

## ASPIDOCERATIDAE (*Physodoceras*, *Benetticeras*, *Orthaspidoceras*) SPECIES FROM THE UPPER JURASSIC DEPOSITS OF THE HĂGHIMAȘ MTS. (EAST CARPATHIANS – ROMANIA)

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**Abstract.** The paper presents ten species/subspecies of ammonites from the Aspidoceratidae Zittel family, 1895, taxons from genera: *Physodoceras* Hyatt, 1900, *Benetticeras* Checa, 1985 and *Orthaspidoceras* Spath, 1925. This fossil fauna comes from the Ghilcoș Kimmeridgian-Tithonian deposits ("Acanthicum Beds" from the Hăghimaș Mountains, Romania). The species previously described by other authors (Neumayr, Herbich and Preda) were revised here, i.e., the species *P. deaki* (Herbich, 1878) were confirmed as *Physodoceras wolffi* (Herbich, 1878) after revision of the specimen; all specimens described by previous authors from this family were revised. For the first time, the presence of a representative from the *Benetticeras* genus, *B. vaii* Sarti, 1993, has now been highlighted, as has the *Orthaspidoceras lallierianum* (d'Orbigny, 1848) which completes the ammonite list from this family in the area.

**Keywords:** *Physodoceras*, *Benetticeras*, *Orthaspidoceras*, paleontology, Hăghimaș.

**Rezumat. Specii de Aspidoceratidae (*Physodoceras*, *Benetticeras*, *Orthaspidoceras*) din depozitele Jurasicului superior din Munții Hăghimaș (Carpații Orientali - România).** În lucrare sunt prezentate zece specii/subspecii de amoniți din Familia Aspidoceratidae Zittel, 1895, taxoni din genurile: *Physodoceras* Hyatt, 1900, *Benetticeras* Checa, 1985 și *Orthaspidoceras* Spath, 1925. Această faună fosilă provine din zăcămintele kimmeridgian-titoniene de la Ghilcoș („Stratele cu Acanthicum” din Munții Hăghimaș, România). Speciile descrise anterior de alți autori (Neumayr, Herbich și Preda) au fost revizuite aici, adică specia *P. deaki* (Herbich, 1878) a fost confirmată ca *Physodoceras wolffi* (Herbich, 1878) după revizuirea specimenului; toate exemplarele descrise de autorii anteriori din această familie au fost revizuite. Pentru prima dată au fost evidențiate prezența unui reprezentant din genul *Benetticeras*, *B. vaii* Sarti, 1993, de asemenea, *Orthaspidoceras lallierianum* (d'Orbigny, 1848), care completează lista amoniților din această familie din zonă.

**Cuvinte cheie:** *Physodoceras*, *Benetticeras*, *Orthaspidoceras*, paleontologie, Hăghimaș.

### INTRODUCTION

The species described in this work belong to the genera *Physodoceras* Hyatt, *Benetticeras* Checa and *Orthaspidoceras* Spath and are part of the association of ammonites collected by the author from the Lacu Roșu (Ghilcoș) region. The fauna comes from the Upper Jurassic (Kimmeridgian - Lower Tithonian) deposits of the "ammonitico rosso" ("acanthicum beds") type, opened on the western slope of the Ghilcoș mountain (Hăghimaș massif); the outcrops, lithology and biostratigraphy were described in detail previously (GRIGORE, 2000, 2002, 2009, 2011). From a geotectonic point of view, the deposits would belong to the Transylvanids and Hăghimaș Nappe (SÂNDULESCU, 1975; 1984) (Fig. 1).

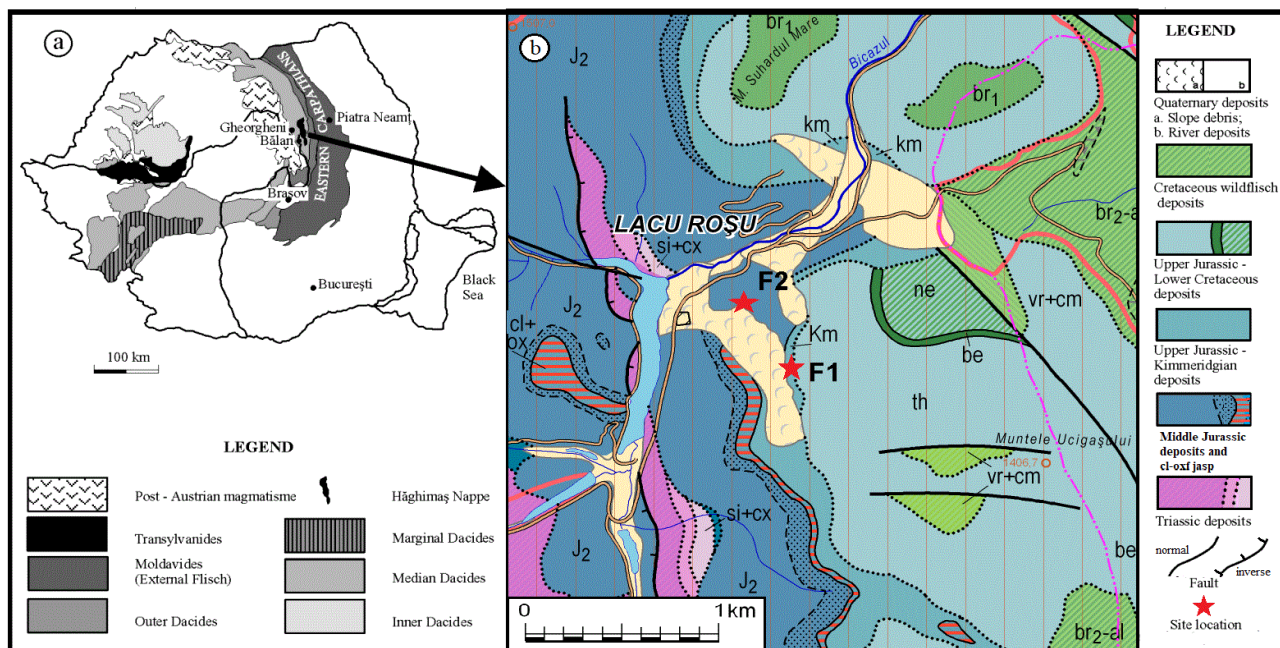


Figure 1. Localization of sites: a) in Romania - geotectonic sketch (after SÂNDULESCU, 1984); b) on the geological map scale 1: 50,000 (after SÂNDULESCU al. 1975, revised GHEUCA & GRIGORE, 2010).

If the representatives of the genus *Aspidoceras* presented previously (GRIGORE, 2023) are frequent in the association here, the species of the genera in question are less frequent with the exception of *Orthaspidoceras uhlandi* OPPEL, which also forms an acme zone, in the sequence here. Their biostratigraphic distribution (Fig. 2) is similar to that of the Tethys area, *Physodoceras* species dominating the lower Kimmeridgian while *Orthaspidoceras* species appear in the upper part of it, characterizing the upper Kimmeridgian.

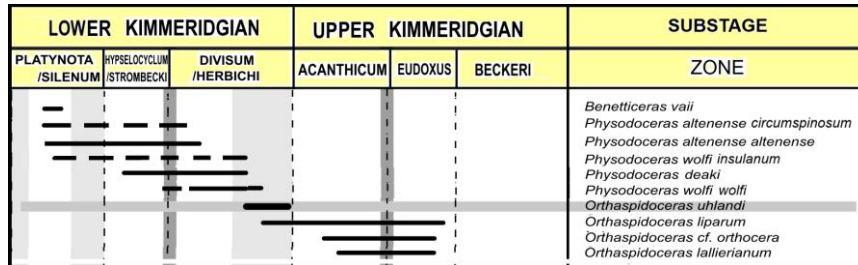


Figure 2. Biostratigraphic distribution of studied taxa from these outcrops.

outcrops were analysed and revised. Thus, the specimens from the Preda Collection housed in two locations were analysed – the Geology Laboratory of the University of Bucharest and the Museum of Natural Sciences in Piatra Neamț and the Herbich Collection housed in the Paleontology Museum of the "Babeș Bolyai" University in Cluj-Napoca.

The method of comparison with similar specimens known in the scientific literature (mentioned in synonymy) were used in the determination of species; comparing morphology and morphometric parameters (U/D, H/D, W/D, H/W). Also, whenever possible, the type specimens (holotypes, lectotype, etc.) were the basis for comparative analysis. In the analysis of the species, we also took into account the amendments brought by OLORIZ (1978), CHECA (1985) and SARTI (1993).

## SYSTEMATICS

Abbreviations for the measurements, collections and outcrops:

Dmax = maximal diameter  
 Dph = phragmocone diameter  
 D = measured diameter  
 U = diameter of umbilicus  
 H = whorl height  
 W = whorl width

UBB = "Babeș Bolyai" University from Cluj Napoca  
 LGB = Geology Laboratory of Bucharest University  
 MPN = Museum of Natural Sciences - Piatra Neamț  
 GIR = Geological Institute of Romania  
 GBA = Geological Institute of Austria (Bundesanstalt)

F1 = Outcrop from western Ghilcoș walls  
 F2 = Outcrop from north-western Ghilcoș slope  
 F17 = Outcrop from "Ciofronca"; all in GRIGORE et al., 2009  
 A, D... K = studied sections (GRIGORE, 2002, 2011)

Family Aspidoceratidae Zittel, 1895

Subfamily Physodoceratinae Schindewolf, 1925

Genus *Physodoceras* Hyatt, 1900

*Physodoceras wolfi* (Neumayr, 1873)

Following the successive revisions (OLORIZ, 1978; CHECA, 1985; SARTI, 1993), several taxa were regrouped within this species, brought to the value of morphotype. Thus, the species includes the following intraspecific varieties (SARTI, 1993), separated by the shape and width of the whorl (trapezoidal, equidimensional, oval), the flatness of the flanks, the roundness of the umbilical margin and the presence/absence of tubercles:

- *wolfi* (NEUMAYR), 1873 – the smooth shell morphotype;
- *insulanum* (GEMMELLARO), 1874 – the morphotype with a periumbilical row of small and numerous tubercles;
- *montisprimi* (CANAVARI), 1903 – the morphotype with a row of large, rare, circular in base and radially arranged periumbilical tubercles.

Since there are no other forms of this species, or a "priority" of any of them, I considered that the three can get the rank of subspecies.

*Physodoceras wolfi wolfi* (Neumayr, 1873)

Pl. 1, Fig. 1.

\*1873 *Aspidoceras wolfi* – NEUMAYR; p. 195; Pl. 38, Figs. 5a, b.

?1888 *Ammonites inflatus macrocephalus* – QUENSTEDT; p. 1022; Pl. 116, Fig. 20.

1973 *Aspidoceras wolfi* NEUMAYR – PREDA; Pl. 18, Fig. 6.

- 1978 *Physodoceras contemporaneum* (FAVRE) – OLORIZ; p. 257; Pl. 22, Figs. 5a, b.  
 1978 *Physodoceras acanthicum wolfi* (NEUMAYR) – OLORIZ; p. 305; Pl. 22, Fig. 3.  
 1985 *Physodoceras wolfi* (NEUMAYR) – CHECA; p. 134; Pl. 24, Fig. 6; Pl. 25, Fig. 4 (Holotype).  
 1993 *Physodoceras wolfi* (NEUMAYR) – SARTI; p. 119.  
 2007 *Physodoceras cf. wolfi* (NEUMAYR) – CECCA & SAVARY; p. 537; Fig. 12A.  
 2011 *Physodoceras wolfi* (NEUMAYR) – FOZY et al.; Figs. 2 / 1, 2.  
 2015 *Physodoceras wolfi* (NEUMAYR) – FOZY; Pl. 6. Figs. 1a, b.  
 2021 *Physodoceras wolfi* (NEUMAYR) – BUJTOR et al.; p. 294; Figs. 10.B1-B2.

Material: LRA13dp Grigore Collection in GIR. NEUMAYR'S Holotype (1873): in the Collection of GBA – originating from red nodular limestones of Ciofronca (F17); the Paratype – originating from the red nodular limestones of the Ghilcoș outcrop (F1). PREDA'S specimen (1973): in Collection of MPN – inv. **43MPN** originating from the red nodular limestones of the Ghilcoș outcrop (F1) (Table 1).

Table 1. Measurements of *Physodoceras wolfi wolfi* (Neumayr, 1873) specimens.

Specimen	Dmax	Dph	D	U	H	W	U/D	H/D	W/D	W/H
Lectotype	90	90	90	24	40	35	0.27	0.44	0.39	0.87
Preda <b>43 MPN</b>	77	58	58	12	25	28	0.21	0.43	0.48	1.12
LRA13dp	95	74	87	22	40	37	0.25	0.46	0.42	0.92

Diagnosis: medium-sized aspidoceratid, convolute and a deep umbilicus. The umbilical wall is straight, and the umbilical edge, rounded. The whorl section is subtrapezoidal, with the flanks and the ventral side slightly curved, the maximum wide being in the lower third of the flanks. It is devoid of ornamentation (smooth shell). The lobar line is characterized by a strong denticulation, with the first tricuspid lateral lobe, strongly asymmetric and longer than the ventral one; the sellae are deeply divided by secondary lobules.

Observations: a single well-preserved specimen (LRA13), of similar size to the type specimen, which preserves 1/3 of the whorl from the living chamber; the whorl section as well as the morphometric parameters are comparable to those of the specimen described by Neumayr (the specimens being almost identical).

Preda's specimen preserves 1/3 of the whorl from the living chamber and is slightly deformed, which is why it has a narrower umbilicus and a more depressed section compared to the type specimen; its lobar line is comparable to that presented by Neumayr (at close diameters).

Occurrence: Lower Kimmeridgian – Divisum Zone in the Ghilcoș and Ciofronca outcrops (F1 and F17); Lower Kimmeridgian – Silenum (Platynota) /Divisum zones in Italy, Spain and Germany.

*Physodoceras wolfi insulanum* (Gemmellaro, 1874)

- 1874 *Aspidoceras insulanum* – GEMMELLARO; p. 123; Pl. 14, Fig. 4.  
 1877 *Ammonites (Aspidoceras) contemporaneus* – FAVRE; p. 65; Pl. 8, Fig. 3.  
 1878 *Aspidoceras bathori* HERBICH – HERBICH; p.170; Pl. 19, Figs. 4a, b.  
 1888 *Ammonites inflatus macrocephalus* – QUENSTEDT; p. 1022; Pl. 116, Fig. 20.  
 1888 *Ammonites inflatus* – QUENSTEDT; p. 1035; Pl. 118, Fig. 10.  
 1973 *Aspidoceras bathori* HERBICH – PREDA; Pl. 17, Fig. 10.  
 1978 *Physodoceras insulanum* (GEMMELLARO) – OLORIZ; p. 255; Pl. 22, Fig. 1.  
 1985 *Physodoceras wolfi* (NEUMAYR) – CHECA; p. 134; Pl. 24, Fig. 5; Pl. 25, Figs. 1-3.  
 1993 *Physodoceras wolfi* (NEUMAYR) – SARTI; p. 119.

Material: HERBICH'S specimen („*A. bathori*” 1878): in the Collection of UBB – inv. **2082 UC** originates from the gray sandy limestones of the Ghilcoș outcrop (F2). PREDA'S specimen (1973): in the Collection of MPN – inv. **46 MPN** originates from the red nodular limestones of the Ghilcoș outcrop (F1) (Table 2).

Table 2. Measurements of *Physodoceras wolfi insulanum* (Gemmellaro, 1874) specimens.

Specimen	Dmax	Dph	D	U	H	W	U/D	H/D	W/D	W/H
Lectotype	82	-	82	25	38	38	0.30	0.46	0.46	1
Herbich ( <i>A. bathori</i> )	52	-	52	15	21	21	0.29	0.41	0.41	1
Preda <b>46 MPN</b>	39	-	32	8	14	14	0.25	0.44	0.44	1

Diagnosis: medium-sized aspidoceratid, with convoluted shell and very deep umbilicus. The umbilical wall is vertical, high, and the umbilical edge, almost angular. The whorl section is sub-trapezoidal /sub-square, with a very wide curved venter, the maximum thickness being in the lower third of the flanks. The ornamentation is made up of a periumbilical row of small and dense tubercles. The lobar line is generally strongly denticulated, with the first lateral lobe tricuspid, asymmetrical and longer than the ventral one (an inaccurate character presented by Checa, in his specimens); the saddles are bifid and asymmetrical, divided by short lobules.

Remarks: we analysed the specimens found by the previous authors, as the species was not found on this occasion. Thus, HERBICH'S specimen is of medium size and preserves the characteristic ornamentation well; it has an isometric whorl section and a slightly narrower umbilicus than the specimen described by Gemmellaro. Preda's specimen is small and has a narrower umbilicus at this diameter than the type specimen.

Occurrence: Lower Kimmeridgian Ghilcoş outcrops (F1 and F2); Lower Kimmeridgian – Silenum (Platynota) /Divisum zones in Italy, Spain, Switzerland and Germany.

*Physodoceras deaki* (Herbich, 1878)

Pl. 1, Fig. 2.

\*1878 *Aspidoceras deaki* HERBICH – HERBICH; p. 175; Pl. 14, Fig. 2.

1973 *Aspidoceras liparum* OPPEL – PREDA; Pl. 18, Fig. 1.

Material: specimen LRa7K9 from the Ghilcoş walls (F1) Grigore Collection in GIR. HERBICH'S Holotype (1878): in the Collection of UBB – inv. **2081 UC** originates from “the green limestones, underbeds with *Pygope janitor*” of the Ghilcoş outcrop. PREDA'S specimen (1973): in the Collection of MPN – inv. **24v MPN** originates from the spotted nodular limestones (green/red) of the Ghilcoş outcrop (W<sub>1-3</sub> or F<sub>1-6</sub> levels) (Table 3).

Table 3. Measurements of *Physodoceras deaki* (Herbich, 1878) specimens.

Specimen	Dmax	Dph	D	U	H	W	U/D	H/D	W/D	W/H
Holotype	100	75	100	34	36	40	0.34	0.36	0.40	1.11
Preda <b>24v MPN</b>	110	87	95	28.5	39	36	0.30	0.41	0.38	0.92
LRa7K9	90	80	80	26	35	34	0.32	0.43	0.42	0.97

From Herbich's description (*Aspidoceras deaki*), the following characteristics result: the specimen (figured holotype) with a diameter of 100 mm preserves 1/3 of whorl from the living chamber and has a width of the umbilicus of 0.34 from the diameter, a section height of 0.36 and a width of 0.40 at the same diameter. The whorl section is subtrapezoidal, with an arched ventral area, slightly convex flanks and an angular umbilical edge; the umbilical wall is high and vertical. On the umbilical margin of the last winding there are 15-16 tubercles (or remnants of spines), perpendicular. This differs from the species *Aspidoceras altenense* by a wider umbilicus and a greater number of tubercles. The lobar line is generally strongly denticulated, with the first tricuspid lateral lobe, asymmetrical and longer than the ventral one; the saddles are bifid and asymmetrical, divided by short lobules.

Discussion: Herbich's specimen shows tubercles with an elliptical and slightly oblique base (as also appears in figure 2 of plate 14 of HERBICH's work, 1878) compared to the species described by Canavari, *Aspidoceras montisprimi* - a character that distinguishes it from it. Consequently, this form could be considered a separate species of the genus *Physodoceras*.

Remarks: my specimen (LRa7K9) is a medium-sized phragmocone that preserves the beginning of the living chamber. The whorl section is oval with flattened flanks and the maximum width in the lower third of those; the ventral area being broadly curved. Compared to Herbich's specimen, mine has a more compressed section at a smaller measured diameter. The specimen preserves only five large, periumbilical tubercles (base of spines) on the last third of the whorl.

Preda's specimen, *Aspidoceras liparum*, shows the morphological characters (whorl section, umbilicus, row of tubercles) of the species *P. deaki*; its tuberculation is finer and denser than in the species *O. liparum*, it does not show extensions in folds on the flanks, and the section is more compressed than in this one. Compared to Herbich's specimen, it has a slightly narrower umbilicus and a more compressed section. In addition, the level from which it was collected corresponds to the Lower Kimmeridgian (~ Strombecki Zone).

Occurrence: Lower Kimmeridgian – Divisum Zone in Ghilcoş outcrops; Lower Kimmeridgian – Silenum (Platynota) /Divisum Zones in Italy, Spain and Germany.

*Physodoceras altenense* (D'Orbigny, 1847)

The species was revised by CHECA (1985) who also reunites the taxa *P. circumspinosum* (OPPEL) and *P. diastrophum* (FONTANNES). Later, SARTI (1993) separates two main morphotypes within this species:

- *altenense* (d'Orbigny) - conch with a narrow ventral side and slightly convex flanks;
- *circumspinosum* (Oppel) - conch with a wide ventral side and much more convex flanks.

*Physodoceras altenense altenense* (D'Orbigny, 1847)

Pl. 1, Figs. 4-5.

1847 *Ammonites altenensis* - D'ORBIGNY; p. 537; Pl. 204, Figs. 1-3.

1873 *Aspidoceras altenense* D'ORBIGNY – NEUMAYR; p. 199; Pl. 42, Figs. 2a-c.

1878 *Aspidoceras altenense* D'ORBIGNY – HERBICH; p. 177.

1877 *Ammonites (Aspidoceras) altenensis* D'ORBIGNY – FAVRE; p. 66; Pl. 7, Figs. 5a-b.

- 1929 *Physodoceras altenense* (D'ORBIGNY) – WEGELE; p. 87; Pl. 11, Figs. 1a-b.  
 1978 *Physodoceras altenense* (D'ORBIGNY) – OLORIZ; p. 253; Pl. 21, Figs. 6a-b.  
 1985 *Physodoceras altenense* (D'ORBIGNY) – CHECA; p. 138; Pl. 26, Fig. 4.  
 1993 *Physodoceras altenense* (D'ORBIGNY) morfotip *altenense* – SARTI; p. 120; Pl. 25, Fig. 1.  
 2015 *Physodoceras altenense* (D'ORBIGNY, 1847) – FOZY; Pl. 14, Figs. 2a-b.

Material: LRA30E3; (*Physodoceras cf. altenense*) LRA100Ap Grigore Collection in GIR. NEUMAYR'S specimens (1873): the Collection of GBA – collected by Herbich from the red nodular limestones of the Ciofronca outcrop. Preda's specimen (1973): in the Collection of MPN – inv. **18 MPN** originates from the green nodular limestones of the Ghilcoș outcrop (Table 4).

Table 4. Measurements of *Physodoceras altenense altenense* (D'Orbigny, 1847) specimens.

Specimen	Dmax	Dph	D	U	H	W	U/D	H/D	W/D	W/H
Lectotype	90	-	90	18	41	40	0.20	0.45	0.44	0.97
Neumayr's	77	-	77	16	38	35	0.21	0.49	0.45	0.92
Preda <b>18 MPN</b>	65	65	65	8	34	29	0.12	0.52	0.45	0.85
LRA30E3	38	-	38	6	21	19	0.16	0.55	0.50	0.90

Diagnosis: small to medium sized aspidoceratid, involute, with a narrow and deep umbilicus. The umbilical wall is vertical, incised, and the umbilical margin is rounded. The whorl section is oval with a narrow venter and slightly convex flanks. The ornamentation consists of a periumbilical row of tubercles, which grow in size and distance themselves, towards external whorls. The lobar line is strongly denticulated, with the first lateral lobe equal to the ventral one in depth, but narrower than it; the

Observations: both my specimens are small (juvenile) and preserve the beginning of the living room. At this size, they have a narrower umbilicus than d'Orbigny's specimen and more convex flanks; at the same time, the tubercles are large and oriented towards the inside of the umbilicus.

The specimen figured by Neumayr is of medium size, well preserved and has morphological and morphometric parameters very close to those of the type specimen. Preda's specimen (18 MPN) represents a deformed phragmocone of medium size, on which tuberculation is not observed; apparently, it has a more compressed section and a narrower umbilicus than the type specimen.

Occurrence: Lower Kimmeridgian – Platynota /Divisum zones in the Ghilcoș (F2) and Ciofronca (F17) outcrops; Lower Kimmeridgian – Platynota (Silenium) /Divisum zones in Europe (Italy, Spain, Germany, Switzerland, Bulgaria).

*Physodoceras altenense circumspinosum* (Oppel, 1863)

- 1863 *Ammonites circumspinosum* – OPPEL; p. 222.  
 1873 *Aspidoceras circumspinosum* QUENSTEDT – NEUMAYR; p. 200.  
 1878 *Ammonites (Perisphinctes) circumspinosus* OPPEL – LORIOLO; p. 119; Pl. 20, Figs. 2a-b; 3a-b.  
 1877 *Ammonites (Aspidoceras) circumspinosum* QUENSTEDT – FAVRE; p. 67; Pl. 8, Figs. 2a-b.  
 1878 *Aspidoceras circumspinosum* QUENSTEDT – HERBICH; p.177; Pl. 20, Figs. 1a; b.  
 1878 *Aspidoceras cyclotum* OPPEL – HERBICH; p. 178; Pl. 20, Fig. 2.  
 1888 *Ammonites inflatus macrocephalus* – QUENSTEDT; p. 1017-1021; Pl.116, Figs. 3-16.  
 1929 *Physodoceras circumspinosum* (OPPEL) – WEGELE; p. 88; Pl. 11, Figs. 2a-b.  
 1966 *Physodoceras circumspinosum* (QUENSTEDT, 1856) – ANDELKOVIC; p. 87; Pl. 20, Fig. 4; Pl. 22, Fig. 4.  
 1973 *Aspidoceras circumspinosum* QUENSTEDT – PEDA; Pl. 17, Fig. 5.  
 1978 *Physodoceras circumspinosum* (OPPEL) – OLORIZ; p. 250; Pl. 21, Figs. 2a-b.  
 1985 *Physodoceras altenense* (D'ORBIGNY) – CHECA; p. 138; Pl. 26, Figs. 1-3.  
 1993 *Physodoceras altenense* (D'ORBIGNY) morfotip *circumspinosum* (OPPEL) – SARTI; p. 120; Pl. 25, Fig. 2.  
 2015 *Physodoceras circumspinosum* (OPPEL) – FOZY; Pl. 14, Figs. 1a-b.

Material: NEUMAYR'S specimen (1873): Collection of GBA – originates from the red nodular limestones of the Ciofronca outcrop. Herbich's specimens (1878): in Collection of UBB – originates from the red sandy limestones of the Ghilcoș outcrop; the "A. *cyclotum*" specimen originates from the red nodular limestones of the Ciofronca and Ghilcoș outcrops (Table 5).

Table 5. Measurements of *Physodoceras altenense circumspinosum* (Oppel, 1863) specimens.

Specimen	Dmax	Dph	D	U	H	W	U/D	H/D	W/D	W/H
Lectotype	38	-	38	12	16	18	0.31	0.42	0.47	1.33
Neumayr's	73	-	73	19	32	47	0.26	0.44	0.64	1.47
Herbich's	40	-	40	6	22	23	0.15	0.56	0.58	1.04
Herbich A. <i>cyclotum</i>	23	-	23	2	16	18	0.09	0.69	0.78	1.12

PEDA's figured specimen (Pl. 17, Fig. 5; 1973): in the Collection of MPN – originates from the gray limestones of the Ghilcoș outcrop.



Diagnosis: small aspidoceratid with involute shell, narrow and deep umbilicus. The navel has a tall, incised wall and a rounded margin. The section is oval, with a wide rounded venter and convex flanks. The ornamentation consists of a periumbilical row of tubercles, spiniform and with ontogenetically variable size. The lobar line is strongly denticulated; the first lateral lobe being of equal depth to the ventral one, but narrower than it; the sellae are divided by secondary, deep lobules.

Observations: on the occasion of this study, we did not find the specimens of the previous authors analysed here. The specimen described by Neumayr, of larger size, has a narrower umbilicus and a wider cross-section than Oppel's specimen. Herbich's specimen is of the same size as the type specimen but has a narrower umbilicus and a more compressed section than it; the ornamentation is similar, however. The specimens of *A. cyclotum* are very small (juveniles) and show morphometric parameters close to those of the species *Schaireria neoburgense* (OPPEL), but the shape of the section is comparable to that of the subspecies *P. altenense circumspinosum*, at a similar diameter; in addition, the levels from which the specimens were collected (red nodular limestones) can reach the base of the Upper Kimmeridgian (Acanthicum Zone), and the species *S. neoburgense* is known from the Lower Tithonian.

Occurrence: Lower Kimmeridgian – Platynota /Divisum zones in the Ghilcoş (F1 and F2) and Ciofronca (F17) outcrops; (Upper Oxfordian?) Lower Kimmeridgian – Platynota (Silenum) /Divisum zones in Europe (Italy, Spain, Germany, France, Switzerland, Bulgaria).

Genus *Benetticeras* Checa, 1985

*Benetticeras vaii* Sarti, 1993

Pl. 1, Fig. 3.

1987 *Benetticeras benetti* CHECA - PAVIA & AL.; p. 77; Pl. 3, Figs. 2a-b.

1993 *Benetticeras vaii* nov.sp. – SARTI; p.120; Pl. 24, Fig. 5; Pl.25, Figs. 3-4.

Material: LRA33E3 Grigore Collection in GIR (Table 6).

Table 6. Measurements of *Benetticeras vaii* Sarti, 1993 specimens.

Specimen	Dmax	Dph	D	U	H	W	U/D	H/D	W/D	W/H
Lectotype	106	84	106	29	41	60	0.27	0.38	0.56	1.46
LRA33E3	84	-	84	25	38	44	0.30	0.45	0.52	1.16

Diagnosis: medium-sized aspidoceratid with convoluted conch and deep umbilicus, delimited by a vertical wall. The whorl section is more or less reniform, depressed, a character that is stronger towards the external whorls. The ornamentation consists of periumbilical tubercles, radially disposed, strong and distant; the tubercles have a round base on the phragmocone and an elliptical one on the living room, where they can also become oblique. The lobar line is generally strongly denticulated, with deep and symmetrical lateral lobes.

Observations: my specimen is in a bad state of preservation, fragmentary and eroded; it represents only a 2/3 sector of a medium-sized shell that partially preserves the living chamber. For the analysis, the coils were defragmented, to observe the section and tuberculation evolution. The convoluted coiling, reniform (depressed) section that is accentuated in the external whorls - highlighted characters with a similar evolution to the type specimen (SARTI); the ornament is represented by strong, periumbilical, rare tubercles, and on the last whorl, two tubercles with an elliptical base can be observed.

Occurrence: Lower Kimmeridgian – Platynota Zone in the Ghilcoş outcrop (E levels). It is the first mention of this genus and species in the region. Lower Kimmeridgian – Silenum Zone in Italy.

Subfamily Aspidoceratinae Zittel, 1895

Genera *Orthaspidoceras* Spath, 1925

*Orthaspidoceras uhlandi* (Oppel, 1863) in QUENSTEDT, 1888

Pl. 2, Figs. 5-7.

1863 *Ammonites uhlandi* nov.sp. - OPPEL; p.224.

1878 *Aspidoceras uhlandi* OPPEL – HERBICH; p. 179; Pl. 19, Fig. 3.

1878 *Ammonites (Aspidoceras) uhlandi* OPPEL - LORIOL; p.121; Pl. 19, Fig. 2.

\*1888 *Ammonites inflatus quadrifinalis* - QUENSTEDT; p. 1009; Pl. 114, Fig. 1 (Lectotype).

1888 *Ammonites inflatus septemfinalis* - QUENSTEDT; p. 1012; Pl.114, Fig. 2.

1888 *Ammonites inflatus sexfinalis* - QUENSTEDT; p. 1012; Pl. 115, Fig. 1.

1900 *Aspidoceras uhlandi* OPPEL var. *exuberata* nov.var. - CANAVARI; p. 7; Pl. 6, Fig. 1.

1929 *Physodoceras uhlandi* (OPPEL) - WEGELE; p. 92; Pl. 11, Fig. 6.

1966 *Physodoceras uhlandi* (OPPEL, 1863) – ANDELKOVIC; p. 84; Pl. 22, Fig. 6; Pl. 30, Fig. 1.

1978 *Aspidoceras uhlandi* (OPPEL) - OLORIZ; p. 284; Pl. 23, Fig. 2.

1979 *Orthaspidoceras uhlandi* (OPPEL) - SAPUNOV; p. 144; Pl. 43, Fig. 2.

1985 *Orthaspidoceras uhlandi* (OPPEL) - CHECA; p. 154; Pl. 31, Fig. 1.

1993 *Orthaspidoceras uhlandi* (OPPEL) - SARTI; p. 127.

2015 *Toulisphinctes* cf. *uhlandi* (OPPEL, 1863) – FOZY; Pl. 13, Fig. 5.

2015 *Toulisphinctes uhlandi* (OPPEL, 1863) – FOZY; Pl. 14, Fig. 3; Pl. 16, Fig. 1.

Material: LRa8T3,0, LRa14A11, LRa34A10, LRa35dp, LRa36dp Grigore Collection in GIR. Herbach's specimens (1878): the Collection of the UBB – "A" specimen originates from the red nodular limestones of Ciofronca outcrop and the second, "B" (figured), from the red nodular limestones of the Ghilcoș outcrop (Table 7).

Table 7. Measurements of *Orthaspidoceras uhlandi* (Oppel, 1863) în QUENSTEDT, 1888 specimens.

Specimen	Dmax	Dph	D	U	H	W	U/D	H/D	W/D	W/H
Lectotype	235	-	235	80	85	90	0.34	0.36	0.38	1.06
Herbach's A	265	?	265	93	90	90	0.35	0.34	0.34	1
Herbach's B	57	?	57	15	27	28	0.26	0.47	0.49	1.04
LRa8T3,0	-	-	-	-	26	31	-	-	-	1.19
LRa14A11	110	90	110	29	46	48	0.26	0.42	0.44	1.04
LRa34A10	100	100	80	22	36	45	0.27	0.45	0.56	1.25
LRa35dp	109	-	109	37	47	60	0.34	0.43	0.55	1.28
LRa36dp	95	-	95	33	40	49	0.35	0.42	0.51	1.22

Diagnosis: medium to large aspidoceratid with globular, convoluted shell and deep umbilicus. The umbilical wall is flared, convex and very high, merging with the flanks practically; there is no umbilical border. The whorl section is ellipsoidal, slightly depressed, with narrow flanks, more arched than the venter, which is very wide. The ornamentation consists of a single row of tubercles, located near the middle of the flanks and more prominent ribs on the venter. The tubercles are spiniform, strong and have a round - wide base; they are perpendicular to the flanks. The ribs are thin in the umbilical region and correspond to each tubercle, from which they bifurcate (/trifurcate) and increase in strength outwards, crossing the venter. The lobar line is generally strongly denticulated, with ample elements; the siphonal lobe is bicuspid and deeper than the lateral ones.

Remarks: I have four medium-sized specimens that preserve short portions of the living chamber and a shell fragment (1/3 sector) from a small-sized specimen (LRa8T3.0). Of these, specimen LRa14A11 is deformed on the living chamber, but it best preserves the specific ornamentation (with three spines preserved). Compared to the species described by Oppel (and the specimen figured by Quenstedt), my specimens, which are smaller in size, show a narrower umbilicus and a more depressed section; but they all preserve the characteristic ornamentation.

Herbach's specimens are well preserved, each preserving portions of the living chamber and the characteristic ornamentation. Specimen "A", with a larger diameter than the type specimen (265), has similar morphometric parameters, while specimen "B" (pictured), of small size, has a narrower umbilicus.

Occurrence: Lower Kimmeridgian – Divisum Zone (Uhlandi Subzone) in the Ghilcoș (F1 and F2) and Ciofronca (F17) outcrops; Lower Kimmeridgian – Divisum Zone (Uhlandi Subzone) in Italy, Spain, Germany, France, Poland, Bulgaria.

*Orthaspidoceras liparum* (Oppel, 1863)

Pl. 2, Figs. 2-3.

1863 *Ammonites liparus* nov. sp. - OPPEL; p. 220; Pl. 59, Figs. 1a-b.

1863 *Ammonites schilleri* nov.sp. - OPPEL; p. 221; Pl. 61, Figs. 1a-b.

1873 *Aspidoceras liparum* OPPEL – NEUMAYR; p. 198.

1878 *Aspidoceras liparum* OPPEL – HERBICH; p. 174; Pl. 18.

1878 *Ammonites (Aspidoceras) liparus* OPPEL - LORLIOL; p. 114; Pl. 19, Fig. 1.

1888 *Ammonites inflatus quadrifinalis* - QUENSTEDT; p. 1006-1009; Pl. 113, Figs. 2-5.

1888 *Ammonites inflatus grandis* - QUENSTEDT; p. 1014; Pl. 115, Fig. 2.

non1973 *Aspidoceras liparum* OPPEL – PREDA; Pl. 18, Fig. 1 (= *Physodoceras wolfi deaki*).

1985 *Orthaspidoceras liparum* (OPPEL) - CHECA; p. 165; Pl. 33, Fig. 1; Pl. 34, Fig. 1.

Material: LRa17A10, LRa16A; *Orthaspidoceras* cf. *liparum*: LRa6K9 Grigore Collection in GIR. Herbach's specimen (1878): in the Collection of UBB – originates from the gray sandy limestones with *Pygope janitor* of the Ghilcoș outcrop (Table 7).

Table 8. Measurements of *Orthaspidoceras liparum* (Oppel, 1863) specimens.

Specimen	Dmax	Dph	D	U	H	W	U/D	H/D	W/D	W/H
Lectotype	140	-	140	40	60	70	0.29	0.43	0.50	1.17
Herbach's	123	70	123	41	53	54	0.33	0.43	0.44	1.02
LRa17A10	122	-	122	40	51	68	0.33	0.42	0.56	1.33
LRa16A	94	75	72	19	34	29	0.26	0.47	0.40	0.85
LRa6K9	33	-	33	10	15	-	0.30	0.45	-	-

Diagnosis: medium-sized aspidoceratid with globular, convoluted shell and deep umbilicus. The umbilical wall is vertical, incised, with a rounded margin. The whorl section is oval, with convex and converging flanks towards a strongly curved venter. The ornamentation is represented by a row of periumbilical spines, seminumerous. The spines have a broad, round base and are oblique to the flanks; folds radiate on the flanks that fade to half the height. The lobar line (less known) is generally poorly denticulated compared to the other representatives of the genus.

Observations: two medium-sized specimens, incomplete and deformed, where the characteristic ornamentation can be distinguished. Due to the deformation, their morphometric parameters differ from those of the type specimen, presenting either a wider umbilicus or, apparently, a more compressed section. Another specimen (LRa6K9) is small (juvenile) and with a small number of spines at this stage; was assigned to this species with reservations.

The specimen illustrated by Herbich is of medium size and well preserved, it almost completely preserves the living chamber and the specific ornamentation. Its morphometric parameters differ very little from those of the type specimen (wider umbilicus and more compressed section).

Occurrence: Kimmeridgian – Divisum/ Eudoxus zones in the Ghilcoş outcrop; Upper Kimmeridgian – Mutabilis /Eudoxus zones in Germany and Switzerland.

*Orthaspidoceras lallierianum* (D'Orbigny, 1848)

Pl. 2, Figs. 1-4.

1848 *Ammonites lallierianus* nov.sp. - D'ORBIGNY; p. 542; Pl. 208, Figs. 1- 4

1888 *Ammonites inflatus quadrifinalis* - QUENSTEDT; p. 1006; Pl. 113, Fig. 1.

1985 *Orthaspidoceras lallierianum* (D'ORBIGNY) - CHECA; p. 167; Pl. 32, Figs. 1-3.

2011 *Orthaspidoceras lallierianum* (D'ORBIGNY) – BAUDOIN & AL.; Pl. 12, Fig. 8.

Material: LRa22H11, LRa39D3, LRa41D2, LRa42D3 Grigore Collection in GIR (Table 9).

Table 9. Measurements of *Orthaspidoceras lallierianum* (D'Orbigny, 1848) specimens.

Specimen	Dmax	Dph	D	U	H	W	U/D	H/D	W/D	W/H
Lectotype	95	-	95	28	40	35	0.29	0.42	0.36	0.87
LRa22H11	79	59	78	24	34	29	0.31	0.43	0.37	0.85
LRa39D3	108	95	108	32	45	49	0.30	0.42	0.45	1.09
LRa41D2	28	-	28	7.5	14	13.5	0.27	0.50	0.48	0.96
LRa42D3	21	-	21	5	10	10.5	0.24	0.48	0.50	1.05

Diagnosis: medium-sized aspidoceratid with convoluted shell and narrow umbilicus. The umbilical wall is vertical with a rounded margin. The section is subtrapezoidal, compressed, with slightly convex flanks, which converge towards a narrow and rounded venter. The ornamentation is represented by a row of rare periumbilical spines. The spines are strong and slightly spatulate (they have an elliptical base and rounded ends); they are disposed radially and obliquely to the flanks. A fold (rib) corresponds to each thorn, that narrows crossing the ventral region. The lobar line is moderately denticulated, with slightly pronounced secondary elements and saddles of greater amplitude than the lobes.

Remarks: two specimens (LRa22H11, LRa39D3) are of medium size, deformed (broken), and preserve the living chamber partially. The other two specimens are small phragmocones (juveniles). They all preserve the specific ornamentation, but the morphometric parameters (the width of the umbilicus or the section) apparently differ from those of the type specimen (D'Orbigny) due to their deformation or size.

Occurrence: Upper Kimmeridgian – Acanthicum /Eudoxus zones in the Ghilcoş outcrop; Upper Kimmeridgian – Mutabilis Zone in Germany (Suabian), France (Aquitaine), England.

*Orthaspidoceras* cf. *orthocera* (D'Orbigny, 1847)

1847 *Ammonites orthocera* – D'ORBIGNY; p. 556; Pl. 218, Figs. 1-2.

1873 *Aspidoceras zeuschneri* ZITTEL – NEUMAYR; p. 199.

1878 *Aspidoceras zeuschneri* ZITTEL – HERBICH; p. 175; Pl. 19, Figs. 1-2.

1973 *Orthaspidoceras orthocera* (D'ORBIGNY) – CONTINI & HANTZPERGUE; p. 157; Pl. 2, Figs. 1, 2; Pl. 3, Figs. 1-2.

1985 *Orthaspidoceras orthocera* (D'ORBIGNY) – CHECA; p. 169; Pl. 35, Fig. 1.

Material: Herbich's specimens ("Aspidoceras zeuschneri", 1878); in the Collection of UBB – originates from green or red sandy limestones with *Pygope janitor* of the Ghilcoş outcrop (Table 10).

Table 10. Measurements of *Orthaspidoceras* cf. *orthocera* (D'Orbigny, 1847) specimens.

Specimen	Dmax	Dph	D	U	H	W	U/D	H/D	W/D	W/H
Checa's	122	-	122	42	48	59	0.34	0.39	0.48	1.23
Herbich's A	45	-	45	5	23	27	0.11	0.51	0.60	1.17
Herbich's B	23	-	23	6	10	13	0.26	0.43	0.56	1.30



Herbich's specimens are small and may represent juvenile individuals of this species or of *Aspidoceras rogoznicense* (Zeuschner), having the same morphological characteristics at this stage, as commented and NEUMAYR (1873).

Occurrence: Upper Kimmeridgian in the Ghilcoș outcrop; Lower Kimmeridgian – Upper Kimmeridgian – Mutabilis Zone in France (Aquitaine), England.

### CONCLUSIONS

Species *Benetticeras vaii* SARTI and *Orthaspidoceras lallierianum* (D'orbigny) were highlighted for the first time here (Ghilcoș), in the Kimmeridgian deposits. Some specimens presented by previous authors (NEUMAYR (1873), HERBICH (1878) and PREDA (1973)) are reviewed here. The species *Aspidoceras bathori* described by HERBICH in 1878 as being similar to *Aspidoceras insulanum* GEMMELLARO presented in 1874, enters its synonymy (based on priority). Based on the analysis of the specimen (Inv. No. 2081) from the Paleontology Museum Collection at Babeș Bolyai University, described by HERBICH as *Aspidoceras deaki*, and the specimens described in this work, the validity of this species could be reconsidered, as *Physodoceras deaki* (HERBICH, 1878).

The stratigraphical range of the *Physodoceras* species is restrictive to the Lower Kimmeridgian, as the occurrence of *Benetticeras* only is due to this (as in Italy), whereas the species of *Orthaspidoceras* characterize the middle part (Divisum to Eudoxus interval) from the Kimmeridgian in this region (Hăghimaș). It should also be mentioned that, in the deposits here, the Uhlandi subzone can be highlighted based on the high frequency of this taxon (acme zone).

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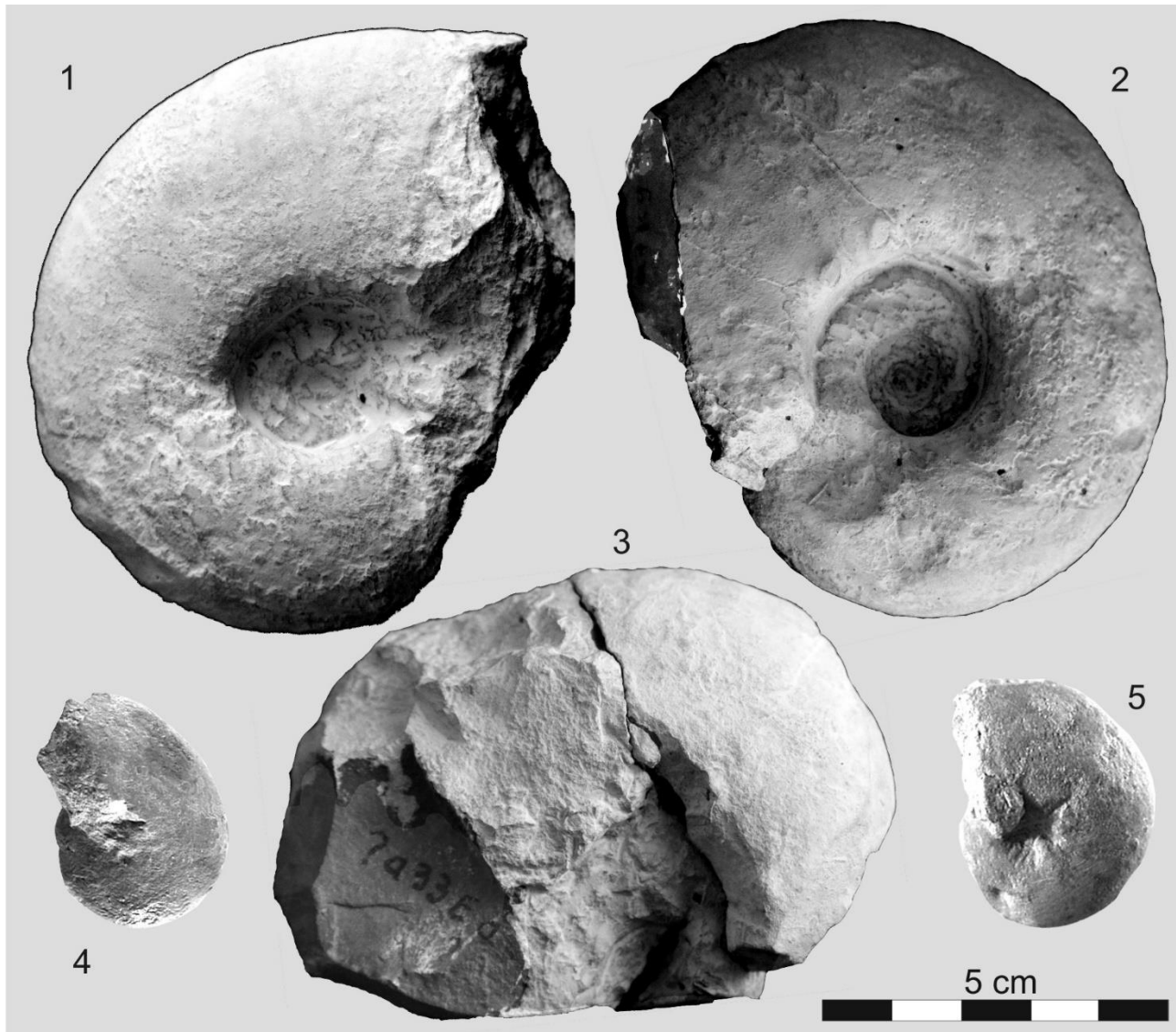
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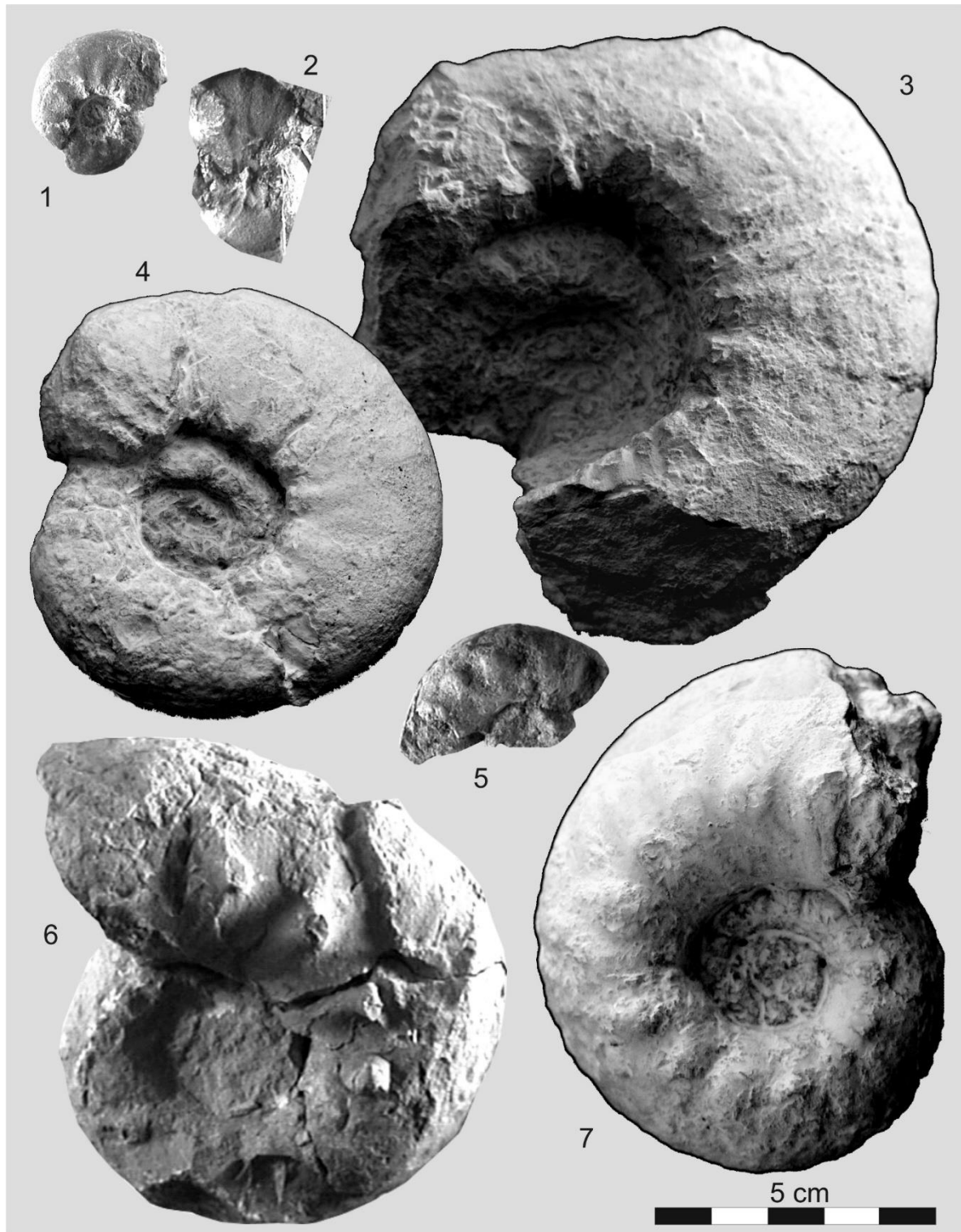
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## Plate 1



Figures: 1. *Physodoceras wolfi wolfi* (NEUMAYR) (LRa13dp), green-grey facies, F2, Lower Kimmeridgian;  
 2. *Physodoceras deaki* (HERBICH) (LRa7K9), red nodular facies, K section level 9 (in Ghilcoș walls), F1, Lower Kimmeridgian -  
 Divisum Zone; 3. *Benetticeras vaii* SARTI (LRa33E3), green-grey facies, block E, level 3, F2. Lower Kimmeridgian – Platynota  
 Zone; 4. *Physodoceras* cf. *altenense* (D'ORBIGNY) (LRa100Ap), green-grey facies, F2, Lower Kimmeridgian;  
 5. *Physodoceras altenense altenense* (D'ORBIGNY) (LRa30E3), green-grey facies in block E,  
 level 3, F2, Lower Kimmeridgian - Strombecki Zone. (F1, F2 – outcrops in Ghilcoș).

## Plate 2



Figures: 1. *Orthaspidoceras lallerianum* (D'ORBIGNY) (LRa41D2), juvenile; green-grey facies in block D, level 2, F2, Upper Kimmeridgian - Acanthicum Zone; 2. *Orthaspidoceras cf. liparum* (OPPEL) (LRa6K9), juvenile; red nodular facies, K section level 9 (in Ghilcoş walls), F1, Lower Kimmeridgian - Divisum Zone; 3. *Orthaspidoceras liparum* (OPPEL) (LRa17A10); green-grey facies in block A, level 10, F2, Lower Kimmeridgian - Divisum Zone; 4. *Orthaspidoceras lallerianum* (D'ORBIGNY) (LRa22H11), deformed specimen; green-grey facies in block H, level 11, F2, Upper Kimmeridgian - Acanthicum Zone; 5. *Orthaspidoceras cf. uhlandi* (OPPEL) (LRa46J), fragment of small specimen; green-grey facies in block J, F2, Lower Kimmeridgian - Divisum Zone; 6. *Orthaspidoceras uhlandi* (OPPEL) (LRa34A10); green-grey facies in block A, level 10, F2, Lower Kimmeridgian - Divisum Zone (Uhlandi Subzone); 7. *Orthaspidoceras uhlandi* (OPPEL) (LRa34A10); green-grey facies in block J, F2, Lower Kimmeridgian - Divisum Zone (Uhlandi Subzone). (F1, F2 – outcrops in Ghilcoş).