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The ammonoid fauna of the Prionocyclus germari Zone (upper Turonian, upper Cretaceous) from Rochefort-en-Valdaine (Drôme, France)

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Abstract: The late Turonian ammonoid fauna of Rochefort-en-Valdaine (Drôme, France) is herein described in detail and the intraspecific variability of *Vocontiiceras vocontiense* DIEBOLD *et al.*, 2018, is studied. The ammonoid assemblage (9 taxa identified) was deposited within the *Prionocyclus germari* Zone, which was defined in Germany, and is now also documented in southeastern France. Moreover, the co-occurrence of the heteromorph ammonoids *Hyphantoceras* (*Hyphantoceras*) *flexuosum* (SCHLÜTER) and *Hyphantoceras* (*Hyphantoceras*) *ernsti* WIESE indicates the lower part of the *Prionocyclus germari* Zone.

Key-words:

- Ammonoidea;
- Turonian;
- Drôme (France);
- biostratigraphy;
- intraspecific variability

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Résumé : *La faune d'ammonites de la Zone à* Prionocyclus germari *(Turonien supérieur) de Rochefort-en-Valdaine (Drôme, France).-* La faune d'ammonites du Turonien supérieur de Rochefort-en-Valdaine (Drôme, France) est décrite en détail et la variabilité intraspécifique de *Vocontiiceras vocontiense* DIEBOLD *et al.*, 2018, est étudiée. Cette faune d'ammonites (9 taxons identifiés) est caractéristique de la Zone à *Prionocyclus germari*, préalablement définie en Allemagne, et dont la présence est maintenant démontrée dans le sud-est de la France. De plus, la présence des ammonites hétéromorphes *Hyphantoceras* (*Hyphantoceras*) *flexuosum* (SCHLÜTER) et *Hyphantoceras* (*Hyphantoceras*) *ernsti* WIESE indique plus précisément la partie inférieure de la Zone à *Prionocyclus germari*.

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Mots-clefs :

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- Turonien ;
- Drôme (France) ;
- biostratigraphie ;
- variation intraspécifique

I. Introduction

For more than a century, the Turonian of south-eastern France has been the subject of numerous studies that outlined the occurrence of significant ammonoid fauna (ROMAN, 1912; ROMAN & MAZERAN, 1913; FARAUD, 1934, 1936, 1940, 1951; SORNAY, 1939, 1946, 1950, 1964; MENNESSIER, 1950; LETOURNEUR & PORTHAULT, 1966; THOMEL, 1969, 1992, 1993; PORTHAULT, 1974; AMÉDRO *et al.*, 1983; DEVALQUE *et al.*, 1983; KENNEDY, 1994; JOLET *et al.*, 2001; DIEBOLD, 2012; ROBASZYNSKI *et al.*, 2014; DIEBOLD *et al.*, 2018) and allowed the establishment of a regional biostratigraphic zonal scheme (Fig. 1) that can be used throughout western Europe (KENNEDY, 1994; ROBASZYNSKI *et al.*, 2014).

As pointed out by ROBASZYNSKI *et al.* (2014), all Turonian ammonites zones were identified in south-eastern France, with the exception of the latest Turonian *Prionocyclus germari* Zone of the standard zonation of western Europe. However, this latter ammonite zone was recognised in the unpublished PhD Thesis of DIEBOLD (2012), and more recently in the work of DIEBOLD *et al.* (2018) by the presence of the index species *Prionocyclus germari* (REUSS, 1845) at Rochefort-en-Valdaine (Drôme, France).

We describe here the entire ammonoid fauna of the Rochefort-en-Valdaine section (Drôme, France), and complete the description of *Vocontiiceras vocontiense* DIEBOLD *et al.*, 2018, in order to provide a better understanding of intraspecific variability within this taxon. Additionally, the description and illustration of *Hyphantoceras* (*Hyphantoceras*) *ernsti* WIESE, 2000, and *Hyphantoceras* (*Hyphantoceras*) *flexuosum* (SCHLÜTER, 1872) confirm the presence of the lower part of the *Prionocyclus germari* Zone in south-eastern France, by correlation with north-western Germany where the *Prionocyclus germari* Zone is well developed (KAPLAN & KENNEDY, 1996; WIESE, 2000a, 2009 with references).

The following taxa are identified at Rochefort-en-Valdaine: *Gaudryceras mite* (HAUER, 1866), cf. *Mesopuzosia* MATSUMOTO, 1954, *Lewesiceras mantelli* C.W. WRIGHT & E.V. WRIGHT, 1951, *Prionocyclus germari* (REUSS, 1845), *Vocontiiceras vocontiense* DIEBOLD *et al.*, 2018, *Hyphantoceras* (*Hyphantoceras*) *flexuosum* (SCHLÜTER, 1872), *Hyphantoceras* (*Hyphantoceras*) *ernsti* WIESE, 2000, *Sciponoceras bohemicum bohemicum* (FRITSCH, 1872) and *Scaphites geinitzii* ORBIGNY, 1850. Thanks to new material, a redescription and a study of intraspecific variation of *Vocontiiceras vocontiense* DIEBOLD *et al.*, 2018, complements the understanding of the family Collignoniceratidae which is of considerable importance for the biostratigraphic recognition of the Turonian/Coniacian boundary (KENNEDY & WALASZCZYK, 2004; DIEBOLD, 2012).

II. Previous works and biostratigraphic settings

The ammonoids studied herein originate from a single section situated near Rochefort-en-Valdaine (Fig. 2) and were collected by C. BAUDOUIN and H. CHATELIER from a thick stratigraphic interval (approximately 2 m; upper part of bed c14; DIEBOLD *et al.*, 2018, Fig. 2). This section belongs to the "Calcaires blancs à silex", a lithostratigraphic interval that was originally described by SORNAY (1950, p. 62). It consists of more or less sandy and glauconitic white limestones. The presence of glaucony could indicate a slight amount of condensation, or a low sedimentation rate (AMOROSI, 2012). FALLOT (1885, p. 178), SORNAY (1939, p. 116; 1950, p. 62), MOULLADE (*in* MIDDLEMISS & MOULLADE, 1968, p. 321) and PORTHAULT (1974, p. 155) reported the occurrence of ammonoids in this section (Table 1) and proposed a late Turonian age for the fauna without identifying ammonite zones.

		Standard ammonites zonation (Western Europe)	North Germany	Anglo-Paris Basin	
				Chalks	Tuffeaux
Coniacian		*Forresteria petrocoriensis*	*Forresteria petrocoriensis*		
Turonian	upper	*Prionocyclus germari*	*Prionocyclus germari*		
		Subprionocyclus bravaisianus	*Subprionocyclus bravaisianus*	*Subprionocyclus neptuni*	
		Romaniceras deverianum		*Romaniceras deverianum*	
	middle	*Romaniceras mexicanum*	*Collignoniceras woollgari*	*Collignoniceras woollgari*	
		Romaniceras ornatissimum			*Romaniceras ornatissimum*
		Romaniceras kallesi			*Romaniceras kallesi*
		Kamerunoceras turoniense			*Kamerunoceras turoniense*
	lower	*Mammites nodosoides*	*Mammites nodosoides*	*Mammites nodosoides*	*Mammites nodosoides*
		Fagesia catinus		*Fagesia catinus*	
		Watinoceras devonense	*Watinoceras Coloradoense*	*Watinoceras devonense*	

Figure 1: Biozonation of the Turonian (Late Cretaceous) of northwest Europe used in this work (from ROBASZYNSKI *et al.*, 2014).

The section and its ammonoid fauna (Table 1) were studied with more detail by DIEBOLD (2012) who presented a composite log of the late Turonian of Rochefort-en-Valdaine. The presence of *Prionocyclus* cf. *germari* (REUSS, 1845), *Hyphantoceras* (*Hyphantoceras*) cf. *flexuosum* (SCHLÜTER, 1872) and *Hyphantoceras* (*Hyphantoceras*) cf. *ernsti* WIESE, 2000, allowed him to identify the *Prionocyclus germari* Zone and to correlate the fauna of Rochefort-en-Valdaine with a level that lays between Marl M_G and the "Heteromorph Beds" of northern Germany (WIESE, 2000a; WALASZCZYK *et al.*, 2010), *i.e.*, the uppermost part of the Salder and lowermost part of the Erwitte formations (NIEBUHR *et al.*, 2007).

More recently, DIEBOLD *et al.* (2018) recorded *Vocontiiceras vocontiense* DIEBOLD *et al.*, 2018, from this section, an endemic species belonging to the Collignoniceratidae C.W. WRIGHT & E.V. WRIGHT, 1951.

III. Methodology

Measurements are given in millimetres; on distorted specimens, they are subject to imprecision and are written in italic. In the case of planispiral ammonoids, the classic measurements (Fig. 3) of the diameter of the umbilicus (*U*), height (*WH*) and width (*WB*) of the whorls were made at the maximum diameter (*D*), and only sometimes at an intermediate diameter when the preservation was sufficient to provide useful measurements. In the case of *Hyphantoceras* HYATT, 1900, only the measurements of height (*WH*) and of thickness (*WB*) of the whorls were made, as well as the maximum diameter for specimen no. Rch14. For *Sciponoceras* HYATT, 1894, only the maximum size ("*L*") and the maximum height of whorl (*WH*) were able to be measured. For *Scaphites* PARKINSON, 1811, the measurements made are the maximum size (*L*), the diameter of the spire (*Ds*), as well as the height of whorl (*WH*) and its width (*WB*) on the flexus.

Table 1: List of the ammonoids reported from the Rochefort-en-Valdaine section in previous works.

FALLOT (1885, p. 178)	*Ammonites* indét., *Hamites* sp.
SORNAY (1939, p. 116)	*Austiniceras austeni* (SHARPE, 1855), *Schloenbachia germari* (REUSS, 1845), *Pachydiscus peramplus* (MANTELL, 1822), *Pachydiscus* aff. *rhodanicus* ROMAN & MAZERAN, 1913, *Scaphites* aff. *geinitzii* ORBIGNY, 1850.
SORNAY (1950, p. 62)	*Barroisiceras* ? n. sp., *Schloenbachia* cf. *albinus* (FRITSCH, 1872), *Schloenbachia* aff. *germari* (REUSS, 1845), *Scaphites geinitzii* ORBIGNY, 1850, *Pachydiscus peramplus* (MANTELL, 1822), *Pachydiscus* sp. juv. aff. *peramplus* (MANTELL, 1822), *P.* aff. *beyrensis* CHOFFAT, 1898, *Prionotropis* sp., *Anisoceras* sp.
MOULLADE (*in* MIDDLEMISS & MOULLADE, 1968, p. 321)	*Germariceras* aff. *germari* (REUSS, 1845), *Scaphites geinitzi* ORBIGNY, 1850, *Lewesiceras peramplum* (MANTELL, 1822), *Pseudotissotia* cf. *nigeriensis* (WOODS, 1911).
PORTHAULT (1974, p. 155)	*Lewesiceras peramplus* (MANTELL, 1822), *Pseudotissotia* (*Bauchioceras*) cf. *nigeriensis* (WOODS, 1911), *Heterotissotia* sp.
DIEBOLD (2012, p. 136)	*Neophylloceras bizonatum* (FRITSCH, 1872), *Gaudryceras* (*Gaudryceras*) *denseplicatum* (JIMBO, 1894), *Lewesiceras mantelli* C.W. WRIGHT & E.V. WRIGHT, 1951, *Prionocyclus* cf. *germari* (REUSS, 1845), *Neoprionocyclus vocontiensis* DIEBOLD, 2012, *Eubostrychoceras* (*Eubostrychoceras*) *saxonicum* (SCHLÜTER, 1875), *Hyphantoceras* (*Hyphantoceras*) cf. *flexuosum* (SCHLÜTER, 1872), *Hyphantoceras* (*Hyphantoceras*) cf. *ernsti* WIESE, 2000, *Sciponoceras bohemicum bohemicum* (FRITSCH, 1872), *Baculites undulatus* ORBIGNY, 1850, *Scaphites geinitzii* ORBIGNY, 1850.
DIEBOLD *et al.* (2018, p. 376 and Fig. 2)	*Vocontiiceras vocontiense* DIEBOLD *et al.*, 2018, *Scaphites geinitzii* ORBIGNY, 1850, *Lewesiceras mantelli* C.W. WRIGHT & E.V. WRIGHT, 1951, *Prionocyclus germari* (REUSS, 1845), *Hyphantoceras* (*Hyphantoceras*) *flexuosum* (SCHLÜTER, 1872), *Hyphantoceras* (*Hyphantoceras*) *ernsti* WIESE, 2000, *Neophylloceras bizonatum* (FRITSCH, 1872), *Gaudryceras* cf. *denseplicatum* (JIMBO, 1894), *Eubostrychoceras* (*Eubostrychoceras*) *saxonicum* (SCHLÜTER, 1875), *Baculites undulatus* ORBIGNY, 1850, *Sciponoceras bohemicum bohemicum* (FRITSCH, 1872).

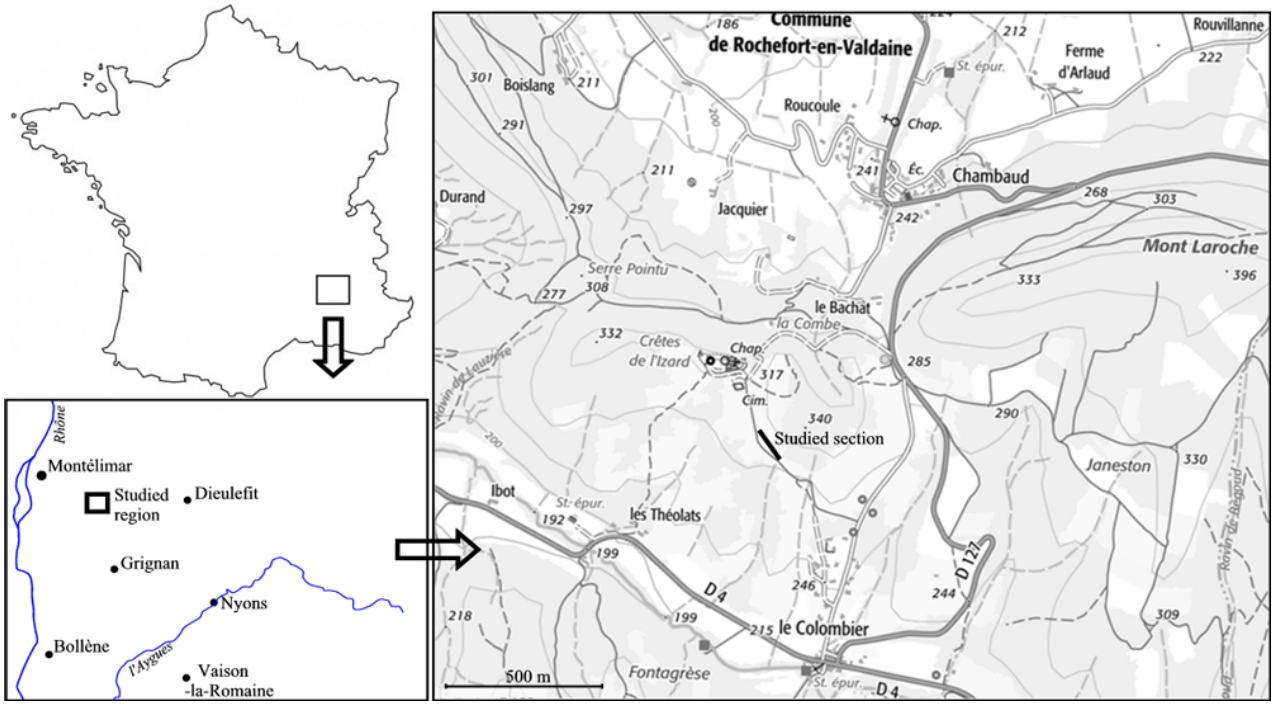

Figure 2: Geographical location of the studied section (source: www.geoportail.gouv.fr).

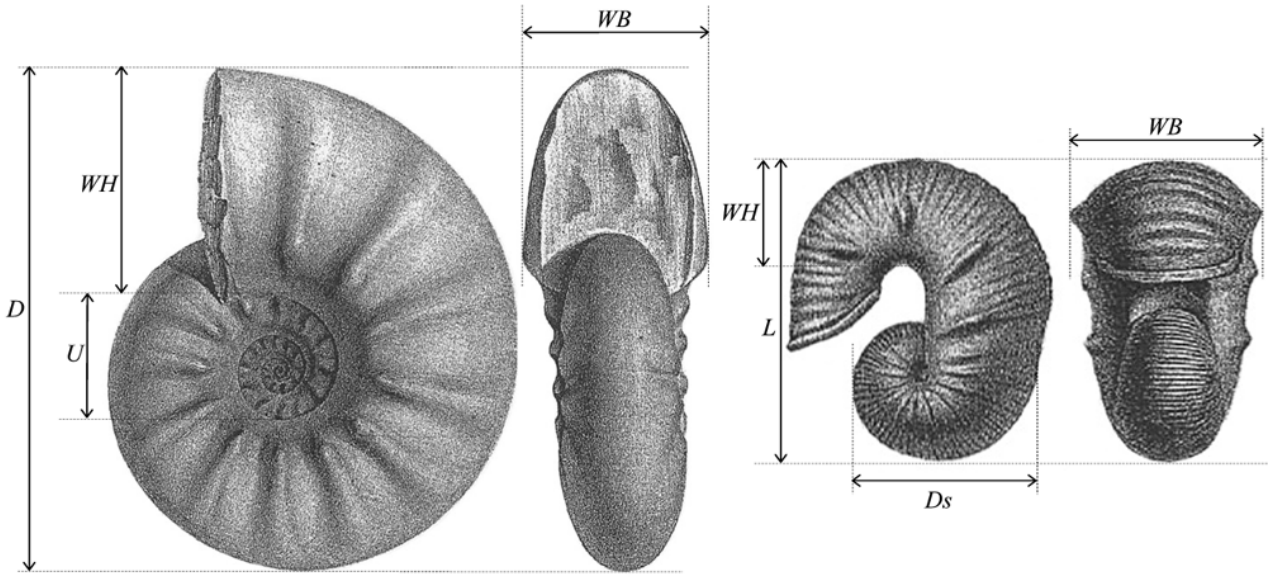

Figure 3: Explanatory scheme for the measurements made on the studied specimens (from ORBIGNY, 1840-1842, modified).

The suture lines are rarely visible and cannot be studied.

Repositories of the studied or quoted specimens are abbreviated and indicated in Table 2.

Table 2: List of abbreviations used in the text.

BGR	Bundesanstalt für Geologie und Rohstoffkunde, Berlin (Germany)
BMNH	British Museum of Natural History, London (England)
GBA	Geologische Bundesanstalt (Wien, Austria)
MNHN	Muséum National d'Histoire Naturelle (Paris, France)
MR	REQUIEN Museum (Avignon, France)
Rch	BAUDOUIN coll.

The biostratigraphic scheme that is used here (Fig. 1) is the composite ammonite scale established by ROBASZYNSKI *et al.* (2014, Fig. 32) for the north-western Europe.

The suprageneric classification used in the paleontological study is that of C.W. WRIGHT, 1996.

IV. Paleontological and systematic study

Order Ammonoidea ZITTEL, 1884

Suborder Lytoceratina HYATT, 1889

Superfamily Tetragonitaceae HYATT, 1900

Family Gaudryceratidae SPATH, 1927

Genus *Gaudryceras* GROSSOUVRE, 1894

(= *Epigaudryceras* SHIMIZU, 1934; *Hemigaudryceras* SHIMIZU, 1934; *Neogaudryceras* SHIMIZU, 1934; *Pseudogaudryceras* SHIMIZU, 1934)

Type species: *Ammonites mitis* HAUER, 1866 [by subsequent designation of BOULE *et al.* (1906, p. 11)].

Gaudryceras mite (HAUER, 1866)

(Pl. 1, fig. 1)

1866. *Ammonites mitis* sp. nov. - HAUER, p. 305, Pl. 2, figs. 3-4.
1873. *Ammonites glaneggensis* sp. nov. – REDTENBACHER, p. 119, Pl. 27, fig. 3.
1894. *Lytoceras denseplicatum* sp. nov. - JIMBO, p. 182, Pl. 23, fig. 1.
1895. *Lytoceras* (*Gaudryceras*) *varagurense* sp. nov. – KOSSMAT, p. 122, Pl. 17, fig. 9; Pl. 18, fig. 2.
1910. *Pachydiscus*? *hellichi* sp. nov. - FRITSCH, Pl. 5, fig. 14.
1920. *Lytoceras* (*Gaudryceras*) *amapondense* sp. nov. – HOEPEN, p. 42, Pl. 24, figs. 4-5.
? 1924. *Neogaudryceras denseplicatum* (JIMBO, 1894) *nonstriata* var. nov. - YEHARA, p. 35, Pl. 2, fig. 1.

1952. *Puzosia lytoceratoides* sp. nov. - HAAS, p. 8, figs. 14-17.
1962. *Gaudryceras navarrense* sp. nov. - WIEDMANN, p. 158, Pl. 9, fig. 3.
1962. *Gaudryceras vascogoticum* sp. nov. - WIEDMANN, p. 159, Pl. 9, figs. 2, 6.
1979. *Gaudryceras glaneggense* (REDTENBACHER, 1873) – KENNEDY & SUMMESBERGER, p. 76, Pl. 3, fig. 1; Pl. 4, fig. 1 (with synonymy).
1979. *Gaudryceras mite* (HAUER, 1866) - KENNEDY & SUMMESBERGER, p. 74, Fig. 1; Pl. 1, fig. 1; Pl. 2, figs. 1-2 (with additional synonymy).
? 1982. *Gaudryceras* ex. gr. *denseplicatum* (JIMBO, 1894) - IMMEL *et al.*, p. 9, Pl. 1, fig. 5.
1982. *Gaudryceras mite* (HAUER, 1866) - TZANKOV, p. 16, Pl. 2, figs. 3-4.
? 1988. *Gaudryceras denseplicatum* (JIMBO, 1894) - SZÁSZ & ION, Pl. 5, fig. 4.
1995. *Gaudryceras denseplicatum* (JIMBO, 1894) – MATSUMOTO, p. 91, Figs. 44-52, 53A, 67E-F (with additional synonymy).
? 1995. *Gaudryceras denseplicatum* (JIMBO, 1894) – KENNEDY *et al.*, p. 390, Pl. 2, figs. 1-3; Pl. 3, figs. 15-16; Pl. 4, figs. 12-13.
1996. *Gaudryceras mite* (HAUER, 1866) - SUMMESBERGER & KENNEDY, p. 112, Pl. 1, figs. 1-4 (with additional synonymy).
2000b. *Gaudryceras mite* (HAUER, 1866) - WIESE, p. 128, Pl. 1, fig. 1 (with additional synonymy).
2005. *Gaudryceras* sp. - ANDRADE, p. 47, Pl. 12, fig. 3.
2012. *Gaudryceras* (*Gaudryceras*) *denseplicatum* (JIMBO, 1894) - DIEBOLD, p. 145, Pl. 1, fig. 2.
? 2012. *Gaudryceras* (*Gaudryceras*) *denseplicatum* (JIMBO, 1894) - DIEBOLD, p. 201, Pl. 1, fig. 2.
2014. *Gaudryceras mite* (HAUER, 1866) - AMÉDRO & DEVALQUE *in* ROBASZYNSKI *et al.*, p. 130, Pl. 35, fig. 1 (with additional synonymy).
2016. *Gaudryceras* cf. *G. mite* (HAUER, 1866) - RAFFI & OLIVERO, p. 380, Fig. 3.1-2.

Type: The holotype by monotypy is the original of HAUER (1866, p. 305, Pl. 2, figs. 3-4 - GBA 1866/01/3) from the Gosau Group (Austria), possibly from the Turonian of the Ofenwand near Strobl/Weißenbach (SUMMESBERGER & KENNEDY, 1996).

Material (n = 1): Specimen no. Rch13.

Description: Evolute shell (*U/D* close to 0.31), almost complete, the last third of whorl corresponding to the body chamber. The whorl section is suboval, with a steep and rounded umbilical wall, moderately rounded flanks and a wide and rounded ventral region.

Ornamentation is visible on the last whorl. Starting with fine, dense and flexuous rectiradiate or slightly prorsiradiate ribs, the adult ornamentation is marked by the sudden apparition of numerous groups of two or three elevated ribs, that form ridges on the flanks and ventral region where they reach their maximum strength. The ridges develop at the base of the umbilical wall. Between these groups of ribs, one or two simple and fine intercalatories occur. This ornamental stage disappears for approximately a quarter of whorl where the ornamentation is composed of simple, relatively strong ribs appearing at the base of the umbilical wall. On the last quarter of whorl, the ornamentation of ridges reappears, separated by two or three fine intercalatories.

Dimensions: **Table 3:** Measurements of *Gaudryceras mite* (HAUER, 1866).

no.	D	U	WH	WB	U/D	U/WH	WH/D	WB/D	WB/WH
Rch13	128.4	40.2	54.3	-	0.313	0.740	0.423	-	-

Discussion and comparisons: The ornamentation of Rch13, represented by a growth interval with fine and dense ribs followed by an interval with ribs grouped in elevated ridges, is characteristic of *Gaudryceras glaneggense* (REDTENBACHER, 1873), a junior synonym of *Gaudryceras mite* (HAUER, 1866) according to SUMMESBERGER & KENNEDY (1996).

Gaudryceras tenuiliratum YABE, 1903, a taxon from the Coniacian to early Campanian of Japan and the Russian Far East (Sakhalin), is considered as a possible synonym of *Gaudryceras denseplicatum* (JIMBO, 1894) [= *Gaudryceras mite* (HAUER)] by IMMEL *et al.* (1982, p. 9), due to the presence of primary ribs on the body chamber. However, the primary ribs of *Gaudryceras tenuiliratum* YABE are very different, far less numerous and do not correspond to groups of fine ribs as seen on the body chamber of *Gaudryceras mite* (HAUER). Furthermore, on the inner whorls the ornamentation of *Gaudryceras tenuiliratum* YABE is different, since towards the venter, the fine ribs are subdivided into numerous extremely fine riblets, characteristic absent in *Gaudryceras mite* (HAUER) (MATSUMOTO, 1995, p. 125). The ribbing of specimen no. Rch13 differs from *G. tenuiliratum* YABE; this specimen is attributed to *G. mite* (HAUER), and *G. tenuiliratum* YABE is considered here as a different species, following the opinion of MATSUMOTO (1995).

Occurrence: *Gaudryceras mite* (HAUER, 1866) has a worldwide distribution and is known to range from the Turonian to the Maastrichtian (SUMMESBERGER & KENNEDY, 1996, p. 114).

Suborder Ammonitina HYATT, 1889

Superfamily Desmoceratacea ZITTEL, 1895

Family Desmoceratidae ZITTEL, 1895

Subfamily Puzosiinae SPATH, 1922

Genus *Mesopuzosia* MATSUMOTO, 1954

(= *Pteropuzosia* MATSUMOTO, 1988)

Type species: *Mesopuzosia pacifica* MATSUMOTO, 1954 [by original designation of MATSUMOTO (1954, p. 79)].

cf. *Mesopuzosia* MATSUMOTO, 1954

(Pl. 1, fig. 2; Pl. 2, fig. 1; Pl. 3, fig. 1)

Material (n = 1): Specimen no. Rch38.

Description: Large-sized specimen, poorly preserved and entirely septate, with moderately evolute coiling (*U/D* close to 0.23). The whorl section is subrectangular. The umbilical wall is high and vertical, with a rounded shoulder; the flanks are moderately rounded and the ventral region is narrow, widening on the last quarter of the preserved whorl.

The ornamentation, only visible on the first quarter of the last whorl, consists of fine and dense, straight, prorsiradiate ribs, bending forward towards the venter. Most ribs arise from the umbilical shoulder, but some intercalatories or bifurcated ribs appear on the outer third of the flanks. A slightly stronger rib, with the same pattern and preceded by an incipient constriction, could correspond to a primary rib.

Dimensions: **Table 4:** Measurements of cf. *Mesopuzosia* MATSUMOTO, 1954.

no.	D	U	WH	WB	U/D	U/WH	WH/D	WB/D	WB/WH
Rch38	255	58.9	115.1	c74	0.231	0.512	0.451	0.290	0.643

Discussion and comparisons: The whorl dimensions, the backward flexure of the ribs and the whorl section point to a Puzosiinae SPATH, 1922, and the fact that ribs reach from the umbilicus over the flanks to the venter shows affinity with *Mesopuzosia* MATSUMOTO, 1954, and more probably with *Mesopuzosia mobergi* (GROSSOUVRE, 1894). However, the poor preservation of the specimen and the suture do not allow confirmation, and therefore the specimen is kept under open nomenclature.

Occurrence: The genus occurs in lower and middle latitudes from the Turonian to the Campanian (C.W. WRIGHT, 1996; KENNEDY & GALE, 2015).

Family Pachydiscidae SPATH, 1922

Genus *Lewesiceras* SPATH, 1939

Type species: *Ammonites peramplus* MANTELL, 1822 [by original designation of SPATH (1939, p. 296)].

Lewesiceras mantelli C.W. WRIGHT & E.V. WRIGHT, 1951

(Pl. 3, figs. 2-3; Pl. 4, fig. 1; Pl. 5, figs. 1-2)

pars 1849. *Ammonites peramplus* MANTELL, 1822 – GEINITZ, p. 116, Pl. 5, figs. 1, ? 3, non 2 (= ? *Lewesiceras* sp.).
pars 1853. *Ammonites peramplus* MANTELL, 1822 – SHARPE, p. 26, Pl. 10, figs. 2-3, non 1 [= *Lewesiceras peramplum* (MANTELL, 1822)].
1926. *Pachydiscus cricki* sp. nov. - SPATH, p. 82 (*non* KOSSMAT, 1898).
1951. *Lewesiceras mantelli* sp. nov. - C.W. WRIGHT & E.V. WRIGHT, p. 20, Pl. 10, fig. 3.
1951. *Lewesiceras sharpei* (SPATH, 1926) - C.W. WRIGHT & E.V. WRIGHT, p. 20, Pl. 10, figs. ? 1, 2.
1964. *Lewesiceras romani* sp. nov. - SORNAY, p. 183, Figs. 1-4.
1967. *Lewesiceras lenesicense* sp. nov. - HOUŠA, p. 35, Pl. 8, figs. 1-7.
1979. *Lewesiceras mantelli* C.W. WRIGHT & E.V. WRIGHT, 1951 - C.W. WRIGHT, p. 310, Pl. 4, figs. 1-3; Pl. 6, figs. 4-5 (with synonymy).
1981. *Lewesiceras mantelli* C.W. WRIGHT & E.V. WRIGHT, 1951 - KENNEDY & C.W. WRIGHT, p. 500, Pl. 75, figs. 8-11; Pl. 76, figs. 3-6.
1981. *Lewesiceras mantelli* C.W. WRIGHT & E.V. WRIGHT, 1951 - C.W. WRIGHT & KENNEDY, p. 31, Pl. 2, figs. 5-6.
1982. *Lewesiceras mantelli* C.W. WRIGHT & E.V. WRIGHT, 1951 - TZANKOV, p. 33, Pl. 14, figs. 2-4.
1988. *Lewesiceras mantelli* C.W. WRIGHT & E.V. WRIGHT, 1951 - SZÁSZ & ION, Pl. 5, fig. 2.
1988. *Lewesiceras mantelli* C.W. WRIGHT & E.V. WRIGHT, 1951 - WALASZCZYK, p. 56, Pl. 5, fig. 3.
1991. *Lewesiceras mantelli* C.W. WRIGHT & E.V. WRIGHT, 1951 - KAPLAN, Pl. 1, fig. 1.
2006. *Lewesiceras mantelli* C.W. WRIGHT & E.V. WRIGHT, 1951 - KENNEDY & JUIGNET *in* GAUTHIER, p. 123, Pl. 62, fig. 1.
2012. *Lewesiceras mantelli* C.W. WRIGHT & E.V. WRIGHT, 1951 - DIEBOLD, p. 146, Pl. 2, figs. 1-2.
2014. *Lewesiceras mantelli* C.W. WRIGHT & E.V. WRIGHT, 1951 - WILMSEN & NAGM, p. 205, Fig. 3c.
2014. *Lewesiceras mantelli* C.W. WRIGHT & E.V. WRIGHT, 1951 - AMÉDRO & DEVALQUE *in* ROBASZYNSKI *et al.*, p. 133, Pl. 34, fig. 3; Pl. 37, fig. 2; Pl. 39, figs. 9-10.
2015. *Lewesiceras mantelli* C.W. WRIGHT & E.V. WRIGHT, 1951 - KENNEDY & GALE, p. 514, figs. 5J, K, P-R.

Type: The species was introduced by C.W. WRIGHT & E.V. WRIGHT, 1951 as *nomen novum* for *Pachydiscus cricki* SPATH, 1926 (*non* KOSSMAT, 1898). The holotype by monotypy is the original of SHARPE (1853, Pl. 10, fig. 3 as *Ammonites peramplus* MANTELL, 1822 - BMNH 88587), from the late Turonian of Oldbury Hill (Wiltshire, England). It was re-illustrated by KENNEDY & C.W. WRIGHT (1981, Pl. 75, figs. 10-11) and C.W. WRIGHT & KENNEDY (1981, Pl. 2, fig. 6).

Material (n = 7): Specimens no. Rch20, Rch21, Rch22, Rch24, Rch49; no. 955, 960, coll. CHATELIER.

Description: All our specimens are small-sized (diameter from 30 to 120 mm) and correspond to juveniles or inner whorls of large ammonoids, except for specimen no. 955 (Pl. 4, fig. 1; Pl. 5, fig. 1) which is an adult. The coiling is involute throughout ontogeny (*U/D* close to 0.30), with a subrectangular whorl section, although dimensions may be affected by the crushing of specimens. The section is circular from *D* = 100 mm (specimen no. 955, Pl. 4, fig. 1; Pl. 5, fig. 1). The umbilical wall is moderately high and rounded. The flanks and the ventral region are rounded.

The ornamentation consists of rectiradiate and slightly concave primary ribs, arising from a bulla just above the umbilical shoulder in the juvenile whorls. Up to a diameter of about 60-70 mm, the primary ribs cross the ventral region without fading and with a slight retroverse projection. On the inner whorls, up to a diameter of 50-60 mm, secondary prorsiradiate ribs, slightly weaker than the primaries, appear on the upper third of the flanks. They cross the ventral region with the same pattern as the primaries. There are two to four secondaries intercalated between primaries. From *D* = 60 mm (specimens no. Rch20, Rch21, Rch22, 955), the primary ribs weaken and fade toward the ventral region with increasing diameter. At *D* = 80-100 mm, there are approximately 10-12 primary ribs per whorl (specimens no. Rch20, Pl. 3, fig. 3, and 960, Pl. 5, fig. 2). On specimen no. Rch21 (Pl. 3, fig. 2), the ribbing fades quickly on the flanks and is not perceptible at *D* > 55 mm.

Dimensions: **Table 5:** Measurements of *Lewesiceras mantelli* C.W. WRIGHT & E.V. WRIGHT, 1951.

no.	D	U	WH	WB	U/D	U/WH	WH/D	WB/D	WB/WH
Rch20	117.8	34.9	49.3	-	0.296	0.708	0.419	-	-
Rch21	77.3	24.1	30.5	20.6	0.312	0.790	0.395	0.266	0.675
Rch22	87.7	-	-	-	-	-	-	-	-
Rch24	30.4	-	-	14.1	-	-	-	0.464	-
Rch49	35.4	-	-	12.6	-	-	-	0.356	-
955	194	64	-	75	0.330	-	-	0.387	-
960	82.4	21.5	28	3.7	0.261	0.768	0.340	0.045	0.132

Discussion and comparisons: *Lewesiceras mantelli* C.W. WRIGHT & E.V. WRIGHT, 1951, is a species close to *Lewesiceras peramplum* (MANTELL, 1822). *Lewesiceras mantelli* C.W. WRIGHT & E.V. WRIGHT can be distinguished by its smaller adult size, wider whorl section and strong umbilical bulla. The ornamentation and the morphology of the shell of the specimens studied here correspond to *Lewesiceras mantelli* C.W. WRIGHT & E.V. WRIGHT, with exception of the compressed whorl section in many specimens, probably related to compaction. The two species also have different stratigraphical ranges: *Lewesiceras mantelli* C.W. WRIGHT & E.V. WRIGHT is strictly restricted to the late Turonian while *Lewesiceras peramplum* (MANTELL) ranges from the early to early late Turonian, with the earliest forms appearing in the latest Cenomanian (WILMSEN & NAGM, 2013, 2014).

Lewesiceras woodi C.W. WRIGHT, 1979, is another species from the late Turonian (*Holaster planus*/*Subprionocyclus neptuni* Zone = *Subprionocyclus bravaisianus* Zone). On the juvenile stage, it differs from *Lewesiceras mantelli* C.W. WRIGHT & E.V. WRIGHT by its lack of umbilical bullae and weaker secondary ribs.

Occurrence: *Lewesiceras mantelli* C.W. WRIGHT & E.V. WRIGHT, 1951, is known to occur in the late Turonian, *Romaniceras deverianum* to *Prionocyclus germari* zones and has been reported from Ireland, England, France, Germany, the Czech Republic, Poland, Ukraine (Crimea), Russia, Kazakhstan and possibly from Austria (KENNEDY & GALE, 2015, p. 514).

Superfamily Acanthoceratoidea GROSSOUVRE, 1894

Family Collignoniceratidae C.W. WRIGHT & E.V. WRIGHT, 1951

Subfamily Collignoniceratinae C.W. WRIGHT & E.V. WRIGHT, 1951

Genus *Prionocyclus* MEEK, 1871

(= *Germariceras* BREISTROFFER, 1947)

Type species: *Prionocyclus wyomingensis* MEEK, 1876 [by subsequent designation of MEEK (1876, p. 452)].

Prionocyclus germari (REUSS, 1845)

(Pl. 5, fig. 3)

1845. *Ammonites Germari* sp. nov. - REUSS, p. 22, Pl. 7, fig. 10.
1872. *Ammonites Schlönbachi* sp. nov. - FRITSCH, p. 33, Pl. 16, fig. 5.
1907. *Schloenbachia gaudryi* sp. nov. - BOULE *et al.*, p. 16, Pl. 3, fig. 1.
1947. *Germariceras germari* (REUSS, 1845) - BREISTROFFER, without pagination.
? 1950. *Schloenbachia* aff. *germari* (REUSS, 1845) - SORNAY, p. 62.
? 1965. *Prionocyclus aberrans* sp. nov. - MATSUMOTO, p. 25, Figs. 8-9; Pl. 5, fig. 1; Pl. 6, fig. 3.
1966. *Prionocyclus carvaholi* sp. nov. - HOWARTH, p. 224, Pl. 1, figs. 8-11; Pl. 2, figs. 3-6.
? 1968. *Germariceras* aff. *germari* (REUSS, 1845) - MOULLADE *in* MIDDLEMISS & MOULLADE, p. 321.
? 1971. *Prionocyclus aberrans* MATSUMOTO, 1965- MATSUMOTO, p. 133, Fig. 3, Pl. 21, fig. 1.
1990. *Prionocyclus germari* (REUSS, 1845) - COBBAN, p. B11, Pl. 7, figs. 1-11.
? 1998. *Prionocyclus* cf. *germari* (REUSS, 1845) - KÜCHLER, p. 194, Pl. 11, fig. 4.
2000. *Prionocyclus germari* (REUSS, 1845) – ROBASZYNSKI *et al.*, p. 402, Pl. 1, figs. 7-8.
2001. *Prionocyclus germari* (REUSS, 1845) – BRAUNBERGER & HALL, p. 1124, Pl. 3, figs. 1-18.
2001. *Prionocyclus germari* (REUSS, 1845) - KENNEDY *et al.*, p. 123, Figs. 108.A-B, D-F, 109-119 (with synonymy).
2003. *Prionocyclus germari* (REUSS, 1845) - KENNEDY *et al.*, p. 433, Fig. 2.
2005. *Prionocyclus germari* (REUSS, 1845) - ANDRADE, p. 47, Pl. 12, fig. 2.
2009. *Prionocyclus germari* (REUSS, 1845) - WIESE, p. 363, Pl. 1, figs. A-J.
2012. *Prionocyclus* cf. *germari* (REUSS, 1845) - DIEBOLD, p. 147, Pl. 3, figs. 1-5.
2012. *Prionocyclus germari* (REUSS, 1845) - DIEBOLD, p. 206, Pl. 2, fig. 1; Pl. 3, figs. 1-3.

2018. *Prionocyclus germari* (REUSS, 1845) - DIEBOLD *et al.*, Figs. 4a-j.

Type: The lectotype is the specimen from the "Planermergel von Werschowitz" figured by REUSS (1845, Pl. 7, fig. 10) by subsequent designation of KENNEDY *et al.* (2001). It was stored in the Natural History Museum of Budapest and probably destroyed in 1953 (KAPLAN, 1988, p. 15).

Material (n = 1): Specimen no. Rch12.

Description: Our specimen, poorly preserved, shows evolute coiling (*U/D* close to 0.34) with a subquadrate whorl section that becomes gradually subrectangular. The umbilical wall is moderately high and vertical. The flanks are slightly rounded and converge towards a flat or slightly fastigiate venter, with a well-expressed and continuous keel. The juvenile ventrolateral shoulder is angular but becomes increasingly rounder during ontogeny.

On the preserved part of the inner whorls, the visible ornamentation consists of rectiradiate, straight and strong ribs that arise from an umbilical tubercle and end at a round ventrolateral tubercle. Sparse secondary ribs, weaker than the primaries, appear on the lower third of the flanks. On the last whorl, the umbilical tubercles weaken, ventrolateral tubercles disappear and the primary ribs are mainly visible on the lower half part of the flanks. The ventral area is well preserved only on the last half of the whorl and shows no ribbing.

Dimensions: **Table 6:** Measurements of *Prionocyclus germari* (REUSS, 1845).

no.	D	U	WH	WB	U/D	U/WH	WH/D	WB/D	WB/WH
Rch12	73.7	24	32.4	21.5	0.326	0.741	0.440	0.292	0.664
	106.4	37.2	41.7	26.7	0.350	0.892	0.392	0.251	0.640

Discussion and comparisons: The general shape of the shell and the ornamentation of specimen no. Rch12 match well with *Prionocyclus germari* (REUSS, 1845) as understood by KENNEDY *et al.* (2001) and WIESE (2009). *Prionocyclus germari* (REUSS) is a rare species in Europe and the only species of this genus in the late Turonian of Europe. *Prionocyclus germari* (REUSS) is fairly close to *Prionocyclus wyomingensis* MEEK, 1876, *Prionocyclus novimexicanus* (MARCOU, 1858) and *Prionocyclus quadratus* COBBAN, 1953. These species are mainly known from the Western Interior of the United States. *Prionocyclus germari* (REUSS) can be distinguished from *Prionocyclus wyomingensis* MEEK by the absence of external ventrolateral tubercles in young specimens, and by the lack of umbilical and lateral tubercles at the adult stage. *Prionocyclus germari* (REUSS) differs from *Prionocyclus novimexicanus* (MARCOU) by more distant ribs in all ontogenenetic stages. It differs from *Prionocyclus quadratus* COBBAN by a higher and subrectangular section, and by the absence of lateral bullae in adult specimens (KENNEDY *et al.*, 2001).

Furthermore, *Prionocyclus germari* (REUSS) has a higher stratigraphic position in the late Turonian than *Prionocyclus wyomingensis* MEEK, *Prionocyclus novimexicanus* (MARCOU) and *Prionocyclus quadratus* COBBAN (KENNEDY *et al.*, 2001, p. 7, Fig. 3).

Occurrence: The species is known from France, Germany, the Czech Republic, Poland, Spain, Brazil, the U.S., Canada, Madagascar, Angola, Tunisia and India. *Prionocyclus germari* (REUSS, 1845) is strictly restricted to the uppermost part of the late Turonian. It is the index species of the uppermost Turonian ammonite Zone.

Subfamily Barroisiceratinae BASSE, 1947

Genus *Vocontiiceras* DIEBOLD *et al.*, 2018

(= *Neoprionocyclus* DIEBOLD, 2012)

Type species: *Vocontiiceras vocontiense* DIEBOLD *et al.*, 2018 [by original designation of DIEBOLD *et al.* (2018, p. 380)].

Emended diagnosis: Involute, with subrectangular to trapezoidal whorl section; flat ventral region, becoming rounded on the body chamber. Ornamentation on the phragmocone consists of prorsiradiate primary ribs that arise from umbilical bullae and of secondary ribs. All ribs end at clavi on the ventrolateral shoulder. Body chamber smooth; continuous ventral keel throughout ontogeny.

Discussion and comparisons: *Vocontiiceras* DIEBOLD *et al.* is fairly close to *Barroisiceras* GROSSOUVRE, 1894, and *Forresteria* REESIDE, 1932, but can be distinguished from these taxa by some unequivocal characteristics. *Barroisiceras* GROSSOUVRE differs by its fastigiate ventral region and its crenulated keel that disappears on the body chamber, whereas in *Vocontiiceras* DIEBOLD *et al.* the ventral region is flat, rounding on the body chamber, and the keel is always continuous; *Forresteria* REESIDE differs by the presence of a lateral tubercle on the inner whorls and by its keel that disappears on the body chamber, whereas it persists on the body chamber of *Vocontiiceras* DIEBOLD *et al.*

In the present state of knowledge, *Vocontiiceras* DIEBOLD *et al.* is restricted to its type species, *Vocontiiceras vocontiense* DIEBOLD *et al.*, 2018.

Because of the absence of inner ventrolateral tubercles and ribbing style that is very close to that of *Barroisiceras* GROSSOUVRE, 1894, *Vocontiiceras* DIEBOLD *et al.*, 2018, clearly belongs to the subfamily Barroisiceratinae BASSE, 1947. However, DIEBOLD *et al.* (2018) have attributed the species to the subfamily Collignoniceratinae C.W. WRIGHT & E.V. WRIGHT, 1951, due to the tabulate venter and the flexure of the ventrolateral clavi.

Vocontiiceras vocontiense DIEBOLD *et al.*, 2018

(Pl. 6, figs. 1-5; Pl. 7, figs. 1-4; Pl. 8, figs. 1-5)

? 1950. *Barroisiceras ?* n. sp. - SORNAY, p. 62.
2012. *Neoprionocyclus vocontiensis* gen. nov. sp. nov. - DIEBOLD, p. 149, Pl. 4, figs. 1-6; Pl. 5, figs. 1-2; Pl. 6, figs. 1-2; Pl. 7, figs. 1-2; Pl. 8, fig. 1.
2018. *Vocontiiceras vocontiense* gen. nov. sp. nov. – DIEBOLD *et al.*, p. 380, Figs. 4o-u, 5a-f, 6a-f.

Type: The holotype is LRP REV1-33, DIEBOLD coll. by original designation of DIEBOLD *et al.* (2018), from the upper Turonian *Prionocyclus germari* Zone, upper part of bed c14 of DIEBOLD (2012) of Rochefort-en-Valdaine (Drôme, France). A cast of the holotype is stored in the Muséum National d'Histoire Naturelle (Paris, France) with the no. MNHN.F.A58223; casts of the paratype no. Rch01 and of specimens no. Rch05, Rch06 and Rch61 are stored in the REQUIEN Museum (Avignon, France) with the no. MR 2.008.326, MR 2.008.327, MR 2.008.325 and MR 2.008.324, and casts of the paratype no. Rch01 and of specimens no. Rch06 and Rch61 are stored in the Muséum National d'Histoire Naturelle (Paris, France) with the no. MNHN.F. A57744, MNHN.F.A57745 and MNHN.F.A57746.

Material (n = 21): Specimens no. Rch01, Rch02, Rch03, Rch04, Rch05, Rch06, Rch07, Rch08, Rch09, Rch10, Rch11, Rch23a, Rch42, Rch47, Rch48, Rch54, Rch58, Rch60, Rch61, Rch62, Rch66.

Description: The coiling is involute (*U/D* = 0.10 to 0.25), becoming clearly more evolute in adult specimens (*U/D* ≥ 0.25: specimens no. Rch01, Pl. 6, fig. 1; no. Rch02, Pl. 7, fig. 1). The whorl section is subrectangular to trapezoidal, of maximum width near the umbilical shoulder. The umbilical wall is low and vertical, with a rounded shoulder. The flanks are flat or slightly rounded and the ventral region is tabulate, with an angular ventrolateral shoulder on the phragmocone, which becomes rounded on the body chamber in adult specimens. On adult specimens the flanks and the ventral region become rounded. A well-defined continuous keel is present throughout ontogeny.

On the phragmocone, the ornamentation varies in strength and is constituted by prorsiradiate and concave ribs, of varying density (11-18 ribs per half whorl). The primary ribs appear on an umbilical bullae. Most primaries are simple, but some bifurcate mid-flank or arise pairwise from the umbilical bullae. Between each pair of primary ribs, one or two secondary ribs appear approximately at mid-flank. All ribs end in sharp clavi on the ventrolateral shoulder. The ventral keel is bordered by two smooth bands. At a highly variable diameter, commonly corresponding to the beginning of body chamber, all ornamental features quickly fade and the shell becomes smooth, with the exception of the persistent ventral keel.

Dimensions: **Table 7:** Measurements of *Vocontiiceras vocontiense* DIEBOLD *et al.*, 2018.

no.	*D*	*U*	*WH*	*WB*	*U/D*	*U/WH*	*WH/D*	*WB/D*	*WB/WH*
Rch01	116.5	29.2	53.4	c33.5	0.251	0.547	0.458	0.288	0.627
	80	16.3	39.3	23.5	0.204	0.415	0.491	0.294	0.598
Rch02	117.6	33.5	49.5	c28.1	0.285	0.677	0.421	0.239	0.568
	79.6	17.9	35.5	23.5	0.225	0.504	0.446	0.295	0.662
Rch03	66.9	7	35.5	16.2	0.105	0.197	0.531	0.242	0.456
	46.7	-	26.1	13.9	-	-	0.559	0.298	0.533
Rch04	81.5	13.6	39.3	-	0.167	0.346	0.482	-	-
Rch05	59.9	9.8	30.4	16.3	0.164	0.322	0.508	0.272	0.536
	42.6	8.2	22.3	13.2	0.192	0.368	0.523	0.310	0.592
Rch06	73.2	12.4	34.6	19.5	0.169	0.358	0.473	0.266	0.564
	52.8	9	26.9	17.5	0.170	0.335	0.509	0.331	0.651
Rch07	88.1	13.2	46.8	-	0.150	0.282	0.531	-	-
	57.6	8.6	31.1	c18.7	0.149	0.277	0.540	0.325	0.601
Rch08	51.1	-	-	c17.5	-	-	-	0.342	-
Rch09	31.2	3.6	16.1	10.5	0.115	0.224	0.516	0.337	0.652
Rch10	47.9	5.1	24.8	12.6	0.106	0.206	0.518	0.263	0.508
	35.8	-	20.6	10.4	-	-	0.575	0.291	0.505
Rch11	64.6	6.8	36.6	13.9	0.105	0.186	0.567	0.215	0.380
Rch23a	26	-	15	6.7	-	-	0.577	0.258	0.447
Rch42	43.2	c7.8	25	c18.8	0.181	0.312	0.579	0.435	0.752
Rch47	53.5	10.4	27.1	15.2	0.194	0.384	0.507	0.284	0.561
Rch48	43.2	c5.4	24.4	-	0.125	0.221	0.565	-	-
Rch54	66.7	10.4	32.4	14	0.156	0.321	0.486	0.210	0.432
Rch58	74.9	-	43.4	16.9	-	-	0.579	0.226	0.389
	52.1	-	26.7	11	-	-	0.512	0.211	0.412
Rch60	60.6	10.1	31.4	13.7	0.167	0.322	0.518	0.226	0.436
	39	9.8	18.3	12.3	0.251	0.536	0.469	0.315	0.672
Rch61	43.3	9.9	20.2	14.9	0.229	0.490	0.467	0.344	0.738
	32.6	7.5	14.4	13.9	0.230	0.521	0.442	0.426	0.965
Rch62	76.3	-	39.7	-	-	-	0.520	-	-
Rch66	114.6	25.6	49.8	-	0.223	0.514	0.435	-	-
	75.7	13.2	38.3	20.6	0.174	0.345	0.506	0.272	0.538

Discussion and comparisons: *Vocontiiceras vocontiense* DIEBOLD *et al.*, 2018, shows a large intraspecific variability. It affects the width of the shells (Fig. 4), the strength of the ornamentation and the ontogenetic stage at which it disappears, with a transition from compressed morphotypes (*WB/WH* close to 0.40: Rch11, Pl. 6, fig. 4) to stout morphotypes (*WB/WH* > 0.90: Rch42, Pl. 6, fig. 5; Rch61, Pl. 8, fig. 5). *U/D* and *WB/WH* are correlated (Fig. 5) and specimens more evolute show also a greater width (Rch02, Pl. 7, fig. 1; Rch61, Pl. 8, fig. 5). On gracile specimens, the ornamentation is weak, sometimes limited to ventrolateral clavi (Rch11, Pl. 6, fig. 4); it also fades prematurely (at approximately *D* = 48 mm in Rch10, Pl. 8, fig. 2). On robust specimens, the ornamentation is stronger and fades between *D* = 85 mm (Rch01, Pl. 6, fig. 1) to *D* = 110 mm in Rch02, where primary ribs are still present. Furthermore, rib density is variable and is higher on

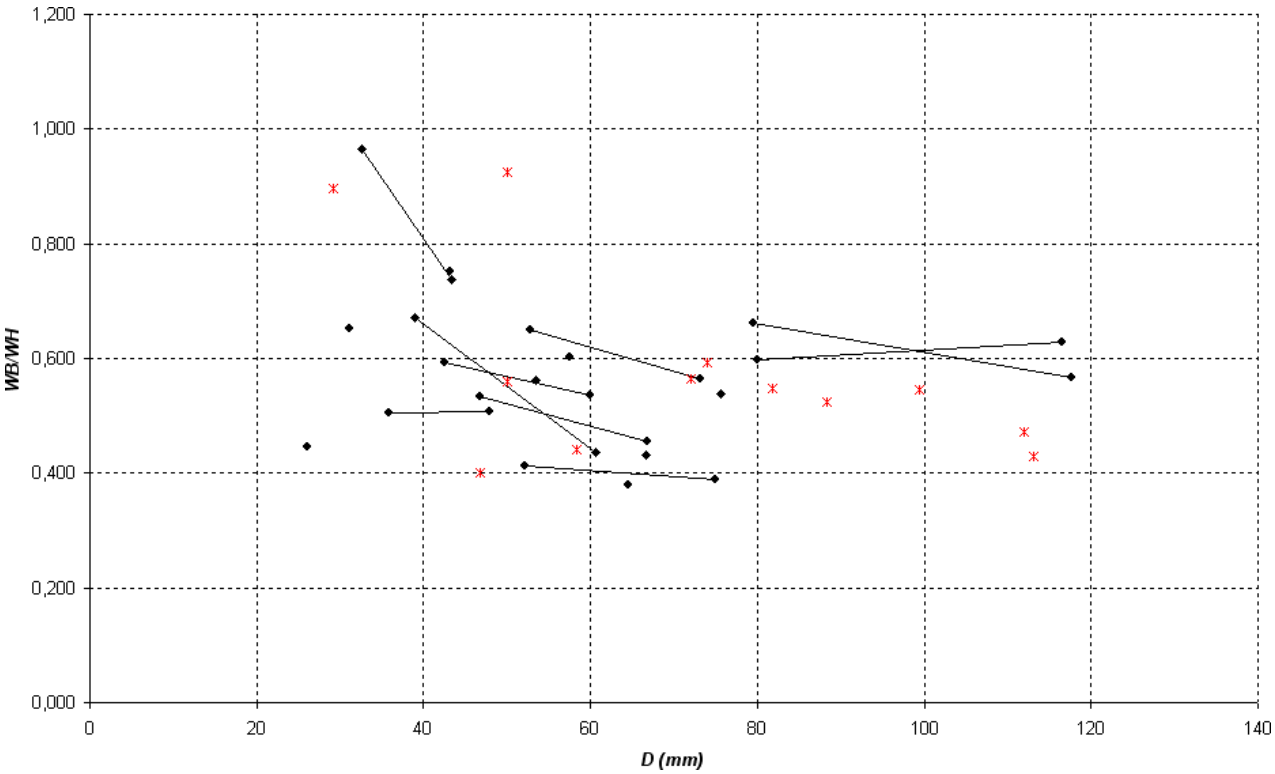

Figure 4: Bivariate diagram of the whorl shape compression (*WB/WH*) through ontogeny (*D*). In black diamonds, *Vocontiiceras vocontiense* DIEBOLD *et al.*, 2018; in red stars, *Barroisiceras haberfellneri* (HAUER, 1866), data from SUMMESBERGER & KENNEDY, 1996. Measurements taken at various diameters of the same specimen are connected with a line.

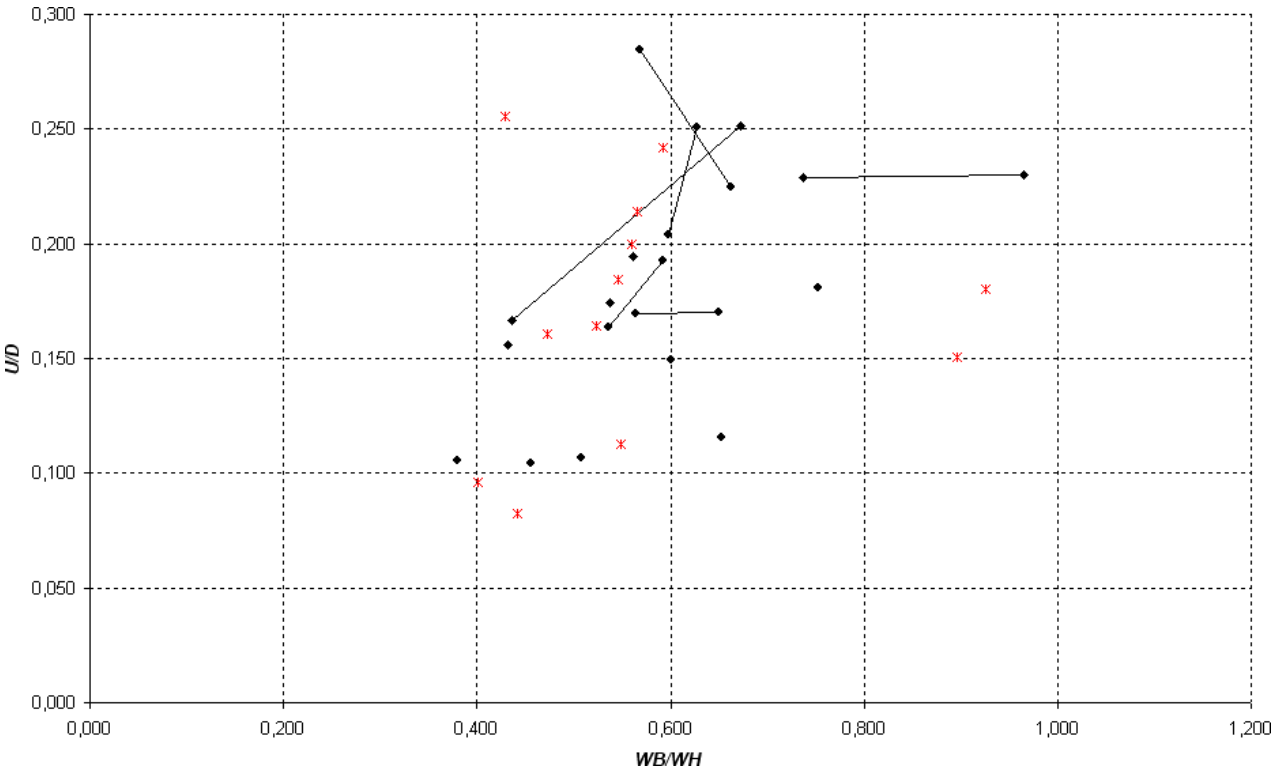

Figure 5: Bivariate diagram of the degree of involution (*U/D*) versus the whorl shape compression (*WB/WH*). In black diamonds, *Vocontiiceras vocontiense* DIEBOLD *et al.*, 2018; in red stars, *Barroisiceras haberfellneri* (HAUER, 1866), data from SUMMESBERGER & KENNEDY, 1996. Measurements taken at various diameters of the same specimen are connected with a line.

compressed morphotypes. For example, Rch08 (Pl. 6, fig. 2) shows 11 ribs per half whorl at *D* = 51 mm, while Rch05 (Pl. 7, fig. 3) has 18 ribs per half whorl at D = 53 mm. These patterns of morphological intraspecific variation correspond to BUCKMAN's rules of covariation (WESTERMANN, 1966; MONNET *et al.*, 2015, and references therein).

Vocontiiceras vocontiense DIEBOLD *et al.*, 2018, shows an intraspecific variability comparable to *Barroisiceras haberfellneri* (HAUER, 1866) (SUMMESBERGER & KENNEDY, 1996, p. 123).

Vocontiiceras vocontiense DIEBOLD *et al.* is close to *Barroisiceras haberfellneri* (HAUER), from the late Turonian (*Prionocyclus germari* Zone) of Austria. It differs by the shape of its venter and ribs ending at ventrolateral clavi in *Vocontiiceras vocontiense* DIEBOLD *et al.*, while they are present on the ventral region of *Barroisiceras haberfellneri* (HAUER). *Vocontiiceras vocontiense* DIEBOLD *et al.* differs further by its well-defined, continuous keel throughout ontogeny, whereas it is crenulated and fading on the body chamber of *Barroisiceras haberfellneri* (HAUER) and all other representatives of *Barroisiceras* GROSSOUVRE, 1894.

Vocontiiceras vocontiense DIEBOLD *et al.* is also comparable to *Barroisiceras romieuxi* PERVINQUIÈRE, 1907, from the Coniacian (?) of Tunisia, known only by its phragmocone. Both species share an involute shell with a similar section and a closely spaced ribbing. *Vocontiiceras vocontiense* DIEBOLD *et al.* differs by its sharp ventrolateral clavi and continuous keel on a flat venter.

Vocontiiceras vocontiense DIEBOLD *et al.* presents similarities with *Prionocycloceras iberiense* (BASSE, 1948), a species from the late Coniacian of Spain. Despite their very similar section, ventral region, umbilical tubercles and ventrolateral clavi, *Prionocycloceras iberiense* (BASSE) differs by its fastigiate venter on the inner whorls, very weak ribbing throughout ontogeny and the fading of the keel on the body chamber.

Vocontiiceras vocontiense DIEBOLD *et al.* can easily be distinguished from *Forresteria* (*Harleites*) *petrocoriensis* (COQUAND, 1859), from the latest Turonian and early Coniacian of Europe, by the lack of lateral tubercles on the inner whorls, the tabulate ventral area and the persistent and continuous keel at all growth stages.

Neoprionocyclus vocontiensis DIEBOLD, 2012, was established in an unpublished thesis. It is therefore a synonym of *Vocontiiceras vocontiense* DIEBOLD *et al.*, 2018.

Occurrence: The species is only known from Rochefort-en-Valdaine (Drôme, France), in the upper part of bed c14 of DIEBOLD (2012), late Turonian, *Prionocyclus germari* Zone.

Suborder Ancyloceratina WIEDMANN, 1966

Superfamily Turrilitoidea GILL, 1871

Family Nostoceratidae HYATT, 1894

Genus *Hyphantoceras* HYATT, 1900

Subgenus *Hyphantoceras* HYATT, 1900

(= *Euhyphantoceras* SHIMIZU, 1935; *Orientoceras* SHIMIZU, 1935; *Ankinatsytes* COLLIGNON, 1965)

Type species: *Heteroceras reussianum* ORBIGNY, 1850 [by original designation of HYATT (1900, p. 587)].

Hyphantoceras (*Hyphantoceras*) *flexuosum* (SCHLÜTER, 1872)

(Pl. 9, fig. 1)

1872. *Heteroceras flexuosum* sp. nov. - SCHLÜTER, p. 108, Pl. 32, figs. 10-12.
pars 1988. *Hyphantoceras flexuosum* (SCHLÜTER, 1872) - KAPLAN & SCHMID, p. 57, Pl. 13, figs. ? 1, 3-4, non 2 [= *Hyphantoceras* (*Hyphantoceras*) *ernsti* WIESE, 2000].
1991. *Hyphantoceras flexuosum* (SCHLÜTER, 1872) - KAPLAN, Pl. 2, fig. 3.
1998. *Hyphantoceras flexuosum* (SCHLÜTER, 1872) - WIESE & KRÖGER, Pl. 2, fig. 8.
2000a. *Hyphantoceras flexuosum* (SCHLÜTER, 1872) - WIESE, p. 409, Pl. 2, figs. 1-10; Pl. 3, figs. 13-14.
2012. *Hyphantoceras* cf. *flexuosum* (SCHLÜTER, 1872) - DIEBOLD, p. 152, Pl. 8, figs. 2-3.
2018. *Hyphantoceras flexuosum* (SCHLÜTER, 1872) - DIEBOLD *et al.*, Fig. 4m-n.

Type: The lectotype is BGR x5687a, the original of SCHLÜTER (1872, Pl. 32, figs. 10-12), designated and re-illustrated by WIESE (2000a, p. 409, Pl. 2, figs. 1-3). It originates from the "Cuvieri Pläner" (*i.e.*, the Erwitte Formation of WIESE *et al. in* NIEBUHR *et al.*, 2007) of the region of Salzgitter (Lower Saxony, Germany). As discussed by WIESE (2000a, p. 410), its age could be early Coniacian.

Material (n = 1): Specimen no. Rch14.

Description: Rch14 is a single whorl of a shell with open and slightly helical coiling and a circular whorl section. The last half of the whorl corresponds to the body chamber.

Ornamentation consists of 17 rectiradiate and concave primary ribs per whorl that appear on the dorsal region and thicken on the outer third of the flanks. Ribs are preceded by a weak constriction. Tuberculation of the primary ribs is mainly visible on the body chamber and consists of a row of small and rounded ventrolateral tubercles and by radially pinched lateral tubercles, both weak. Three to five finer secondary ribs are intercalated between the primaries.

Dimensions: **Table 8:** Measurements of *Hyphantoceras* (*Hyphantoceras*) *flexuosum* (SCHLÜTER, 1872).

no.	"D"	WH	WB	WB/WH
Rch14	-	7.6	8	1.053
	46.3	12.9	12.7	0.984
	55.3	16.6	13.3	0.801

Discussion and comparisons: Rch14 matches perfectly the lectotype of *Hyphantoceras* (*Hyphantoceras*) *flexuosum* (SCHLÜTER, 1872) and falls into the conception of the species *sensu* WIESE (2000a) based on the general shape of its shell and ornamentation.

Hyphantoceras (*Hyphantoceras*) *flexuosum* (SCHLÜTER) and *Hyphantoceras* (*Hyphantoceras*) *reussianum* (ORBIGNY, 1850) are closely allied species with similar ribbing. The distinction between both taxa is difficult with fragmentary specimens. On more complete specimens, *Hyphantoceras* (*Hyphantoceras*) *flexuosum* (SCHLÜTER) differs by a higher apical angle of coiling, a body chamber without retroversum and weaker ornamentation. The two species also occur at slightly different stratigraphic positions in the late Turonian; *Hyphantoceras* (*Hyphantoceras*) *reussianum* (ORBIGNY) is a species from the *Subprionocyclus bravaisianus* Zone, that may still be present at the base of the *Prionocyclus germari* Zone, while *Hyphantoceras* (*Hyphantoceras*) *flexuosum* (SCHLÜTER) is only present with certainty in the lower part of the *Prionocyclus germari* Zone (WIESE, 2000a, p. 409, Fig. 2, and herein).

Hyphantoceras (*Hyphantoceras*) *ernsti* WIESE, 2000, can be distinguished by crioconic or weakly helicoidal coiling and a high apical angle. Furthermore, the ribbing of *Hyphantoceras* (*Hyphantoceras*) *ernsti* WIESE is similar to that of *Hyphantoceras* (*Hyphantoceras*) *flexuosum* (SCHLÜTER) on the early whorls, but later in ontogeny, the primary ribs arise in collars and become irregular while the secondary ribs tend to fade. Both species co-occur in the lower part of the *Prionocyclus germari* Zone.

Occurrence: *Hyphantoceras* (*Hyphantoceras*) *flexuosum* (SCHLÜTER, 1872) is known from Germany and now from south-eastern France. When well dated, *Hyphantoceras* (*Hyphantoceras*) *flexuosum* (SCHLÜTER, 1872) occurs in the late Turonian, *Prionocyclus germari* Zone, and is a major element of the "Heteromorph Beds" of WIESE (2000a), that caracterize the lower part of the *Prionocyclus germari* Zone in North Germany. The presence of the species in the early Coniacian, suggested by the stratigraphical position of the lectotype ("Cuvieri Pläner des Windmühlenberges bei Salzgitter", cf. WIESE, 2000a, p. 410) given by SCHLÜTER (1872, p. 108), lacks confirmation.

Hyphantoceras (*Hyphantoceras*) *ernsti* WIESE, 2000

(Pl. 9, figs. 2-6)

pars 1968. *Hyphantoceras reussianum* (ORBIGNY, 1850) - TRÖGER, p. 45, Fig. 2, Pl. 1, fig. 3; non Fig. 1, non Pl. 1, figs. 1-2 [= *Hyphantoceras reussianum* (ORBIGNY, 1850)].

pars 1988. *Hyphantoceras flexuosum* (SCHLÜTER, 1872) - KAPLAN & SCHMID, p. 57, Pl. 13, fig. 2, non figs. 1, 3-4 [= *Hyphantoceras* (*Hyphantoceras*) *flexuosum* (SCHLÜTER, 1872)].

1995. *Hyphantoceras reussianum* (ORBIGNY, 1850) – TRÖGER & VOIGT, Pl. 1, fig. 3.

1997. *Neocrioceras* aff. *paderbornense* (SCHLÜTER, 1872) - HORNA & WIESE, Pl. 1, figs. F-G.

1998. *Neocrioceras* sp. aff. *paderbornense* (SCHLÜTER, 1872) - WIESE & KRÖGER, p. 270, Pl. 2, fig. 7.

2000a. *Hyphantoceras ernsti* sp. nov. - WIESE, p. 410, Fig. 3, Pl. 1, figs. 1-11; Pl. 3, figs. 3, 9, 15.

2012. *Hyphantoceras* cf. *ernsti* WIESE, 2000 - DIEBOLD, p. 152, Pl. 9, figs. 1-4.

Type: The holotype is the original of TRÖGER (1968, Fig. 2 and Pl. 1, fig. 1) by original designation, initially identified as *Hyphantoceras reussianum* (ORBIGNY, 1850) and re-figured by WIESE (2000a, Fig. 3 and Pl. 1, figs. 1-3). It originates from the late Turonian, *Prionocyclus germari* Zone (Strehlen Formation) of Dresden-Blasewitz (Saxony, Germany). It is stored without registration number in the collections of the Geological Institute of the TU Bergakademie, Freiberg (Saxony, Germany) (WIESE, 2000a, p. 410).

Material (n = 5): Specimens no. Rch16, Rch17, Rch18, Rch19, Rch51.

Description: All of our specimens are fragments of whorls, with loose crioconic or very slightly helicoidal coiling. The section is circular to oval and seems to become more compressed during ontogeny.

The ornamentation consists of prorsiradate primary ribs which strengthen during ontogeny, with small and round ventrolateral tubercles. The primary ribs originate dorsally where they are weaker than on the flanks and ventrally. Two to five secondary ribs are intercalated, and strengthen from the dorsal toward the ventral region.

Rch51 (Pl. 9, fig. 3) represents a larger ontogenetic stage, with more and irregular primaries and irregularly fading secondaries.

Dimensions: **Table 9:** Measurements of *Hyphantoceras* (*Hyphantoceras*) *ernsti* WIESE, 2000.

no.	WH	WB	WB/WH
Rch16	8.8	-	-
Rch17	7.3	6.1	0.836
Rch18	9.2	7.9	0.859
Rch19	8.7	6.8	0.782
Rch51	14.7	7.1	0.483
	10.6	6.1	0.575

Discussion and comparisons: Likely due to the poor preservation of our specimens, the lateral tubercles indicated in the original description of *Hyphantoceras* (*Hyphantoceras*) *ernsti* WIESE, 2000, seem to be present but are difficult to observe. The five specimens studied here match well with the original description of the species of WIESE (2000a).

Hyphantoceras (*Hyphantoceras*) *ernsti* WIESE can be distinguished from *Hyphantoceras* (*Hyphantoceras*) *reussianum* (ORBIGNY, 1850) by its different coiling which is loosely crioconic or very slightly helicoidal while it is helicoidal with a smaller angle apical in the ORBIGNY's species. *Hyphantoceras* (*Hyphantoceras*) *reussianum* (ORBIGNY) also has a slightly older stratigraphical distribution, situated in the *Subprionocyclus bravaisianus* Zone and maybe at the base of the *Prionocyclus germari* Zone.

Hyphantoceras (*Hyphantoceras*) *ernsti* WIESE is close to *Hyphantoceras* (*Hyphantoceras*) *flexuosum* (SCHLÜTER, 1872). Differences between the two species were discussed above.

Hyphantoceras (*Hyphantoceras*) *yabei* (COLLIGNON, 1965), from the early Coniacian of Madagascar, is a poorly known species, also close to *Hyphantoceras* (*Hyphantoceras*) *ernsti* WIESE. It differs essentially by its helicoidal coiling with a smaller apical angle and its stronger ribbing.

Occurrence: *Hyphantoceras* (*Hyphantoceras*) *ernsti* WIESE, 2000, is present in Germany and France, and likely in Kazakhstan (Mangyshlak) (WIESE, 2000a). The species is known from the late Turonian, *Prionocyclus germari* Zone, with special reference to the lower part of the zone ("Heteromorph Beds" of WIESE, 2000a).

Family Baculitidae GILL, 1871

Genus *Sciponoceras* HYATT, 1894

(= *Cyrtochilus* MEEK, 1876, *non* JAKOWLEW, 1875; *Cyrtochella* STRAND, 1929)

Type species: *Hamites baculoides* MANTELL, 1822 [by original designation of HYATT (1894, p. 578)].

Sciponoceras bohemicum bohemicum (FRITSCH, 1872)

(Pl. 9, figs. 7-8)

1872. *Baculites faujassi* LAMARCK, 1822 var. *bohemica* - FRITSCH, p. 49, Pl. 13, figs. 23-25, 29-30.
1909. *Baculites baculoides* MANTELL, 1822 - WANDERER, p. 61, Pl. 9, fig. 2.
non 1959. *Sciponoceras* aff. *S. bohemicum* (FRITSCH, 1822) - MATSUMOTO, p. 109, Figs. 7-11, Pl. 30, figs. 2-3; Pl. 31, fig. 4 (= *Sciponoceras intermedium* MATSUMOTO & OBATA, 1963).
1979. *Sciponoceras bohemicum* (FRITSCH, 1822) - C.W. WRIGHT, p. 285, Pl. 1, figs. 3-5; Pl. 7, figs. 10, 12 (with synonymy).
1981. *Sciponoceras bohemicum bohemicum* (FRITSCH, 1872) - C.W. WRIGHT & KENNEDY, p. 116, Pl. 31, fig. 9.
1984. *Sciponoceras bohemicum bohemicum* (FRITSCH, 1872) - KENNEDY *et al.*, p. 42, Fig. 2 (e)-(g).
1988. *Sciponoceras bohemicum* (FRITSCH, 1872) – WALASZCZYK, p. 56, Pl. 5, fig. 5.
1992. *Sciponoceras bohemicum* (FRITSCH, 1872) subsp. inc. - SANTAMARIA ZABALA, p. 236, Pl. 2, fig. 7.
1992. *Sciponoceras bohemicum* (FRITSCH, 1872) ssp. – SUMMESBERGER, p. 123, Pl. 8, figs. 7-9.
1996. *Sciponoceras bohemicum bohemicum* (FRITSCH, 1872) - SUMMESBERGER & KENNEDY, p. 134, Pl. 18, figs. 4, 26.
2001. *Sciponoceras bohemicum* (FRITSCH, 1872) – KLINGER & KENNEDY, p. 258, Figs. 181, 182A-G, I-M, 183.
2012. *Sciponoceras bohemicum bohemicum* (FRITSCH, 1872) - DIEBOLD, p. 153, Pl. 9, figs. 6, 8-9.
2014. *Sciponoceras bohemicum* (FRITSCH, 1872) – WILMSEM & NAGM, p. 233, Fig. 13k.
2015. *Sciponoceras bohemicum bohemicum* (FRITSCH, 1872) - KENNEDY & GALE, p. 519, Figs. 7K-O.

Type: The lectotype is the original of *Baculites faujassi* LAMARCK, 1822, var. *bohemica* of FRITSCH (1872, p. 49, Pl. 13, fig. 25), by subsequent designation of C.W. WRIGHT (1979, p. 285). It is from the late Turonian (*Prionocyclus germari* Zone) of Lenesice, near Louny (Czech Republic).

Material (n = 3): Specimens no. Rch15, Rch44, Rch45.

Description: All specimens are fragments preserved on matrix, only a half of the section is visible, although deformed by compaction on specimen no. Rch45. The whorl section is elliptical.

Ornamentation is composed of low, wide and straight, strongly prorsiradiate ribs strengthening and widening to form ridges on the ventral region. On the body chamber (specimen no. Rch45), strong, widely spaced and strongly prorsiradiate primary ribs are comparable to the specimen figured by KLINGER & KENNEDY (2001, Fig. 181E). Several shallow constrictions follow the ribs on Rch15 but are poorly preserved. On specimen no. Rch44, two shallow constrictions can be found.

Dimensions: **Table 10:** Measurements of *Sciponoceras bohemicum bohemicum* (FRITSCH, 1872).

no.	"L"	WH
Rch15	42.4	4.9
Rch44	60	9.4
Rch45	81.2	15.1

Discussion and comparisons: The three studied specimens correspond to different ontogenetic stages. Rch15 is likely a juvenile with part of the body chamber preserved, while specimens no. Rch44 and Rch45 are of larger size. Specimen no. Rch45 is represented by the end of the phragmocone and the body chamber. They are comparable to specimens illustrated in the

literature, particularly by C.W. WRIGHT (1979) and by KLINGER & KENNEDY (2001). Their ornamentation is identical to the one of the specimens illustrated on the Fig. 181 of KLINGER & KENNEDY (2001).

Sciponoceras bohemicum anterius C.W. WRIGHT & KENNEDY, 1981, from the late Cenomanian (*Neocardioceras juddii* Zone) differs from *Sciponoceras bohemicum bohemicum* (FRITSCH, 1872) by its flat flanks and by its ribs and constrictions that cross the venter in a very broad arch (C.W. WRIGHT & KENNEDY, 1981, p. 115, and KENNEDY & GALE, 2015, p. 520).

Sciponoceras intermedium MATSUMOTO & OBATA, 1963, a species from the late Turonian of Japan, differs mainly from *Sciponoceras bohemicum bohemicum* (FRITSCH) by weaker constrictions and more numerous, weaker and more prorsiradiate ribs (MATSUMOTO & OBATA, 1963, p. 27).

Sciponoceras bohemicum bohemicum (FRITSCH) is close to *Sciponoceras gracile* (SHUMARD, 1860), a late Cenomanian species, that differs by its more rounded section, stronger and more regularly rounded adult ribbing, and shallower constrictions on the dorsal region and the flanks (C.W. WRIGHT, 1979, p. 286).

Sciponoceras bohemicum bohemicum (FRITSCH) is also very close to the first *Baculites* LAMARCK, 1799, of the same age, with special reference to *Baculites undulatus* ORBIGNY, 1850, from which it can easily be distinguished by the presence of constrictions, that are unknown in *Baculites* LAMARCK, and by its stronger ribs that form ridges on the ventral region (C.W. WRIGHT, 1979, p. 287; SUMMESBERGER & KENNEDY, 1996, p. 135).

Occurrence: *Sciponoceras bohemicum bohemicum* (FRITSCH, 1872) is known from England, France, Germany, Northern Spain, the Czech Republic, Austria, Poland and likely from Kazakhstan (KENNEDY & GALE, 2015, p. 520). *Sciponoceras bohemicum bohemicum* (FRITSCH, 1872) is present in the late Turonian, *Subprionocyclus bravaisianus* Zone and *Prionocyclus germari* Zone. According to WILMSEN & NAGM (2014, p. 233), the species could also be present in the early Coniacian.

Superfamily Scaphitoidea GILL, 1871

Family Scaphitidae GILL, 1871

Subfamily Scaphitinae GILL, 1871

Genus *Scaphites* PARKINSON, 1811

(= *Anascaphites* HYATT, 1900; *Jahnnites* HYATT, 1900; *Holcoscaphites* NOWAK, 1911)

Type species: *Scaphites equalis* J. SOWERBY, 1813 [by subsequent designation of MEEK (1876, p. 145)].

Scaphites geinitzii ORBIGNY, 1850

(Pl. 9, figs. 9-20)

? 1841. *Ammonites cottae* sp. nov. - ROEMER, p. 86, Pl. 13, fig. 4.
1850. *Scaphites geinitzii* sp. nov. - ORBIGNY, p. 214.
1855. *Ammonites Wiltonensis* sp. nov. - SHARPE, p. 53, Pl. 23, fig. 10.
1913. *Scaphites planus* sp. nov. - ROMAN & MAZERAN, p. 13, Pl. 4, figs. 15-17.
1959. *Scaphites geinitzi* ORBIGNY, 1850 - NAIDIN & SHIMANSKI, p. 195, Pl. 7, fig. 3.
1979. *Scaphites geinitzii geinitzii* ORBIGNY, 1850 - C.W. WRIGHT, p. 300, Pl. 3, figs. 1-4, 6-7; Pl. 7, fig. 9.
1979. *Scaphites geinitzii laevior* ssp. nov. - C.W. WRIGHT, p. 302, Pl. 3, figs. 8-9; Pl. 7, fig. 7.
1982. *Scaphites geinitzi* ORBIGNY, 1850 - TZANKOV, p. 23, Pl. 7, figs. 1-5.
1987. *Scaphites geinitzii* ORBIGNY, 1850 - KAPLAN *et al.*, p. 10, Pl. 1, figs. 1-4, 6-10; Pl. 2, figs. 1-13; Pl. 3, figs. 1-5, 9-11; Pl. 4, figs. 1-2, 7; Pl. 6, fig. 6 (with synonymy).
1988. *Scaphites geinitzi* ORBIGNY, 1850 - WALASZCZYK, p. 56, Pl. 5, fig. 1.
1991. *Scaphites geinitzii* ORBIGNY, 1850 - KAPLAN, Pl. 2, fig. 1a.
? 1992. *Scaphites* (*Scaphites*) *geinitzii* ORBIGNY, 1850 - SANTAMARIA ZABALA, p. 248, Pl. 2, fig. 10.
1998. *Scaphites geinitzii* ORBIGNY, 1850 - KÜCHLER, p. 194, Pl. 11, fig. 7.
2000. *Scaphites geinitzii* ORBIGNY, 1850 - ARKADIEV *et al.*, p. 120, Pl. 10, figs. 5-7.
2002. *Scaphites geinitzii* ORBIGNY, 1850 - C.W. WRIGHT & KENNEDY, p. 218, Pl. 41, figs. 8-10.
2004. *Scaphites geinitzii* ORBIGNY, 1850 - WIESE & KAPLAN, Pl. 1, fig. 2.
2012. *Scaphites geinitzii* ORBIGNY, 1850 - DIEBOLD, p. 155, Pl. 9, figs. 10-12.
2014. *Scaphites geinitzii* ORBIGNY, 1850 - AMÉDRO & DEVALQUE *in* ROBASZYNSKI *et al.*, p. 163, Pl. 37, fig. 1; Pl. 39, fig. 14.
2014. *Scaphites geinitzi* ORBIGNY, 1850 - WILMSEN & NAGM, p. 236, Pl. 13, figs. l, n (with additional synonymy).
? 2014. *Scaphites geinitzi* ORBIGNY, 1850 or *Scaphites* cf. *kieslingswaldensis doylei* C.W. WRIGHT, 1979 – WILMSEN & NAGM, Pl. 13, fig. p.
2015. *Scaphites geinitzii* ORBIGNY, 1850 - KENNEDY & GALE, p. 520, Figs. 7.A-B, E-H.

Type: The lectotype, by subsequent designation of C.W. WRIGHT (1979, p. 299), is the original of ORBIGNY (1850) from the late Turonian of Strehlen, near Dresden (Germany) (MNHN.F. R01235 - cat. no. 7197 of the ORBIGNY collection). Originaly described without figure, a cast of the lectotype was illustrated by C.W. WRIGHT (1979, Pl. 3, fig. 1) and the original specimen was later figured by KAPLAN *et al.* (1987, Pl. 2, fig. 3).

Material (n = 21): Specimens no. Rch25, Rch26, Rch27, Rch28, Rch29, Rch30, Rch31, Rch32, Rch33, Rch34, Rch35, Rch36, Rch37, Rch50, Rch53, Rch57, Rch59, Rch63, Rch64, Rch65, Rch67.

Description: Our specimens are of rather small size, with a maximum length (*L*) of 22 to

24 mm for the presumed microconchs; and 22-34 mm for the macroconchs. The coiling is very involute, with a narrow umbilicus and a circular whorl section. On the proversum, the height of the whorl quickly increases. This is typical of the macroconch specimens where the dorsal swelling at the beginning of the proversum hides a part of the spire. At that stage, the whorl section becomes oval. Whorl width reaches its maximum on the middle of the flexus. On the retroversum, the height of the whorl decreases and the section becomes circular again.

The spire is ornamented by radial, straight, strong primary ribs that bifurcate or trifurcate at about the mid-flank, forming secondary ribs which cross the ventral region. Occasionally secondary ribs are intercalated. On the proversum, the ornamentation strengthens and the furcation point of the ribs moves gradually towards the outer third of the flanks. At the edge of the proversum and on the flexus, the furcation point of the ribs is situated on the ventrolateral shoulder and bears a tubercle of variable strength. On the retroversum, tubercles and primary ribs vanish and the ornamentation is reduced to fine ribs on the upper half of the flanks and the ventral region. The peristome on Rch50 (Pl. 9, fig. 15) shows a deep constriction.

Dimensions: **Table 11:** Measurements of *Scaphites geinitzii* ORBIGNY, 1850.

no.	L	Ds	WH	WB	Ds/L	WH/L	WB/L
Rch25	32.1	17.7	12.7	11.4	0.551	0.396	0.355
Rch26	25.3	15.8	11.5	10.4	0.625	0.455	0.411
Rch27	25.4	17.6	9.7	8.7	0.693	0.382	0.343
Rch28	23.9	-	-	-	-	-	-
Rch29	31.3	17.2	11.3	-	0.550	0.361	-
Rch30	28	18.2	13.1	7.4	0.650	0.468	0.264
Rch31	28.7	21	9.9	8.3	0.732	0.345	0.289
Rch32	25.5	18	11.6	8.8	0.706	0.455	0.345
Rch33	29.6	23.5	11.1	6.7	0.794	0.375	0.226
Rch34	23	15.6	9.5	-	0.678	0.413	-
Rch35	22.3	13.6	9.1	7	0.610	0.408	0.314
Rch36	27.7	19.9	11.5	8.9	0.718	0.415	0.321
Rch37	30.3	15.2	12.9	7.9	0.502	0.426	0.261
Rch50	23.7	17.9	10	8.3	0.755	0.422	0.350
Rch53	34.1	20.9	13	10.6	0.613	0.381	0.311
Rch57	24.1	13.5	10.4	6	0.560	0.432	0.249
Rch59	24.9	16.8	9.1	6.8	0.675	0.365	0.273
Rch63	21.7	15.9	10.1	6.1	0.733	0.465	0.281
Rch64	23	15.6	-	5.4	0.678	-	0.235
Rch65	23.3	14.2	9.8	-	0.609	0.421	-
Rch67	32.9	17	14.1	9.4	0.517	0.429	0.286

Discussion and comparisons: Most of the studied specimens are macroconchs, characterized by rapid increase in *WH* on the proversum. Despite their poor preservation, Rch35 (Pl. 9, fig. 20) and Rch57 (Pl. 9, fig. 19) are interpreted as microconchs, due to their smaller size, their umbilicus which seems more evolute and their lower increase of *WH* on the proversum. By their general shape of the shell and their ornamentation, all specimens agree with the description of the species *Scaphites geinitzii* ORBIGNY, 1850, *sensu* KAPLAN *et al.* (1987), particularly the ornamentation of the spire with distinct primary and secondary ribs and lack of tubercles.

Scaphites planus ROMAN & MAZERAN, 1913, a species that is only known by its poorly preserved type-specimens from the late Turonian, *Subprionocyclus bravaisianus* Zone of Uchaux (Vaucluse, France), is considered as a junior synonym of *Scaphites geinitzii* ORBIGNY by AMÉDRO & DEVALQUE *in* ROBASZYNSKI *et al.* (2014). We follow this opinion herein.

Scaphites kieslingwaldensis LANGENHAN & GRUNDEY, 1891, a species from the Coniacian of Europe and Madagascar, differs from *Scaphites geinitzii* ORBIGNY by its more evolute tuberculated spire, the higher furcation point of its ribs, and the presence of clavate tubercles on the proversum and the flexus (KAPLAN *et al.*, 1987, p. 12).

Scaphites diana C.W. WRIGHT, 1979, is a species mostly known from the late Turonian, *Subprionocyclus bravaisianus* Zone, but is still present beneath the Turonian/Coniacian boundary and at the base of the *Forresteria petrocoriensis* Zone of the early Coniacian in northwest Germany (KAPLAN *et al.*, 1987). It differs by its more evolute spire, more numerous and sharper ventrolateral tubercles, and more rectangular whorl section on the proversum and on the retroversum (KAPLAN *et al.*, 1987, p. 17).

Scaphites warreni MEEK & HAYDEN, 1860, *Scaphites ferronensis* COBBAN, 1951, *Scaphites whitfieldi* COBBAN, 1951, *Scaphites nigricollensis* COBBAN, 1951, and *Scaphites corvensis* COBBAN, 1951, constitute a late Turonian lineage that is endemic to the Western Interior of the United States. *Scaphites geinitzii* ORBIGNY differs from these by its more involute spire, bulged proversum and by the highly differentiated ribbing pattern of its spire where there is a greater number of secondary ribs. Furthermore, in the North American species, the primary ribs are less numerous and more widely spaced on the proversum and the flexus, and do not bear ventrolateral tubercles.

Occurrence: *Scaphites geinitzii* ORBIGNY, 1850, is known from southern England, France, Germany, Poland, Czech Republic, northwestern Spain, Bulgaria, Romania, Ukraine (Crimea, Donbass), Kazakhstan, Turkmenistan and Greenland (KENNEDY & GALE, 2015, p. 521). Occurrences of *Scaphites geinitzii* ORBIGNY, 1850, are reported from the middle and late Turonian, early Coniacian, and likely middle Coniacian (C.W. WRIGHT, 1979, p. 300).

V. Conclusions

The ammonoid fauna from Rochefort-en-Valdaine (Drôme, France) studied here is composed of *Gaudryceras mite* (HAUER, 1866), cf. *Mesopuzosia* MATSUMOTO, 1954, *Lewesiceras mantelli* C.W. WRIGHT & E.V. WRIGHT, 1951, *Prionocyclus germari* (REUSS, 1845), *Vocontiiceras vocontiense* DIEBOLD *et al.*, 2018, *Hyphantoceras* (*Hyphantoceras*) *flexuosum* (SCHLÜTER, 1872), *Hyphantoceras* (*Hyphantoceras*) *ernsti* WIESE, 2000, *Sciponoceras bohemicum bohemicum* (FRITSCH, 1872), and *Scaphites geinitzii* ORBIGNY, 1850. These records confirm that the *Prionocyclus germari* Zone is also present in south-eastern France.

Vocontiiceras vocontiense DIEBOLD *et al.*, 2018, is only known from Rochefort-en-Valdaine and potentially represents an endemic species. It was shown here that it has closer affinities to the Barroisiceratinae BASSE, 1947, than to the Collignoniceratinae C.W. WRIGHT & E.V. WRIGHT, 1951. It shows the same whorl section, ornamentation of the flanks and intraspecific variability as in the genus *Barroisiceras* GROSSOUVRE, 1894, but differs by its flat venter and continuous keel present on the complete shell. Its morphological and ornamental similarities with *Barroisiceras haberfellneri* (HAUER, 1866) suggest a close relationship between these two species, that will only be elucidated by the discovery and study of a more abundant and well-horizoned material.

The occurrence at Rochefort-en-Valdaine of *Prionocyclus germari* (REUSS, 1845), *Hyphantoceras* (*Hyphantoceras*) *flexuosum* (SCHLÜTER, 1872) and *Hyphantoceras* (*Hyphantoceras*) *ernsti* WIESE, 2000, taxa essentially known in Germany, allows correlation of the French fauna studied herein with the German "Heteromorph Beds" of WIESE (2000a, Fig. 2), that characterize the lower part of the *Prionocyclus germari* Zone. Our study also shows that, despite numerous previous works, the late Turonian of south-eastern France remains relatively poorly known and requires further studies. The current work is a step forward in our understanding of the latest Turonian ammonoids of France.

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Plates

Plate 1:

Fig. 1a-b: *Gaudryceras mite* (HAUER, 1866). Specimen no. Rch13, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

Fig. 2: cf. *Mesopuzosia* MATSUMOTO, 1954. Specimen no. Rch38, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

Asterisks indicate the beginning of the body chamber.

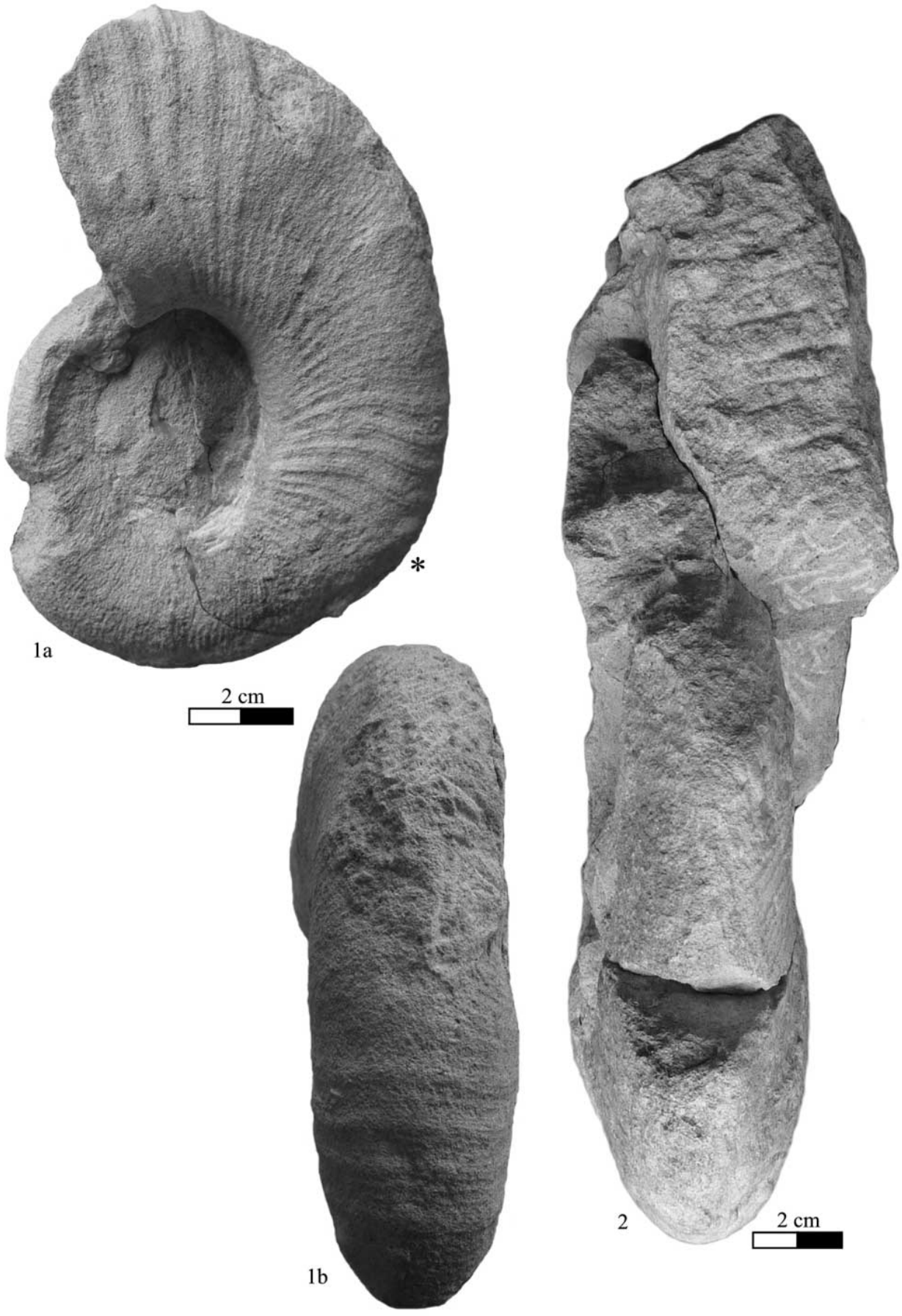
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Plate 2: Fig. 1: cf. *Mesopuzosia* MATSUMOTO, 1954. Specimen no. Rch38, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).


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Plate 3:

Fig. 1: cf. *Mesopuzosia* MATSUMOTO, 1954. Specimen no. Rch38, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

Fig. 2a-c: *Lewesiceras mantelli* C.W. WRIGHT & E.V. WRIGHT, 1951. Specimen no. Rch21, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

Fig. 3a-b: *Lewesiceras mantelli* C.W. WRIGHT & E.V. WRIGHT, 1951. Specimen no. Rch20, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

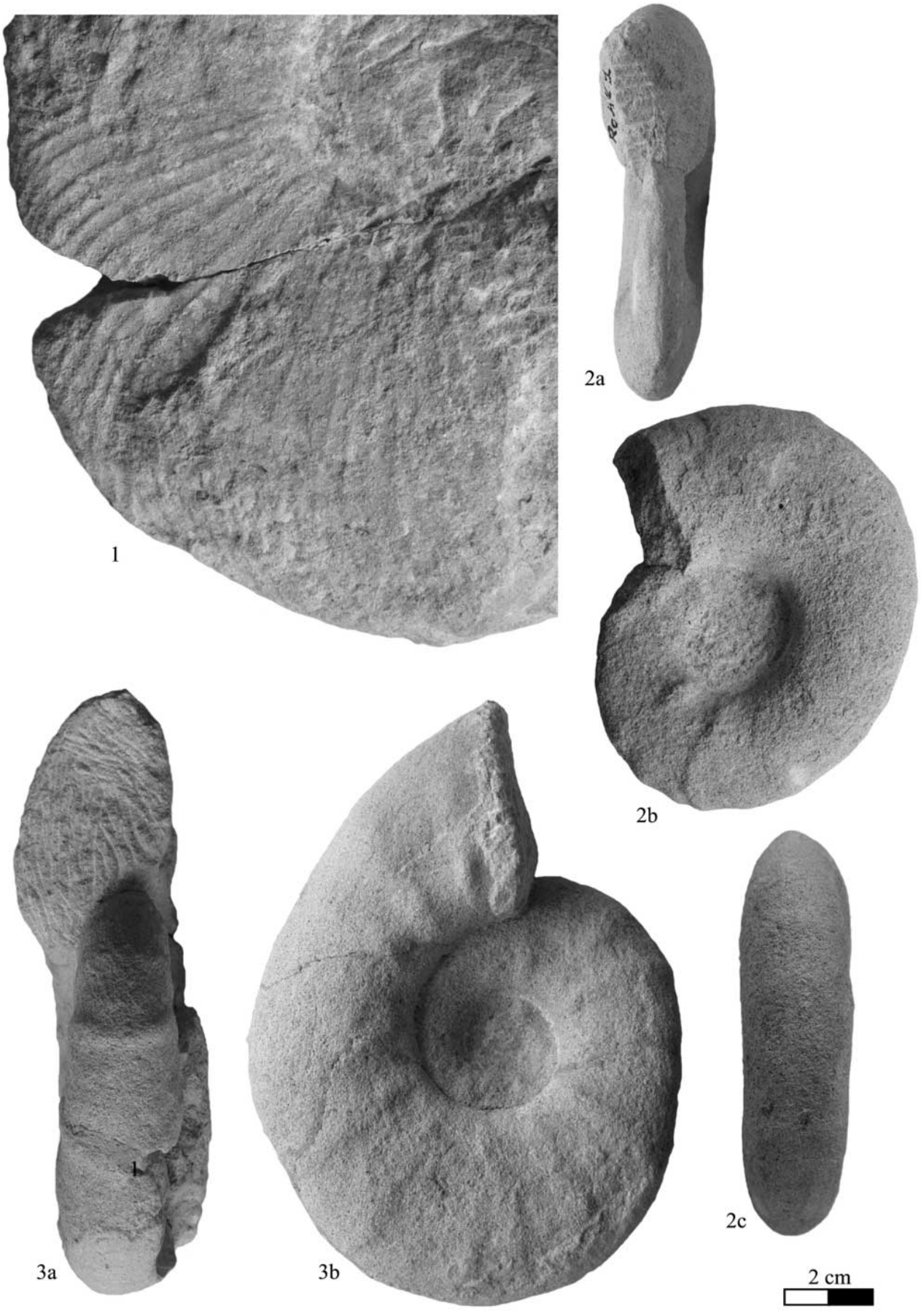
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Plate 4: Fig. 1: *Lewesiceras mantelli* C.W. WRIGHT & E.V. WRIGHT, 1951. Specimen no. 955, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France). CHATELIER coll. Asterisks indicate the beginning of the body chamber.

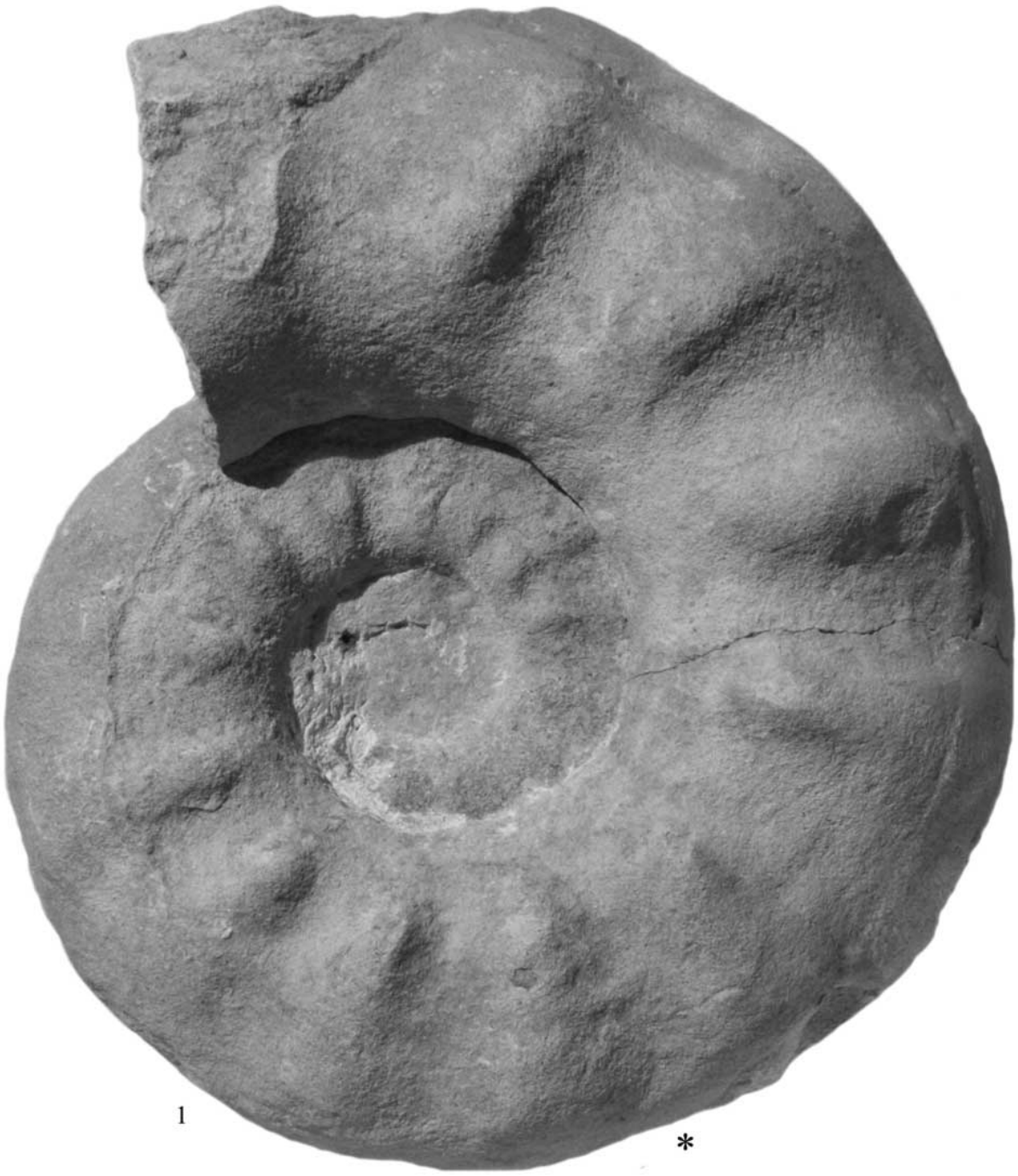
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Plate 5:

Fig. 1: *Lewesiceras mantelli* C.W. WRIGHT & E.V. WRIGHT, 1951. Specimen no. 955, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France). CHATELIER coll.

Fig. 2a-b: *Lewesiceras mantelli* C.W. WRIGHT & E.V. WRIGHT, 1951. Specimen no. 960, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France). CHATELIER coll.

Fig. 3a-b: *Prionocyclus germari* (REUSS, 1845). Specimen no. Rch12, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

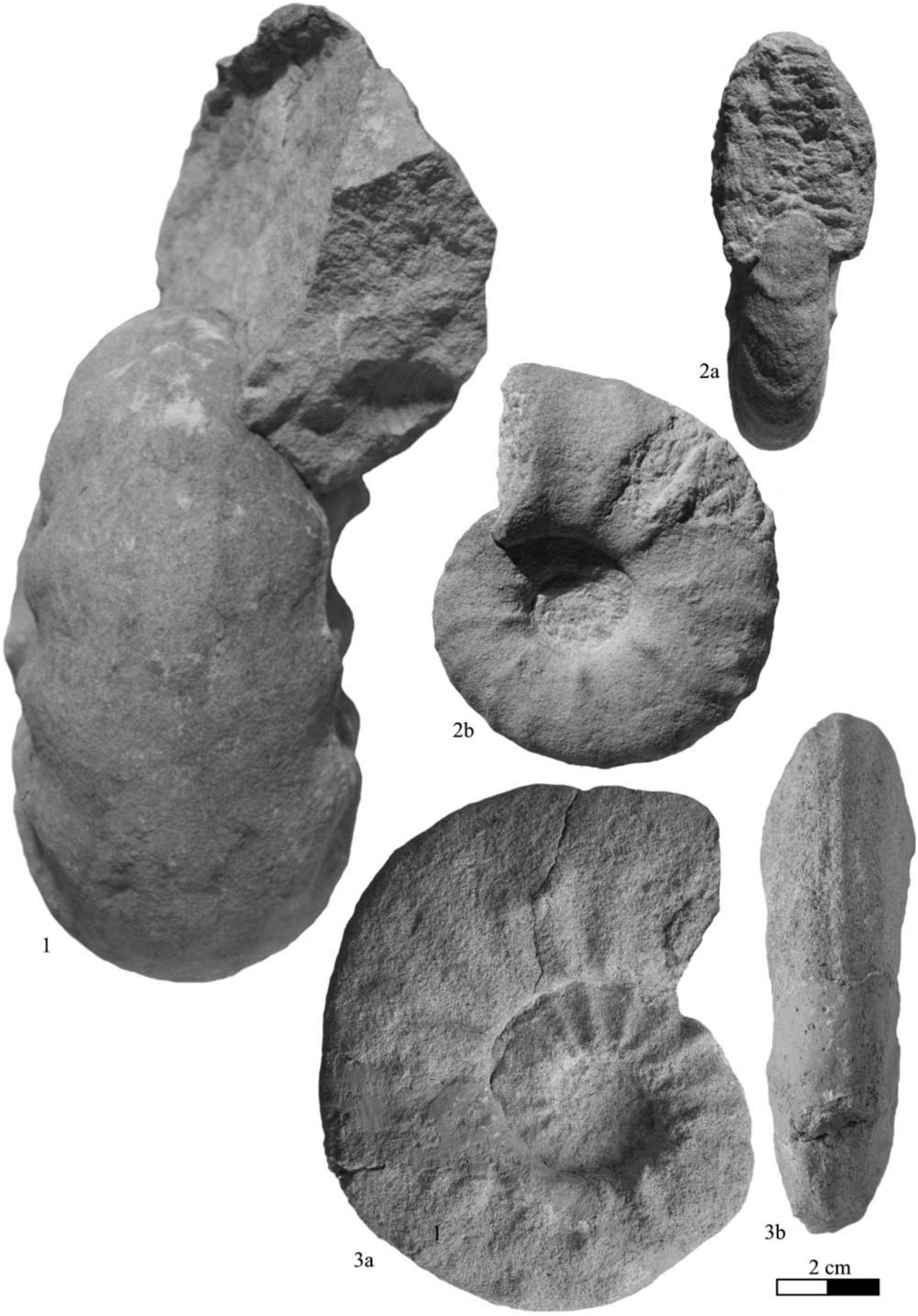
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Plate 6:

Fig. 1a-c: *Vocontiiceras vocontiense* DIEBOLD *et al.*, 2018. Paratype no. Rch01, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

Fig. 2a-b: *Vocontiiceras vocontiense* DIEBOLD *et al.*, 2018. Paratype no. Rch08, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

Fig. 3a-b: *Vocontiiceras vocontiense* DIEBOLD *et al.*, 2018. Specimen no. Rch04, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

Fig. 4a-c: *Vocontiiceras vocontiense* DIEBOLD *et al.*, 2018. Specimen no. Rch11, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

Fig. 5a-b: *Vocontiiceras vocontiense* DIEBOLD *et al.*, 2018. Specimen no. Rch42, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

Asterisks indicate the beginning of the body chamber.

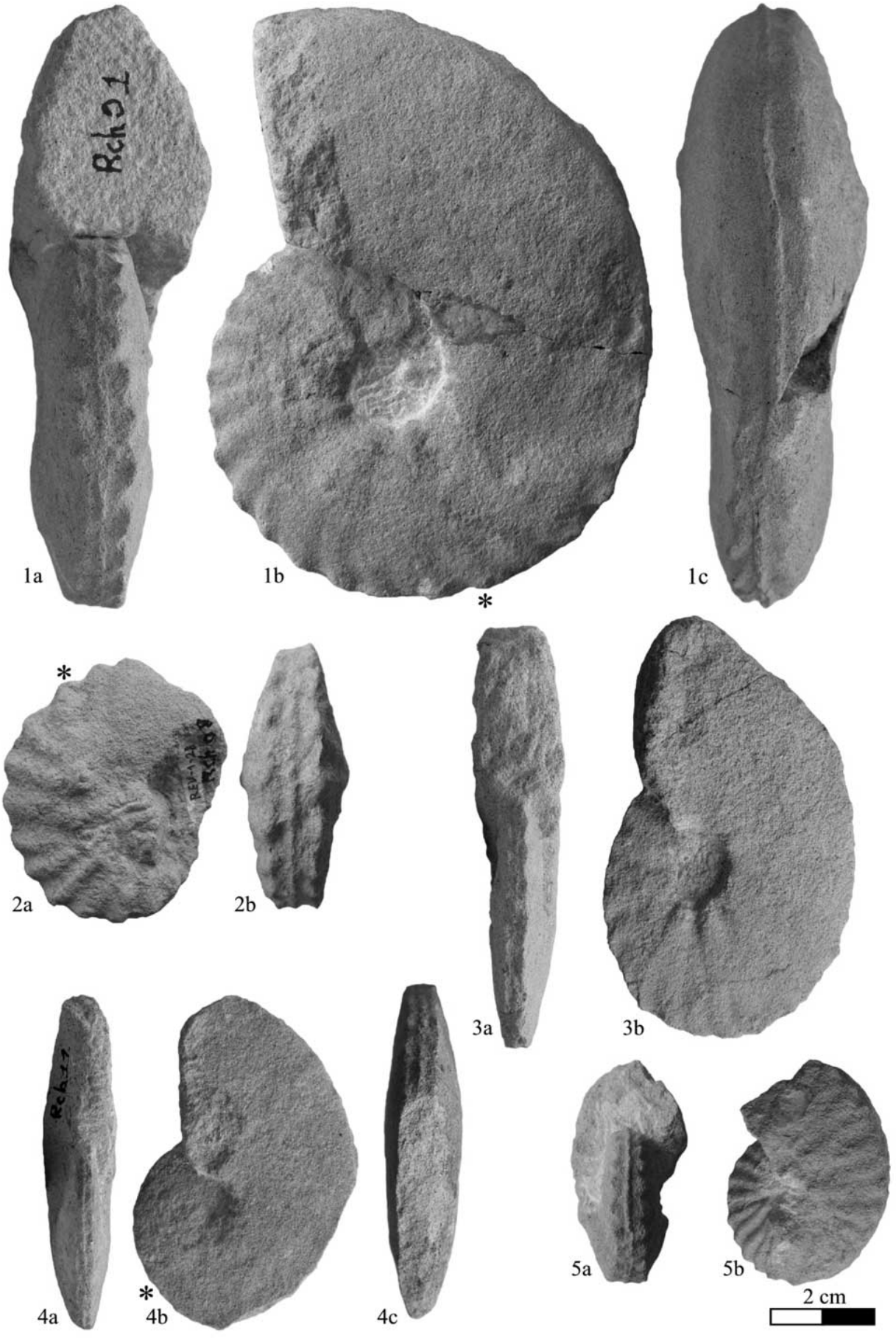
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Plate 7:

Fig. 1a-c: *Vocontiiceras vocontiense* DIEBOLD *et al.*, 2018. Paratype no. Rch02, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

Fig. 2a-c: *Vocontiiceras vocontiense* DIEBOLD *et al.*, 2018. Specimen no. Rch06, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

Fig. 3a-b: *Vocontiiceras vocontiense* DIEBOLD *et al.*, 2018. Specimen no. Rch05, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

Fig. 4a-b: *Vocontiiceras vocontiense* DIEBOLD *et al.*, 2018. Specimen no. Rch47, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

Asterisks indicate the beginning of the body chamber.

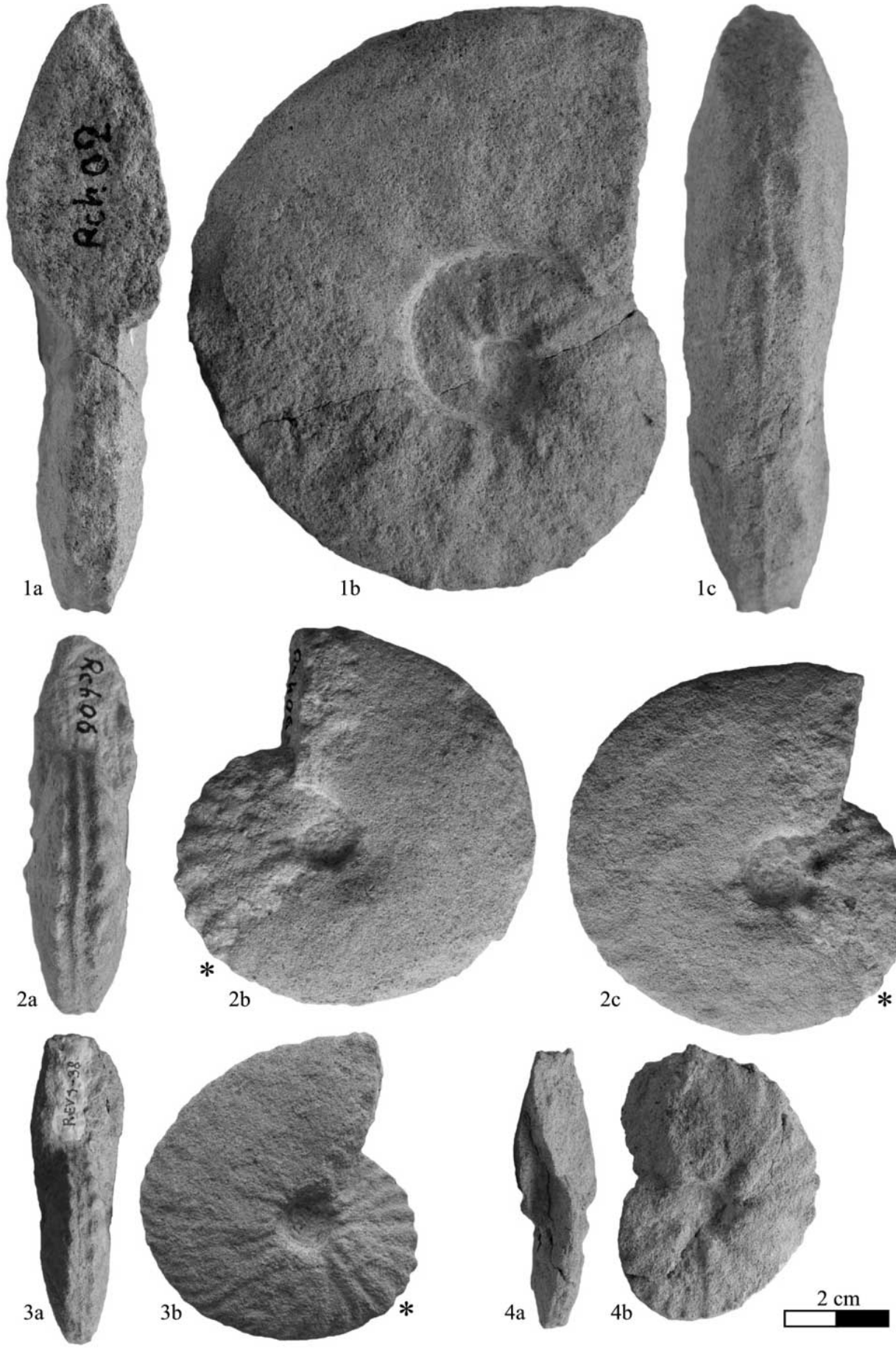
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Plate 8:

Fig. 1a-b: *Vocontiiceras vocontiense* DIEBOLD *et al.*, 2018. Specimen no. Rch60, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

Fig. 2a-b: *Vocontiiceras vocontiense* DIEBOLD *et al.*, 2018. Paratype no. Rch10, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

Fig. 3a-b: *Vocontiiceras vocontiense* DIEBOLD *et al.*, 2018. Paratype no. Rch07, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

Fig. 4a-b: *Vocontiiceras vocontiense* DIEBOLD *et al.*, 2018. Specimen no. Rch03, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

Fig. 5a-b: *Vocontiiceras vocontiense* DIEBOLD *et al.*, 2018. Specimen no. Rch61, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

Asterisks indicate the beginning of the body chamber.

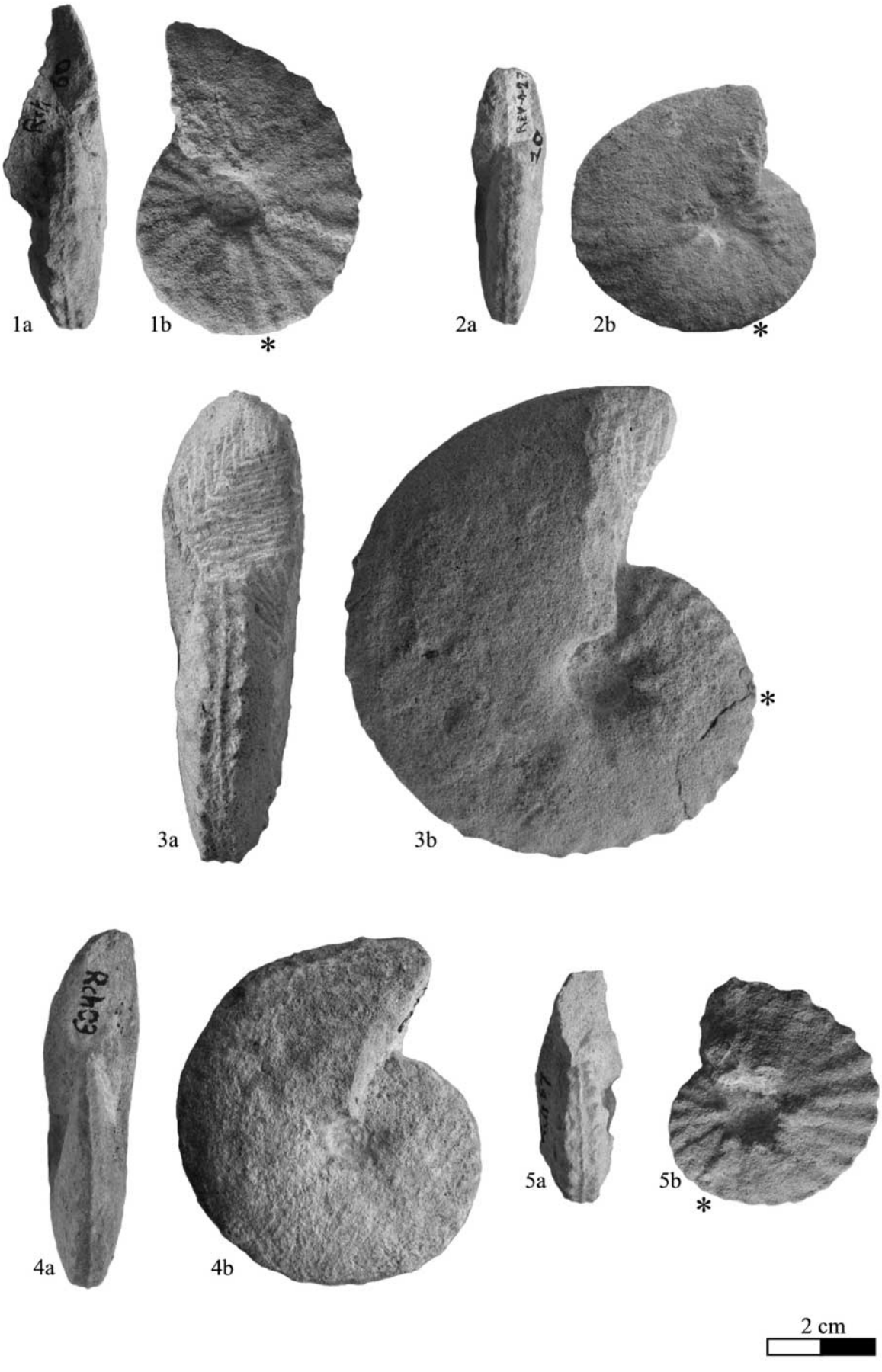
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Plate 9:

Fig. 1a-c: *Hyphantoceras* (*Hyphantoceras*) *flexuosum* (SCHLÜTER, 1872). Specimen no. Rch14, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

Fig. 2a-b: *Hyphantoceras* (*Hyphantoceras*) *ernsti* WIESE, 2000. Specimen no. Rch19, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

Fig. 3a-b: *Hyphantoceras* (*Hyphantoceras*) *ernsti* WIESE, 2000. Specimen no. Rch51, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

Fig. 4a-b: *Hyphantoceras* (*Hyphantoceras*) *ernsti* WIESE, 2000. Specimen no. Rch17, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

Fig. 5a-b: *Hyphantoceras* (*Hyphantoceras*) *ernsti* WIESE, 2000. Specimen no. Rch18, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

Fig. 6: *Hyphantoceras* (*Hyphantoceras*) *ernsti* WIESE, 2000. Specimen no. Rch16, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

Fig. 7: *Sciponoceras bohemicum bohemicum* (FRITSCH, 1872). Specimen no. Rch44, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

Fig. 8: *Sciponoceras bohemicum bohemicum* (FRITSCH, 1872). Specimen no. Rch45, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

Fig. 9: *Scaphites geinitzii* ORBIGNY, 1850 [M]. Specimen no. Rch63, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

Fig. 10a-b: *Scaphites geinitzii* ORBIGNY, 1850 [M]. Specimen no. Rch59, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

Fig. 11: *Scaphites geinitzii* ORBIGNY, 1850 [M]. Specimen no. Rch53, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

Fig. 12a-c: *Scaphites geinitzii* ORBIGNY, 1850 [M]. Specimen no. Rch25, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

Fig. 13a-b: *Scaphites geinitzii* ORBIGNY, 1850 [M]. Specimen no. Rch27, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

Fig. 14: *Scaphites geinitzii* ORBIGNY, 1850 [M]. Specimen no. Rch26, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

Fig. 15: *Scaphites geinitzii* ORBIGNY, 1850 [M]. Specimen no. Rch50, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

Fig. 16: *Scaphites geinitzii* ORBIGNY, 1850 [M]. Specimen no. Rch32, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

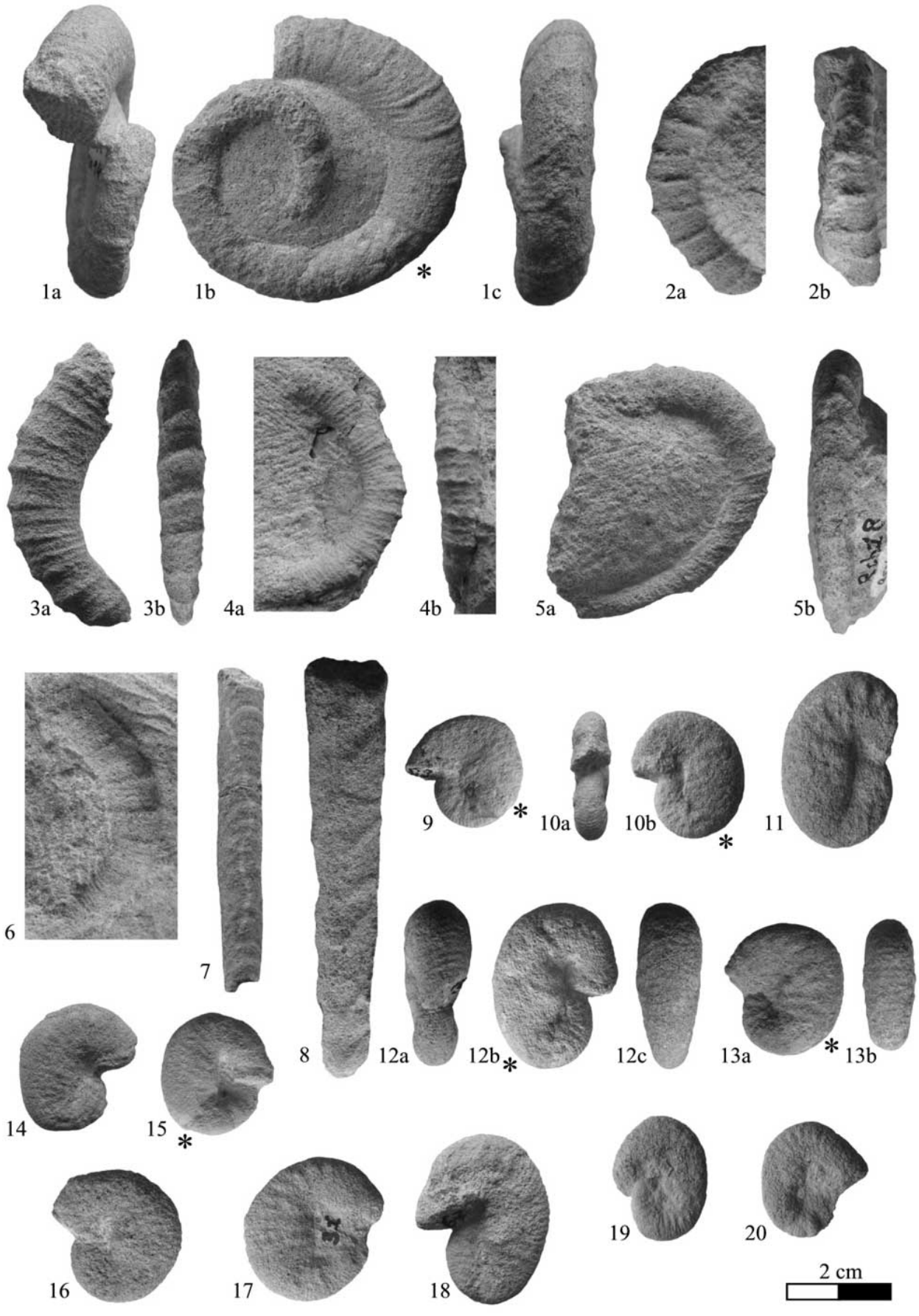
Fig. 17: *Scaphites geinitzii* ORBIGNY, 1850 [M]. Specimen no. Rch31, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

Fig. 18: *Scaphites geinitzii* ORBIGNY, 1850 [M]. Specimen no. Rch67, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

Fig. 19: *Scaphites geinitzii* ORBIGNY, 1850 [m] ?. Specimen no. Rch57, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

Fig. 20: *Scaphites geinitzii* ORBIGNY, 1850 [m] ?. Specimen no. Rch35, late Turonian, *Prionocyclus germari* Zone, Rochefort-en-Valdaine (Drôme, France).

Asterisks indicate the beginning of the body chamber.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