ABHANDLUNGEN DER GEOLOGISCHEN BUNDESANSTALT
Abh. Geol. B.-A. | ISSN 0378-0864 | ISBN 978-3-85316-093-0 | Band 71 | S. 151–248 | Wien, Oktober 2017

Integrated stratigraphy of the upper Santonian (Upper Cretaceous) Hochmoos and Bibereck Formations of the Schattaugraben section (Gosau Group; Northern Calcareous Alps, Austria)

HERBERT SUMMESBERGER[1], WILLIAM J. KENNEDY[2], ERIK WOLFGRING[3], MICHAEL WAGREICH[3], KARL-ARMIN TRÖGER[4] & PETER SKOUMAL[5]

17 Text-Figures, 14 Tables, 21 Plates

In memoriam

JOHN MICHAEL "JAKE" HANCOCK (1928–2004)

CHRISTOPHER J. WOOD (1939–2016)

Österreichische Karte 1:50.000
BMN / UTM
95 Sankt Wolfgang im Salzkammergut / NL 33-01-17 Hallstatt

Gosau Group
Santonian (Cretaceous)
Macro-, Micro-, Nannofossils
Stable Isotopes
Schattaugraben

Contents

1 HERBERT SUMMESBERGER: Museum of Natural History Vienna, Burgring 7, 1010 Vienna, Austria. herbert.summesberger@nhm-wien.ac.at
2 WILLIAM J. KENNEDY: Oxford University Museum of Natural History, Parks Road, Oxford OX1 3PW, UK. jim.kennedy@earth.ox.ac.uk
3 ERIK WOLFGRING: University of Vienna, Faculty of Earth Sciences, Geography and Astronomy, Department of Geodynamics and Sedimentology, Althanstraße 14, 1090 Vienna, Austria. erik.wolfgring@univie.ac.at
3 MICHAEL WAGREICH: University of Vienna, Faculty of Earth Sciences, Geography and Astronomy, Department of Geodynamics and Sedimentology, Althanstraße 14, 1090 Vienna, Austria. michael.wagreich@univie.ac.at
4 KARL-ARMIN TRÖGER: Geologisches Institut BAF, Meißer Bau, Zeunerstraße 12, 09596 Freiberg/Sachsen, Germany. troeger@geo.tu-freiberg.de
5 PETER SKOUMAL: Bastiengasse 56, 1180 Vienna, Austria. pskoumal@aon.at

Abstract

The Schattaugraben section in the Salzburg (Rußbach) part of the Gosau basin was logged and sampled in detail. Its lower part is presented here as type section for the upper Santonian Hochmoos Formation (Hochmoosschichten; WEIGEL, 1937) including the "Sandkalkbank Member". Its position on the northern slope of the Bibereck mountain and its fossiliferous higher part makes the Schattaugraben section equally suitable as a reference section for the lower part of the Bibereck Formation (Bibereck-Schichten; WEISS, 1975, 1977) according to the succeeding overlying part of the section including the *Micraster* Bed, comprising a 30 m interval of marls up to the top of the section.

Nautiloidea, ammonoidea, inoceramids, foraminifera and nannofossils are described. 40 taxa of cephalopods make the Schattaugraben assembles together with that from the Finstergrabenwandl to one of the most diverse late Santonian cephalopod faunas.

Some taxa are described for the first time from the Austrian Gosau Group, e.g. *Eutrephoceras montiscastoris* spec. nov., *Glyptoxoceras crispatum* (MOBERG, 1885) from the Hochmoos Formation and *Marsupites laevigatus* (FORBES in DIXON, 1850) from the Bibereck Formation, the latter co-occurring with *Boehmoceras arculus* (MORTON, 1834) and *Placenticeras paraplanum* WIEDMANN, 1978, indicating for the *Paraplanum* Subzone of the late Santonian, and with *Nowakites savini* (DE GROSSOUVRE, 1894), *Scalarites serta* (MÜLLER & WOLLEMANN, 1906) in the *Micraster* Bed of the Bibereck Formation. *Texasia dentatocarinata* (F. ROEMER, 1852) recorded for the first time from the Gosau Group occurs 16 m above the *Micraster* Bed and is the highest ammonite from the Bibereck Formation and equally the youngest one in the type area of the Gosau Group. *Cordiceramus muelleri muelleri* (PETRASCHECK, 1906) and *Sphenoceramus* ex gr. *pachti/cardissoides* occur in a remarkable cluster of articulated specimens in the Sandkalkbank Member of the topmost Hochmoos Formation. Within the *Micraster* Bed the planktic foraminifera *Globotruncanita elevata* (BROTZEN) and *Globotruncanita stuartiformis* (DALBIEZ) have their first (local) appearance. *Dicarinella asymetrica* (SIGAL) is still present up to the top of the section, indicating the *asymetrica* total range zone or the *asymetrica-elevata* concurrent range zone according to planktic foraminiferal zonations. Nannofossils give evidence for nannofossil standard zones CC17 and UC12–13.

The Schattaugraben was chosen as type section of the Hochmoos Formation as it is closest to the Hochmoosgraben mentioned by FELIX (1908) and used by WEIGEL (1937) as type area of the "Hochmoos Schichten". The Sandkalkbank Member (WEIGEL, 1937) is included in the topmost interval of the Hochmoos Formation. Ammonites (WIEDMANN, 1978; SUMMESBERGER, 1979, 1980, 1992; revised herein), bivalves (DHONDT, 1987) and gastropods (KOLLMANN, 1980) described from the Sandkalkbank Member are part of the Hochmoos Formation at the Schattaugraben section.

The higher part of the Schattaugraben section was chosen as a reference section for the Bibereck Formation as it is best exposed at the northern slope of the type area, the Bibereck mountain. The *Micraster* Bed is included in the lower part of the Bibereck Formation.

Integrierte Stratigrafie des oberen Santoniums (Oberkreide) der Hochmoos- und Bibereck-Formation im Bereich des Schattaugrabens (Gosau-Gruppe; Nördliche Kalkalpen, Österreich)

Zusammenfassung

Das Profil des Schattaugrabens im Salzburger Teil des Beckens von Gosau (Rußbach) wurde vermessen und detailliert beprobt. Der Liegendteil einschließlich des Sandkalkbank Members bis zur Unterkante der *Micraster* Bank wird zum Typusprofil der obersantonen Hochmoos-Formation (= Hochmoosschichten; WEIGEL, 1937) vorgeschlagen. Der namengebende Hochmoosgraben verläuft parallel zum Schattaugraben in geringer Distanz. Der konkordant über der Hochmoos-Formation folgende und durch seine Lage am Nordabhang des Biberecks prädestinierte Hangendteil des Schattaugrabens wird als Referenzprofil für den tieferen Teil der Bibereck-Formation (= Bibereck Schichten; WEISS, 1975, 1977) vorgeschlagen. Dazu zählt von der Unterkante der *Micraster* Bank aufwärts die 30 Meter mächtige Mergelfolge bis zum Profilende.

Cephalopoden, Inoceramen, Foraminiferen und Nannofossilien werden beschrieben. 40 Taxa machen die Cephalopodenfauna des Schattaugrabens mit der benachbarten Fundstelle des „Finstergrabenwandls" zu einer der reichsten des oberen Santoniums.

Einige Taxa werden zum ersten Mal aus der österreichischen Gosau-Gruppe bekannt gemacht: *Glyptoxoceras crispatum* (MOBERG, 1885) aus der Hochmoos-Formation, *Nowakites savini* (DE GROSSOUVRE, 1894) gemeinsam mit *Marsupites laevigatus* aus der *Micraster* Bank der Bibereck-Formation. *Boehmoceras arculus* (MORTON, 1834) und *Placenticeras paraplanum* WIEDMANN, 1978, kennzeichnend für die *Paraplanum* Subzone des oberen Santoniums, treten von der „Sandkalkbank" bis einschließlich der *Micraster* Bank auf. *Texasia dentatocarinata* (F. ROEMER, 1852) tritt 16 m über der *Micraster* Bank auf und ist der jüngste bisher aus der Typusregion der Gosau Gruppe bekannt gewordene Ammonit. *Cordiceramus muelleri muelleri* (PETRASCHECK, 1906) und *Sphenoceramus* ex gr. *pachti/cardissoides* bilden einen bemerkenswerten Cluster doppelklappiger Individuen in der Sandkalkbank der Hochmoos-Formation.

In der *Micraster* Bank treten die planktonischen Foraminiferen *Globotruncanita elevata* (BROTZEN) und *Globotruncanita stuartiformis* (DALBIEZ) (lokal) erstmals auf. *Dicarinella asymetrica* (SIGAL) weist die *asymetrica* Reichweitenzone und die *asymetrica-elevata* Überlappungszone der Planktonforaminiferen-Zonierungen bis an das obere Profilende nach. Nannofossilien belegen die Nannofossil-Standard Zonen CC17 und UC12–13.

Der Schattaugraben wird als Typusprofil der Hochmoos-Formation vorgeschlagen, da er nahe dem Hochmoosgraben liegt, der von FELIX (1908) erwähnt und von WEIGEL (1937) als Typusgebiet der „Hochmoos Schichten" festgelegt wurde. Die Sandkalkbank-Subformation (WEIGEL, 1937) ist damit Teil des höchsten Abschnittes der Hochmoos-Formation. Ammoniten (WIEDMANN, 1978; SUMMESBERGER, 1979, 1980, 1992; revidiert in dieser Arbeit), Bivalven (DHONDT, 1987) und Gastropoden (KOLLMANN, 1980) aus der Sandkalkbank-Subformation sind damit der Hochmoos-Formation des Schattaugraben-Profils gegenüberzustellen.

Der höhere Teil des Schattaugraben-Profils bildet ein Referenzprofil für die Bibereck-Formation als gut aufgeschlossener Teil im Typusgebiet dieser Formation, dem Bibereck. Die *Micraster* Bank ist damit ein Teil des unteren Abschnittes der Bibereck-Formation.

Introduction

MICHAEL WAGREICH & HERBERT SUMMESBERGER

Late Cretaceous chronostratigraphy still lacks formally defined and agreed Global Boundary Stratotype Sections and Points (GSSP), e.g. for the base of the Campanian (see GALE et al., 2008; WAGREICH et al., 2010; OGG & HINNOV, 2012). At the Second International Symposium on Cretaceous Stage Boundaries in Brussels in 1995 a decision was made to use the extinction level (LO – last occurrence) of the crinoid *Marsupites testudinarius* (SCHLOTHEIM, 1820) as the boundary-marker (HANCOCK & GALE, 1996). GALE et al. (2008) proposed the Waxahachie dam-spillway (WDS) in the Austin chalk in north-central Texas, USA, as a GSSP for the base of the Campanian stage. However, the succession of biostratigraphic events and their correlations to chemostratigraphic and magnetostratigraphic scales still remains partly unresolved, especially in correlating low- ("tethyan") and high-latitude ("boreal") zones in the late Santonian (e.g. SAGEMAN et al., 2014; COCCIONI & PREMOLI SILVA, 2015; THIBAULT et al., 2016). More recent-

ly, the base of the Campanian was proposed to be rather defined by magnetostratigraphy, using the base of Chron C33r, i.e. the first reversal after the Long Cretaceous Normal magnetochron C34n (Ogg & Hinnov, 2012; Wagreich et al., 2015) which is in close proximity to the major bioevents around the boundary, i.e. the LO *Marsupites testudinarius,* the LO of the planktic foraminifer *Dicarinella asymetrica*, and the first occurrence (FO) of the nannofossil *Broinsonia* (*Aspidolithus*) *parca parca*.

Wagreich et al. (2010) reported briefly on the results of an integrated stratigraphic investigation of an upper Santonian section in the type area of the Gosau Group in the Northern Calcareous Alps of Austria with respect to its implications for boundary markers and events. Correlation to the proposed GSSP at the WDS was possible, focusing especially on calcareous nannofossil and planktic foraminifera zonations. The present paper gives detailed results on the palaeontology of cephalopods, inoceramid bivalves as well as some details on nannofossils and foraminifera. A correlation to the proposed GSSP at the WDS and other sections is given, and stratigraphic events are summarised and discussed.

Geological setting and geographical position

Michael Wagreich & Herbert Summesberger

The Gosau Group (Turonian–Eocene) of the Northern Calcareous Alps (Text-Fig. 1A) was deposited in the northwestern Tethys at a palaeolatitude of about 30° N in a subtropical climatic belt (Wagreich & Faupl, 1994; Faupl & Wagreich, 2000). The Gosau Group records transtensional strike-slip and pull-apart basin subsidence after a major deformational event (Wagreich & Decker, 2001), followed by a deepening event (Wagreich, 1993). The Gosau basin succession of the type area around Gosau (Upper Austria) comprises about 1,000 m of upper Turonian to lowermost Campanian terrestrial and shallow-water marine sediments of the Lower Gosau Subgroup, which are unconformably overlain by deep-water deposits of the Upper Gosau Subgroup (Wagreich & Faupl, 1994) (Text-Fig. 2).

A transgressive and deepening succession of late Turonian to Santonian age is overlain by a shallowing succession of upper Santonian age, including the Hochmoos Formation. The overlying marls of the Bibereck Formation record a sudden deepening of the Gosau basin, leading to the deposition of bathyal pelagic marls and marly limestones and turbidites (Wagreich & Krenmayr, 2005). The Schattaugraben section described by Wagreich et al. (2010) and in this paper records a transitional interval from the upper part of the Hochmoos Formation continuously to the lower part of the Bibereck Formation in the upper Santonian. It is situated within the basin centre, thus recording an extended stratigraphic interval compared to coeval condensed basin margin sections to the south (Wagreich & Decker, 2001; Wagreich & Neuhuber, 2005). The Schattaugraben ("Schattau" of local collectors; geographic coordinates of crossing point of Schattaugraben with the Schattau forest road: WGS 84 N 47°35'10,1" E 013°30'01,1") is located on the Salzburg side of the Gosau basin in the area of the village of Rußbach.

The Hochmoos Formation with the Sandkalkbank Member representing the top of the formation, overlain by the Bibereck Formation is exposed. The Schattaugraben locality is mentioned several times in the literature (e.g. Reuss, 1854; Petrascheck, 1906; Felix, 1908: Tab. 1, "Hochmoosgraben und Schattauwald", 330–335; Kühn, 1925). The highly fossiliferous Sandkalkbank Member (Finstergrabenwandl locality; WGS 84 N 47°35'00", E 013°30'49") which was extensively studied by previous workers (Wiedmann, 1978; Summesberger, 1979, 1980, 1992; Kollmann, 1980; Dhondt, 1987) crosses also the Schattaugraben, interrupted by a minor local fault (Text-Fig. 3). Clusters of articulated *Cordiceramus muelleri muelleri* (Petrascheck, 1906) together with *Sphenoceramus* ex gr. *pachti/cardissoides* occurring within the Sandkalkbank Member indicate a late Santonian age. This is in accordance with the ammonite fauna of the Zone of *Placenticeras paraplanum* and *Boehmoceras arculus* (Wagreich et al., 2010). The *Micraster* Bed (Kühn, 1925) lies about 10 metres above the top of the Sandkalkbank Member at the base of the Bibereck Formation [N 47°35'02,3", E 013°30'04,4" (= UTM33 0387286 / 5271168)]. The stratigraphic age was also proven by foraminifera (*D. asymetrica*; Weiss, 1975; Wagreich et al., 2010) and the presence of *Marsupites laevigatus* (Forbes in Dixon, 1850) (Wagreich et al., 2010).

The Schattaugraben section comprises a total of ca. 94 metres of marly siltstone to sandstone with abundant macrofossil content (gastropods, solitary corals, inoceramids and other bivalves, ammonites, echinoderms). The sequence was deposited under generally shallow marine environmental conditions. Unfortunately, planktic microfauna and nannoflora are rather poor in the lower part of the section (parts of the Hochmoos Formation) and first and last occurrences of marker taxa may be influenced by facies changes. Three occurrences of fossils in the Schattaugraben sequence deserve to be named "mass occurrences": The occurrence of echinoids in the *Micraster* Bed, the cluster of inoceramids within the Sandkalkbank Member and the repeated occurrence of *Gervillia solenoides* Defrance in the whole section especially in the *Micraster* Bed (Text-Fig. 3).

Locality

The Cretaceous-Paleogene Gosau basin extends across the border of two Austrian federal states: Upper Austria around the village of Gosau; Salzburg around the village of Rußbach (Text-Fig. 1B). The Schattaugraben section is on the Salzburg side. The locality Finstergrabenwandl belongs to the village Gosau on the Upper Austrian side of the basin. The two villages are connected by road No. B 166 across the Pass Gschütt (996 m).

Locality details

Junction of the Schattaugraben with the forest road Schattau: (= N 47°35'10,1" E 013°30'01,1").

Position outcrop *Micraster* Bed: N 47°35'02,3"
E 013°30'04,4" (= UTM33 0387286 / 5271168).

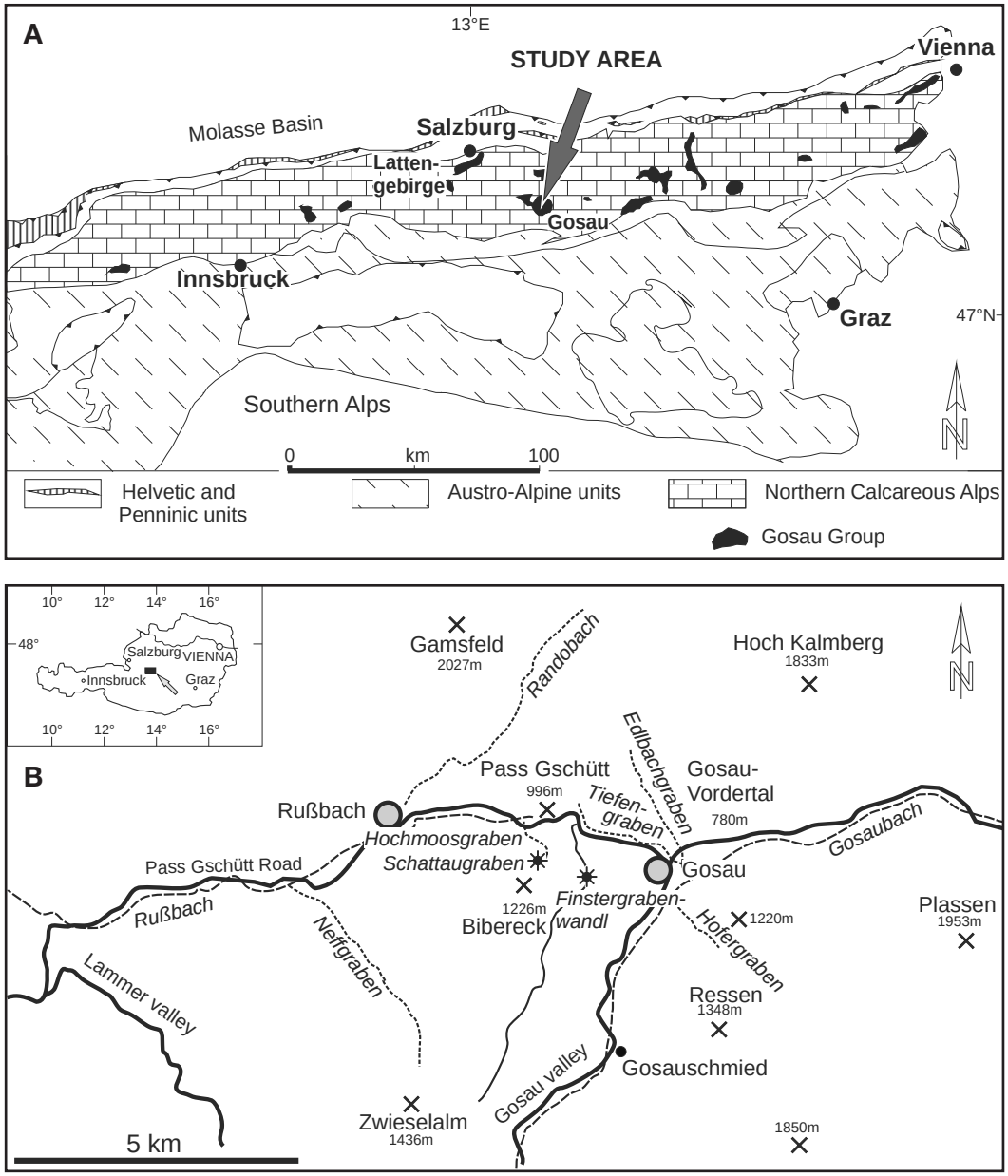
Position Finstergrabenwandl locality: N 47°35'00", E 013°30'49" (WGS 84).

Geological Map of the Republic of Austria 1:50.000, Sheet 95 St. Wolfgang im Salzkammergut.

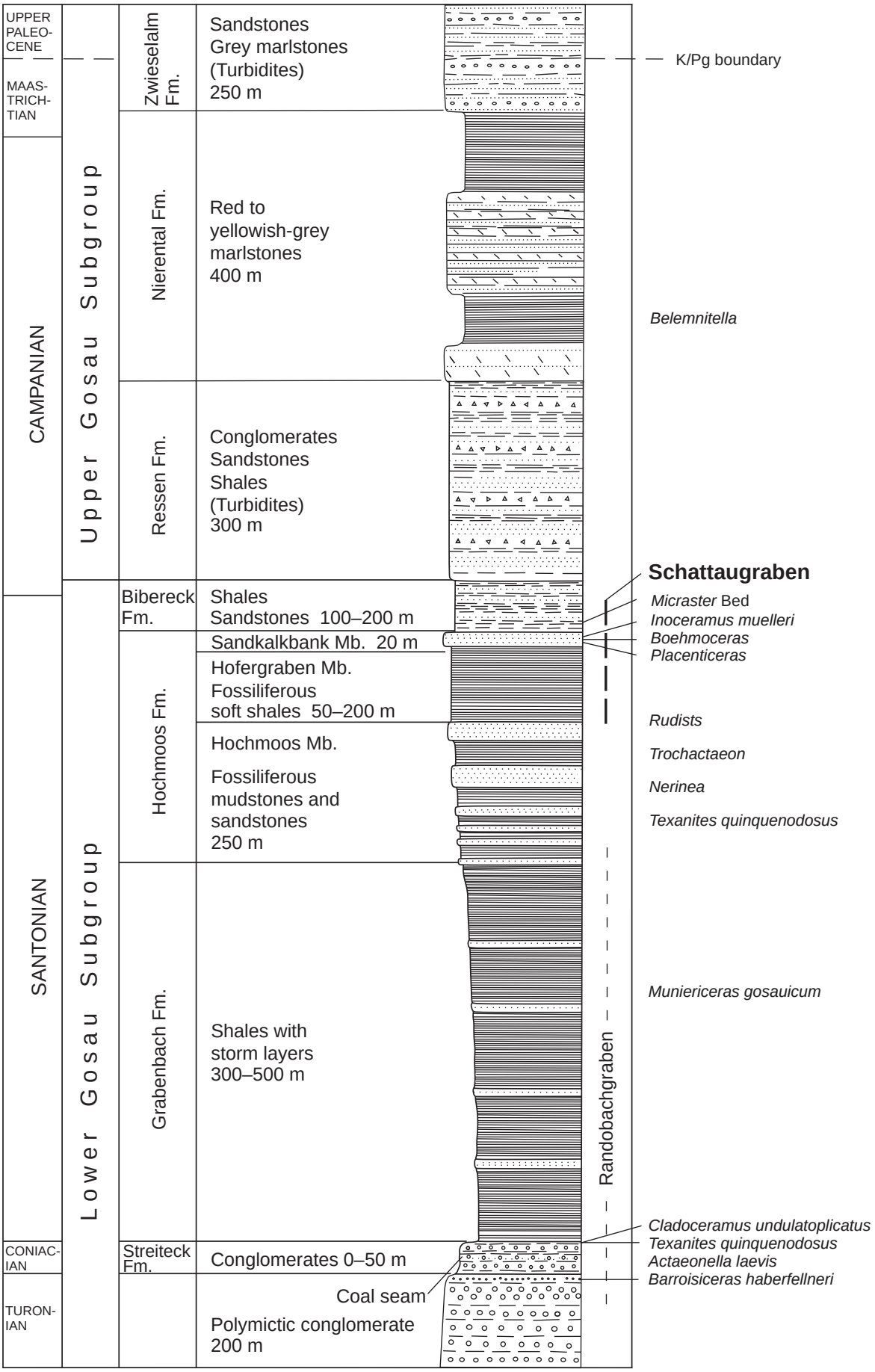
Gosauschmied: The locality "Gosauschmied" is close to a restaurant of the same name, the former house of a blacksmith and 4 km SSE from the Schattaugraben. The Neffgraben (also: Nefgraben) is a large gorge situated south of Rußbach more or less parallel to the Schattaugraben and towards the west to the nearby situated chairlift.

Methods

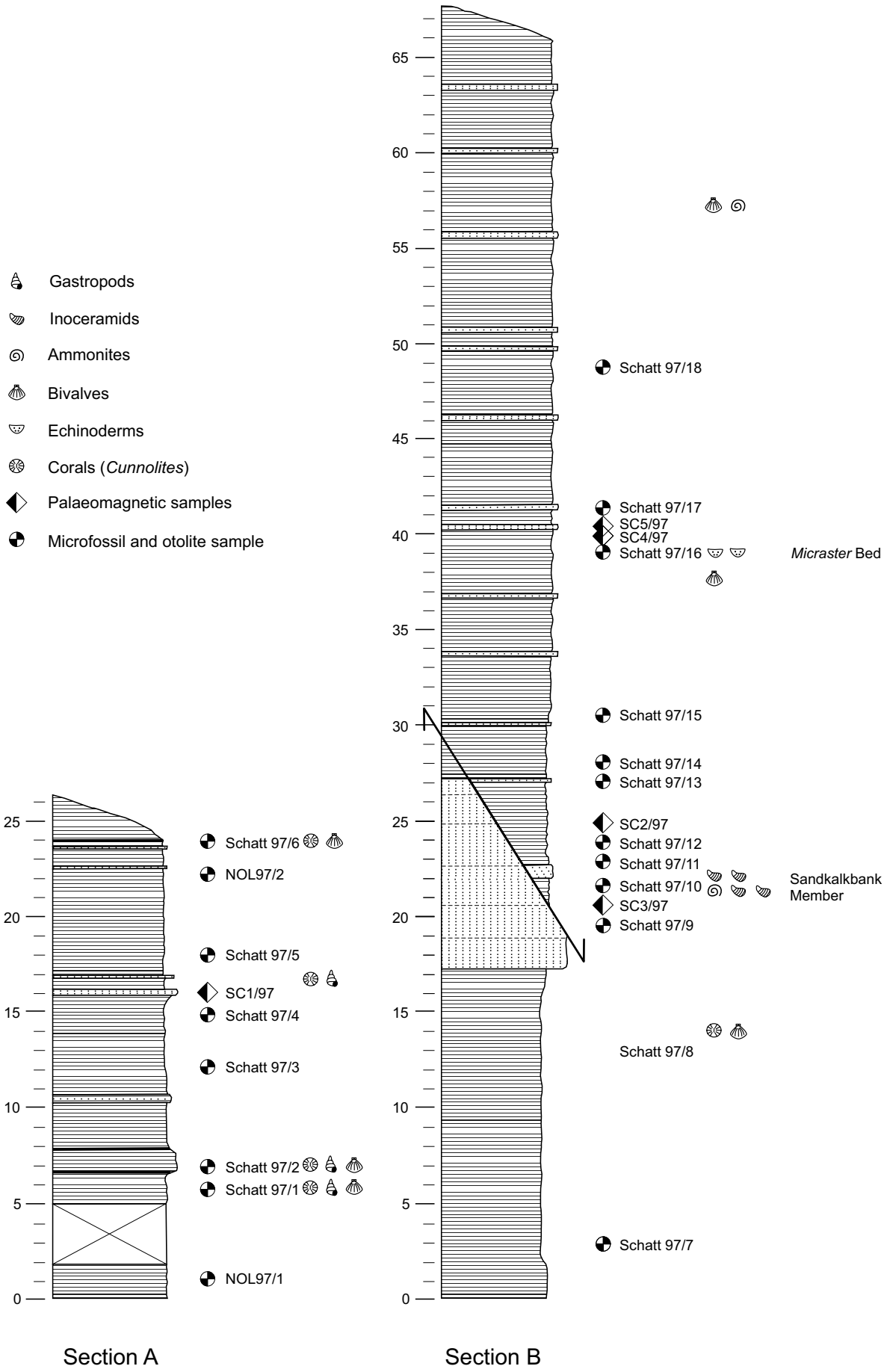
The integrated multi-disciplinary stratigraphic investigation of the Schattaugraben section included macrofossil sampling and identification, especially of ammonites, inoceramids (H. Summesberger, W.J. Kennedy, P. Skoumal, K.-A. Tröger), foraminifera (M. Trenkwalder, E. Wolfgring, M. Wagreich), calcareous nannofossils (M. Wagreich), palaeomagnetic sampling (R. Scholger, H. Haubold), stable isotope data (C. Spötl, M. Wagreich) and strontium isotope data (M. Horschinegg, M. Wagreich). Sampling was done essentially in two phases, starting in 1997/1998 (macrofossils, foraminifera, nannofossils, palaeomagnetics) and continuing in 2005/2006 after the finding of *Marsupites laevigatus* (foraminifera, nannofossils, isotope samples). For methods used on foraminifera, nannofossils, stable isotopes and strontium isotopes see WAGREICH et al. (2010). Macrofossil samples are housed in the collection of the Department of Geology and Palaeontology of the Museum of Natural History Vienna (NHMW), microfossil samples are stored in the collection of the Department of Geodynamics and Sedimentology, University of Vienna.



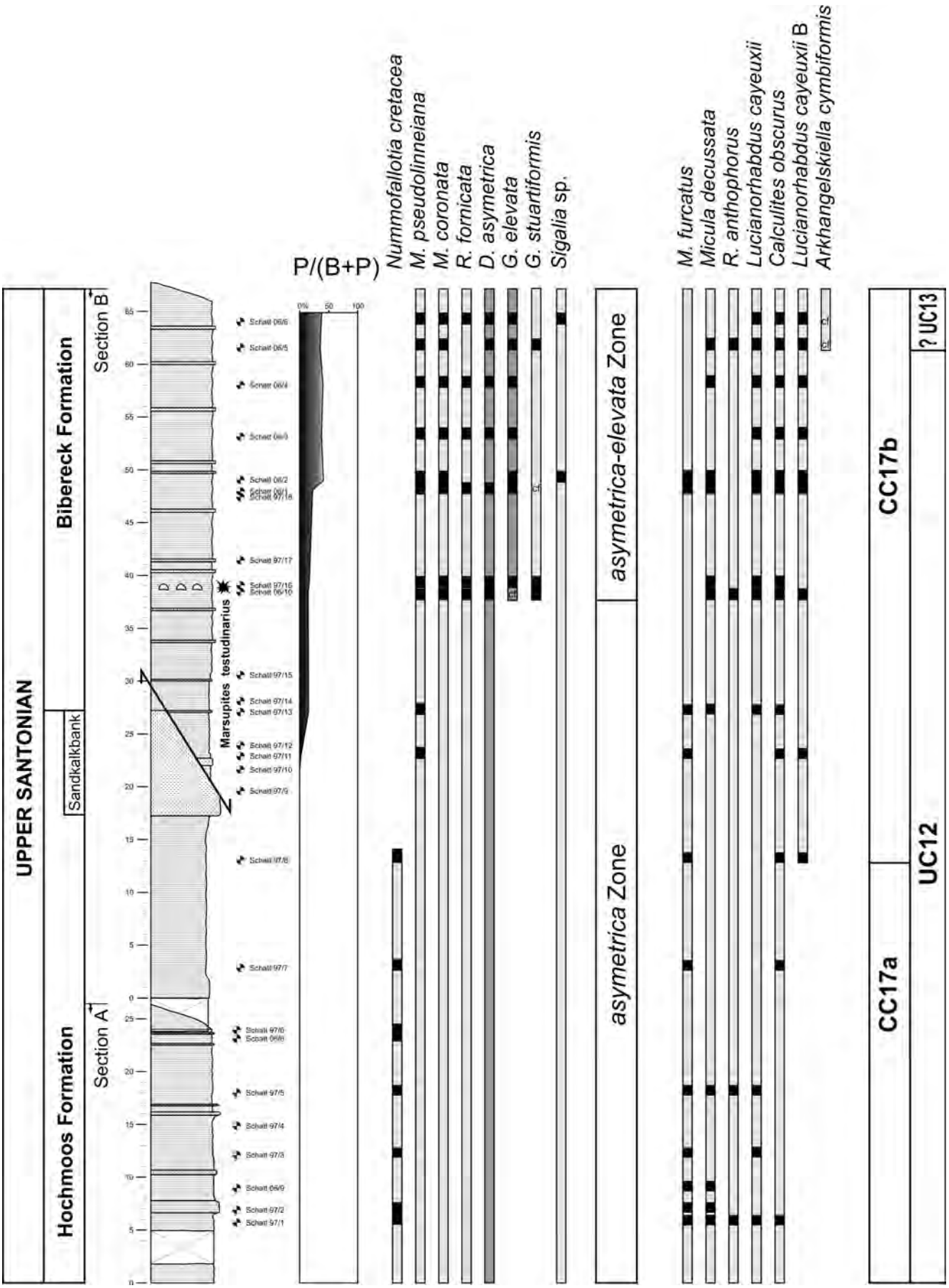
Text-Fig. 1.
A. Schematic geological map of the Eastern Alps. Occurrences of Gosau sediments (black). B. Overview road map of the position of the Schattaugraben section indicating the localities mentioned in the text. With alterations after WAGREICH et al. (2010); * localities of Schattaugraben and Finstergrabenwandl.



Text-Fig. 2.
Compiled section of the Gosau area indicating the Schattaugraben section (with alterations after SUMMESBERGER et al., 2017a, b).



Text-Fig. 3.
Section of the Schattaugraben measured in 1997 by SUMMESBERGER, WAGREICH, SCHNEIDER & TRENKWALDER.

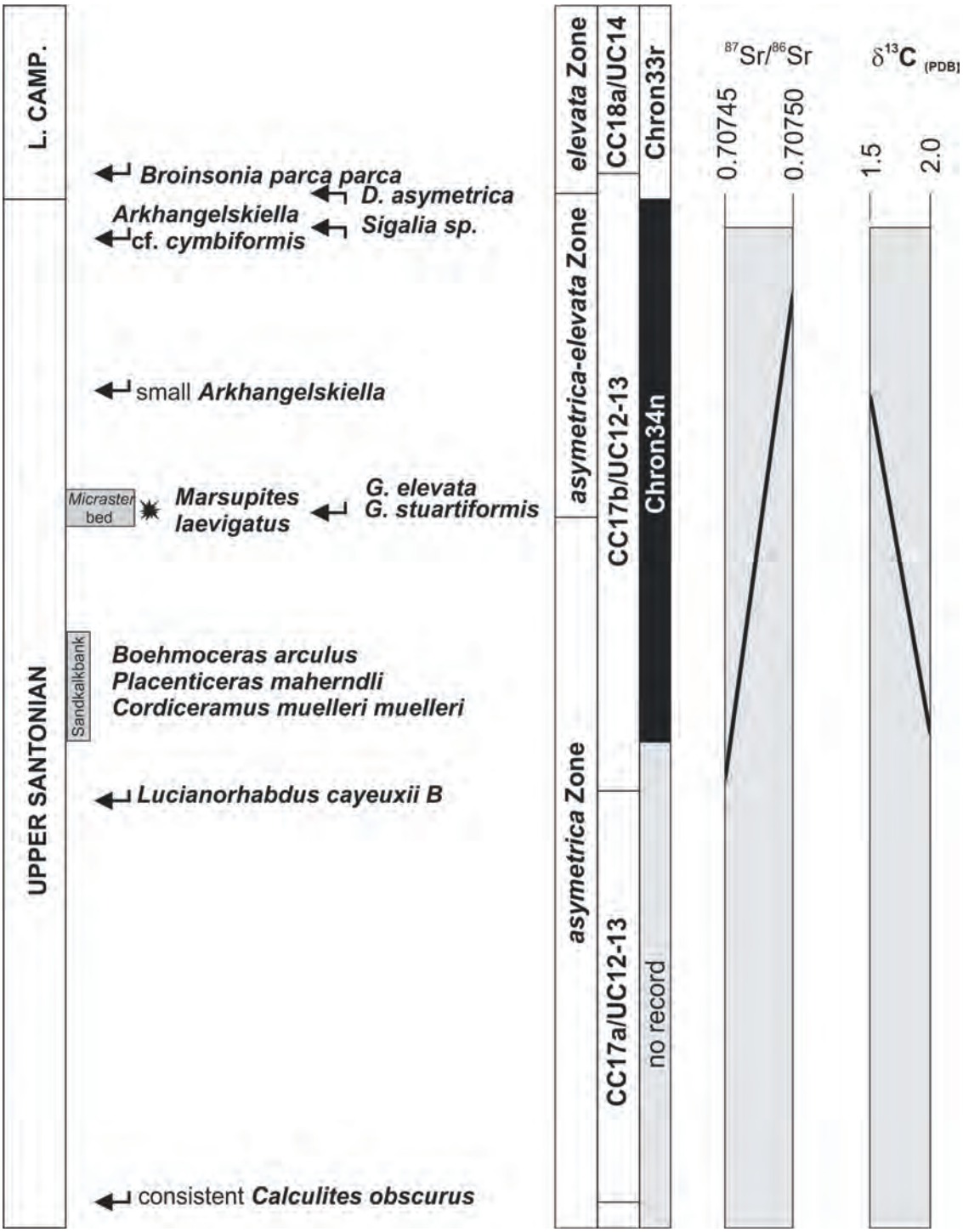


Text-Fig. 4.
Overview of the lithological log of the Schattaugraben section (parts A and B), zonations and ranges of key planktic foraminifera and nannofossils. Asterix marks occurrence of the crinoid *Marsupites laevigatus* in the section. P/(B+P) – percentage of planktonic foraminifera out of total foraminiferal assemblage (size fraction > 0.25 mm). With alterations after WAGREICH et al. (2010).

Results

Lithostratigraphy

The sedimentological and stratigraphic data from the Schattaugraben section allow a more precise insight into the lithostratigraphy of the Gosau Group of Gosau-Abtenau in the centre of the Gosau basin (compare PLÖCHINGER, 1982; WAGREICH, 1988). The lower part of the section includes fossiliferous marls and sandstones of the Hochmoos Formation. The succeeding Sandkalkbank Member, an up to 30 m thick sandstone interval, marks the top of the Hochmoos Formation (KOLLMANN, 1982). The overlying marls with few sandstone beds are still fossiliferous and include the *Micraster* Bed about 10 m above the top of the Sandkalkbank Member. By definition, this part of the section has to be included into the Bibereck Formation (WEISS, 1975, 1977; WAGREICH, 1988), and forms a transitional interval into the typically macrofossil-poor, increasingly pelagic grey marls of the Bibereck Formation described from other sections (WAGREICH, 1988; WAGREICH & NEUHUBER, 2005).



Text-Fig. 5.
Integrated stratigraphy around the Santonian/Campanian boundary in the Gosau area (after WAGREICH et al., 2010, 2015).

The Schattaugraben is parallel and close to the Hochmoosgraben (Felix, 1908: Pl. 26) and is thus situated in the type area of the Hochmoos Formation (Weigel, 1937: Text-Fig. 2). The sedimentary contact of the Hochmoos Formation with the underlying Grabenbach Formation (Weigel, 1937; Weiss, 1975; Kollmann, 1982) is not exposed in the Schattaugraben section. As outcrops in the Hochmoosgraben are unsatisfactory, we propose to use the Schattaugraben section as type section for the Hochmoos Formation, because it exposes the upper part of this formation including the Sandkalkbank Member, and the boundary with the overlying Bibereck Formation. This boundary is thus situated at the lithological change from fine-grained indurated calcareous sandstones of the topmost Sandkalkbank Member to softer grey marls and marlstones of the Bibereck Formation.

The *Micraster* Bed outcrops near the base of the Bibereck Formation and rests conformably on the Hochmoos Formation (Text-Fig. 6). The upper part of the Bibereck Formation in the Schattaugraben is covered by Quaternary moraine, but continuity is given by another parallel ditch west of the Schattaugraben where an increasingly fine-grained argillaceous succession is exposed. The depositional environment changed continuously to deeper water/bathyal due to accelerating subsidence (Wagreich, 1988, 1993). The Bibereck Formation is also exposed at the nearby Zwieselberg forest road (type section of Weiss, 1975, 1977 and Wagreich, 1988) and at the Hofergraben (Text-Fig. 1B) a few kilometres towards southeast. The continuous exposure of the Schattaugraben section makes it an important reference section for the lower part of the Bibereck Formation.

Foraminifera

(Michael Wagreich & Erik Wolfgring)

In the lower part of the Schattaugraben section the shallow-water depositional depths hindered the application of planktic foraminiferal zonations due to the lack of planktic foraminifera in the foraminiferal assemblages below and immediately above the Sandkalkbank Member (Trenkwalder, 1999). *Nummofallotia cretacea* is a typical benthic shallow-water foraminifera present in most of the samples from these shallow-water marls (Weiss, 1977). This species may be restricted to the Coniacian–Santonian (Gendrot, 1968).

The presence of the planktic foraminifer *Dicarinella asymetrica* within the underlying Grabenbach Formation outside the Schattau section (Wagreich, 1992) indicates a possible correlation of the lower part of the Schattaugraben section to the Santonian *asymetrica* Zone of the standard planktic foraminiferal zonations (e.g. Caron, 1985; Robaszynski & Caron, 1995) up to 38 m (Text-Fig. 4). The first local occurrence of the planktic foraminifera *Globotruncanita* cf. *elevata* and *G. stuartiformis*, still associated with *Dicarinella asymetrica*, are recognised in grey marls of the *Micraster* Bed about 18 m above the fault that displaces the Sandkalkbank Member against the marls (Text-Figs. 3–5). This indicates the *asymetrica–elevata* Concurrent Range Zone (Wagreich, 1992) from 38 to 64 m of the Schattau section (Text-Fig. 4). *Sigalia decoratissima* and *Sigalia* sp. are rarely present within this part of the section, pointing to the lower part of the *asymetrica–elevata* Zone (Wagreich, 1992), probably still below the Santonian/Campanian boundary (Gale et al., 2008).

According to Gale et al. (1995), the Santonian/Campanian boundary, as defined by the LO of *Marsupites testudinarius*, is situated within the *asymetrica* Total Range Zone or the *asymetrica–elevata* Concurrent Range Zone. Based on the WDS section, Gale et al. (2008) indicated that the LO of *Marsupites testudinarius* occurs above the FO of both *Globotruncanita stuartiformis* and the LO of the *Sigalia*-group, and below the LO of *D. asymetrica*. Thus it lies within the *asymetrica–elevata* Zone sensu Wagreich (1992), as the FO of *G. stuartiformis* approximates to the FO of *G. elevata* (e.g. Premoli Silva & Sliter, 1994; Coccioni & Premoli Silva, 2015).

The Schattaugraben section records a rich benthic foraminifera-fauna. The foraminiferal communities from the lower part of the section (below the Sandkalkbank) indicate a shallow water environment; the Hochmoos Formation yields abundant larger benthic foraminifera (*Nummofallotia cretacea*), miliolid foraminifera (*Quinqueloculina* spp, *Spiroloculina fassistomata*) as well as rotaliid foraminifera (*Hoeglundina* spp., *Gavelinella* spp.). Following the distinct deepening recorded upwards the Sandkalkbank Member, fully marine outer neritic conditions prevail and consequently

Text-Fig. 6.
Schattaugraben, Rußbach, Salzburg; *Micraster* Bed. Outcrop situation 2010.

some elements of the benthic foraminiferal fauna change: tubular and bi- and triserial agglutinated foraminifera (e.g. *Ammobaculites* spp., *Dorothia* spp., *Gaudryina* spp., *Tritaxia* spp.) as well as spiral calcareous benthic foraminifera (*Gavelinella* spp., *Lenticulina* spp.) are recorded in the younger deposits at the Schattau section (in the Bibereck Formation). A list of taxa identified from the Schattaugraben can be found below in the following list. Plates 17–21 depict stratigraphically indicative planktic and benthic foraminifera from the Schattaugraben section.

Alphabetic list of foraminiferal taxa present in the Schattau section.

Ammobaculites agglutinans (D'ORBIGNY)

Bolivinopsis praelonga (SCHWAGER)

Bulbobaculites sp.

Conorboides squamiformis REUSS

Contusotruncana fornicata (PLUMMER)

Contusotruncana morozovae (VASILENKO)

Dentalina cf. *solvata* (CUSHMAN)

Dentalina communis D'ORBIGNY

Dentalina gracilis D'ORBIGNY

Dicarinella asymetrica (SIGAL)

Dicarinella concavata (BROTZEN)

Dorothia biformis FINLAY

Dorothia bulletta (CARSEY)

Dorothia oxycona (REUSS)

Dorothia pupa (REUSS)

Dorothia trochus (D'ORBIGNY)

Eouvigerina sp.

Epistomina cf. *colomi* DUBORDIEU & SIGAL

Epistomina sp.

Frondicularia angusta

Frondicularia sp.

Gaudryina laevigata FRANKE

Gaudryina pyramidata CUSHMAN

Gaudryina reicheli (?) BARTENSTEIN, BETTENSTAEDT & BOLLI

Gaudryina rugosa D'ORBIGNY

Gavelinella ammonoides (REUSS)

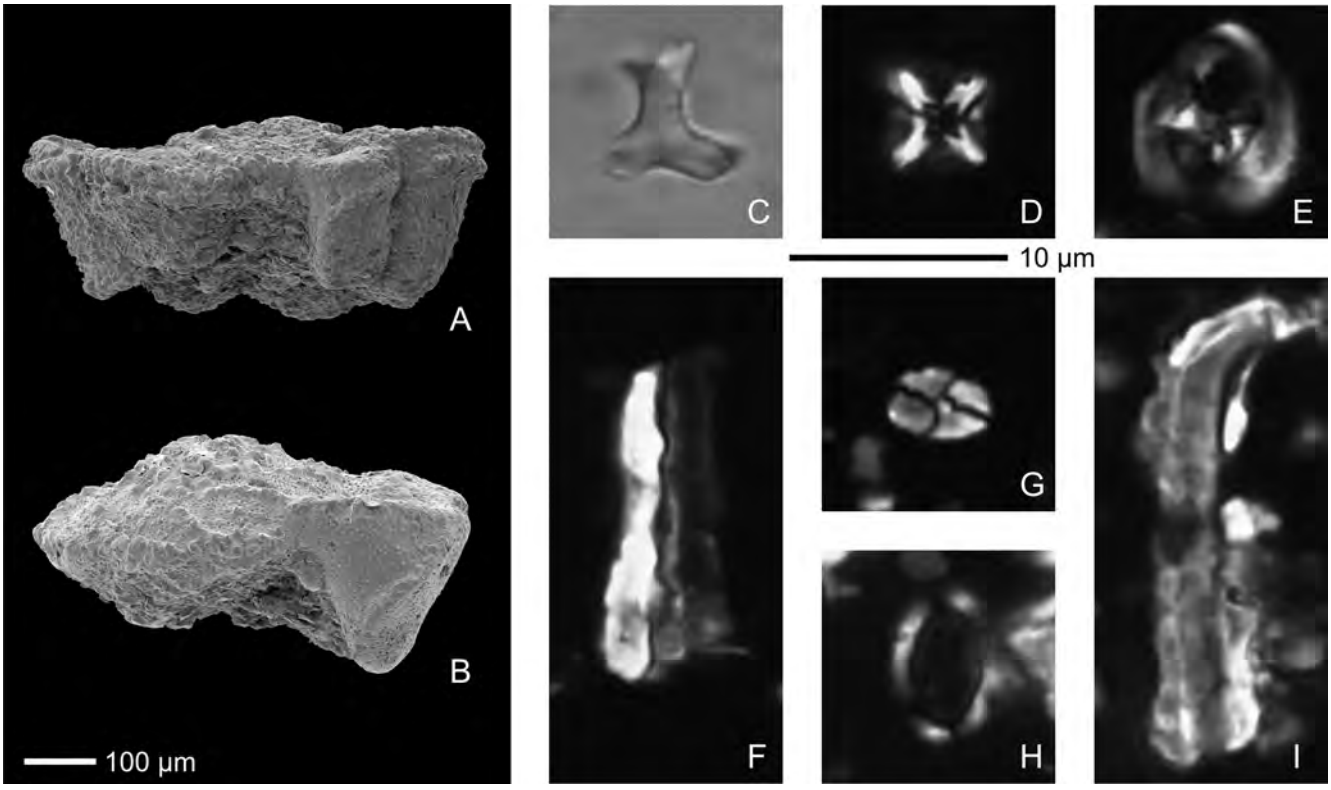
Gavelinella lorneiana (D'ORBIGNY)

Gavelinella stelligera (MARIE)

Gavelinella tumida BROTZEN

Globorotalites michelinianus (D'ORBIGNY)

Globotruncana bulloides (VOGLER)



Text-Fig. 7.
Key planktic foraminifera and nannofossil marker species recognised in the Schattau section.
Planktic foraminifera (SEM photographs): A. *Dicarinella asymetrica* (SIGAL, 1952), side view, sample Schatt 06-4; B. *Globotruncanita stuartiformis* (DALBIEZ, 1955), side view, sample Schatt 06-10.
Calcareous nannofossils (Zeiss light microscope, all crossed-polarised light except C; for taxonomy see p. 162–163; C. *Marthasterites furcatus*, sample Schatt 97-1; D. *Micula decussata*, sample Schatt 97-1; E. *Reinhardtites anthophorus*, sample Schatt 97-1; F. *Lucianorhabdus cayeuxii*, Schatt 06-3; G. *Calculites obscurus*, sample Schatt 97-1; H. *Arkhangelskiella* cf. *cymbiformis*, sample Schatt 06-5; I. *Lucianorhabdus cayeuxii* (curved morphotype), sample Schatt 97-13.

Globotruncana cf. *arca* Cushman

Globotruncana linneiana (d'Orbigny)

Globotruncana neotricarinata Petrizzo

Globotruncanita elevata (Brotzen)

Globotruncanita stuartiformis (Dalbiez)

Gyroidinoides beisseli (White)

Gyroidinoides nitidus (Reuss)

Haplophragmium aequale (Roemer)

Haplophragmoides sp.

Planoheterohelix globulosa (Ehrenberg)

Hoeglundina cf. *supracretacea*

Lagena sp.

Lagena sulcatiformis Pozaryska & Urbanek

Lenticulina marcki (Reuss)

Lenticulina secans (Reuss)

Lenticulina spp.

Lenticulina subalata (Reuss)

Lenticulina subangulata (Reuss)

Marginotruncana angusticarinata (Gandolfi)

Marginotruncana coronata Bolli

Marginotruncana marginata Reuss

Marginotruncana pseudolinneiana Pessagno

Marginotruncana sinuosa Porthault

Marginotruncana undulata (Lehmann)

Neoflabellina laterecompressa Tollmann

Nodosaria affinis (?) d'Orbigny

Nodosaria cf. *vertebralis* d'Orbigny

Nodosaria sp.

Nodosaria sp. 1

Nodosaria zippei Reuss

Nummofallotia cretacea (Schlumberger)

Oridosalis umbonatus (Reuss)

Osangularia sp.

Praebulimina braebra (Stemprokova-Jirova)

Praebulimina reussi (Morrow)

Quadrimorphina sp.

Quinqueloculina aspera d'Orbigny

Ramulina sp. 1

Saracenaria triangularis (d'Orbigny)

Sigalia decoratissima (De Klasz)

Sigalia sp.

Spiroloculina fassistomata Grzybowski

Spiroplectammina baudouiniana (d'Orbigny)

Spiroplectammina praelonga (Reuss)

Stensioeina exsculpta (Reuss)

Subreophax scalaris

Triplasia murchisoni Reuss

Tritaxia jarvisii Cushman

Tritaxia tricarinata (Reuss)

Tritaxia trilatera (Cushman)

Vaginulina trilobata d'Orbigny

Valvulineria lenticula (Reuss)

Ventilabrella eggeri (Cushman)

Verneuilina muensteri Reuss

Nannoplankton

(Michael Wagreich)

Nannoplankton samples from the Schattaugraben section display a good to moderate preservation with a higher degree of overgrowth in the upper part of the section. Nannofossil abundances are moderate at around 10–20 specimens per field of view, with varying amounts of calcareous silt. In total, 71 nannofossil species could be distinguished Nannofossil assemblages are dominated by the genera *Watznaueria, Zeugrhabdotus, Prediscosphaera, Cribrosphaerella, Chiastozygus* and *Eiffellithus*. Holococcoliths like *Lucianorhabdus* ssp. and *Calculites* ssp. are consistently present in moderate to high abundances.

The Schattaugraben section shows the following succession of nannofossils marker species from base to top (Text-Figs. 5, 7): (1) co-occurrence of *Lucianorhabdus cayeuxii* and *Calculites obscurus* together with *Marthasterites furcatus* (Text-Fig. 8) and *Micula decussata* from the base of the section onwards, (2) curved *Lucianorhabdus cayeuxii* (*L. cayeuxii* B of Wagreich, 1992) are consistently present from below the Sandkalkbank upwards, (3) small *Arkhangelskiella* sp. (< 10 µm) resembling *Arkhangelskiella cymbiformis* occur above the *Micraster* Bed, in the topmost part of the section. The first occurrence of *Broinsonia parca parca* is not recorded in the section. *Broinsonia parca expansa*, the possible ancestor of *B. parca parca*, is extremely rare and was found only in two samples. In neighbouring sections and elsewhere in the Gosau Basin, *B. parca parca* appears in the uppermost part of the Bibereck Formation (Wagreich, 1992; Wagreich & Neuhuber, 2005), apparently not exposed in the Schattaugraben section.

Calcareous nannoplankton zonations at the Santonian–Campanian boundary interval either use the classical standard zonation scheme of Sissingh (1977) and Perch-Nielsen (1985) with CC zones (see also Ogg & Hinnov, 2012) or the newer Burnett (1998) UC zones. In the late Santonian/early Campanian interval, Perch-Nielsen (1985) recognised the standard zones CC16 (defined by the FO of *Lucianorhabdus cayeuxii*), CC17 (defined by the FO ["first regular occurrence" after Sissingh (1977)] of *Calculites obscurus*), and CC18 (defined by the FO of *Broinsonia parca parca*). Most nannofossil workers placed the base of the Campanian within CC17 or at the base of CC18 (e.g. Perch-Nielsen, 1985; Wagreich, 1992; Cunha et al., 1997). Wagreich (1992) recognised the FO of curved morphotypes of

Lucianorhabdus cayeuxii as a regional marker in northwestern Tethyan sections from Spain to Hungary within CC17, below the Santonian/Campanian boundary (WAGREICH, 1992; LANTOS et al., 1997; KÜCHLER & WAGREICH, 2002) and thus divided this zone into two subzones, CC17a and CC17b, base defined by the FO of curved *Lucianorhabdus cayeuxii*.

BURNETT (1998) defined new UC zones and subzones for the Santonian to basal Campanian: zone UC12, base defined by the LO of *Lithastrinus septenarius* (middle to late Santonian), UC13, base defined by the FO of *Arkhangelskiella cymbiformis*, and UC14a, base defined by the FO of *Broinsonia parca parca*, top defined by the FO of *Broinsonia parca constricta*. Originally, BURNETT (1998) placed the Santonian/Campanian boundary as defined by the LO of *Marsupites testudinarius*, in the uppermost part of UC12, just below the FO of *Arkhangelskiella cymbiformis* LATERON, HAMPTON et al. (2007) found the FO of *Arkhangelskiella cymbiformis* considerably lower in the late Santonian, close to the base of the *Uintacrinus socialis* crinoid Zone which indicates that *A. cymbiformis* is not a reliable marker for the Santonian/Campanian boundary.

Within the Schattaugraben section, nannofossil standard zone CC17 of PERCH-NIELSEN (1985) was identified in the lower part of the section based on the co-occurrence of *Lucianorhabdus cayeuxii* and *Calculites obscurus*. This corresponds to zone UC12 of BURNETT (1998) as *Lithastrinus septenarius* is absent in the section except one questionable occurrence in one sample probably due to reworking. Curved *Lucianorhabdus cayeuxii* are present from below the Sandkalkbank Member upwards, which indicates the regional nannofossil zone CC17b of WAGREICH (1992). No abundance increase of *Calculites obscurus* has been recognised in contrast to chalk sections where an acme of this species was recognised around the Santonian/Campanian boundary (HAMPTON et al., 2007). The topmost part of the Schattaugraben section can be assigned to UC13 as small morphotypes of *Arkhangelskiella* cf. *cymbiformis* are present. However, *Arkhangelskiella cymbiformis* is not regarded as a reliable marker here due to the very low abundances encountered. According to HAMPTON et al. (2007) the Santonian/Campanian boundary has to be placed above that nannofossils event, and is not represented in the Schattaugraben section but occurs in neighbouring sections to the west where *Broinsonia parca parca* was found (WAGREICH, 1988). A full list of all nannofossil taxa encountered in the Schattaugraben section is given below.

List of nannofossil taxa encountered in the Schattaugraben section. Nannofossil taxonomy follows mainly BURNETT (1998) and the Nannotax web site (www.mikrotax.org/Nannotax3/index.html); bibliographic references can be found in PERCH-NIELSEN, 1985, and BURNETT, 1998). *Marthasterites* cf. *inconspicuus/furcatus*: see Text-Figure 8.

Ahmuellerella octoradiata (GÓRKA, 1957) REINHARDT, 1966

Amphizygus brooksii BUKRY, 1969

Arkhangelskiella cf. *A. cymbiformis* VEKSHINA, 1959 (< 10 µm)

Biscutum constans (GÓRKA, 1957) BLACK in BLACK & BARNES, 1959

Biscutum cf. *B. ellipticum* (GÓRKA, 1957) BLACK in BLACK & BARNES, 1959

Braarudosphaera bigelowii (GRAN & BRAARUD, 1935) DEFLANDRE, 1947

Broinsonia enormis (SHUMENKO, 1968) MANIVIT, 1971

Broinsonia cf. *B. matalosa* (STOVER, 1966) BURNETT in GALE et al., 1995

Broinsonia parca expansa (STRADNER, 1963) WISE & WATKINS in WISE, 1983

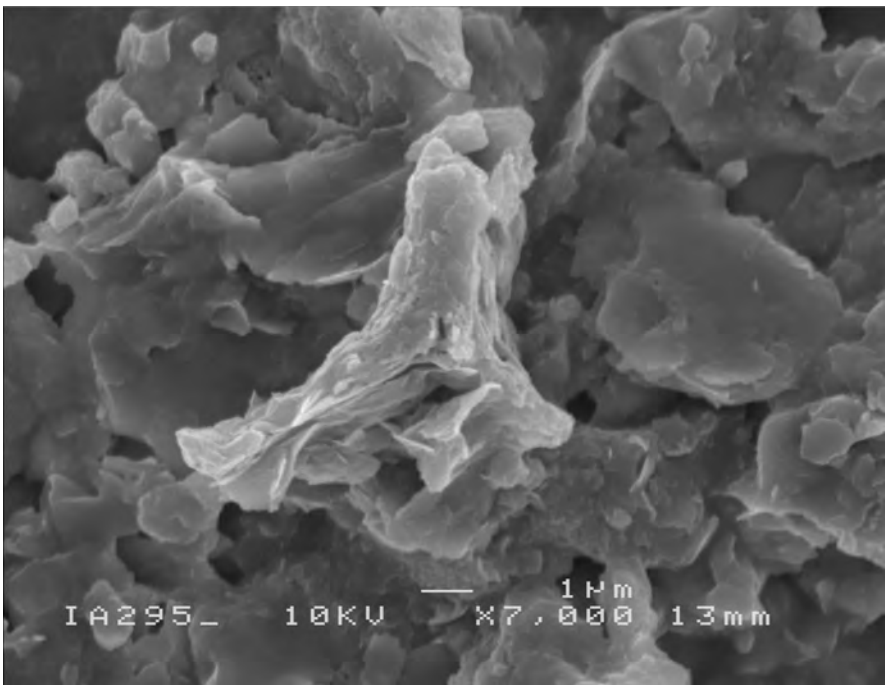
Calculites obscurus (DEFLANDRE, 1959) PRINS & SISSINGH in SISSINGH, 1977

Calculites ovalis (STRADNER, 1963) PRINS & SISSINGH in SISSINGH, 1977

Chiastozygus litterarius (GÓRKA, 1957) MANIVIT, 1971

Corollithion exiguum STRADNER, 1961

Corollithion signum STRADNER, 1963



Text-Fig. 8.
Marthasterites cf. *inconspicuus/furcatus,* sample Schatt 97-1 (SEM photograph). Note: bad preservation.

Cretarhabdus conicus Bramlette & Martini, 1964

Cribrosphaerella ehrenbergii (Arkhangelsky, 1912) Deflandre in Piveteau, 1952

Cyclagelosphaera sp.

Cylindralithus sp.

Cylindralithus biarcus Bukry, 1969

Cylindralithus cf. *C. sculptus* Bukry, 1969

Cylindralithus serratus Bramlette & Martini, 1964

Eiffellithus eximius (Stover, 1966) Perch-Nielsen, 1968

Eiffellithus turriseiffelii (Deflandre in Deflandre & Fert, 1954) Reinhardt, 1965

Gartnerago obliquum (Stradner, 1963) Noel, 1970

Gartnerago cf. *G. segmentatum* (Stover, 1966) Thierstein, 1974

Haqius sp.

Helicolithus trabeculatus (Górka, 1957) Verbeek, 1977

Lithastrinus grillii Stradner, 1962

Lithastrinus cf. L. septenarius Forchheimer, 1972

Lithraphidites carniolensis Deflandre, 1963

Lucianorhabdus arcuatus Forchheimer, 1972

Lucianorhabdus sp.

Lucianorhabdus cayeuxii Deflandre, 1959

Lucianorhabdus cayeuxii ssp. B Deflandre, 1959 (curved morphotype)

Lucianorhabdus maleformis Reinhardt, 1966

Lucianorhabdus cf. *L. maleformis* Reinhardt, 1966 (small morphotype)

Manivitella pemmatoidea (Deflandre in Manivit, 1965) Thierstein, 1971

Marthasterites furcatus (Deflandre in Deflandre & Fert, 1954) Deflandre, 1959

Microrhabdulus belgicus Haye & Towe, 1963

Microrhabdulus decoratus Deflandre, 1959

Micula decussata Vekshina 1959

Nannoconus sp.

Nannoconus cf. *N. multicadus* Deflandre & Deflandre-Rigaud, 1959

Nannoconus cf. *N. truitti truitti* Brönnimann, 1955

Octolithus multiplus (Perch-Nielsen, 1973) Romein, 1979

Ottavianus giannus Risatti, 1973

Pharus simulacrum Wind & Wise in Wise & Wind, 1977

Prediscosphaera cretacea (Arkhangelsky, 1912) Gartner, 1968

Prediscosphaera spinosa (Bramlette & Martini, 1964) Gartner, 1968

Quadrum cf. *Q. gartneri* Prins & Perch-Nielsen in Manivit et al., 1977 (small morphotype)

Reinhardtites anthophorus (Deflandre, 1959) Perch-Nielsen, 1968

Retecapsa crenulata (Bramlette & Martini, 1964) Grün in Grün & Allemann, 1975

Retecapsa cf. *R. surirella* (Deflandre & Fert, 1954) Grün in Grün & Allemann, 1975

Rhagodiscus angustus (Stradner, 1963) Reinhardt, 1971

Rhagodiscus asper (Stradner, 1963) Reinhardt, 1967

Rhagodiscus reniformis Perch-Nielsen, 1973

Rhagodiscus splendens (Deflandre, 1953) Verbeek, 1977

Rotelapillus sp.

Russellia sp.

Semihololithus? sp.

Staurolithites cf. *crux* (Deflandre & Fert, 1954) Caratini, 1963

Stephanolithion? sp.

Tranolithus minimus (Bukry, 1969) Perch-Nielsen, 1984

Tranolithus orionatus (Reinhardt, 1966a) Reinhardt, 1966b

Watznaueria barnesiae (Black, 1959) Perch-Nielsen, 1968

Zeugrhabdotus biperforatus (Gartner, 1968) Burnett, 1998

Zeugrhabdotus diplogrammus (Deflandre in Deflandre & Fert, 1954) Burnett in Gale et al., 1996

Zeugrhabdotus embergeri (Noël, 1958) Perch-Nielsen, 1984

Zeugrhabdotus erectus (Deflandre in Deflandre & Fert, 1954) Reinhardt, 1965

Zeugrhabdotus cf. *Z. sigmoides* (Bramlette & Sullivan, 1961) Bown & Young, 1997

Zeugrhabdotus spiralis (Bramlette & Martini, 1964) Burnett, 1998

Biostratigraphy

(Herbert Summesberger & Michael Wagreich)

Kennedy et al. (1995: 385, Fig. 7) established the *Paraplanum* Subzone as top Santonian subzone of the *Polyopsis* Zone, demonstrable in the Corbières, in Aquitaine, in the Münster basin (Rapen near Recklinghausen) and originally in the Austrian "Sandkalkbank" of the Gosau Group, the index ammonite *Placenticeras polyopsis* (Dujardin, 1837) co-occurs in the lower part of the zone in Northwest Europe and the Corbières, but co-occurring with typical late Santonian taxa like *Marsupites*, *Boehmoceras* and *P. paraplanum* in the Münster basin, Aquitaine. This assemblage of the *Paraplanum* Subzone is described and completed in the Schattaugraben section of the Gosau Group (Austria). *Texasia dentatocarinata* occurring above the *Micraster* Bed near the top of the section together with *Inoceramus germanicus* is the youngest ammonite in the Gosau area. After Hancock & Gale (1996) it occurs below the Santonian/Campanian boundary. All indications by inoceramids point to a top Santonian age (Hancock & Gale: 167), corroborated by the findings of *Marsupites laevigatus*, a precursor of *M. testudinarius*, in the upper part of the section (Wagreich et al., 2010). Based on ammonites and inoceramids it was not possible to find a marker horizon for the base of the Campanian in the Schattaugraben section.

Chronostratigraphy

(Michael Wagreich)

Biostratigraphic data from the Schattaugraben section are corroborated by stable isotope data and strontium isotopes (Wagreich et al., 2010) to fix the chronostratigraphic position of the section within the Santonian–Campanian boundary interval. Carbon isotope data from the section indicate a trend from higher values around the Sandkalkbank Member to lower values at the top of the section. Correlation with the standard curve of Jarvis et al. (2006) may

thus indicate that the profile from the Sandkalkbank Member to the top of the section may represent the decreasing part of the late Santonian Hawks Brow event (WAGREICH et al., 2010). The Hawks Brow event has its peak around the base of the *Marsupites* Zone with a succeeding decrease in the lower part of this zone. However, our data did not allow the position of the peak to be identified.

$^{87}Sr/^{86}Sr$ ratios were also reported by WAGREICH et al. (2010). The corrected isotope value (for methods see WAGREICH et al., 2010) from the Sandkalkbank Member (0.707466) is markedly lower than the value for the *Micraster* Bed (around 0.707500) (Text-Fig. 5). This ratio is already above the range of reported values for the Santonian/Campanian boundary (GALE et al., 1995; SCHÖNFELD et al., 1996; MCARTHUR et al., 2001) although still within the error range for the strontium isotope curve of MCARTHUR et al. (2001). WAGREICH et al. (2010) concluded that high diagenetic influence may have slightly altered strontium isotopes from the Schattaugraben section.

Putting all evidence together the chronostratigraphic position of the Schattaugraben section can be constrained to the late Santonian, below the lower boundary of the Campanian, both as defined by the LO of *Marsupites testudinarius* and by the base of the magnetochron C33r. A late Santonian age is based on evidence from carbon isotopes, i.e. the decreasing part of the late Santonian Hawks Brow event of JARVIS et al. (2006) below the Santonian/Campanian boundary event (WENDLER, 2013), planktic foraminifera, i.e. the *asymetrica-elevata* Concurrent Range Zone or the *asymetrica* Zone, nannofossils, i.e. standard zones CC17 and UC12/UC13, echinoids, ammonites and inoceramids.

According to the carbon isotope curve of JARVIS et al. (2006) and their absolute age models the upper part of the Schattaugraben section (65 m) may most probably cover an interval from ca. 84.2 Ma (Hawks Brow peak) to ca. 83.8 Ma (onset of carbon isotope increase to Santonian/Campanian boundary event), i.e. around 400 ka. Although the base is only loosely constrained this gives a mean sediment accumulation rate of ca. 16 cm/ka. According to newer age models of SAGEMAN et al. (2014) and cyclostratigraphy applied by THIBAULT et al. (2016) the total stratigraphic range of *Marsupites* covers only one single 405 ka orbital cycle, thus the upper part of the Schattaugraben section may include an even shorter time interval of considerably less than 405 ka, slightly older than the Santonian/Campanian boundary at 84.19 Ma (SAGEMAN et al., 2014).

Abbreviations

NHMW	Museum of Natural History Vienna, Austria.
SK	Dr. Peter Skoumal collection, Vienna, Austria.
MA	Wolf-Peter Maherndl collection, Bad Ischl, Austria.
CG	Gustav Gapp collection, Gosau, Austria.
PIUW	Institute of Palaeontology, University of Vienna, Austria.
HNS	Haus der Natur, Salzburg, Austria.
GBA	Geologische Bundesanstalt (Geological Survey of Austria, former k. k. Geologische Reichsanstalt), Vienna, Austria.
OÖLM	Oberösterreichisches Landesmuseum, Linz, Austria.
BMNH	British Museum of Natural History, London, UK.
BSP	Bayerische Staatssammlung für Paläontologie und historische Geologie, Munich, Germany.
GIUL	Geological Institute University of Leipzig, Germany.
TUBF	Inoceramid Collection, Geological Institute, Mining Academy Freiberg, Germany.
r	right valve
l	left valve
d	double valved
def.	deformed
rest.	restored
est.	estimated

Systematic Palaeontology

Inoceramids

(KARL-ARMIN TRÖGER & HERBERT SUMMESBERGER)

Phylum Mollusca LINNAEUS, 1758
Class Bivalvia LINNAEUS, 1758
Subclass Pteriomorpha BEURLEN, 1944
Order Pteroida NEWELL, 1965
Superfamily Pteriacea GRAY, 1847
Family Inoceramidae GIEBEL, 1852

Five species of Inoceramidae occur in the Late Santonian *Paraplanum* Subzone of the Schattaugraben section: *Cordiceramus muelleri muelleri* (PETRASCHECK, 1906), *Cordiceramus germanicus* (HEINZ, 1928), *Cordiceramus bueltenensis* (SEITZ, 1961), *Platyceramus ahsenensis* (SEITZ, 1961) and *Sphenoceramus* ex gr. *pachti/cardissoides*.

Genus *Cordiceramus* HEINZ, 1932

Type species: *Inoceramus cordiformis* J. DE C. SOWERBY (1823), designated by HEINZ (1932).

Cordiceramus muelleri muelleri (PETRASCHECK, 1906)

Pl. 1, Fig. 2

1866 *Inoceramus cripsi* var. *regularis* D'ORBIGNY; ZITTEL: Pl. 14, Fig. 3, Pl. 15, Fig. 5.

1906 *Inoceramus Mülleri* nov. spec. PETRASCHECK: 160, Text-Fig. 1, Pl. 6, Figs. 1, 2.

1961 *Inoceramus* (*Cordiceramus*) *mülleri mülleri* PETRASCHECK; SEITZ: 127, Pl. 7, Figs. 2, 5, 8, Text-Figs. 27, 28.

1961 *Inoceramus* (*Cordiceramus*) *mülleri gosauensis* n. subsp.; SEITZ: 135, Pl. 8, Fig. 3, Text-Figs. 29, 30.

1967 *Inoceramus* (*Cordiceramus*) *mülleri* PETRASCHECK; SEITZ: 45, 126, Pl. 1, Fig. 4.

1987 *Inoceramus* (*Cordiceramus*) *muelleri* PETRASCHECK, 1906; DHONDT: 65, Pl. 3, Figs. 4, 5.

1994 *Cordiceramus muelleri muelleri* (PETRASCHECK); TRÖGER & SUMMESBERGER: 185, Pl. 3, Fig. 5.

2000 *Cordiceramus muelleri* (PETRASCHECK); SUMMESBERGER in EGGER et al.: 27.

2007 *Cordiceramus muelleri* (PETRASCHECK); WALASZCZYK & COBBAN: 137, 139, Fig. 6A.

2010 *Cordiceramus muelleri muelleri* (PETRASCHECK, 1906); WAGREICH et al.: 186.

2017c *Cordiceramus muelleri muelleri* (PETRASCHECK, 1906); SUMMESBERGER et al.: 123.

Type: Lectotype is GBA/1906/006/0001, the original of *Inoceramus Mülleri* PETRASCHECK, 1906 (Pl. 6, Figs. 1, 2), designated by SEITZ (1961: 127). A cast was refigured by SEITZ (1961: Pl. 7, Fig. 2a).

Type locality: Hofergraben, Gosau (Upper Austria), close to the localities Finstergrabenwandl and Gosauschmied, late Santonian Sandkalkbank Member of the Hochmoos Formation.

Material: Besides the lectotype (GBA/1906/006/0001) eight partially bivalved specimens from the Schattaugraben section: SK/B/SG/1996/1, SK/B/SG/1996/2/1 r and l, SK/B/SG/1996/2/2 r and l, SK/B/SG/1996/2a, SK/B/SG/1996/3 r and l; NHMW 2006z0165/0001 r and l, NHMW 2000/0004 r and l, NHMW 2000/0006 r and l; one specimen from Finstergraben (Gosau; Collection Felix, GIUL); three specimens from Heudeber-Danstedt near Halberstadt (Subhercynian Cretaceous Basin; TUBF).

Description: For description see SEITZ (1961: 127–130), for new interpretation of the *Endocostea* 'scar' see LÓPEZ (2006).

Discussion: DHONDT (1987: 66) suggested "that the differences stated to exist by Seitz between the 'subspecies' of *I. muelleri* are probably simply due to normal biological variability, … combined with a deformation factor." In this context it is interesting to note, that the type specimen of SEITZ (1961: Pl. 8, Fig. 3) new subspecies "*Inoceramus* (*Cordiceramus*) *mülleri gosauensis*" is a specimen from the Schattaugraben section. Already SEITZ (1967) concluded, that "*Inoceramus* (*Cordiceramus*) *mülleri gosauensis"* was a deformed specimen of "*Cordiceramus muelleri muelleri* (PETRASCHECK)". This was confirmed by DHONDT (1987).

Occurrence: In the type area (Gosau basin, Austria) *Cordiceramus muelleri muelleri* occurs abundantly in the late Santonian *Paraplanum* Subzone. There is a remarkable mass occurrence in the Sandkalkbank Member of the Santonian Schattaugraben section. Elsewhere (e.g. Germany) it occurs in the late Santonian and possibly in the lowermost Campanian (DHONDT, 1987: 66).

Cordiceramus germanicus (HEINZ, 1928)

Pl. 2, Fig. 1

1928 *Inoceramus germanicus* HEINZ: 82, footnote 1.

1931 *Endocostea typica* WHITFIELD; RIEDEL: 664, Pl. 75, Figs. 3, 4 [only].

1932 *Inoceramus nigrita* HEINZ: 12.

1933 *Germanoceramus germanicus* (HEINZ); HEINZ: 250, Pl. 21, Fig. 2 [only].

1961 *Inoceramus* (*Cordiceramus*) *mülleri germanicus* HEINZ, 1928; SEITZ: 131–135, Pl. 7, Fig. 6, Pl. 8, Figs. 1, 6, 7, Pl. 15, Fig. 1, Text-Figs. 29, 30 [with synonymy].

1967 *Inoceramus* (*Cordiceramus*) *mülleri germanicus* HEINZ; SEITZ: 129–131, Pl. 23, Fig. 3, Pl. 26, Figs. 4, 5, Pl. 27, Figs. 1, 4, 6.

1994 *Cordiceramus muelleri germanicus* (HEINZ, 1928); TRÖGER & SUMMESBERGER: 176, 185, Pl. 3, Fig. 5.

2006 *Cordiceramus germanicus* (HEINZ, 1933); WALASZCZYK & COBBAN: 314, Figs. 43.1, 43.2 [with complete synonymy].

2008 *Cordiceramus germanicus* (HEINZ, 1933); WALASZCZYK in GALE et al.: 150, Text-Figs. 15A–C, E.

Holotype is the original of *Inoceramus germanicus* (HEINZ, 1933: Pl. 21, Fig. 2) from Groß Bülten next Braunschweig (Germany) designated by SEITZ (1961: 131).

Material: NHMW 2010/0081/0010 from the Bibereck Formation on top of the Schattaugraben section, NHMW 2000z0003d, NHMW 2010/0003 r from the Schattaugraben section, NHMW 1997z0144/0001 l, NHMW 1997z0144/0006 l, NHMW 1990/0029/0201, NHMW 1990/0029/0195 from the Sandkalkbank Member of the Hochmoos Formation, furthermore ZITTEL'S original (1866: Pl. 15, Fig. 5; NHMW 1864/0040/1187) from the nearby situated Hofergraben (Gosau, Upper Austria).

Description and Discussion: For description see SEITZ (1961: 131–135), for discussion see WALASZCZYK & COBBAN (2006: 315).

Occurrence: Following SEITZ (1961: 131) *Cordiceramus germanicus* (HEINZ, 1928) occurs in the Santonian and is possibly limited to the late Santonian. In the Gosau Group it occurs in the late Santonian *Paraplanum* Subzone of the Schattaugraben section from the Sandkalkbank Member of the Hochmoos Formation through the basal Bibereck Formation, co-occurring at the top of the section with *Texasia dentatocarinata* (F. ROEMER, 1852). After WALASZCZYK & COBBAN (2006: 316) it occurs in the late Santonian and early Campanian of Europe, West Asia, Africa and North America. After WALASZCZYK in GALE et al. (2008: 150) *C. germanicus* marks the lowest of three inoceramid Zones in the Austin Chalk of the Waxahachie section of Texas.

Cordiceramus bueltenensis (SEITZ, 1961)

Pl. 2, Fig. 2

1961 *I.* (*Cordiceramus*) *bueltenensis bueltenensis* n. sp., n. ssp.; SEITZ: 142, Pl. 9, Figs. 2, 4–6, Text-Figs. 33, 34.

2006 *Cordiceramus bueltenensis* SEITZ, 1961; WALASZCZYK & COBBAN: 318, Text-Figs. 45.1–45.3, 45.6, 46.1 [with synonymy].

2008 *Cordiceramus bueltenensis*; COBBAN et al.: Fig. 2.

Type: Holotype by original designation is the original of SEITZ (1961: Pl. 9, Fig. 1).

Material: A single specimen, NHMW 2010/0081/0011, from the *Micraster* Bed (sample n°: Schattau 16).

Description: NHMW 2010/0081/0011 is an internal mould of the right valve with preserved remnants of shell.

Discussion: After WALASZCZYK & COBBAN (2006: 318) the differences between the two subspecies *I.* (*Cordiceramus*) *bueltenensis bueltenensis* (SEITZ, 1961) and *I.* (*Cordiceramus*) *bueltenensis wolanskyae* (SEITZ, 1961) reflects size differences and are not of taxonomic importance.

Occurrence: *Cordiceramus bueltenensis* (SEITZ, 1961) occurs in the Santonian of Germany (Groß Bülten), Spain, France, Romania, Crimea, Caucasus, Turkmenian Republic, Madagascar, North- and Central America. In the Schattaugraben section it occurs in the *Micraster* Bed of the Bibereck Formation (*Paraplanum* Subzone) and is described here for the first time from the Gosau Group of Austria.

Genus *Platyceramus* HEINZ, 1932

Type species: *Inoceramus mantelli* (DE MERCEY) BARROIS, 1879 (Pl. 4, Fig. 1) by original designation of HEINZ (1932).

Platyceramus ahsenensis (SEITZ, 1961)

Pl. 1, Fig. 1

1931 *Inoceramus cycloides* WEGNER var. *quadrata* n. var. RIEDEL: 662, Pl. 74, Fig. 4.

1961 *Inoceramus* (*Platyceramus*) *cycloides ahsenensis* SEITZ: 63, Pl. 1, Figs. 7, 9, 10, Text-Figs. 12, 13 [with synonymy].

1967 *Inoceramus* (*Platyceramus*) *cycloides ahsenensis* SEITZ, 1961; SEITZ: 45, 81, Pl. 1, Fig. 2, Pl. 11, Figs. 1, 2, Pl. 13, Fig. 3, Text-Figs. 12, 13.

1987 *Inoceramus* (*Platyceramus*) spec. cf. *Inoceramus* (*Platyceramus*) *cycloides ahsenensis* SEITZ, 1961; DHONDT: 66.

1994 *Platyceramus cycloides ahsenensis* (SEITZ, 1961), TRÖGER & SUMMESBERGER: 173, Text-Fig. 3.

2004 *Platyceramus ahsenensis* (SEITZ, 1961); REMIN: 593.

2006 *Platyceramus ahsenensis* (SEITZ, 1961); WALASZCZYK & COBBAN: 295, Text-Figs. 32.2–32.5.

2008 *Platyceramus ahsenensis* (SEITZ, 1961); WALASZCZYK in GALE et al.: 153–154, Text-Figs. 16A–D.

Type: Holotype by the subsequent designation of SEITZ (1961: 64) is *Inoceramus cycloides* WEGNER var. *quadrata* n. var. RIEDEL, 1931 (662, Pl. 74, Fig. 4).

Material: A single specimen NHMW 2010/0081/0012 is from the *Micraster* Bed in the Bibereck Formation.

Description: NHMW 2010/0081/0012 is an almost complete internal mold of a left valve with adherent shell remains. The specimen is slightly flattened, the hinge line is preserved. The surface is covered by a thin rusty layer.

Discussion of the species: See WALASZCZYK & COBBAN (2006: 295).

Occurrence: The occurrence in the Schattaugraben section is late Santonian. *P. ahsenensis* occurs in the *Micraster* Bed together with *Boehmoceras arculus* and *B. krekeleri* in the *Paraplanum* Subzone. Elsewhere it occurs from Santonian to early Campanian (see WALASZCZYK & COBBAN, 2006: 295). In the Waxahachie section (Texas; WALASZCZYK in GALE et al., 2008: 151, Text-Fig. 14) it occurs in the *Platyceramus ahsenensis* Acme Zone, this is above the *Cordiceramus germanicus* Zone and 3–5 metres below the base of the Campanian.

Genus *Sphenoceramus* J. BOEHM, 1915

Type species: *Inoceramus cardissoides* GOLDFUSS (1835) by subsequent designation of SEITZ (1965: 29).

Sphenoceramus ex gr. *cardissoides* (GOLDFUSS, 1835) / *pachti* (ARKHANGELSKY, 1916)

Pl. 2, Figs. 3a–b

cf. 1994 *Sphenoceramus cardissoides* (GOLDFUSS, 1835) subsp. indet. (transition to *Sphenoceramus pachti* ARKHANGELSKY, 1916); TRÖGER & SUMMESBERGER: 177, Pl. 3, Figs. 3, 3a, 3b.

Types: The holotype of *Sphenoceramus cardissoides* (GOLDFUSS, 1835) is the original of *Inoceramus cardissoides* GOLDFUSS, 1835 (Pl. 110, Fig. 2) from Germany. The lectotype of *Sphenoceramus pachti pachti* is the original of *Inoceramus cardissoides* var. *pachti* (ARKHANGELSKY, 1916 (Pl. 3, Fig. 2).

Material: A single specimen NHMW 2010/0081/0013 from the *Micraster* Bed of the Bibereck Formation.

Description: NHMW 2010/0081/0013 is a distorted fragment with shell remains.

Discussion: TRÖGER in TRÖGER & SUMMESBERGER (1994) noted the close relation between the figured specimen of *Sphenoceramus cardissoides* (GOLDFUSS, 1835) and *Sphenoceramus pachti* (ARKHANGELSKY, 1916). Again WALASZCZYK (in WALASZCZYK & COBBAN, 2006) understood both taxa as representatives of a group. SEITZ (1961) used the *Sphenoceramus cardissoides/pachti* group as a biostratigraphical marker for the base of the Santonian.

Occurrence: Following TRÖGER (2009: 128) *Sphenoceramus pachti pachti* occurs in the early and middle Santonian and rarely in the late Santonian, more or less contemporane-

ously with *Sphenoceramus cardissoides cardissoides*, which occurs in the middle and rarely in the late Santonian and early Campanian, also in the latest Coniacian. The Austrian occurrence is late Santonian *Paraplanum* Subzone.

Age indication by inoceramids

(Herbert Summesberger & Karl-Armin Tröger)

Following Walaszczyk (in Gale et al., 2008) *Cordiceramus germanicus* occurs in the *C. germanicus* Acme Zone which is dominated by the *C. muelleri* fauna. The *C. germanicus* Acme Zone is followed by the *Platyceramus ahsenensis* Acme Zone. This biostratigraphic succession in the top Santonian/Campanian Waxahachie section can be correlated tentatively with the Schattaugraben section: the mass occurrence of *Cordiceramus muelleri* in the Sandkalkbank Member corresponding to the *Cordiceramus germanicus* Acme Zone and the rare occurrence of *Platyceramus ahsenensis* in the *Micraster* Bed with the occurrence of the *P. ahsenensis* fauna in the Waxahachie section. Elsewhere (e.g. Germany) *Cordiceramus muelleri* occurs in the late Santonian too and possibly in the earliest Campanian (Dhondt, 1987: 66). All age indications by inoceramids point to a top Santonian age (Zone of *Placenticeras paraplanum* and *Boehmoceras arculus*) of the lithostratigraphical part of the Hochmoos and Bibereck Formations.

Cephalopods

Abbreviations

Wh	whorl height in mm
Wb	whorl breadth in mm
D	whorl diameter in mm
U	umbilicus in mm
U %	percentage of U in relation to D

Nautiloids

(Herbert Summesberger)

Class Cephalopoda Cuvier, 1797
Subclass Nautiloidea Agassiz, 1847
Order Nautilida Agassiz, 1847
Suborder Nautilina Agassiz, 1847
Superfamily Nautilacea de Blainville, 1825
Family Nautilidae de Blainville, 1825
Genus *Eutrephoceras* Hyatt, 1894

Type species: *Nautilus Dekayi* Morton (1834) by designation of Whitfield (1892).

Eutrephoceras cf. *indicum* (d'Orbigny, 1850)

Pl. 3, Figs. 1–5, Pl. 4, Figs. 1–3, Text-Figs. 9, 10, Tab. 1

Compare

cf. 1850 *Nautilus indicus* d'Orbigny, Prodrome II: 211.

cf. 1960a *Eutrephoceras indicum* (d'Orbigny, 1850); Wiedmann: 159, Text-Figs. 3–5, Pl. 21, Fig. G, Pl. 25, Figs. 1–4). With additional synonymy.

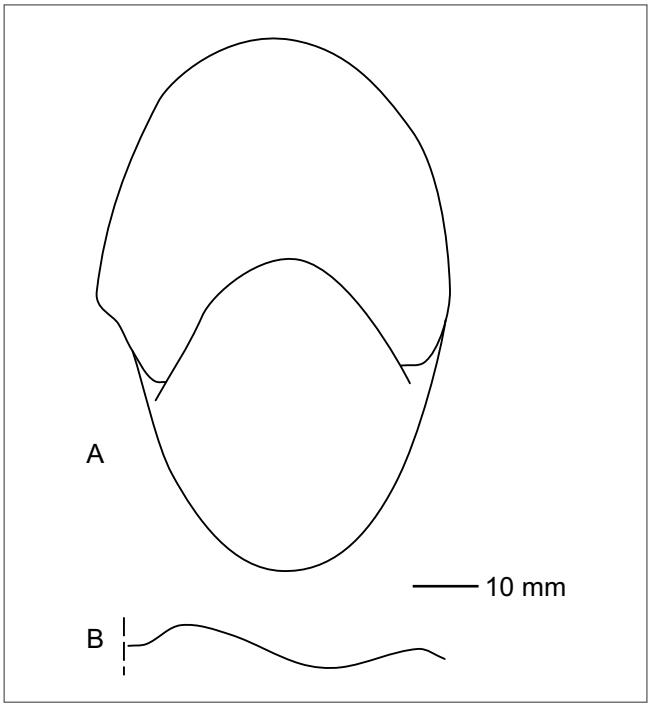
cf. ? 1960b *Eutrephoceras sublaevigatum* (d'Orbigny); Wiedmann: 715.

cf. 2000 *Eutrephoceras* cf. *indicum* (d'Orbigny, 1850); Wilmsen: 39, Pl. 4, Figs. 3a–c, Pl. 5, Figs. 10, 23.

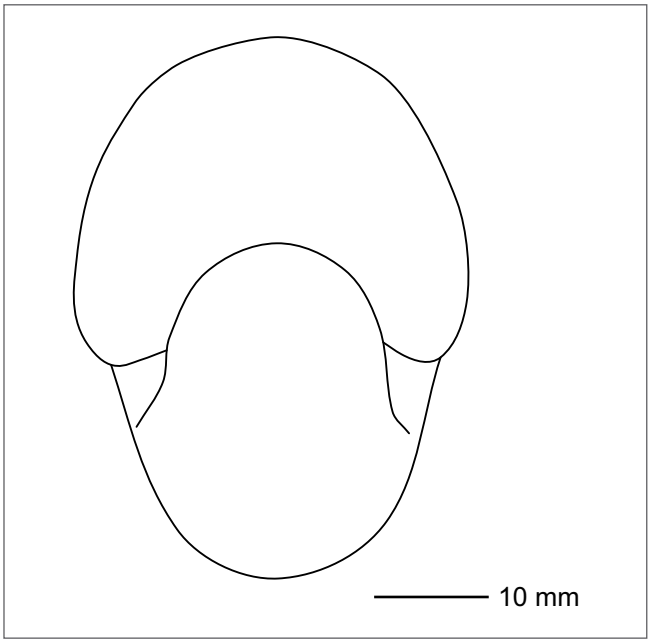
Type: See Wiedmann (1960a: 159).

Material: A single adult specimen from the Schattaugraben section NHMW 2009z0045/0001, a second adult one from the Gosau Group without locality details: NHMW 2009z0046/0001, a single subadult specimen (NHMW 1990/0029/0517a) and nine juveniles (NHMW 1990/0029/0515b, NHMW 1990/0029/0518a, NHMW 2009z0047/0002, SK/1983/10, SK/1983/14/1–5) from the Late Santonian Sandkalkbank Member (Hochmoos Formation, Gosau Group) of the locality Finstergrabenwandl (Gosau, Upper Austria). Two very small juveniles of *Eutrephoceras* cf. *indicum* (d'Orbigny, 1850) (D about 26 mm; SK/SG/2010/52a, b) are the only representatives of the Nautilida in the *Micraster* Bed of the Bibereck Formation.

Description: NHMW 2009z0045/0001 (Pl. 3, Figs. 1a, b, Text-Fig. 9) is the internal mould of a body chamber with two chambers of the phragmocone preserved. Although lacking the greater part of the phragmocone it is undeformed. The apertural margin is more or less complete



Text-Fig. 9.
A. *Eutrephoceras* cf. *indicum* (d'Orbigny, 1850) from the Austrian Gosau Group, NHMW 2009z0045/0001; upper Santonian, Schattaugraben section, Salzburg; diagrammatic cross section, restored. B. suture.



Text-Fig. 10.
Eutrephoceras cf. *indicum* (D'ORBIGNY, 1850), NHMW 1990/0029/0515/2 from the Late Santonian Hochmoos Formation/Sandkalkbank Member of the locality Finstergrabenwandl, Gosau, Upper Austria; apertural diagrammatic cross section, restored.

(Text-Fig. 9). The shell is missing but a few areas retaining a white powdery substance. The matrix is a fine grained hard calcareous sand- to siltstone. The section is slightly high oval. The greatest whorl breadth is close to the umbilicus. The flanks are gently inflated and continuously passing into the rounded umbilical wall as well as into the evenly rounded venter without ventrolateral shoulders. The umbilicus is tiny. There is no sculpture visible on the internal mould. Close to the apertural margin there is a moderate protuberance only on the left side possibly recording a minor pathological deformation or damage in life. The septa are slightly sinuous with concavities mid-flank and on the venter. The position of the siphuncle is unknown.

NHMW 2009z0046/0001 from the Austrian Gosau Group but without locality details is of comparable shape and size with shell preserved. Distinct growth lines are visible (Pl. 3, Fig. 2b). They arise projecting forward, bending backward at midflank forming a large concave sinus over the venter. NHMW 1990/0029/0515b (Pl. 3, Figs. 3a, b, Text-Fig. 10) is an undeformed and wholly septate juvenile.

Discussion: It should be kept in mind that NHMW 2009z0046/0001 lacks locality details. Its horizon within the Austrian Gosau Group remains doubtful. Nevertheless, its close to identical shape leads to the assumption that both specimens might be conspecific. Therefore, the preserved growth lines of NHMW 2009z0046/0001 might be used additionally to the description. Open nomenclature is used as the identification is based only on a small collection from the middle Turonian of Spain (WIEDMANN, 1960a: 159, Text-Figs. 3–5, Pl. 21, Fig. G, Pl. 24, Figs. 1–4).

Eutrephoceras indicum (D'ORBIGNY, 1850) from the middle Turonian of Spain differs by its slightly triangular whorl section (WIEDMANN, 1960a: Text-Figs. 3, 4). *Eutrephoceras* cf. *indicum* (D'ORBIGNY, 1850) from the middle Turonian *Romaniceras ornatissimum* Zone in Spain (WILMSEN, 2000: 39, Pl. 4, Figs. 3a–c, Pl. 5, Figs. 10, 23) is very similar and differs by slightly wider whorl breadth (Wb/Wh = 1.02 after WILMSEN, 2000: 39). *Eutrephoceras montiscastoris* spec. nov. described below is globular with a laterally widened aperture. *Eutrephoceras sublaevigatum* (D'ORBIGNY, 1850) (see WIEDMANN, 1960a: 165) from the Maastrichtian Gosau Group of Grünbach (Lower Austria) differs in its greater whorl breadth. *Eutrephoceras bouchardianum* (D'ORBIGNY, 1840) from the Albian of France (TINTANT & GAUTHIER, 2006) has a much wider aperture. *Eutrephoceras darupense* (SCHLÜTER, 1876) has much more widely spaced septa and has a more compressed whorl section. *Cimomia gosavica* (REDTENBACHER, 1873), co-occurring and re-described below differs in its high oval whorl section. *Angulithes* sp. from the early Maastrichtian of Gams (SUMMESBERGER et al., 2009) differs in its much narrower whorl section. *Angulithes* (*Angulithes*) *neubergicus* (REDTENBACHER, 1873) from the early Maastrichtian of Neuberg (Styria, Austria) differs from *Eutrephoceras indicum* in its triangular narrow whorl section, and fastigiate venter.

Occurrence: NHMW 2009z0045/0001 is from the upper Santonian of the Schattaugraben section without detailed information about its position within the section. NHMW 2009z0046/0001 is an unlabelled specimen from the Austrian Gosau Group. The remaining ones are from the Sandkalkbank Member of the Hochmoos Formation (late Santonian, Zone of *Boehmoceras arculus* and *Placenticeras paraplanum*, Gosau Group, Austria). Elsewhere *Eutrephoceras indicum* (D'ORBIGNY, 1850) is reported from the late middle Turonian of Spain and from the "Senonian" of India and Chile (WIEDMANN, 1960a; WILMSEN, 2000).

Inventory No.	D_{rest} (mm)	Wb (mm)	Wh (mm)	Wb/Wh	U (%)
NHMW 2009z0045/0001	84	52	50	1.04	--
NHMW 2009z0046/0001	83	48.6	57.5	0.84	--
NHMW 1990z0029/515b	51.4	35	26	1.34	2.5
NHMW 1990z0029/517a	72	45	40	1.15	--
NHMW 1990z0029/518a	48.5	34	30	1.13	--

Tab. 1.
Measurements of *Eutrephoceras* cf. *indicum* (D'ORBIGNY, 1850) from the Austrian Gosau Group. U % of D.

Eutrephoceras montiscastoris SUMMESBERGER, spec. nov.

Pl. 4, Figs. 4–6, Pl. 5, Figs. 1–3, Text-Fig. 11, Tab. 2

? 1876 *Nautilus* cf. *Neubergicus* SCHLÜTER: 174; non REDTENBACHER, 1873.

? 1876 *Nautilus Neubergicus* SCHLÜTER: Pl. 48, Figs. 3–5; non REDTENBACHER, 1873.

? 1960a *Eutrephoceras darupense* (SCHLÜTER, 1876); WIEDMANN: 157 (partim).

? 1960b *Eutrephoceras* cf. *neubergicum* (REDTENBACHER); WIEDMANN: 715.

? 1960b *Eutrephoceras* sp.; WIEDMANN: 717.

? 1991 *Eutrephoceras darupense* (SCHLÜTER, 1876); RIEGRAF & SCHEER: 428.

? 2000 *Eutrephoceras darupense* (SCHLÜTER, 1876); WILMSEN: 39, Pl. 4, Figs. 4, 5.

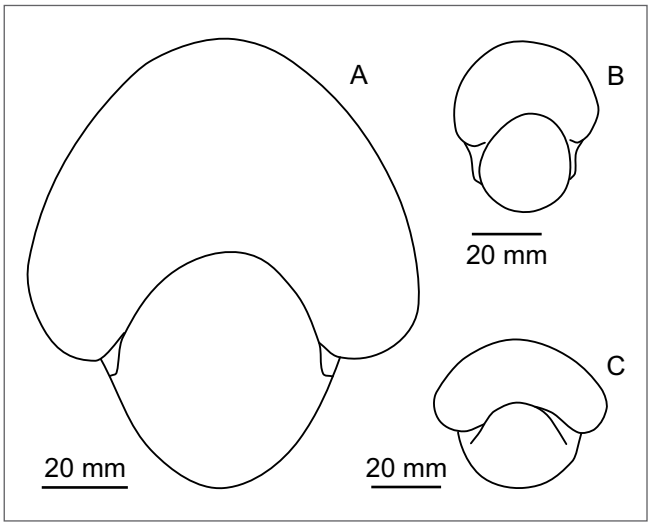
Type: Holotype designated herein is NHMW 1990/0029/0515a (Pl. 5, Figs. 1a–c) from the Sandkalkbank Member of the Hochmoos Formation of the locality Finstergrabenwandl at the Upper Austrian side of the basin of Gosau.

Etymology: After the Bibereck mountain (lat.: mons castoris) where the localities Schattaugraben and Finstergrabenwandl are situated.

Material: Besides the holotype (NHMW 1990/0029/0515a) a single individual (SK/SG/2007/49) is from the Schattaugraben section, five are from the Sandkalkbank Member of the locality Finstergrabenwandl (NHMW 1990/0029/0515/3, NHMW 1990/0029/0519/1, NHMW 2009z0047/0001, 2009z0047/0002, SK/1978/23) and a single specimen from the Sandkalkbank Member of the Schattau forest road (NHMW 2009z0048/0001).

Diagnosis: Globular shape in all growth stages, umbilicus deep and narrow, in adult stages closed, hornlike widened aperture in adults.

Description: One adult specimen (NHMW 1990/0029/0515a) and four juveniles from the Sandkalkbank Member of the locality Finstergrabenwandl are preserved as internal moulds with adherent remnants of white chalky shell. The general outline is globular. The whorl section is depressed and reniform. The width increases rapidly, widening finally to a hornlike aperture (Pl. 4, Figs. 4–6, Pl. 5, Figs. 1–3) with a maximum width close to the umbilicus. The umbilicus is very narrow and deep, in adult specimens closed. The umbilical wall is almost vertical, the umbilical shoulder is narrowly rounded. The flanks are constantly curved passing continuously into the venter. There is no ornament visible on the moulds from the Finstergrabenwandl. The regularly spaced sutures are prorsiradiate next to the umbilicus, sweeping back at the umbilical shoulder forming a shallow concavity midflanks and bending forward again in the ventrolateral region, crossing the venter with a slight concavity. The position of the siphuncle cannot be observed.



Text-Fig. 11.
Diagrammatic cross sections of *Eutrephoceras montiscastoris* spec. nov.: A. NHMW 1990/0029/0515/1; B. NHMW 1990/0029/0519/1; C. SK/SG/2007/49.

SK/SG/2007/49 from the Schattaugraben section is a distorted individual mainly consisting of the body chamber. It is, extraordinarily for the Schattaugraben section, preserved with light brownish shell. This preservation records fine somewhat irregular and occasionally thickened growth lines. They cross the flanks slightly curved and the venter with a marked concavity. The umbilicus of this specimen seems to have been almost closed. The apertural margin is damaged. All data measured on the deformed specimen are still meaningful. NHMW 2009z0048/0001 from the Schattaugraben forest road is a fragment of an internal mould of the phragmocone with adherent shell.

Discussion: *Eutrephoceras montiscastoris* spec. nov. differs from all described taxa from the Gosau Group by its globular shape and its laterally extremely widened aperture. *Eutrephoceras sublaevigatum* (D'ORBIGNY) (see WIEDMANN (1960a: 165) from the Maastrichtian Gosau Group of Grünbach (Lower

Inventory No.	D (mm)	Wb (mm)	Wh (mm)	Wb/Wh	U (%)
NHMW 1990/0029/0515a	98.5	66	51	1.29	--
NHMW 1990/00290/515/3	38	24	20	1.2	--
NHMW 1990/0029/0519/1	32	24	16	1.5	--
NHMW 2009z0047/0001	46.7	32.5	30	1.08	--
NHMW 2009z0047/0002	47.4	32	27	1.18	--
SK/SG/2007/49	65	42	36	1.16	--

Tab. 2.
Measurements of *Eutrephoceras montiscastoris* spec. nov. from the Late Santonian Sandkalkbank Member of the Gosau Group. U % of D.

Austria) differs in its narrower whorl section. The apertures cannot be compared as the only adult specimen, the original of REDTENBACHER (1873: 95, 96, Pl. 22, Fig. 2) lacks the body chamber. *Cimomia gosavica* (REDTENBACHER, 1873), co-occurring with *Eutrephoceras montiscastoris* spec. nov. and re-described below differs by its high oval section without any widening of the adult aperture. *Nautilus sowerbianus* HAUER, 1858 (non D'ORBIGNY, 1840) from the early Maastrichtian of Neuberg (Styria, Austria) was re-described under *Nautilus neubergicus* by REDTENBACHER (1873: 97, Pl. 22, Fig. 4; see below) and put under synonymy of *A.* (*Angulithes*) *fleuriausianus* (D'ORBIGNY, 1840) by WIEDMANN (1960a: 183). SCHLÜTER (1876: Pl. 48, Figs. 2, 4, 5) described two specimens from the Westphalian late Coniacian Zone of *Ammonites Margae* and compared them in the text with some caution with *Nautilus* cf. *neubergicus* REDTENBACHER (SCHLÜTER, 1876: 174, 175). He figured them under *Nautilus neubergicus* REDTENBACHER (SCHLÜTER, 1876: Pl. 48, Figs. 2, 4, 5). In our opinion Schlüter's specimens belong to a distinct taxon which possibly is identical or at least a close ally of *E. montiscastoris* spec. nov. described above. WIEDMANN (1960a: 157) put *N.* cf. *neubergicus* SCHLÜTER (non REDTENBACHER) under synonymy with *Eutrephoceras darupense* (SCHLÜTER, 1876). He was followed by RIEGRAF & SCHEER (1991: Pl. 48), WITTLER et al. (1999: 37) and WILMSEN (2000: 39). We believe that *N. darupensis* SCHLÜTER, 1876 (Pl. 49, Figs. 3, 4) is also a distinct taxon differing from *N.* cf. *neubergicus* SCHLÜTER (non REDTENBACHER) by its much wider spaced chamber walls and narrower whorl section (see also KENNEDY, 2002: Pl. 43, Figs. 1, 2). We follow WIEDMANN's opinion (1960a: 183, 184) that *Nautilus neubergicus* REDTENBACHER from the Maastrichtian Gosau Group of Neuberg (Styria) is an *Angulithes*. But we do not believe that it is synonymous with *A.* (*Angulithes*) *fleuriausianum* (D'ORBIGNY, 1840) as WIEDMANN (1960a: 183) suggested (a typical Cenomanian species after COBBAN & KENNEDY, 1993: E2). We are certain that SCHLÜTER's specimens of *Nautilus neubergicus* SCHLÜTER (non REDTENBACHER) do not belong to *E. darupense* (SCHLÜTER, 1876), nor to *Angulithes neubergicus* (REDTENBACHER, 1873). Anyway, this Maastrichtian taxon differs also from *E. montiscastoris* spec. nov. by its narrower whorl section and fastigiate venter. *Angulithes* sp. from the early Maastrichtian of Gams (SUMMESBERGER et al., 2009) differs in its much narrower discoidal shape and its fastigiate venter.

Eutrephoceras cf. *indicum* (D'ORBIGNY, 1850) from the Schattaugraben section (see above) and also co-occurring with *E. montiscastoris* spec. nov. differs in its narrower whorl breadth and its slightly high oval whorl section. Also *Eutrephoceras indicum* (D'ORBIGNY, 1850) differs in its narrower aperture. *Eutrephoceras darupense* (SCHLÜTER, 1876) from the Westphalian and British Campanian differs by wider spaced chamber walls and also, compared with SCHLÜTER's measurement (1876: 175) by a somewhat narrower whorl section (see also: KENNEDY, 2002: Pl. 43, Figs. 1, 2). *Eutrephoceras bouchardianum* (D'ORBIGNY, 1840) from the Albian of France (TINTANT & GAUTHIER, 2006) is similar, its whorl section even more depressed. The general shape is globular but without hornlike widening of the aperture.

Occurrence: Upper Santonian Hochmoos Formation in the Schattaugraben section (Rußbach, Salzburg, Austria) and Sandkalkbank Member of the Hochmoos Formation of the Finstergrabenwandl, situated next to the Schattaugraben (Gosau, Upper Austria).

Family Hercoglossinae SPATH, 1927
Genus *Cimomia* CONRAD, 1866

Type species: *Nautilus Burtini* GALEOTTI 1837 from the Eocene of Belgium by original designation of CONRAD (1866). We follow KUMMEL (1956: 441) and place *Cimomia* as a distinct genus into the subfamily Hercoglossinae (SPATH, 1927).

Cimomia gosavica (REDTENBACHER, 1873)

Pl. 6, Figs. 1–3, Pl. 7, Fig. 1, Text-Figs. 12, 13, Tab. 3

1873 *Nautilus gosavicus* REDTENBACHER: 96, Pl. 22, Figs. 2a, b.

1956 *Eutrephoceras gosavicus* (REDTENBACHER) 1873; KUMMEL: 382.

1960b *Angulithes* (*Cimomia*) *gosavicus* (REDTENBACHER) 1873; WIEDMANN: 178, Pl. 20, Fig. M.

1975 *Cimomia* ?*gosavicus* (REDTENBACHER, 1873); SHIMANSKY: 134, Tab. 41.

2009 *Angulithes* (*Angulithes*) sp. indet.; SUMMESBERGER et al.: 166.

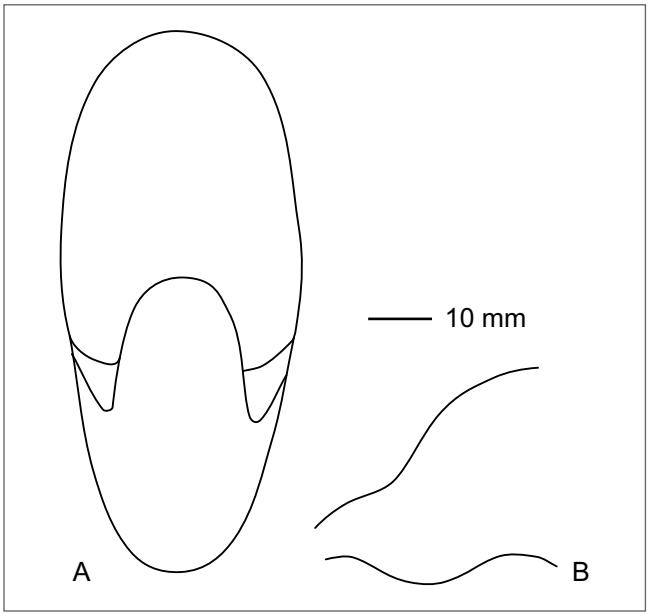
2009 *Angulithes* (*Cimomia*) *gosavicus* (REDTENBACHER, 1873); SUMMESBERGER et al.: 167.

2012 *Cimomia gosavica* (REDTENBACHER, 1873); SUMMESBERGER & ZORN: 104, Pl. 6, Figs. 3 a–d.

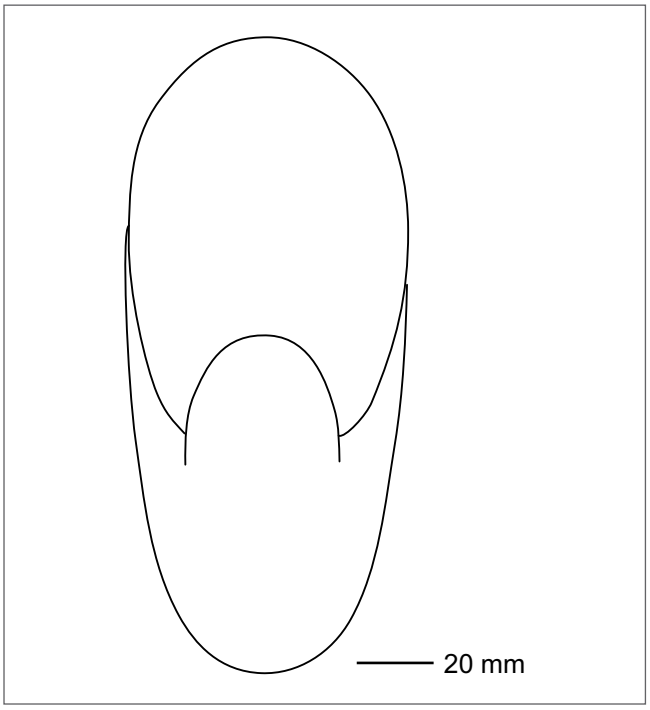
Type: Holotype by monotypy is the original of *Nautilus gosavicus* REDTENBACHER, 1873 (Pl. 22, Figs. 2a, b) preserved in the collections of the Geological Survey of Austria (GBA 1873/0001/0003) designated and refigured herewith (Pl. 6, Figs. 2a–d).

Material: Five specimens: NHMW 2009z0045/0002, an internal mould from the late Santonian of the Schattaugraben section, NHMW 1990/0029/0514, NHMW 1990/0029/0520 (on display in the NHMW exhibition hall 8), SK/1983/13 all from the late Santonian of the Finstergrabenwandl and the type specimen, the original of REDTENBACHER (1873: Pl. 22, Fig. 2; GBA 1873/0001/0003) from the nearby Neffgraben at the Salzburg side (Rußbach) of the Gosau Basin.

Description: NHMW 2009z0045/0002 (Pl. 6, Figs. 1a–c) from the Schattaugraben is a distorted internal mould of a phragmocone with adherent massive remains of shell within and around the umbilicus. The body chamber is broken away. D_{max}: 81.3 mm, Wh_{est}: 50 mm, Wb_{est}: 33.4 mm, Wb/Wh: 0.67 (Tab. 3). Wh increases rapidly, greatest breadth is at the internal third of the flank, the flanks are moderately inflated and slightly convergent towards the venter. The venter is evenly rounded without distinct ventrolateral shoulders. The flanks pass smoothly into the rounded umbilical wall. The umbilicus is occluded by massive shell remains. There are about 23 chambers present on the preserved whorl of the phragmocone. The sutures are strongly sinuous with a backward flexure mid-flank. The position of the siphuncle cannot be observed. There is no ornamentation. NHMW 2009z0045/0002 is interpreted here as the phragmocone of an adult individual. GBA 1873/0001/0003, REDTENBACHER's original (1873: Pl. 22, Figs. 2a, b) from the Neffgraben section is interpreted as the phragmocone of a juvenile individual. It is a partially crushed chambered



Text-Fig. 12.
Cimomia gosavica (REDTENBACHER, 1873) from the Austrian Gosau Group, NHMW 2009z0045/0002; Late Santonian, Schattaugraben section, Salzburg; diagrammatic cross section, restored. A. apertural view, B. suture.



Text-Fig. 13.
Cimomia gosavica (REDTENBACHER, 1873) from the Austrian Gosau Group, NHMW 1990/0029/0514; Late Santonian, Finstergrabenwandl, Gosau, Upper Austria; diagrammatic cross section, restored; apertural view.

phragmocone with parts of the shell preserved. The suture is slightly sinuous. The flanks pass evenly into the rounded umbilical wall and equally into the rounded venter. The siphuncle is in central position. Indistinct growth lines are visible in the umbilical region, where shell is preserved. NHMW 1990/0029/0514 (Pl. 7, Figs. 1a, b) is the internal mould of a large adult specimen with preserved extensive remnants of light brownish shell. The shell was bored by sponges. The individual is very involute with a tiny but not occluded umbilicus. The whorl section is high oval. The flanks are gently curved, passing without developing a ventrolateral shoulder into the rounded venter, and without umbilical edge into the more or less vertical umbilical wall. Whorl height and width increase proportionally. About three quarters of the last whorl are body chamber, the apertural margin is gently curved. The suture as far as it can be observed crosses the flank with a slight concavity flexed backwards on the outer third of the flank, possibly crossing the venter in a broad convexity. SK/1983/13 is of similar size to NHMW 1990/0029/0514 but preserved with white chalky shell remains. The umbilicus is closed due to *post mortem* distortion.

Discussion: There is a little difference between REDTENBACHER's original from the Neffgraben (Pl. 6, Figs. 2a–d), apparently a juvenile, and the specimen from the Schattaugraben section (Pl. 6, Figs. 1a–c). Both have a tiny to occluded umbilicus, and both are laterally compressed with a high oval whorl section. *Angulithes* (*A.*) *neubergicus* (REDTENBACHER, 1873) from the early Maastrichtian of Krampen near Neuberg and suggested by WIEDMANN (1960a: 183–185) to be synonymous with the Cenomanian *Angulithes* (*A.*) *fleuriausianus* (D'ORBIGNY, 1840) differs in its more slender shape and fastigiate venter (WIEDMANN, 1960a: Pl. 20, Fig. O). *Angulithes* (*A.*) *fleuriausianus* (D'ORBIGNY, 1840) from Cenomanian through Coniacian of western Europe and Spain (WIEDMANN, 1960a: 185) has a more accentuated venter and distinctly convergent flanks leading to its characteristic "triangular" shape (see WIEDMANN, 1960a: Pl. 21, Fig. L). *Angulithes* (*A.*) sp. indet. from the early Maastrichtian of the Gams Basin (Styria, Austria) (SUMMESBERGER et al., 2009: Figs. 1, 5) differs in its angular venter and small but open umbilicus. *Eutrephoceras sublaevigatum* (D'ORBIGNY, 1840) (REDTENBACHER, 1873: 95, Pl. 22, Figs. 1a, b) and "*Nautilus resupinatus*" (REDTENBACHER, 1873 (97, Pl. 22, Figs. 3a, b), conspecific after WIEDMANN (1960a: 165) with the former, both from the Maastrichtian of Grünbach (Lower Austria) differ in their much greater whorl breadth. *Eutrephoceras montiscastoris* spec. nov. described above from the neighboured Finstergrabenwandl, from the Schattaugraben section and from the Schattaugraben forest road differs in its globular shape and hornlike widening of the aperture. *Eutrephoceras indicum* (D'ORBIGNY, 1850) differs in its stouter whorl section.

Inventory No.	D (mm)	Wh (mm)	Wb (mm)	Wb/Wh	U (mm)	U (%)
GBA 1873/0001/0003	66	35.5	27.4	0.77	--	--
NHMW 1990z0029/0514190	110.7	77	69	0.9	5	2.6
NHMW 2009z0045/0002	81.3	50	33.4	0.67	--	--

Tab. 3.
Measurements of *Cimomia gosavica* (REDTENBACHER, 1873) from the Gosau Group. U % of D.

Occurrence: NHMW 2009z0045/0002 occurs within the Schattaugraben sequence. Its stratigraphic range within the *Paraplanum* Subzone of the late Santonian is without any doubt. This is also the case in NHMW 1990/0029/0514, NHMW 1990/0029/0520 and SK/1983/13 from the upper Santonian Sandkalkbank Member of the Hochmoos Formation of the Finstergrabenwandl (Gosau, Upper Austria). Redtenbacher's original from the nearby Neffgraben is of (possibly middle) Santonian age.

Ammonites

(Herbert Summesberger & William J. Kennedy)

Subclass Ammonoidea Zittel, 1884

Introduction

As the "Sandkalkbank" Member of the Hochmoos Formation is included in the Schattaugraben section, we include a revision of the nearby and stratigraphically synchronous ammonite fauna of the Finstergrabenwandl (Wiedmann, 1978; Summesberger, 1979, 1980, 1992) below.

Suborder Lytoceratina Hyatt, 1889
Superfamily Tetragonitoidea Hyatt, 1900
Family Gaudryceratidae Spath, 1927
Genus and Subgenus *Gaudryceras* Grossouvre, 1894

Type species: *Ammonites mitis* Hauer, 1866 by subsequent designation of Boule et al. (1906).

Gaudryceras mite (Hauer, 1866)

not figured

1866 *Ammonites mitis* Hauer: 6, Pl. 2, Figs. 3, 4.

1873 *Ammonites glaneggense* Redtenbacher: 119, Pl. 27, Fig. 3.

1979 *Gaudryceras mite* (Hauer); Summesberger: 113, Pl. 1, Fig. 1.

1979 *Gaudryceras mite* (Hauer); Kennedy & Summesberger: 74, Pl. 1, Figs. 1a–d, Pl. 2, Figs. 1a–c, 2a, b, Text-Fig. 1 [with synonymy].

1979 *Gaudryceras glaneggense* (Redtenbacher); Kennedy & Summesberger: 76, Pl. 3, Figs. 1a–b, Pl. 4, Figs. 1a–b [with synonymy].

1980 *Gaudryceras mite* (Hauer); Summesberger: 276, Pl. 1, Fig. 1, Text-Fig. 2.

1995 *Gaudryceras mite* (Hauer, 1866); Kennedy et al.: 390, Pl. 1, Figs. 20, 21.

1996 *Gaudryceras mite* (Hauer, 1866); Summesberger & Kennedy: 112, Pl. 1, Figs. 1–4 [with synonymy].

2000 *Gaudryceras mite* (Hauer, 1866); Wiese: 128, Pl. 1, Fig. 1 [with synonymy].

2017a *Gaudryceras mite* (Hauer, 1866); Summesberger et al.: 15.

Type: Holotype by monotypy: GBA 1866/0001000/3 in the collection of the Geological Survey of Austria, the original of Hauer (1866: Pl. 2, Figs. 3, 4) refigured by Summesberger & Zorn (2012: Pl. 5, Figs. 1a–d).

Material: SK/1979/4 from the locality Finstergrabenwandl (Gosau, Upper Austria).

Discussion: *Gaudryceras glaneggense* (Redtenbacher, 1873) was put under synonymy of *Gaudryceras mite* (Hauer, 1866) by Summesberger & Kennedy (1996).

Occurrence: *Gaudryceras mite* (Hauer, 1866) has a worldwide distribution and a range from Turonian to Maastrichtian. In Austria it occurs in the Turonian (Strobl/Weissenbach, Salzburg), in the Coniacian (Glanegg, Strobl/Weissenbach) and in the middle Santonian of Randobach (Rußbach, Salzburg) and in the late Santonian of the locality Finstergrabenwandl (Gosau, Upper Austria).

Genus *Anagaudryceras* Shimizu, 1934

Type species: *Ammonites sacya* Forbes (1846: 113, Pl. 14, Fig. 10) by the original designation of Shimizu (1934: 67).

Anagaudryceras redtenbacheri (Immel, Klinger & Wiedmann, 1982)

Pl. 8, Fig. 1, Tab. 4

1873 *Ammonites* sp. indet. cfr. *sacya* Forbes; Redtenbacher: 125, Pl. 30, Figs. 4a, b.

1982 *Gaudryceras* sp.; Immel et al.: 10, Pl. 1, Fig. 6.

1982 *Patagiosites redtenbacheri* n. sp.; Immel et al.: 19, Pl. 5, Fig. 7, Pl. 6, Figs. 5–7, Pl. 7, Figs. 1a, b.

1987 *Patagiosites redtenbacheri* Immel, Klinger & Wiedmann 1982; Immel: 94.

2017a *Anagaudryceras redtenbacheri* (Immel, Klinger & Wiedmann, 1982); Summesberger et al.: 14.

Type: Holotype by original designation is the original of *Patagiosites redtenbacheri* Immel et al., 1982 (Pl. 7, Fig. 1; BSP 1982 I 9) from the lower Santonian Gosau Group of Mühlbach/Brandenberg (Tyrol, Austria).

Material: A single specimen SK/SG/2003/38 from the Schattaugraben section (Rußbach, Salzburg).

Description: SK/SG/2003/38 is a 57.6 mm long fragment of an internal mould of the body chamber with adherent yellowish to brownish shell. The preserved part is not much deformed. General shape is a polygyral coil with relatively slowly increasing whorl height and a shallow and wide umbilicus. The section is compressed oval with slightly inflated flanks and greatest breadth at midflank. The ventrolateral shoulder is gently curved, the venter is smooth, *post mortem* compaction has produced a spurious "keel", the umbilical shoulder is narrowly rounded, the umbilical wall is (sub)vertical. The surface of the shell is covered by

Inventory No.	D_{est} (mm)	Wh (mm)	Wb (mm)	Wb/Wh	U (mm)	U (%)
SK/SG/2003/38	58	19.7	12.3	0.62	25.9	4.6

Tab. 4.
Measurements in mm of *Anagaudryceras redtenbacheri* (IMMEL, KLINGER & WIEDMANN, 1982). U % of D.

fine and dense slightly falcoid lirae. Three strong collar ribs succeeded by a shallow constriction and a fourth weaker one are crowded on the adapertural portion (30 mm) of the body chamber.

Discussion: The species, new for the Hochmoos Formation, is undoubtedly identical with that from the early Santonian of Brandenberg described by IMMEL et al. (1982: 19, Pl. 5, Fig. 7, Pl. 6, Figs. 5–7, Pl. 7, Fig. 1). Polygyral coiling, relatively wide umbilicus and the crowding of collar ribs on the adapertural portion of the body chamber excludes an assignment to the genus *Patagiosites.* Crowding of collar ribs suggests an adult representative of the Gaudryceratidae. *Ammonites* sp. indet. cfr. *Ammonites sacya* FORBES from the Utatur Group of South India discussed by IMMEL et al. (1982: 19), has a different style of ornamentation on the apertural end of the body chamber (STOLICZKA, 1965: Pl. 75, Fig. 7), and its whorl height increases more rapidly. *Ammonites* sp. indet. cfr. *Ammonites sacya* FORBES (REDTENBACHER, 1873: 125, Pl. 30, Fig. 4) from the late Coniacian of Glanegg (Salzburg, Austria) seems to be identical with the present species rather than closer to the Cenomanian *Gaudryceras sacya* (FORBES, 1846) which is synonymous with *Anagaudryceras buddha* (FORBES, 1846; fide KENNEDY & KLINGER, 1979: 146). REDTENBACHER (1873: 125) in contrast to the interpretation of IMMEL et al. (1982: 19) excluded the identity of *Ammonites* sp. indet. cfr. *sacya* (FORBES, 1846) with *Ammonites patagiosus* SCHLÜTER. *G. denseplicatum* JIMBO, 1894 has a higher whorl section and a smaller umbilicus (KENNEDY et al., 1995: Pl. 4, Figs. 12, 13); *G. varicostatum* VAN HOEPEN, 1921, described at length by KENNEDY & KLINGER (1979: 133, Fig. 1, Pl. 3, Figs. 1–3, Pl. 4, Figs. 1a, b, Pl. 7, Figs. 2a–c, Pl. 14, Figs. 11a–c) has a coarser liration and more rapidly increasing whorl height on the body chamber. *Gaudryceras mite* (HAUER, 1866), co-occurring in the Gosau Group and originally described from the late Turonian of Strobl/Weissenbach (Salzburg, Austria) extends stratigraphically up to the late Santonian Sandkalkbank Member (SUMMESBERGER, 1979, 1980) of the Hochmoos Formation. Its adult stage is much larger (SUMMESBERGER & KENNEDY, 1996: Pl. 1, Fig. 4), the liration of subadult individuals is much coarser than that of the present one (e.g. the holotype; SUMMESBERGER & KENNEDY, 1996: Pl. 1, Fig. 1; SUMMESBERGER, 1979: Pl. 1, Fig. 1).

Occurrence: *Anagaudryceras redtenbacheri* (IMMEL, KLINGER & WIEDMANN, 1982) occurs in the Austrian Gosau Group at three localities of different age: Glanegg/late Coniacian, *Serratomarginatum* Zone; Brandenberg/early Santonian, *Undulatoplicatus* Zone; Schattaugraben section, Hochmoos Formation/late Santonian *Paraplanum* Subzone.

Family Tetragonitidae HYATT, 1900
Subfamily Tetragonitinae HYATT, 1900
Genus *Pseudophyllites* KOSSMAT, 1895

Type species: *Ammonites indra* FORBES, 1846 by original designation.

Pseudophyllites loryi (KILIAN & REBOUL, 1909)

not figured

1909 *Desmoceras* (*Latidorsella*) *Loryi* KILIAN & REBOUL: 18, Pl. 1, Figs. 4, 5.

1926 *Tetragonites latus* MARSHALL: 149, Pl. 20, Figs. 6, 6a, Pl. 32, Figs. 1, 2.

? 1926 *Pseudophyllites whangaroaensis* MARSHALL: 153, Pl. 20, Fig. 2, Pl. 21, Fig. 11, Pl. 32, Figs. 5, 6.

1953 *Pseudophyllites peregrinus* SPATH: 4, Pl. 1, Figs. 6–9.

1965 *Pseudophyllites skoui* BIRKELUND: 37, Pl. 3, Figs. 2–6, Text-Figs. 26–33.

1977 *Pseudophyllites latus* (MARSHALL, 1926); KENNEDY & KLINGER: 190, Figs. 25, 26 [with synonymy].

1982 *Pseudophyllites latus* (MARSHALL 1926); IMMEL et al.: 10, Pl. 2, Figs. 3, 4.

1986 *Pseudophyllites loryi* (KILIAN & REBOUL, 1909); MACELLARI: 18, Figs. 11.1–11.10, 13.

1987 *Pseudophyllites latus* (MARSHALL 1926); IMMEL: 67.

1992 *Pseudophyllites latus* (MARSHAL, 1926); SUMMESBERGER: 98, Pl. 1, Fig. 1, Text-Fig. 1.

1993 *Pseudophyllites loryi* (KILIAN & REBOUL, 1909); WARD & KENNEDY: 22 [with additional synonymy].

2000 *Pseudophyllites latus* (MARSHALL); SUMMESBERGER in EGGER et al.: 26.

Type: Lectotype subsequently designated by MACELLARI (1986: 16): the original of *Desmoceras* (*Latidorsella*) *Loryi* KILIAN & REBOUL, 1909 (Pl. 1, Figs. 4, 5).

Discussion: MACELLARI (1986: 18) pointed out that *Pseudophyllites latus* (MARSHALL, 1926) and *P. peregrinus* (SPATH, 1953) are junior synonyms of *P. loryi* (KILIAN & REBOUL, 1909). WARD & KENNEDY (1993: 54) also put *P. skoui* BIRKELUND, 1965 and *P. whangaroensis* MARSHALL, 1926 under synonymy of *P. loryi* (KILIAN & REBOUL, 1909). The latter one is attributed in the synonymy with a question mark, as it shows a distinct sculpture in the only figured fragment (MARSHALL, 1926: Pl. 32, Fig. 5).

Occurrence: *Pseudophyllites loryi* (KILIAN & REBOUL, 1909) has a worldwide distribution occurring in the southern hemisphere as well as in Greenland. From the Gosau Group of Austria, it was first described from the late Santonian Sandkalkbank Member of the Hochmoos Formation (SUM-

MESBERGER, 1992: 97, Pl. 1, Text-Fig. 1). Stratigraphically it ranges from Santonian to Maastrichtian (see WARD & KENNEDY (1993: 22).

Suborder Ammonitina HYATT, 1889
Superfamily Desmoceratoidea ZITTEL, 1895
Family Desmoceratidae ZITTEL, 1895
Puzosiinae SPATH, 1922
Genus and Subgenus *Parapuzosia* NOWAK, 1913

Type species: *Sonneratia daubreei* DE GROSSOUVRE (1894: 154, Pl. 28) by original designation.

Parapuzosia (*Parapuzosia*) *corbarica* (DE GROSSOUVRE, 1894)

Pl. 8, Fig. 4, Text-Fig. 14, Tab. 5

1894 *Puzosia corbarica* DE GROSSOUVRE: 174, Pl. 27, Fig. 1.

1982 *Parapuzosia corbarica* (DE GROSSOUVRE 1894); IMMEL et al.: 12, Pl. 3, Fig. 3, Pl. 4, Fig. 1.

1987 *Parapuzosia corbarica* (DE GROSSOUVRE 1894); IMMEL: 89.

1995 *Parapuzosia* (*Parapuzosia*) *corbarica* (DE GROSSOUVRE, 1894); KENNEDY & KAPLAN: 27, Pl. 34.

1995 *Parapuzosia* (*Parapuzosia*) *corbarica* (DE GROSSOUVRE, 1894); KENNEDY et al.: 391, Pl. 2, Fig. 9, Pl. 5, Figs. 1–3, Text-Figs. 12, 13 [with synonymy].

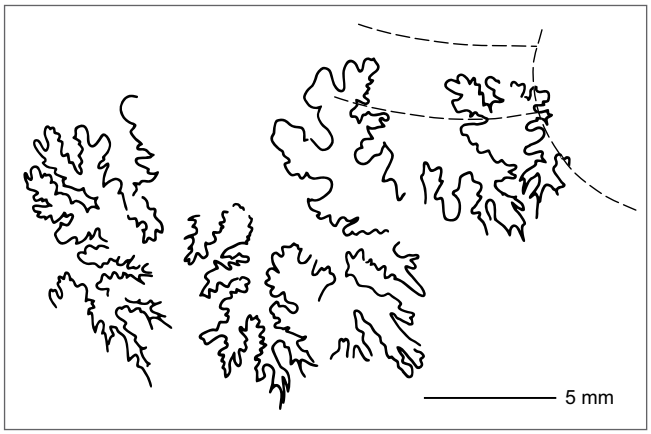
2017a *Parapuzosia corbarica* (DE GROSSOUVRE, 1894); SUMMESBERGER et al.: 18.

Type: Holotype by original designation is the original of DE GROSSOUVRE (1894: 174, Pl. 27, Figs. 1a, b), refigured by KENNEDY & KAPLAN (1995: Pl. 34).

Material: A single juvenile specimen NHMW 1978/1955/0003 ex Schauberger collection from the Schattaugraben section.

Description: NHMW 1978/1955/0003 is an internal mould of a juvenile individual of about 85 mm in diameter with adherent whitish shell remains. It is slightly elongated into an ellipse, measurements nevertheless still being meaningful.

The general outline is identical with that of the holotype: the section high oval with gently rounded flanks, a gently rounded ventrolateral shoulder and an abruptly rounded umbilical edge. The umbilical wall is vertical. The umbilicus is rather deep and relatively narrow, the outer whorl covering more than two thirds of the preceding one. Wh expanding rapidly, Wb expanding slowly. The body chamber comprises about 200° of the last whorl. The terminal part of the phragmocone is marked by the well preserved last suture (Text-Fig. 14). There are about seven collar ribs per whorl arising from weak bullae at the umbilical edge in regular distances, each followed by a distinct constriction. The primaries are separated by approximately eleven prorsiradiate riblets, about 70 per whorl covering the external third of the flanks, all concave at the flank and strongly projected over the venter. The inner two thirds of the flanks are more or less smooth with the exception of the constrictions and collar ribs. The suture (Text-Fig. 14) is deeply incised with a large irregularly bifid E/L.



Text-Fig. 14.
External suture of *Parapuzosia* (*Parapuzosia*) *corbarica* (DE GROSSOUVRE, 1894), NHMW/1978/1955/0003. Scale bar: 5 mm.

Discussion: The species was discussed at length by KENNEDY et al. (1995: 391–393). The Schattau specimen differs in some details from the Corbières specimen: The umbilicus is deeper and the number of intercalatories lower. The holotype from Sougraignes aux Croutets has more primaries.

Occurrence: The Schattau specimen is from the late Santonian Zone of *Boehmoceras arculus*, *Placenticeras paraplanum* and *Marsupites testudinarius.* Its position within the measured section is unknown. The species also occurs in the early Santonian of the Gosau Group of Brandenberg/Mühlbach (Tyrol; IMMEL et al., 1982) and the middle Santonian of the Randograben (Rußbach, Salzburg; SUMMESBERGER et al., 2017a). In the Corbières (France; KENNEDY, 1995) it ranges from the late Coniacian *Serratomarginatus* Zone through the late Santonian *Paraplanum* Subzone.

Inventory No.	$D_{max/rest}$ (mm)	Wh_{max} (mm)	Wb_{max} (mm)	Wb/Wh	$U_{max/rest}$ (mm)	U (%)
NHMW 1978/1955/0003	90	39.5	23.3		23	25
	$D_{-90°}$	$Wh_{-90°}$ (mm)	$Wb_{-90°}$ (mm)	Wb/Wh	$U_{-90°}$ (mm)	U (%)
NHMW 1978/1955/0003	61.7	26.3	20.2		15.1	24.5
		$Wh_{-270°}$ (mm)	$Wb_{-270°}$ (mm)			
NHMW 1978/1955/0003		18.8	12.4		--	--

Tab. 5.
Parapuzosia (*Parapuzosia*) *corbarica* (DE GROSSOUVRE, 1894). rest = restored. U % of D.

? Parapuzosia (*Parapuzosia*) cf. *seppenradensis* (Landois, 1895)

not figured

Compare

cf. 1895 *Pachydiscus seppenradensis* Landois: 1–10, Pls. 1, 2.

? cf. 1979 *Parapuzosia* cf. *seppenradensis* (Landois); Summesberger: 126, Pl. 4, Fig. 24, Pl. 5, Fig. 25, Text-Figs. 14, 15.

cf. 1995 *Parapuzosia* (*Parapuzosia*) *seppenradensis* (Landois, 1895); Kennedy & Kaplan: 21, Pls. 35–41, Text-Figs. 4–7 [with synonymy].

2016 *Parapuzosia* (*Parapuzosia*) *seppenradensis* (Landois, 1895); Kaplan: 49–61, 8 Figs.

Type: Lectotype designated by Kennedy & Kaplan (1995: 21): the larger of the specimens figured by Landois (1895: Pl. 2) from the Early Campanian of Lüdinghausen-Seppenrade, Dülmener Schichten, Germany.

Discussion: There is no additional information on the large Austrian specimen since the description of Summesberger (1979). Additional discussion by Kennedy & Kaplan (1995: 21) leads finally to the same conclusion, that the Gosau specimen cannot be identified with certainty with *Parapuzosia* (*P.*) *seppenradensis* (Landois, 1895). *Parapuzosia* (*Parapuzosia*) *daubréei* (de Grossouvre, 1894: Pl. 28) from the early Santonian of the Corbières differs in its smaller umbilicus and slightly curved very strong primary ribs and numerous intercalatories projecting forward over the venter. *Parapuzosia* (*Parapuzosia*) *corbarica* (de Grossouvre, 1894: Pl. 27), described above from the Schattaugraben section has even more intercalatories between somewhat weaker primaries followed by constrictions.

Occurrence: A single specimen of *? Parapuzosia* (*Parapuzosia*) cf. *seppenradensis* (Landois, 1895) was collected from the late Santonien Zone of *Boehmoceras arculus* and *Placenticeras paraplanum* of the Sandkalkbank Member of the Hochmoos Formation at the Upper Austrian side of the basin of Gosau.

Genus *Kitchinites* Spath, 1922 (= *Neopuzosia* Matsumoto, 1954)

Type species: *Holcodiscus pondycherryanus* Kossmat (1897) by the original designation of Spath (1922). Splitting into the subgenera *Kitchinites* Spath (1922) and *Neopuzosia* (Matsumoto, 1954) was discussed by Henderson (1970: 33, 34) and Summesberger (1979: 133). We follow Wright (1996: 78) who regarded *Neopuzosia* as junior synonym of *Kitchinites*.

Kitchinites stenomphalus Summesberger, 1979

not figured

1979 *Kitchinites stenomphalus* Summesberger: 131, Pl. 7, Figs. 28, 29, Text-Fig. 18.

Non 1982 *Kitchinites stenomphalus* Summesberger, 1979; Immel et al.: 14, Pl. 2, Fig. 5. (= *Nowakites carezi* (de Grossouvre, 1894, juv.)).

Non 1987 *Kitchinites stenomphalus* Summesberger 1979; Immel: 90. (= *Nowakites carezi* (de Grossouvre, 1894, juv.)).

Type: Holotype by original designation: SK/1978/12, the original of *Kitchinites stenomphalus* Summesberger, 1979 (131, Pl. 7, Figs. 27–29, Text-Fig. 18).

Material: A single specimen: SK/1978/12 from the Finstergrabenwandl, figured and described by Summesberger (1979).

Discussion: The specimen from the lower Santonian Gosau Group of Brandenberg (Tyrol, Austria) figured and described by Immel et al. (1982: 14, Pl. 2, Fig. 5) and Immel (1987) differs from the holotype from the Finstergrabenwandl in its much lower whorl height. It is better assigned to juveniles of *Nowakites carezi* (de Grossouvre, 1894).

Occurrence: *K. stenomphalus* Summesberger (1979) occurs only in the upper Santonian of the Finstergrabenwandl in the Austrian Gosau Group.

Genus *Hauericeras* de Grossouvre, 1894

Type species: *Ammonites pseudogardeni* Schlüter (1872) by the original designation of de Grossouvre (1894).

Subgenus *Gardeniceras* Matsumoto & Obata, 1955

Type species: *Ammonites gardeni* Baily (1855) by the original designation of Matsumoto & Obata (1955).

Hauericeras (*Gardeniceras*) *welschi* de Grossouvre, 1894

not figured, Tab. 6

1894 *Hauericeras Welschi* de Grossouvre: 222, Pl. 35, Fig. 9.

1925 *Hauericeras Welschi* Grossouvre; Diener: 96.

1939 *Hauericeras Welschi* de Grossouvre, 1894; Basse: 46, Pl. 3, Fig. 9.

1979 *Hauericeras* (*Gardeniceras*) *gardeni* (Baily); Summesberger: 133, Pl. 6, Fig. 27, Text-Fig. 19.

1995 *Hauericeras* (*Gardeniceras*) *welschi* de Grossouvre, 1894; Kennedy: 396, Pl. 3, Fig. 12, Pl. 4, Figs. 3–5, Text-Fig. 14.

2000 *Hauericeras* (*G.*) *gardeni* (Baily); Summesberger in Egger et al.: 26.

Type: *Hauericeras welschi* de Grossouvre, 1894 (222, Pl. 35, Fig. 9) is based on two syntypes, which could not be traced by Kennedy et al. (1995: 396).

Material: A single specimen (NHMW 1980/0064) from the Böhm collection (Salzburg) from the Finstergrabenwandl site (Gosau Group, Hochmoos Formation, "Sandkalkbank" Member; Gosau, Upper Austria).

Inventory No.	D_{est} (mm)	Wh (mm)	Wb (mm)	U (mm)	U (%)
NHMW 1980/0064	69.6	27.8	--	25.0	35.7

Tab. 6.
Measurements of *Hauericeras* (*Gardeniceras*) *welschi* DE GROSSOUVRE, 1894 (NHMW 1980/0064). U % of D.

Description: NHMW 1980/0064 is the internal mould of a phragmocone, possibly a subadult specimen, without adherent remnants of shell. The surface is of brown "rusty" colour. Coiling is evolute, the umbilicus comprising 35.7 % of the diameter, the subsequent chambers covering the earlier ones by one third. The whorl height increases regularly, the whorl breadth is not measurable. The flanks are gently rounded, the maximum width being close to the umbilicus. *Post mortem* the specimen is laterally compacted. The umbilical wall is low (1.6 mm), subvertical and gently convex. The umbilical edge is sharp. Towards the outer third the flanks are convex, converging to the fastigiate venter. The siphonal keel is visible where the adherent matrix is preserved. Five distinctly feeble sinuous biconcave constrictions per whorl are present on the internal mould. They arise at the umbilical edge with a shallow concavity, changing below midflanks into a distinct convexity and bending forward again into a distinct concavity ending at the keel. There is no sculpture visible on the mould. For the well preserved suture see SUMMESBERGER (1979: Fig. 19).

Discussion: The single specimen (SUMMESBERGER, 1979: 133, Pl. 6, Fig. 27, Text-Fig. 19) from the late Santonian Gosau Group of Finstergrabenwandl (Gosau, Upper Austria) was originally described as *Hauericeras* (*Gardeniceras*) *gardeni* (BAILY, 1855). It is described here as *Hauericeras* (*Gardeniceras*) *welschi* DE GROSSOUVRE, 1894, differing from *H.* (*G.*) *gardeni* (BAILY, 1855), see KENNEDY & KLINGER (2011: Figs. 1A–C, 2, 3A–D, 4A–F, 5A–H, 6, 7, 10M–O) in its more rapidly expanding whorl height and smaller umbilicus. The most distinctive difference is the shape of the constrictions: NHMW 1980/64 has five biconcave constrictions per volution whereas *H.* (*G.*) *gardeni* (BAILY, 1855) shows concave constrictions, projecting distinctly forward on the ventrolateral shoulder. Biconcave constrictions are common in *Hauericeras pseudogardeni* (SCHLÜTER, 1872), e.g. KENNEDY & KAPLAN (1995: Pls. 1, 2, Pl. 3, Figs. 1, 2, Pl. 4, Pl. 5, Figs. 1, 2, 6, Pl. 6, Figs. 1, 7, Pl. 7, Figs. 1–4, Pl. 8) and MATSUMOTO in MATSUMOTO et al. (1990: Fig. 1).

Hauericeras gardeni (IMMEL et al., 1982: Pl. 5, Fig. 1–4, Pl. 6, Fig. 1; non BAILY, 1855) from the early Santonian Gosau Group of Brandenberg (Tyrol, Austria) differs in its concave constrictions (IMMEL et al., 1982: Pl. 5, Fig. 1), and has a wider umbilicus and slower expanding whorl height. This is also the case in a specimen from the early Santonian Gosau Group of Rußbach (Salzburg, Austria), which is conspecific in our opinion with the specimens from Tyrol. They are described under *Hauericeras* (*Gardeniceras*) aff. *gardeni* BAILY 1855 by SUMMESBERGER et al. (2017a).

Hauericeras (*Gardeniceras*) *lagarum* (REDTENBACHER, 1873), a close ally of *Hauericeras* (*Gardeniceras*) *gardeni* (BAILY, 1855) and *Hauericeras angustum* (YABE, 1904) from India and Japan but both have a wider umbilicus. In *H. angustum* it is 37–44 % after MATSUMOTO in MATSUMOTO et al. (1990: 445).

In *Hauericeras* (*Gardeniceras*) *pseudoangustum* COLLIGNON, 1961 the umbilicus is somewhat wider, the height of the whorls increasing more slowly than in *H.* (*G.*) *welschi* (DE GROSSOUVRE, 1894) and its constrictions (fide KENNEDY & KLINGER, 2011: 53) are concave.

Hauericeras (*Gardeniceras*) *madagascariense* COLLIGNON, 1961 differs in its larger size, larger umbilicus, lower whorl height and concave constrictions (KENNEDY & KLINGER, 2011: Fig. 8).

Hauericeras schlueteri (REDTENBACHER, 1873: 114, Pl. 26, Fig. 2) from the middle Coniacian of the Schmolnauer Alpe (Strobl/Weissenbach, Salzburg, Austria) has a distinctly narrower umbilicus.

Hauericeras (*Hauericeras*) *pseudogardeni* (SCHLÜTER, 1872) differs in its much smaller umbilicus (e.g. KENNEDY & KAPLAN, 1995: Pls. 1–4, Pl. 5, Figs. 1, 2, 6, Pl. 6, Figs. 1, 7, Pls. 7, 8.) and in case of adult individuals much larger size.

The lectotype of *Hauericeras rembda* (FORBES, 1846) from the Maastrichtian of India is a small individual with relatively narrow umbilicus (KENNEDY & HENDERSON, 1992: Pl. 6, Figs. 10–12; KENNEDY & KLINGER, 2011: Figs. 10G, H). The paralectotype (KENNEDY & HENDERSON, 1992: Pl. 6, Fig. 16; KENNEDY & KLINGER, 2011: Fig. 10A) shows a fragmentary constriction which seems to be concave.

Hauericeras fayoli DE GROSSOUVRE, 1894 from the late Campanian/Maastrichtian of Tercis (France; teste KENNEDY & SUMMESBERGER, 1984: 157, Pl. 1, Figs. 8, 12, Pl. 2, Figs. 13–15) differs by its flexuous constrictions, greater whorl breadth and smaller whorl height. The Maastrichtian *Hauericeras sulcatum* (KNER, 1849) is more involute, with 6–7 rather concave constrictions per whorl.

Occurrence: *Hauericeras* (*Gardeniceras*) *welschi* DE GROSSOUVRE, 1894 was described originally from the Santonian of the chemin de Sougraignes in the Corbières, southern France, which corresponds after KENNEDY et al. (1995: 384) with the late Santonian *Paraplanum* Subzone. The same age is given for the individual from the Austrian Gosau Group.

Hauericeras (*Gardeniceras*) *lagarum* (REDTENBACHER, 1873)

Pl. 8, Figs. 2, 3, Pl. 9, Fig. 7, Text-Fig. 15, Tab. 7

1873 *Ammonites lagarus* REDTENBACHER: 112, Pl. 25, Figs. 3a, b.

1901 *Hauericeras lagarum*; DE GROSSOUVRE: 638.

1925 *Hauericeras lagarum* (REDTENBACHER, 1873); DIENER: 95.

1935 *Hauericeras lagarum* REDT.; BRINKMANN: 3.

1961 *Hauericeras lagarum* REDTENBACHER; COLLIGNON: 95.

1985 *Hauericeras lagarum* (REDTENBACHER); SUMMESBERGER: 152.

1995 *Hauericeras* (*Gardeniceras*) *lagarum* (REDTENBACHER, 1873); KENNEDY et al.: 397, Pl. 4, Fig. 17 [with synonymy].

2012 *Hauericeras* (*Gardeniceras*) *lagarum* (REDTENBACHER, 1873); SUMMESBERGER & ZORN: 106, Pl. 13, Fig. 2.

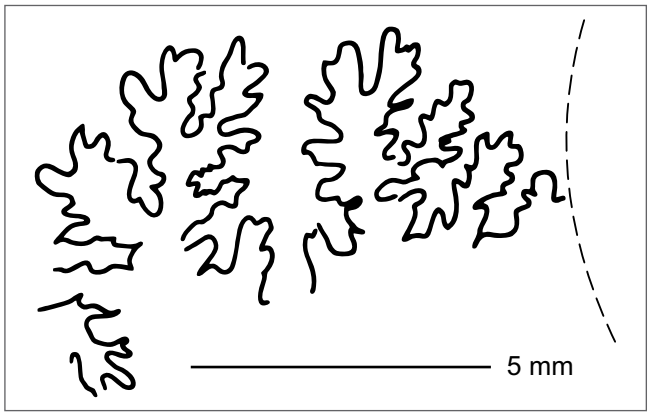
2017a *Hauericeras* (*Gardeniceras*) *lagarum* (REDTENBACHER, 1873); SUMMESBERGER et al.: 21, Text-Fig. 5.

Types: *Ammonites lagarus* REDTENBACHER, 1873 (112, Pl. 25, Figs. 3a, b) from the Austrian Coniacian is based upon two syntypes combined by REDTENBACHER in his original figure (1873: Pl. 25, Fig. 3), one of them is lost (KENNEDY et al., 1995: 397). The surviving one, HNS 6391 (Pl. 9, Figs. 7a, b) from the late Coniacian Gosau Group of Glanegg (Salzburg) is here designated lectotype. The second and lost syntype was a gypsum cast of an external mould from the middle Coniacian Gosau Group of the Schmolnauer Alpe (Strobl/Weissenbach, Salzburg; SUMMESBERGER, 1985: 150) and after REDTENBACHER (1873: 113: "…, so dass sich beide Stücke aufs schönste ergänzen." [fitting in excellently to the first specimen]). The gypsum cast is lost but the external mould used for its production has been located in the collection of the Geological Survey of Austria in Vienna (SUMMESBERGER & ZORN, 2012: 106) and is a paralectotype.

Material: Two specimens from the late Santonian *Paraplanum* Subzone of the Hochmoos Formation of the Schattaugraben section (Rußbach, Salzburg): NHMW 1978/1955/0001 ex Schauberger collection without locality details and SK/SG/1984/3 from the *Micraster* Bed. The preservation of NHMW 1978/1955/0001 suggests that it might be from the same level. A juvenile specimen, NHMW 2006z0203/0001, from the *Micraster* Bed is referred with some doubt to the same species. HNS 6391 the original of REDTENBACHER (1873: 112, Pl. 25, Figs. 3a, b.) from the late Coniacian Glanegg Marls (Gosau Group) of Glanegg (Salzburg).

Description: The whorl section, somewhat deformed by compaction, appears to have been strongly compressed with flattened inner flanks, convergent outer flanks and a sharp and entire siphonal keel. The umbilical wall is low and distinctly convex, the umbilical edge is gently rounded. Both specimens from the Schattaugraben section are flattened and elongated by *post mortem* deformation; both are internal moulds with preserved yellowish shell. Coiling is evolute, with a very small overlap over the preceding volution, a slowly expanding whorl height and a wide and shallow umbilicus. The phragmocones are badly crushed. Both Schattaugraben individuals are of equal size, the better preserved one SK/SG/1984/3 measures D: 59 mm, Wh: 11.8 mm and Wb: 7.2 mm. Wh is relatively low. The flanks are smooth except for approximately 4–5 slightly flexuous constrictions per whorl (Pl. 8, Figs. 2a–c) which are only visible on the internal mould and strongly projected forwards at the ventrolateral shoulder. The suture is partially visible in NHMW 1978/1955/0001 (Text-Fig. 15).

HNS 6391 preserved in hard brownish sandstone fits well with the Schattau specimens differing only in its more rapidly increasing whorl height.



Text-Fig. 15.
External suture (fragment) of *Hauericeras* (*G.*) *lagarum* (REDTENBACHER, 1873); NHMW/1978/1955/0001 from the Schattaugraben section. Scale bar: 5 mm.

Discussion: *Hauericeras* (*Gardeniceras*) *lagarum* (REDTENBACHER, 1873) is a close ally of *Hauericeras* (*Gardeniceras*) aff. *gardeni* (BAILY, 1855) differing in the minor overlapping of the preceding whorl. *Hauericeras* (*Gardeniceras*) *welschi* (GROSSOUVRE, 1894) from the French and Austrian Santonian and its ally *H. angustum* (YABE, 1904) from India and Japan differ in their greater whorl height and sharp umbilical edge. *Hauericeras schlueteri* (REDTENBACHER, 1873: 114, Pl. 26, Fig. 2) from the middle Coniacian of the Schmolnauer Alpe (Strobl/Weissenbach, Salzburg, Austria) is based on a juvenile with a distinctly narrower umbilicus.

Occurrence: *Hauericeras* (*Gardeniceras*) *lagarum* (REDTENBACHER, 1873) occurs in the middle Coniacian of the Corbières (France; KENNEDY et al., 1995) and Austria (the paralectotype), in the late Coniacian (Glanegg; the lectotype) and in the late Santonian *Paraplanum* Subzone of the Hochmoos Formation (Schattaugraben section; this paper).

Subfamily Desmoceratinae ZITTEL, 1895

Genus *Damesites* MATSUMOTO, 1942

Type species: *Desmoceras damesi* JIMBO (1894) by original designation.

Damesites sugata (FORBES, 1846)

not figured

1846 *Ammonites Sugata* FORBES: 113, Pl. 10, Figs. 2a–c.

1864 *Ammonites Sugata* FORBES; STOLICZKA: 60, Pl. 32, Figs. 4–6, Pl. 33, Figs. 1, 2.

1921 *Desmoceras compactum* VAN HOEPEN: 21, Pl. 4, Figs. 5–7, Text-Fig. 11.

Inventory No.	D_{est} (mm)	Wh (mm)	Wb (mm)	U (mm)	U (%)
SK/SG/1984/3	47.3	15.6 (32 %)	7.4	21	44.4
NHMW 1978/1955/0001	47	17.9 (38 %)	8.3	22.6	48.1
HNS 6391	67	23 (34 %)	--	27	40.2

Tab. 7.
Measurements of representatives of *Hauericeras* (*Gardeniceras*) *lagarum* (REDTENBACHER, 1873): 1 and 2 from the Schattaugraben section (this paper); 3 from Glanegg (Late Coniacian). U % of D.

1961 *Damesites compactus* (VAN HOEPEN, 1921); COLLIGNON: 70, Pl. 26, Figs. 4a, b, Text-Fig. 8.

1980 *Damesites compactus* (VAN HOEPEN); SUMMESBERGER: 278, Pl. 1, Figs. 3–4, Text-Fig. 4.

1982 *Damesites* cf. *compactus* (VAN HOEPEN, 1921); IMMEL et al.: 14, Pl. 2, Fig. 6.

1982 *Damesites* sp.; IMMEL et al.: 15, Pl. 2, Fig. 7.

1987 *Damesites compactus* (VAN HOEPEN 1921); IMMEL: 90, Pl. 8, Fig. 5.

2013 *Damesites sugata* (FORBES, 1846); KENNEDY & KLINGER: 44, Text-Figs. 7A–J.

2017a *Damesites sugata* (FORBES, 1846); SUMMESBERGER et al.: 22, Pl. 8, Figs. 1, 2, 4, 5, Text-Fig. 6 (with complete synonymy).

Types: The lectotype is BMNH C22647, the original of FORBES (1846: Pl. 10, Figs. 2a–c). It was figured by KENNEDY & HENDERSON (1991: Text-Figs. 1A, B) and KENNEDY & KLINGER (2013: Text-Figs. 7D, E). There are three paralectotypes, BMNH C22675, of which BMNH C3561a is a further fragment, and BMNH 24196a, b, while BMNH C3561b may be a further paralectotype. The type material is from South India.

Material: SK/1979/7, a single specimen from the Sandkalkbank Member of the Finstergrabenwandl locality (Hochmoos Formation, Gosau Group), described by SUMMESBERGER (1980: 278, Pl. 1, Figs. 3, 4, Text-Fig. 4) and SK/NE/1991/15.

Description and discussion: The specimen from the Sandkalkbank Member was described by SUMMESBERGER (1980) under *Damesites compactus* (VAN HOEPEN, 1921) as a juvenile. In 2013 KENNEDY & KLINGER put *Damesites compactus* under synonymy of *Damesites sugata* (FORBES, 1846). We follow this opinion.

Occurrence: *Damesites sugata* (FORBES, 1846) ranges from the late Coniacian through the Santonian of the Corbières and in the Circumpacific Realm (KENNEDY et al., 1995). It occurs in the Coniacian to Santonian of India, Madagascar and South Africa, in Japan and Saghalin it occurs „approximately" (MATSUMOTO & OBATAN, 1955: 133, Pl. 26, Figs. 4a, b, 5a, b, Pl. 27, Figs. 3a, b, 4a–d) in the Santonian. SK/1979/7 is from the late Santonian Sandkalkbank Member (Hochmoos Formation; Finstergrabenwandl; Gosau, Upper Austria); SK/NE/1991/15 from the middle Santonian Hochmoos Formation of the Neffgraben.

Damesites cf. *sugata* (FORBES, 1846)

Pl. 8, Fig. 6

Compare

1846 *Ammonites Sugata* FORBES: 113, Pl. 10, Figs. 2a–c.

1864 *Ammonites Sugata* FORBES; STOLICZKA: 60, Pl. 32, Figs. 4–6, Pl. 33, Figs. 1, 2.

1921 *Desmoceras compactus* VAN HOEPEN: 21, Pl. 4, Figs. 5–7, Text-Fig. 12.

1961 *Damesites compactus* VAN HOEPEN; COLLIGNON: 70, Pl. 26, Figs. 4a, b, Text-Fig. 8.

1980 *Damesites compactus* (VAN HOEPEN); SUMMESBERGER: 278, Pl. 1, Figs. 3, 4, Text-Fig. 4.

1982 *Damesites* cf. *compactus* (VAN HOEPEN 1921); IMMEL et al.: 14, Pl. 2, Figs. 6a, b.

1982 *Damesites* sp.; IMMEL et al.: 14, Pl. 2, Fig. 7.

? 1982 *Damesites obscurus* (SCHLÜTER, 1872); IMMEL et al.: 15.

1987 *Damesites compactus* (VAN HOEPEN 1921); IMMEL: 90, Pl. 8, Fig. 5.

Material: A single specimen SK/SG/1992/15 from the Schattaugraben section.

Description: The specimen before us is a small (D 21 mm), crushed internal mould with much of the partly nacreous shell adherent. The feeble but distinct keel is well preserved.

Discussion: The above specimen from the Hochmoos Formation is not well enough preserved to separate it clearly from other taxa.

Occurrence: Late Santonian Gosau Group of the Schattaugraben section.

Family Pachydiscidae SPATH, 1922

Genus *Nowakites* SPATH, 1922

Type species: *Pachydiscus carezi* DE GROSSOUVRE, 1894 (190, Pl. 25, Fig. 3, Pl. 37, Fig. 5), by original designation. The genus was discussed by KENNEDY et al. (1995: 400).

Nowakites draschei (REDTENBACHER, 1873)

Pl. 8, Fig. 8

1873 *Ammonites Draschei* nov. sp.; REDTENBACHER: 123, Pl. 30, Fig. 1.

1979 *Nowakites draschei* (REDTENBACHER); SUMMESBERGER: 138, Pl. 8, Figs. 33–36, Text-Figs. 23–25 (with synonymy).

1995 *N. draschei* (REDTENBACHER, 1873); KENNEDY in KENNEDY et al.: 400.

Type: Holotype by monotypy and refigured here (Pl. 8, Figs. 8a, b), *Ammonites Draschei* REDTENBACHER, 1873 (Pl. 30, Fig. 1; OÖLM 1938/30).

Material: Four individuals: OÖLM 1938/30, the holotype from the Santonian of the Neffgraben at Rußbach (Salzburg side of the Gosau basin), NHMW 2013/0467/0001and SK/1977/8, 11.

Discussion: *N. draschei* (REDTENBACHER, 1873) from the Santonian of the nearby Neffgraben (Rußbach, Salzburg, Gosau Group) is very close to or even conspecific with *N. tallavignesi* (D'ORBIGNY, 1850); see KENNEDY et al. (1995: 401, Pl. 6, Figs. 15–19, Pl. 8, Figs. 1–5, 8–12). The species was discussed by SUMMESBERGER (1979: 138) and KENNEDY et al. (1995: 400).

Occurrence: In the Austrian Gosau Group *Nowakites draschei* was erroneously interpreted to be of Coniacian age by previous authors (FELIX, 1908; DIENER, 1925; BRINKMANN, 1935). Its true Santonian age was pointed out by COLLIGNON (1955).

Nowakites savini (DE GROSSOUVRE, 1894)

Pl. 8, Fig. 9, Tab. 8

1894 *Sonneratia savini* DE GROSSOUVRE: 152, Pl. 25, Fig. 4 [only].

Non 1894 *Sonneratia savini* DE GROSSOUVRE: 152, Pl. 37, Fig. 4 (= microconch of *N. talavignesii* (D'ORBIGNY, 1850) fide KENNEDY et al., 1995: 401).

1922 *Nowakites savini* GROSSOUVRE; SPATH: 124.

1983 *Nowakites savini* (DE GROSSOUVRE); COLLIGNON in BILOTTE & COLLIGNON: 186, Pl. 2, Fig. 6.

1995 *Nowakites savini* (DE GROSSOUVRE, 1894); KENNEDY et al.: 402, Pl. 8, Figs. 16–23, Pl. 9, Figs. 1, 6, 7, Pl. 19, Fig. 7, Pl. 22, Figs. 1, 2, 4, Text-Fig. 20C [with synonymy].

? 2004 *Nowakites savini*; REMIN: 590, Fig. 4 (Tab.).

2017a *Nowakites savini* (DE GROSSOUVRE, 1894); SUMMESBERGER et al.: 25, Pl. 9. Figs. 1, 2, Pl., 10, Fig. 1.

Type: The holotype by original designation is the original of DE GROSSOUVRE (1894: Pl. 25, Fig. 4). It could not be traced by KENNEDY et al. (1995: 402) and seems to be lost.

Material: Three specimens: NHMW 2010/0081/0001 from the *Micraster* Bed of the late Santonian Bibereck Formation of the Schattaugraben section, MA 1982/19 also from the Schattaugraben section, NHMW 2010/0082/0001 from the early Santonian Grabenbach Formation of the Edlbachgraben of Gosau (Upper Austria) and SK/RA/2014/164 from the early Santonian of the Randobach (Rußbach, Salzburg).

Description: NHMW 2010/0081/0001 (Pl. 8, Fig. 9) is a crushed and corroded fragment of the body chamber of a relatively large individual partially preserved with whitish shell. Umbilical dimensions cannot be measured due to preservation. NHMW 2010/0082/0001 from the early Santonian Grabenbach Formation is the best preserved specimen and apparently conspecific with the above mentioned one. *Nowakites savini* (DE GROSSOUVRE, 1894) is a medium sized species with involute coiling. The umbilicus is moderately deep, the umbilical wall slightly convex. The whorl section is high oval. The distinctive feature is the very coarse sculpture: about nine umbilical tubercles give rise to coarse and sharp single, slightly prorsiradiate and concave ribs or pairs of ribs, two or three intercalatories are situated between, all coarsening towards the aperture, about 40 on the last whorl. Ribs are projecting forwards on the ventrolateral shoulder. Few indistinct constrictions per whorl are accompanied by strong "collar" ribs.

Discussion: The specimens NHMW 2010/0081/0001 and NHMW 2010/0082/0001 are very close to GROSSOUVRE's type specimen of *N. savini* (DE GROSSOUVRE, 1894: Pl. 25, Fig. 4) from Sougraignes aux Croutets (Aude, France) which is now apparently lost (KENNEDY, 1995: 402). We have not seen the unfigured specimen quoted by REMIN (2004) from Poland. *Nowakites carezi* (DE GROSSOUVRE, 1894) differs in its finer ribbing in juvenile stages, with distinct coarsening during late ontogeny. *Nowakites tallavignesi* (D'ORBIGNY, 1850) from the Coniacian (?) of the Corbières (KENNEDY, 1995: Pl. 8, Figs. 1–5, 8–12) and from Romania and Armenia differs in its lower whorl height and less prominent ribbing, with about 20 ribs per half whorl. *Nowakites pailletteanus* (D'ORBIGNY, 1841) from the *Tridorsatum* and *Margae* Zones of the French Coniacian is more delicately ribbed with narrower ribs and wider rib interspaces.

Occurrence: *Nowakites savini* (DE GROSSOUVRE, 1894) is a long ranging species. In the Corbières it occurs in the early and middle Santonian, in Bulgaria in the Coniacian. In the Gosau Group it occurs together with *Cladoceramus undulatoplicatus* (ROEMER) from basal Santonian to the top Santonian *Micraster* Bed within the Zone of *Boehmoceras arculus*, *Placenticeras paraplanum* and *Marsupites laevigatus* several meters above the Sandkalkbank Member with the main occurrence of *Cordiceramus muelleri muelleri* (PETRASCHECK, 1906).

Genus *Eupachydiscus* SPATH, 1922

Type species: *Ammonites isculensis* REDTENBACHER, 1873 (122, Pl. 29, Fig. 1) by the original designation of SPATH (1922).

Eupachydiscus isculensis (REDTENBACHER, 1873)

Pl. 8, Fig. 7

1873 *Ammonites isculensis* REDTENBACHER, 1873 (122, Pl. 29, Fig. 1.

1979 *Eupachydiscus isculensis* (REDTENBACHER, 1873); HERM et al.: 49, Pl. 8, Fig. A.

1979 *Eupachydiscus isculensis* (REDTENBACHER, 1873); SUMMESBERGER: 136, Pl. 7, Figs. 30, 31, Pl. 8, Fig. 32, Text-Figs. 20–22.

1982 *Eupachydiscus isculensis* (REDTENBACHER, 1873); IMMEL et al.: 22, Pl. 7, Figs. 8–11, Pl. 8, Figs. 1–4.

1982 *Pseudomenuites katschthaleri* IMMEL, KLINGER & WIEDMANN: 20, Pl. 7, Figs. 2–5.

1986 *Eupachydiscus isculensis* (REDTENBACHER, 1873); KENNEDY: 52, Pl. 2, Figs. 5, 6, Pl. 10, Figs. 13, 14, Text-Fig. 19 [with synonymy].

Inventory No.	**D (mm)**	**$Wh_{maxrest}$ (mm)**	**$Wb_{maxrest}$ (mm)**		
NHMW 2010/0081/0001	108	48.3	31.8		
Inventory No.	**D_{est} (mm)**	**Wh (mm)**	**Wb (mm)**	**U (mm)**	**U (%)**
NHMW 2010/0082/0001	99.3	51.6	31.3	21.9	22

Tab. 8.
Measurements of *Nowakites savini* (DE GROSSOUVRE, 1894) from the Santonian of the Gosau Group. U % of D.

1987 *Eupachydiscus isculensis* (REDTENBACHER, 1873); IMMEL: 94.

1987 *Pseudomenuites katschthaleri* IMMEL et al.; IMMEL: 96.

? 1992 *Eupachydiscus* cf. *isculensis* (REDTENBACHER, 1873); KENNEDY et al.: 270, Pl. 1, Figs. 9, 10.

1995 *Eupachydiscus isculensis* (REDTENBACHER, 1873); KENNEDY: 404, Pl. 9, Figs. 9, 10, Pl. 10, Fig. 12, Pl. 11, Figs. 1–3, 5–8, Text-Figs. 18, 19 [with additional synonymy].

2000 *Eupachydiscus isculensis* (REDTENBACHER, 1873); SUMMESBERGER in EGGER et al.: 26, Fig. 17.

2000 *Eupachydiscus isculensis* (REDTENBACHER, 1873); KENNEDY & KAPLAN: 60, Pls. 5–7.

2006 *Eupachydiscus isculensis* (REDTENBACHER, 1873); KENNEDY & KLINGER: 34, Figs. 15, 16 [with additional synonymy].

2010 *Eupachydiscus isculensis* (REDTENBACHER, 1873); REMIN: 175, Figs. 14F, 17I.

2017a *Eupachydiscus isculensis* (REDTENBACHER, 1873); SUMMESBERGER et al.: 27, Pl. 9, Figs. 6–8, Pl. 10, Fig. 3.

Type: The holotype by monotypy is the original of *Ammonites isculensis* REDTENBACHER (1873: Pl. 29, Fig. 1) from the Gosau Group of Kohlbüchl near Bad Ischl (Upper Austria), refigured by KENNEDY (1986: Text-Fig. 19), KENNEDY (1995: 404, Text-Fig. 18) and KENNEDY & KAPLAN (2000: Pl. 6), OÖLM 2/2007 in the collection of the Oberösterreichisches Landesmuseum, Linz, Austria.

Material: A complete and well preserved juvenile NHMW 1935/0003/0037 and two small fragments of juveniles from the Schattaugraben section SK/SG/1990/4, SK/SG/1990/6 in addition to the specimens from the Sandkalkbank Member described by SUMMESBERGER (1979).

Description: In spite of their preservation both specimens show the specific characteristics of *E. isculensis*. Additional descriptions of the species are provided by KENNEDY (1986), KENNEDY (1995) and KENNEDY & KLINGER (2006).

Discussion: KENNEDY (1986: 54) believed *Pseudomenuites katschthaleri* IMMEL et al. (1982) from the early Santonian of Mühlbach (Brandenberg, Tyrol) to be the microconch of *Eupachydiscus isculensis* (REDTENBACHER, 1873). This was recently endorsed by KENNEDY & KLINGER (2006: 34).

Occurrence: *E. isculensis* is common at all Santonian localities of the Gosau Group. It occurs together with *Cladoceramus undulatoplicatus* in the early Santonian of Mühlbach (Brandenberg, Austria; IMMEL et al., 1982), in the late Santonian Sandkalkbank Member together with *Boehmoceras arculus* and *Placenticeras paraplanum*. REDTENBACHER's type specimen (1873: 29) from the Gosau Group of Bad Ischl (Austria) is not precisely horizoned. *E. isculensis* occurs in the Corbières, in Romania and Zululand. In Madagascar it ranges from Santonian to early Campanian. Its occurrence in the Coniacian mentioned by HERM et al. (1979: 49) needs revision (see IMMEL, 1987: 94).

Genus *Pachydiscus* ZITTEL, 1884

Type species: *Ammonites neubergicus* HAUER (1858) subsequently designated by DE GROSSOUVRE, 1894.

Pachydiscus sp. indet. juv.

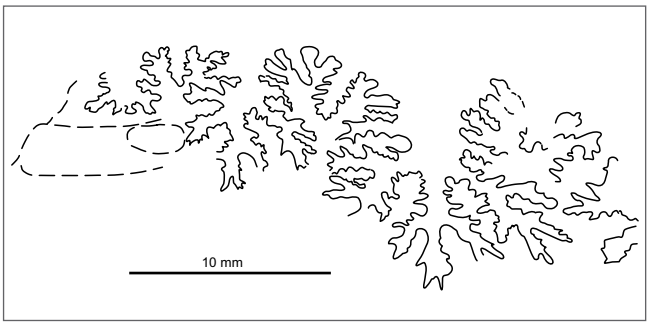
Pl. 8, Fig. 5, Text-Fig. 16, Tab. 9

Material: A single small specimen from the Schattaugraben section: NHMW 2010/0081/0002.

Description: The specimen is a laterally slightly crushed and elliptically elongated internal mould without adherent shell. The surface is covered by excellently preserved sutures, enhanced by brownish colouring of the saddles and lobes possibly due to iron oxide. The sculpture consists of about eleven single primary ribs on the last whorl, arising at the umbilical edge with a distinct bulla and a few irregularly intercalated ones arising near the umbilical edge or midflanks without a bulla. All ribs weaken towards the ventrolateral edge, and are effaced on the venter.

Discussion: Juvenile individuals of *Eupachydiscus isculensis* of comparable size differ in general in their greater Wb, and denser ribs that cross the venter in a distinct convexity. Juvenile pachydiscids from the Corbières, figured by KENNEDY (1995: Pl. 10, Figs. 1–6, 9–11) differ in having smooth shells with occasional constrictions. *Pseudomenuites katschthaleri* (IMMEL et al., 1982: 20, Pl. 7, Figs. 2–5) interpreted as the microconch of *E. isculensis* (fide KENNEDY, 1995) differs in having looped ribs and ventrolateral tubercles (IMMEL et al., 1982: Pl. 7, Figs. 2–5). Similar but also differing in having ventrolateral tubercles is the juvenile *E. isculensis* from the Mzamba Formation of Pondoland, South Africa figured by KENNEDY & KLINGER (2006: Fig. 15).

Occurrence: Upper Santonian *Micraster* Bed of the Bibereck Formation of the Schattaugraben section.



Text-Fig. 16.
External suture of *Pachydiscus* sp. indet. juv.; NHMW 2010/0081/0002 from the *Micraster* Bed, Schattaugraben, Rußbach, Salzburg.

Inventory No.	D_{rest} (mm)	Wh_{max} (mm)	Wb_{max} (mm)	U (mm)	U (%)
NHMW 2010/0081/0002	22	10	8.1	4	18

Tab. 9.
Measurements of *Pachydiscus* sp. indet. juv.; NHMW 2010/0081/0002 from the *Micraster* Bed, Schattaugraben section, Salzburg. Rest = restored, max = maximum. U % of D.

Family Muniericeratidae Wright, 1952
Genus *Texasia* J.B. Reeside Jr., 1932
(= *Lehmaniceras* Collignon, 1966)

Type species: *Ammonites dentato-carinatus* F. Roemer (1852) by subsequent designation of Wright (1957: 432).

Texasia dentatocarinata (F. Roemer, 1852)

Pl. 9, Fig. 1, Tab. 10

1849 *Ammonites dentato-carinatus* F. Roemer: 417 [nom. nud.].

1852 *Ammonites dentato-carinatus* F. Roemer: 33, Pl. 1, Figs. 2a, b.

1904 *Schloenbachia dentato-carinata* F. Roemer, 1852; Lasswitz: 29.

1928 *Barroisiceras dentatocarinatum* (Roemer); Adkins: 252.

1932 *Barroisiceras dentatocarinatum* (Roemer); Adkins: 453.

1932 *Barroisiceras* (*Texasia*) *dentatocarinatum* (Roemer) Lasswitz; Reeside: 15, Pl. 3, Figs. 1–10, Pl. 4, Figs. 1–3, Pl. 5, Fig. 1.

1963 *Texasia dentatocarinata* (Roemer, 1852); Young: 119, Pl. 72, Figs. 1–3, 6, 7, Pl. 73, Figs. 1–3, 5, 6, 10, Text-Figs. 10h, p, q, 11b.

1969 *Texasia dentatocarinata* (Römer); Matsumoto: 300–301, Text-Figs. 1, 2.

? 1982 *Barroisiceras* (*Texasia*) *dentatocarinatum* (Roemer); Renz: 113, Pl. 38, Fig. 3.

1996 *Texasia dentatocarinata* (Roemer); Wright: 107, Text-Figs. 82a–c.

2004 *Texasia dentatocarinata* (Roemer, 1852); Kennedy et al.: 437, Pl. 2, Figs. 1–2, 6–7.

2008 *Texasia dentatocarinata* (Römer); Cobban et al.: 85.

2010 *Texasia dentatocarinata* (F. Roemer, 1852); Wagreich et al.: 186.

2013 *Texasia dentatocarinata* (Roemer, 1852); Kennedy & Klinger: 39, Fig. 4.

Type: The lectotype is the original of F. Roemer (1852: Pl. 1, Figs. 2a, b), by the subsequent designation of Matsumoto (1969: 300), housed in the Geological Institute of the University of Bonn (Inv. Nr. 48a).

Material: NHMW 1998z0013/0001, a single specimen from above the *Micraster* Bed in the Bibereck Formation of the Schattaugraben section, Rußbach, Salzburg.

Description: The crushed fragment of an internal mould is preserved with adherent chalky shell. Most of the specimen is the adapertural part of the body chamber. The phragmocone is damaged. The suture is not visible. The specimen is high whorled, slender, with flat flanks, the whorls rapidly increasing in height. The umbilicus is rather narrow and deep, the umbilical wall is vertical. The venter seems to have been fastigiate. Coarse umbilical tubercles are widely spaced. With increasing diameter, they elongate into a strong bulla, giving rise to single, sometimes bifurcating straight and prorsiradiate primary ribs, with terminal ventrolateral clavi. Nine umbilical tubercles on the last whorl correspond to about 14 or 15 ventrolateral clavi. The style of ribbing is somewhat irregular. Some of the ribs fade out on the flanks, leaving large smooth intervals between the ribs. The most striking feature is the siphonal keel bearing strong clavi.

Discussion: General shape and ornament agree well with those of the figured specimens from Texas (e.g. Roemer, 1852: Pl. 1, Fig. 2; Reeside, 1932: Pl. 3, Fig. 6; Young, 1963: Pl. 72, Figs. 3, 6, 7, Pl. 73, Fig. 1; Kennedy et al., 2004: Pl. 2, Figs. 1–3, 6–7; Kennedy & Klinger, 2013: Fig. 4). The widely variable *Texasia cricki* (Spath, 1921) is similar in some of its synonyms, e.g. *Lehmaniceras sornayi* (Collignon, 1966) (see the refigured holotype in the revision of Kennedy & Klinger, 2013: Fig. 2A), has about eight umbilical bullae becoming coarse and rounded tubercles during ontogeny. The ribs are broader than those of *T. dentatocarinata*. *Texasia rivierae* (Collignon, 1983), following Kennedy & Klinger (2013: 34) also synonymous with *Texasia cricki* (Spath) from the early Santonian of southern France differs in its slightly flexuous ribs (Kennedy, 1995: Pl. 13, Figs. 1, 5, 6, 9, 13, 14, Pl. 18, Figs. 13, 14). *Texasia gracile* (Collignon, 1966), another synonym of *T. cricki* (Spath) following Kennedy & Klinger (2013) differs in its narrower and feebly convex ribbing with about 30 ventrolateral clavi per whorl. The specimen from Venezuela figured by Renz (1982: Pl. 38, Fig. 3) is much larger, with slightly flexuous ribs and seems rather to belong to the Coniacian *T. dartoni* Reeside (1932) which is also present in the early Coniacian of Spain (Santamaria Zabala, 1991: 206, Pl. 14, Fig. 3).

Occurrence: *Texasia dentatocarinata* (F. Roemer, 1852) occurs in the Dessau Formation (Young, 1963: 14) of the Austin Group (Young, 1963: 11) (= Austin Chalk) in Texas and ranges from the *Texanites shiloensis* Zone upwards into the *Submortoniceras tequesquitense* Zone (Young, 1963: 22, 23, 120): late Santonian to early Campanian after Young (1963). Hancock & Gale (1996) place its occurrence below the Santonian/Campanian boundary making it to a useful index fossil of the late Santonian. It is described herein for the first time from Europe and the Gosau Group.

Inventory No.	D (mm)	Wh (mm)	Wb (mm)	U (mm)	U (%)
NHMW 1998z0013/0001	64.4	30 $_{\text{between clavi}}$	--	14.8	22.9

Tab. 10.
Texasia dentatocarinata (F. Roemer, 1852), measurements of NHMW 1998z0013/0001. U % of D.

Superfamily Hoplitoidea H. Douville, 1890
Family Placenticeratidae Hyatt, 1900
Genus *Placenticeras* Meek, 1876

Type species: *Ammonites placenta* Dekay (1828) by original designation.

Placenticeras polyopsis (Dujardin, 1837)

Pl. 9, Figs. 3, 4, 6, Pl. 10, Figs. 1, 6

1837 *Ammonites polyopsis* Dujardin: 232, Pl. 17, Fig. 12a.

1872 *Ammonites syrtalis* Morton; Schlüter: 46, Pl. 14, Figs. 1–10, Pl. 15, Fig. 5.

1903 *Placenticeras depressum* Hyatt: 237.

1925 *Placenticeras depressum* Hyatt; Diener: 185.

1935 *Placenticeras depressum* Hyatt; Brinkmann: 5.

1935 *Placenticeras* ex aff. *syrtale* (Morton, 1872); Brinkmann: 5.

1935 *Barroisiceras haberfellneri* Hauer; Brinkmann: 5.

1978 *Stantonoceras depressum* (Hyatt); Wiedmann: 667, Pl. 1, Figs. 1, 2, Text-Figs. 2B, 3A.

1979 *Stantonoceras depressum* (Hyatt); Summesberger: 145, Pl. 10, Figs. 42–43, Pl. 11, Figs. 44–47, Pl. 12, Figs. 48–52, Text-Figs. 31–37.

1980 *Diplacmoceras*; Summesberger in Matura & Summesberger: 146, Fig. 33.

1982 *Diplacmoceras*; Kollmann & Summesberger: 37, 49.

1982 *Stantonoceras depressum* (Hyatt); Kollmann & Summesberger: 49.

1983 *Placenticeras polyopsis* (Dujardin, 1837); Kennedy & Wright: 856, Pls. 85–86, Text-Figs. 1–4 [with synonymy].

1985 *Placenticeras polyopsis* (Dujardin); Summesberger: 158, Tab. 3.

1985 *Placenticeras* cf. *bidorsatum* (Roemer); Summesberger: 159.

? 1985 *Placenticeras* aff. *paraplanum* Wiedmann; Amedro & Hancock: 24, Figs. 11a–c, f, g.

1987 *Placenticeras polyopsis* (Dujardin 1837); Immel: 98.

1991 *Placenticeras polyopsis* (Dujardin, 1837); Kennedy & Cobban: 176.

1991 *Placenticeras polyopsis* (Dujardin 1837); Santamaria Zabala: 83, Pl. 3, Fig. 3, Pl. 4, Fig. 3.

1992 *Placenticeras polyopsis* (Dujardin, 1837); Santamaria Zabala: 229, Pl. 1, Figs. 6, 7.

1994 *Placenticeras* cf. *bidorsatum*; Tröger & Summesberger: 186, Tab. 15.

1994 *Placenticeras polyopsis* (Dujardin); Tröger & Summesberger: 185.

1995 *Placenticeras polyopsis* (Dujardin, 1837); Kennedy in Kennedy et al.: 410, Pl. 17, Figs. 2–7, 9, 10, Pl. 18, Figs. 7–12, Text-Fig. 21 [with additional synonymy].

Non 1995 *Placenticeras polyopsis* (Dujardin 1837); Lommerzheim: 61, Pl. 5, Figs. 3–5.

2000 *Placenticeras polyopsis* (Dujardin); Summesberger in Egger et al.: 26.

2007 *Placenticeras polyopsis* (Dujardin, 1837); Summesberger: 408, Figs. 6, 7.

2007 *Placenticeras polyopsis*; Gallemi et al.: 12, Fig. 8.

2017c *Placenticeras polyopsis* (Dujardin, 1837), juv.; Summesberger et al.: 124.

Type: The lectotype is the original of Dujardin (1837: Pl. 17, Fig. 12a) by the subsequent designation of Kennedy & Wright (1983: 856).

Material: There are five large fragments from the Schattaugraben section at our disposal, one from the Maherndl collection: MA 1976/19 (Pl. 10, Fig. 6), four from the Skoumal collection: SK/SG/1998/29 (Pl. 10, Fig. 1), SK/SG/1998/29a, SK/SG/1998/30 (Pl. 9, Fig. 4) and SK/SG/2002/35 (Pl. 9, Fig. 3). All are from the Sandkalkbank Member of the Schattaugraben (Text-Fig. 3). Summesberger (1979: 145) mentioned 33 specimens from the Sandkalkbank Member of the Finstergrabenwandl (Gosau, Upper Austria). One from the Finstergrabenwandl is CG, 1978/02 (Pl. 9, Fig. 6). Many more are housed in private collections. Further specimens from the late Santonian of the Scharrergraben (Lower Austria) and from the late Santonian of Maiersdorf (Lower Austria) will be described elsewhere.

Discussion: Summesberger (1979: 145ff.) described macroconchs (form A) and microconchs (form B) of *P. polyopsis* from the late Santonian of the Finstergrabenwandl. They are distinguished by the larger adult size of the former and the more prominent ornamentation of the latter. *Placenticeras paraplanum* Wiedmann, 1978 is closely related to *P. polyopsis,* from which it differs in its narrower venter and less prominent sculpture. *P. maherndli* Summesberger,1979 differs in its distinct falcoid ribbing. Co-occurring *P. polyopsis*, *P. paraplanum* and *P. maherndli* show distinct dimorphism (see also the comprehensive discussion of Kennedy & Wright, 1983: 858–866).

Misidentification of *P. polyopsis* from the Schattaugraben section (Pl. 10, Figs. 6a, b) as *Diplacmoceras* (Summesberger in Matura & Summesberger, 1980: 146, Fig. 33; Kollmann & Summesberger, 1982: 37) respectively *Placenticeras* cf. *bidorsatum* (Roemer, 1841) (Kollmann & Summesberger, 1982: 37; Summesberger, 1985: 158) led to the erroneous interpretation of the Schattaugraben locality as early Campanian.

Occurrence: *P. polyopsis* ranges through the Santonian in France (Kennedy & Wright, 1983: 866; Kennedy, 1995: 411). The Austrian occurrences of *P. polyopsis* are limited to the late Santonian *Paraplanum* Subzone, co-occurring with *Boehmoceras arculus*, *P. paraplanum* and *Cordiceramus muelleri* ssp., all indicative for a late Santonian age (Schattaugraben section, Gosau Basin, Salzburg, Finstergrabenwandl; Gosau Basin, Upper Austria; Maiersdorf, "Neue Welt Basin", Lower Austria; Scharrergraben/Piesting, Lower Austria). Recent investigation (Wagreich et al., 2010) leaves no doubt, that the boundary between Santonian and Campanian cannot be placed exactly in the Schattau section. The evidence for the presence of Campanian

sediments is still missing. Therefore the "Ammonite Fauna Gosau V" of "Early Campanian" age of SUMMESBERGER (1985) is abandoned.

Local evolutionary trends: Smooth individuals of the genus *Placenticeras* occur in the early Santonian parts of the sections (Grabenbach, Gosau; KOLLMANN & SUMMESBERGER, 1982: 58) of the Gosau Group, generally badly preserved, but identifiable as representatives of the genus *Placenticeras* even in small fragments by their characteristic sutures. Coarsely sculptured individuals appear for the first time some metres below the Sandkalkbank Member in the Hochmoos Formation of the Neffgraben (Rußbach, Salzburg). In the *Paraplanum* Subzone of the Sandkalkbank Member the genus *Placenticeras* is represented by three taxa: *P. polyopsis* (DUJARDIN), *P. paraplanum* WIEDMANN, 1978 and *P. maherndli* SUMMESBERGER, each of them by a dimorphic pair. The occurrence of *Placenticeras polyopsis* (DUJARDIN, 1837) might be due to immigration from West. Out of this pool in the Gosau Group, possibly deriving from the *P. paraplanum* stock, the Early Campanian *Milleri-Bidorsatum* group (SUMMESBERGER et al., 1996; SUMMESBERGER, 2007) developed. *Placenticeras milleri* (HAUER, 1866: 4, Pl. 2, Figs. 1, 2) occurs in the early Campanian Gosau Group of the Gosau Basin of Kainach (Austria, Styria) whereas *Placenticeras bidorsatum* (F.A. ROEMER, 1841) appears contemporaneously in Germany (e.g. Münster Basin).

Placenticeras paraplanum WIEDMANN, 1978

Pl. 9, Fig. 5

1978 *Placenticeras paraplanum* WIEDMANN: 666, Pl. 1, Figs. 3, 4, Text-Fig. 2a.

1979 *Placenticeras paraplanum* WIEDMANN; SUMMESBERGER: 152, Pl. 13, Figs. 53–57, Text-Figs. 38, 39.

1980 *Placenticeras paraplanum* WIEDMANN; SUMMESBERGER: 281.

1985 *Placenticeras* aff. *paraplanum* WIEDMANN; AMEDRO & HANCOCK: 24, Text-Figs. 11a–c, f, g.

1987 *Placenticeras paraplanum* WIEDMANN, 1978; KENNEDY: 769, Pl. 80, Figs. 1–3, 8–10.

1991 *Placenticeras paraplanum* WIEDMANN, 1978; KENNEDY & COBBAN: 176.

1995 *Placenticeras paraplanum* WIEDMANN, 1978; KENNEDY in KENNEDY et al.: 411, Pl. 17, Figs. 11, 12, Pl. 18, Figs. 1–4.

2000 *Placenticeras paraplanum* (WIEDMANN); SUMMESBERGER in EGGER et al.: 26.

2007 *Placenticeras paraplanum* WIEDMANN, 1978; SUMMESBERGER: 409, Figs. 8, 9.

2017a *Placenticeras paraplanum* WIEDMANN, 1978; SUMMESBERGER et al.: 35., Pl. 10, Fig. 4, Tab. 12.

Type: Holotype by original designation is the original of WIEDMANN (1978: Pl. 1, Figs. 3, 4, Text-Fig. 2a) from the late Santonian *Paraplanum* Subzone (Sandkalkbank Member, Hochmoos Formation, Gosau Group) of Gosau (Upper Austria), refigured here (Pl. 9, Figs. 5a–c).

Description, Discussion, Occurrence: Besides the holotype in the Gapp collection (Gosau) four specimens of *P. paraplanum* WIEDMANN, 1978 are described by SUMMESBERGER (1979: 152, Pl. 1, Figs. 3, 4) from the Skoumal collection (Vienna). All are from the late Santonian Sandkalkbank Member (Hochmoos Formation, Gosau Group) of the Finstergrabenwandl site (Gosau, Upper Austria). A fine specimen from the Neffgraben (Rußbach, Salzburg) was described by SUMMESBERGER et al. (2017a, this volume). Elsewhere it occurs in the Corbières and in the Aquitaine basin in France.

Placenticeras maherndli SUMMESBERGER, 1979

Pl. 9, Fig. 2, Tab. 11

1979 *Placenticeras maherndli* SUMMESBERGER: 155, Pl. 14, Figs. 58–61, Pl. 15. Figs. 62–66, Text-Figs. 40–47.

1982 *Placenticeras maherndli* SUMMESBERGER; KOLLMANN & SUMMESBERGER: 49.

1983 *Placenticeras maherndli* SUMMESBERGER, 1979; KENNEDY & WRIGHT: 866.

1987 *Placenticeras maherndli* SUMMESBERGER 1979; IMMEL: 98.

1991 *Placenticeras maherndli* SUMMESBERGER, 1979; KENNEDY & COBBAN: 176.

1994 *Placenticeras maherndli* SUMMESBERGER; TRÖGER & SUMMESBERGER: 185.

1995 *Placenticeras maherndli* SUMMESBERGER, 1979; KENNEDY in KENNEDY et al.: 411, Pl. 22, Fig. 7.

? 1995 *Placenticeras maherndli* SUMMESBERGER 1979; LOMMERZHEIM: 63, Pl. 6, Figs. 1–3.

2000 *Placenticeras maherndli* SUMMESBERGER; SUMMESBERGER in EGGER et al.: 26, Fig. 16/2.

? 2000 *Placenticeras maherndli* SUMMESBERGER, 1979; KENNEDY & KAPLAN: 74, Pl. 2, Fig. 6.

2007 *Placenticeras maherndli* SUMMESBERGER, 1979; SUMMESBERGER: 410, Figs. 10, 11.

cf. 2017c *Placenticeras* aff. *maherndli* SUMMESBERGER, 1979; SUMMESBERGER et al.: 124, Fig. 7/4, Tab. 2.

Type: The holotype by original designation is MA 1977/2, the original of SUMMESBERGER (1979: Pl. 14, Figs. 58, 59).

Material: SK/SG/1981/1, a single specimen collected loose in the bed of the Schattaugraben, preservation suggests it came from the Sandkalkbank Member.

Description: SK/SG/1981/1 is a fragment mainly consisting of the body chamber but with the septal face of the inner whorl exposed. The surface is heavily corroded, leaving traces of whitish shell between the falcoid ribs only. The main characteristic of the specimen is its inflated body chamber section especially towards the apparently preserved aperture. The moderately narrow umbilicus is about 10 mm deep, the umbilical wall is vertical to slightly convex. The umbilical shoulder is moderately rounded. About six umbilical bullae per half whorl give rise to pairs of falcoid ribs, in between three or four intercalated ones, all in slightly irregular distances more or less equal to the width of the ribs. Ribs are corroded towards the aperture but preserved umbilical bullae indicate by crowding that the aperture is very close.

Inventory No.	D (mm)	Wh (mm)	Wb (mm)	U (mm)	U (%)
SK/SG 1981/1	85.0 ($D_{max/est}$)	35.8	38.3	10.8	12.7
SK/SG 1981/1	65.3 ($D_{-180°}$)	35.6	25.7	8.9	13.6
SK/SG 1981/1	45.0 ($D_{-360°}$)	19.3	12.7	7.9	17.5

Tab. 11.
Measurements of *Placenticeras maherndli* SUMMESBERGER, 1979 (SK/SG 1981/1). The data are slightly altered by deformation but still meaningful. U % of D.

Discussion: The characteristic falcoid ribbing leaves no doubt about this specimen belonging to *Placenticeras maherndli* SUMMESBERGER, 1979. The specimen differs in its inflated body chamber from previous described material from the Gosau Group (SUMMESBERGER, 1979) and from specimens from the Corbières (KENNEDY, 1995: 411, Pl. 22, Fig. 7). *Placenticeras maherndli* SUMMESBERGER, 1979 described by LOMMERZHEIM (1995: 63, Pl. 6, Figs. 1–3) from boreholes in the Münster Basin (NW Germany) are doubtful in our view as the preservation of the figured specimens is rather poor (unidentifiable after KENNEDY & KAPLAN, 2000: 74, Pl. 2, Fig. 6).

Occurrence: The species was originally described in 1979 from the Sandkalkbank Member of the Hochmoos Formation of the Austrian Gosau Group. Outside the Gosau Group the species was found in the *Paraplanum* Zone of the Corbières (KENNEDY, 1995). The report from the Münster Basin (Germany) is doubtful (see above).

Superfamily Acanthoceratoidea DE GROSSOUVRE, 1894

Family Sphenodiscidae HYATT, 1900

Subfamily Lenticeratinae HYATT, 1900

Genus *Diaziceras* SPATH, 1921

Type species: *Diaziceras tissotiaeforme* SPATH (1921) by original designation.

Diaziceras austriacum (SUMMESBERGER, 1979)

not figured

1979 *Skoumalia austriaca* gen. nov., sp. nov., Form A; SUMMESBERGER: 141, Pl. 9, Figs. 37–38, Text-Figs. 26–28.

Non 1979 *Skoumalia austriaca* gen. nov., sp. nov., Form B; SUMMESBERGER: 143, Pl. 9, Figs. 39–41, Text-Figs. 29, 30 (= *Eulophoceras jacobi* HOURCQ, 1949).

Non 1980 *Skoumalia austriaca* gen. nov., sp. nov., Form B; SUMMESBERGER: 280, Pl. 2, Figs. 5, 6, Pl. 3, Figs. 7, 8, Text-Figs. 5, 6 (= *Eulophoceras jacobi* HOURCQ, 1949).

1995 *Eulophoceras austriacum* (SUMMESBERGER, 1979); KENNEDY: 426, Pl. 25, Figs. 3–5, Pl. 26, Fig. 8.

1996 *Eulophoceras austriacum* SUMMESBERGER, 1979; WRIGHT: 205, Figs. 157c, d.

2012b *Diaziceras austriacum* (SUMMESBERGER, 1979); KENNEDY & KLINGER: 12.

Type: The holotype by original designation is SK/1977/14, the original of *Skoumalia austriaca*, form A, SUMMESBERGER (1979: 141, Pl. 9, Figs. 37–38 (only), Text-Figs. 26–28 (only).

Material: SK/1977/14, the holotype, is the only known specimen.

Description: SK/1977/14 is a laterally compressed internal mould of a throughout chambered phragmocone, the body chamber is missing. There is no shell preserved. General outline is oxycone with fastigiate venter and sharp keel. Wh increases rapidly, the last whorl covering most of the preceding one. The umbilicus comprises about 13 % of the diameter. The umbilical shoulder is rounded, the umbilical wall as far as visible is slightly convex. Measurements of *Skoumalia austriaca*, form A are given by SUMMESBERGER (1979: 141). Four strong irregular umbilical bullae give rise to straight prorsiradiate, shallow ribs terminating with irregular interspaces in about eight weak ventral bullae. For the characteristic suture see SUMMESBERGER (1979: Text-Figs. 27, 28) and KENNEDY & KLINGER (2012b: Figs. 4A, C). E/A is deeply incised with irregular folioles, deep narrow A and bifid A/U_2.

Discussion: *Diaziceras austriacum* (SUMMESBERGER, 1979) was originally described as the form A of a pair of dimorphs (*Skoumalia austriaca* SUMMESBERGER, 1979), whose partner *Skoumalia austriaca* SUMMESBERGER 1979, form B (143, Text-Figs. 29, 30; 1980: 280, Pl. 2, Figs. 5–6, Pl. 3, Figs. 7–8, Text-Figs. 5, 6) is now separated as *Eulophoceras jacobi* HOURCQ, 1949, described below.

Diaziceras tissotiaeforme SPATH, 1921 is much more inflated and differs strongly in sculpture: Seven very strong umbilical tubercles give rise to prorsiradiate strong bifurcating and trifurcating primary ribs. Together with some intercalatory ones they terminate in about 20 conical ventrolateral tubercles. The asymmetrical E/A of the holotype (see KENNEDY & KLINGER, 2012b: Fig. 4F) is deeply incised with intricated suture elements.

Diaziceras guillantoni HOURCQ, 1949 is similar but somewhat more inflated than *D. austriacum*. Its umbilicus is also somewhat wider – 17 % in the holotype and 18–21 % in the specimens figured by COLLIGNON (1969), compared to 13 % in case of *D. austriacum*. The main difference is in the ornament: about 6–7 relatively weak umbilical tubercles connected by low broad ribs to about 20 ventrolateral tubercles. The sutures are less deeply incised than those of *D. austriacum*. *Eulophoceras jacobi* HOURCQ, 1949, formerly interpreted as the partner of a dimorphic pair with *D. austriacum* was discussed in 2012 (KENNEDY & KLINGER, 2012a: 35, Pl. 12A–C). *E. jacobi* (see below) differs strongly in its near-smooth surface and smaller umbilicus.

Eulophoceras natalense HYATT, 1903 differs in its tiny umbilicus and its dimorphism described by SUMMESBERGER et al. (2017a).

Occurrence: *Diaziceras austriacum* (SUMMESBERGER, 1979) was described under *Skoumalia austriaca* SUMMESBERGER, 1979 from the late Santonian of the Gosau Basin and under *Eulophoceras austriacum* (SUMMESBERGER, 1979) from the *Paraplanum* Subzone of the La Jouane section in the French Corbières (KENNEDY, 1995: 426, Pl. 25, Figs. 3–5).

Genus *Eulophoceras* Hyatt, 1903

Type species: *Eulophoceras natalense* Hyatt, 1903 by original designation.

Eulophoceras jacobi Hourcq, 1949

Pl. 10, Figs. 2–5, Text-Fig. 17

1949 *Eulophoceras Jacobi* Hourcq: 95, Pl. 1, Fig. 2.

1969 *Eulophoceras Jacobi* Hourcq; Collignon: 204, Pl. 600, Fig. 2253.

1979 *Skoumalia austriaca* gen. nov., sp. nov., Form B; Summesberger: 143, Pl. 9, Figs. 39–41, Text-Figs. 29, 30.

Non 1979 *Skoumalia austriaca* gen. nov., sp. nov., Form A; Summesberger: 141, Pl. 9, Figs. 37–38, Text-Figs. 26–28 (= *Diaziceras austriacum* (Summesberger, 1979)).

1980 *Skoumalia austriaca* Summesberger; Form B; Summesberger: 280, Pl. 2, Figs. 5–6, Pl. 3, Figs. 7–8, Text-Figs. 5, 6.

1982 *Skoumalia austriaca* Summesberger; Kollmann & Summesberger: 49, partim.

1985 *Eulophoceras austriacum* (Summesberger) "forme B"; Amédro & Hancock: 23–24, Figs. 11d, e.

1987 ? *Eulophoceras austriacum* (Summesberger 1979); Immel: 113, partim.

1987 *Eulophoceras austriacum* (Summesberger, 1979); Kennedy: 776, Pl. 82, Figs. 1–3.

1995 *Eulophoceras austriacum* (Summesberger, 1979); Kennedy in Kennedy et al.: 426, Pl. 26, Fig. 8, Text-Fig. 33.

Non 1995 *Eulophoceras austriacum* (Summesberger, 1979); Kennedy in Kennedy et al.: 426, Pl. 25, Figs. 3–5, Text-Fig. 34 (= *Diaziceras austriacum* (Summesberger, 1979).

Non 1995 *Eulophoceras austriacum* (Summesberger 1979); Lommerzheim: 61, Pl. 5, Fig. 2.

2000 *Eulophoceras austriacum* (Summesberger); Summesberger in Egger et al.: 26, partim.

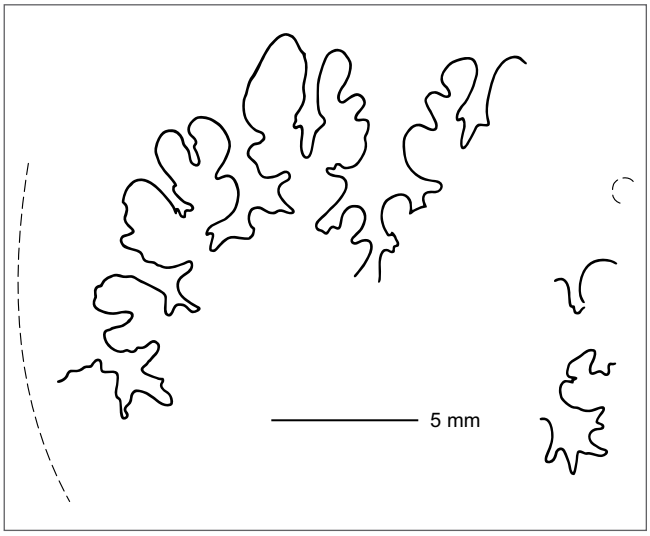
2012a *Eulophoceras jacobi* Hourcq, 1949; Kennedy & Klinger: 32, 35, Figs. 4, 12A–C.

2017c *Eulophoceras jacobi* Hourcq, 1949; Summesberger et al.: 125, Fig. 4/1–8, Tab. 3.

Type: The lectotype is the original of Hourcq (1949: Pl. 11, Fig. 2, Text-Fig. 7) subsequently designated by Kennedy & Klinger (2012a: 35).

Material: SK/SG/1998/31 and SK/SG/2002/32 from the Sandkalkbank Member of the Schattaugraben, SK/SG 2007/44, 45 from the *Micraster* Bed of the Schattaugraben section, SK/1978/21 and SK/1979/3, all from the Sandkalkbank Member of the locality Finstergrabenwandl.

Description: SK/SG/1998/31 is discoidal with an entire keel, which is distinctly separated from the flank by a ventrolateral facet. Towards the aperture the entire sharp keel becomes rounded.



Text-Fig. 17.
External suture of *Eulophoceras jacobi* Hourcq, 1949. SK/SG/1998/31 from the Sandkalkbank Member (Hochmoos Formation, Schattaugraben section); fragment of the external suture. Scale bar: 5 mm.

Coiling is involute with a tiny umbilicus (U = 6.6 %). Umbilical bullae are indicated by tiny swellings. About 10 feeble ventrolateral and slightly prorsiradiate bullae are present.

SK/SG/1998/31 is very close to SK/1979/3 described by Summesberger (1980: 280, Pl. 2, Figs. 5, 6, Pl. 3, Figs. 7, 8, Text-Figs. 5, 6). Ribs are very low and barely detectable (Summesberger, 1980: Pl. 2, Fig. 7) as are the spiral ridges (Summesberger, 1980: Pl. 3, Fig. 7). SK/SG/2002/32 is a juvenile with partially preserved shell. It is impregnated by iron oxide indicated by the brownish colour. It shows distinct umbilical bullae, giving rise to indistinct falcoid ribs with tiny bullae at the ventrolateral shoulder. For the characteristic suture see Summesberger (1980: Text-Fig. 6) and Kennedy & Klinger (2012a: Fig. 11D). E/A is deeply incised with irregular folioles, deep wide A and bifid A/U_2.

Discussion: *Diaziceras austriacum* (Summesberger, 1979) differs in its larger umbilicus (13 %) and in the strong umbilical tubercles (Summesberger, 1979: 142, Pl. 9, Fig. 37, Text-Fig. 26).

Eulophoceras natalense Hyatt, 1903 differs in its distinctly rounded venter towards the aperture in adult specimens and in its dimorphism described by Summesberger et al. (2017a).

E. bererense Hourcq, 1949; differs in its prorsiradiate and falcoid ribbing (Kennedy & Klinger, 2012a: Text-Fig. 12D, Figs. 13A–D, Fig. 14); for further discussion see the revision of Kennedy & Klinger (2012a). We have not seen the specimen figured by Lommerzheim (1995: Pl. 5, Fig. 2). In our opinion it seems to be a different taxon.

Occurrence: The Austrian specimens of *E. jacobi* Hourcq, 1949; are from the top Santonian Sandkalkbank Member of the Hochmoos Formation of the Gosau Group. Further specimens are from the late Santonian of the Hofergraben site (Gosau, Upper Austria; Summesberger et al., 2017c). It is also described from the late Santonian of France (from the Charentes: Amedro & Hancock, 1985; from the Aquitaine Basin: Kennedy, 1987; from the Corbières: Kennedy, 1995). Co-occurrence with *Placenticeras*

paraplanum, *Boehmoceras arculus* and *Marsupites laevigatus* endorses the stratigraphical position of *E. jacobi* in the top Santonian. On the other hand, the specimens from Madagascar are said to be lowest Campanian (COLLIGNON, 1969). Juvenile SK/SG/2002/32 (Pl. 10, Fig. 5) recalls the juvenile ornamentation of *E. natalense* described by SUMMESBERGER et al. (2017a).

Family Collignoniceratidae WRIGHT & WRIGHT, 1951

Subfamily Texanitinae COLLIGNON, 1948

Genus *Reginaites* REYMENT, 1957

Type species: *Peroniceras* (*Reginaites*) *quadrituberculatum* REYMENT (1957) by original designation.

Remarks: *Reginaites* REYMENT (1957) was introduced as a subgenus of the Coniacian genus *Peroniceras*. YOUNG (1963: 76) ranked it within the subfamily Texanitinae. This was followed and discussed at length by KLINGER & KENNEDY (1980: 107–111) and WRIGHT (1996: 197).

Reginaites gappi WIEDMANN, 1978

Pl. 10, Figs. 7–8

1978 *Reginaites gappi* WIEDMANN: 668–669, Pl. 2, Figs. 1–3, Text-Figs. 2C, 3B.

1979 *Reginaites gappi* WIEDMANN 1978; SUMMESBERGER: 159.

1980 *Reginaites gappi* WIEDMANN; SUMMESBERGER: 281.

1980 *Reginaites gappi* WIEDMANN (1978); KLINGER & KENNEDY: 110.

1987 *Reginaites gappi* WIEDMANN 1978; IMMEL: 112.

1991 *R. gappi* WIEDMANN, 1978; KENNEDY & COBBAN: 177.

Type: The holotype by original designation is the specimen figured by WIEDMANN (1978: Pl. 2, Figs. 1–3) registered under CG 03 in the Gapp collection (Gosau, Upper Austria) and refigured here (Pl. 10, Figs. 8a, b).

Material: Three specimens: CG 03 (Gapp collection), the original of WIEDMANN (1978), NHMW 1990/0029/0526 and an unregistered specimen in the Maherndl collection (Bad Ischl).

Description: The sculpture of *R. gappi* consists of about 24 prorsiradiate bituberculate strong ribs. The interspaces are somewhat wider than the ribs. The tubercles are very strong, even in the juvenile stage. For details see the description of WIEDMANN (1978: 668–669).

Discussion: *R. quadrituberculatum* (sic) REYMENT, 1957 differs in its generally weaker ornament, especially the umbilical tubercles of the adult specimen and in a lateral row of very feeble tubercles (KLINGER & KENNEDY, 1980: Fig. 89). *R. durhami* YOUNG (1963: 92, Pl. 39, Fig. 2, Pl. 49, Figs. 1, 2, 4, Text-Fig. 22b) also has weaker ornament and a lateral row of weak tubercles.

R. hataii MATSUMOTO (1965: 240) was thought by the author to merit assignment to another genus (*Reymentites* (= *Reginaites*) REYMENT following KENNEDY & KLINGER, 1980 and WRIGHT, 1996).

It differs from *R. gappi* in its narrower ribs and a lateral row of tubercles that efface on the outer whorls.

R. leei (REESIDE, 1927) from the Early Campanian of New Mexico (KLINGER & KENNEDY, 1980: 110) has weaker ornament, and tiny umbilical tubercles. The main difference from *R. reymenti* KLINGER & KENNEDY, 1980 (111, Figs. 86–88) is the splitting of the ventrolateral node into two at a diameter larger than 60 mm. Furthermore, the umbilical tubercles are much smaller than in *R. gappi*. In *R. zulu* KLINGER & KENNEDY, 1980 (116, Figs. 90–92, 93A, B, 94) distant ribs (19 per whorl) are strongly prorsiradiate, becoming somewhat indistinct in the later growth stage.

The existence of a median row of tubercles at least in some representatives convinced YOUNG (1963: 38) as well as KLINGER & KENNEDY (1980) to include the genus *Reginaites* in the subfamily Texanitinae. They were followed by WRIGHT (1996) and by the present authors.

Reginaites exilis KENNEDY & COBBAN, 1991 ("*subtilis*" in plate explanation) from the Late Santonian *Shiloensis* Zone of Texas and Mississippi (USA) differs in its feeble tuberculation

Occurrence: *Reginaites gappi* WIEDMANN, 1978 is known only from the Sandkalkbank Member of the Hochmoos Formation (Gosau Group, locality Finstergrabenwandl) which belongs to the Subzone of *Placenticeras paraplanum* and *Boehmoceras arculus*.

Suborder Ancyloceratina WIEDMANN, 1966

Superfamily Turrilitoidea GILL, 1871

Family Nostoceratidae HYATT, 1894

Nostoceratidae gen. et sp. indet.

Pl. 12, Fig. 3

Material: A single specimen (NHMW 1978/1963/0027), already described by SUMMESBERGER (1979: 124, Pl. 3, Fig. 20) and refigured here, from the nearby Finstergrabenwandl.

Description and Discussion: NHMW 1978/1963/0027 shows four slowly expanding whorls of an apparently helicoidal spire. It has been flattened by *post mortem* compaction of the helix making measuring of the apical angle impossible. It differs in more irregular ribbing and ventrolateral spines of 1.7 mm length from the initial helix SK/SG/1998/27, which is tentatively assigned to *Glyptoxoceras* group 2 (see below) and from the initial coils SK/SG/1996/23, 24 which are tentatively assigned to *Amapondella amapondense* (VAN HOEPEN, 1921). They differ also in their more rapid increasing whorl height and whorl breadth. Assignment to a co-occurring taxon seems unlikely at this time.

Occurrence: *Paraplanum* Subzone (late Santonian Sandkalkbank Member, Hochmoos Formation, Gosau Group; Austria), co-occurring with *Placenticeras paraplanum* and *Boehmoceras arculus.*

Genus *Amapondella* KLINGER & KENNEDY, 1997b

Type species: *Heteroceras amapondense* VAN HOEPEN (1921) by original designation of KLINGER & KENNEDY (1997b: 246).

Amapondella amapondensis (VAN HOEPEN, 1921)

Pl. 11, Figs. 1–11

1921 *Heteroceras amapondense* VAN HOEPEN: 17, Pl. 4, Figs. 1–2.

1976 *Hyphantoceras* (*Madagascarites* ?) *amapondense* (VAN HOEPEN), 1921; KLINGER: 71, Pl. 32, Figs. 5a, b, Pl. 33, Figs. 2, 3, Text-Figs. 10d, e.

1979 *Hyphantoceras* (*Madagascarites* ?) *amapondense* (VAN HOEPEN); SUMMESBERGER: 123, Pl. 3, Fig. 19, Text-Fig. 13.

1979 ?*Diplomoceras* (Subgenus ?) *largesulcatum* (FORBES); SUMMESBERGER: 125, Pl. 3, Figs. 22, 23.

1980 *Hyphantoceras* (*Madagascarites* ?) *amapondense* (VAN HOEPEN); SUMMESBERGER: 277, Pl. 1, Fig. 2, Text-Fig. 3.

1982 *Hyphantoceras* (?) *amapondense* (VAN HOEPEN, 1921); LEWY: 24, Figs. 1–6.

1985 *Hyphantoceras* (?*Madagascarites*) *amapondense* (VAN HOEPEN, 1921); KLINGER: 6, Figs. 4J–K.

1987 *Hyphantoceras* (?*Madagascarites*) *amapondense* (VAN HOEPEN 1921); IMMEL: 134.

1991 *Hyphantoceras* (?) *amapondense* (VAN HOEPEN, 1921); KENNEDY & COBBAN: 181, Figs. 9, 10.

1995 *Hyphantoceras* ? *amapondense* (VAN HOEPEN, 1921); KENNEDY in KENNEDY et al.: 428, Pl. 28, Figs. 24–30.

? 1995 *Scalarites serta* (MÜLLER & WOLLEMANN, 1906); KENNEDY & KAPLAN: 31, Pl. 20, Figs. 6, 7, [only; Figs. 4, 5 = *Scalarites serta* (MÜLLER & WOLLEMANN, 1906)].

1997 *Eubostrychoceras* (*Amapondella*) *amapondense* (VAN HOEPEN, 1921); KLINGER & KENNEDY: 239, Figs. 12A–C, Figs. 13A–C, Fig. 14A, Figs. 15A–E, Figs. 17A–C.

? 2000 *Hyphantoceras* sp.; KENNEDY & KAPLAN: 92, Pl. 38, Fig. 8.

2003 *Eubostrychoceras* (*Amapondella*) *amapondense* (VAN HOEPEN, 1921); KLINGER & KENNEDY: 235, Figs. 5, 6, 7A, 8A–D, 9A–C [with synonymy].

2007 *Amapondella amapondense* (VAN HOEPEN, 1921); KLINGER et al.: 104, Text-Figs. 11A–C, Figs. 12B–I.

Type: Holotype by original designation is the specimen figured by VAN HOEPEN (1921: Pl. 4, Figs. 1–2).

Material: A series of fragments of body chambers and middle growth stages was available for study: MA1976/12, 13; SK/SG/1992/14, SK/SG/2003/36, 37; SK/SG/2005/39; NHMW 2010/0081/0003 from the Schattaugraben section. SK/2000/1 from the Sandkalkbank Member from the exposures of a forest road close to the Finstergrabenwandl locality (Zwieselalm forest road); NHMW 1978/1963/0020 (SUMMESBERGER, 1979: Pl. 3, Fig. 19, Text-Fig. 13); NHMW 1978/1963/0028 (SUMMESBERGER, 1979: Pl. 3, Figs. 22, 23), SK 1979/2 (SUMMESBERGER, 1980: Pl. 1, Fig. 2, Text-Fig. 3). Furthermore, we assign some helically coiled initial stages from the *Micraster* Bed of the Schattaugraben section to the species: SK/SG/1996/23, 24 and fragments of subadult phragmocones: NHMW 2010/0081/0003, NHMW 2010/0081/0004 and a very small fragment NHMW 2010/0081/0005 all from the Schattaugraben section.

Description: Initial stage: SK/SG/1996/23, 24 (Pl. 11, Figs. 10–11) are two slightly crushed fragments of a loosely helically coiled low spire, the whorls originally apparently not touching but barely separated. Both are slightly elongated into a somewhat elliptical outline of 14–17 mm in diameter. Wh as far as measurable is from 2 to 5 mm, U is approximately 8 mm, U % is > 50 %. Wh and Wb are increasing rapidly. The style of ribbing recalls the "standard" ribbing of the adult individuals. The ribs are sharp, distant, undivided, occasionally accentuated and sometimes with wider interspaces anticipating the irregular ribbing of the adult shells with wider interspaces and flares.

Adult stage: MA/1976/12 (Pl. 11, Fig. 2) is a 51 mm long fragment of an internal mould of an irregularly coiled helical whorl with adherent powdery shell remnants. The general outline of the fragment suggests it to be the aperture of an adult individual. The width close to the apertural end is 13.6 mm. Four prominent flared, very strong and sharp ribs are spaced at irregular distances from 11 to 13 mm. In between 3 to 6 much weaker ribs of different width are intercalated at irregular intervals. The intercalated ribs are weakened on the dorsum or even efface. The primary ribs cross the whorl without interruption. MA 1976/13 (Pl. 11, Fig. 4) is of comparable proportions, shape and style of ribbing but badly corroded. SK/SG/1992/14 (Pl. 11, Fig. 6) is a badly crushed body chamber fragment too, which shows the ventrally arranged flares. The best specimen is SK/2000/1 representing two parts of the volution of an adult specimen, interrupted by a missing piece (Pl. 11, Figs. 1a, b). No sutures are visible as all specimens are body chamber fragments. The type of ribbing unites these fragments of different portions of the shell: single undivided sharp ribs with ribs narrower than the interspaces, in juvenile stages accentuated ones, in adult stages flared ones accompanied by wider interspaces. Between the dominating primaries are three to eight secondaries arranged in distances wider than the ribs.

Discussion: The identification is based on the combined characteristics of fragments which are tentatively interpreted to belong together. Initial coils are never found preserved together with the adult phragmocone and body chamber of a single individual. Combined with the already described specimens from the upper Santonian Sandkalkbank Member (SUMMESBERGER, 1979, 1980) the restored shell was an initial low helix followed by an irregular loose helix with wider distances between whorls (SUMMESBERGER, 1980: Pl. 1, Fig. 2) and finally an upward turned aperture (KLINGER & KENNEDY, 1997b: Figs. 12F, 13A–C; 2003: Fig. 5F, the holotype). In 1997 KLINGER & KENNEDY (1997b) state the early ornament consisted of uniform ribbing, but in some cases the later ornament might appear also in the very early stages of the helix. This seems to be the case in two individuals from the *Micraster* Bed of the Schattaugraben section. Affinities and differences are discussed at length by KLINGER & KENNEDY (2003). *Eodidymoceras enigma* (KLINGER et al., 2007: 102, Figs. 14A–K, 15A–N) is very similar but has bituberculate ribbing.

The flattened initial coil of a specimen of Nostoceratinae gen. et sp. indet. from the Sandkalkbank of the Finstergrabenwandl (SUMMESBERGER, 1979: 124, Pl. 3, Fig. 20; see above) differs in its low expansion rate of the section together with a different style of ribbing. Ribs are less sharp, even blunt in section, more irregularly and tightly spaced. Combined with distinct spines of almost 2 mm length the restored helix belongs to a different taxon.

The initial coil (SK/SG/1998/27) of what we believe to belong to *Glyptoxoceras* group 2 (Pl. 13, Fig. 9; see below) differs by lower expanding rate and sharp narrow ribs with wider interspaces.

Occurrence: *Amapondella amapondensis* (VAN HOEPEN, 1921) occurs in the *Paraplanum* Subzone of the Sandkalkbank Member of the Hochmoos Formation of the Gosau Group of the Schattaugraben section and of the Finstergrabenwandl, Austria. After KLINGER & KENNEDY (1997b) the occurrences in Zululand, Pondoland and Madagascar are late Santonian or earliest Campanian in age which agrees well with the Austrian range at the top of the upper Santonian Sandkalkbank member.

Family Diplomoceratidae SPATH, 1926
Subfamily Diplomoceratinae SPATH, 1926
Genus *Scalarites* WRIGHT & MATSUMOTO, 1954

Type species: *Helicoceras scalare* YABE, 1904 (Pl. 9, Fig. 2 only) by original designation.

Scalarites serta (MÜLLER & WOLLEMANN, 1906)

Pl. 12, Fig. 2.

1906 *Crioceras serta* MÜLLER & WOLLEMANN: 20, Pl. 9, Fig. 3, Pl. 10, Figs. 1, 2 [only; Fig. 3 = *? Glyptoxoceras* (fide KENNEDY & KAPLAN, 1995: 31)].

1995 *Scalarites serta* MÜLLER & WOLLEMANN, 1906; KENNEDY & KAPLAN: 31, Pl. 20, Figs. 4, 5 [only; non: Figs. 6, 7 = *? Amapondella amapondensis* (VAN HOEPEN, 1921)].

2000 *Scalarites serta* (MÜLLER & WOLLEMANN, 1906); KENNEDY & KAPLAN: 102.

2000 *Scalarites serta*; KAPLAN & KENNEDY: 111.

Type: Lectotype herewith designated is the original of *Crioceras serta* MÜLLER & WOLLEMANN, 1906 (Pl, 10, Fig. 1) from the early lower Campanian (after KAPLAN in KENNEDY & KAPLAN, 1995: 11) of the brick pit "Aktienziegelei" (formerly: Actien-Ziegelei) near Braunschweig (Germany).

Material: A single specimen SK/SG/1981/2 from the *Micraster* Bed of the Hochmoos Formation (Schattaugraben section, Rußbach, Salzburg).

Description: SK/SG/1981/2 is an internal mould of a curved fragment of the phragmocone with yellowish shell preserved. Length is 63.7 mm, Wh 7.8–9.1 mm (deformed), length measured ventrally is 94 mm. The specimen is flattened by *post mortem* deformation, its original whorl section might have been circular or slightly elliptical. As far as visible the coiling was criocone in an even plane. The surface is covered by straight and rectiradiate undivided riblets with a moderately sharp section. In irregular distances of 3 to 8 "normal" ones delicately flared collar riblets occur followed by indistinct constrictions. Riblets and interspaces are of equal width. The rib index is about eight per cm.

Discussion: We follow KENNEDY & KAPLAN (1995: 102) keeping *Scalarites serta* (MÜLLER & WOLLEMANN, 1906) specifically separated from *Scalarites cingulatum* (SCHLÜTER, 1872) from the Early Campanian of Westphalia, the latter differing by sharper rib section and less intercalated "normal" riblets between flared ones. Future work might lead to referring both rare forms to a single species. See also KENNEDY & KAPLAN (1995: 31, Pl. 20, Figs. 1–3; 2000: 100, Pl. 34, Fig. 1). The above described specimen resembles closely the earlier part of the loosely coiled specimen figured by MÜLLER & WOLLEMANN (1906: Pl. 10, Fig. 1).

Scalarites scalaris (YABE, 1904) from the Japanese Turonian differs in its more even 10–12 sharp and narrowly spaced riblets between the flared ones (WRIGHT & MATSUMOTO, 1954: Text-Fig. 1). *Scalarites mihoensis* WRIGHT & MATSUMOTO, 1954 (Pl. 7, Figs. 1, 2, Text-Fig. 2) from the Japanese Turonian to Coniacian is similar to *S. scalaris* with only a few flared ribs and occasional constrictions. *Scalarites* sp. from the French Coniacian (KENNEDY, 1984: 140, Pl. 32, Figs. 7–10) is a badly preserved fragment with much coarser ribbing.

Occurrence: *Scalarites serta* occurs in the late Santonian Zone of *Boehmoceras arculus* (sensu KAPLAN in KENNEDY & KAPLAN, 2000), *Placenticeras paraplanum* and *Marsupites testudinarius* of the Schattaugraben section, in the upper *B. arculus* Zone in the Münster Basin (Germany; KAPLAN & KENNEDY, 2000: 111) and in the early Campanian *Bidorsatum* Zone of Braunschweig (Germany; KAPLAN in KENNEDY & KAPLAN, 1995: 11).

Genus *Glyptoxoceras* SPATH, 1925

Type species: *Hamites rugatus* (FORBES, 1846) by the original designation of SPATH (1925).

Remarks: As described below, the co-occurrence of six taxa of the genus *Glyptoxoceras* in the *Micraster* Bed of about 1 m thickness is questionable and further studies of additional material are needed to clarify intraspecific variation.

Glyptoxoceras souqueti COLLIGNON, 1983

Pl. 12, Fig. 1

1983 *Glyptoxoceras souqueti* COLLIGNON: 186, Pl. 1, Fig. 4.

1995 *Glyptoxoceras souqueti* COLLIGNON, 1983; KENNEDY in KENNEDY et al.: 429, Pl. 29, Figs. 14, 15, 18.

? 1995 *Glyptoxoceras souqueti* COLLIGNON, 1983; KENNEDY in KENNEDY et al.: 429, Pl. 29, Figs. 12, 13, 16, 17.

Type: The holotype by original designation is the original of COLLIGNON (1983: Pl. 1, Fig. 4), refigured by KENNEDY (1995: Pl. 29, Figs. 14, 15, 18).

Material: A single fragment SK/SG/2007/47 from the *Micraster* Bed of the Bibereck Formation.

Description: SK/SG/2007/47 is a fragment of an internal mould with most of the shell preserved. It is laterally compacted by *post mortem* deformation in a single plane. Length is about 47 mm. The original shape of the whole individual cannot be restored from such a small fragment. It might have been loosely coiled. Coiling radius changes close to the adapertural end of the specimen. The section, distinctly increasing with age, might have been round or oval from 5 to 8 mm. Ribbing in regular distances is recti- to slightly prorsiradiate. Rib index might have been from 3 to 5. Ribs are single and relatively strong and cross the dorsum and venter without interruption. Rib interspaces are about the double width of the ribs. Rib section is squarish, the rib vertex is flat. The suture is not visible.

Discussion: SK/SG/2007/47 differs from other representatives of *Glyptoxoceras* from the Schattaugraben locality (see below) in having squarish rib sections, wider and regular rib distances and by the conspicuously increasing diameter of the restored whorl section. Its changing radius of involution is comparable to that of the holotype (KENNEDY, 1995: Pl. 29, Figs. 14, 15). The absence of straight portions, in both the Corbières material, and the Gosau specimen supports specific separation from *Glyptoxoceras crispatum* described below (see KENNEDY, 1995: 429).

Occurrence: *Glyptoxoceras souqueti* COLLIGNON occurs in the *Paraplanum* Subzone of the Gosau Group and in the *Gallicus* and *Paraplanum* Zones of the Corbières (KENNEDY, 1995).

Glyptoxoceras crispatum (MOBERG, 1885)

Pl. 12, Figs. 6–13

1885	*Anisoceras* (*Hamites*) *crispatus* MOBERG: 32, Pl. 3, Figs. 12, 13.
1979	?*Diplomoceras* (Subgenus ?) *tenuisulcatum* (FORBES); SUMMESBERGER: 124, Pl. 3, Fig. 21.
1982	*Diplomoceras* (*Glyptoxoceras*) *indicum* (FORBES 1846); IMMEL et al.: 26, Pl. 10, Figs. 5, 6.
1982	*Diplomoceras* (*Glyptoxoceras*) *subcompressum* (FORBES 1846); IMMEL et al.: 26, Pl. 10, Fig. 7.
Non 1982	*Diplomoceras* (*Glyptoxoceras*) *subcompressum* (FORBES 1846); IMMEL et al.: 26, Pl. 9, Figs. 4, 5, Pl. 11, Fig. 4.
1995	*Glyptoxoceras crispatum* (MOBERG, 1895); KENNEDY & JAGT: 275–295.
1995	*Glyptoxoceras crispatum* (MOBERG, 1885), KENNEDY et al.: 430, Pl. 27, Figs. 16, 24, Pl. 29, Figs. 1, 8, 11, 19, 20 [with synonymy].
2000	*Glyptoxoceras* cf. *tenuisulcatum* (FORBES); SUMMESBERGER in EGGER et al.: 26.
2000	*Glyptoxoceras crispatum* (MOBERG, 1885); KENNEDY & KAPLAN: 96, Pl. 34, Fig. 2.
2017b	*Glyptoxoceras crispatum* (MOBERG, 1885); SUMMESBERGER et al.: 108, Pl. 1, Figs. 11–13, Pl. 2, Fig. 5.

Types: A series of fragments is preserved in the type collection of the Geological Survey of Sweden (KENNEDY et al., 1995: 430). The types were figured and a lectotype designated in KENNEDY & CHRISTENSEN (1997: 107, Text-Fig. 24 A).

Material: SK/SG/1992/11, SK/SG/1996/18, SK/SG/2002/33, SK/SG/2006/41, all from the late Santonian Sandkalkbank Member of the Hochmoos Formation, SK/SG/1996/20, 22 and NHMW 2010/0081/0006 from the late Santonian *Micraster* Bed of the Bibereck Formation, all from the Schattaugraben section, furthermore NHMW 1978/1963/0029, the original of SUMMESBERGER (1979: Pl. 3, Fig. 21) from the late Santonian Sandkalkbank Member of the nearby Finstergrabenwandl locality (Gosau, Upper Austria). A further fragment at our disposal is NHMW 2010/0083/0002 (2011/0054/0006) from the neighbouring late Santonian locality Gosauschmied (Gosau, Upper Austria). Three specimens from the early Santonian Brandenberg/Mühlbach site (Tyrol) figured by IMMEL et al. (1982: M 12, the original of Pl. 10, Fig. 5, BSP, 1963 XXX 30), the original of IMMEL et al. (1982: Pl. 10, Fig. 6), and with some doubt M 14, the original of IMMEL et al. (1982: 10, Fig. 7).

Description: SK/SG/2002/33 from the Schattaugraben section provides a fairly complete view of an adult individual (Pl. 12, Fig. 13). The open criocone coil (Wd_{est} = 36 mm) of the phragmocone is followed by a straight shaft of about 75 mm length. The preserved part of the shaft is slightly curved at the adapertural end suggesting a terminal hook. A body chamber fragment possibly belonging to the specimen mentioned, is preserved on the same slab. The embryonic part is missing. The preserved parts of the individual are bilaterally symmetrical. NHMW 1978/1963/0029, the original of SUMMESBERGER (1979: Pl. 3, Fig. 21) from the late Santonian Sandkalkbank Member of the Finstergrabenwandl at the adapical part of the figured plaster cast also shows the beginning of a curvature leading to the initial criocone coil. All individuals are deformed by lateral compaction suggesting an originally round or high oval cross section. The surface is covered by regular narrow sharp delicate, slightly rursi- to rectiradiate ribs increasing regularly in strength through ontogenesis. The ribs cross the dorsum and the venter without interruption. There are no bifurcations nor intercalatories. Rib index at a tentatively restored section is, reduced with age, approximately 9 in the final stage but about 14 in the curved parts in the initial coil. A straight fragment of the shaft of 61 mm length from the *Micraster* Bed of the Schattaugraben section sequence (SK/SG/1996/18) sugggests its prorsiradiate ribbing being possibly caused by distortion. There are no sutures visible.

Discussion: A redescription of MOBERG's (1885) original was given by KENNEDY (1995: 430). None of the specimens from the Corbières provides the complete view of the shell. The specimen from the Schattau and the individual from Westphalia figured by KENNEDY in KENNEDY & KAPLAN (2000: Pl. 34, Fig. 2) confirm the opinion (KENNEDY, 1995), that fragments of the criocone part and fragments of the straight shaft belong together. The Westphalian specimen supports our view, that the adult individual had a final hook after the straight shaft. The juvenile portion is visible on neither specimen. We agree with KENNEDY (1995: 430), that the late Maastrichtian taxa *Diplomoceras* (*Glyptoxoceras*) *subcompressum* (FORBES, 1846) and *Diplomoceras*

(*Glyptoxoceras*) *indicum* (FORBES, 1846) from India are not present in the early Santonian of Brandenberg (Tyrol) (IMMEL et al., 1982: 26, Pl. 9, Figs. 4, 5, Pl. 10, Figs. 5–7, Pl. 11, Fig. 4). As none of the specimens figured, none of the Austrian specimens nor Moberg's types (MOBERG, 1885: Pl. 3, Fig. 12) show rib bifurcations, we doubt also the assignment of the Brandenberg specimens (IMMEL et al., 1982: 26, Pl. 9, Figs. 4, 5, Pl. 11, Fig. 4) to *Glyptoxoceras crispatum* (MOBERG, 1885) as suggested by KENNEDY (1995: 430).

Glyptoxoceras aquisgranense (SCHLÜTER, 1872) from the lower Campanian Vaals Formation (Germany, Belgium) and from Ariège (France; KENNEDY et al., 1992) differs by its open planispiral adult stage and by the absence of straight portions apart from the initial shaft.

Glyptoxoceras rubeyi (REESIDE, 1927) from the Pierre Shale of Wyoming has an open elliptical coiling in a single plane. Specimens figured are preserved with ammonitella. Ribbing is initially closely spaced, becoming more distant towards the aperture. Ribs are rectiradiate. Rib index changes from 4 to 5. The specimens are very small, the most complete one measures 22 mm in length.

Glyptoxoceras roemeri (GEINITZ, 1849) from the Vaals Formation of the Aachener Kreide (HOLZAPFEL, 1887: Pl. 5, Figs. 4, 5) has an elliptical open coil with initially tight ribbing and increasing rib distances towards the aperture (KENNEDY in KENNEDY & KAPLAN, 2000: Pl. 35, Fig. 5).

Glyptoxoceras vaalsiensis (HOLZAPFEL, 1887: Pl. 5, Figs. 6, 7) from the Vaals Formation of the Aachener Kreide is known from fragments only, indicating an open criocone or elliptical coil with strong narrow spaced rectiradiate ribs.

Glyptoxoceras novimexicanum (REESIDE, 1927) from the upper part of the Mancos Shales in New Mexico is a large taxon, with criocone or elliptical coiling, straight and distant ribs which appear to be prorsiradiate (REESIDE, 1927: Pl. 4, Figs. 1–3). If REESIDE's other specimens (Pl. 4, Figs. 5, 6) also belong to this species, it also has straight shafts and at least one hook.

Glyptoxoceras sp. (*Hamites* sp.) REESIDE (1927: Pl. 4, Figs. 7, 8 only) from the same locality as his Figs. 1–4 on the same plate is a short straight fragment with more distant ribbing.

Glyptoxoceras sp. (*Hamites* sp.) REESIDE (1927: Pl. 4, Figs. 9, 10 only) is a curved fragment with narrow spaced prorsiradiate ribbing.

Fragments of *Glyptoxoceras ellisoni* YOUNG 1963 from the lower Campanian Dessau limestone of Texas (Austin Chalk) are larger and have blunt rectiradiate ribs (rib index 4) weakening on the dorsum. The shape of the complete individual is unknown, fragments are straight or slightly curved suggesting a complex shape of the whole shell.

Glyptoxoceras octocostatum (COLLIGNON, 1969) is larger with sharp regularly spaced annular ribs. Individuals figured by KLINGER & KENNEDY (2003: Figs. 56A, B, D, E, F) are slightly curved. A single one (Fig. 56D) has a curved adapical portion suggesting two parallel shafts. Nevertheless, the shape of the complete shell is unknown.

Glyptoxoceras souqueti COLLIGNON, 1983 from the middle and upper Santonian of the Corbières differs in the absence of straight portions. It has an irregular elliptical coiling and coarser ribbing (KENNEDY, 1995: 430).

Glyptoxoceras texanum KENNEDY, LANDMAN & COBBAN, 2001 from the late Santonian Blossom Sand (Austin Chalk) of Texas is based on a relatively large body chamber fragment with rursiradiate ribbing and constrictions. The rib index is 6–10, the ribs are crowding towards the aperture.

Neoglyptoxoceras retrorsum (SCHLÜTER, 1872) from the Campanian of Germany and France is much larger and possibly criocone (KENNEDY, 1986: 106, Pl. 16, Figs. 1–4, 6, 7, Pl. 17, Figs. 1, 2).

As already stated by KENNEDY (1995: 430) *Diplomoceras* (*Glyptoxoceras*) *indicum* (non FORBES, 1846), (IMMEL et al., 1982: 26, Pl. 10, Figs. 5–7) would be better assigned to *Glyptoxoceras crispatum* than to the late Maastrichtian species.

Diplomoceras (*Glyptoxoceras*) *subcompressum* (FORBES, 1846), (IMMEL et al., 1982: 26, Pl. 9, Figs. 4, 5, Pl. 11, Fig. 4) was put in synonymy with *Glyptoxoceras crispatum* (MOBERG, 1885) by KENNEDY (1995: 430). We doubt this, as the ribs of these specimens figured partially bifurcate.

Occurrence: Early Santonian of Eriksdal (Sweden) and Brandenberg (Austria); from early Santonian *carezi* Subzone to the middle Santonian *gallicus* Subzone of the Corbières, France. Late Santonian Zone of *Boehmoceras arculus* (sensu KAPLAN in KENNEDY & KAPLAN, 2000) in Westphalia and late Santonian Zone of *Boehmoceras arculus*, *Placenticeras paraplanum* and *Marsupites testudinarius* in the Schattaugraben section (Austria).

Fragmentary *Glyptoxoceras*

Individuals of *Glyptoxoceras* from the Schattaugraben that are too fragmentary to identify specifically are shown in Plate 13 from Figure 1 to 15, and in Plate 14 from Figure 1 to 6.

The sequence includes numerous fragments of *Glyptoxoceras* that differ in coiling mode, rib style and density. The nature of the material is such that we cannot establish the extent of intraspecific variation, or how many species are present. The material falls into four groups:

Glyptoxoceras group 1 differs by coarser ribbing, rib index being about 6. *Glyptoxoceras* group 2 differs by wider spaced ribbing and generally smaller dimensions. *Glyptoxoceras* group 3 differs by its smaller dimensions and by development of hooks in a stage of growth, where *G. crispatum* is criocone. *Glyptoxoceras* group 4 differs by narrowing of rib distances towards the aperture (all are described below).

Group 1

Pl. 13, Fig. 1

Material: A single specimen, MA 1976/16 from the *Paraplanum* Subzone of the Schattaugraben section (Hochmoos Formation, Gosau Group; Rußbach, Salzburg, Austria).

Description and discussion: MA 1976/16 is a fragment of a straight shaft (L 40 mm) with indication of curvature at one end. It is an internal mould with subcircular whorl section and adherent white powdery shell. It has regularly arranged rectiradiate annular sharp ribs, somewhat narrower than the interspaces. The rib index is 6. The suture is not visible. This poor fragment does not allow specific identification but it is clearly belonging to the present genus.

It differs from *Glyptoxoceras crispatum* (MOBERG, 1885) in its wider rib interspaces. It differs from group 2, 3 and 4 described below in its larger size.

Similar fragments occur in the early Campanian Vaals Formation of Belgium (JAGT, 1989).

Group 2

Pl. 13, Figs. 3–9

Material: Seven specimens: SK/SG1998/27, SK/SG/2006/40, SK/SG/2007/48; NHMW 2006z0203/0004-0005; NHMW 2011/0054/0004 (ex collection Skoumal), all from the Schattaugraben section (Rußbach, Salzburg). NHMW 2011/0054/0005 from the locality "Gosauschmied" (Gosau, Upper Austria) close to the Schattaugraben. One unregistered specimen from the Skoumal collection.

Description: All specimens are slightly curved fragments of internal moulds indicating a criocone shape of the shell. All are preserved with adherent white or yellowish remnants of chalky shell. The length of the fragments is from 18 to 42 mm. NHMW 2006z0203/0004 consists of two fragments, 42 and 28 mm long suggesting a circular whorl of about 50 mm diameter. SK/SG/1998/27 (Pl. 13, Fig. 9) is a fragment of a tightly coiled initial helix of about 25 mm diameter with a wide apical angle. It consists of three visible whorls. All specimens are deformed to different degrees. The whorl section appears to have been circular with a restored Wh of 4–9 mm. The rectiradiate to prorsiradiate ribs are narrow and widely spaced; the rib index is between 4 and 5. The ribs and interspaces are equal or subequal. A few individuals have one or two accentuated ribs or irregularly wider interspaces.

Discussion: The identic style of ribbing leads to the conclusion that the initial helix (SK/SG/1998/27) and the gently curved body fragments are parts of a criocone heteromorph ammonite. The connection between helix and adult part of the shell remains unknown, as is the shape of body chamber and aperture.

Group 3

Pl. 13, Figs. 10–15, Pl. 14, Figs. 1–6, Tab. 12

Material: 11 specimens from the *Micraster* Bed of the Bibereck Formation of the Schattaugraben section: NHMW 2006z0203/0001–0003, NHMW 2006z0203/0007, NHMW 2011/0054/0002, SK/SG/1992/13,16, SK/SG/1994/17, SK/SG/2002/34, SK/SG/2006/42, 43, SK/SG2009/50 and one from the Gosauschmied site: NHMW 2011/0153/0001.

Description: All specimens are fragments of small individuals from 26 to 33 mm length, all have a straight or slightly curved shaft. All but a single one have a hook at the adapertural end. NHMW 2006z0203/0002 has a hook at its adapical end. All are internal moulds with adherent remnants of shell. There is no embryonic part preserved, and no sutures are visible. All are laterally crushed. Whorl height is from 3 to 5 mm. The Wh data (Tab. 12) are slightly restored. The ribs are sharp and narrow, the interspaces somewhat wider than the ribs. Where the shell is preserved (SK/SG/1994/17, SK/SG/2006/43) rib section is more rounded and ribs and interspaces are of equal width. Rib density is about 10 per cm, rib index is from 3 to 6 (Tab. 12). Ribs are prorsiradiate on the shaft and recti- to rursiradiate (NHMW 2011/0054/0002) on the hook. All ribs are equally shaped, none are collared, flared, or bifurcating. They cross venter and dorsum without interruption. On the hooks the interspaces are becoming somewhat wider with the exception of SK/SG/1992/16. This specimen has also a single constriction and a distinct collar rib. SK/SG/2006/42 is an elliptoidical fragment changing from narrow to wider spaced ribbing with age. None of the specimens has a visible suture.

Discussion: Corresponding shape and identic style of ribbing leads to the conclusion that all specimens belong together to a group of *Glyptoxoceras,* which is clearly separated from other heteromorphs of the Schattaugraben sequence.

Group 4

Pl. 13, Fig. 2

Material: A single fragment NHMW 2006z0203/0006 from the *Micraster* Bed of the Schattaugraben.

Description: NHMW 2006z0203/0006 is a straight fragment of 28.8 mm length. Wh_{rest} is from 5.1 to 5.9 mm. Rib density changes from rib index 4 to 6 towards the aperture. Ribs are circular, undivided and (due to deformation?) prorsiradiate. The preserved fragment of the shaft is characterised by a major change in ribbing. At the adapical part interspaces are rather wide. After a distinct constric-

Inventory No.	Ribs on shaft	Ribs on hook	Index shaft	Index hook	W_{est} (mm)
SK/SG/1992/13	prorsiradiate	rectiradiate	5–6	3–4	5_{est}
SK/SG/1992/16	prorsiradiate	recti/rursi	4	5	4_{est}
SK/SG/2002/34	prorsiradiate	rectiradiate	3	3–4	4
NHMW 2011/0054/0002	prorsiradiate def.	rursiradiate	3	3–4	> 3
NHMW 2006z0203/0001	rectiradiate	rectiradiate	4	4	4.6_{est}
NHMW 2006z0203/0002	prorsiradiate	rectiradiate	4	4	4–5
SK/SG/1994/17	rectiradiate	rursiradiate	5	4	4_{est}

Tab. 12.
Rib direction and rib indices of *Glyptoxoceras* group 3 in relation to whorl height. est = estimated.

tion followed by a collar rib the ribs become successively denser towards the aperture. The adapertural end seems to be preserved.

Discussion: The unique case of denser ribbing towards the aperture is an indication to keep NHMW 2006z0203/0006 separated from the other representatives of the genus. Further studies might see this in a different light (pathological?).

Genus *Schlueterella* Wiedmann, 1962

Type species: *Ancyloceras pseudoarmatum* Schlüter (1872) by original designation.

Schlueterella sp. indet. 1

Pl. 14, Fig. 7

Material: MA 1976/17, a single specimen from the Schattaugraben section.

Description: MA 1976/17 is a hook-shaped laterally compressed fragment of the terminal part of the body chamber, with the aperture apparently preserved. The internal mould with adherent whitish shell measures about 70 mm in length, measured along the venter about 90 mm. Wh_{def} 26 mm, Wb_{def} about 15 mm. The restored section may have been rounded or slightly compressed oval and of approximately 20/22 : 18/20 mm. The shape of the complete shell cannot be established. The narrow sharp single ribs appear to have been rursiradiate, possibly a result of *post mortem* deformation. Ribs and interspaces are equal. The rib index is about 8 per cm, counted at midflank, and the rib distances are narrowing towards the dorsum (about 10/cm) and widening towards the venter (6/cm). The ribs are slightly curved with a convexity at midflank, crossing the dorsum and venter without effacing. Two wider interspaces indicate the proximity of the aperture. A few bases of spines are preserved, apparently indicating (Pl. 14, Fig. 7a) four irregular rows in a ventrolateral position without tuberculation on the flanks. The ribs are not arranged in looped pairs, but sometimes crowded at the position of the tubercles.

Discussion: Despite its bad preservation the distinct features of the sculpture separate the specimen from all the described heteromorphs of the Santonian Gosau Group. *Schlueterella compressum* Klinger, 1976 from the early Santonian of Brandenberg (Immel et al., 1982: 25, Pl. 9, Fig. 3, Pl. 10, Figs. 1–4, Pl. 11, Fig. 3) differs in its coarser ribs which are connected in pairs by rib-loopings. Its narrowly spaced tubercles are arranged in four regular rows which are placed laterally and ventrolaterally. *Neocrioceras maderi* Immel et al., 1982 (24, Pl. 9, Fig. 2, Pl. 11, Figs. 1, 2) from the early Santonian of Brandenberg is more densely ribbed and tuberculated more regularly. An undescribed fragment (MA 1976/18) of loosely elliptoidical (criocone?) shape from the lower Santonian of the Tiefengraben (Gosau, Upper Austria) is distinguished by having only two rows of tubercles in more regular distances in ventrolateral position. SK/SG/1992/12 provisionally treated separately (see below) under *Schlueterella* sp. indet. 2 differs in its wider spaced ribbing. *Neocrioceras* (*N.*) *spinigerum* (Jimbo, 1894) differs in its rapidly increasing whorl height and breadth and its coarse tuberculation.

Occurrence: Late Santonian Zone of *Placenticeras paraplanum* and *Boehmoceras arculus* (Hochmoos Formation, Gosau Group, Austria).

? *Schlueterella* sp. indet. 2

Pl. 14, Fig. 8

Material: A single fragment SK/SG/1992/12.

Description: SK/SG/1992/12 is a poor fragment of the terminal part of the body chamber of a loosely coiled heteromorph ammonite. It has about five sharp and undivided ribs per cm separated by somewhat wider interspaces. Only two tubercles or spine bases are visible without indication how they may have been arranged. It is not possible to restore the original shape of the shell.

Discussion: SK/SG/1992/12 is referred to *Schlueterella* with some doubt. It differs from *Schlueterella* sp. indet. One by its somewhat coarser ribbing.

Occurrence: Late Santonian Zone of *Placenticeras paraplanum* and *Boehmoceras arculus* (Hochmoos Formation, Gosau Group, Austria).

Subfamily Polyptychoceratinae Matsumoto, 1938

Genus *Polyptychoceras* Yabe, 1927

Type species: *Ptychoceras pseudogaultinum* Yokoyama (1890) by original designation.

Polyptychoceras sp. indet.

Pl. 12, Figs. 4, 5

Material: Two specimens, MA 1976/14, 15 from the Hochmoos Formation of the Schattaugraben.

Description: Both specimens are small internal moulds with adherent whitish shell remnants. MA 1976/14 is a 15 mm long fragment of two parallel shafts with the connecting portion preserved, 37 mm measured around the curvature. The Wh is 7.4 / 4.4 mm, the distance between the shafts is 13.3 mm, all measurements modified by compaction. The original whorl section seems to have been circular in both specimens. In MA 1976/15 (length 16 mm) only one part of the adapertural limb is preserved together with one half of the curved part. Both specimens are sharply and distantly ribbed, the ribs rectiradiate on the adapertural limb, prorsiradiate – possibly as a result of *post mortem* deformation – on the preserved adapical limb of MA 1976/14. Increasing separation of the ribs on the adapertural portion suggests the proximity of the aperture. The ribbing of MA 1976/15 seems to be rectiradiate as far as observable.

Discussion: Both specimens seem to belong to the same taxon. Being so fragmentary reference to the genus *Polypty-*

choceras can only be tentative. No comparable material is recorded so far from other Gosau occurrences. *Polyptychoceras obliquecostatum* from the upper Campanian of the Gschliefgraben (Helvetic unit, Austria) is more densely ribbed, the ribs oblique and prorsiradiate with less sharp rib-section (KENNEDY & SUMMESBERGER, 1999: Pl. 2, Figs. 1, 2, 3, 7, 8). Another indeterminate representative of Polyptychoceratinae from the Gschliefgraben (KENNEDY & SUMMESBERGER, 1999: Pl. 3, Fig. 6) differs in its narrower ribbing. Apart from ontogenetic changes in ornament described by OKAMOTO & SHIBATA (1997), which cannot be observed due to fragmentary preservation, specimens of *P. pseudogaultinum* (YOKOYAMA, 1890; OKAMOTO & SHIBATA, 1997) seem to differ in their wider spaced ribs in all ontogenetic stages.

Occurrence: Schattaugraben, *Paraplanum* Subzone (Hochmoos Formation, Gosau Group, Austria.

Family Baculitidae GILL, 1871

Genus *Baculites* LAMARCK, 1799

Type species: *Baculites vertebralis* LAMARCK (1799) by subsequent designation of MEEK (1876).

Baculites fuchsi REDTENBACHER, 1873

Pl. 15, Fig. 4

1873 *Baculites fuchsi* REDTENBACHER: 134, Pl. 30, Fig. 15.

1979 *Baculites fuchsi* REDTENBACHER; SUMMESBERGER: 113, Pl. 1, Figs. 2–4, Text-Figs. 2, 3 [with synonymy].

? 1979 *Baculites* cf. *fuchsi* REDTENBACHER; SUMMESBERGER: 115, Pl. 1, Figs. 5–7, Text-Fig. 4.

1982 *Baculites fuchsi* REDTENBACHER 1873; IMMEL et al.: 28, Pl. 11, Fig. 8.

1987 *Baculites fuchsi* REDTENBACHER 1873; IMMEL: 129.

2017b *Baculites fuchsi* REDTENBACHER, 1873; SUMMESBERGER et al.: 119, Pl. 10, Figs. 1–15, Text-Fig. 6.

2017c *Baculites fuchsi* REDTENBACHER, 1873; SUMMESBERGER et al.: 129, Fig. 7/2, 3.

Type: The holotype by monotypy is REDTENBACHER's original specimen (1873: 134, Pl. 30, Fig. 15) preserved in the collections of the NHMW (NHMW 1865/0001/0138) and refigured here (Pl. 15, Figs. 4a–c).

Material: Besides the type specimen: SK/1977/5, figured by SUMMESBERGER (1979: Pl. 1, Figs. 2–4, Text-Figs. 2, 3).

Description: The holotype is a crushed body chamber fragment, 63 mm long with the aperture and the original nacreous shell preserved. The whorl section appears to have been compressed, with a broadly rounded dorsum and a narrowly rounded venter, with traces of sulci parallel to the venter. SK/1977/5 is an internal mould and 200 mm long, the whorl section (SUMMESBERGER, 1979: Text-Fig. 2) is identical with that of the holotype. The restored shell must have measured 700 mm in length (SUMMESBERGER, 1979: 114) based on the 3° angle of taper. Ornament consists of growth striae and narrow ribs of variable strength. These form a strong convexity on the dorsum, strengthening across the dorsolateral shoulder into concave crescentic ribs and striae on the dorsal third of the flank (Pl. 15, Figs. 4a–b) eventually running subparallel to the venter. They then cross the venter in a narrow convexity (Pl. 15, Figs. 4a–c). The aperture runs parallel to these ribs and striae and in consequence bears a long ventral rostrum.

Discussion: *Baculites fuchsi* REDTENBACHER, 1873 differs from *Baculites* sp. indet. One described below by the smooth shell of the latter and its apparently compressed oval whorl section without keel. *Baculites* cf. *tanakae* MATSUMOTO & OBATA, 1963, figured by SUMMESBERGER (1979: Pl. 2, Figs. 10–13, Text-Fig. 6) differs by its irregular ribbing and bullate tuberculation. *Baculites sulcatus* BAILY, 1855, which occurs in the *Micraster* Bed of the Bibereck Formation, differs in its much smaller and curved body chamber, much stronger bullate and U-shaped ribs. *Baculites* sp. from the Finstergrabenwandl (SUMMESBERGER, 1979: 116, Pl. 1, Figs. 8, 9, Text-Fig. 5) differs in delicate narrow ribs on the venter.

Occurrence: The type specimen is from the early or middle Santonian of the Tiefengraben (= Grabenbach) of Gosau (Upper Austria). Another individual from the early Santonian is described by IMMEL et al. (1982) from the Mühlbach locality at Brandenberg (Gosau Group, Tyrol). The specimen described by SUMMESBERGER (1979: Pl. 1, Figs. 2, 3, 4, Text-Figs. 2, 3) is from the late Santonian of the Finstergrabenwandl (Gosau, Upper Austria).

Baculites sulcatus BAILY, 1855

Pl. 16, Figs. 1–3, Tab. 13

1855 *Baculites sulcatus* BAILY: 457, Pl. 11, Fig. 5c.

1977 *Baculites sulcatus* BAILY, 1855; KLINGER & KENNEDY: 75, Figs. 3B–E, J–L.

1997a *Baculites sulcatus* BAILY, 1855; KLINGER & KENNEDY: 111, Figs. 63–66, 67A–D, 68–77, 78C [with full synonymy].

Type: The lectotype, designated by WOODS (1906), is the specimen figured by BAILY (1855: Pl. 11, Fig. 5c). See the discussion of KLINGER & KENNEDY (1997a: 118ff.).

Material: Five individuals, SK/SG/1998/26, SK/SG/1996/21, NHMW 2006z 0203/0011 from the *Micraster* Bed of the Bibereck Formation (Gosau Group; Schattaugraben), NHMW 2006z0203/0013 apparently from the Sandkalkbank Member of the Schattau and SK/SG/1990/7 from the late Santonian of the Schattaugraben section without detailed information.

Description: All five specimens are small slightly curved fragments of internal moulds. All have adherent remnants of white or brownish shell remains. All are crushed to a certain degree. Measurements are nevertheless still useful. Wb/Wh values around 0.7 are not much compressed, whereas Wb/Wh values around 0.5 indicate considerable lateral compaction. The restored section is triangular/ovoid with rounded dorsum and a narrowly rounded venter accompanied or not by longitudinal sulci.

SK/SG/1998/26 is a fragment of the body chamber with preserved aperture and a distinct rostrum of about 10 mm length. It continues the narrow crenulated ventral keel. SK/

Inventory No.	L_{frag} (mm)	Wh (mm)	Wb (mm)	Wb/Wh
SK/SG/1998/26	52.1	10.3	5.2	0.5
SK/SG/1996/21	51.7	10.9	5.4	0.49
SK/SG/1990/7	32	14.9	7.6	0.51
NHMW 2006z0203/0011	30.7	10	7	0.7
NHMW 2006z0203/0013	34.4	14.2	10.2	0.71

Tab. 13.
Measurements of *Baculites sulcatus* BAILY, 1855 fragments from the Schattaugraben, L = length.

SG/1998/26 and SK/SG/1990/7 are the only specimens with a distinct keel.

Most striking feature are the strong and characteristic ribs that arise strongly rursiradiate at the dorsolateral edge, sweep back across the dorsolateral margin and strengthen into concave lateral bullae. These project forwards and weaken across the flanks, producing a distinctive concave U-shaped flank ribbing, weakening and ending at the sulcus, but apparently connected with the crenulation of the ventral keel. The sculpture is relatively irregular. The dorsum may be smooth.

Discussion: *Baculites incurvatus* DUJARDIN, 1837 differs by its more or less straight shell with the exception of the body chamber close to the aperture. See the figures of DUJARDIN (1837) and D'ORBIGNY (1842) refigured by KENNEDY (1984: Text-Fig. 41) and the photographs of the lectotype: KENNEDY (1984: Pl. 33, Figs. 3–5). There is also a big difference in tuberculation as *B. incurvatus* has smaller, more widely separated dorsolateral conical tubercles (IMMEL et al., 1982: Pl. 10, Figs. 5–7) not comparable to the prominent bullate, laterally elongated and U-shaped (auriculate) ribs of *B. sulcatus*.

Baculites fuchsi REDTENBACHER, 1873 (Pl. 15, Figs. 4a–c) from the Santonian of the Gosau Group differs in its smooth flanks without tuberculation, the ornament limited to weak closely spaced lateral ribs that sweep over the flank in a distinct curvature, projecting strongly forward in the ventrolateral third, effacing close to the sulcus and re-strengthening over the crenulated keel, with weak ribbing over the venter (SUMMESBERGER, 1979: Pl. 1, Figs. 1–3).

Representatives of the genus *Boehmoceras* RIEDEL (1931) differ by the narrower radius of curvature of the shell combined with a greater whorl height and a more distinctly crenulated keel. Nevertheless, ornament is very close. Similarity between *Boehmoceras arculus* (MORTON, 1834) and *Baculites sulcatus* BAILY, 1855 led KLINGER & KENNEDY (1997a: 121) to their reflection about a phylogenetic relationship with *Baculites capensis* WOODS, 1906 as ancestor. In short fragments differentiation from *B. arculus* is difficult to impossible.

Baculites sp. indet. 1, described below, differs in its smooth shell surface. *Baculites* cf. *tanakae* MATSUMOTO & OBATA, 1963 described from the late Santonian of the Finstergrabenwandl (SUMMESBERGER, 1979) differs in its narrower and asymmetric ribbing and its larger Wb and Wh. The specimen from the Finstergrabenwandl is laterally compressed as a result of *post mortem* crushing.

Occurrence: *Baculites sulcatus* BAILY, 1855 was described from the early Campanian of South Africa (KLINGER & KENNEDY, 1997a: 120). Its occurrence in Madagascar (COLLIGNON, 1931) was doubted by KLINGER & KENNEDY (1997a: 118). In Austria it occurs in the late Santonian Subzone of *Placenticeras paraplanum* and *Boehmoceras arculus* (Hochmoos and Bibereck Formations, Gosau Group). Its co-occurrence in the Schattaugraben section with the closely related *Boehmoceras arculus* (MORTON, 1834) supports the idea of a common ancestor (see above).

Baculites sp. indet. 1

Pl. 15, Figs. 1–3

Material: Six fragments: SK/SG/1990/5, NHMW 2006z0203/0007–0010, 12, all from the Upper Santonian *Micraster* Bed of the Bibereck Formation of the Schattaugraben section, Rußbach, Salzburg, Austria.

Description: SK/SG/1990/5 is a slab of matrix with three fragments of internal moulds of apparently one individual, partially preserved with adherent whitish shell. A is a body chamber fragment 46 mm long, B is a body chamber fragment 70 mm long preserved together with a part of the phragmocone, C is a 15 mm long phragmocone fragment. Wh close to the aperture is 10 mm. The total length might have been 200 mm. The angle of taper is about 3–4°. All fragments are laterally compacted, the original section seems to have been high oval without a keel. The aperture is not preserved. The surface is smooth. Faint undulations on the dorsum apart about 3 mm are visible only in extremely oblique light (Pl. 15, Fig. 3). NHMW 2006z0203/0007–0010, 12 are smooth phragmocone fragments of 11 to 60 mm length.

Discussion: *Baculites fuchsi* REDTENBACHER, 1873 (Pl. 30, Fig. 15) from the Santonian of the Gosau Group, Upper Austria) differs in its fine but distinct concave ribs, which are projected ventrally, anticipating the partially preserved rostrum. This ribbing continues over the crenulated keel and is also present on the visible part of the internal mould. The internal mould of *B. fuchsi* REDTENBACHER figured by SUMMESBERGER (1979: Pl. 2, Figs. 2–4) from the late Santonian of the Sandkalkbank Member differs in its ornamentation too, which is more undulose and indistinct than that of the type specimen with preserved shell. Late Santonian *Baculites* sp. from the Sandkalkbank Member of the Hochmoos Formation (SUMMESBERGER, 1979: Pl. 1, Figs. 8, 9, Text-Fig. 5) differs in its faint and tight accentuated riblets on the ventral third of the flank, crossing the venter without interruption and projecting towards the aperture. No distinct keel associated by ventrolateral furrows. *Baculites* cf. *tanakae* MATSUMOTO & OBATA, 1963 figured by SUMMESBERGER (1979: Pl. 2, Figs. 10–13) differs in having concave ribs with a coarse tubercle in ventrolateral position.

Occurrence: *Baculites* sp. indet. 1 occurs frequently in the *Micraster* Bed of the Bibereck Formation of the Schattaugraben section.

Baculites cf. *tanakae* MATSUMOTO & OBATA, 1963

not figured

Compare

cf. 1963 *Baculites* cf. *tanakae* MATSUMOTO & OBATA: 51.

cf. 1979 *Baculites* cf. *tanakai* [sic!] MATSUMOTO & OBATA, 1963; SUMMESBERGER: 116, Pl. 2, Figs. 10–13, Text-Fig. 6.

cf. 1997a *Baculites menabensis* COLLIGNON, 1969; KLINGER & KENNEDY: 108.

cf. 1997a *Baculites tanakae* MATSUMOTO & OBATA, 1963; KLINGER & KENNEDY: 109.

Description: See SUMMESBERGER (1979: 116).

Discussion: The single specimen from the Finstergrabenwandl is a poorly preserved fragment, we follow KLINGER & KENNEDY (1997a: 109), interpreting *B. tanakae* as a senior synonym of *B. menabensis* COLLIGNON, 1963. As the authors suggest, further investigation is necessary to differentiate *B. menabensis* COLLIGNON, 1963, which they believe to be synonymous with a number of Madagascan species erected by COLLIGNON (1963) and with *B. incurvatus* DUJARDIN, 1837.

Occurrence: Late Santonian Sandkalkbank Member (Hochmoos Formation, Gosau Group; Finstergrabenwandl, Gosau, Upper Austria).

Baculites sp.

not figured

Material: SK/1977/7, a single fragment from the Sandkalkbank Member of the Finstergrabenwandl locality.

Description: SK/1977/7 (SUMMESBERGER, 1979: 116, Pl. 1, Figs. 8, 9, Text-Fig. 5) is a 42, 2 mm long fragment of an internal mould partially covered with white chalky shell remains. It is laterally compressed by *post mortem* compaction. The original section cannot be restored. Its well preserved suture is figured by SUMMESBERGER (1979: Text-Fig. 5).

Discussion: SK/1977/7 differs from the above described *Baculites* sp. indet. 1 by its narrow ribbing projecting over the venter.

Occurrence: Late Santonian Sandkalkbank Member (Hochmoos Formation, Gosau Group) from the Finstergrabenwandl locality (Gosau, Upper Austria).

Genus *Boehmoceras* RIEDEL, 1931

Type species by subsequent designation of WRIGHT (1957: L 220) is *Ancyloceras krekeleri* WEGNER (1905: 210, Pl. 8, Fig. 2).

Boehmoceras krekeleri (WEGNER, 1905)

Pl. 16, Figs. 4–6, Tab. 14

1905 *Ancyloceras Krekeleri* WEGNER: 210, Pl. 8, Fig. 2.

1931 *Böhmoceras Krekeleri* (WEGNER); RIEDEL: 691, Pl. 77, Figs. 3–5, Pl. 78, Figs. 1, 2.

1957 *B. krekeleri* (WEGNER); WRIGHT: 220, Fig. 247/2.

1979 *Boehmoceras krekeleri* (WEGNER); SUMMESBERGER: 118, Pl. 2, Fig. 14, Text-Figs. 7, 8.

1983 *Boehmoceras krekeleri* (WEGNER, 1905); KENNEDY & WRIGHT: 866.

1985 *Boehmoceras krekeleri* (WEGNER 1905); SCHÖNFELD: 33, Pl. 2, Fig. 4.

1987 *Boehmoceras krekeleri* (WEGNER); KENNEDY: 778, Text-Fig. 3b [only].

1993 *Boehmoceras krekeleri* (WEGNER, 1905); KENNEDY & CHRISTENSEN: 150, 154, Figs. 2D–H, 4C, D, H, J.

1995 *Boehmoceras krekeleri* (WEGNER, 1905); KENNEDY in KENNEDY et al.: 431, Pl. 30, Fig. 37, 38, 41, 42; Text-Fig. 37.

1996 *B. krekeleri* (WEGNER); WRIGHT: 258, Fig. 199, 4 a–c.

2000 *Boehmoceras krekeleri* (WEGNER); SUMMESBERGER in EGGER et al.: 26.

2000 *Boehmoceras krekeleri* (WEGNER, 1905); KENNEDY in KENNEDY & KAPLAN: 110, Pl. 36, Figs. 1–6, Pl. 37, Figs. 1, 2, Pl. 38, Figs. 5–7, 12.

Type: The holotype by monotypy is the original of WEGNER (1905: Pl. 8, Fig. 2).

Material: From the Schattaugraben section: NHMW 2011/0054/0008 (ex coll. Skoumal, 2007), SK/SG/1996/25, SK/SG/1998/28; from the Finstergrabenwandl: SK/1978/5.

Description: Three specimens from the Schattaugraben section allow additional observations to those from the previously described specimen (SUMMESBERGER, 1979: 118). NHMW 2010/0081/0008 is an almost complete specimen. It is laterally compressed as a result of *post mortem* crushing and somewhat distorted. The general outline is criocone. The body chamber is preserved with the aperture, the phragmocone is heavily corroded with the suture line visible. Ribs are concave at the adapical part of the phragmocone, narrowly spaced and faint. At Wh 10 mm ornament changes into the adult style of ribbing, ribs be-

Inventory No.	D (mm)	Wh (mm)	Wb (mm)	Wb/Wh	U (mm)	U (%)
NHMW 2011/0054/0008	65.5	17.7	8.8	0.5	40.6	62
SK/SG/1998/28	55	16.8	6.9	0.41	31.7	57
SK/SG/1996/25	--	15	5.5	0.36	--	--

Tab. 14.
Boehmoceras krekeleri (WEGNER, 1905) from the Schattaugraben section. Wb values are reduced by compaction, Wh values are exaggerated. Tentatively corrected values lead to a Wb/Wh relation of about 0.6. U % of D.

coming coarser, but flattened by *post mortem* compaction on the body chamber. SK/SG/1998/28 is a body chamber fragment with about 15 mm of the phragmocone being preserved showing the same change from the juvenile to the adult ornament. All three specimens show the distinctly crenulated keel, the crenulation linking to the ribs. The keel is flanked by ventral sulci where the ribs are partially effaced.

Discussion: *B. krekeleri* differs from *B. arculus* (MORTON, 1834) in its greater Wh and denser ribbing, whereas *B. arculus* is smaller, has a lower Wh and wider spaced strongly concave ribbing. KENNEDY & COBBAN (1991) were inclined to discuss them as terminal members of a broad intraspecific variation, sexual dimorphism was discussed by SUMMESBERGER (1979). KENNEDY in KENNEDY & KAPLAN (2000: Pl. 36, Figs. 1–6, Pl. 37, Figs. 1, 2, Pl. 38, Fig. 12) suggested dimorphism within *B. krekeleri* between a macroconch (Pl. 36, Fig. 3, Pl. 37, Fig. 2) and a microconch form. In his opinion the Schattaugraben material NHMW 2011/0054/0008 could be the macroconch, SK/SG/1996/25 and SK/SG/1998/28 could be microconchs. As the differences in the collection from Westphalia are rather small (Pl. 36, Figs. 1–6 and 37, Figs. 1–3 in KENNEDY & KAPLAN, 2000), we doubt if sexual dimorphism within *B. krekeleri* should be adopted and applied to the poor Austrian material.

Occurrence: *Boehmoceras krekeleri* (WEGNER, 1905) was originally described from the upper Santonian Recklinghäuser Sandmergel (Recklinghausen, Münster Basin, Germany) and was subsequently found in the late Santonian Gosau Group (Sandkalkbank Member of the Hochmoos Formation) of Austria (SUMMESBERGER, 1979). It occurs (KENNEDY in KENNEDY & KAPLAN, 2000) in the Westphalian late Santonian (*B. arculus*, *M. testudinarius* Zone). It was not present in the late Santonian *Boehmoceras arculus* fauna of the American Gulf Coast (KENNEDY & COBBAN, 1991). And it was also absent in the type Santonian of the Aquitaine Basin (KENNEDY, 1986, 1987) where *B. arculus* occurs. All occurrences are within the *Paraplanum/Testudinarius* Zone of the late Santonian.

Boehmoceras arculus (MORTON, 1834)

Pl. 16, Fig. 7

1834 *Hamites arculus* MORTON: 44, Pl. 15, Figs. 1, 2.

1834 *Hamites arculus* var. A; MORTON: 45.

1931 *Böhmoceras löscheri*; RIEDEL: 692, Pl. 78, Figs. 3–6.

1971 *Böhmoceras löscheri* RIEDEL; ULBRICH: Pl. 5, Fig. 6.

1979 *Boehmoceras loescheri* RIEDEL; SUMMESBERGER: 119, Pl. 2, Figs. 15, 16, 18, Text-Figs. 9–12.

1983 *B. loescheri* (RIEDEL, 1931); KENNEDY & WRIGHT: 866.

1985 *Boehmoceras* sp.; KENNEDY: Pl. 2, Fig. 1.

1987 *Boehmoceras krekeleri* (WEGNER); KENNEDY: 778, Text-Fig. 3a [only].

1987 *Boehmoceras loescheri* RIEDEL, 1931; KENNEDY: 777, Pl. 82, Figs. 4–16, Text-Fig. 2.

1991 *Boehmoceras arculus* (MORTON, 1834); KENNEDY & COBBAN: 182, Fig. 6: 2; Fig. 8: 9–15, 18–22; Fig. 9: 1, 2, 11–52; Fig. 10: 21, 22, 24–26; Fig. 12: 3.

1993 *Boehmoceras arculus* (MORTON, 1834); KENNEDY & CHRISTENSEN: 154, Figs. 3, 4 L.

1995 *Boehmoceras arculus* (MORTON, 1834); KENNEDY in KENNEDY et al.: 432, Pl. 30, Figs. 39, 40.

1996 *B. loescheri* RIEDEL; WRIGHT: 258, Fig. 199, 4d.

2000 *Boehmoceras arculus* (MORTON, 1834); KENNEDY in KENNEDY & KAPLAN: 112, Pl. 37, Fig. 3, Pl. 38, Figs. 10, 11.

Type: The lectotype designated by KENNEDY & CHRISTENSEN (1993: 155, Text-Fig. 3) is the specimen figured by MORTON (1834: Fig. 3) from the Tombigbee Sand Member (Upper Santonian) of the Eutaw Formation (USA).

Material: One specimen from the Schattaugraben section: NHMW 2010/0081/0009 and four specimens from the Finstergrabenwandl: SK/1977/1, SK/1978/9, 10, 22.

Description: NHMW 2010/0081/0009 is the external mould of a criocone specimen of about 48 mm in diameter. Wh as far as measurable is from 8–12.5 mm. Ornament consists of regular alternations between two prorsiradiate and concave ribs and a third strengthened one, strengthening increasing towards the adapical end of the fragment. Maximum thickness of the ribs is midflanks, diminishing towards the venter. The distinctly crenulated keel is hardly visible in this specimen.

Discussion: Co-occurrence of *B. krekeleri* (NHMW 2011/0054/0008, SK/SG/1996/25, SK/SG/1998/28) with *B. arculus* (= *loescheri;* NHMW 2011/0054/0007) in the Sandkalkbank Member was interpreted (SUMMESBERGER, 1979: 121–122) as a pair of sexual dimorphs, *B. krekeleri* being the macroconch, *B. arculus* being the microconch. They co-occur also in the *Micraster* Bed of the Bibereck Formation (Gosau Basin, Schattaugraben, Salzburg), in Nordlünen (Germany; KAPLAN in KENNEDY & KAPLAN, 2000: 24) and Rapen (Germany; RIEDEL, 1931: 617), in Ahaus in the Münster Basin (Germany; KAPLAN in KENNEDY & KAPLAN, 2000: 10). American occurrences in the Tombigbee Member of the Eutaw Formation (Mississippi, Alabama) and in Texas comprise numerous specimens of *B. arculus* only. The Swedish occurrences of both forms are described from different levels in a borehole (KENNEDY & CHRISTENSEN, 1993). Dimorphism was suggested within *B. krekeleri* by KENNEDY in KENNEDY & KAPLAN (2000).

Occurrence: *Boehmoceras arculus* (MORTON, 1834) occurs in the *Paraplanum* Subzone (Sandkalkbank Member of the Hochmoos Formation and in the *Micraster* Bed of the Bibereck Formation) of the Gosau Group of the Schattaugraben section and at the Finstergrabenwandl (Austria). It occurs in the *Boehmoceras arculus* Zone of the Münster Basin (Westphalia, Germany), in the *Paraplanum* Subzone of the Corbières (France), in the upper Santonian of the Tombigbee Member of the Eutaw Formation (Mississippi, Alabama) and in the Santonian of Sweden. Co-occurrence with *Placenticeras paraplanum* WIEDMANN, 1978, *Marsupites* and a narrow vertical range make it a marker fossil indicating the top of the Santonian. The same index fossils are also present in the *Paraplanum* Subzone (KENNEDY, 1995: 385) of Saintes in France. In the Corbières (KENNEDY, 1995) *B. arculus* occurs already in the middle Santonian *Gallicus* Subzone.

Conclusion of Cephalopoda

Earlier misinterpretation of the Schattau locality as being of "Campanian" in age was based on the misidentification of *Placenticeras polyopsis* DUJARDIN, 1837 as *Diplacmoceras bidorsatum* ROEMER, 1841 by SUMMESBERGER (1985). In fact, there is no evidence for a Campanian part of the sequence.

Long ignored Nautilidae are partially revised or described for the first time. Remarkable is the co-occurrence of three different species of the ammonite genus *Placenticeras*, each of them represented by a pair of dimorphs. Another point of interest is the disappearance of the genus *Texanites* with its last occurrence approximately in the middle Santonian (Neffgraben). In the late Santonian Sandkalkbank Member the genus is replaced by *Reginaites*, which is the last representative of the Texanitinae in the type region of the Gosau Group. A last representative of the Muniericeratidae is the occurrence of *Texasia* near the top of the Bibereck Formation. Muniericeratidae are common in the middle Santonian of the Gosau Group (Randograben section). Another – not completely solved phenomenon – is the co-occurrence of two taxa of the genus *Glyptoxoceras* (*G. souqueti*, *G. crispatum*), with four different forms of *Glyptoxoceras* provisionally described under *G.* group 1–4. The disappearance of the genus *Scaphites* – common in the Coniacian and Campanian of the Gosau Group – is interpreted here as due to palaeoclimatic differences to the possibly cooler periods before and after the Santonian. The last representative of the genus *Scaphites* in the Santonian occurs in the middle Santonian of the Neffgraben (GERTH, 1956).

Palaeogeographic connections

The highest degree of faunistic affinity is between the late Santonian assemblages of the Schattaugraben section and the late Santonian *Paraplanum* Subzone of the Corbières: *Gaudryceras mite*, *Parapuzosia corbarica*, *Hauericeras lagarum*, *Nowakites savini*, *Eupachydiscus isculensis*, *Placenticeras polyopsis*, *Pl. paraplanum*, *Pl. maherndli*, *Eulophoceras jacobi*, *Amapondella amapondense*, *Glyptoxoceras souqueti*, *Gl. crispatum*, *Boehmoceras krekeleri*, *Boehmoceras arculus* are 14 species contemporarily occurring in both areas. The absence of *Scaphites* in the late Santonian of the Gosau area indicates a position within the Tethys or at least closer to Tethyan influence, whereas the Corbières are within Boreal influence.

Taxa in common with the Aquitaine basin (France; KENNEDY, 1987) are *Placenticeras polyopsis*, *Placenticeras paraplanum*, *Eulophoceras jacobi* and *Boehmoceras arculus* which are ranging from middle to late Santonian in France. Diversity in Aquitaine seems to be rather poor compared with the Corbières and the Gosau.

The occurrence of *Parapuzosia seppenradensis*, *Scalarites serta*, *Glyptoxoceras crispatum Boehmoceras krekeleri* and *B. arculus* indicate a palaeogeographic connection between the Gosau area and the Münster Basin in Germany (see also SUMMESBERGER, 1979). The presence of Scaphitids indicates Boreal influence in the Münster basin.

Few indications make also a Santonian connection of the Gosau with South Africa likely (e.g. *Hauericeras gardeni* (BAILY, 1855), *Baculites sulcatus* (BAILY, 1855)).

Palaeoclimatic approach

Few palaeoclimatic indicative taxa point towards a relative warm tropical to subtropical climate during the late Santonian in the studied region: The presence of rudist bioherms in the Hochmoos Formation, the absence of Scaphitids, typical for the Boreal Realm and widespread in the Coniacian and Campanian of the Gosau Group, the occurrence of *Pleurotomaria* in the Sandkalkbank Member of the Finstergrabenwandl (KOLLMANN, 1980) is in contrary indicating cooler temperature.

List of cephalopods described from the Late Santonian *Paraplanum/Arculus/Marsupites* Zone of the Schattaugraben section (Rußbach, Salzburg, Austria) and the Finstergrabenwandl locality (Gosau, Upper Austria). In bold: described in this paper.

Eutrephoceras cf. *indicum* (D'ORBIGNY, 1850)

Eutrephoceras montiscastoris spec. nov.

Cimomia gosavica (REDTENBACHER, 1873)

Gaudryceras mite (HAUER, 1866)

Anagaudryceras redtenbacheri (IMMEL, KLINGER & WIEDMANN, 1983)

Pseudophyllites loryi (KILIAN & REBOUL, 1909)

Parapuzosia (*Parapuzosia*) *corbarica* (DE GROSSOUVRE, 1894)

? *Parapuzosia* (*Parapuzosia*) cf. *seppenradensis* (LANDOIS, 1895)

Kitchinites stenomphalus SUMMESBERGER, 1979

Hauericeras (*Gardeniceras*) *welschi* DE GROSSOUVRE, 1894

Hauericeras (*Gardeniceras*) *lagarum* (REDTENBACHER, 1873)

Damesites sugata (FORBES, 1846)

Damesites cf. *sugata* (FORBES, 1846)

Nowakites draschei (REDTENBACHER, 1873)

Nowakites savini DE GROSSOUVRE, 1894

Eupachydiscus isculensis (REDTENBACHER, 1873)

Pachydiscus sp. indet. juv.

Texasia dentatocarinata (F. ROEMER, 1852)

Placenticeras polyopsis (DUJARDIN, 1837)

Placenticeras paraplanum WIEDMANN, 1978

Placenticeras maherndli SUMMESBERGER, 1979

Diaziceras austriacum (SUMMESBERGER, 1979)

Eulophoeras jacobi (HOURCQ, 1949)

Reginaites gappi WIEDMANN, 1978

Nostoceratidae gen. et sp. indet.

Amapondella amapondensis (VAN HOEPEN, 1921)

Scalarites serta (MÜLLER & WOLLEMANN, 1906)

Glyptoxoceras souqueti (DE GROSSOUVRE, 1894)

Glyptoxoceras crispatum (MOBERG, 1885)

Glyptoxoceras, 4 groups

Schlueterella sp. indet. 1

? *Schlueterella* sp. indet. 2

Polyptychoceras sp. indet.

Baculites fuchsi REDTENBACHER, 1873

Baculites sulcatus BAILY, 1855

Baculites sp. indet. 1

Baculites cfr. *tanakae* (MATSUMOTO & OBATA, 1963)

Baculites sp.

Boehmoceras krekeleri WEGNER, 1905

Boehmoceras arculum (MORTON, 1834)

Acknowledgements

Alice Schumacher (NHMW) is gratefully acknowledged for the photographical work. The authors are grateful also for the financial support by the "Friends of the Museum of Natural History, Vienna". And we are deeply indebted to Wolf-Peter Maherndl (Bad Ischl) for the long-time loan of specimens from his collection. Andreas Kroh (NHMW) and the technical staff of the NHMW provided assistance in the field and laboratory, Andreas Kroh also in preparing the manuscript. We are grateful to Monika Horschinegg (University of Vienna, Department for Lithosphere Research) for the Sr-Isotope analyses. We thank also Michaela Trenkwalder and Martin Schneider for field assistance and data acquisition. Ruth Meindl and Franz Freitag assisted with GPS measures in the field. Finally the authors thank Gustav Gapp (Gosau) for the loan of his Gosau ammonites. Christoph Janda and his cooperating team (Geological Survey of Austria, Vienna) and Ilka Wünsche (University of Vienna) is gratefully acknowledged for editorial support, the reviewers for their contribution to the final scientific quality of the paper. Gerhard Niedermayr (†, NHMW) presented one of the nautiloids. Robert Scholger (Montanuniversität Leoben) and Herbert Haubold (Austrian Environmental Agency, Vienna) supported by palaeomagnetic investigation of the Schattau sequence. Michael Wagreich and Erik Wolfgring thank the Austrian Academy of Sciences and UNESCO IGCP 609 (Climate-environmental deteriorations during greenhouse phases: Causes and consequences of short-term Cretaceous sea-level changes) for financial support.

References

ADKINS, W.S. (1928): Handbook of Texas Cretaceous Fossils. – Bulletin of the University of Texas, **2838**, 385 pp., Austin.

ADKINS, W.S. (1932): The Mesozoic systems in Texas. – In: SELLARDS, E.H., ADKINS, W.S. & PLUMMER, F.B.: The Geology of Texas, Volume 1. Stratigraphy. – Bulletin of the University of Texas, **3232**, 1007 pp., Austin.

AMEDRO, F. & HANCOCK, J.M. (1985): Les Ammonites de l'Autoroute «L'Aquitaine». France (Turonien et Santonien). – Cretaceous Research, **6**, 15–32, London.

ARKHANGELSKY, A.D. (1916): Les Mollusques du Crétacé supérieur du Turkestan. – Mémoires du Comité Géologique, Nouvelle Série, **152**, 1–57, Petrograd.

BAILY, W.H. (1855): Description of some Cretaceous fossils from South Africa. – Quarterly Journal of the Geological Society of London, **11**, 454–465, London.

BARROIS, C. (1879): Sur quelques espèces nouvelles ou peu connues du terrain crétacé du Nord de la France. – Annales Societé géologique du Nord, **6**, 449–457, Lille.

BASSE, E. (1939): Sur quelques mollusques crétacés des Corbières méridionales. – Bulletin de la Societé géologique de France, **5**/9, 35–58. Paris.

BEURLEN, K. (1944): Beiträge zur Stammesgeschichte der Muscheln. – Sitzungsberichte der mathematisch-naturwissenschaftlichen Abteilung der Bayerischen Akademie der Wissenschaften zu München, **1–2**, 133–145, München.

BILOTTE, M. & COLLIGNON, M. (1983): Biostratigraphie et Paléontologie des ammonites du Sénonien inférieur de Rennes les Bains. Sougraigne (Aude) [Zone sous-Pyrenéenne Orientale]. – Documents du Laboratoire Géologique, Faculté des Sciences, Université Claude Bernard, Lyon, H.S., **6**, 175–223, Lyon.

BIRKELUND, T. (1965): Ammonites from the Upper Cretaceous of West Greenland. – Meddelelser om Grønland, **179**, 1–192, København.

BÖHM, J. (1915): Vorlage von Inoceramen aus dem subhercynen Emscher und Untersenon. – Zeitschrift der Deutschen Geologischen Gesellschaft, **67**, 181–183, Stuttgart.

BOULE, M., LEMOINE, P. & THÉVENIN, A. (1906): Paléontologie de Madagascar, III. Céphalopodes crétacés des environs de Diego-Suarez. – Annales de Paléontologie, **1**, 173–192; **2**, 1–56, Paris.

BRINKMANN, R. (1935): Die Ammoniten der Gosau und des Flysch in den nördlichen Ostalpen. – Mitteilungen aus dem Geologischen Staatsinstitut in Hamburg, **15**, 1–14, Hamburg.

BURNETT, J.A. with contributions from GALLAGHER, L.T. & HAMPTON, M.J. (1998): Upper Cretaceous. – In: BOWN, P.R. (Ed.): Calcareous Nannofossil Biostratigraphy. – British Micropalaeontological Society, Publications Series, 132–199, London.

CARON, M. (1985): Cretaceous planktonic foraminifera. – In: BOLLI, H.M., SAUNDERS, J.B. & PERCH-NIELSEN, K. (Eds.): Plankton Stratigraphy, 17–86, Cambridge.

COBBAN, W.A. & KENNEDY, W.J. (1993): Cenomanian (Upper Cretaceous) Nautiloids from New Mexico. Shorter Contributions to Paleontology and Stratigraphy. – Bulletin of the United States Geological Survey, **2073 E**, 3 pp., Washington, D.C.

COBBAN, W.A., HOOK, S.C. & MCKINNEY, K.C. (2008): Upper Cretaceous molluscan record along a transect from Virden, New Mexico, to Del Rio, Texas. – New Mexico Geology, **30**/3, 75–92, Albuquerque.

COCCIONI, R. & PREMOLI SILVA, I. (2015): Revised Upper Albian-Maastrichtian planktonic foraminiferal biostratigraphy and magnetostratigraphy of the classical Tethyan Gubbio section (Italy). – Newsletters on Stratigraphy, **48**/1, 47–90, Stuttgart.

COLLIGNON, M. (1931): Faunes Sénoniennes du Nord et de l'Ouest de Madagascar. – Annales géologiques du Service des Mines, Madagascar, **1**, Tananarive.

COLLIGNON, M. (1948): Ammonites néocrétacées du Menabe (Madagascar) I. Les Texanitidae. – Annales géologiques du Service des Mines de Madagascar, **13**, 7–60 (63–116), Tananarive.

COLLIGNON, M. (1955): Ammonites néocrétacés du Menabe (Madagascar). II. Les Pachydiscidae. – Annales géologiques du Service des Mines, **21**, 98 pp., Tananarive.

COLLIGNON, M. (1961): Ammonites néocrétacées du Menabe (Madagascar), VII. Les Desmoceratidae. – Annales géologiques du Service des Mines, **31**, 1–115, Tananarive.

COLLIGNON, M. (1966): Atlas des fossiles caracteristiques de Madagascar (Ammonites) XIV, Santonien. – 88 pp., Tananarive.

COLLIGNON, M. (1969): Atlas des fossiles caracteristiques de Madagascar (Ammonites) XV, Campanien inférieur. – 216 pp., Tananarive.

COLLIGNON, M. (1983): Les faunes d'Ammonites du Santonien. – In: BILOTTE, M. & COLLIGNON, M.: Biostratigraphie et Paléontologie des ammonites du Sénonien inférieur de Rennes-les-Bains – Sougraigne (Aude) [Zone sous-pyrénéenne orientale]. – Documents du Laboratoire Géologique, Faculté des Sciences, Université Claude Bernard, Lyon, H.S., **6**, 175–223, Lyon.

CONRAD, T.A. (1866): Observations on recent and fossil shells, with proposed new genera and species. – American Journal of Conchology, **2**, 101–103, Philadelphia.

CUNHA, A.S., ANTUNES, R.L. & BURNETT, J.A. (1997): Calcareous nannofossils and the Santonian/Campanian and Campanian/Maastrichtian boundaries on the Brazilian Continental Margin: historical overview and state of the art. – Cretaceous Research, **18**, 823–832, London.

DALBIEZ, F. (1955): The genus *Globotruncana* in Tunisia. – Micropaleontology, **1**/2, 161–171, New York.

DEKAY, J.E. (1828): Report on several fossil multilocular shells from the state of Delaware: with observations on a second specimen of the new fossil genus Eurypterus. – Annals of the Lyceum of Natural History of New York, **2**, 273–279, New York.

DHONDT, A. (1987): Bivalves from the Hochmoos Formation (Gosau-Group), Oberösterreich, Austria. – Annalen des Naturhistorischen Museums in Wien, Serie A, **88**, 41–102, Wien.

DIENER, C. (1925): Fossilium Catalogus. Ammonoidea Neocretacea. – 244 pp., Amsterdam.

DIXON, F. (1850): The Geology and Fossils of the Tertiary and Cretaceous Formations of Sussex. – 469 pp., London.

DOUVILLÉ, H. (1890): Sur la Classification des Ceratites de la Craie. – Bulletin de la Société Géologique de France, **2**/18 275–292, Paris.

DUJARDIN, F. (1837): Mémoire sur le couches du sol en Touraine et description des coquilles de la Craie et des Faluns. – Mémoires de la Societé géologique de la France, **4**, 11, 285–320, Paris.

FAUPL, P. & WAGREICH, M. (2000): Late Jurassic to Eocene palaeogeography and geodynamic evolution of the Eastern Alps. – Mitteilungen der Österreichischen Geologischen Gesellschaft, **92**, 79–94, Wien.

FELIX, J. (1908): Studien über die Schichten der oberen Kreideformation in den Alpen und den Mediterrangebieten. – Palaeontographica, **54**/6, 251–339, Stuttgart.

FORBES, E. (1846): Report on the fossil Invertebrata from Southern India, collected by Mr. Kaye and Mr. Cunliffe. – Transactions of the Geological Society of London, series 2, **7**, 97–147, London.

GALE, A.S., MONTGOMERY, P., KENNEDY, W.J., HANCOCK, J.M., BURNETT, J.A. & MACARTHUR, J.M. (1995): Definition and global correlation of the Santonian-Campanian boundary. – Terra Nova, **7**, 611–622, Oxford.

GALE, A.S., HANCOCK, J.M., KENNEDY, W.J., PETRIZZO, M.R., LEES, J.A., WALASZCZYK, I. & WRAY, D.D. (2008): An Integrated study (geochemistry, stable oxygen and carbon isotopes, nannofossils, planktonic foraminifera, inoceramid bivalves, ammonites and crinoids) of the Waxahachie Dam Spillway section, north Texas: a possible boundary stratotype for the base of the Campanian stage. – Cretaceous Research, **29**/1, 131–167, London.

GALEOTTI, M.H. (1837). Mémoire sur la constitution géognostique de la province de Brabant, en réponse à la question suivante: décrire la constitution géologique de la province de Brabant, déterminer avec soin les espèces minérales et les fossiles que les divers terrains renferment et indiquer la synonymie des auteurs qui en ont déja traité. – Mémoires couronnés de l'Academie Royale des Sciences Belgique, **12**, 1–192, Bruxelles.

GALLEMI, J., LÓPEZ, G., MARTINEZ, R. & PONS, J.M. (2007): Macrofauna of the Cantera de Margas section, Olazagutia: Coniacian/Santonian boundary, Navarro-Cantabrian Basin, northern Spain. – Cretaceous Research, **28**/1, 5–17, London.

GEINITZ, H.B. (1849–1850): Das Quadersandsteingebirge oder Kreidegebirge in Deutschland. – 229 pp., Freiberg.

GENDROT, C. (1968): Stratigraphie et micropaléontologie du Sénonian de la région des Martigues près Marseille (Bouches-du-Rhône). – Eclogae Geologicae Helvetiae, **61**, 657–694, Basel.

GERTH, H. (1956): Ein neuer Fund eines Scaphiten in den unteren Gosaumergeln der Gosau und seine stratigraphische Bedeutung. – Neues Jahrbuch für Geologie und Paläontologie, Monatshefte, **1956**/9, 433–438, Stuttgart.

GIEBEL, C.G. (1852): Allgemeine Palaeontologie: Entwurf einer systematischen Darstellung der Fauna und Flora der Vorwelt. – 413 pp., Leipzig (Ambrosius Abel).

GILL, T. (1871): Arrangement of the Families of Mollusks. – Smithsonian Miscellaneous Collections, **227**, xvi + 49 pp., Washington, D.C.

GOLDFUSS, A. (1833–1841) unter Mitwirkung GRAF GEORGS ZU MÜNSTER: Petrefacta Germaniae tam ea, quae in museo universitatis regiae Borussicae Fridericiae Wilhelmiae Rhenanae servantur quam alia quaequemque in museis Hoeninghusiano, Muensteriano aliisque extant, iconibus et illustrationibus illustrata. – II. Teil, 69–141, Düsseldorf.

GROSSOUVRE, A. DE (1894): Recherches sur la craie supérieure. 2. Partie, Paléontologie. Les ammonites de la craie supérieure. – Mémoires du Service Carte géologique détaillée de La France, 264 pp., Paris.

GROSSOUVRE, A. DE (1901): Recherches sur la craie supérieure. 1. Partie. Stratigraphie générale. – Mémoires du Service Carte géologique détaillée de La France, vii + 1014 pp., Paris.

HAMPTON, M.J., BAILEY, H.W., GALLAGHER, L.T., MORTIMORE, R.N. & WOOD, C.J. (2007): The biostratigraphy of Seaford Head, Sussex, southern England; an international reference section for the basal boundaries for the Santonian and Campanian Stages in chalk facies. – Cretaceous Research, **28**, 46–60, London.

HANCOCK, J.M. & GALE, A.S. (1996): The Campanian Stage. Proceedings of the 2. International Symposium Cretaceous Stage Boundaries. – Bulletin de l'Institut Royal des Sciences Naturelles de Belgique, Sciences de la Terre, **66**/Supplement, 103–109, Bruxelles.

HAUER, F. (1858): Über die Cephalopoden der Gosauschichten. – Beiträge zur Palaeontographie von Österreich, 7–17, Wien.

HAUER, F. (1866): Neue Cephalopoden aus den Gosaugebilden der Alpen. – Sitzungsberichte der kaiserlichen Akademie der Wissenschaften, mathematisch-naturwissenschaftliche Classe, **53**, 1–9, Wien.

HEINZ, R. (1928): Über die Oberkreide-Inoceramen Süd-Amerikas und ihre Beziehungen zu denen Europas und anderer Gebiete. – Mitteilungen aus dem Mineralogisch-Geologischen Staatsinstitut in Hamburg, **5**, 41–97, Hamburg.

HEINZ, R. (1932): Aus der neuen Systematik der Inoceramen. Beiträge zur Kenntnis oberkretazischer Inoceramen XIV. – Mitteilungen aus dem Mineralogisch-Geologischen Staatsinstitut in Hamburg, **14**, 1–26, Hamburg.

HEINZ, R. (1933): Inoceramen von Madagaskar und ihre Bedeutung für die Kreide-Stratigraphie. Beiträge zur Kenntnis oberkretazischer Inoceramen, XII. – Zeitschrift der Deutschen Geologischen Gesellschaft, **85**, 241–259, Berlin.

HENDERSON, R. (1970): Ammonoidea from the Mata Series (Santonian–Maastrichtian) of New Zealand. – Palaeontology, Special Papers, **6**, 1–81, London.

HERM, D., KAUFMANN, E.G. & WIEDMANN, J. (1979): The age and depositional environment of the "Gosau"-group (Coniacian–Santonian), Brandenberg, Tirol, Austria. – Mitteilungen der Bayerischen Staatssammlung für Paläontologie und historische Geologie, **19**, 27–92, München.

HOEPEN, E.C.N. VAN (1921): Cretaceous Cephalopoda from Pondoland. – Annals of the Transvaal Museum, **8**/1, 1–48, Pretoria.

HOLZAPFEL, E. (1887–1888): Die Mollusken der Aachener Kreide. Cephalopoda und Glossophora. – Palaeontographica, **34**/1, Stuttgart.

HOURCQ, V. (1949): Paléontontologie de Madagascar XXVIII. Sur quelques ammonies du Sénonien. – Annales de Paléontologie, **35**, 10–31, Paris.

HYATT, A. (1889): Genesis of the Arietidae. – Smithsonian Contributions to Knowledge, **673**, 238 pp., Washington, D.C.

HYATT, A. (1894): Phylogeny of an acquired characteristic. – Proceedings of the American Philosophical Society, **23**, 349–647, Philadelphia.

HYATT, A. (1900): Cephalopoda – In: ZITTEL, K.A.: Textbook of Palaeontology, 502–604, London.

HYATT, A. (1903): Pseudoceratites of the Cretaceous. – Monographs of the United States Geological Survey, **44**, 351 pp., Washington, D.C.

IMMEL, H. (1987): Die Kreideammoniten der nördlichen Kalkalpen. – Zitteliana. Abhandlungen der Bayerischen Staatssammlung für Paläontologie und historische Geologie, **15**, 3–163, München.

IMMEL, H., KLINGER, H.C. & WIEDMANN, J. (1982): Die Cephalopoden des Unteren Santon der Gosau von Brandenberg/Tirol, Österreich. – Zitteliana, **8**, 3–32, München.

JAGT, J.W.M. (1989): Ammonites from the early Campanian Vaals Formation at the CPL quarry (Haccourt, Liège, Belgium) and their stratigraphic implications. – Mededelingen van de Rijks Geologische Dienst, **43**, 1–33, Maastricht.

JARVIS, I., GALE, A.S., JENKYNS, H.C. & PEARCE, M.A. (2006): Secular variation in Late Cretaceous carbon isotopes: a new δ13C carbonate reference curve for the Cenomanian–Campanian (99.6–70.6 Ma). – Geological Magazine, **143**, 561–608, London.

JIMBO, K. (1894): Beiträge zur Kenntniss der Fauna der Kreideformation von Hokkaido. – Paläontologische Abhandlungen, Neue Folge, **2**, 149–193, Jena.

KAPLAN, U. (2016): Ein neues Exemplar von *Parapuzosia* (*Parapuzosia*) *seppenradensis* (LANDOIS, 1895) aus dem Typusgebiet von Seppenrade, Münsterland. – Geologie und Paläontologie in Westfalen, **88**, 49–61.

KAPLAN, U. & KENNEDY, W.J. (2000): Santonian ammonite stratigraphy of the Münster basin, NW Germany. – Acta Geologica Polonica, **50**/1, 99–117, Warszawa.

KENNEDY, W.J. (1984): Systematic palaeontology and stratigraphic distribution of the ammonite faunas of the French Coniacian. – Special Papers in Palaeontology, **31**, 160 pp., London.

KENNEDY, W.J. (1985): Ammonite faunas of the Coniacian, Santonian and Campanian Stages in the Aquitaine Basin. – Géologie Méditerranéenne, **10**, 103–113, Aix-en-Provence–Marseille.

KENNEDY, W.J. (1986): Campanian and Maastrichtian Ammonites from northern Aquitaine, France. – Special Papers in Palaeontology, **36**, 145 pp., London.

KENNEDY, W.J. (1987): Ammonites from the type Santonian and adjacent parts of the northern Aquitaine, western France. – Palaeontology, **30**/4, 765–782, London.

KENNEDY, W.J. (1995): Systematic Palaeontology. – In: KENNEDY, W.J., BILOTTE, M. & MELCHIOR, P.: Ammonite faunas, biostratigraphy and sequence stratigraphy of the Coniacian-Santonian of the Corbières (NE Pyrénées). – Bulletin des Centres de Recherches Exploration-Production Elf-Aquitaine, **19**/2, 388–499, Boussens.

KENNEDY, W.J. (2002): Nautiloids. – In: SMITH, A.B. & BATTEN, D.J. (Eds.): Fossils of the Chalk, 219–231, London.

KENNEDY, W.J. & CHRISTENSEN, W.K. (1993): Santonian ammonites from the Köpingsberg 1 borehole, Sweden. – Tove Birkelund Memorial Volume. – Bulletin of the Geological Society of Denmark, **40**/1–2, 149–156, København.

KENNEDY, W.J. & CHRISTENSEN, W.K. (1997): Santonian to Maastrichtian ammonites from Scania, southern Sweden. – Fossils and Strata, **44**, 75–128, Oslo.

KENNEDY, W.J. & COBBAN, W.A. (1991): Upper Cretaceous (upper Santonian) *Boehmoceras* fauna from the Gulf Coast region of the United States. – Geological Magazine, **128**, 167–189, London.

KENNEDY, W.J. & HENDERSON, R.A. (1991): A note on *Ammonites sugata* FORBES, 1846. – Neues Jahrbuch für Geologie und Paläontologie, Monatshefte, **1991**, 470–476, Stuttgart.

KENNEDY, W.J. & HENDERSON, R.A. (1992): Non-heteromorph ammonites from the Upper Maastrichtian of Pondicherry, South India. – Palaeontology, **35**/2, 381–442, London.

KENNEDY, W.J. & JAGT, J.W.M. (1995): Lower Campanian heteromorph ammonites from the Vaals Formation around Aachen, Germany, and adjacent parts of Belgium and the Netherlands. – Neues Jahrbuch für Geologie und Paläontologie – Abhandlungen, **197**, 275–294, Stuttgart.

KENNEDY, W.J. & KAPLAN, U. (1995): *Parapuzosia* (*Parapuzosia*) *seppenradensis* (LANDOIS) und die Ammonitenfauna der Dülmener Schichten, unteres Unter-Campan, Westfalen. – Geologie und Paläontologie in Westfalen, **33**, 127 pp., Münster.

KENNEDY, W.J. & KAPLAN, U. (2000): Ammonitenfaunen des hohen Oberconiac und Santon in Westfalen. – Geologie und Paläontologie in Westfalen, **57**, 131 pp., Münster.

KENNEDY, W.J. & KLINGER, H.C. (1977): Cretaceous faunas from Zululand and Natal, South Africa. The ammonite family Tetragonitidae. – Annals of the South African Museum, **73**/7, 149–197, Cape Town.

KENNEDY, W.J. & KLINGER, H.C. (1979): Cretaceous Faunas from Zululand and Natal, South Africa. The ammonite family Gaudryceratidae. – Bulletin of the British Museum (Natural History), **31**/2, 122–174, London.

KENNEDY, W.J. & KLINGER, H.C. (2006): Cretaceous Faunas from Zululand and Natal, South Africa. The ammonite family Pachydiscidae SPATH, 1922. – African Natural History, **2**, 17–166, Cape Town.

KENNEDY, W.J. & KLINGER, H.C. (2011): Cretaceous Faunas from Zululand and Natal, South Africa. The ammonite subgenus *Haucericeras* (*Gardeniceras*) MATSUMOTO & OBATA, 1955. – Palaeontologia Africana, **46**, 43–58, Johannesburg.

KENNEDY, W.J. & KLINGER, H.C. (2012a): Cretaceous Faunas from Zululand and Natal, South Africa. The Santonian-Campanian ammonite genus *Eulophoceras* HYATT, 1903. – African Natural History, **8**, 30–39, Cape Town.

KENNEDY, W.J. & KLINGER, H.C. (2012b): The ammonite genus *Diaziceras* SPATH, 1921, from the Campanian of KwaZulu-Natal, South Africa, and Madagascar. – Palaeontologia Africana, **47**, 3–13, Johannesburg.

KENNEDY, W.J. & KLINGER, H.C. (2013): Cretaceous Faunas from Zululand and Natal, South Africa. *Texasia cricki* SPATH, 1921 (Cephalopoda: Ammonoidea) an early Santonian marker fossil from the Mzamba Formation of the Eastern Cape Province. – Palaeontologia Africana, **48**, 34–40, Johannesburg.

KENNEDY, W.J. & SUMMESBERGER, H. (1979): A revision of *Ammonites mitis* HAUER and *Ammonites glaneggensis* REDTENBACHER from the Gosau Beds (Upper Cretaceous) of Austria. – Beiträge zur Paläontologie von Österreich, **6**, 71–87, Wien.

KENNEDY, W.J. & SUMMESBERGER, H. (1984). Upper Campanian ammonites from the Gschliefgraben (Ultrahelvetic, Upper Austria). – Beiträge zur Paläontologie von Österreich, **11**, 149–206, Wien.

KENNEDY, W.J. & SUMMESBERGER, H. (1999): New Upper Campanian Ammonites from the Gschliefgraben near Gmunden, Ultrahelvetic, Austria). – Beiträge zur Paläontologie, **24**, 23–39, Wien.

KENNEDY, W.J. & WRIGHT, C.W. (1983): *Ammonites polyopsis* DUJARDIN, 1837 and the Cretaceous Ammonite family Placenticeratidae, HYATT, 1900. – Palaeontology, **26**/4, 855–873, London.

KENNEDY, W.J., HANSOTTE, M., BILOTTE, M. & BURNETT, J. (1992): Ammonites and Nannofossils from the Campanian of Nalzen (Ariège, France). – Geobios, **25**/2, 263–278, Amsterdam.

KENNEDY, W.J., BILOTTE, M. & MELCHIOR, P. (1995): Ammonite faunas, biostratigraphy and sequence stratigraphy of the Coniacian-Santonian of the Corbières (NE Pyrénées). – Bulletin des Centres de Recherches Exploration-Production Elf-Aquitaine, **19**/2, 377–499, Boussens.

KENNEDY, W.J., LANDMAN, N.H. & COBBAN, W.A. (2001): Santonian ammonites from the Blossom Sand in northeast Texas. – American Museum Novitates, **3332**, 1–9, New York.

KENNEDY, W.J., HANCOCK, J.M., COBBAN, W.A. & LANDMAN, N.H. (2004): A revision of the ammonite types described in F. Roemer's 'Die Kreidebildungen von Texas und ihre organischen Einschlüsse'. – Acta Geologica Polonica, **54**/4, 433–445, Warszawa.

KILIAN, W. & REBOUL, P. (1909): Les céphalopodes néocrétacés des iles Seymour and Snow Hill. – Wissenschaftliche Ergebnisse der Schwedischen Südpolar Expedition, **3**, 1–75, Stockholm.

KLINGER, H.C. (1976): Cretaceous heteromorph ammonites from Zululand. – Memoirs of the Geological Survey of the Republic of South Africa, **69**, 1–142, Pretoria.

KLINGER, H.C. (1985): Upper Cretaceous Cephalopoda from the offshore deposits off the Natal south coast, South Africa. – Palaeontographica Africana, **26**/1, 1–12, Johannesburg.

KLINGER, H.C. & KENNEDY, W.J. (1977): Upper Cretaceous ammonites from a borehole near Richards Bay, South Africa. – Annals of the South African Museum, **72/**5, 69–107, Cape Town.

KLINGER, H.C. & KENNEDY, W.J. (1980): Cretaceous faunas from Zululand and Natal, South Africa. The ammonite subfamily Texanitinae COLLIGNON, 1948. – Annals of the South African Museum, **80**, 1–357, Cape Town.

KLINGER, H.C. & KENNEDY, W.J. (1997a): Cretaceous Faunas from Zululand and Natal, South Africa. The ammonite family Baculitidae GILL, 1871 (excluding the genus *Eubaculites*). – Annals of the South African Museum, **105/**1, 1–206, Cape Town.

KLINGER, H.C. & KENNEDY, W.J. (1997b): On the affinities of *Madagascarites andimakensis* COLLIGNON, 1966, and allied Upper Cretaceous heteromorph ammonites. – Annals of the South African Museum, **105**, 227–247, Cape Town.

KLINGER, H.C. & KENNEDY, W.J. (2003): Cretaceous Faunas from Zululand and Natal, South Africa. The ammonite families Nostoceratidae HYATT, 1894 and Diplomoceratidae SPATH, 1926. – Annals of the South African Museum, **110**/6, 219–336, Cape Town.

KLINGER, H.C., KENNEDY, W.J. & GRULKE, W.E. (2007): New and little-known Nostoceratidae and Diplomoceratidae (Cephalopoda: Ammonoidea) from Madagascar. – African Natural History, **3**, 89–115, Cape Town.

KNER, R. (1849): Versteinerungen des Kreidemergels von Lemberg und seiner Umgebung. – Naturwissenschaftliche Abhandlungen, **3**/2, 1–42, Wien.

KOLLMANN, H.A. (1980): Gastropoden aus der Sandkalkbank (Hochmoosschichten, Obersanton) des Beckens von Gosau (O.Ö.). – Annalen des Naturhistorischen Museums in Wien, **83**, 187–213, Wien.

KOLLMANN, H.A. (1982): Gosauablagerungen im Becken von Gosau – In: PLÖCHINGER, B.: Erläuterungen zur Geologischen Karte der Republik Österreich 1:50.000, Blatt 95 St. Wolfgang im Salzkammergut, 30–34, Wien.

KOLLMANN, H.A. & SUMMESBERGER, H. (1982): Excursions to Coniacian–Maastrichtian in the Austrian Alps. – Working Group on the Coniacian–Maastrichtian Stages, 4th Meeting, 105 pp., Vienna.

KOSSMAT, F. (1895–1898): Untersuchungen über die südindische Kreideformation. – Beiträge zur Paläontologie und Geologie Österreich-Ungarns, **9** (1895), 97–203, **11** (1898), 1–46, Wien.

KÜCHLER, T. & WAGREICH, M. (2002): The Santonian - Campanian boundary in Navarra and Alava, northern Spain. A multistratigraphic approach. – In: WAGREICH, M. (Ed.): Aspects of Cretaceous Stratigraphy and Palaeobiogeography. – Österreichische Akademie der Wissenschaften, Schriftenreihe der Erdwissenschaftlichen Kommission, **15**, 333–350, Wien.

KÜHN, O. (1925): Die Echinodermen der Gosauformation. – Annalen des Naturhistorischen Museums in Wien, **39**, 177–189, Wien.

KUMMEL, B. (1956): Post-Triassic Nautiloid genera. – Bulletin of the Museum of Comparative Zoology, Harvard College, **114**/7, 324–494, Cambridge, Massachusetts.

LAMARCK, J.B.P.A. DE M. (1799). Prodrome d'une nouvelle classification des coquilles. – Mémoires du Museum National d'Histoire Naturelle, 63–90, Paris.

LANDOIS, H. (1895): Die Riesenammoniten von Seppenrade. – Jahresberichte des Westfälischen Provinzial-Vereins für Wissenschaft und Kunst, **23**, 1–10, Münster.

LANTOS, M., WAGREICH, M., SIEGL-FARKAS, A., BODNÁR, E. & CSZÁSZÁR, G. (1997): Integrated stratigraphic correlation of the Upper Cretaceous sequence in the borehole Bakonyjákó 528. – Advances in Austrian-Hungarian Geological Research, **1996**, 97–117, Budapest.

LASSWITZ, R. (1904): Die Kreide-Ammoniten von Texas. – Geologische und Palaeontologische Abhandlungen, N.F., **4**/4, 40 pp., Jena.

LEWY, Z. (1982): A well-preserved Upper Santonian heteromorph ammonite from Israel. – Geological Survey of Israel, Current Research, **1982**, 24–27, Jerusalem.

LINNAEUS, C. (1758): Systema natura per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis, Tomus I., Editio decima, reformata. – 1–4, 1–824, Holmiae [Stockholm] (Laurentii Salvii).

LOMMERZHEIM, A.J. (1995): Stratigraphie und Ammonitenfaunen des Santons und Campans im Münsterländer Becken (NW-Deutschland). – Geologie und Paläontologie in Westfalen, **40**, 97 pp., Münster.

LÓPEZ, G. (2006): First evidences of a major radial fold in the inoceramid (Bivalvia) shell. – International Congress on Bivalvia, Bellaterra, July 2006, Abstracts, 53, Bellaterra.

MACELLARI, C.E. (1987): Progressive endemism in the Late Cretaceous ammonite family Kossmaticeratidae and the breakup of Gondwanaland. – In: MCKENZIE, G.D. (Ed.): Gondwana Six: Stratigraphy, Sedimentology, and Paleontology. – American Geophysical Union, Geophysical Monographs, **41**, 85–92, New Jersey.

MARSHALL, P. (1926): The Upper Cretaceous Ammonites of New Zealand. – Transactions of the New Zealand Institute, **56**, 129–210, Wellington.

MATSUMOTO, T. (1938): A biostratigraphic study on the Cretaceous deposits of the Naibuchi Valley, South Karahuto. – Proceedings of the Imperial Academy of Japan, **14**, 190–194, Tokio.

MATSUMOTO, T. (1942): A note on the Japanese Cretaceous ammonites belonging to the subfamily Desmoceratinae. – Proceedings of the Imperial Academy of Japan, **18**, 24–29, Tokyo.

MATSUMOTO, T. (1954): Family Puzosiidae from Hokkaido and Saghalien (Studies on Cretaceous Ammonoidea from Hokkaido and Saghalien-V). – Memoirs of the Faculty of Science, Kyushu University (Series D, Geology), **5**/2, 69–118, Fukuoka.

MATSUMOTO, T. (1965): A Monograph of the Collignoniceratidae from Hokkaido, Part III. – Studies of the Cretaceous Ammonites from Hokkaido and Saghalien, XV. – Memoirs of the Faculty of Science, Kyushu University (Series D, Geology), **16**/3, 209–244, Fukuoka.

MATSUMOTO, T. (1969): A Monograph of the Collignoniceratidae from Hokkaido, Part V. – Studies of the Cretaceous Ammonites from Hokkaido and Saghalien, XX. – Memoirs of the Faculty of Science, Kyushu University (Series D, Geology), **19**/3, 297–330, Fukuoka.

MATSUMOTO, T. & OBATA, I. (1955): Some Upper Cretaceous desmoceeratids from Hokkaido and Saghalien. – Memoirs of the Faculty of Science, Kyushu University (Series D, Geology), **5**/3, 119–151, Fukuoka.

MATSUMOTO, T. & OBATA, I. (1963): A monograph of the Baculitidae from Japan. – Memoirs of the Faculty of Science, Kyushu University (Series D, Geology), **13**/1, 1–116, Fukuoka.

MATSUMOTO, T., TOSHIMITSU, S. & KAWASHITA, Y. (1990): On *Hauericeras* DE GROSSOUVRE, 1894, a Cretaceous ammonite genus. – Transactions and Proceedings of the Palaeontological Society of Japan, New Series, **158**, 439–458, Tokyo.

MATURA, A. & SUMMESBERGER, H. (1980): Geology of the Eastern Alps. Excursion Guide, 26. Congres Geologique Internationale. – Abhandlungen der Geologischen Bundesanstalt, **34**, 103–170, Wien.

MCARTHUR, J.M., HOWARTH, R.J. & BAILEY, T.R. (2001): Strontium isotope stratigraphy: LOWESS Version 3: best fit to the marine Sr-isotope curve for 0–509 Ma and accompanying look-up table for deriving numerical age. – The Journal of Geology, **109**, 155–170, Chicago.

MEEK, F.B. (1876): A report on the invertebrate Cretaceous and Tertiary fossils of the upper Missouri country. – U.S. Geological Survey, Territories, **9**, 629 pp., Washington, D.C.

MOBERG, J.C. (1885): Cephalopoderna i Sveriges Kritsystem, II. Artbeskrifning. – Sveriges Geologiska Undersökning, Serie C, Afhandlingar och uppsatser, **73**, 3–64, Uppsala.

MORTON, S.G. (1834): Synopsis of the Organic Remains of the Ferrugineous Sand Formation of the United States. Illustrated by nineteen plates, to which is added an appendix containing a tabular view of the Tertiary fossils discovered in America. – 88 pp., Philadelphia (Key and Biddle).

MÜLLER, G. & WOLLEMANN, A. (1906): Die Molluskenfauna des Untersenon von Braunschweig und Ilsede. II. Die Cephalopoden. – Abhandlungen der Preussischen Geologischen Landesanstalt, Neue Folge, **47**, 1–30, Berlin.

NEWELL, N.D. (1965): Classification of the Bivalvia. – American Museum Novitates, **2206**, 1–25, New York.

NOWAK, J. (1913): Untersuchungen über die Cephaopoden der oberen Kreide in Polen. III. Teil. – Bulletin Academie des Sciences, Cracovie, Classe mathematique naturelle, Serie B, Science naturelle, 335–415, Cracow.

OGG, J.G. & HINNOV, L.A. (2012): Cretaceous. – In: GRADSTEIN, F.M., OGG, J.G., SCHMITZ, M.D. & OGG, G.M. (Eds.): The Geological Time Scale 2012, 793–853, Amsterdam.

OKAMOTO, T. & SHIBATA, M. (1997): A cyclic mode of shell growth and its implications in a Late Cretaceous ammonite *Polyptychoceras pseudogaultinum* (YOKOYAMA). – Paleontological Research, **1**/1, 29–46, Tokyo.

ORBIGNY, A. D' (1840–1842): Paléontologie française: Terrains crétacés. I. Céphalopodes. – 662 pp., Paris.

ORBIGNY, A. D'. (1850): Prodrome de Palérontologie stratigraphique universelle des animaux mollusques et rayonnés faisant suite au cours élémentaire de Paléontologie, vol. **1**, 394 pp.; vol. **2**, 428 pp., Paris.

PERCH-NIELSEN, K. (1985): Mesozoic calcareous nannofossils. – In: BOLLI, H.M., SAUNDERS, J.B. & PERCH-NIELSEN, K. (Eds.): Plankton Stratigraphy, 329–426, Cambridge.

PETRASCHECK, W. (1906): Über Inoceramen aus der Gosau und dem Flysch der Nordalpen. – Jahrbuch der k. k. Geologischen Reichsanstalt, **56**, 155–168, Wien.

PLÖCHINGER, B. (1982): Geologische Spezialkarte der Republik Österreich 1:50.000, Blatt 95 St. Wolfgang. – Geologische Bundesanstalt, Wien.

PREMOLI SILVA, I. & SLITER, W.V. (1994): Cretaceous planktonic foraminiferal biostratigraphy and evolutionary trends from the Bottaccione section, Gubbio, Italy. – Palaeontographia Italica, **82**, 1–89, Pisa.

REDTENBACHER, A. (1873): Die Cephalopodenfauna der Gosauschichten in den nordöstlichen Alpen. – Abhandlungen der k. k. Geologischen Reichsanstalt, **5**, 91–140, Wien.

REESIDE, J.B. JR. (1927): The cephalopods of the Eagle Sandstone and related formations in the Western Interior of the United States. – United States Geological Survey, Professional Paper, **151**, 87 pp., Washington, D.C.

REESIDE, J.B. JR. (1932): The Upper Cretaceous Ammonite Genus Barroisiceras in the United States. – United States Geological Survey, Professional Paper, **170-B**, 9–29, Washington, D.C.

REMIN, Z. (2004): Biostratigraphy of the Santonian in the SW margin of the Holy Cross Mountains near Lipnik, a potential reference section for extra-Carpathian Poland. – Acta Geologica Polonica, **54**/4, 587–596, Warszawa.

REMIN, Z. (2010): Upper Coniacian, Santonian, and lowermost Campanian ammonites of the Lipnik-Kije Section, central Poland-taxonomy, stratigraphy, and palaeogeographic significance. – Cretaceous Research, **31**, 154–180, London.

RENZ, O. (1982): The Cretaceous Ammonites of Venezuela. – 132 pp., Basel.

REUSS, A.E. (1854): Beiträge zur Charakteristik der Kreideschichten in den Ostalpen, besonders im Gosauthale und am Wolfgangsee. – Denkschriften der kaiserlichen Akademie der Wissenschaften, mathematisch-naturwissenschaftliche Classe, **VII**, 1–136, Wien.

REYMENT, R. (1957): Über einige wirbellose Fossilien aus Nigerien und Kamerun, Westafrika. – Palaeontographica **109**, 41–70, Stuttgart.

RIEDEL, L. (1931): Zur Stratigraphie und Faciesbildung im Oberemscher und Untersenon am Südrande des Beckens von Münster. – Jahrbuch der Preussischen Geologischen Landesanstalt zu Berlin, **51**, 605–713, Berlin.

RIEGRAF, W. & SCHEER, U. (1991): Cephalopoden der oberen deutschen Kreide. – 454 pp., Reproduktion der Ausgabe von SCHLÜTER, C. (1867–1876), Korb.

ROBASZYNSKI, F. & CARON, M. (1995): Foraminiferes planctoniques du Crétacé: commentaire de la zonation Europe-Méditerranée. – Bulletin de la Société Géologique de France, **6**, 681–692, Paris.

ROEMER, F.A. (1841): Die Versteinerungen des norddeutschen Kreidegebirges. – iv + 145 pp., Hannover.

ROEMER, F. (1849): Texas. – 168 pp., Bonn.

ROEMER, F. (1852): Die Kreidebildungen von Texas und ihre organischen Einschlüsse. – 100 pp., Bonn.

SAGEMAN, B.B., SINGER, B.S., MEYERS, S.R., SIEWERT, S.E., WALASZCZYK, I., CONDON, D.J., JICHA, B.R., OBRADOVICH, J.D. & SAWYER, D.A. (2014): Integrating $^{40}Ar/^{39}Ar$, U-Pb, and astronomical clocks in the Cretaceous Niobrara Formation, Western Interior Basin, USA. – Geological Society of America Bulletin, **126**, 956–973, Boulder.

SANTAMARIA ZABALA, R. (1991): Ammonoideos del Cretacico Superior de la Plataforma Nord-Castellana y Parte de la Cuenca Navarro Cantabra, Paleontologia y Bioestratigrafia. – Thesis Doctoral Universitat Autònoma de Barcelona, 397 pp., Bellaterra.

SANTAMARIA ZABALA, R. (1992): Los Ammonoideos del Cenomaniense superior al Santoniense de la plataforma nord-castellana y la cuenca navarro-cantabra. Parte 1. Bioestratigraff a sistematica: Phylloceratina, Ammonitina (Desmoceratáceae y Hoplitaceae) y Ancyloceratina. – Treballs del Museu de Geologia Barcelona, **2**, 171–268, Barcelona.

SCHLOTHEIM, E.F. v. (1820): Die Petrefaktenkunde auf ihrem jetzigen Standpunkte durch die Beschreibung seiner Sammlung. – lxii + 437 pp., Gotha.

SCHLÜTER, C. (1871–1876): Cephalopoden der oberen deutschen Kreide. – Palaeontographica, **21**, 1–24, (1871); **21**, 25–120 (1872); **24**, 1–144 (121–264) + x (1876), Cassel.

SCHÖNFELD, H.-J. (1985): Zur Lithologie, Biostratigraphie und Fossilführung des Ober-Santon Mergels von Westerwiehe (Ostwestfalen). – Geologie und Paläontologie in Westfalen, **5**, 7–50, Münster.

SCHÖNFELD, J., SCHULZ, M.-G., MCARTHUR, J.M., BURNETT, J., GALE, A.S., HAMBACH, U., HANSEN, H.J., KENNEDY, W.J., RASMUSSEN, K.L., THIRLWALL, M.F. & WRAY, D.S. (1996): New results on biostratigraphy, palaeomagnetism, geochemistry and correlation from the standard section for the Upper Cretaceous white chalk of northern Germany (Lägerdorf-Kronsmoor-Henmoor). – Mitteilungen aus dem Geologisch-Paläontologischen Institut der Universität Hamburg, **77**, 545– 575, Hamburg.

SEITZ, O. (1961): Die Inoceramen des Santon von Nordwestdeutschland. I. Teil (Die Untergattungen *Platyceramus*, *Cladoceramus* und *Cordiceramus*). – Geologisches Jahrbuch, Beihefte, **46**, 186 pp., Hannover.

SEITZ, O. (1965): Die Inoceramen des Santon und Unter-Campan von Nordwestdeutschland. II. Teil (Biometrie, Dimorphismus und Stratigraphie der Untergattung *Sphenoceramus* J. BÖHM). – Geologisches Jahrbuch, Beihefte, **69**, 194 pp., Hannover.

SEITZ, O. (1967): Die Inoceramen des Santon und Unter-Campan von Nordwestdeutschland. III. Teil. Taxonomie und Stratigraphie der Untergattungen *Endocostea*, *Haenleinia*, *Platyceramus*, *Cladoceramus*, *Selenoceramus* und *Cordiceramus* mit besonderer Berücksichtigung des Parasitismus bei diesen Untergattungen. – Geologisches Jahrbuch, Beihefte, **75**, 171 pp., Hannover.

SHIMANSKY, V.N. (1975): Cretaceous Nautilids. [In Russian]. – Trudy Palaeontologiceskogo Instituta Akademii Nauk SSSR, **150**, 1–208, Moscow.

SHIMIZU, S. (1934): Ammonites. – In: SHIMIZU, S. & OBATA, T.: Ammonites: Iwanami's lecture series of Geology and Palaeontology, 137 pp., Tokyo.

SIGAL, J. (1952): Aperçu stratigraphique sur la micropaléontologie du Cretacé. – Monographies Régionales, **1**/26, 3–43, Algérie.

SISSINGH, W. (1977): Biostratigraphy of Cretaceous calcareous nannoplankton. – Geologie en Mijnbouw, **56**, 37–56, Utrecht.

SOWERBY, J. DE C. (1823): The Mineral Conchology of Great Britain (continued). – **4**, Pls. 384–407, London.

SPATH, L.F. (1921): Cretaceous Cephalopoda from Zululand. – Annals of the South African Museum, **12**/7, 217–321, Cape Town.

SPATH, L.F. (1922): On the Senonian Ammonoidea of Pondoland. – Transactions of the Royal Society of South Africa, **10**, 113–147, Cape Town.

SPATH, L.F. (1925): On Senonian Ammonoidea from Jamaica. – Geological Magazine, **62**, 28–32, London.

SPATH, L.F. (1926): On new ammonites from the English Chalk. – Geological Magazine, **63**, 77–83, London.

SPATH, L.F. (1927): Revision of the Jurassic Cephalopod fauna of Kachh (Cutch). – Memoirs of the Geological Survey of India, Palaeontologica Indica, **11**, 1–71, Calcutta.

SPATH, L.F. (1953): The Upper Cretaceous cephalopod fauna of Graham Land. – Falkland Islands Dependencies Survey, Scientific Report, **3**, 1–60, London.

STOLICZKA, F. (1863–1866): The fossil cephalopoda of the Cretaceous rocks of southern India. Ammonitidae with revision of the Nautilidae. – Memoirs of the Geological Survey of India, Palaeontologica Indica, **3**/1, 41–56, Plates 26–31 (1863); **3**/2–5, 57–106, Plates 32–54 (1864); **3**/6–9, 107–154, Plates 55–80 (1865); **3**/10–13, 155–216, Plates 81–94 (1866), Calcutta.

SUMMESBERGER, H. (1979): Eine obersantone Ammonitenfauna aus dem Becken von Gosau (Oberösterreich). – Annalen des Naturhistorischen Museums in Wien, Serie A, **82**, 109–176, Wien.

SUMMESBERGER, H. (1980): Neue Ammoniten aus der Sandkalkbank der Hochmoosschichten (Obersanton; Gosau, Österreich). – Annalen des Naturhistorischen Museums in Wien, Serie A, **83**, 275–283, Wien.

SUMMESBERGER, H. (1985): Ammonite Zonation of the Gosau Group (Upper Cretaceous, Austria). – Annalen des Naturhistorischen Museums in Wien, Serie A, **87**, 145–166, Wien.

SUMMESBERGER, H. (1992): *Pseudophyllites latus* (MARSHAL), Ammonoidea, aus der Sandkalkbank der Hochmoosschichten (Obersanton, Gosau, Österreich). – Annalen des Naturhistorischen Museums in Wien, Serie A, **94**, 103–133, Wien.

SUMMESBERGER, H. (2000): Stop. 2.5. Forest road into the Finstergraben N of the village Gosau. – In: EGGER, J., KOLLMANN, H.A., SANDERS, D., SUMMESBERGER, H. & WAGREICH, M.: Excursion Guide. Field trip C, 6th International Cretaceous Symposium, Vienna, 2000, 25–29, Vienna.

SUMMESBERGER, H. (2007): Auf den Spuren der Evolution in Oberösterreich am Beispiel der Ammoniten der Gosau Gruppe. – Denisia, **20**, Neue Serie **66** (2007), 405–412, Linz.

SUMMESBERGER, H. & KENNEDY, W.J. (1996): Turonian Ammonites from the Gosau Group (Upper Cretaceous; Northern Calcareous Alps; Austria) with a revision of *Barroisiceras haberfellneri* (HAUER, 1866). – Beiträge zur Paläontologie von Österreich, **21**, 1–75, Wien.

SUMMESBERGER, H. & ZORN, I. (2012): A catalogue of the type specimens of Late Cretaceous Cephalopods housed in the Collections of the Geological Survey of Austria in Vienna. – Abhandlungen der Geologischen Bundesanstalt, **152**/1–4, 101–144, Wien.

SUMMESBERGER, H., JURKOVSEK, B. & KOLAR-JURKOVSEK, T. (1996): Aptychi associated with ammonites from the Lipica-Formation (Upper Cretaceous, Slovenia). – Annalen des Naturhistorischen Museums in Wien, Serie A, **97**, 1–19, Wien.

SUMMESBERGER, H., WAGREICH, M. & BRYDA, G. (2009): Upper Maastrichtian cephalopods and the correlation to calcareous nannoplankton and planktic foraminifera zones in the Gams Basin (Gosau Group; Styria, Austria). – Annalen des Naturhistorischen Museums in Wien, Serie A, **111**, 159–182, Wien.

SUMMESBERGER, H., KENNEDY, W.J. & SKOUMAL, P. (2017a): Early and middle Santonian Cephalopods from the Gosau Group (Upper Cretaceous, Austria) 1. Nautiloidea and non-heteromorph Ammonoidea. – Abhandlungen der Geologischen Bundesanstalt, **71**, 5–99, Wien.

SUMMESBERGER, H., KENNEDY, W.J. & SKOUMAL, P. (2017b): Early and middle Santonian Cephalopods from the Gosau Group (Upper Cretaceous, Austria) 2. Heteromorph Ammonoidea. – Abhandlungen der Geologischen Bundesanstalt, **71**, 101–149, Wien.

SUMMESBERGER, H., KENNEDY, W.J. & SKOUMAL, P. (2017c): Late Santonian Ammonites from the Hofergraben (Gosau Group, Upper Cretaceous, Austria). – Austrian Journal of Earth Sciences, **110**, 122–141, Wien.

THIBAULT, N., JARVIS, I., VOIGT, S., GALE, A.S., ATTREE, K. & JENKYNS, H.C. (2016): Astronomical calibration and global correlation of the Santonian (Cretaceous) based on the marine carbon isotope record. – Paleoceanography, **31**/6, 847–865, Washington, D.C. DOI: https://dx.doi.org/10.1002/2016PA002941

TINTANT, H. & GAUTHIER, H. (2006): Nautiloides. – In: GAUTHIER, H.: Révision critique de la Paléontologie Francaise d'Alcide d'Orbigny, Céphalopodes Crétaces, 19–23, Leiden.

TRENKWALDER, M. (1999): Stratigraphie, Tektonik und Mikrofauna der Oberen Kreide südlich von Gosau. – Unpublizierte Diplomarbeit, Universität Innsbruck, 154 pp., Innsbruck.

TRÖGER, K.-A. (2009): Katalog oberkretazischer Inoceramen. – Geologica Saxonica (Journal of Central European Geology), **55**, 188 pp., Dresden.

TRÖGER, K.-A. & SUMMESBERGER, H. (1994): Coniacian and Santonian inoceramid bivalves from the Gosau-Group (Cretaceous, Austria) and their biostratigraphic and palaeogeographic significance. – Annalen des Naturhistorischen Museums in Wien, Serie A, **96**, 161–197, Wien.

ULBRICH, H. (1971): Mitteilungen zur Biostratigraphie des Santon und Campan des mittleren Teils der subherzynen Kreidemulde. – Freiberger Forschungshefte, **267**, 47–71, Leipzig–Freiberg.

WAGREICH, M. (1988): Sedimentologie und Beckenentwicklung des tieferen Abschnittes (Santon-Untercampan) der Gosauschichtgruppe von Gosau und Rußbach (Oberösterreich-Salzburg). – Jahrbuch der Geologischen Bundesanstalt, **131**, 663–685, Wien.

WAGREICH, M. (1992): Correlation of Late Cretaceous calcareous nannofossil zones with ammonite zones and planktonic foraminifera: the Austrian Gosau sections. – Cretaceous Research, **13**, 505–516, London.

WAGREICH, M. (1993): Subcrustal tectonic erosion in orogenic belts – A model for the Late Cretaceous subsidence of the Northrn Calcareous Alps (Austria). – Geology, **21**, 941–944, Boulder.

WAGREICH, M. & DECKER, K. (2001): Sedimentary tectonics and subsidence modelling of the type Upper Cretaceous Gosau basin (Northern Calcareous Alps, Austria). – International Journal of Earth Sciences (Geologische Rundschau), **90**, 714–726, Berlin–Heidelberg.

WAGREICH, M. & FAUPL, P. (1994): Palaeogeography and geodynamic evolution of the Gosau Group of the Northern Calcareous Alps (Late Cretaceous, Eastern Alps. – Palaeogeography, Palaeoclimatology, Palaeoecology, **110**, 235–252, Amsterdam.

WAGREICH, M. & KRENMAYR, H.-G. (2005): Upper Cretaceous oceanic red beds (CORB) in the Northern Calcareous Alps (Nierental Formation, Austria): slope topography and clastic input as primary controlling factors. – Cretaceous Research, **26**, 57–64, London.

WAGREICH, M. & NEUHUBER, S. (2005): Stratigraphy and geochemistry of an Early Campanian deepening succession (Bibereck Formation, Gosau Group, Austria). – Earth Science Frontiers, **12**, 123–131, Beijing.

WAGREICH, M., SUMMESBERGER, H. & KROH, A. (2010): Late Santonian bioevents in the Schattau section, Gosau Group of Austria – implications for the Santonian-Campanian boundary stratigraphy. – Cretaceous Research, **31**, 181–191, London.

WAGREICH, M., DINARÈS-TURELL, J. & WOLFGRING, E. (2015): A reference section for the Santonian-Campanian boundary: The Postalm section, Austria. – EGU General Assembly 2015, Geophysical Research, Abstracts, **17**, EGU2015-8542.

WALASZCZYK, I. & COBBAN, W.A. (2006): Inoceramid fauna and biostratigraphy of the middle Upper Coniacian and Santonian of the U.S. Western Interior. – Acta Geologica Polonica, **56**, 241–348, Warszawa.

WALASZCZYK, I. & COBBAN, W.A. (2007): Inoceramid fauna and biostratigraphy of the upper Middle Coniacian–lower Middle Santonian of the Pueblo Section (SE Colorado, US Western Interior). – Cretaceous Research, **28**, 132–142, London.

WARD, P.D. & KENNEDY, W. J. (1993): Maastrichtian ammonites from the Biscay region (France, Spain). – Journal of Paleontology, Memoir **34**, 1–58, Lawrence.

WEGNER, T. (1905): Die Granulatenkreide des westlichen Münsterlandes. – Zeitschrift der Deutschen Geologischen Gesellschaft, **57**, 112–232, Stuttgart.

WEIGEL, O. (1937): Stratigraphie und Tektonik des Beckens von Gosau. – Jahrbuch der Geologischen Bundesanstalt, **87**, 11–40, Wien.

WEISS, W. (1975): Mikropaläontologische Gliederung der Unteren Gosauschichten im N-Teil des Beckens von Gosau (Oberösterreich). – Diplomarbeit, Universität München, 73 pp., München.

WEISS, W. (1977): Korrelation küstennaher und küstenferner Faziesbereiche in den Unteren Gosauschichten (Oberkreide, Österreich). – Neues Jahrbuch für Geologie und Paläontologie, Monatshefte, **1977**, 289–302, Stuttgart.

WENDLER, I. (2013): A critical evaluation of carbon isotope stratigraphy and biostratigraphic implications for Late Cretaceous global correlation. – Earth Science Reviews, **126**, 116–146, Amsterdam.

WHITFIELD, R. P. (1892): Gastropoda and Cephalopoda of the Raritan clays and Greensand marls. – U.S. Geological Survey, Monographs, **18**, 1–402, Washington.

WIEDMANN, J. (1960a): Zur Systematik jungmesozoischer Nautiliden unter besonderer Berücksichtigung der iberischen Nautilinae d'Orb. – Palaeontographica, **A 115**, 44–206, Stuttgart.

WIEDMANN, J. (1960b): Le Crétacé supérieur de l'Espagne et du Portugal et ses Céphalopodes. – C.R 84e Congrès des Sociétés savantes (1959), Section scientifique, Colloque sur le Crétacé supérieur francais, 709–764. Paris.

WIEDMANN, J. (1962): Ammoniten aus der Vascogotischen Kreide (Nordspanien). 1. Phylloceratina, Lytoceratina. – Palaeontographica, **118**, 119–237, Stuttgart.

WIEDMANN, J. (1966): Stammesgeschichte und System der posttriadischen Ammonoideen, ein Überblick. – Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen, **125**/1–3, 49–79; **127**, 13–81, Stuttgart.

WIEDMANN, J. (1978): Eine paläogeographisch interessante Ammonitenfaunula aus der alpinen Gosau (Santon, Becken von Gosau, Oberösterreich). – Eclogae Geologicae Helvetiae, **71**/3, 663–675, Basel.

WIESE, F. (2000): Coniacian (Upper Cretaceous) ammonites from the North Cantabrian Basin (Cantabria, northern Spain). – Acta Geologica Polonica, **50**/1, 25–142, Warszawa.

WILMSEN, M. (2000): Late Cretaceous nautilids from northern Cantabria, Spain. – Acta Geologica Polonica, **50**/1, 29–43, Warszawa.

WITTLER, F.A., ROTH, R. & LEGANT, J. (1999): Die Nautiliden der oberen Kreide (Cenoman–Campan) vom Süd- und Westrand des Münsterländer Beckens. – Arbeitskreis Paläontologie Hannover, **27**, 1–52, Hannover.

WOODS, H. (1906): The Cretaceous fauna of Pondoland. – Annals of the South African Museum, **4**/7, 275–350, Cape Town.

WRIGHT, C.W. (1952): A classification of the Cretaceous ammonites. – Journal of Paleontology, **26**, 213–226, London.

WRIGHT, C.W. (1957): Cretaceous Ammonites. – In: MOORE, R.C. (Ed.): Treatise on Invertebrate Paleontology. Part L, Mollusca 4. – xxii + 490 pp., New York–Lawrence.

WRIGHT, C.W., CALLOMON, J.H. & HOWARTH, M.K. (1996): Cretaceous Ammonoidea. – In: KAESLER, R.L. (Ed.): Treatise on Invertebrate Paleontology, Part L., Mollusca 4, revised. – 362 pp., Boulder, Colorado and Lawrence, Kansas.

WRIGHT, C.W. & MATSUMOTO, T. (1954): Some doubtful Cretaceous ammonite genera from Japan and Saghalin. – Memoirs of the Faculty of Science, Kyushu University (serie D, Geology), **4,** 107–134, Kyushu.

WRIGHT, C.W. & WRIGHT, E.V. (1951): A survey of the fossil Cephalopoda of the Chalk of Great Britain. – Palaeontographical Society, Monographs, 40 pp., London.

YABE, H. (1904): Cretaceous Cephalopoda from the Hokkaido. Part II. *Turrilites*, *Helicoceras*, *Heteroceras*, *Nipponites*, *Olcostephanus*, *Desmoceras*, *Hauericeras*, and an undetermined genus. – Journal of the College Science, Imperial University Tokyo, **20**/2, 1–45, Tokyo.

YABE, H. (1927): Cretaceous stratigraphy of the Japanese Islands. – Science Report of the Tohoku Imperial University, Sendai, (series 2, Geology) **11**, 27–100, Sendai.

YOKOYAMA, M. (1890): Versteinerungen aus der japanischen Kreide. – Palaeontographica, **36**, 159–202, Stuttgart.

YOUNG, K. (1963): Upper Cretaceous Ammonites from the Gulf Coast of the United States. – Bulletin of the University of Texas, **6304**, 373 pp., Austin.

ZITTEL, K.A. (1865–1866): Die Bivalven der Gosaugebilde in den östlichen Alpen. Beitrag zur Charakteristik der Kreideformation in Österreich. – Denkschriften der kaiserlichen Akademie der Wissenschaften, mathematisch-naturwissenschaftliche Classe, **24**, 1–72; **25**, 73–198, Wien.

ZITTEL, K.A. (1884): Handbuch der Paläontologie. I. Abteilung, 3. Lieferung, Cephalopoda, 359–522, Munich and Leipzig.

ZITTEL, K.A. (1895): Grundzüge der Paläontologie (Paläozoologie). – 972 pp., Munich and Leipzig.

Received: 6. October 2016, accepted: 25. March 2017

Plate 1

Fig. 1: *Platyceramus ahsenensis* (SEITZ, 1961); NHMW 2010/0081/0012; Bibereck Formation, *Micraster* Bed.

Fig. 2: *Cordiceramus muelleri muelleri* (PETRASCHECK, 1906); SK/B/SG/1996/3, an articulated specimen with symmetric "*endocostea* scars"; Hochmoos Formation, Sandkalkbank Member.

All figures are natural size. All specimens are coated with ammonium chloride and from the Schattaugraben section.


1
2
1 cm

Plate 2

Fig. 1: *Cordiceramus germanicus* (HEINZ, 1928); NHMW 2010/0081/0010; Bibereck Formation, above the *Micraster* Bed on top of the section.

Fig. 2: *Cordiceramus bueltenensis* (SEITZ, 1961); NHMW 2010/0081/0011; Bibereck Formation, *Micraster* Bed.

Figs. 3a–b: *Sphenoceramus* ex gr. *cardissoides* (GOLDFUSS, 1835) / *pachti* (ARKHANGELSKY, 1916); NHMW 2010/0081/0013; Bibereck Formation, top of the section.

All figures are natural size. All specimens are coated with ammonium chloride and from the Schattaugraben section.

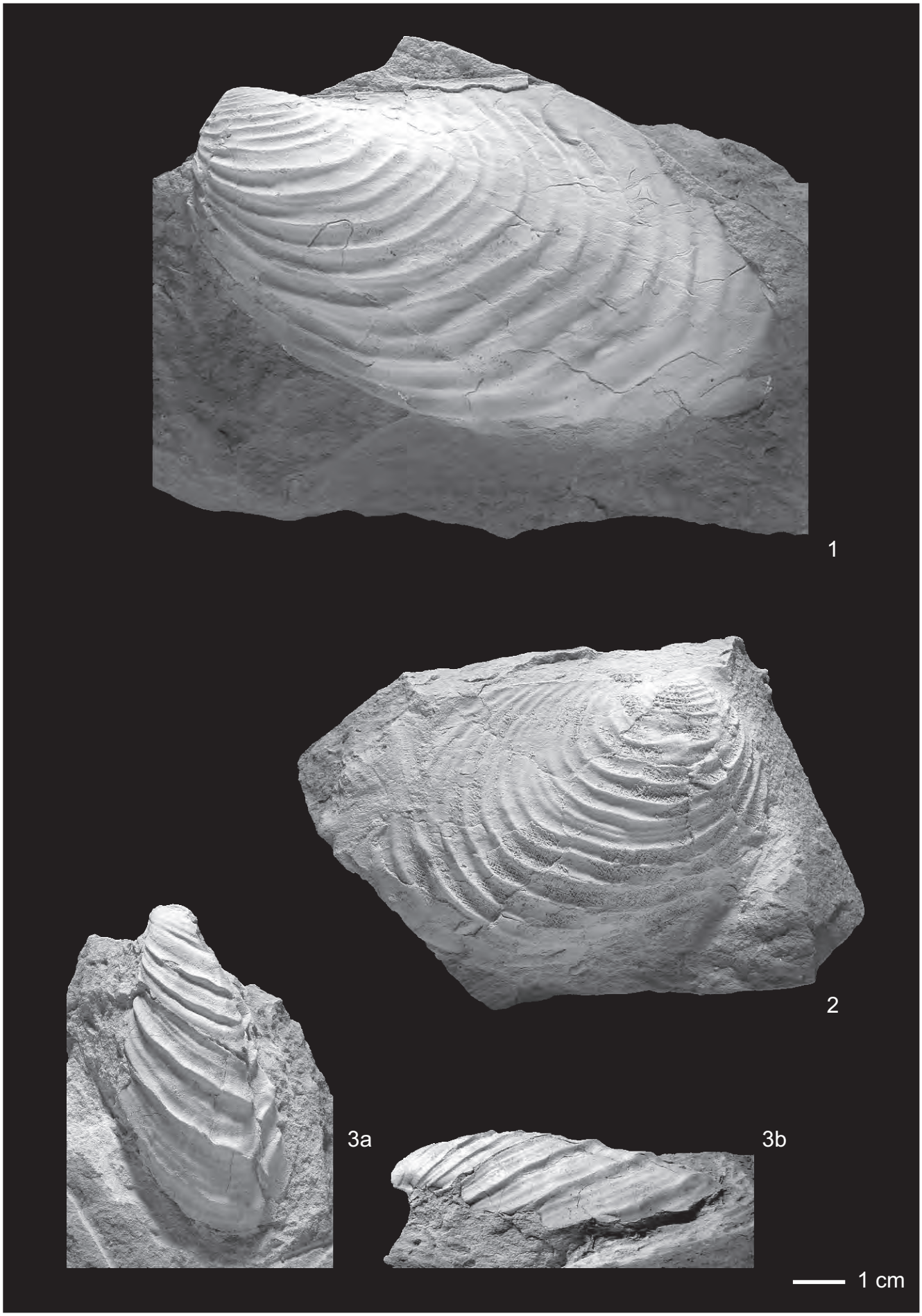

1
2
3a
3b
1 cm

Plate 3

Figs. 1a–b: *Eutrephoceras* cf. *indicum* (D'ORBIGNY, 1850); NHMW 2009z0045/0001; Gosau Group, Schattaugraben section.

Figs. 2a–b: *Eutrephoceras* cf. *indicum* (D'ORBIGNY, 1850); NHMW 2009z0046/0001; Gosau Group, without locality details.

Figs. 3a–b: *Eutrephoceras* cf. *indicum* (D'ORBIGNY, 1850); NHMW 1990/0029/0515b; Hochmoos Formation, Sandkalkbank Member, Finstergrabenwandl.

Figs. 4a–b: *Eutrephoceras* cf. *indicum* (D'ORBIGNY, 1850); SK/1983/14/1; Hochmoos Formation, Sandkalkbank Member, Finstergrabenwandl.

Figs. 5a–c: *Eutrephoceras* cf. *indicum* (D'ORBIGNY, 1850); SK/1983/14/2; Hochmoos Formation, Sandkalkbank Member, Finstergrabenwandl.

All figures are natural size. All specimens are coated with ammonium chloride and from the upper Santonian of the Gosau Group.

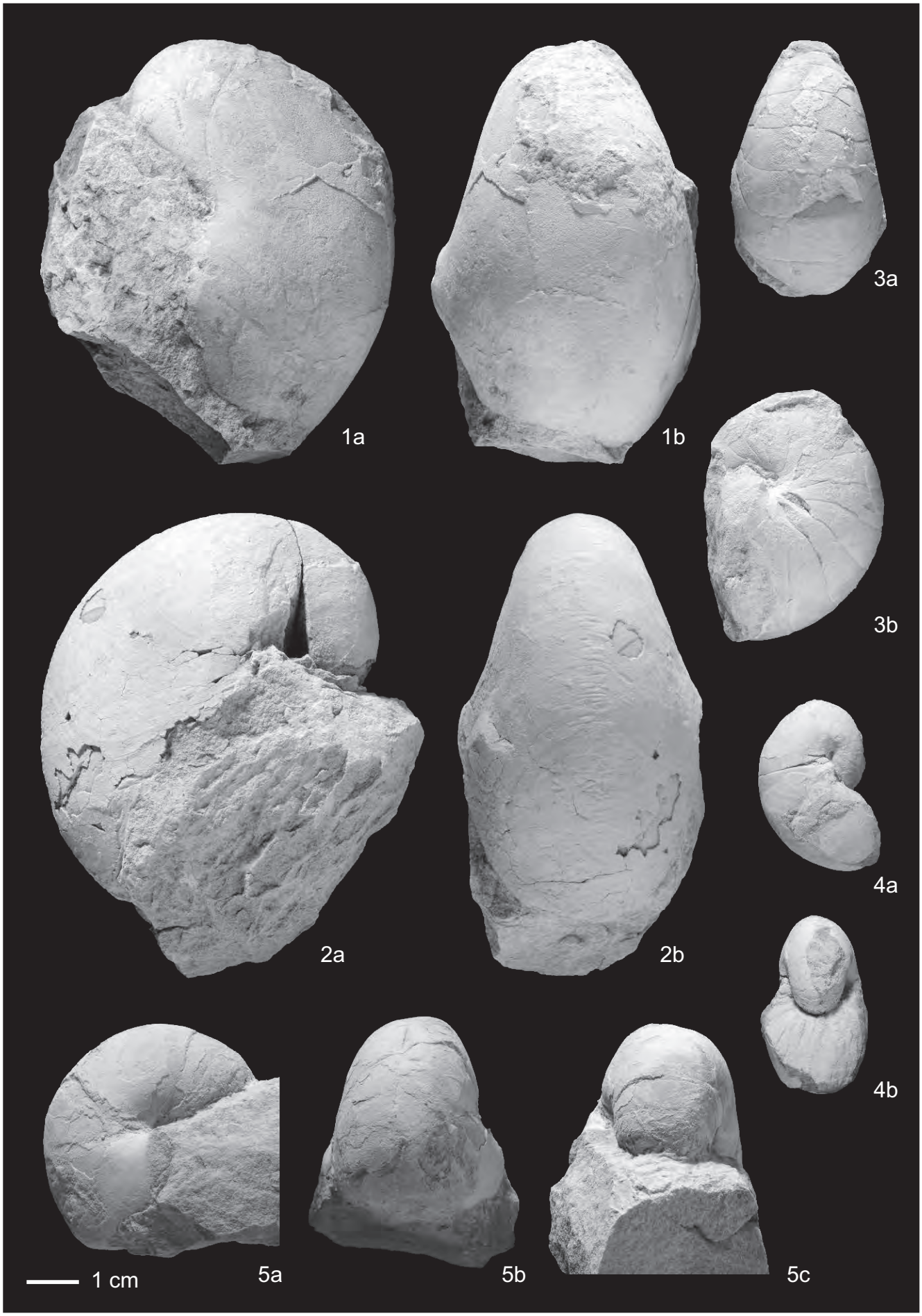

1a
1b
3a
3b
2a
2b
4a
4b
5a
5b
5c
1 cm

Plate 4

Figs. 1a–c: *Eutrephoceras* cf. *indicum* (d'Orbigny, 1850); SK/1983/14/5.

Figs. 2a–d: *Eutrephoceras* cf. *indicum* (d'Orbigny, 1850); SK/1983/14/3.

Fig. 3: *Eutrephoceras* cf. *indicum* (d'Orbigny, 1850); SK, 1983/10.

Fig. 4: *Eutrephoceras montiscastoris* spec. nov.; NHMW 2009z0048/0001; paratype.

Figs. 5a–d: *Eutrephoceras montiscastoris* spec. nov.; NHMW 1990/0029/0519/1; paratype.

Figs. 6a–c: *Eutrephoceras montiscastoris* spec. nov.; NHMW 2009z0047/0001; paratype.

All figures are natural size. All specimens (except 2d and 3) are coated with ammonium chloride and from the upper Santonian Sandkalkbank Member of the Hochmoos Formation.

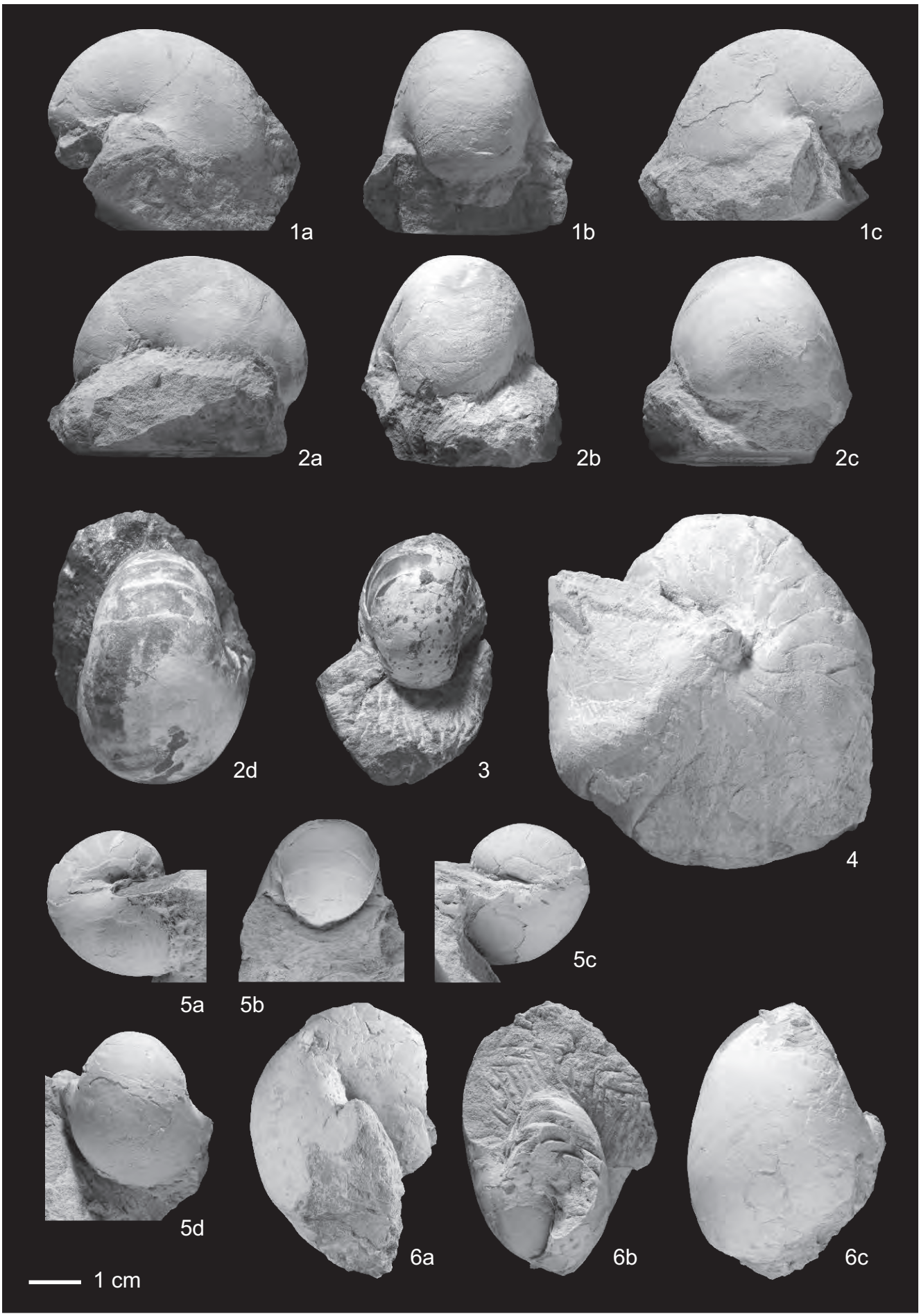

1a
1b
1c
2a
2b
2c
2d
3
4
5a
5b
5c
5d
6a
6b
6c
1 cm

Plate 5

Figs. 1a–c: *Eutrephoceras montiscastoris* spec. nov.; NHMW 1990/0029/0515a; the holotype; from Finstergrabenwandl.

Figs. 2a–b: *Eutrephoceras montiscastoris* spec. nov.; SK/SG/2007/49; paratype; from the Schattaugraben section.

Figs. 3a–d: *Eutrephoceras montiscastoris* spec. nov.; SK/1978/23; paratype; from Finstergrabenwandl.

All figures are 90 % of natural size. All specimens are coated with ammonium chloride and from the upper Santonian Hochmoos Formation of the Gosau Group.

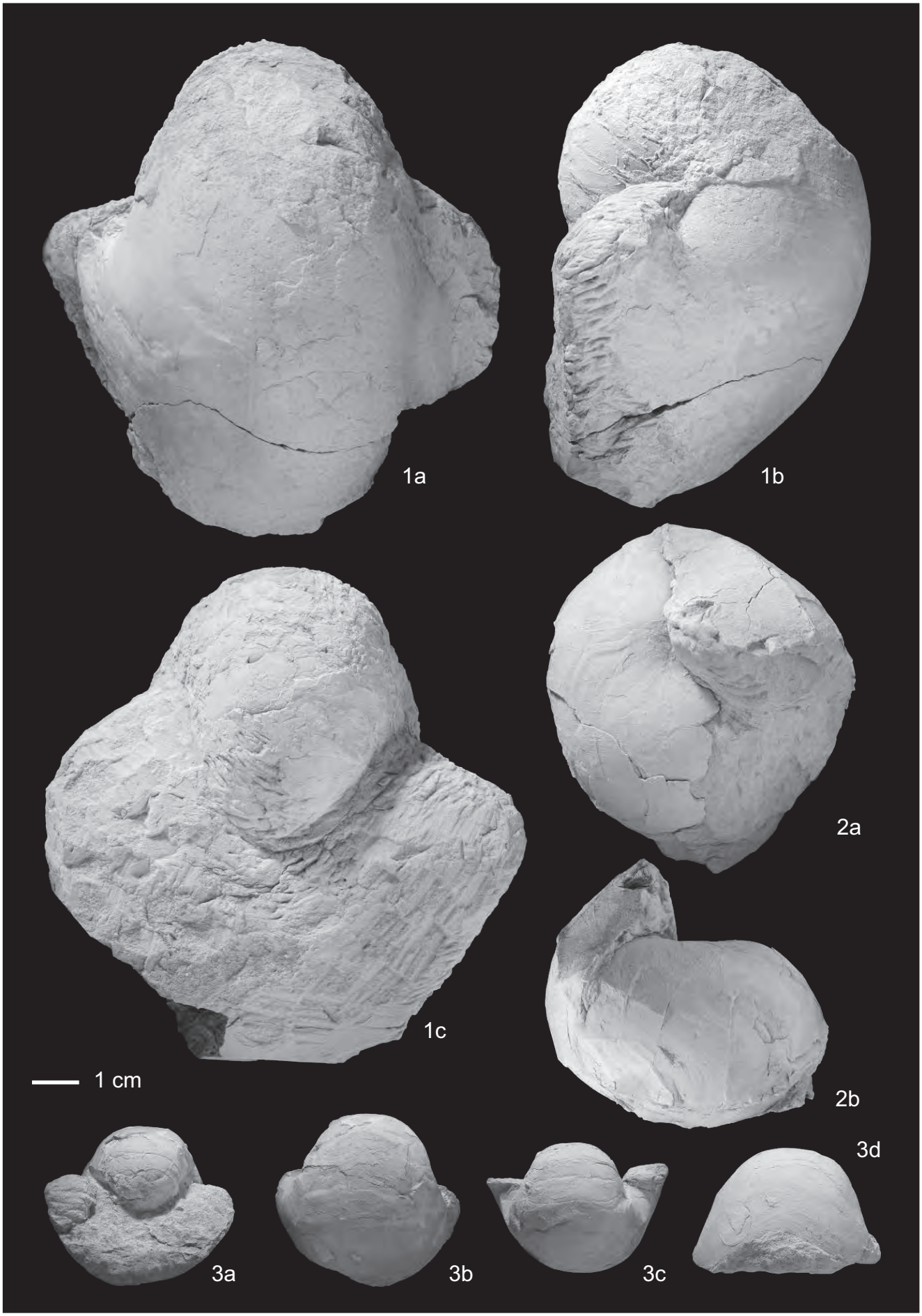

1a
1b
1c
2a
2b
1 cm
3a
3b
3c
3d

Plate 6

Figs. 1a–c: *Cimomia gosavica* (REDTENBACHER, 1873); NHMW 2009z0045/0002; from the Schattaugraben section.

Figs. 2a–d: *Cimomia gosavica* (REDTENBACHER, 1873); GBA 1873/0001/0003; the holotype of *Nautilus gosavicus* (REDTENBACHER, 1873: 96, Pl. 22, Fig. 2); from the Santonian Gosau Group of Neffgraben, Rußbach, Salzburg.

Fig. 3: *Cimomia gosavica* (REDTENBACHER, 1873); NHMW 1990/0029/0520; from the late Santonian Sandkalkbank Member of the Hochmoos Formation (Finstergrabenwandl, Gosau, Upper Austria).

All figures are 85 % of natural size. Figs. 2a–d and 3 are coated with ammonium chloride.

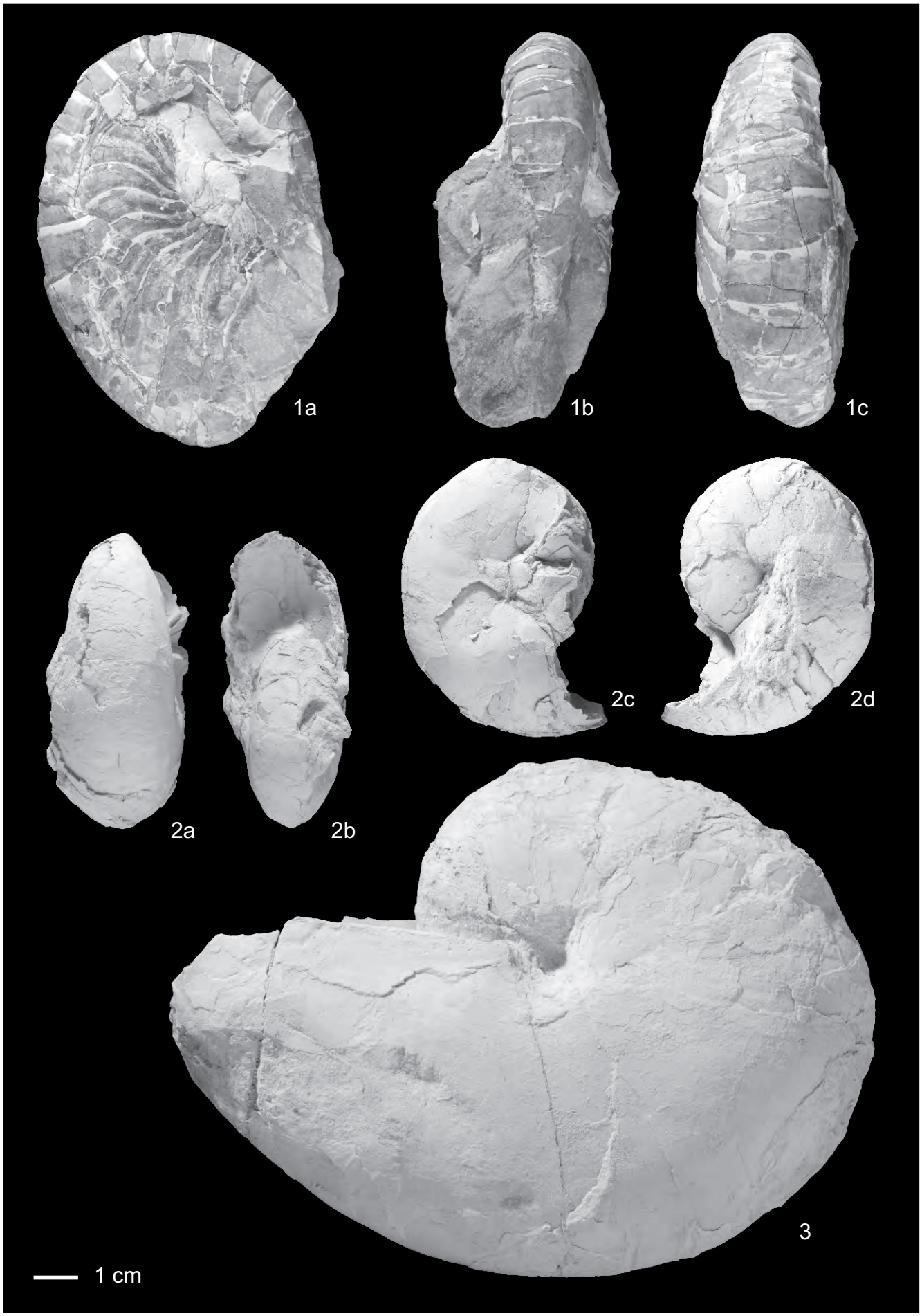

1a
1b
1c
2a
2b
2c
2d
3
1 cm

Plate 7

Figs. 1a–b: *Cimomia gosavica* (REDTENBACHER, 1873); NHMW 1990/0029/0514.

All figures are natural size. All specimens are coated with ammonium chloride and from the Upper Santonian of the Sandkalkbank Member of the Hochmoos Formation (Finstergrabenwandl, Gosau, Upper Austria).


1a
1b
1 cm

Plate 8

Figs. 1a–b: *Anagaudryceras redtenbacheri* (IMMEL, KLINGER & WIEDMANN, 1982); SK/SG/2003/38.

Figs. 2a–c: *Hauericeras* (*Gardeniceras*) *lagarum* (REDTENBACHER, 1873); NHMW 1978/1955/0001; from the Schattaugraben.

Fig. 3: *Hauericeras* (*Gardeniceras*) *lagarum* (REDTENBACHER, 1873); SK/SG/1984/3; from the *Micraster* Bed.

Figs. 4a–b: *Parapuzosia* (*Parapuzosia*) *corbarica* (DE GROSSOUVRE, 1894); NHMW 1978/1955/0003.

Fig. 5: *Pachydiscus* sp. indet. juv.; NHMW 2010/0081/0002; from the *Micraster* Bed.

Fig. 6: *Damesites* cf. *sugata* (FORBES, 1846); SK/SG/1992/15; from the Schattaugraben section (probably from the Sandkalkbank Member).

Figs. 7a–b: *Eupachydiscus isculensis* (REDTENBACHER, 1873); SK/SG/1990/4; from the *Micraster* Bed.

Figs. 8a–b: *Nowakites draschei* (REDTENBACHER, 1873); OÖLM 1938/30; the holotype of REDTENBACHER (1873: Pl. 30, Figs. 1a–b).

Fig. 9: *Nowakites savini* (DE GROSSOUVRE, 1894); NHMW 2010/0081/0001; from the *Micraster* Bed.

All figures are natural size and coated with ammonium chloride. All but Fig. 8 are from the *Paraplanum*-Zone of the Schattaugraben section, Fig. 8 is from the Santonian of Neffgraben west of Schattaugraben, Rußbach, Salzburg.

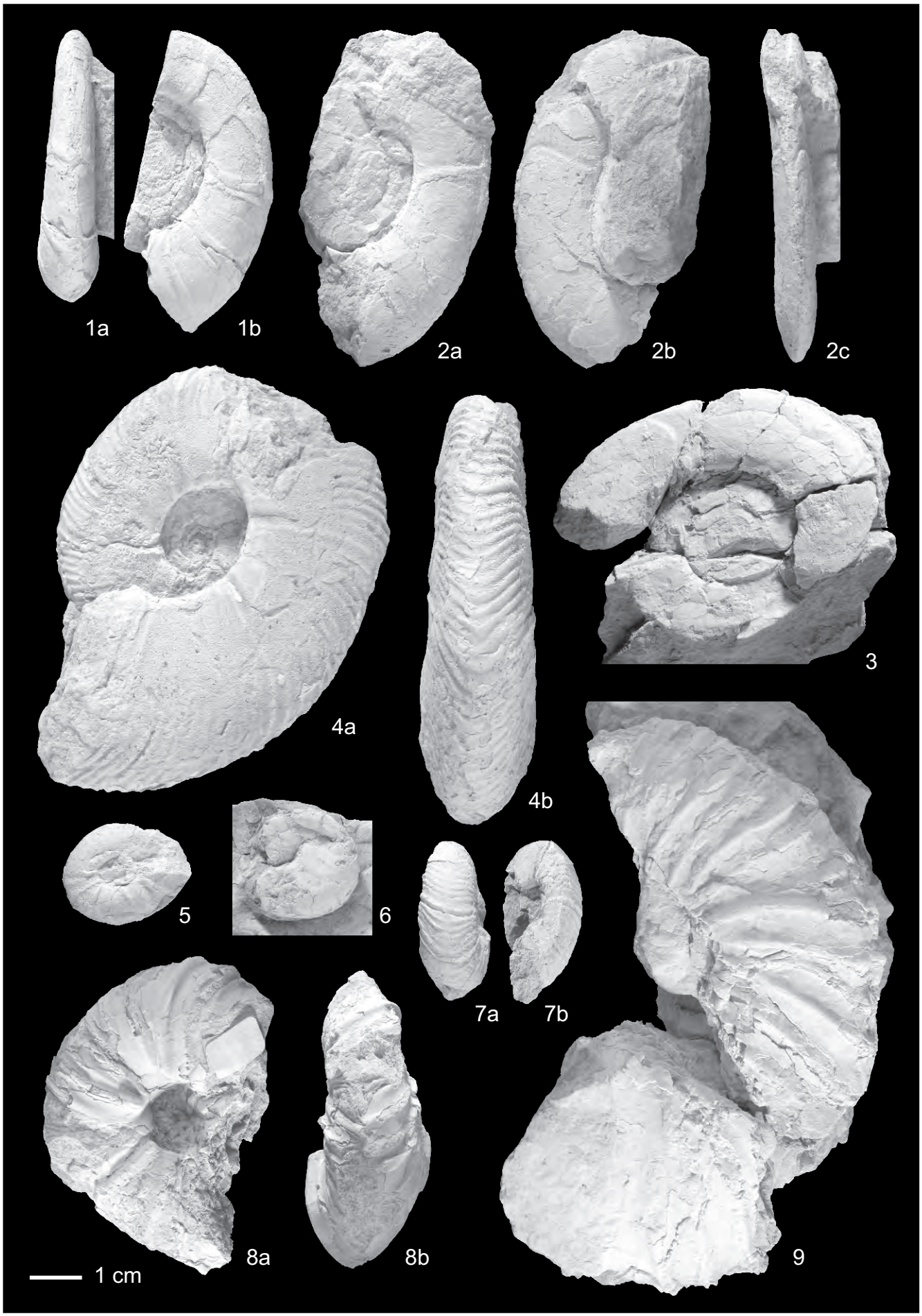

1a
1b
2a
2b
2c
3
4a
4b
5
6
7a
7b
8a
8b
9
1 cm

Plate 9

Fig. 1: *Texasia dentatocarinata* (F. ROEMER, 1852); NHMW 1998z0013/0001.

Figs. 2a–b: *Placenticeras maherndli* SUMMESBERGER, 1979; SK/SG/1981/1; probably from the Sandkalkbank Member.

Fig. 3: *Placenticeras polyopsis* (DUJARDIN, 1837), juv.; SK/SG/2002/35; probably from the Sandkalkbank Member.

Fig. 4: *Placenticeras polyopsis* (DUJARDIN, 1837), juv.; SK/SG/1998/30; probably from the Sandkalkbank Member.

Figs. 5a–c: *Placenticeras paraplanum* WIEDMANN, 1978; CG, 1978/01; the holotype of WIEDMANN (1978, Pl. 1, Figs. 3, 4).

Figs. 6a–b: *Placenticeras polyopsis* (DUJARDIN, 1837); CG, 1978/02; the original of *Stantonoceras depressum* (HYATT) of WIEDMANN (1978: Pl. 1 Figs. 1, 2).

Figs. 7a–b: *Hauericeras* (*Gardeniceras*) *lagarum* (REDTENBACHER, 1873); the lectotype; HNS 6391 from the Coniacian of Glanegg.

All figures are 80 % natural size and coated with ammonium chloride. All are from the *Paraplanum* Zone. Figs. 2–6 are from the Sandkalkbank Member, Figs. 1–4 are from the Schatttaugraben, from above the *Micraster* Bed, Figs. 5–6 are from the Finstergrabenwandl.

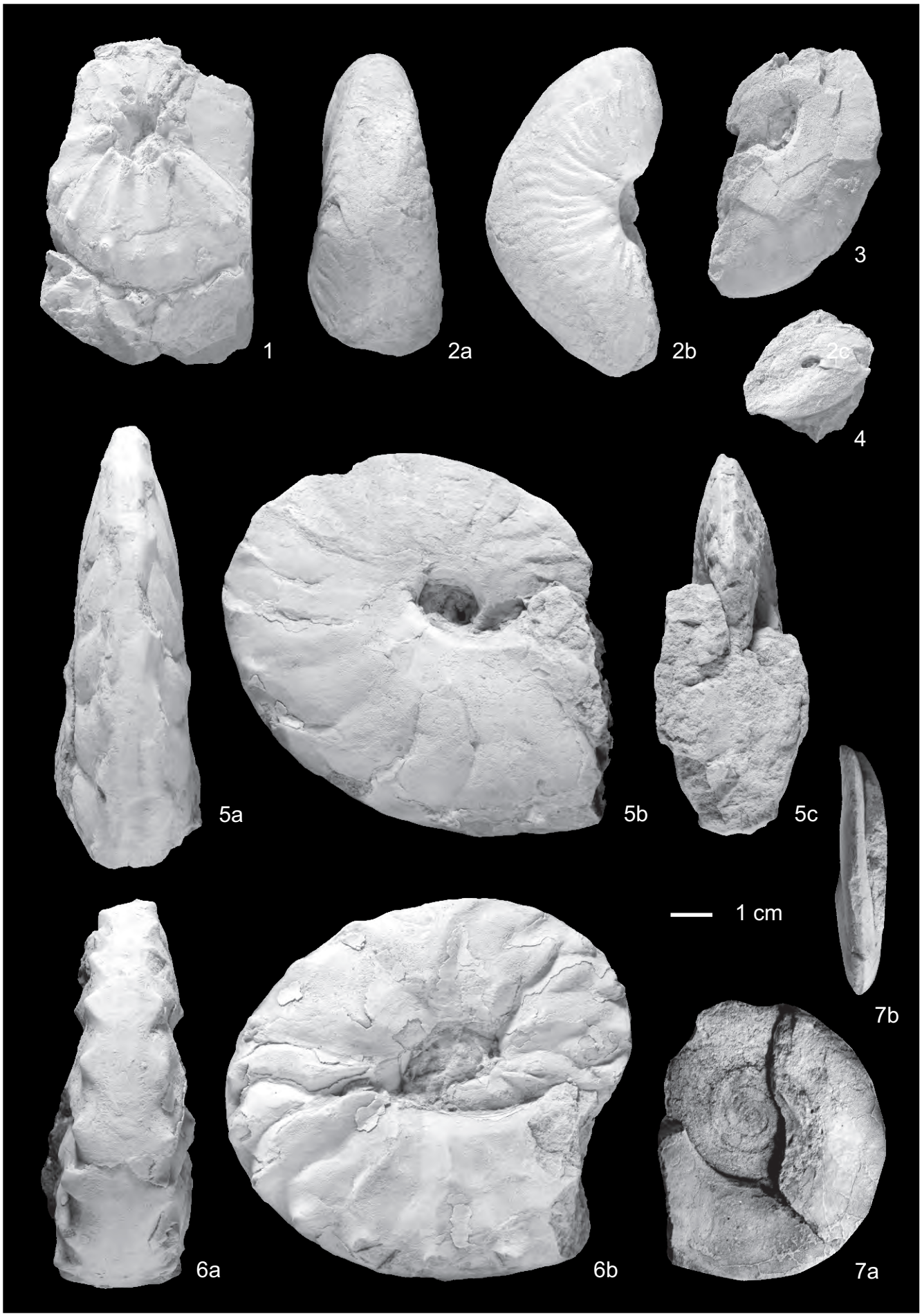

1
2a
2b
3
2c
4
5a
5b
5c
1 cm
7b
6a
6b
7a

Plate 10

Fig. 1: *Placenticeras polyopsis* (DUJARDIN, 1837); SK/SG/1998/29.

Fig. 2: *Eulophoceras jacobi* (HOURCQ, 1949); SK/SG/1998/31.

Fig. 3: *Eulophoceras jacobi* (HOURCQ, 1949), juv.; SK/SG/2007/44.

Fig. 4: *Eulophoceras jacobi* (HOURCQ, 1949), juv.; SK/SG/2007/45.

Fig. 5: *Eulophoceras jacobi* (HOURCQ, 1949), juv.; SK/SG/2002/32.

Figs. 6a–b: *Placenticeras polyopsis* (DUJARDIN, 1837); MA 1976/19.

Figs. 7a–b: *Reginaites gappi* WIEDMANN, 1978; NHMW 1990/0029/0526.

Figs. 8a–b: *Reginaites gappi* WIEDMANN, 1978; the holotype; CG 03.

All figures are 75 % natural size, except Figs. 3–5, which are 150 % natural size. All are coated with ammonium chloride. Figs. 1–6 are from the Schattaugraben section, Figs. 1, 6a–b are from the Sandkalkbank Member, Figs. 2–5 are from the *Micraster* Bed, Figs. 7–8 are from the Sandkalkbank Member of the Finstergrabenwandl site. Scale bar labelled “1 cm” is valid for Figs. 1–2 and 6–8. Scale bars of Figs. 3–4 equal 5 mm.

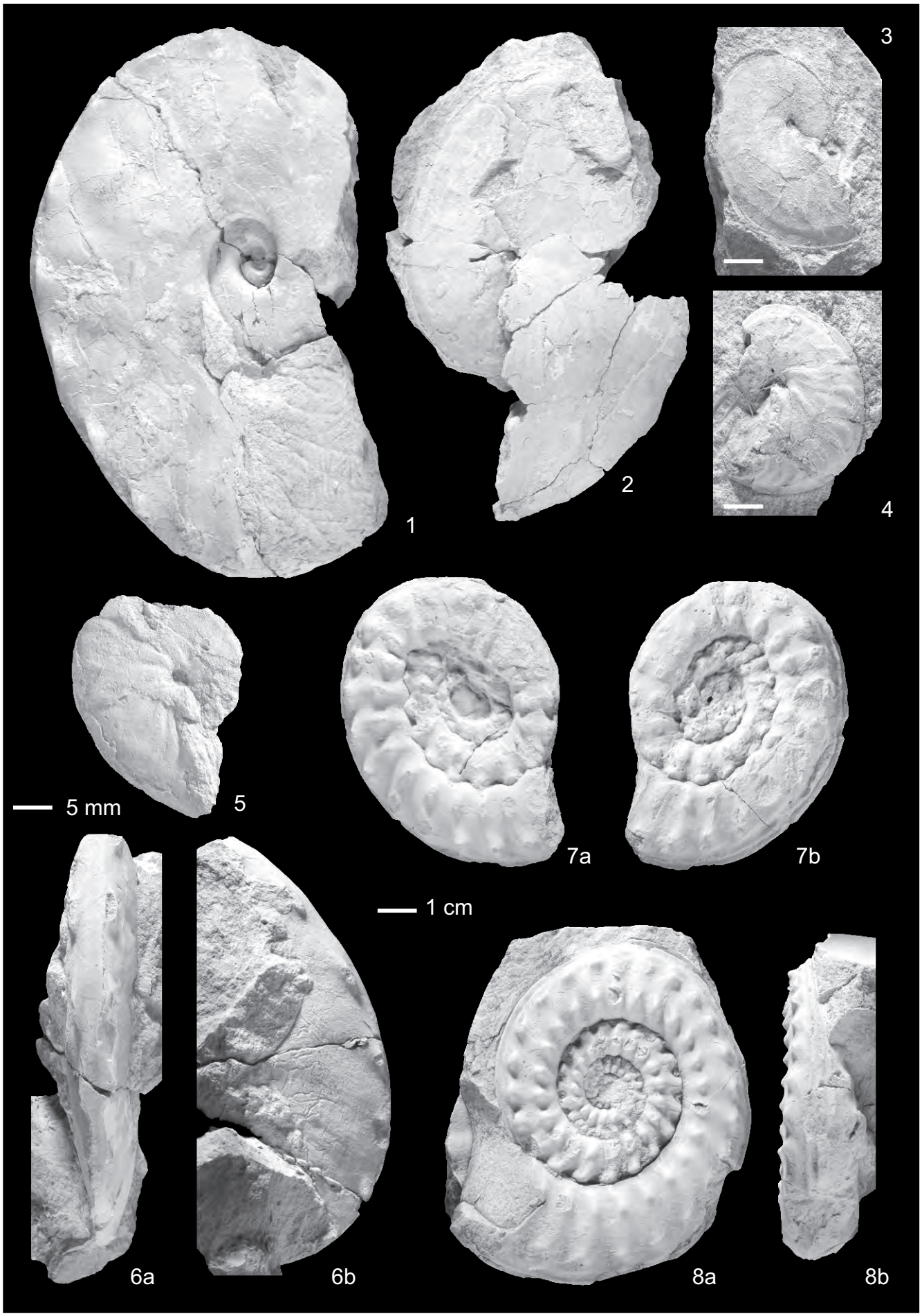

1
2
3
4
5
5 mm
7a
7b
1 cm
6a
6b
8a
8b

Plate 11

Figs. 1–11: *Amapondella amapondensis* (VAN HOEPEN, 1921); 1a–b: SK 2000/1; 2: MA 1976/12; 3: SK/SG/2003/37; 4: MA 1976/13; 5: NHMW 2010/0081/0003; 6: SK/SG/1992/14; 7: SK/SG/2003/36; 8: NHMW 1978/1963/0028, the original of SUMMESBERGER (1979: Pl. 3, Figs. 22, 23); 9: SK/SG/2005/39; 10a–b: SK/SG/1996/24; 11: SK/SG/1996/23.

Fig. 1 (SK 2000/1) is from the forest road at the Tauerngraben below the Finstergrabenwandl, Figs. 2–7 are from the Sandkalkbank Member in the Schattaugraben section, Fig. 8 is from the Sandkalkbank Member exposed at the Finstergrabenwandl, Figs. 9–11 are from the *Micraster* Bed in the Schattaugraben section.
All specimens coated with ammonium chloride. 1 cm-scale bar valid for Figs. 1–9 (natural size), 5 mm-scale-bar valid for Figs. 10–11 (200 %).

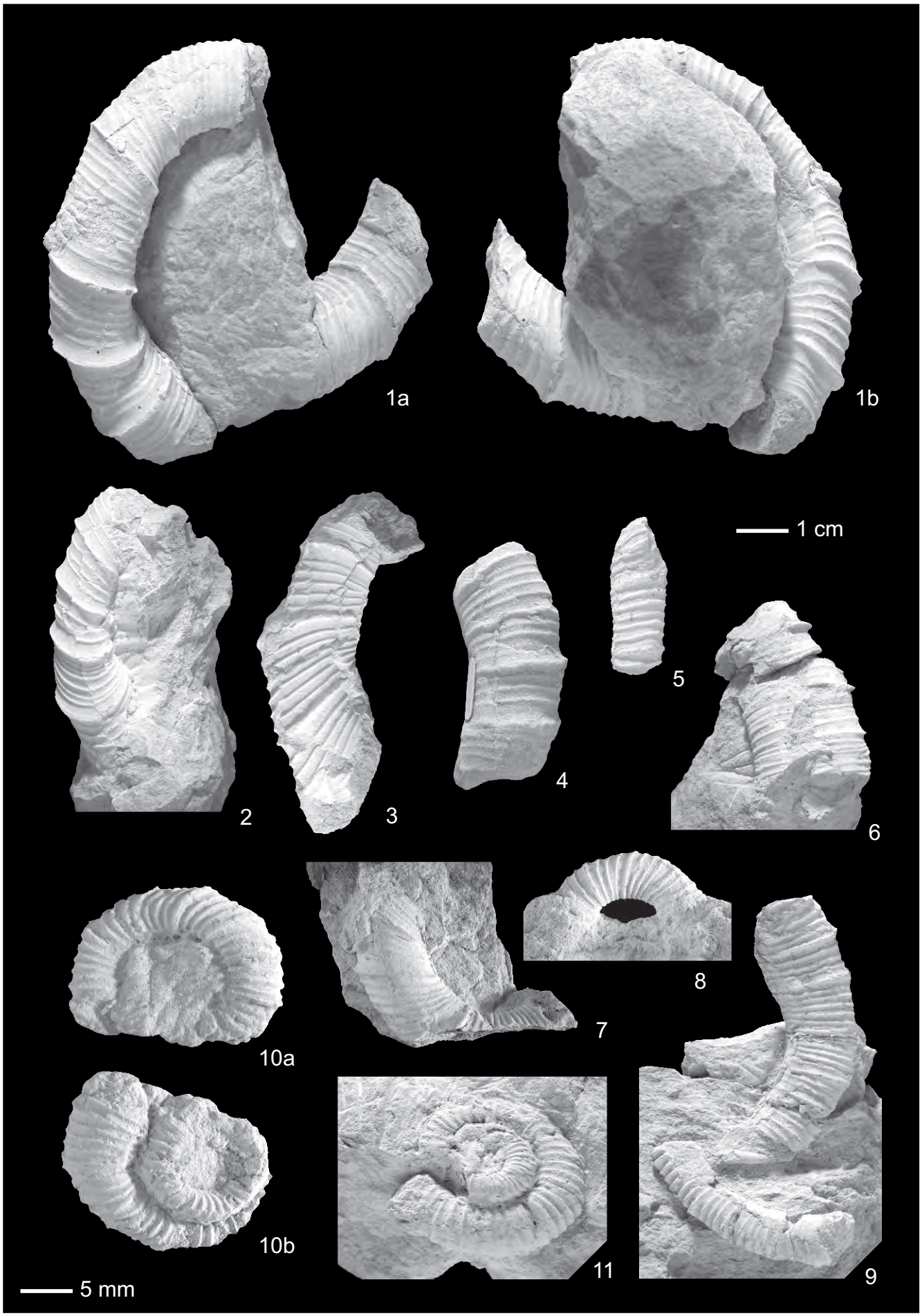

1a
1b
1 cm
2
3
4
5
6
7
8
9
10a
10b
11
5 mm

Plate 12

Figs. 1a–b: *Glyptoxoceras souqueti* COLLIGNON, 1983; SK/SG/2007/47; from the *Micraster* Bed in the Schattaugraben section.

Fig. 2: *Scalarites serta* (MÜLLER & WOLLEMANN, 1906); SK/SG/1981/2; from the *Micraster* Bed in the Schattaugraben section.

Fig. 3: Nostoceratidae gen. et sp. indet.; NHMW 1978/1963/0027; from the Finstergrabenwandl (Sandkalkbank Member), figured in SUMMESBERGER (1979: Pl. 3, Fig. 20).

Figs. 4–5: *Polyptychoceras* sp. indet.; 4: MA1976/14, 5: MA1976/15; both from the Schattaugraben section (Sandkalkbank Member).

Figs. 6–13: *Glyptoxoceras crispatum* (MOBERG, 1885); 6: SK/SG/1992/11; 7: NHMW 2011/0054/0006; 8: SK/SG/1996/22; 9: SK/SG/2006/41; 10: NHMW 1978/1963/0029, figured in SUMMESBERGER (1979: Pl. 3, Fig. 21); 11a, b: SK/SG/1996/18; 12: SK/SG/1996/20; 13: SK/SG/2002/33.

Figs. 6, 9, 11, 13 are from the Sandkalkbank Member of the Schattaugraben section, Fig. 10 is from the Sandkalkbank Member of the Finstergrabenwandl, Fig. 7 is from the Hochmoos Formation of Gosauschmied, Figs. 8 and 12 are from the *Micraster* Bed.
All specimens coated with ammonium chloride. 10 mm-scale bar valid for Figs. 1–2, 6–8, 12 (150 %), 5 mm-scale bar (200 %) valid for Figs. 3–5, 1-cm-scale bar valid for Figs. 9–11, 13 (natural size).

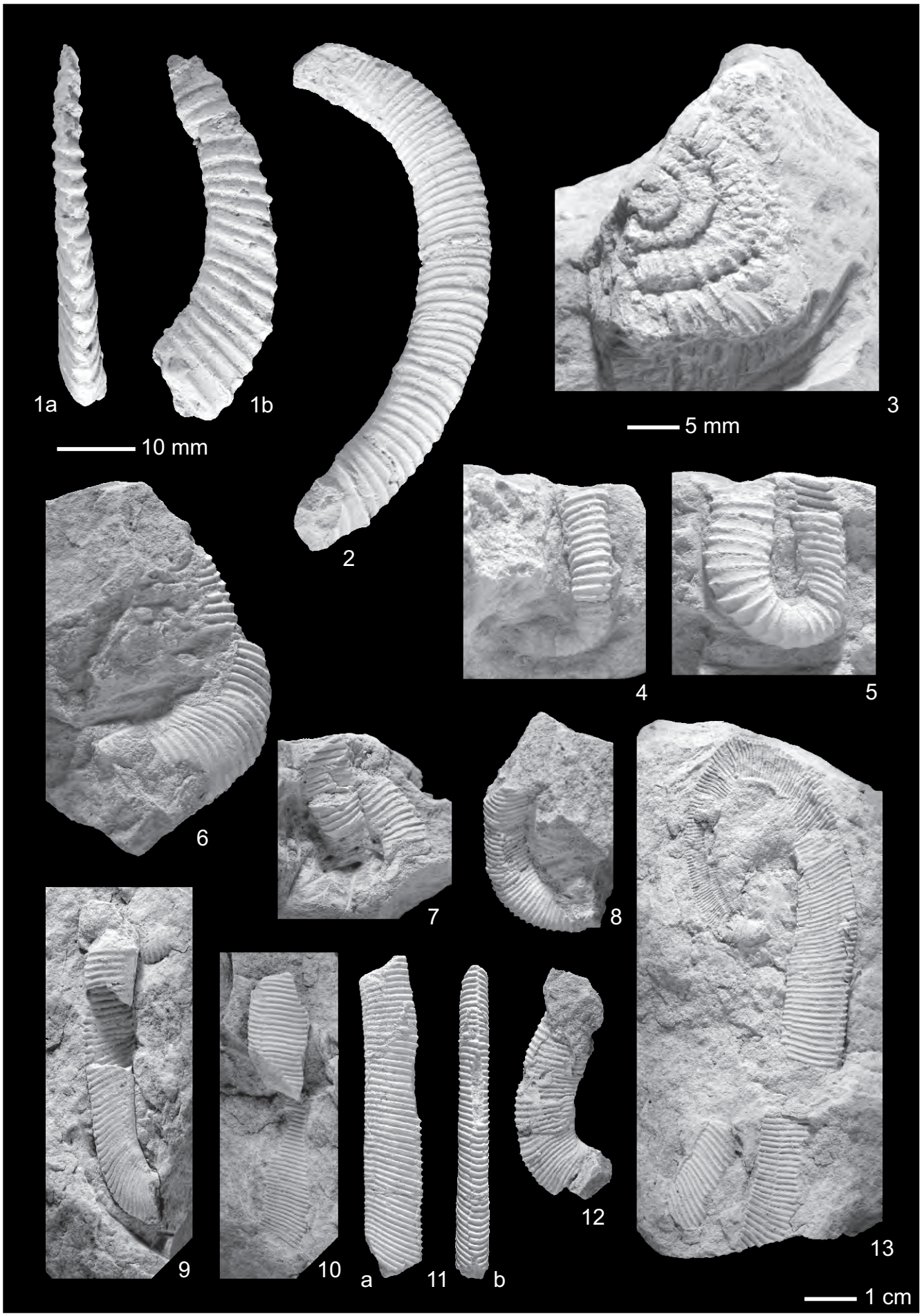

1a
1b
10 mm
2
3
5 mm
4
5
6
7
8
9
10
a
11
b
12
13
1 cm

Plate 13

Figs. 1a–b: *Glyptoxoceras* group 1; MA 1976/16.

Figs. 2a–b: *Glyptoxoceras* group 4; NHMW 2006z0203/0006; from the *Micraster* Bed (Schattaugraben section).

Figs. 3–9: *Glyptoxoceras* group 2; 3: NHMW 2006z0203/0005; 4: NHMW 2011/0054/0005; 5: NHMW 2011/0054/0004; 6: SK/SG/2007/48; 7a–b: NHMW 2006z0203/0004; 8: SK/SG/2006/40; 9: SK/SG/1998/27, initial coil.

Figs. 10–15: *Glyptoxoceras* group 3; 10: NHMW 2011/0153/0001; 11: SK/SG/2002/34; 12: SK/SG/1992/16; 13: NHMW 2011/0054/0002; 14: SK/SG/2006/42; 15: SK/SG/1994/17.

Figs. 1a–b, 6, 15 are from the Sandkalkbank Member of the Schattaugraben section, Figs. 5 and 8 are from the Hochmoos Formation of the Schattaugraben, Figs. 3, 4 and 10 are from the Hochmoos Formation of Gosauschmied, Figs. 2a–b, 7a–b, 9, 11–15 are from the *Micraster* Bed.
All specimens coated with ammonium chloride. All are enlarged x 1,5.

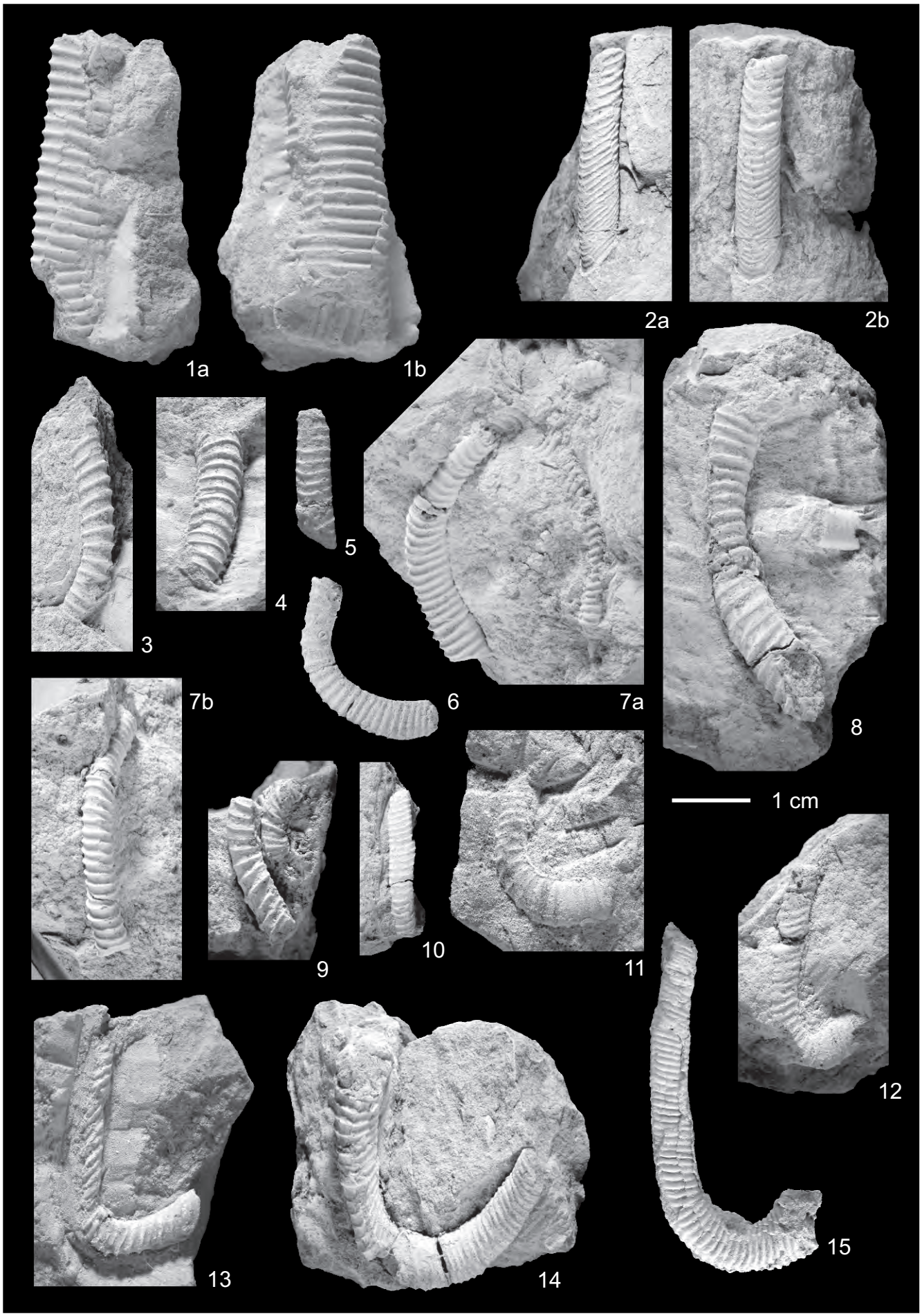

1a
1b
2a
2b
3
4
5
6
7a
7b
8
1 cm
9
10
11
12
13
14
15

Plate 14

Figs. 1–6: *Glyptoxoceras* group 3; 1: SK/SG/1992/13; 2: NHMW 2006z0203/0001; 3: SK/SG2009/50; 4: NHMW 2006z0203/0007; 5: SK/SG/2006/43; 6: NHMW 2006z0203/0002.

Figs. 7a–b: *Schlueterella* sp. indet. 1; MA 1976/17.

Fig. 8: *Schlueterella* sp. indet. 2; SK/SG/1992/12.

Figs. 1–6 are from the *Micraster* Bed (Schattaugraben section), Figs. 7a–b and 8 are from the Hochmoos Formation of the Schattaugraben section.
All specimens coated with ammonium chloride. All specimens are enlarged x 1.5.

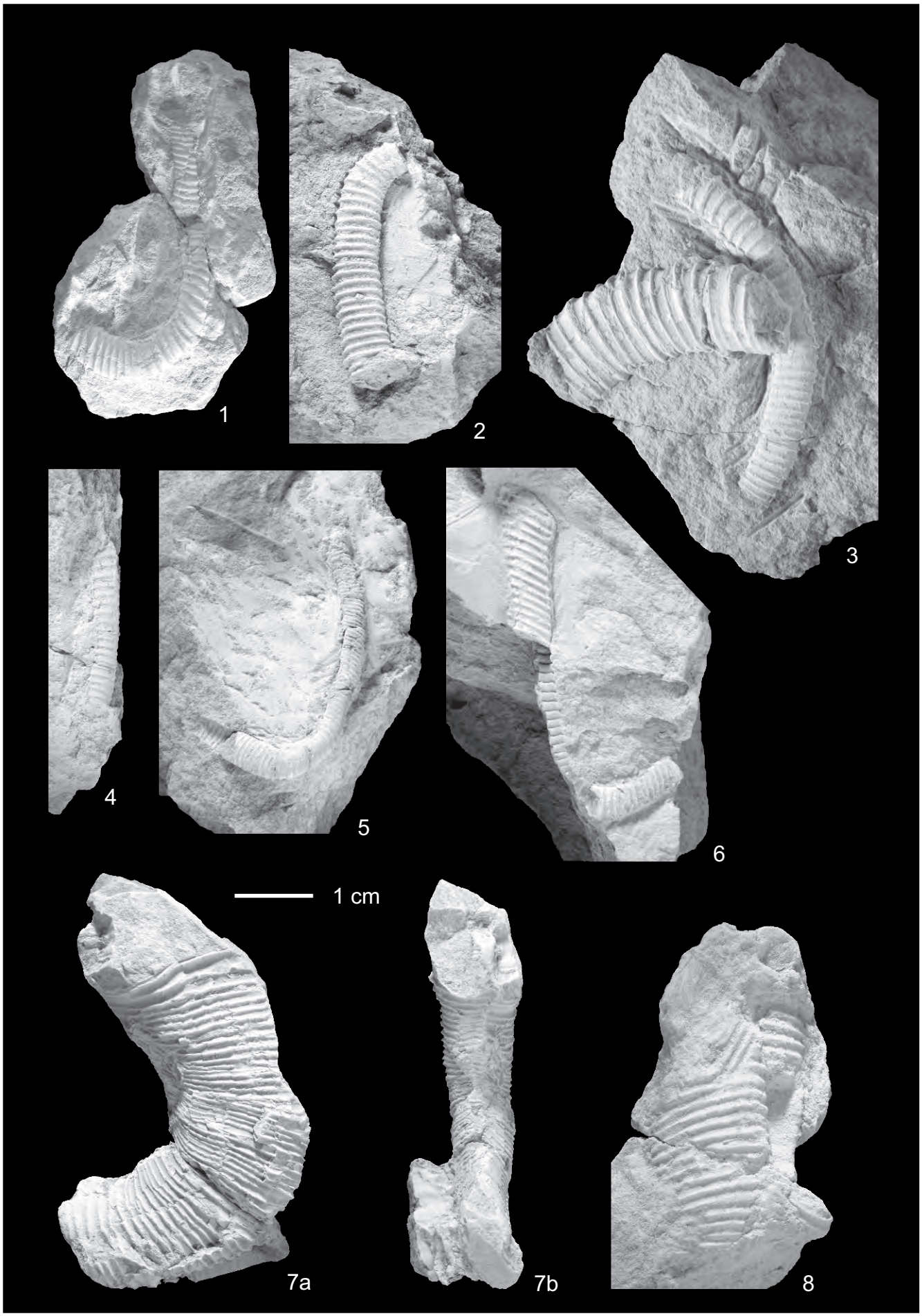

1
2
3
4
5
6
1 cm
7a
7b
8

Plate 15

Figs. 1–3: *Baculites* sp. indet. 1; 1: NHMW 2006z0203/0007; 2: NHMW 2006z0203/0008; 3: SK/SG/1990/5; all are from the *Micraster* Bed (Schattaugraben section).

Figs. 4a–c: *Baculites fuchsi* REDTENBACHER, 1873 (Pl. 30, Fig. 15); NHMW 1865/0001/0138; the holotype; from the lower to middle Santonian of the Tiefengraben (= Grabenbach, Gosau, Upper Austria).

All specimens coated with ammonium chloride. All specimens are enlarged x 1.5.

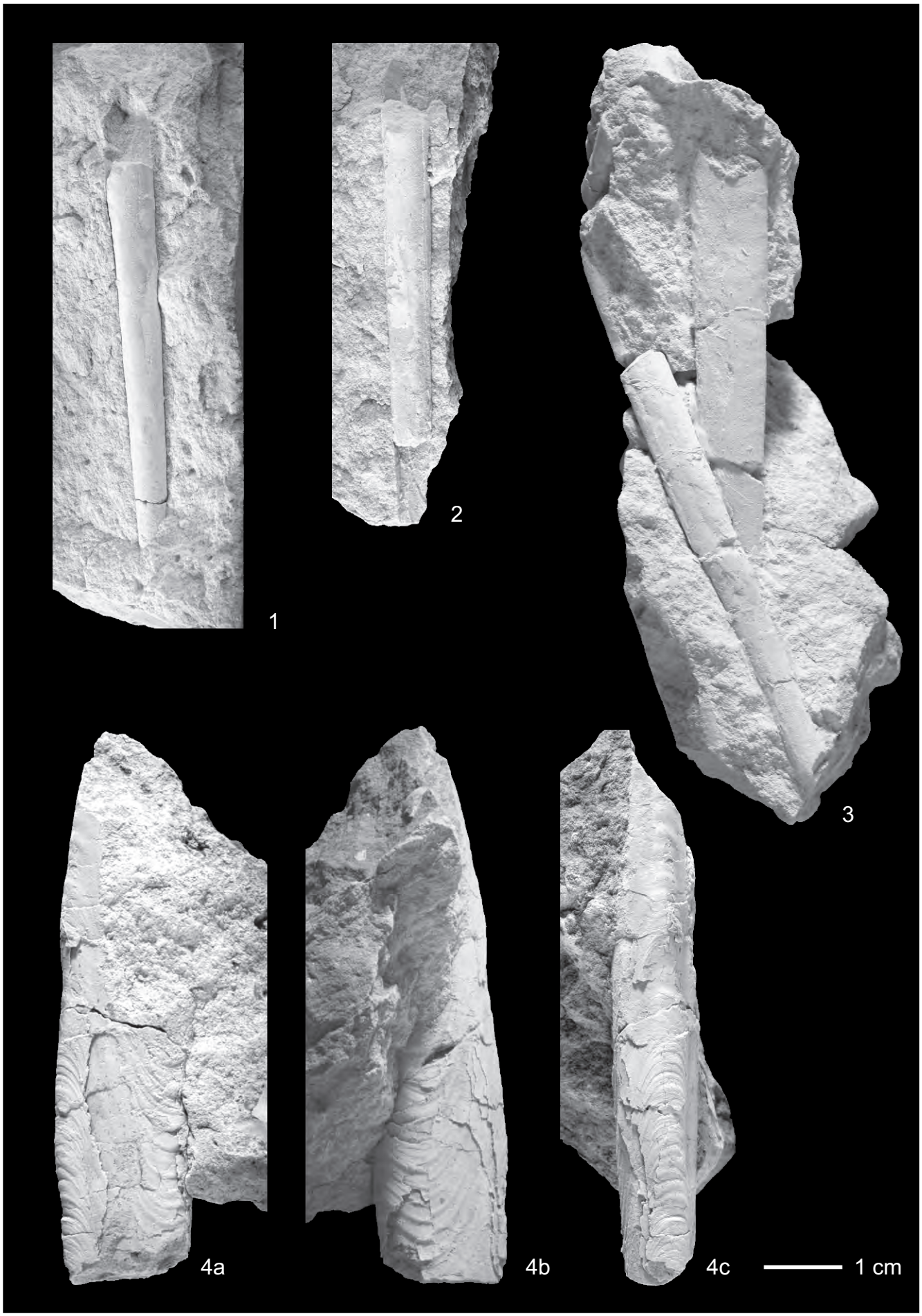

1
2
3
4a
4b
4c
1 cm

Plate 16

Figs. 1–3: *Baculites sulcatus* Baily, 1855; 1a–b: SK/SG/1998/26; 2: SK/SG/1990/7; 3: SK/SG/1996/21.

Figs. 4–6: *Boehmoceras krekeleri* (Wegner, 1905); 4a–d: SK/SG/1998/28; 5: NHMW 2011/0054/0008 (ex Skoumal collection); 6: SK/SG/1996/25.

Fig. 7: *Boehmoceras arculus* (Morton, 1834); NHMW 2010/0081/0009.

All specimens are from the Schattaugraben section. Figs. 4–6 are from the Sandkalkbank Member, Figs. 1, 3, 7 are from the *Micraster* Bed, Fig. 2 is from the Hochmoos Formation.
All specimens coated with ammonium chloride. 5 mm-scale bar valid for Figs. 1–3 (x 1,5), 1 cm-scale bar valid for Figs. 4–7 (natural size).


5 mm
1a
1b
2
3
4a
4b
4c
4d
5
6
7
1 cm

Plate 17

Fig. 1: *Spiroloculina fassistomata* GRZYBOWSKI, 97/16.

Figs. 2a–b: *Nummofallotia cretacea* (SCHLUMBERGER), 97/07.

Figs. 3a–b: *Quinqueloculina aspera* D´ORBIGNY (?), 97/07.

Fig. 4: *Dentalina communis* D´ORBIGNY, 06/02.

Fig. 5: *Pyramidulina* sp., 97/13.

Fig. 6: *Nodosaria* cf. *vertebralis* D´ORBIGNY, 97/13.

Figs. 7a–b: *Lenticulina secans* (REUSS), 06/04.

Figs. 8a–b: *Lenticulina secans* (REUSS), 06/04.

Figs. 9a–b: *Frondicularia angusta* (NILSSON), 97/16.

Figs. 10a–b: *Ramulina* sp., 06/04.

Fig. 11: *Neoflabellina laterecompressa* TOLLMANN, 06/10.

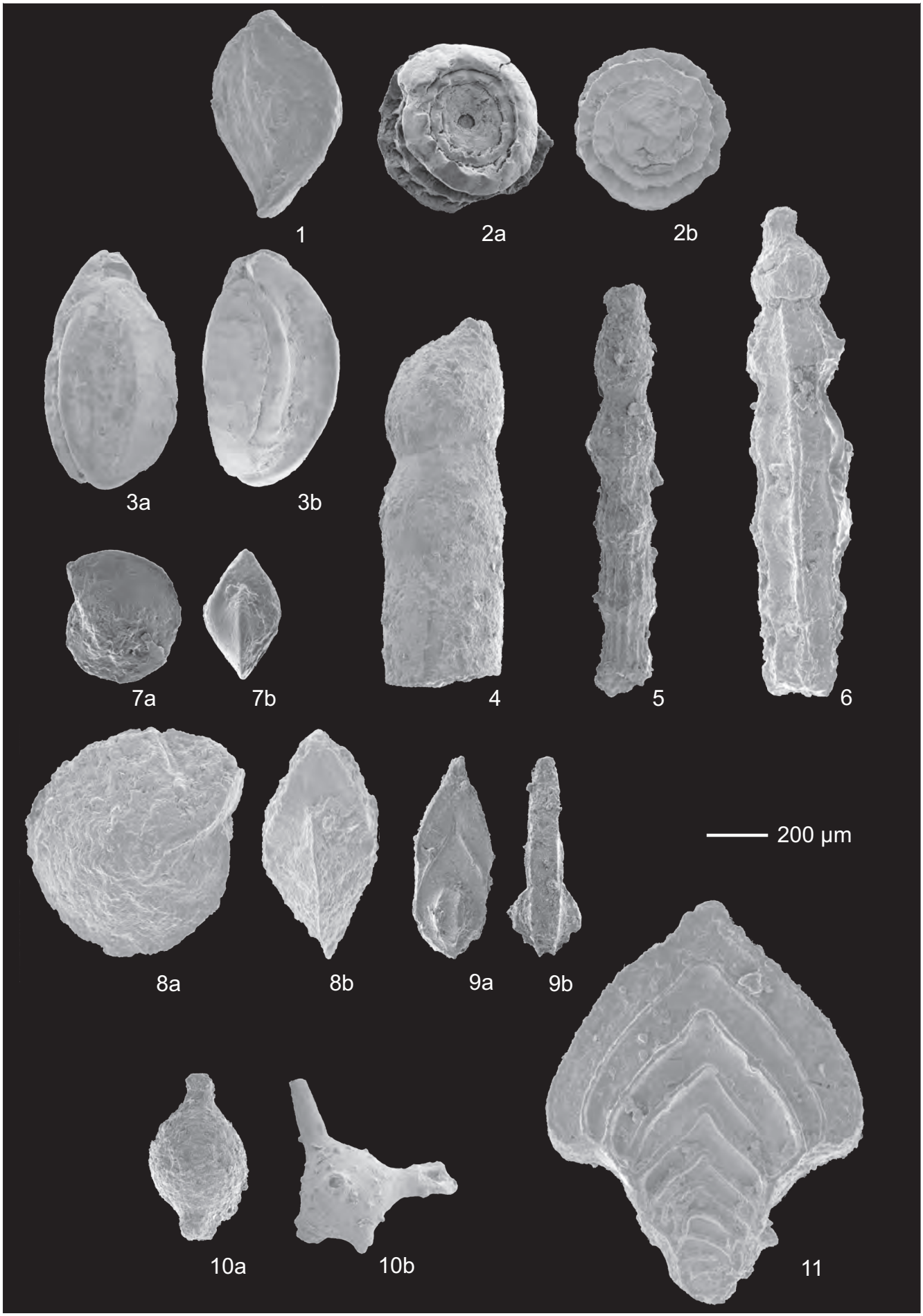

1
2a
2b
3a
3b
4
5
6
7a
7b
200 µm
8a
8b
9a
9b
10a
10b
11

Plate 18

Fig. 1: *Haplophragmium aequale* (ROEMER), 97/13.

Fig. 2: *Ammobaculites agglutinans* (D'ORBIGNY), 97/11.

Fig. 3: *Subreophax scalaris* (GRZYBOWSKI), 06/04.

Fig. 4: *Spiroplectammina praelonga* (REUSS), 06/04.

Fig. 5: *Gaudryina* cf. *reicheli* BARTENSTEIN, 97/13.

Fig. 6: *Dorothia bulletta* CARSEY.

Fig. 7: *Dorothia biformis* FINLAY.

Figs. 8, 9: *Dorothia oxycona* (REUSS), 06/04.

Fig. 10: *Dorothia trochus* (D'ORBIGNY).

Fig. 11: *Tritaxia tricarinata* (REUSS).

Fig. 12: *Tritaxia trilatera* (CUSHMAN).

Fig. 13: *Gaudryina pyramidata* CUSHMAN, 06/04.

Fig. 14: *Gaudryina* sp., 06/10.

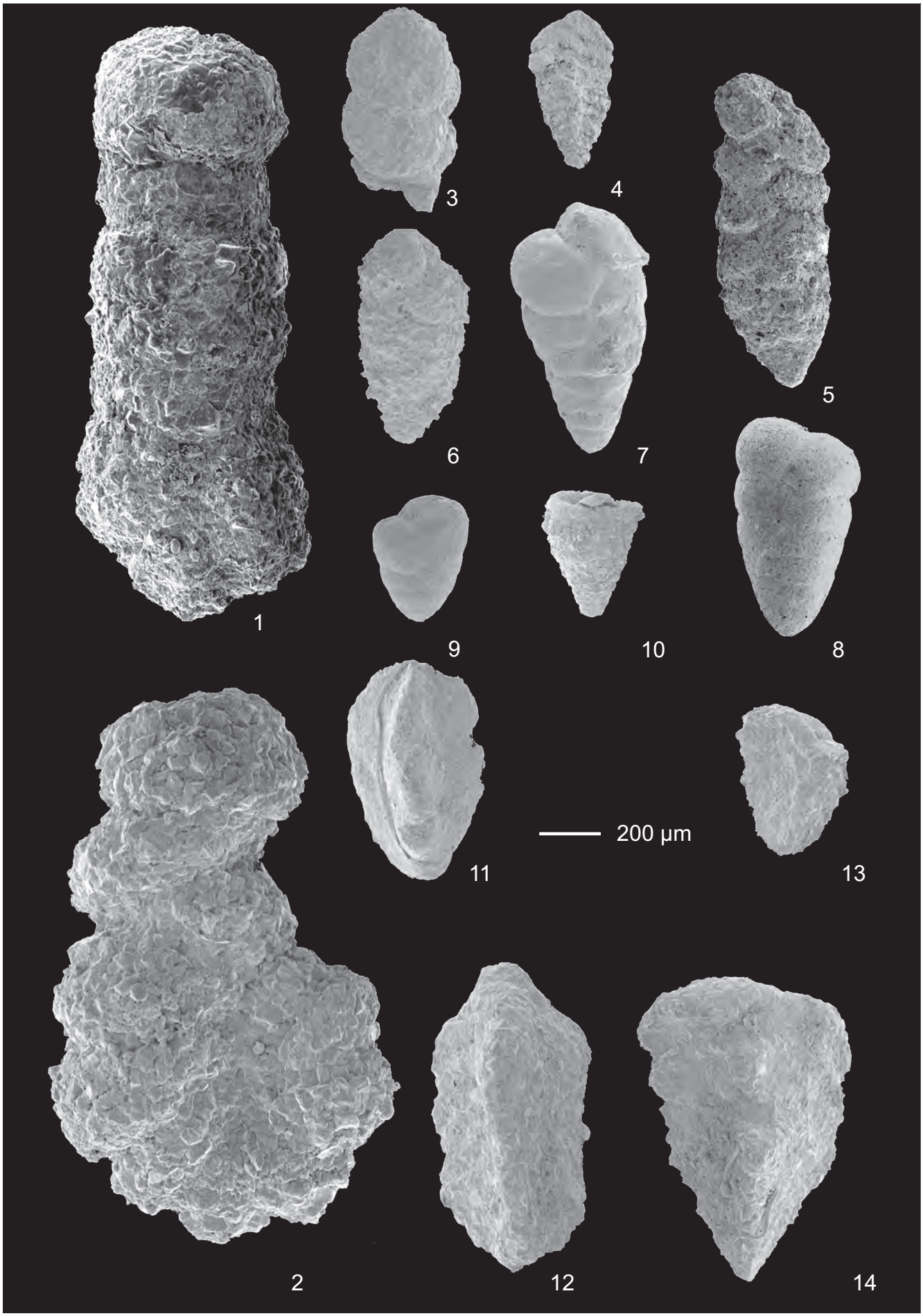

1
2
3
4
5
6
7
8
9
10
11
12
13
14
200 µm

Plate 19

Figs. 1a–c: *Epistomina* cf. c*olomi* DUBOURDIEU & SIGAL, 97/17.

Figs. 2a–b: *Osangularia* sp., 06/04.

Figs. 3a–c: *Hoeglundina* cf. *supracretacea* (TEN DAM), 97/11.

Figs. 4a–c: *Globorotalites michelinianus* (D'ORBIGNY), 06/05.

Figs. 5a–c: *Gavelinella lorneiana* (D'ORBIGNY), 06/04.

Figs. 6a–c: *Valvulineria lenticula* (REUSS), 06/10.

Figs. 7a–c: *Gavelinella stelligera* (MARIE) (?), 97/13.

Figs. 8a–b: *Stensioeina exsculpta* (REUSS), 06/06.

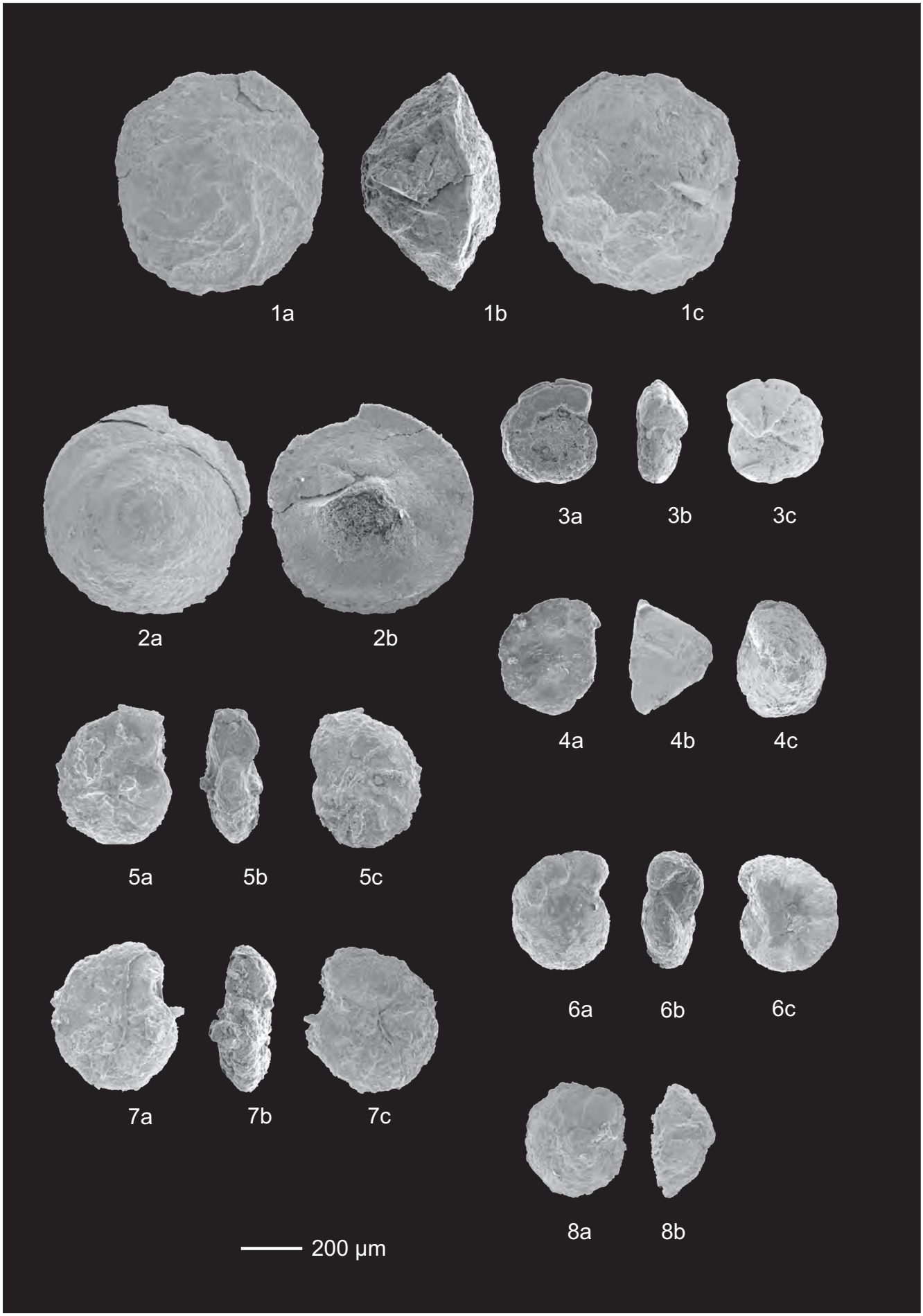

1a
1b
1c
2a
2b
3a
3b
3c
4a
4b
4c
5a
5b
5c
6a
6b
6c
7a
7b
7c
8a
8b
200 µm

Plate 20

Figs. 1a–c: *Dicarinella asymetrica* (SIGAL), 06/04.

Figs. 2a–c: *Dicarinella asymetrica* (SIGAL), 06/04.

Figs. 3a–b: *Sigalia decoratissima* (DE KLASZ), 06/10.

Fig. 4: *Ventilabrella eggeri* CUSHMAN, 06/10.

Figs. 5a–c: *Marginotruncana angusticarinata* (GANDOLFI), 06/04.

Figs. 6a–c: *Marginotruncana* sp., 97/16.

Figs. 7a–c: *Marginotruncana sinuosa* PORTHAULT, 06/04.

Figs. 8a–c: *Marginotruncana undulata* (LEHMANN), 06/04.

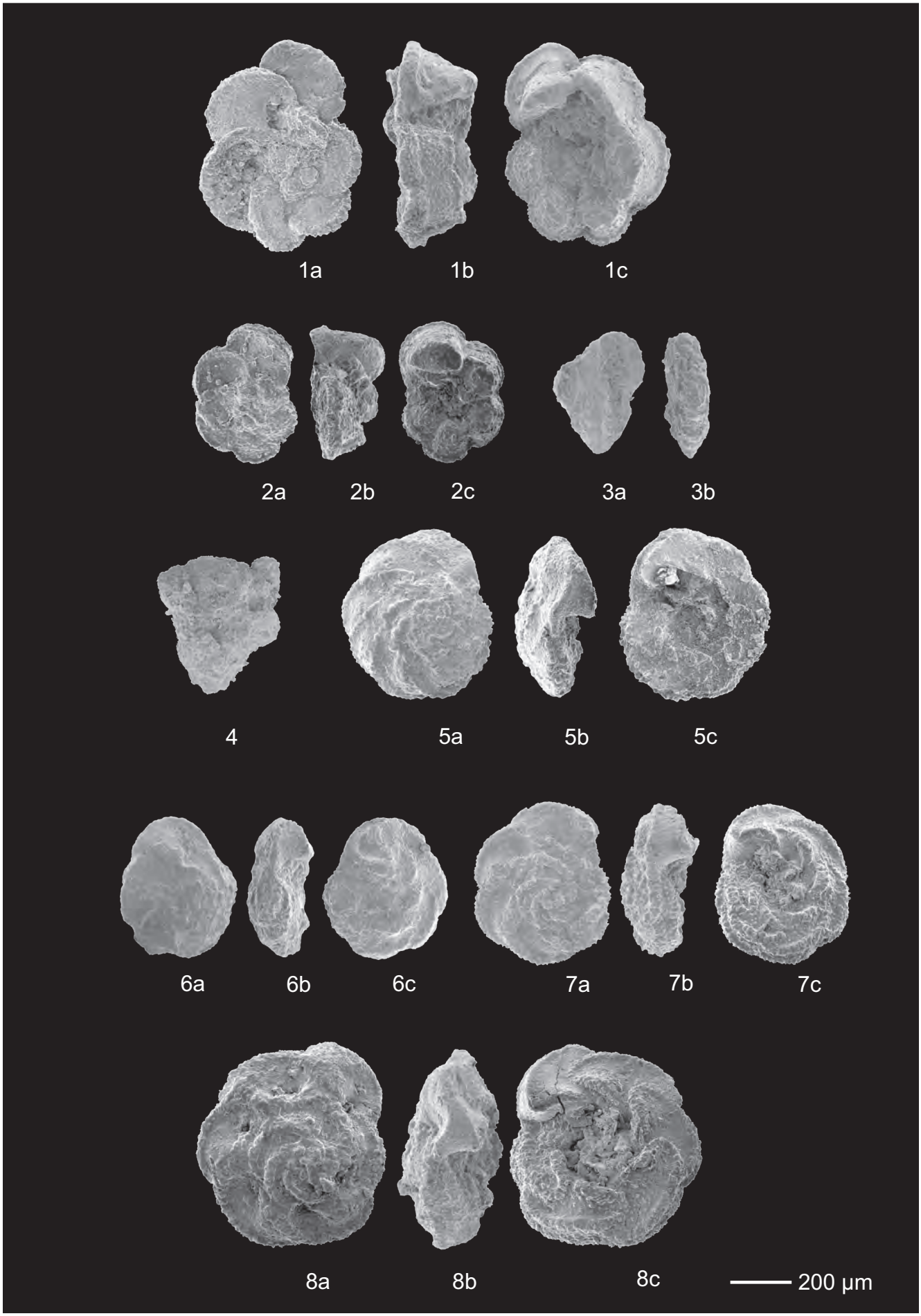

1a
1b
1c
2a
2b
2c
3a
3b
4
5a
5b
5c
6a
6b
6c
7a
7b
7c
8a
8b
8c
200 µm

Plate 21

Figs. 1a–c: *Globotruncana arca* (CUSHMAN), 97/16.

Figs. 2a–c: *Globotruncana bulloides* (VOGLER), 06/04.

Figs. 3a–c: *Globotruncana bulloides* (VOGLER), 06/04.

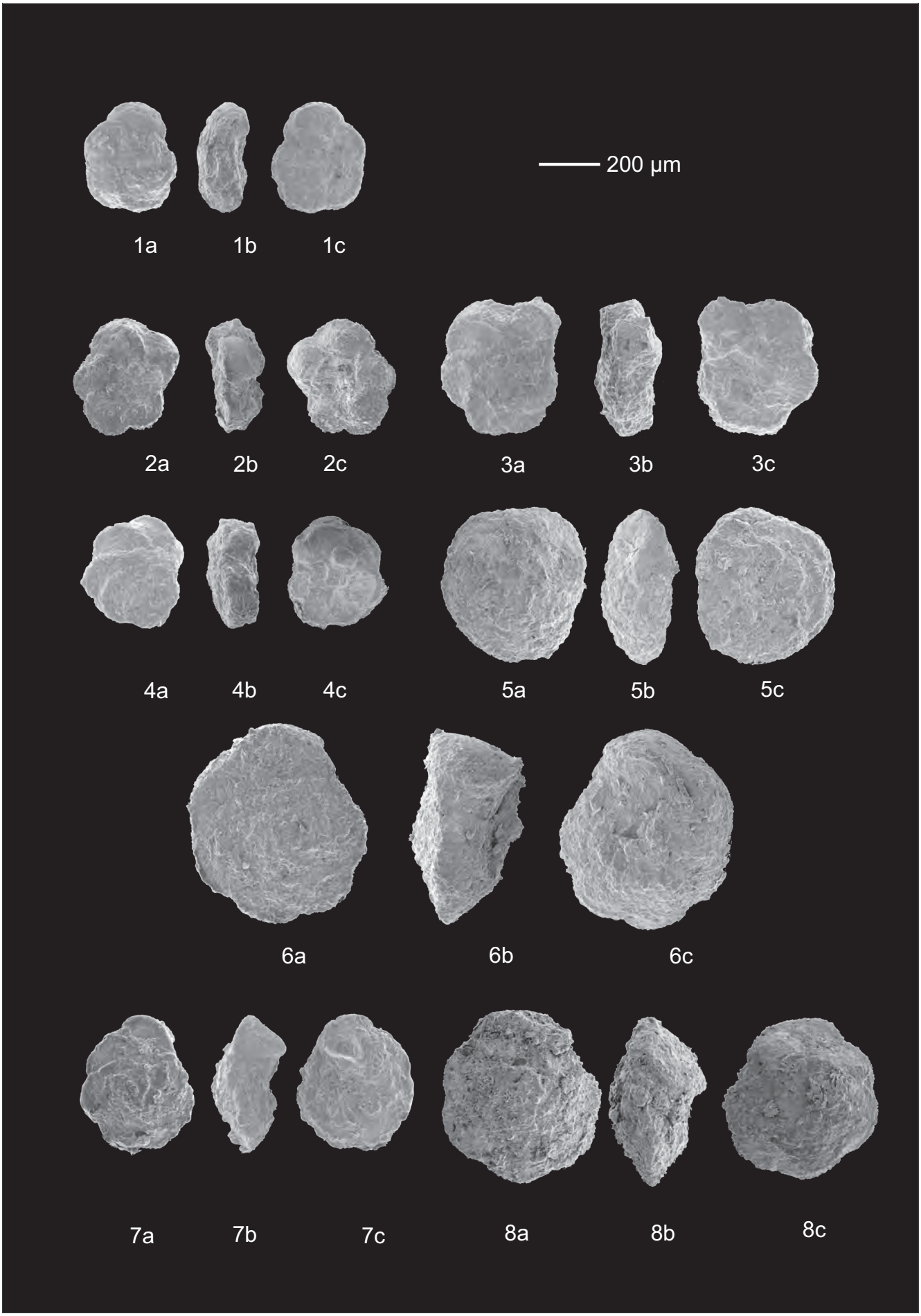
Figs. 4a–c: *Globotruncana linneiana* (D'ORBIGNY), 97/16.

Figs. 5a–c: *Contusotruncana morozovae* (VASILENKO), 06/06.

Figs. 6a–c: *Globotruncanita elevata* (BROTZEN), 06/06.

Figs. 7a–c: *Globotruncanita stuartiformis* (DALBIEZ), 97/16.

Figs. 8a–c: *Globotruncanita stuartiformis* (DALBIEZ), 97/16.


200 µm
1a
1b
1c
2a
2b
2c
3a
3b
3c
4a
4b
4c
5a
5b
5c
6a
6b
6c
7a
7b
7c
8a
8b
8c

Index

Zeitschrift/Journal: Abhandlungen der Geologischen Bundesanstalt in Wien

Jahr/Year: 2017

Band/Volume: 71

Autor(en)/Author(s): Summesberger Herbert, Kennedy William James, Wolfgring Eric, Wagreich Michael, Tröger Karl-Armin, Skoumal Peter

Artikel/Article: Integrated stratigraphy of the upper Santonian (Upper Cretaceous) Hochmoos and Bibereck Formations of the Schattaugraben section (Gosau Group; Northern Calcareous Alps, Austria) 151-248