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# Upper Maastrichtian cephalopods and the correlation to calcareous nannoplankton and planktic foraminifera zones in the Gams Basin (Gosau Group; Styria, Austria)

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(With 5 figures and 1 plate)

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**Abstract**

A short section within the siliciclastic sequence of the Gosau Group of the Gams Basin provides for the first time an upper Maastrichtian cephalopod fauna, which consists of: *Angulithes* (*Angulithes*) sp. indet., *Hauericeras* sp. indet. juv., *Pachydiscus* (*Pachydiscus*) *gollevillensis* (D'ORBIGNY 1850), *Glyptoxoceras* cf. *rugatum* (FORBES, 1846) and *Neancyloceras bipunctatum* (SCHLÜTER 1872).

The ammonite *Pachydiscus* (*Pachydiscus*) *gollevillensis* (D'ORBIGNY 1850) is a typical Late Maastrichtian taxon. Nannofossil (CC25b/ UC20a$^{TP}$) and planktic foraminiferal data (upper part of *Gansserina gansseri* Zone below the first occurrence of *Abathomphalus mayaroensis*) give a more precise stratigraphic frame for the cephalopod fauna and allow correlation to the boreal belemnite zonation of NW Europe. Integrating foraminiferal and nannofossil data leads to a position within the *Spyridoceramus tegulatus /Belemnitella junior* Subzone to the lower part of the *Tenuipteria argentea /Belemnitella junior* Subzone.

**Keywords:** Cephalopoda, calcareous nannoplankton, foraminifera; Maastrichtian; Gams Basin

**Zusammenfassung**

Ein kurzer Profilabschnitt in der siliziklastischen Schichtfolge der Gosau-Gruppe von Gams hat erstmals eine Cephalopodenfauna des oberen Maastrichtiums geliefert: *Angulithes* (*Angulithes*) sp. indet., *Hauericeras* sp. indet. juv., *Pachydiscus* (*Pachydiscus*) *gollevillensis* (D'ORBIGNY 1850), *Glyptoxoceras* cf. *rugatum* (FORBES, 1846) und *Neancyloceras bipunctatum* (SCHLÜTER 1872). Der Ammonit *Pachydiscus* (*Pachydiscus*) *gollevillensis* (D'ORBIGNY 1850) ist ein kennzeichnendes Taxon für das obere Maastrichtium. Nannofossildaten (CC25b/ UC20a$^{TP}$) und Daten planktonischer Foraminiferen (oberer Teil der *Gansserina gansseri* Zone) geben einen präzisieren stratigraphischen Rahmen für die Cephalopodenfauna und erlauben eine Korrelation mit der borealen Belemnitenzonierung. Die Integration der Foraminiferen- und Nannofossildaten führt zu einer Einstufung von der *Spyridoceramus tegulatus /Belemnitella junior* Subzone bis zum tieferen Teil der *Tenuipteria argentea /Belemnitella junior* Subzone.

**Schlüsselwörter:** Cephalopoda, Nannoplankton, Foraminifera; Maastrichtium; Gams Becken

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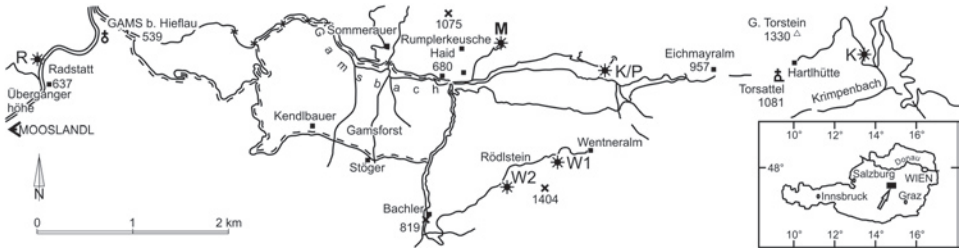


Fig. 1. Sketch map of the Gams area indicating the exposure of Maastrichtian strata with cephalopods described herein and additional points of stratigraphical interest (M – Maastrichtian outcrop described in this paper; W – Wentneralm I, II; K – Krimpenbach, K/P – Cretaceous/Paleogene boundary site in the Knappengraben of STRADNER & RÖGL (1988); R – Radstatt).

## Introduction

The Upper Cretaceous sedimentary succession of the Gosau Group of the Gams Basin in Styria has been an area of investigation since the beginning of geological studies in the Eastern Alps: *Trochactaeon lamarcki* (SOWERBY) was collected by SEDGWICK & MURCHISON in 1832 and described by SOWERBY in 1835. *Barroisiceras haberfellneri* (HAUER) was described in 1866. WICHER & BETTENSTAEDT (1956) introduced micropalaeontology as a stratigraphical tool in the Gams Basin, KOLLMANN (1964) presented a detailed stratigraphic study of the Cretaceous basin filling on the base of foraminifera and macrofossils. KENNEDY (1984) identified GROSSOUVRE's (1894) Lower Coniacian "*Barroisiceras haberfellneri*" as true *Forresteria petrocoriensis* (COQUAND). The Late Turonian age of *Barroisiceras haberfellneri* (HAUER 1866) turned out, when accompa-

Fig. 2. Photograph of the investigated outcrop within the Nierental Formation; hammer (in circle) for scale. Ammonite symbol indicates cephalopod-bearing beds.

nying "kleine Inoceramen" (REDTENBACHER 1874) where identified as *Didymotis* sp. (Chris WOOD, pers. comm., 1982). SUMMESBERGER & KENNEDY (1996) corroborated the Late Turonian age by identification of co-occurring *Barroisiceras minimus* (HAYASAKA & FUKADA (1951) an Upper Turonian index fossil in Japan. SUMMESBERGER et al. (1999) described two Campanian cephalopod faunas and accompanying inoceramid, nannofossil and foraminifera assemblages from the Gams Basin (Wentneralm I, Wentneralm II). Lithostratigraphy and biostratigraphy of the Upper Cretaceous/Paleogene basin filling was the target of investigations in the last decade: SIEGL- FARKAS & WAGREICH (1997), KOLLMANN & SACHSENHOFER (1998), SUMMESBERGER et al. (1999), WAGREICH et al. (2000), EGGER & WAGREICH (2001), PAVLISHINA et al. (2004), WAGREICH (2004), EGGER et al. (2004).

This work describes the youngest cephalopod fauna found so far from the Gams Basin and gives information on accompanying nannofossil floras and planktic foraminifera. Based on these data ammonite, nannofossil and foraminiferal zonations are correlated and an age assignment is made. No inoceramids are found at the investigated locality.

## Geological setting

The Gosau basin of Gams is situated in the Northern Calcareous Alps. It is filled by mainly siliciclastic sediments of the Gosau Group from Late Turonian to Eocene age (KOLLMANN 1964; KOLLMANN & SUMMESBERGER 1982; SUMMESBERGER & KENNEDY 1996; SUMMESBERGER 1997; SUMMESBERGER et al. 1999; WAGREICH 1993; SIEGL-FARKAS & WAGREICH 1997). The Gosau Group unconformably overlies Permian to Upper Jurassic strata of the Tirolian (Unterberg- and Göller-) nappe system of the Northern Calcareous Alps. At its southern border it has been overthrusted by cut-out slices of the Göller nappe (KOLLMANN 1964), the middle and upper Triassic of the Bergstein-Säusenstein mountain range and the Mürzalpen nappe in post Eocene times. Due to its position in the vicinity of the sinistral SEMP (Salzach-Ennstal-Mariazell-Puchberg) fault zone, especially the southern border of the basin was incorporated into the sinistral wrench corridor of the SEMP line.

The Gams Basin can be divided into a western part (mainly Upper Turonian – Campanian strata) and an eastern part (mainly Campanian – Lower Eocene strata). The Gams area is also well known for an exposure of the Cretaceous/Paleogene boundary (STRADNER & RÖGL 1988; EGGER et al. 2004; GRACHEV et al. 2005).

The described outcrop (fig. 1, 2) is situated in the western part of the Gams Basin, in the area of the Gamsbach/Krautgraben (see KOLLMANN 1964; EGGER et al. 2004), 600 m NE of Haid (point 680 m; coordinates in WGS84: Lat. 47.66657693°, Long. 14.86017572°; see fig. 1). The cephalopod fauna was found in the ditch along a dead-end forest road that branches off northward from the main forest road, which leads to Kronsteiner. 1.5 km to the east of the cephalopod site, the Cretaceous/Paleogene (K/P) boundary of the Knappengraben (STRADNER & RÖGL 1988) is situated.

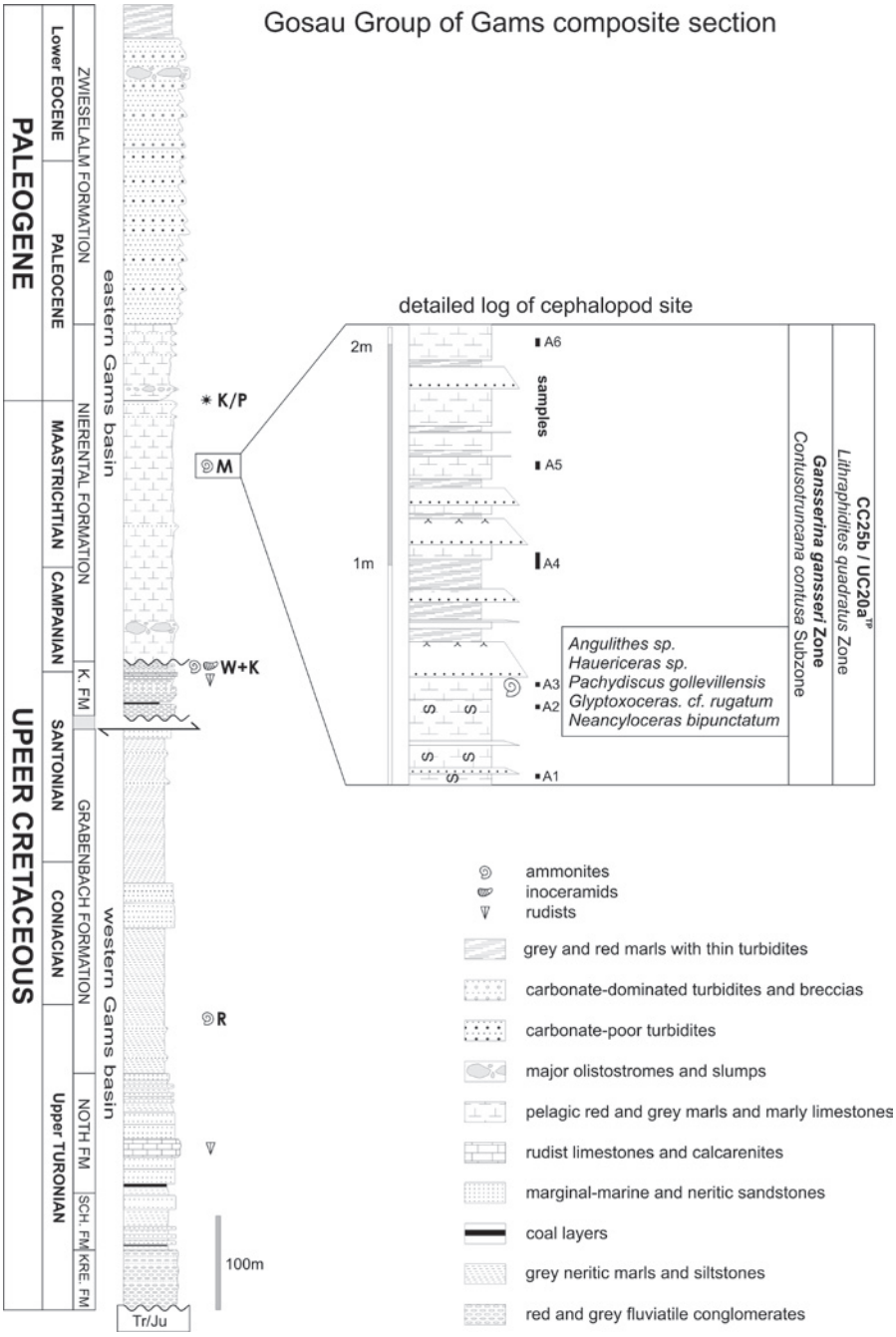


Fig. 3. Composite log of the Gosau Group of the Gams area (compiled from KOLLMANN 1964; SIEGL-FARKAS & WAGREICH 1997; KOLLMANN & SACHSENHOFER 1998: SUMMESBERGER et al. 1999; WAGREICH et al. 2000; EGGER et al. 2004; WAGREICH 2004) and measured log of the outcrop described herein. (K. FM – Krimpenbach Formation; SCH. FM – Schönleiten Formation; KRE. FM – Kreuzgraben Formation; for abbreviations R, W, M, K/T see fig. 1).

## Lithostratigraphy and sedimentology

In the eastern Gams Basin around Gamsforst, Krautgraben and Krimpenbach (fig. 1), deep-water sediments of the Nierental Formation (upper Gosau Subgroup) rest unconformably upon a relatively thin Santonian/Campanian succession, which was mainly attributed to the Krimpenbach Formation by SUMMESBERGER et al. (1999) and WAGREICH (2004). The Nierental Formation (KRENMAYR 1999) comprises mainly pelagic, hemipelagic and turbiditic strata of Campanian to Early Eocene age (KOLLMANN 1964; LAHODYNSKY 1988; EGGER et al. 2004) and is a widespread lithofacies of the Gosau Group (KRENMAYR 1996; WAGREICH & KRENMAYR 2005).

The investigated outcrop within the Nierental Formation exposes about 5 metres of thin and evenly bedded sandy/silty grey shales and marls with a few intercalations of coarse sandstones below 10 cm thickness. The beds are a few centimetres thick, the bedding planes are more or less even. Some bedding planes are coated by a rusty cover. Bioturbation is common, especially in the lower part of the outcrop. *Chondrites* is a typical trace fossil present at topmost parts of graded sandstone/ siltstone turbidite beds. Some bedding planes also show grazing traces by echinoids. Pelitic beds can be subdivided into soft sandy turbiditic shales and more indurated marls, which are interpreted as hemipelagic. The stratigraphic position of the cephalopod-bearing grey marl bed is below a 16 cm thick graded sandstone layer and thus is also interpreted as a hemipelagic, non-turbiditic layer.

## Nannoplankton

Six samples from a 210 cm section around the cephalopod-bearing bed were prepared using a small piece of sediment suspended in distilled water. Suspension was dropped on a glass slide, air dried and covered by glass cover-slip using canada balsam. The samples were examined under the light microscope for nannofossil biostratigraphy. The reader is referred to PERCH-NIELSEN (1985) and BURNETT (1998) for nannofossil taxonomy.

All six samples contain similar nannoplankton assemblages, which can be attributed to the same nannofossil zones. Therefore, the nannofossil assemblage is given as a common table for all six samples.

*Ahmuellerella octoradiata*
*Arkhangelskiella cymbiformis*
*Biscutum constans*
*Biscutum ellipticum*
*Biscutum melaniae*
*Braarudosphaera bigelowi*
*Calculites obscurus*
*Ceratolithoides aculeus*
*Chiastozygus litterarius*
*Corollithion completum*
*Cretarhabdus conicus*
*Cribrosphaerella ehrenbergii*
*Cylindralithus biarcus*

*Cylindralithus* cf. *nudus*
*Cylindralithus* sp.
*Eiffellithus turriseiffelii*
*Helicolithus trabeculatus*
*Kamptnerius magnificus*
*Lithraphidites carniolensis*
*Lithraphidites praequadratus*
*Lithraphidites quadratus*
*Lucianorhabdus cayeuxii*
*Manivitella pemmatoidea*
*Microrhabdulus decoratus*
*Micula decussata*
*Micula praemurus*
*Placozygus* cf. *fibuliformis*
*Prolatipatella multicarinata*
*Prediscosphaera cretacea*
*Prediscosphaera grandis*
*Prediscosphaera spinosa*
*Prediscosphaera* cf. *stoveri*
*Retecapsa crenulata*
*Rhagodiscus angustus*
*Rhagodiscus reniformis*
*Rhagodiscus cf. asper*
*Rucinolithus* sp.
*Russellia multiplus*
"*Thoracosphaera*" (*Operculodinella*) *operculata*
*Tranolithus minimus*
*Vekshinella* sp.
*Watznaueria barnesae*
*Zeugrhabdotus biperforatus*
*Zeugrhabdotus diplogrammus*
*Zeugrhabdotus embergeri*
*Zeugrhabdotus praesigmoides*
*Zeugrhabdotus spiralis*

Probably reworked taxa:
*Broinsonia* sp.
*Quadrum* sp.
*Quadrum* (*Uniplanarius*) *sissinghi*
*Quadrum* (*Uniplanarius*) *trifidum*
*Tranolithus* sp.
*Reinhardtites anthophorus*

The most important marker species recognized is *Lithraphidites quadratus.* This species is rare to very rare (1 specimen in around 100 fields of view). The presence of *L. quadratus* in all the samples and the absence of *Micula murus* and *Nephrolithus frequens* allow the recognition of standard nannoplankton zones CC25b (according to SISSINGH

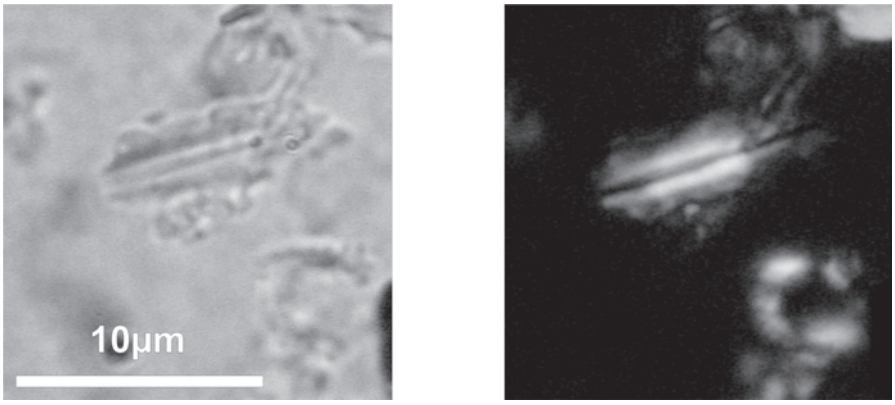


Fig. 4. Light microscope photographs of the marker nannofossil species *Lithraphidites quadratus* BRAMLETTE & MARTINI, 1964 (sample A1); left: normal light, parallel polarisators, right: crossed polarisators.

1977; PERCH-NIELSEN 1985) and UC20a$^{TP}$ (BURNETT 1998). The presence of *Corollithion completum* further corroborates this assignment according to BURNETT (1998). An early Late Maastrichtian age is interpreted in correlation to belemnite zonations (*tegulatus/junior* Subzone or younger; BURNETT 1998). Very rarely, Campanian to Lower Maastrichtian taxa such as *Broinsonia* and *Quadrum* are found, which are interpreted as reworked from older strata.

## Planktic Foraminifera

Three samples were disintegrated by the tenside Rewoquad® and washed over 63 µm and 125 µm sieves. All samples contain a similar foraminifera assemblage, mainly characterized by high amounts (>90 %) of planktic foraminifera. The most characteristic and stratigraphically important taxa present are (for taxonomy see CARON 1985):

*Globotruncanita stuarti*
*Rosita contusa*
*Abathomphalus intermedius*
*Racemiguembelina intermedia*

*Globotruncanita stuarti* and *Rosita contusa* are typical Maastrichtian species (e.g. ROBASZYNSKI et al. 1984). *Abathomphalus intermedius* and *Racemiguembelina intermedia* both have a first occurrence higher up in the Maastrichtian, within the *Gansserina gansseri* Zone (NEDERBRAGT 1991; ROBASZYNSKI & CARON 1995 However, both species comprise evolutionary lineages from *Abathomphalus intermedius* to *Abathomphalus mayaroensis* and *Racemiguembelina* (*Pseudotextularia*) *intermedia* to *Racemiguembelina fructicosa*, respectively and thus some uncertainties may arise from different taxonomic concepts (e.g. compare WEISS 1983 and NEDERBRAGT 1991). According to PREMOLI SILVA & SLITER (1994), ROBASZYNSKI & CARON (1995) and CHÁCON et al. (2004) *Racemiguembelina fructicosa* occurs before *Abathomphalus mayaroensis*, whereas WEISS (1983) and NEDERBRAGT (1991) indicated a first appearance essentially

at the same level, and ROBASZYNSKI et al. (2000) reported a first occurrence of *Racemiguembelina fructicosa* above *Abathomphalus mayaroensis* in Tunisia.

Thus, the samples can be attributed to the upper part of the *Gansserina gansseri* Zone, the *Contusotruncana contusa* (Sub-) Zone, which, according to PREMOLI SILVA & SLITER (1994) and CHÁCON et al. (2004) can be distinguished as a zone above or upper subzone within the upper part of the *Gansserina gansseri* Zone, just below the first occurrence of *Abathomphalus mayaroensis*, which marks the base of the *A. mayaroensis* Zone. A "middle" Maastrichtian age can be inferred from this planktic foraminiferal assemblage. According to LI et al. (1999, 2000), based on data from El Kef/Tunisia, the assemblage with *Racemiguembelina* (*Pseudotextularia*) *intermedia and Rosita contusa* defines their planktic zone CF5 (*Pseudotextularia intermedia* Zone), which has a duration of ca. 800.000 yrs, from 69.1 Ma to 68.3 Ma using the GRADSTEIN et al. (1995) timescale. LI et al. (2000) reconstructed a cool-arid climate and a low relative sea-level during the time interval of CF5.

## Systematic Palaeontology

**Abbreviations**:

| | |
|---|---|
| NHMW | Natural History Museum Vienna |
| BMNH | Natural History Museum London |
| D | diameter |
| Wh | whorl height |
| U | width of umbilicus |
| U% | relation umbilicus : diameter |
| max | measurable maximum |
| maxest | estimated maximum |

Class Cephalopoda CUVIER, 1797

Order Nautilida AGASSIZ, 1847

Suborder Nautilina AGASSIZ, 1847

Family Nautilidae DE BLAINVILLE, 1825

Genus *Angulithes* MONTFORT, 1808

T y p e s p e c i e s : "*Nautilites*" *triangularis* MONTFORT, 1808 by subsequent designation of SPATH (1927: 21).

### *Angulithes* (*Angulithes*) sp. indet.

(pl. 1, figs 1a-b)

M a t e r i a l : NHMW 2008z0016/0001, a single internal mould.

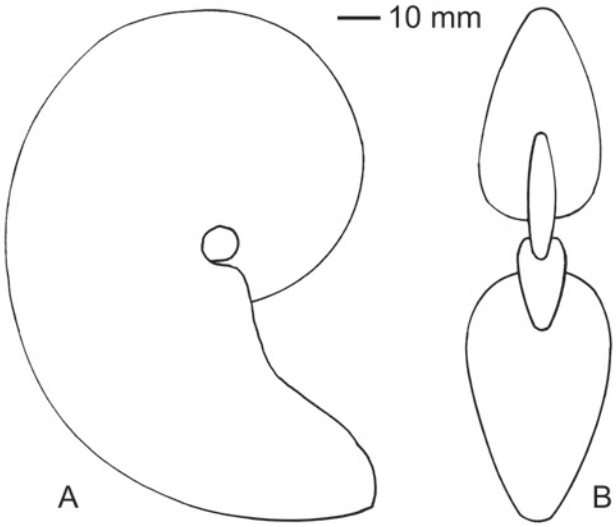


Fig. 5. NHMW 2008z0016/0001. Restored side view (A) and section (B) of *Angulithes* (*Angulithes*) sp. indet. from the Upper Maastrichtian of Gams. Scale bar 10 mm.

D e s c r i p t i o n : NHMW 2008z0016/0001 is a fragment of the internal mould of the phragmocone and a part of the body chamber of a nautilid in sandy/silty matrix. The internal volution is visible as the covering part of the phragmocone is broken away. A few remnants of the shell without ornament are preserved, the surface of the mould is also smooth and covered by a rusty crust. The specimen is distorted, its apparently original slender shape is exaggerated by *post mortem* processes. The whorl section seems to have been high oval with the greatest width below midflanks. The flanks are slightly inflated. Umbilical edge, ventrolateral shoulder and venter are gently rounded. The entire "keel" of the internal volution is possibly caused by lateral compaction. The position of the sipho cannot be observed. The umbilicus is moderately wide and due to increasing Wh and distortion in "excentric" position. The umbilical wall is vaulted and undercut. The suture as far as visible, is biconvex with a concavity midflanks.

M e a s u r e m e n t s : $D_{maxest}$ 75 mm, $Wh_{max}$ 49 mm, U 9.2 mm, U% 12 %

D i s c u s s i o n : NHMW 2008z0016/0001 is a unique specimen, differing from all described Gosau taxa by its slender shape.

*Angulithes* (*Angulithes*) *fleuriausianus* (D'ORBIGNY, 1840) from the Lower Maastrichtian Gosau Group of Krampen near Neuberg (Styria; KENNEDY & SUMMESBERGER 1986) (= *Nautilus neubergicus* REDTENBACHER, 1873: 97, pl. 22, fig. 4, fide WIEDMANN 1960: 183) is a close ally differing by slightly smaller umbilicus and more inflated whorl section.

*Angulithes* (*Cimomia*) *gosavicus* (REDTENBACHER, 1873: 96, pl. 1, figs 2 a, b) from the Santonian Gosau Group of Nefgraben (Russbach, Salzburg; basin of Gosau) differs by its smaller umbilicus and more inflated whorl section.

*Eutrephoceras sublaevigatum* (D'ORBIGNY, 1840); (REDTENBACHER 1873, pl. 22, fig. 1) from the Maastrichtian Gosau Group of Grünbach (Lower Austria) differs by its rounded and depressed whorl section, *E. resupinatum* (REDTENBACHER, 1873: 97, pl. 1,

figs 3 a, b), also from the Maastrichtian Gosau Group of Grünbach (Gosau Group; Lower Austria) and after WIEDMANN (1960: 165) synonymous with *E. sublaevigatum* differs by its globular shape and tiny umbilicus.

*Cymatoceras sharpei* (SCHLÜTER, 1876) from the Lower Santonian Gosau Group of Brandenberg (Tyrol; IMMEL et al. 1982) differs by its subglobular shape and by its characteristic ribbing.

*Angulithes* (*A.*) *sowerbyanus* (D'ORBIGNY, 1840) from the Turonian (fide WIEDMANN 1960) of France differs by its wider whorl breadth, *Angulithes* (*Cimomia*) *galicianus* (ALTH, 1850, pl. 10, fig. 26) from the Maastrichtian of Lviv (Ukraina, Galicia) by its smaller umbilicus and its shallow ribbing (FAVRE 1869: 6; pl. 2, fig. 2).

O c c u r r e n c e : Lower Upper Maastrichtian; Gams, Styria, Austria.

Subclass Ammonoidea ZITTEL, 1884

Order Ammonitida HYATT, 1889

Suborder Ammonitina HYATT, 1889

Superfamily Desmoceratoidea ZITTEL, 1895

Family Desmoceratidae ZITTEL, 1895

Subfamily Puzosiinae SPATH, 1922

Genus *Hauericeras* DE GROSSOUVRE, 1894

T y p e s p e c i e s : *Ammonites pseudo-gardeni* SCHLÜTER, 1872 by original designation.

***Hauericeras* sp. indet. juv.**
(pl. 1, fig. 2)

M a t e r i a l : NHMW 2008z0016/0002, a single juvenile specimen.

D e s c r i p t i o n : NHMW 2008z0016/0002 is a small internal mould, preserved in sandy/silty matrix, the surface covered by a rusty crust, only few remnants of the shell being preserved. The shape is compressed with slowly increasing Wb and fast expanding Wh. Greatest Wb is midflanks, the umbilicus is shallow and relatively narrow, three quarters of the volution being covered by the next one. The umbilical wall is steep, the umbilical edge narrowly rounded. The venter is fastigiate with an entire and sharp keel. $D_{max}$ is 36 mm, Wb 5 mm, Wh 13.8 mm, U 8.7 mm and U% 24 %. There are neither ribs nor constrictions, a few growth lines are visible at the preserved remnant of the shell. Sutures are not visible.

D i s c u s s i o n : The above described specimen seems to be a juvenile individual. The characteristic features make sure that the specimen belongs to the genus *Hauericeras*. *Hauericeras schlueteri* (REDTENBACHER, 1873; pl. 26, figs 2 a-c) from the Mid-Coni-

acian Gosau Group of Schmolnauer Alpe (Salzburg, Austria) is very close, differing by slightly faster increasing Wh. *Hauericeras lagarum* (REDTENBACHER, 1873; pl. 25, fig. 3) from the Coniacian Gosau Group of Glanegg and Schmolnauer Alpe (Salzburg, Austria) differs by its wider umbilicus and slowly expanding Wh. *H. gardeni* (BAILY, 1855; pl. 11, fig. 3) from the Lower Santonian Gosau Group of Brandenberg (Tyrol; IMMEL et al. 1982, pl. 5, figs 1- 4; pl. 6, fig. 1) and from the Upper Santonian Gosau Group of Gosau (Upper Austria; SUMMESBERGER 1979: 6, fig. 27) differs by its wider and shallower umbilicus.

*H. fayoli* DE GROSSOUVRE, 1894 (pl. 27, fig. 3) from the Upper Campanian of the Gschliefgraben (Helvetic nappe; Upper Austria) differs by its wider and shallower umbilicus. *H. sulcatum* (KNER, 1848) (KENNEDY & SUMMESBERGER 1987) from the Lower Maastrichtian and *H. rembda* (FORBES 1846) from the Upper Maastrichtian are differing by their much larger umbilicus. According to its preservation the nomenclature of this juvenile has to be left open.

O c c u r r e n c e : Lower Upper Maastrichtian; Gams, Styria, Austria.

## Family Pachydiscidae SPATH, 1922

## Genus *Pachydiscus* ZITTEL, 1884

T y p e s p e c i e s : *Ammonites neubergicus* HAUER, 1866 by the subsequent designation of DE GROSSOUVRE 1894.

### *Pachydiscus* (*Pachydiscus*) *gollevillensis* (D'ORBIGNY, 1850)
(pl. 1, fig. 3)

| | | |
|---|---|---|
| | 1842 | *Ammonites lewesiensis* D'ORBIGNY: 336, pars: pl. 101, figs 1-3; non: pl. 102, figs 1, 2; non MANTELL 1822. |
| | 1850 | *Ammonites gollevillensis* D'ORBIGNY: 212. |
| | 1935 | *Pachydiscus gollevillensis* (D'ORB.); BRINKMANN: 5. |
| | 1985 | *Pachydiscus gollevillensis* (D'ORBIGNY); SUMMESBERGER: 163. |
| | 1986a | *Pachydiscus* (*Pachydiscus*) *gollevillensis* (D'ORBIGNY, 1850); KENNEDY: 168, pl. 12, figs 4, 5; pl. 15, figs 8-11, 14, 15; pl. 22, figs 1-5; text-figs 7A, C. [with synonymy] |
| | 1986b | *Pachydiscus* (*Pachydiscus*) *gollevillensis* (D'ORBIGNY, 1850); KENNEDY: 28, pls 1-3, pl. 4, figs 4-6; pl. 5, figs 12-14; 20-24; pl. 11, figs 1-5. [with synonymy] |
| | 1993 | *Pachydiscus* (*Pachydiscus*) *gollevillensis* (D'ORBIGNY, 1850); WARD & KENNEDY: 34; figs 29.6, 31.1, 31.5, 32.1-32.3, 33. |
| ? | 1997 | *Pachydiscus* (*Pachydiscus*) *gollevillensis* (D'ORBIGNY, 1850); MARTINEZ: 379, fig. 4. |
| | 2000 | *Pachydiscus gollevillensis* (D'ORBIGNY, 1850); ARKADIEV et al.: 112, pl. 13, fig. 4. |

T y p e : Neotype, designated by KENNEDY (1986b: 29) is BMNH C38179 from the Upper Maastrichtian Calcaire à *Baculites* of Fresville (France).

M a t e r i a l : a single specimen, NHMW 2008z0016/0003 from Gams (Styria). NHMW1984/38 (nannosample, see p. 163) and NHMW 1893/8 are from Gahnsleiten (Lower Austria).

D e s c r i p t i o n : NHMW 2008z0016/0003 is a single external mould, preserved in sandy/silty matrix, the bedding plane covered by remnants of a rusty crust. $D_{max}$ is 65 mm, U is 13.4 mm, U% is about 20 %. About 10 ribs on the last volution arise with a strong bulla at the umbilical seam projecting forward and fading out midflanks. About 60 marginal riblets arise at the external third of the flank projecting forward and crossing the venter.

D i s c u s s i o n : *Pachydiscus* (*Pachydiscus*) *gollevillensis* (D'ORBIGNY, 1850) was discussed at length by KENNEDY (1986b: 28).

O c c u r r e n c e : In the Austrian Gosau Group *P.* (*P.*) *gollevillensis* occurs in the lower Upper Maastrichtian of Gams (Styria, Austria) and Gahnsleiten (Lower Austria, BRINKMANN 1935; SUMMESBERGER 1985). This is also the case in many occurrences of Europe, Turkey, Madagascar.

Suborder Ancyloceratina WIEDMANN, 1966

Family Diplomoceratidae SPATH, 1926

Subfamily Diplomoceratinae SPATH, 1926

Genus *Glyptoxoceras* SPATH, 1925

T y p e s p e c i e s : *Hamites rugatus* FORBES, 1846 (p. 116, pl. 11, fig. 6) by original designation of SPATH (1925: 30); (see: KENNEDY & HENDERSON 1992: 695).

### *Glyptoxoceras* cf. *rugatum* (FORBES, 1846)

(pl. 1, fig. 5)

cf. 1846 *Hamites rugatus* FORBES: 117; pl. 11, fig. 2.
cf. 1992 *Glyptoxoceras rugatum* (FORBES, 1846); KENNEDY & HENDERSON: 695, pl. 1, figs 1-2, 5-16; pl. 2, figs 10-11, 14-29; pl. 3, figs 1-3; pl. 4, figs 2, 12-15; text-figs 1A, E. [With full synonymy]
cf. 1992 *Glyptoxoceras rugatum* (FORBES, 1846); HENDERSON et al.:145, figs 8-13.
cf. 1993 *Glyptoxoceras rugatum* (FORBES, 1846); WARD & KENNEDY: 49; figs 8.14, 43.10-43, 45.4.
cf. 1998 *Glyptoxoceras rugatum* (FORBES, 1846); KENNEDY & JAGT: 161; pl. 1, fig. 7.
cf. 2003 *Glyptoxoceras rugatum* (FORBES, 1846); KLINGER & KENNEDY: 307, fig. 56 C.

M a t e r i a l : NHMW 2008z0016/0005, a single specimen

D e s c r i p t i o n : NHMW 2008z0016/0005 is a 37 mm long fragment of a straight or almost straight portion of the shell of a heteromorph ammonite, Wh is about 14 mm. The surface is covered by regular narrow and sharp ribs, crossing venter and dorsum apparently without interruption.The ribs are straight and undivided, rib index is about 6.

D i s c u s s i o n : Shape and ribbing of the fragment leads to the supposition, the specimen is a representative of the Late Maastrichtian *Glyptoxoceras rugatum* (FORBES, 1846) (see: KENNEDY & HENDERSON 1992: 695). Open nomenclature was used because of the unsatisfying state of preservation.

O c c u r r e n c e : *Glyptoxoceras* cf. *rugatum* (FORBES, 1846) from the Gams Basin is the first record of the genus from the Maastrichtian of the Gosau Group (Austria). Elsewhere *G. rugatum* occurs in the upper Lower to lower Upper Maastrichtian of the Maastrichtian type area (Netherlands; KENNEDY & JAGT 1998), in France, Belgium and Spain, outside Europe in the Maastrichtian of southern India, Brazil and Western Australia (HENDERSON et al. 1992).

## Genus *Neancyloceras* SPATH, 1926

T y p e s p e c i e s : *Ancyloceras bipunctatum* SCHLÜTER, 1872 by original designation by SPATH.

### *Neancyloceras bipunctatum* (SCHLÜTER, 1872)
(pl. 1, fig. 4)

1872 *Ancyloceras bipunctatum* SCHLÜTER: 98, pl. 29, figs 1-3.
1982 *Ancyloceras bipunctatum* SCHLÜTER; KLINGER: 219-232, figs 1 (1-3), 2-8A-E, 9.
1982 *Exiteloceras bipunctatum* (SCHLÜTER, 1872); KLINGER: 234-235, figs 2A, 2B, 3, 4A-C, 5, 6, 7A-D, 8A-E, 9A-D.
1993 *Neancyloceras bipunctatum* (SCHLÜTER, 1872); KENNEDY & COBBAN: 107, pl. 3, figs 11-16, 20, 21; text-fig. 3.
1999 *Neancyloceras bipunctatum* (SCHLÜTER, 1872); KENNEDY & SUMMESBERGER: 27; pl. 2, fig. 6. [with synonymy]
2001 *Neancyloceras bipunctatum* (SCHLÜTER, 1872); KENNEDY & SUMMESBERGER: 89, pl. 6, figs 1-3.

T y p e s : Lectotype by subsequent designation of BLASZKIEWICZ (1980: 29) is the original of SCHLÜTER (1872: pl. 29, fig. 3); refigured by KLINGER (1982: figs 3, 4a).

M a t e r i a l : A single specimen (NHMW 2008z0016/0004).

D e s c r i p t i o n : NHMW 2008z0016/0004 is a fragment of an internal mould without adherent shell, covered by a brownish “rusty” crust. It is a slightly curved shaft with a curved adapertural part. Both ends are broken away. Length is 67 mm, width (restored) might have been 8 mm. The specimen is flattened by post mortem compaction. Its original section might have been round or close to round. The whole shape of the ammonite cannot be restored. Its eye-catching feature is the ribbing. The ribs are narrow and low with a rounded section and wide interspaces distinctly separated from the ribs. Rib index must have been 3 for the restored section. The ribs cross venter and dorsum uninterruptedly. Each rib bears a small tubercle close to the median line of the venter. The ventral double row of tubercles significant of the taxon is badly worn and hardly visible.

D i s c u s s i o n : The double row of minute ventral tubercles separates NHMW 2008z0016/0004 clearly from representatives of the genus *Glyptoxoceras*.

O c c u r r e n c e : *N. bipunctatum* occurs in the Upper Campanian of Germany, Poland, Russia, France and in the Gschliefgraben (Austria; KENNEDY & SUMMESBERGER 1999). It is described herein for the first time from the Upper Maastrichtian of the Gosau Group.

## Chronostratigraphic correlation

The most indicative ammonite taxon present is *Pachydiscus* (*P.*) *gollevillensis* (D'ORBIGNY, 1850), which ranges at Zumaya (Spain) from the upper part of the *Gansseri* Zone to the middle *Mayaroensis* Zone (WARD & KENNEDY 1993, fig. 5). In terms of ammonite zones this corresponds to the *Anapachydiscus fresvillensis* Zone, which is upper Lower Maastrichtian to lower Upper Maastrichtian. The L.O. level of *P.* (*P.*) *gollevillensis* at Zumaya is within the Upper Maastrichtian zones of *Anapachydiscus fresvillensis* and *Abathophalus mayaroensis* (WARD & KENNEDY 1993: fig. 5), and above the F.O. of *Lithraphidites quadratus* in the Biscay region (BURNETT et al. 1992), within nannofossil zone UC20 (BURNETT 1998; KLINGER et al. 2001). A nannofossil sample taken from a specimen of *P. gollevillensis* from another Austrian Gosau Group outcrop, the Gahnsleiten south of Vienna (Lower Austria; BRINKMANN 1935; SUMMESBERGER 1985) also contains *Lithraphidites quadratus* and thus can be attributed to the same nannofossil zone CC25b/ UC20a$^{TP}$.

At Sopelana I (Spain) *P. gollevillensis* occurs about 50 m below the K/P boundary near the base of the *Mayaroensis* Zone (WARD & KENNEDY 1993: fig. 6), at Sopelana II (Spain; WARD & KENNEDY 1993: fig. 7) it occurs about 50 m below K/P in the *Gansseri* Zone, at Hendaye (France, loc.cit., fig. 8) it ranges within the topmost Maastrichtian Zone of *Anapachydiscus terminus*. Its extinction level is about 10 m below K/P. At Bidart II (France, loc.cit., fig. 11) it occurs in the *Mayaroensis* Zone. Taken together all informations from the Bay of Biscay *P. gollevillensis* is mainly an Upper Maastrichtian species, appearing at the top of the upper Lower Maastrichtian *Gansseri* Zone.

Combining nannofossil (CC25b/UC20a$^{TP}$) and planktic foraminiferal data (upper part of *Gansserina gansseri* Zone, *Contusotruncana contusa* (Sub-) Zone, CF5 of LI et al. 1999; below the first occurrence of *Abathomphalus mayaroensis*) gives a more precise stratigraphic frame for the cephalopod fauna and allows correlation to other zonations, e.g. the boreal belemnite zonation of northern Europe. However, several authors report the first occurrence of *Lithraphidites quadratus* above that of *Abathomphalus mayaroensis* and *Racemiguembelina fructicosa*, (e.g., in Gubbio – PREMOLI SILVA & SLITER 1994; in the eastern Mediterranean – PREMOLI SILVA et al. 1998; in El Kef – LI et al. 1999); a diachronous F.O. of *A. mayaroensis* was recognized by LI et al. (2000).

The first occurrence of *Lithraphidites quadratus* was recognized within the *Belemnitella junior* Zone of NW Germany, i.e. within the *tegulatus/junior* Subzone, the lowermost subzone of the Upper Maastrichtian (SCHÖNFELD et al. 1996). According to the absence of the nannofossil *Micula murus* in our samples, the age cannot be younger than the top of the *Belemnitella junior* Zone. Integrating foraminiferal data, especially the lack of *Abathomphalus mayaroensis*, leads to a correlation of the investigated cephalopod horizon with the interval from the base of the *Spyridoceramus tegulatus*/*Belemnitella*

*junior* Subzone to the lower part of the *Tenuipteria argentea*/*Belemnitella junior* Subzone (BURNETT 1998; OGG et al. 2004 and TSCreator, www.stratigraphy.org).

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**Plate 1**

Fig. 1a-b. *Angulithes* (*Angulithes*) sp. indet.; NHMW 2008z0016/0001.

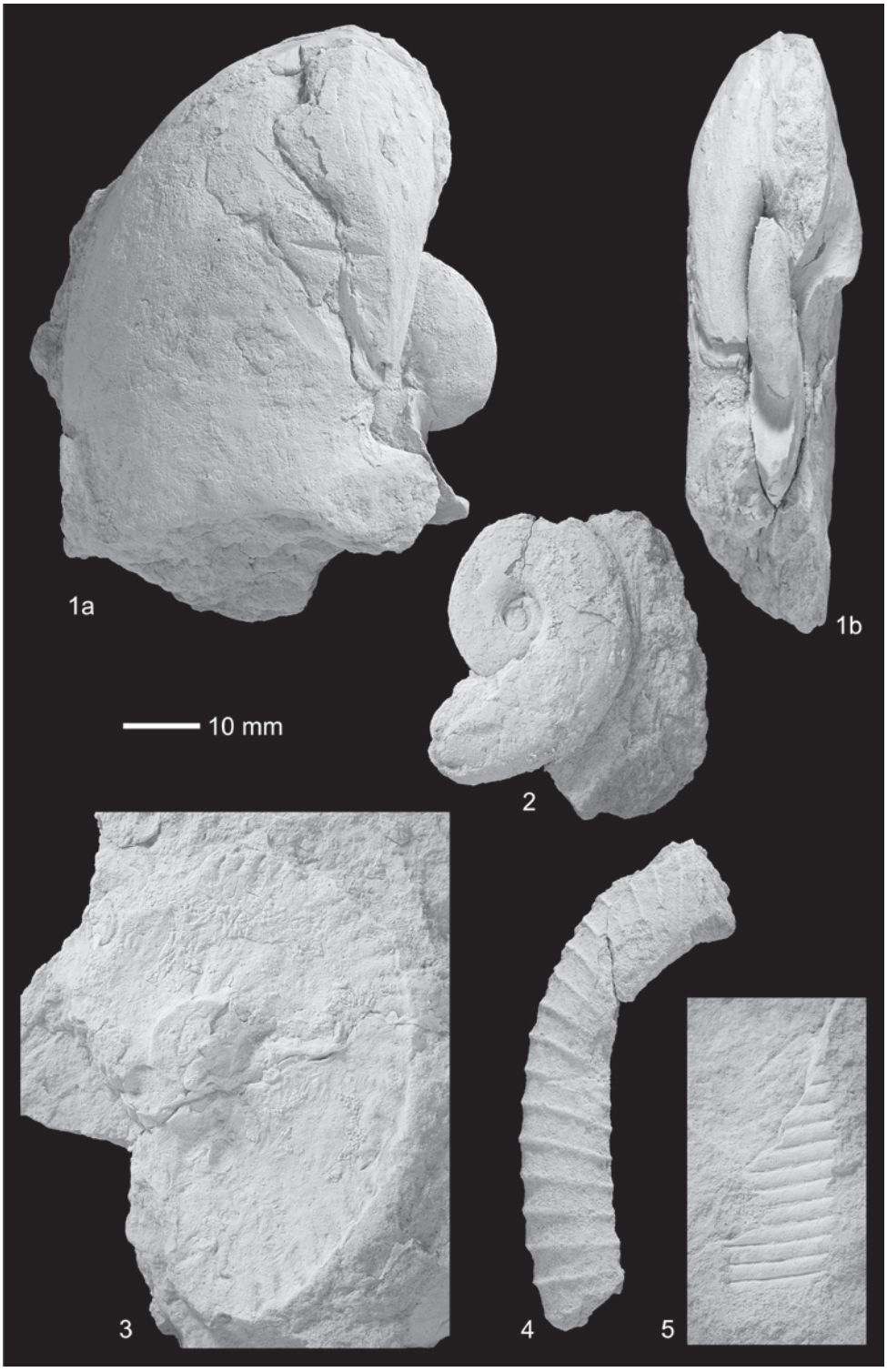
Fig. 2. *Hauericeras* sp. indet. juv.; NHMW 2008z0016/0002.

Fig. 3. *Pachydiscus* (*Pachydiscus*) *gollevillensis* (D'ORBIGNY 1850); NHMW 2008z0016/0003.

Fig. 4. *Neancyloceras bipunctatum* (SCHLÜTER 1872); NHMW 2008z0016/0004.

Fig. 5. *Glyptoxoceras* cf. *rugatum* (FORBES 1846), NHMW 2008z0016/0005.

All from the Upper Maastrichtian of Gams (Styria, Austria).


1a
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