] specimens (PU112463-112483) from beds RF-113 (x2), LD-109 (x10), LD-113 (x7), LD-114, RC-277, 3 [m] specimens (PU112484-112486) from beds LD-110, LD-113, LD-114.
Diagnosis: An emended diagnosis is necessary in absence of the original one:

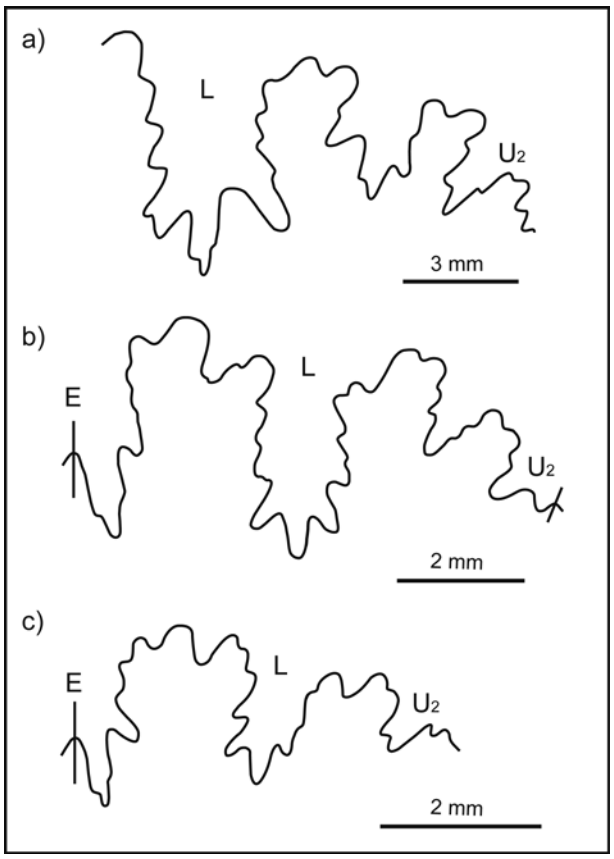

Fig. 11: Suture-lines drawn on pyritic internal whorls.
a: *Caumontisphinctes diniensis* PAVIA [M]. (PU112483). Les Dourbes section, LD-109. Basal bed of the Banksii Subzone, *Diniensis* Biohorizon.
b: *Caumontisphinctes diniensis* PAVIA [m]. (PU112484). Les Dourbes section, LD-114. Lower Banksii Subzone, *Diniensis* Biohorizon.
c: *Infraparkinsonia debilis* (WETZEL) [m]. (PU112547). Ravin du Feston section, RF-121. Upper Banksii Subzone, *Nodatus* Biohorizon.

Macroconchs with subquadratic whorl section (W/H: 1.04), gently arched flanks and slightly flattened venter; strong ribbing with sub-rectiradiate primary ribs (35-37 on ca. 50 mm diameter measured at the end of the adult phragmocone); bifurcation at the outer three-fifth of the flank with small, pointed tubercles on the phragmocone; secondaries slightly turned forwards and intercalated with single ribs and free secondaries; ventral ribbing interrupted by a large smooth band and regularly displaced. Microconchs more evolute with stronger ribbing; peristome with relatively large lappets.
Suture-lines of both macroconchs and microconchs show clearly retracted auxiliary elements of the suspensive lobe at the umbilical seam; the 2nd lateral saddle is large and deeply bifid.
Remarks: PAVIA'S description gives a detailed account of the species characteristics. The newly collected [M] specimens document the ribbing variability, whereas architectural features appear constant; wider umbilicus is correlated with stronger ornamentation (Pl. I, fig. 11). The differences with *C. garnieri* concern the depressed venter, the sub-rectiradiate primaries, the small tubercles at the bifurcation point, and the regular interruption and displacement of ribbing on the venter. The microconchs of *C. diniensis* (Pl. I, figs. 6, 7) were referred by PAVIA (1973) as a new unnamed subspecies of *Infraparkinsonia debilis*, from which they differ by stronger primary ribs with small tubercles. These ornament characteristics allow a close comparison of the microconchs of *C. diniensis* with those of "*Infragarantiana*" *primitiva* (WETZEL, 1937; see WESTERMANN, 1956) though umbilicus appears larger in WETZEL'S species; additional type-material is therefore necessary to confirm the similarities between the two taxa.
At present, the species record is limited to the West Tethyan Subrealm, everywhere from the Banksii Subzone. Digne data limit *C. diniensis* to the lower part of this Subzone, within the *Diniensis* Biohorizon.

Caumontisphinctes nodatus BUCKMAN, 1921 [M]
Pl. I, figs. 10, 13

v 1921. *Caumontisphinctes nodatus* BUCKMAN, 1909-30, pl. 242 (holotype).
1936. *Praebigotites westfalicus* WETZEL, p. 533, pl. 21, figs. 1-5.
v 1968. *Caumontisphinctes aplous* BUCKMAN. - PAVIA & STURANI, p. 313 (pars).
v 1969. *Caumontisphinctes aplous* BUCKMAN. - PAVIA, p. 448 (pars), text-fig. 3.
v 1973. *Caumontisphinctes aplous aplous* BUCKMAN. - PAVIA, p. 115 (pars), pl. 21, fig. 6 (non fig. 3 = *C. aplous*).
1980. *Caumontisphinctes* (*Caumontisphinctes*) *nodatus nodatus* BUCKMAN. - DIETL, 1980a, p. 13, text-fig. 3c, pl. 2, figs. 1-2.
1985. *Caumontisphinctes nodatus* BUCKMAN. - FERNÁNDEZ-LÓPEZ, p. 328, pl. 42, fig. 3.
1998. *Caumontisphinctes* (*Caumontisphinctes*) *diniensis* PAVIA. - BESNOSOV & MITTA, p. 27, pl. 16, figs. 6-8.

Material: As a whole the collection comprises 33 specimens. 1+9 specimens (PU112487-112496) come from beds RC-271 and RC-267 respectively. 22 specimens (PU112497-112518) come from beds RF-117 (x2), RF-119, RF-123 (x2), LD-121 (x7), LD-123 (x2), LD-125 (x5), LD-127 (x3).
An additional specimen is the gypsum mould of *C. nodatus* holotype registered as PU112519.
Remarks: DIETL (1980a) described the species in great detail, so that only a few comments on the synonymy list are needed. He instituted the subspecies *C. n. bisingensis* DIETL from the same levels of *C. n. nodatus*; due to the compaction of fossils, so that the smaller ventral band of the former subspecies is hardly recognizable in Digne specimens, we will deal only with the nominal species.

The newly collected material confirms the hypothesis formulated by PAVIA (1973, p. 114, text-fig. 6) about the close phylogenetic relationships between *C. diniensis* and *C. nodatus* (the latter being partially amended in this paper with *C. aplous*, see below). Actually, their morphological differences lie on the stronger ribbing with shorter primaries and on smaller tubercles typical of *C. diniensis*, whereas *C. nodatus* exhibits more flattened flanks.

PAVIA (1973) erroneously identified all specimens from beds overlying the basal Banksii Subzone as *C. aplous*. After checking on *C. aplous*' (see Pl. II, fig. 1) and *C. nodatus* holotypes there is no doubt that part of the Digne material should be assigned to *C. nodatus*, considering the spaced and tubercle-bearing ribbing with bifurcation point near the middle of the flanks.

Praebigotites westfalicus was instituted by WETZEL (1936) based on a lot of specimens sampled from the lower Niortense Zone of Bielefeld (N Germany: WESTERMANN, 1956, p. 266). The original diagnosis of *P. westfalicus* is undefined except for its suture-line (*Dactylioceras*-like), which seems to be simple, thus very different from that of Leptosphinctinae to which the author repeatedly referred to. Actually the ribbing of "*P.*" *westfalicus*, type species of *Praebigotites*, resembles the one found on *Bigotites*, mainly for the "uncertain" interruption on the venter. ARKELL *et al.* (1957) placed dubitatively *Praebigotites* within Leptosphinctinae and, later on, GALÁCZ (1980) and DIETL (1980b) assigned the genus to *Caumontisphinctes* (see also FERNÁNDEZ-LÓPEZ, 1985, p. 461). The type-series seems to be missing; however both architecture and ribbing are sufficiently evident on the figures published by WETZEL (1936) in order to justify the synonymy with *C. nodatus*.

The synonymy list indicates that *C. nodatus* is widely distributed in all Tethyan provinces both in Banksii and Polygyralis subzones.

Caumontisphinctes rota (BENTZ, 1924) [M]
Pl. II, fig. 3

1924. *Parkinsonia rota* BENTZ, p. 184, text-figs. 18-19, pl. 8, fig. 2 (lectotype, here proposed), fig. 3.
1980. *Caumontisphinctes* (*Caumontisphinctes*) *rota* (BENTZ). - DIETL, 1980a, p. 23, text-figs. 2c, 3e, 4, pl. 5, figs. 1-2.
1985. *Caumontisphinctes rota* (BENTZ). - FERNÁNDEZ-LÓPEZ, p. 402, pl. 42, fig. 6.
1998. *Caumontisphinctes* (*Caumontisphinctes*) *rota* BENTZ. - BESNOSOV & MITTA, p. 27, pl. 16, figs. 4-5.

Material: As a whole the collection consists of 5 specimens (PU112520-112524) sampled in 2011 from beds RF-123, LD-119, LD-121, LD-129, RC-263.

Remarks: DIETL's revision (1980a) demonstrated the opportunity to distinguish *C. rota* from *C. bifurcus*, of which STURANI (1971, p. 167) and PAVIA (1973, p. 117) thought to be a younger synonym. The most evident characters of *C. rota* on Digne specimens are the extremely wide umbilicus, the medium-spaced, slightly concave ribbing with faint tubercles, and the bifurcation point near the ventrolateral edge. In this respect, they show a little difference from the FERNÁNDEZ-LÓPEZ's specimen that shows a rectangular whorl section with tubercles at the ventrolateral edge.

The synonymy list indicates that *C. rota* is widely distributed in all Tethyan provinces from Banksii to Polygyralis subzones.

Caumontisphinctes aplous BUCKMAN, 1921 [M]
Pl. II, figs. 1, 2

v 1921. *Caumontisphinctes aplous* BUCKMAN, 1909-30, pl. 241 (holotype).
v 1968. *Caumontisphinctes aplous* BUCKMAN. - PAVIA & STURANI, p. 313 (pars).
v 1969. *Caumontisphinctes aplous* BUCKMAN. - PAVIA, p. 448 (pars).
v 1973. *Caumontisphinctes aplous aplous* BUCKMAN. - PAVIA, p. 115 (pars), pl. 21, fig. 3 (non fig. 6 = *C. nodatus*).
1976. *Caumontisphinctes (C.) aplous* BUCKMAN. - PARSONS, p. 130.
1980. *Caumontisphinctes* (*Caumontisphinctes*) cf. *aplous* BUCKMAN. - DIETL, 1980a, p. 16, pl. 2, figs. 7-8.
1990. *Caumontisphinctes aplous* BUCKMAN. - CALLOMON & CHANDLER, p. 100.
1996. *Caumontisphinctes aplous* BUCKMAN. - CALLOMON & COPE, p. 71.
1996. *Caumontisphinctes aplous* BUCKMAN. - GAUTHIER *et al.*, p. 35, pl. 5, figs. 3-4.
1998. *Caumontisphinctes* (*Caumontisphinctes*) *aplous* BUCKMAN. - BESNOSOV & MITTA, p. 27, pl. 16, fig. 3.

Material: As a whole the collection comprises 6 specimens (PU112525-112530) sampled from beds RF-117 (x2), LD-135, RC-267 (x2), RC-265.

An additional specimen is the gypsum mould of *C. aplous* holotype registered as PU112531 (Pl. II, fig. 1).

Remarks: For the mistakes in the identification of Digne specimens (PAVIA, 1973), see comments for *C. nodatus*. DIETL (1980a) described the species in great detail. The morphological characteristics that distinguish *C. aplous* from other coeval species are the oval whorl section with rounded flanks, the dense ribbing with very fine tubercles on the bifurcation point near the ventrolateral edge, and the coupled, forward turned secondary ribs. In this sense, similarities are with *C. rota* (distinct for wider umbilicus and more spaced ribs), and with *C. bifurcus* BUCKMAN (distinct for stronger ornaments, thicker and subquadratic whorl-section).

The synonymy list indicates that *C. aplous* is widely distributed in all Tethyan provinces both in Banksii and Polygyralis subzones.

Infraparkinsonia debilis (WETZEL, 1937) [m]
Pl. I, fig. 12; Fig. 11c

1937. *Parkinsonia debilis* WETZEL, p. 120, pl. 12, fig. 3 (holotype).
v 1973. *Caumontisphinctes* (*Infraparkinsonia*) *debilis* (WETZEL). - PAVIA, p. 117, pl. 20, figs. 8, 11.
non 1980. *Caumontisphinctes* (*Infraparkinsonia*) *debilis* (WETZEL). - DIETL, 1980a, p. 30, text-figs. 2g, 5d, pl. 5, fig. 8 (= *I. pierae* n. sp.).
non 1998. *Caumontisphinctes* (*Infraparkinsonia*) *debilis* (WETZEL). - BESNOSOV & MITTA, p. 27, pl. 16, figs. 10-11 (= *I. phaula*).

Material: As a whole the collection comprises 27 specimens (PU112532-112558) sampled from beds RF-119 (x8), RF-121, LD-119, LD-123 (x4), LD-125 (x7), RC-273 (x2), RC-271 (x2), RC-269, RC-261.
Remarks: According to the detailed descriptions of WETZEL (1937) and PAVIA (1973), the species is characterized by open umbilicus, spaced and subrectiradiate primary ribs on the phragmocone that become denser on the bodychamber, clear tubercles on the bifurcation point nearly at mid-flank, slightly proverse secondaries, spatulate lappets (PAVIA, 1973, pl. 20, fig. 8: PU112534). The suture-line shows squat primary elements; the 2nd lateral saddle is barely bifid and the suspensive lobe is only a little retracted.
Morphological characteristics suggest the dimorphic partnership of *Infraparkinsonia debilis* and *Caumontisphinctes nodatus*.
Infraparkinsonia debilis has been repeatedly misidentified in literature, so that at present its synonymy list is reduced to WETZEL's and PAVIA's papers. Future revisions should enlarge its distribution through upper Banksii and lower Polygyralis subzones within the Tethyan Realm.

Infraparkinsonia pierae n. sp. [m]
Pl. II, fig. 4

1980. *Caumontisphinctes* (*Infraparkinsonia*) *debilis* (WETZEL). - DIETL, 1980a, p. 30, text-figs. 2g, 5d, pl. 5, fig. 8.
? 1985. *Infraparkinsonia phaula* (WETZEL). - FERNÁNDEZ-LÓPEZ, p. 408, pl. 42, fig. 10.

Derivation of name: The species is dedicated to Piera ROSSO (Giulio PAVIA's wife) who sampled the holotype on the field.
Type-series: 3 syntypes sampled in 2011 from beds LD-123, LD-125, LD-127. The holotype (PU112560) comes from bed LD-125 and is figured at Pl. II, fig. 4. Paratypes come from beds LD-123 and LD-127 and are registered respectively as PU112559 and PU112561. Measurements are approximate due to deformation: at 17 mm diameter the holotype measures H 0,28 and U 0,51.
Type-locality: The holotype comes from bed LD-125 of the Les Dourbes section.
Stratum-type: The holotype comes from the topmost Banksii Subzone, European Standard Niortense Zone, late Bajocian. As a whole, *I. pierae* n. sp. spans from the upper Banksii to the lower Polygyralis subzones.

Diagnosis: Serpenticone forms with subcircular whorl section of the phragmocone, flattened flanks of the bodychamber, medium-open umbilicus, dense ribbing, strait primary ribs and secondaries a little turned forwards, bifurcation point at the outer third of the flank.
Remarks: Further morphological elements of the new species are round flanks delimiting deep umbilical seam, dense ribbing with 36 primaries on the holotype (35 on the phragmocone of DIETL's specimen at 22 mm diameter), one single rib every two bifurcations.
DIETL's specimen (1980a) fits the architectural and the morphological parameters of both holotype and paratypes. It is an adult specimen judging by the flattened adoral part of the bodychamber and the denser ribs that, usually, precede the peristome. Unfortunately neither the type-series nor DIETL's specimen preserve the peristome lappets. Types' characteristics suggest referring the specimen from the Polygyralis Subzone of the Iberian Range (FERNÁNDEZ-LÓPEZ, 1985) to the new species.
According to morphological and biostratigraphical equivalences, the dimorphic partnership *Infraparkinsonia pierae* n. sp. and *Caumontisphinctes aplous* is highly plausible.

Infraparkinsonia phaula (BUCKMAN, 1922) [m]
Pl. II, fig. 5

1922. *Caumontisphinctes phaulus* BUCKMAN, 1909-30, pl. 169 (holotype).
v. 1971. *Caumontisphinctes* (*Infraparkinsonia*) *phaulus* BUCKMAN. - STURANI, p. 168, pl. 16, figs. 15-16.
v 1973. *Caumontisphinctes* (*Infraparkinsonia*) *phaulus* BUCKMAN. - PAVIA, p. 118, pl. 21, fig. 1.
? 1976. *C. (Infraparkinsonia)* cf. *phaulus* - PARSONS, p. 130.
1980. *Caumontisphinctes* (*Infraparkinsonia*) *phaulus* BUCKMAN. - DIETL, 1980a, p. 25, pl. 5, fig. 4.
non 1985. *Infraparkinsonia phaula* (WETZEL). - FERNÁNDEZ-LÓPEZ, p. 408, pl. 42, fig. 10. (= ? *I. pierae* n. sp.).
? 1990. *C.* (*Infraparkinsonia*) cf. *paula* (sic). - CALLOMON & CHANDLER, p. 100.
1998. *Caumontisphinctes* (*Infraparkinsonia*) *debilis* (WETZEL). - BESNOSOV & MITTA, p. 27, pl. 16, figs. 10-11.

Material: The collection consists of 10 specimens (PU112562-112571) sampled from beds RF-117, RF-119 (x3), LD-119, LD-121, LD-125 (x2), LD-127 (x2).
An additional specimen is the gypsum mould of *I. phaula* holotype registered as PU112572.
Remarks: The species is sufficiently known in literature; there is no need for additional description (see STURANI, 1971, and DIETL, 1980a, for details). The main characteristics are the medium-spaced primary ribs regularly distributed on both phragmocone and bodychamber, the bifurcation points with faint tubercles near the mid-flank, and the sharp, slightly proverse secondaries that reinforce on the venter and are interrupted by a narrow, furrow-like, median band.
The synonymy list indicates that *Infraparkinsonia*

phaula is widely distributed in all Tethyan provinces both in Banksii and Polygyralis subzones, in parallel with the distribution of *Caumontisphinctes rota*, its likely macroconch partner.

Superfamily Perisphinctaceae STEINMANN, 1890
Family Perisphinctidae STEINMANN, 1890
Subfamily Leptosphinctinae ARKELL, 1950
Genus [M] *Leptosphinctes* BUCKMAN, 1920
Type-species: *Leptosphinctes leptus* BUCKMAN, 1920.

Remarks: The dimorphic couple [M] *Leptosphinctes* - [m] *Cleistosphinctes* constitutes a typical and widespread distributed taxonomic element of upper Bajocian successions. Many papers issued in the last century described an extremely large set of taxa that in some cases, mainly in absence of an incontrovertible biostratigraphy, makes it difficult to identify common taxa or recognize synonymies because of recurrent homeomorphisms. So, continuous and thick successions such as those of SE France, Portugal and Caucasus, assume such a high relevance to need further revisions and possibly supplementary field works.
In the late Bajocian successions of the Digne district, Leptosphinctinae are frequently found from the middle part of the Niortense Zone, i.e. from the Polygyralis Subzone. On the contrary, as for the Banksii Subzone, at present only one dimorphic taxon and scattered specimens may be confirmed in the Digne successions, whereas in other outcrops of the Tethyan Realm leptosphinctid occurrence seems to be more diversified. In this sight, it is worth noting that the Digne successions document the so-far oldest occurrences of Leptosphinctinae in the European lower Bajocian represented by the three taxa known in the middle-upper Blagdeni Subzone (PAVIA, 1973, 1983a; see Fig. 4); further leptosphinctid records from the upper Blagdeni Subzone are occasionally cited in the literature of the Submediterranean Province (e.g., ROCHÉ, 1943; GABILLY *et al*., 1971; FERNÁNDEZ-LÓPEZ & GÓMEZ, 1978; FERNÁNDEZ-LÓPEZ, 1985). In this respect, the record of *Leptosphinctes chaudonensis* PAVIA from beds RC-311 and RC-305 (middle Blagdeni Subzone) is of primary importance to support the origin of Leptosphinctinae from Tethyan Stephanoceratidae (namely the genus *Phaulostephanus*) in the upper Humphriesianum Zone, and their worldwide spreading at the passage to the late Bajocian.

***Leptosphinctes festonensis* PAVIA, 1973 [M] & [m]**
Pl. II, figs. 6-8

1943. *Leptosphinctes cleistus* BUCKMAN. - ROCHÉ, p. 22, pl. 1, fig. 3.
v 1969. *Leptosphinctes* aff. (*Vermisphinctes*) *subdivisus* (BUCKMAN). - PAVIA, p. 448, text-fig. 4.
v 1973. *Leptosphinctes* (*L.*) *festonensis* PAVIA, p. 126, pl. 25, fig. 6, pl. 26, fig. 1 (holotype).
v 1983. *Leptosphinctes* (*L.*) *festonensis* PAVIA. - PAVIA, 1983a, p. 121, text-fig. 30.
non 1980. *Leptosphinctes* (*Leptosphinctes*) *festonensis* PAVIA. - DIETL, 1980b, p. 20, text-figs. 6h, pl. 9, fig. 2.
non 1983. *Leptosphinctes* (*Leptosphinctes*) *festonensis* PAVIA. - SANDOVAL, 1983, p. 369, pl. 30, fig. 8.
1985. *Leptosphinctes* aff. *festonensis* PAVIA. - FERNÁNDEZ-LÓPEZ, p. 404, pl. 48, fig. 6.
non 1985. *Leptosphinctes festonensis* PAVIA sensu DIETL. - FERNÁNDEZ-LÓPEZ, p. 404, pl. 48, figs. 3, 5.
1998. *Praebigotites* (*Praebigotites*) cf. *festonensis* PAVIA. - BESNOSOV & MITTA, p. 25, pl. 11, fig. 10.

Material: The type-series consists of 25 [M] syntypes, 2 from bed RF-99 (PU112573-112574), 4 from bed RC-297 (PU112575-112578), 1 from bed RC-289 (PU112579), 18 from bed RC-287 (PU112580-112597). The holotype is numbered PU112580, the figured paratype is numbered PU112581.
2011 sampling provided 21 new specimens: 11 [M] topotypes (PU112598-112608) from beds RC-297, RC-287 (x7), RC-286 (x2), RC-285, 5 [M] specimens (PU112609-112613) from RF-111, LC-97, LC-103, LC-107 (x2), 3 [m] specimens (PU112614-112616) from bed RC-287.
The record of *L. festonensis* from RC-295 is documented by an external cast on the bed surface.
Diagnosis: An emended diagnosis is requested in absence of the original one.
Macroconchs with subcircular whorl section (W/H: 1.03); wide umbilicus ranging between 0.48-0.53 on a diameter measured at the beginning of bodychamber (0.51 on 71.8 mm of the holotype); two deep constrictions per whorl; projected ribbing with mid-elevated and dense primary ribs (41 on 71.8 mm of the holotype); evanescent bifurcation point at the outer three-fifth of the flank; coupled secondaries occasionally intercalated by single ribs and free external riblets; secondaries fading externally on the bodychamber with nearly smooth venter; peristome preceded by deep constriction and adoral single rib, and largely projected on the venter. Microconchs with very wide umbilicus (0.56 at 37 mm diameter measured at the end of the phragmocone), dense ribbing (42 primaries at 37 mm diameter) and 1.5 secondary/primary rib ratio.
Remarks: The species was repeatedly discussed in literature, except for microconchs which are here described for the first time. The suture line is typically leptosphinctid (PAVIA, 1983a), implying that the onset of Leptosphinctinae occurred deep in the upper part of the Humphriesianum Zone. Microconch specimens have been sampled in 2011 (Pl. II, fig. 6) and show a serpenticone coiling relatively different from the subplanulate shells of microconch Leptosphinctinae assigned to the taxon *Cleistosphinctes* (e.g., PAVIA, 1973; DIETL, 1980b).
DIETL (1980b) and more recently GALÁCZ (accepted) interpret the figured paratype of *L. festonensis* as belonging to a different taxon because of wider umbilicus, denser

and straight ribbing. Actually, the paratype is deformed so that umbilical measurements result distorted and ribs seem to be pseudo-rectiradiate. However, the ribbing density of that paratype falls within the variability range of the type-series and the topotypes, in which the number of the primary ribs intergrades between 46-48 (holotype and Pl. II, fig. 7) and 54-56 per whorl (paratype and Pl. II, fig. 8) at equivalent diameters.

As for the synonymy list, the record from southern Germany (DIETL, 1980b) refers to a different, still unnamed species dating back to the Polygyralis Subzone, as confirmed by FERNÁNDEZ-LÓPEZ (1985) from a coeval level of the Iberian Range.

All the Tethyan records of *L. festonensis* from Iberian Range (FERNÁNDEZ-LÓPEZ, 1985), SE France (present work) and Hungary (GALÁCZ, accepted), as well as the interesting specimen from Mont d'Or Lyonnais figured by ROCHÉ (1943), refer to the upper Blagdeni Subzone. The specimen of "*Praebigotites*" cf. *festonensis* (BESNOSOV & MITTA, 1998, p. 25) testifies the palaeobiogeographic extension of the species to the northeastern Tethyan border.

Leptosphinctes constrictus (BESNOSOV, 1993)
[M] & [m]
Pl. II, figs. 9, 10

v 1973. *Leptosphinctes* (*L.*) aff. *garnieri* PAVIA. - PAVIA, p. 128, pl. 26, fig 5.
1983. *Leptosphinctes* (*L.*) aff. *garnieri* PAVIA. - SANDOVAL, p. 374, pl. 5, fig 5.
1993. *Praebigotites* (*Praebigotites*) *constrictus* BESNOSOV in BESNOSOV & MITTA, p. 173, pl. 8, fig. 6 (holotype).
1998. *Praebigotites* (*Praebigotites*) *constrictus* BESNOSOV. - BESNOSOV & MITTA, p. 25, pl. 11, fig. 9 (holotype).

Material: 1 [M] specimen (PU112617) sampled in 1973 from bed RF-114 and 1 [m] specimen (PU112618) sampled in 2011 from bed LD-114. Their state of preservation prevents measurements.

Description: The macroconch specimen is almost complete at 98 mm diameter. It shows an extremely evolute, serpenticone shell with open umbilicus (U 55% at 65 mm diameter), rounded-quadrangular whorl section, arched venter and steep umbilical wall. Ornamentation is composed of projected primary ribs bifurcating at the outer third of flank without tubercles; a single rib intercalates every two-three couples of secondary ribs (at 65 mm diameter: 48 primaries, 86 secondaries); secondary ribs cross the venter with light attenuation. Two proverse and deep constrictions per whorl reflect segmental growth and are marked by an adoral, sharp single rib slightly more projected than ribbing. The peristome is partly preserved.

The microconch specimen does not show any clear constriction on the bodychamber; the peristome shows stunt lateral lappets visible only on the left side. Umbilicus value is 53% at 31.5 mm diameter. Ornamentation (22 primaries, 38 secondaries on half world at 35.2 mm diameter) shows the same style of the macroconch counterpart.

Remarks: All fossils cited in the synonymy list come from an equivalent horizon: the lower-middle part of the Niortense Zone. Their coiling, whorl section, umbilicus width, ribbing and constrictions are very similar, and correspond to the holotype (see BESNOSOV & MITTA, 1993, 1998).

Very similar forms are *L. cliffensis* IMLAY (1962, p. 12, pl. 5/10-11) and *L. evolutus* IMLAY (1964, p. 54, pl.28/4-6) both from the North America Rotundum Zone (HALL & WESTERMANN, 1980), equivalent to the European Niortense Zone. They differ from *L. constrictus* for higher whorl-section, more spaced ribs, and stunt secondaries. Nevertheless, apart these morphological differences, the three species (*cliffensis*, *constrictus*, *evolutus*) seem to constitute a widespread stock of forms that reflects connections between Tethyan Realm and East Pacific Subrealm at the beginning of late Bajocian, in parallel with other discussed taxa (*Phaulostephanus* and so on).

VI. CONCLUDING REMARKS

Different reflections arise from the previously discussed taxonomic records documented in beds at the lower to upper Bajocian transition of the Digne district.

The first topic deals with the style of the ammonite assemblages encountered in the studied sections. Though ammonites are present throughout the whole Bajocian succession, their abundance is extremely variable; in some beds they are almost absent, but very frequent in others as in beds RF-119, LD-109, LD, 123-125, RC-297, RC-293, RC-287, RC-281, and RC-267. Furthermore, ammonoid assemblages show non-homogeneous taxonomic record: for instance, beds RC-287 and RC-281 are rich in specimens of *Leptosphinctes festonensis* and *Caumontisphinctes diniensis*, respectively, which become nearly exclusive within Ammonitida. Such discontinuous records might reflect the supply of taphonic entities (ammonoid shells) on the bottom of burial. Textures and structures of limestone-marl alternation, the taphonomic features of ammonoid fossils grouped in a single taphorecord, the pattern of distribution, the lateral variation in ammonoid assemblages among sections, moving from RF to RC, and the frequent discontinuity in taxonomic composition are interpreted as the consequence of repeated supplies of sediment and biostratinomic elements by currents flowing down from different sectors of the FSB platform (cf. Fig. 3).

Knowledge on the origin of the dimorphic couple *Caumontisphinctes-Infraparkinsonia* is reduced to a few papers with conflicting evidences. PAVIA (1973) hypothesized a direct radiation of *Caumontisphinctes*

from *Leptosphinctes* based on the chronostratigraphic sequence *Leptosphinctes festonensis* - "*Leptosphinctes*" *garnieri* - *Caumontisphinctes diniensis* finely documented in the Ravin de la Coueste section at Chaudon. Subsequently, on the basis of well preserved specimens, Dietl (1980a) demonstrated the inconsistence of the hypothesis proposed by Pavia (1973) due to simpler, quite different suture line compared with that of *Leptosphinctes*, and to ribbing definitively typical of *Caumontisphinctes*, in terms of style and interruption of secondary ribs on the venter; moreover, the scattered constrictions on the bodychamber of "*Leptosphinctes*" *garnieri* were interpreted as meaningless. Dietl (1980a) concluded that the taxon *garnieri* must be assigned to *Caumontisphinctes* and that the two genera should belong to different evolutionary lineages. A useful contribution was provided by Donovan *et al*. (1980) who suggested that the "*Caumontisphinctes* … probably arose from some slightly earlier stephanoceratids, in line … with *Parabigotites*". This sentence recalls the previously discussed generalities of the genus *Phaulostephanus*, whose phyletic connection with *Parabigotites* of the mid-lower Bajocian of the East Pacific Subrealm has been affirmed by Sandoval & Westermann (1986) (see also Hillebrandt *et al*., 1992). The data from the Humphriesianum Zone of Digne integrate the Pacific occurrence of *Phaulostephanus*, and lead to the *Caumontisphinctes* onset just below the basal boundary of the upper Bajocian (Pavia, 2000, p. 403). The array of taxa collected in the Ravin de la Coueste section (*Phaulostephanus paululus*, *Phaulostephanus diniensis*, *Phaulostephanus* n. sp. ind., *Phaulostephanus* aff. *burckhardti*) does not appear to be directly related to a single phyletic lineage; these taxa refer to distinct chronostratigraphic levels with intercalated sets of beds delivering rich stephanoceratid assemblages none of which characterized by a typical phaulostephanid morphology. Such a discontinuous record reflects successive dispersion phases during which Pacific biota entered the West Tethyan Subrealm, up to the event of the *Caumontisphinctes* onset. Unfortunately, both *P.* cf. *burckhardti* specimens are fragmentary and do not preserve the suture line that would definitively provide support to relate *Caumontisphinctes garnieri* to the former taxon. Nevertheless, architectural and morphological equivalences, as well as ribbing, are here regarded as valuable characters to hypothesize the origin of *Caumontisphinctes* from *Phaulostephanus* and the suture-lines support this assumption. In fact, the suture-lines of earliest *Caumontisphinctes* (*C. garnieri* in Dietl, 1980a, text-fig. 3a; *C. diniensis* in this paper, Figs. 11a, b) are very similar to those of *Phaulostephanus* (Pavia, 1983a; Sandoval & Westermann, 1986) mainly for the retracted suspensive lobe; on the contrary, this structural analogy gets lost in [M] and [m] forms of the upper Banksii Subzone (Dietl, 1980a, text-figs. 3, 4; this paper, Fig. 11c).

Many taxa of the Humphriesianum and basal Niortense zones are sorts of scattered "ghosts" that occasionally appear in the successions of West Tethyan Realm. We refer either to the above-discussed *Phaulostephanus* or to other taxa encountered in the studied sections (*Subcollina*, *Patrulia*, *Torrensia*), as well as to *Parastrenoceras* recorded from different Tethyan countries. Sandoval & Westermann (1986) discussed the East Pacific origin of *Subcollina* and *Parastrenoceras* from *Phaulostephanus*, namely from *P. burckhardti*. Pavia (2000) confirmed the plausibility of such an evolutionary lineage and the dispersion of these taxa from the East Pacific Subrealm to different Tethyan areas via Central Atlantic. This area apparently functioned bi-directionally since Aalenian times, and possibly earlier in the Early Jurassic (Elmi, 1992; Westermann, 1993; Moyne & Neige, 2007; Page, 2008; Fernández-López, 2011). Effective exchanges through that migration seaway (Hispanic Corridor of Smith, 1983; Riccardi, 1991) were supported by the early Bajocian sea-level rise to which the maximum faunal affinity at both ends of the Central-Atlantic seaway is correlated (Sandoval *et al*., 2001; O'Dogherty *et al*., 2006, and reference therein). This radiation seems to have been effective in separated times (e.g., *Phaulostephanus* and *Subcollina* in the latest Humphriesianum Zone, *Patrulia* in the earliest Niortense Zone) during which occasional, short-living populations entered Tethyan environments, developed with punctual dispersion, and possibly continued the exchange with the Eastern Pacific Subrealm (*Subcollina* and *Parastrenoceras* for instance: Pavia, 2000) or limited to the Tethyan Realm (*Caumontisphinctes* and *Infraparkinsonia*) giving rise to a diversified set of taxa that spread through different provinces.

Since the latest decades of the past century, the International Subcommission on Jurassic Stratigraphy (ISJS) promoted activities to get definitions for the Global Boundary Stratotype Section and Point (GSSP) of each stage of the Jurassic System. It is the case, for instance, of the Bathonian GSSP ratified in 2008 at the Bas Auran area in the southern Digne district (Fernández-López *et al*., 2009b). Recently (Morton, 2003) ISJS Scientific Committee asserted the opportunity to locate or review sections that could be proposed as reference for the basal boundary of substages. For the Bajocian Stage, Dietl & Pavia (1984) anticipated the project with a forerunner, preliminary proposal in this direction, and indicated bed 281 of the Ravin de la Coueste section at Chaudon as the reference for definition of the late Bajocian GSSP, assuring correlation towards Submediterranean (Dietl, 1980a) and Northwest European Provinces (Parsons, 1976). The formal process stopped in 1984 awaiting for more detailed information. The 2011 sampling increases the ammonite record in beds below and above RC-281 and allows integration of data from sections LD and RF to RC sections, so that a more complete biostratigraphic scheme is now available (Fig. 4). The continuous

lithostratigraphic succession without discontinuities, the abundance of fossils sufficiently preserved to be identifiable, the homogeneous preservations of fossils, testifying only preburial reworking (resedimentation, no reelaboration), confirm the suitability of those sections to support the proposal of late Bajocian GSSP, that would be fixed at bed RC-281 of the Ravin de la Coueste section (Figs. 6, 12) perfectly correlated with beds RF-113 (Fig. 2) and bed LD-109 (Fig. 5). Overall, the degree of documentation satisfies most of the requirements of the International Commission on Stratigraphy for GSSP formalisation (REMANE *et al*., 1996; GRADSTEIN *et al*., 2003), but radio-isotopic and geochemical information is still unavailable. Moreover, the project needs investigation assuring wide correlation, in particular for microfossil content presently limited to a cursory report based on calcareous nannofossil (ERBA, 1990).

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Fig. 12: Beds at the lower/upper Bajocian boundary in the Ravin de la Coueste section. Bed RC-281 was indicated as the possible GSSP of the Late Bajocian by DIETL & PAVIA (1984); its value is confirmed in the present paper. Bed RC-293 is the most fossiliferous layer in the uppermost Blagdeni Subzone; several tens of ammonites were sampled on its largely exposed surface. Bed RC-267 marks the lower boundary of the Polygyralis Subzone.
The small square locates a car parked at the side of the road Chaudon-Norante, 500 m far from the outcrop. Easy accessibility is one of the IUGS requirements for GSSP proposal.

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Plate I

Figs. 1, 2: *Phaulostephanus* aff. *burckhardti* SANDOVAL & WESTERMANN [**M**] & [**m**].
Uppermost Blagdeni Subzone, *Festonensis* Biohorizon.
[**M**] - 1: PU112401, bed RC-289, left side.
[**m**] - 2: PU112402, bed RC-283, right side.

Figs. 3-5: *Caumontisphinctes garnieri* (PAVIA) [**M**] & [**m**].
Uppermost Blagdeni Subzone, *Festonensis* Biohorizon.
[**m**] - 3a, b: PU112412, bed RC-285. (a) Left side. (b) Right side.
[**M**] - 4: topotype, PU112408, bed RC-283, left side. 5a, b: topotype PU112409, bed RC-283, right side.

Figs. 6-9, 11: *Caumontisphinctes diniensis* PAVIA [**M**] & [**m**].
Lower Banksii Subzone, *Diniensis* Biohorizon.
[**m**] 6: PU112486, bed RF-1113, left side. 7: PU112437, bed LD-109, right side.
[**M**] 8: PU112467, bed LD-109, right side. 9: topotype, PU112438, bed RC-281, right side. 11: PU112466, bed LD-109, left side.

Figs. 10, 13: *Caumontisphinctes nodatus* BUCKMAN [**M**].
10: PU112502, bed LD-121, left side. Upper Banksii Subzone, *Nodatus* Biohorizon.
13: PU112489, bed RC-267, right side. Lower Polygyralis Subzone.

Fig. 12: *Infraparkinsonia debilis* (WETZEL) [**m**].
PU112550, bed LD-125, right side. Upper Banksii Subzone, *Nodatus* Biohorizon.

White asterisks indicate the end of the phragmocone. Scale bar: 1 cm.

Plate I

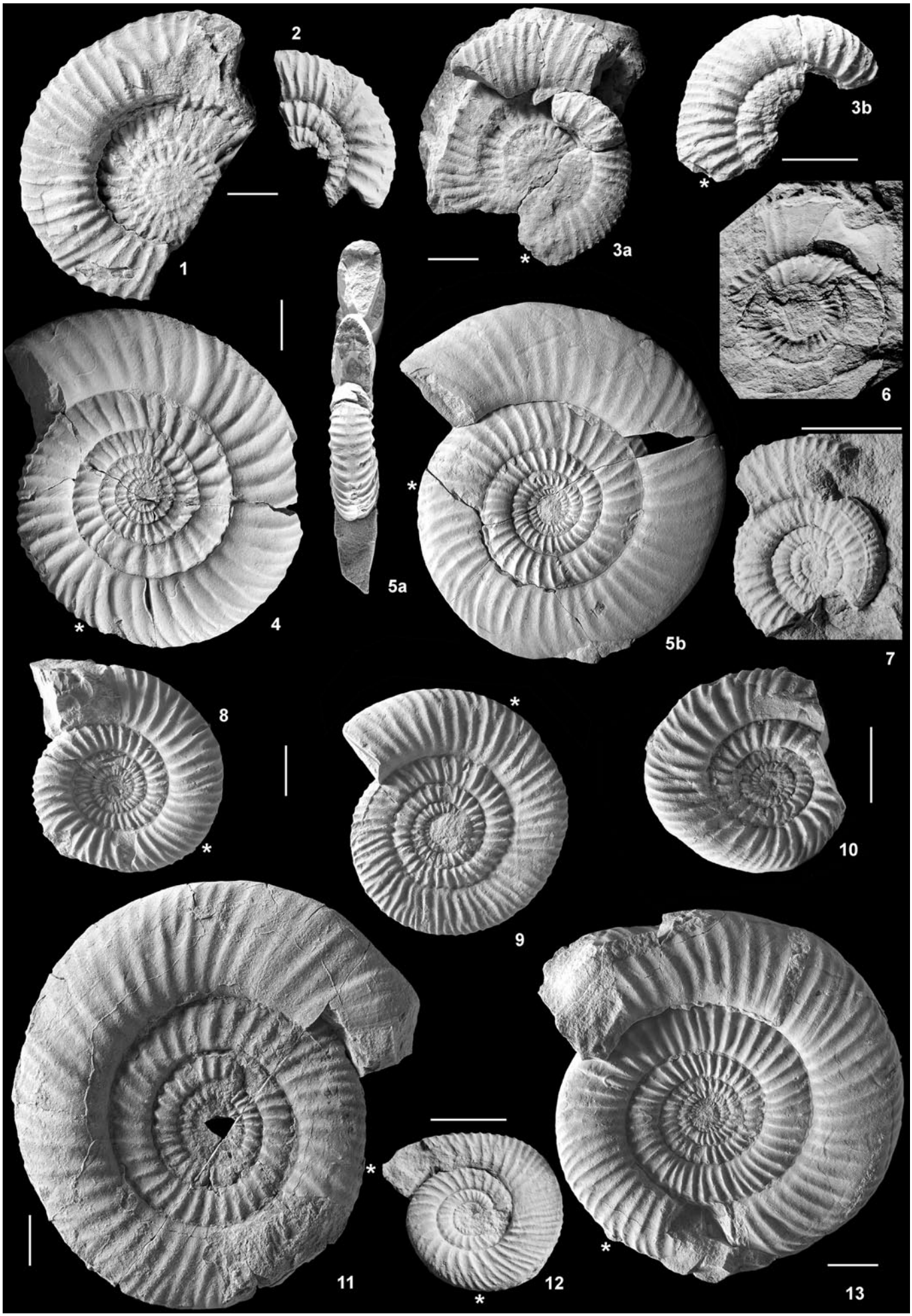

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Plate II

Figs. 1, 2: *Caumontisphinctes aplous* BUCKMAN [**M**].
1: Holotype (gypsum mould), right side. Frogden quarry, Dorset. (PU112531).
2: PU112530, bed RC-267, left side. Lower Polygyralis Subzone. (the same in PAVIA 1973, pl. 21, fig. 3).

Fig. 3: *Caumontisphinctes rota* (BENTZ) [**M**].
PU112522, bed LD-121, left side. Upper Banksii Subzone, *Nodatus* Biohorizon.

Fig. 4: *Infraparkinsonia pierae* n. sp. [**m**].
Holotype. PU112560, bed LD-125, left side. Upper Banksii Subzone, *Nodatus* Biohorizon.

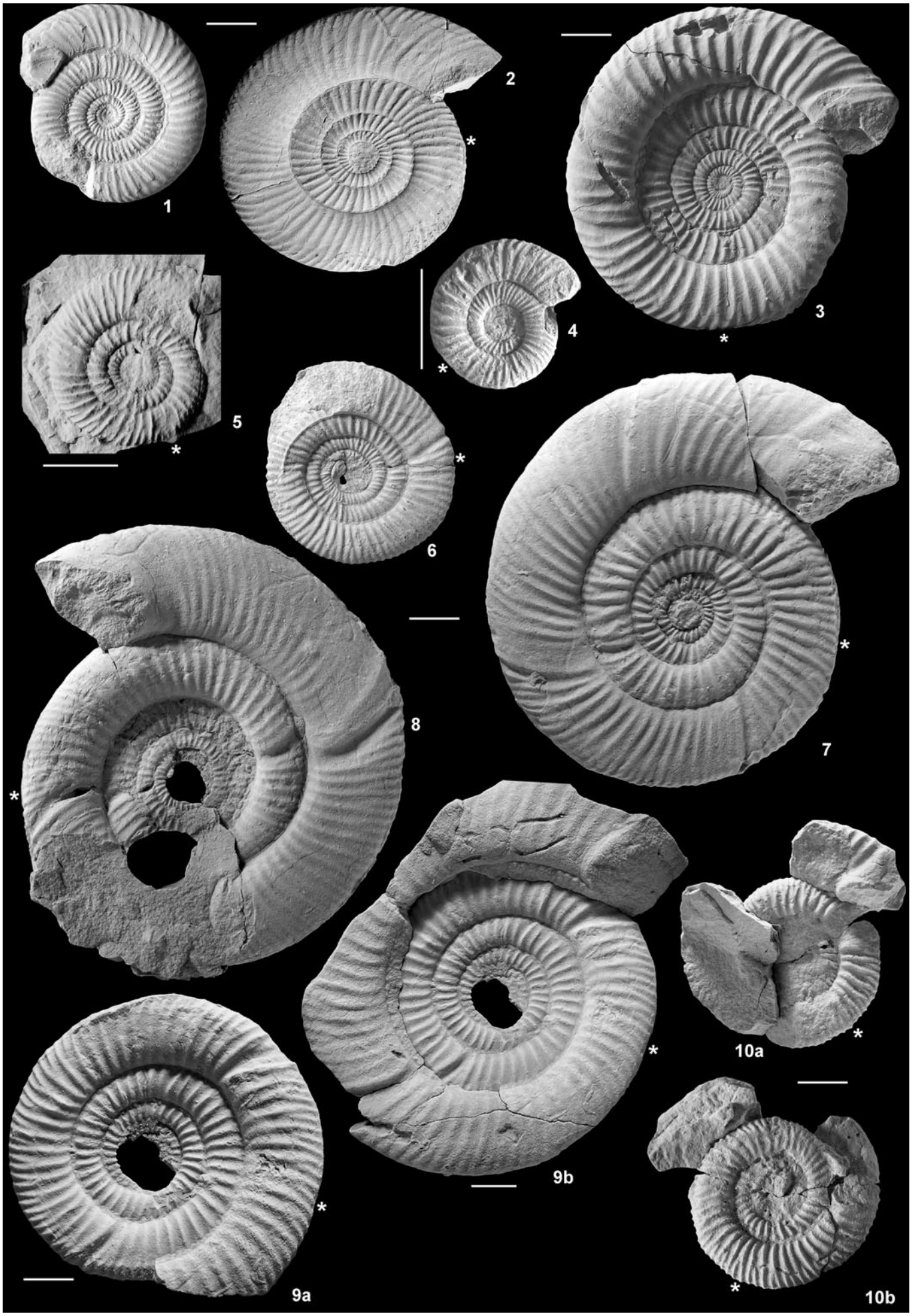
Fig. 5: *Infraparkinsonia phaula* BUCKMAN [**m**].
PU112569, bed LD-125, left side. Upper Banksii Subzone, *Nodatus* Biohorizon.

Figs. 6-8: *Leptosphinctes festonensis* PAVIA [**M**] & [**m**].
Uppermost Blagdeni Subzone, *Festonensis* Biohorizon.
[**m**] - 6: PU112614, bed RC-287, right side.
[**M**] - 7: topotype, PU112599, bed RC-287, left side. 8: topotype, PU112600, bed RC-287, right side.

Figs. 9, 10: *Leptosphinctes constrictus* (BESNOSOV) [**M**] & [**m**].
[**M**] - 9a, b: PU112617, bed RF-114, left side. Upper Banksii Subzone, *Nodatus* Biohorizon. (the same in PAVIA 1973, pl. 26, fig. 5).
[**m**] - 10a, b: PU112618, bed RC-279, (a) right side, (b) left side. Lower Banksii Subzone, *Diniensis* Biohorizon.

White asterisks indicate the end of the phragmocone. Scale bar: 1 cm.

Plate II



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