New data on Early Cretaceous (Hauterivian-Barremian) heteromorphic ammonites from northern Germany

Micheil V. Kakabadze & Philip J. Hoedemaeker

Kakabadze, M.V. & Hoedemaeker, Ph.J. New data on Early Cretaceous (Hauterivian-Barremian) heteromorphic ammonites from northern Germany. *Scripta Geologica*, **140**: 1-168, 86 pls., 12 figs., Leiden, January 2010.
M.V. Kakabadze, A. Djanelidze Institute of Geology, M. Alexidze St. 1/9, 0193 Tbilisi, Georgia (mishakakab@hotmail.com); Ph.J. Hoedemaeker, Nationaal Natuurhistorisch Museum, P.O. Box 9517, NL-2300 RA Leiden, The Netherlands (hoedemaeker@naturalis.nnm.nl).

Key words – heteromorphic ammonites, systematics, Hauterivian, Barremian, stratigraphy, northern Germany, new taxa.
The stratigraphic ranges and systematics of heteromorphic ammonites from Lower Cretaceous (Hauterivian-Barremian) deposits in Lower Saxony, northern Germany, are revised. Nine genera and forty-seven species of the family Ancyloceratidae Gill, 1871, are described. One genus (*Fissicostaticeras*) and 20 species are new; *Emericiceras ressense*, *E. sornayiforme*, *E. serpentinum*, *E. subtilicostatum*, *E. gotti*, *E. hannoverense*, *E. kemperi*, *Crioceratites hastensis*, *C. subisocostatus*, *C. vermiformis*, *Fissicostaticeras claviferum*, *F. aequicostatoides*, *F. rarocinctoides*, *Paracrioceras kleini*, *Acrioceras* (*Acrioceras*) *sarstedtense*, *A.* (*A.*) *crassicostatum*, *A.* (*A.*) *aegidii*, *A.* (*A.*) *longum*, *A.* (*A.*) *astrictum* and *Uhligia aegidii*.

Contents

Introduction

In 2002, the Nationaal Natuurhistorisch Museum – Naturalis (NNM) obtained a rich collection of Early Cretaceous ammonites from northern Germany, the collection of Kurt Wiedenroth. The main part of this collection consists of excellently preserved specimens, which have been collected bed by bed from the Valanginian to Barremian of northern Germany. The stratigraphic provenance of these ammonites is well documented by lithological columns of every quarry sampled. Heteromorphic ammonites are especially well represented in the Wiedenroth Collection; it is these ammonites which form the main zonal index fossils for the Boreal Hauterivian and Barremian. The majority of these specimens were collected between 1977 and 1996 when, due to temporary excavations or canal works, Kurt Wiedenroth had the opportunity to measure and draw in detail litho- and biostratigraphical columns, and to collect the fossils from these sections. Examples include the construction of the subways at the Aegidientor Square in Hannover; along the Hildesheimerstasse; along the S-Bahn at the Hannover Airport; along the Mittelland Canal works in the district of Haste; at quarries

along the Mittelland Canal near Wilhelmsdorf; at the O. Gott quarry near Sarstedt; the Resse quarry near Hainholz; and the Flemming quarry near Berenbostel. However, the ammonites in the Wiedenroth collection were insufficiently identified until now, most only to the generic level.

Von Koenen (1902, 1904, 1908) was the first author to publish systematic descriptions of ammonites and elaborate a detailed biostratigraphical subdivision of the Early Cretaceous of northern Germany. These data still have great theoretical and practical significance. Detailed litho- and biostratigraphic descriptions of the most important Lower Cretaceous sections of northern Germany have been published subsequently, but only a relatively small number of ammonites have been described or identified by later authors (Kemper, 1971, 1976, 1992; Immel & Mutterlose, 1980; Mutterlose, 1989, 1995, 1998; Mutterlose & Wiedenroth, 1996; Mutterlose *et al.*, 1997; Mutterlose & Bornemann, 2002). A monographic study of Early Cretaceous heteromorphic ammonites from this area against the background of a new systematic approach is desirable.

In the present paper the systematic position of the Hauterivian and Barremian heteromorphic genera and species is considered. It contains descriptions of new species and of taxa that were in need of reinvestigation. The present collection is undoubtedly of importance for a detailed biostratigraphic subdivision of the Hauterivian to Barremian rocks of northern Germany and adjacent areas of The Netherlands, as well as for zonal correlation between the Boreal regions of Europe-North America-Asia and for the Tethyan-Boreal zonal correlation. As the Wiedenroth Collection is representative of the greater part of the Hauterivian and Barremian ammonite fauna of the North Sea basin *sensu lato* from England to Poland, it also provides a reference for ammonites found in boreholes in the oil-bearing strata of the North Sea.

All specimens described are kept in the Nationaal Natuurhistorisch Museum – Naturalis, Leiden. The registration numbers are prefixed with RGM, referring to the former Rijksmuseum van Geologie en Mineralogie.

Stratigraphic framework

The ammonites from the Wiedenroth collection described in this monograph come from the upper Hauterivian and Barremian of the Hannover area. The ammonite zones in this stratigraphic interval are the following:

Upper Barremian (which includes the German "middle Barremian")
Parancyloceras bidentatum Zone
Simancyloceras stolleyi Zone
Paracrioceras rude Zone
Emericiceras sparsicosta Zone
Ancyloceras innexum Zone
Paracrioceras denckmanni Zone
Paracrioceras elegans Zone

Lower Barremian
Fissicostaticeras fissicostatum Zone
Fissicostaticeras rarocinctum Zone

Upper Hauterivian
Simbirkites (Craspedodiscus) discofalcatus Zone
Simbirskites (Craspedodiscus) gottschei Zone
Simbirskites (Milanowskia) staffi Zone
Aegocrioceras beds (correlated with a part of the *Simbirskites (Speetoniceras) inversum* Zone in England)

Most heteromorphic ammonites of the Wiedenroth collection were collected from the *staffi* Zone, from bed 83 (*rarocinctum* Zone) in the Gott quarry near Sarstedt, and from beds 6 and 7 (*fissicotatum* and *fissicostatum-elegans* zonal boundary, respectively) in the subway of the Aegidientor Square in Hannover. No heteromorphs were collected from the *gottschei*, *innexum* and *stolleyi* zones.

The large number of specimens of *Aegocrioceras* contained in the Wiedenroth Collection have not been studied and will be described elsewhere. The *Aegocrioceras* beds represent a rather cold phase during the Hauterivian, but, when temperatures rose again, *Aegocrioceras* gradually disappeared to give way to species of *Crioceratites* and *Simbirskites* (Kemper *et al*., 1987).

The first specimens of *Emericiceras* and *Crioceratites* were collected from bed 44 at quarry 4 along the Mittelland Canal near Wilhelmsdorf (Haste), which is the lowest of the boundary beds between the upper Hauterivian *Aegocrioceras* beds and the *staffi* Zone. The first fragments of *Simbirskites* occur in bed 46, but *Simbirskites staffi* itself was not found below bed 48 (K. Wiedenroth *in* Mutterlose, 1997b, p. 100).

Bed 44 (which correlates with bed 19 at the S-Bahn of Hannover Airport) yielded *Emericiceras ressense* sp. nov., *E. kemperi* sp. nov., *E. nolani, E. subtilicostatum* sp. nov., *E. wermbteri, E. hannoverense* sp. nov. and *Crioceratites subisocostatus* sp. nov. These species, except for *E. ressense*, have also been found in the *staffi* Zone above bed 48 together with *Crioceratites hastensis* sp. nov., *C. vermiformis* sp. nov., *Emericiceras woeckeneri, E. serpentinum* sp. nov., *E. strombecki* and *E. gotti* sp. nov.

The two last-named also occur in the *discofalcatus* Zone together with *Acrioceras* aff. *monopujaae yvanii* and *Acrioceras* sp. *Emericiceras* ex gr. *emerici* occurs in the boundary bed between the *discofalcatus* and *rarocinctum* zones.

Bed 83 of the lower Barremian *rarocinctum* Zone at the Gott quarry yielded *Parancyloceras aegoceras*, the last *Emericiceras nolani*, *E. sornayiforme* sp. nov., *Fissicostaticeras claviferum*, *F. rarocinctum*, *F. rarocinctoides* sp. nov., *Hoplocrioceras phillipsi*, *Acrioceras sarstedtense* sp. nov., *A. sarasini*, *A. meriani* and *A. longum* sp. nov.

The greater part of the *fissicostatum* Zone is represented by the black shales of the so-called 'Hauptblätterton', which yield no ammonites. Bed 6 in the top part of the *fissicostatum* Zone in the subway of Aegidientor Square yielded *Uhligia minuta, U. aegidii* sp. nov., *Uhligia* sp., *Hoplocrioceras laeviusculum*, *Acrioceras crassicostatum*, *A. nodulosum*, *Fissicostaticeras fissicostatum*, *F.* ex gr. *fissicostatum* and *F. aequicostatoides*.

The four last-named species also occur in the *fissicostatum-elegans* zonal boundary bed 7 of the same locality together with *Acrioceras angulosum*, *A.* aff. *incumbens*, *A. aegidii* sp. nov., *A. astrictum* sp. nov., *Paracrioceras stadtlaenderi*, *P. denckmanni*, *P. elegans*, *P. kleini* sp. nov. and *Paracrioceras* sp. The remainder of the *elegans* Zone yielded *Paracrioceras elegans*, *Fissicostaticeras aequicostatum* and the last *Emericiceras strombecki*.The last-named species has a long range, viz. from the *staffi* Zone up to the *elegans* Zone.

Wiedenroth apparently did not collect the index species of the *denckmanni* Zone from the zone itself, but collected *Paracrioceras stadtlaenderi, P. tuba* and *P. crassispina*. In the *sparsicosta* Zone, Wiedenroth collected only *Emericiceras sparsicosta*, while the *rude* Zone yielded *Paracrioceras* aff. *stadtlaenderi* of which one of us (M.V.K.) remarked that it strongly resembles *P. rude*, but that he could not identify them properly because of poor preservation. The *bidentatum* Zone, the highest zone of the Boreal Barremian, yielded *Parancyloceras aegoceras* and *Audouliceras* aff. *urbani*.

Key of measurements

D = diameter of the plane spiral; H = whorl height of the plane spiral; h = whorl height at 180°; W = whorl thickness of the plane spiral; U = umbilical width; H_1 = height of shaft section; W_1 = whorl thickness of shaft; H_2 = height of hook section; W_2 = whorl thickness of hook; D_1 = transverse diameter of uncoiled shell (shaft and hook); L = length of shaft; L_1 = length of the entire shell; K = coefficient reflecting rate of whorl increase in height: K= (H-h) / D [K > 0.2: rapidly increasing; K= 0.1-0.2: moderately increasing; K < 0.1: slowly increasing; - = not measured]. All measurements are in mm.

The numbers between brackets are the measurements at a smaller diameter of the same specimen.

Systematic descriptions

Class Cephalopoda von Zittel, 1884
Order Ammonitida von Zittel, 1884
Suborder Ancyloceratina Wiedmann, 1966
Superfamily Ancyloceratoidea Gill, 1871
Family Ancyloceratidae Gill, 1871
Subfamily Crioceratitinae Gill, 1871
Genus *Parancyloceras* Spath, 1924

Type species – *Crioceras bidentatum* von Koenen, 1902, p. 329, pl. 38, fig. 2, upper Barremian of Sarstedt, Lower Saxony, northern Germany, by original designation.

Diagnosis – The earliest whorls may be contiguous or nearly contiguous, slowly or moderately increasing in height. Later, the shell consists of tightly coiled crioconic whorls, and it is possible that in some species the shell straightens and terminates with a hook. The cross section of the early whorls is subcircular, but later becomes subellipsoidal. The sculpture consists of uniform, straight, radial or oblique simple ribs, with more or less distinct ventrolateral tubercles. In some species lateral nodes may occur. On the venter ribs may be doubled between the outer tubercles.

Distribution – Upper Barremian of northern Germany, England, Romania and northern Caucasus.

Parancyloceras aegoceras (von Koenen, 1902)

Pl. 1; Pl. 2, fig. 1; Fig. 1

1902 *Crioceras aegoceras* von Koenen, p. 328, pl. 36, figs. 1-3.
? 1914 *Crioceras aegoceras* von Koenen; Kazansky, p. 37.
1971 *Parancyloceras aegoceras* (von Koenen); Kemper, pl. 1, fig. 1.
1976 *Parancyloceras aegoceras* (von Koenen); Kemper, pl. 1, fig. 1.
1992 *Parancyloceras aegoceras* (von Koenen); Kemper, pl. 66, fig. 13.

Lectotype – The specimen figured by von Koenen (1902, pl. 36, figs. 2, 3) from the upper Barremian of Sarstedt, Lower Saxony, northern Germany. Designated herein.

Material – Four specimens, RGM 214 475, 213 796, 213 799 and 213 801.

Description – Large shell with whorls just touching each other. From D = 80-90 mm the whorls become slightly crioconic. In the early and middle growth stages the whorls increase moderately, but in later growth stages they increase only slowly, in height. The flanks are slightly rounded; the venter is narrow and almost flat, while the dorsum is wide and flat. The whorl section is subellipsoidal, while the section along the main ribs (costal section) is subrectangular. The sculpture consists of distant, strong, radial, simple ribs which cross the venter in the straight line. There are prominent nodes on the ventrolateral margin of the early whorls, but in later growth stages all ribs cross the venter without ventrolateral thickenings.

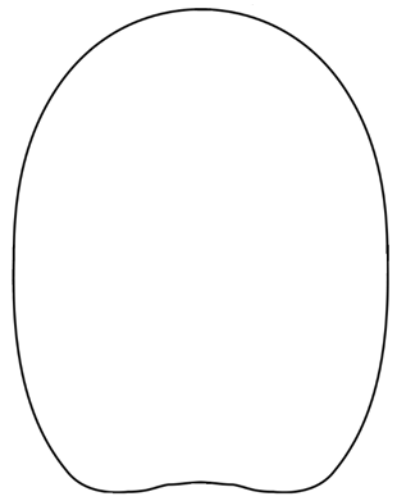

Fig. 1. Whorl section of *Parancyloceras aegoceras* (von Koenen, 1902), RGM 214 475. × 1.

Measurements –

№	D	H	h	W	U	H/D	W/D	U/D	H/W	H/h	K
214 475	260.0	67.0	59.0	65.0	144.0	0.26	0.25	0.55	1.03	1.13	0.03
	(140.0)	(43.5)	(29.3)	-	(73.0)	(0.31)	-	(0.52)	-	(1.48)	(0.10)
213 801	157.0	50.2	30.6	40.0	81.0	0.32	0.26	0.51	1.22	1.74	0.12
213 799	115.0	38.2	21.7	-	58.0	0.33	-	0.50	-	1.76	0.14
213 796	130.0	38.0	26.0	-	67.0	0.29	-	0.51	-	1.46	0.09

Comparison – This species differs from *Parancyloceras bidentatum* (von Koenen) in having more distant and stronger ribs and weaker ventrolateral nodes.

Occurrence – RGM 213 799, 213 801 and 214 475, upper uppermost Barremian *bidentatum* Zone, Gott quarry near Sarstedt; RGM 213 796, lower Barremian *rarocinctum* Zone, bed 83, Gott quarry near Sarstedt.

Distribution – Northern Germany, upper Barremian, *rarocinctum* to *bidentatum* zones; northern Caucasus(?), upper Barremian.

Genus *Emericiceras* Sarkar, 1954

Type species – *Crioceratites emerici* Léveillé, 1837, p. 314, pl. 23, fig. 1a-b, from the Barremian? of the Destourbes Mountains, southeast of Castellane (Alpes-de-Haute-Provence, France).

Diagnosis – Crioconic shell with whorls that slowly or moderately increase in height. The last whorl may be more evolute, forming a sort of incurved hook. Cross section of the early whorls is subcircular, but later becomes ellipsoidal, trapezoidal or oval. The sculpture consists of trituberculate main ribs and non-tuberculate intermediate ribs. The ribs may form loops between the lateral and umbilical spines. The number of intermediate ribs usually varies from 3-8 or more; in later growth stages their number decreases and, in the mature stage, commonly the main ribs only remain. Constrictions may occur adapically or adorally of the main ribs.

Remarks – The introduction by Vermeulen (2004) of the family Emericiceratidae and of the genus *Davouxiceras* was unnecessary. The genera listed in Emericiceratidae (*Davouxiceras* Vermeulen, 2004; *Emericiceras* Sarkar, 1954; *Honnoratia* Busnardo *in* Busnardo *et al*., 2003; *Paracrioceras* Spath, 1924; *Cryptocrioceras* Aguirre-Urreta, 1981; *Pedioceras* Gerhardt, 1897; *Protacrioceras* Sarkar, 1955) should be assigned to the Crioceratitinae Gill, 1871. In the papers by Vermeulen (2004, 2005, 2006) on the systematics of heteromorphic ammonites, important facts such as sexual dimorphism (Ropolo, 1995), and intrageneric and intraspecific variation (Kakabadze, 2004), are ignored. It should be noted that Company (*in* Klein *et al*., 2007, p. 67) regarded *Davouxiceras*, which includes species with tritubeculate main ribs, in its present state as an artificial genus; it cannot be considered distinct. We endorse Company's opinion.

However, we follow Vermeulen partly in separating groups with trituberculate main ribs from those with only ventrolateral and/or umbilical tubercles (or none at all), in particular, the genus *Davouxiceras* (type species *Crioceratites nolani* Kilian, 1910) from *Crioceratites* Léveillé, 1837 (type species *Crioceratites duvali* Léveillé, 1837). According to our data there is not sufficient difference in the principal morphological features (mode of coiling, sculpture, cross section, *etc*.) between the type species of *Emericiceras* and *Davouxiceras*, and in our opinion *Davouxiceras* represents a junior subjective synonym of *Emericiceras*.

Distribution – Hauterivian-Barremian. Western and central Europe, Crimea, Caucasus, Cuba, North America, South America, north Africa, Japan.

Emericiceras nolani (Kilian, 1910)

Pl. 2, fig. 2; Pl. 3; Pl. 4, fig. 1.

1840 *Crioceras Duvalii* Léveillé; d'Orbigny, p. 459, pl. 113, figs. 1-4.

pars 1861 *Ancyloceras Duvali* (Léveillé); Pictet & Campiche, p. 37, pl. 47*bis*, fig. 2, *non* fig. 1 [= *Emericiceras Jurense* (Kilian, 1910)].

1863 *Crioceratites Duvali* Léveillé; Pictet & Campiche, p. 9, pl. 1, fig. 2.
1910 *Crioceras Nolani* Kilian, p. 224, note 1, pl. 4, fig. 3a, b.
non 1960 *Crioceratites nolani* (Kilian); Drushchits, p. 289, pl. 31, fig. 5, pl. 32, fig. 3.
1962 *Crioceratites (Crioceratites) nolani* (Kilian); Wiedmann, p. 111, text-fig. 35:2.
1964 *Crioceratites (Crioceratites) nolani* (Kilian); Thomel, p. 15, text-fig. 1 (see synonymy).
1976 *Crioceratites (Crioceratites) nolani* (Kilian); Mandov, p. 55, pl. 3, figs. 1, 2.
non 1983 *Crioceratites (Crioceratites) nolani* (Kilian, 1910); Adamiková *et al.*, p. 602, pl. 1, fig. 3.
? 1983 *Crioceratites (Crioceratites) emerici* Léveillé; Adamiková *et al.*, p. 600, pl. 2, fig. 2.
non 1992 *Crioceratites nolani* (Kilian); Kemper, pl. 55, fig. 13.
1995 *Crioceratites nolani* (Kilian); Avram, p. 118, pl. 6, figs. 7, 8.
? 1995 *Crioceratites nolani* Adamíkova, *non* Kilian; Hoedemaeker, p. 228, pl. 6, fig. 8.
1995 *Crioceratites nolani* (Kilian); Faraoni *et al.*, p. 230, pl. 2, fig. 10.
1996 *Crioceratites nolani* (Kilian); Wright *et al.*, p. L211, fig. 164, 5a-b.
? 1996 *Crioceratites* cf. *nolani* (Kilian); Mutterlose *et al.*, p. 89, figs. 49:1-3.
2002 ?*Crioceratites* (*Crioceratites*) *nolani* (Kilian); Vašíček, pl. 3, fig. 1.
? 2003 *Crioceratites* gr. *nolani* (Kilian); Busnardo *et al.*, p. 64, pl. 31, fig. 2.
2006 *Crioceratites* (*Crioceratites*) cf. *nolani* (Kilian); Lukeneder & Aspmair, pl. 3, fig. 5.
2006 *Crioceratites nolani* (Kilian); Busnardo & Gauthier *in* Gauthier *et al.*, p. 134, pl. 14, figs. 1a, b, 2a-c, pl. 15, fig. 1, text-figs. 63, 64.

Holotype – The specimen described and figured by Pictet & Campiche (1861, p. 37, pl. 47*bis*, fig. 2) as *Ancyloceras Duvali* (Léveillé) from the Neocomian (Hauterivian?) of the Stockhorn Mountain (Switzerland). This specimen is the type of *Crioceras Picteti* Nolan, 1894 (p. 186). As the latter name was preoccupied, Kilian (1910, p. 224, note 1) renamed it *Crioceras Nolani*.

Material – Five rather well-preserved specimens, RGM 213 860, 213 861, 213 884, 213 634, 213 636.

Description – The crioconic whorls increase moderately in height. Only the latest whorl slowly increases in height. Up to D = 50 mm, the flanks are moderately convex, but in later growth stages they become almost flat. The venter is rounded, whereas the dorsum is flattened. In the early growth stage (up to D = 15-18 mm), the whorl section is subcircular, but in later growth stages it becomes subellipsoidal. The sculpture consists of trituberculate main ribs and non-tuberculate intermediate ribs. All ribs cross the venter without broadening. The number of intermediate ribs between every two main ones is 5-8. (RGM 213 860 is not well preserved and, on the early whorl, it is unclear how many intermediate ribs occur between the main ribs.) Most of the intermediate ribs are simple, but there are a few bifurcate ribs (bifurcation point is in the upper quarter of the whorl height). The constrictions are well expressed on the last whorl. The constrictions are as wide as the main ribs and develop adorally or adapically of the main ribs.

Measurements –

№	D	H	h	W	U	H/D	W/D	U/D	H/W	H/h	K
213 860	107.0	33.4	22.3	-	52.8	0.31	-	0.49	-	1.49	0.10
	(41.2)	(15.2)	(7.5)		(19.4)	(0.36)		(0.47)		(2.02)	(0.16)
213 884	150.0	46.8	35.0	45.0	-	0.31	0.30	-	1.04	1.34	0.07
	(94.0)	(35.0)	(15.7)			(0.37)				(2.23)	(0.20)
213 861	41.9	14.4	8.8	-	18.0	0.34	-	0.43	-	1.63	0.13

Remarks – As shown in the list of synonyms, the diagnosis of *C. duvali* (Léveillé) was misinterprted; specimens really belonging to *C. nolani* were identified as *C. duvali* (see, for example, d'Orbigny, 1840; Pictet & Campiche, 1861, 1863). Thomel (1964) presented a comprehensive diagnosis of *C. nolani* (Kilian): crioconic whorls, with subellipsoidal cross section; the sculpture consisting of trituberculate main and non-tuberculate intermediate ribs; the number of intermediate ribs between every two main ribs on the early whorls is 5-6, but in later growth stages 7-8, rarely more; in addition to the simple intermediate ribs there are rare bifurcate ribs; adorally or adapically (sometimes only adapically) of each main rib are constrictions.

Occurrence – RGM 213 860, 213 861, Hauterivian *inversum* zone, Mittelland Canal near Wilhelmsdorf (Haste); RGM 213 636 (Bed 56), 213 634, Hauterivian *staffi* Zone, Mittelland Canal near Wilhelmsdorf (Haste); RGM 213 884, lowest Barremian *rarocinctum* Zone, Gott quarry, near Sarstedt.

Distribution – Hauterivian to lowest Barremian of France, Spain, Italy, Czechian Republic, Hungary, Romania, northern Germany, Bulgaria, Crimea and Caucasus.

Emericiceras woeckeneri (von Koenen, 1902)

Pl. 4, figs. 2, 3; Pl. 5.

? 1861 *Ancyloceras Duvalii* (Léveillé) Astier; Pictet & Campiche, p. 37, pl. 47, figs. 1a, b, 3a, b.
? 1894 *Crioceras Picteti* var. *Jurensis*; Nolan, p. 186, 192.
1902 *Crioceras Woeckeneri* von Koenen, pp. 288, pl. 20, figs. 1, 2.
1902 *Crioceras* cf. *Woeckeneri*? von Koenen, p. 290, pl. 22, figs. 3a, b, 4, pl. 32, figs. 1a, b.
? 1910 *Crioceras Jurense* Kilian; Kilian, p. 270.

Lectotype – The specimen figured by von Koenen (1902) on pl. 20, figs. 1, 2. Designated herein. Deposited in the Geologisch-Paläontologisches Institut Göttingen 457-64

Material – Three specimens, RGM 213 508, 214 091, 216 604, all consisting of 1.5 whorls.

Description – Moderately open crioconic shell with whorls moderately increasing in height. The dorsum is flat, while flanks and venter are rounded. Whorl section is subellipsoidal. The section formed by the main trituberculate ribs (costal section) has a subrectangular shape.

The sculpture consists of straight, radial, trituberculate main ribs of which every two are separated by 3-4, rarely two or five non-tuberculate intermediate ribs. They cross the venter in a straight line, without interruption and without broadening. On the venter and between the prominent ventrolateral spines, the ribs are reduced in strength. The main ribs are significantly thicker than the intermediate ones. The ventrolateral tubercles are much more prominent than the lateral and umbilical ones. The lateral tubercles are in a row at two-thirds of the flank height and are stronger than the umbilical ones. Both of them are stretched in the direction of the ribs. Among the intermediate ribs there are a very few bifurcate ribs; the point of bifurcation is situated at two-thirds of the whorl height. On the venter the intermediate ribs are equal and cross the venter in a straight line. On the dorsum all ribs are equally thin and prorsiradiate.

Measurements –

№	D	H	h	W	U	H/D	W/D	U/D	H/W	H/h	K
214 091	92.2	29.0	16.8	26.0	47.3	0.31	0.28	0.51	1.11	1.73	0.12
216 604	52.0	16.0	10.6	14.5	27.6	0.30	0.27	0.53	1.10	1.50	0.10

Comparison – This species resembles *E. nolani* (Kilian) in the moderately open crioconic shells and the subellipsoidal whorl section, but differs from it in having a smaller number (3-4 instead of 6-8) intermediate ribs between each pair of main ribs. Moreover, the latter are thicker in the present taxon.

Occurrence – RGM 213 508 in *staffi* Zone of quarry 2 along the Mittelland Canal near Wilhelmsdorf (Haste); RGM 214 091 in *staffi* Zone, bed 53, of quarry 4 along the Mittelland Canal near Wilhelmsdorf (Haste); RGM 216 604, *staffi* Zone, bed 38, in the tunnel of the S-Bahn, Hannover airport, near Hannover.

Distribution – Upper Hauterivian-lowermost upper Barremian, northern Germany.

Emericiceras strombecki (von Koenen, 1902)

Pls. 6-11.

1902 *Crioceras Strombecki* von Koenen, p. 305, pl. 10, fig. 1a, b.
1997 *Crioceratites strombecki* von Koenen; Mutterlose *et al*., p. 66, figs. 41 (1-3).

Holotype – Fixed by monotypy. The specimen figured by von Koenen (1902, pl. 10, fig. 1a, b) from the uppermost Hauterivian of Thiede, Lower Saxony, Northern Germany.

Material – Seventeen fairly well-preserved specimens, RGM 213 859, 214 092, 214 184, 214 087, 214 088, 214 474, 213 633, 213 636, 213 641, 197 178, 197 180, 214 583, 216 239, 216 515, 214 472, 213 760, 214 095.

Description – Crioconic whorls which increase slowly or moderately in height. The ventral and dorsal sides of the early whorls are rounded; the flanks are convex. After D = 110-115 mm the flanks and dorsum become flattened. The section of the early whorls is circular, then becomes ellipsoidal (higher than wide), but after D = 100-120 mm is again circular, becoming trapezoidal with the point of maximum thickness at the lower third of the whorl height.

The sculpture of the earliest part of the whorl is well expressed on RGM 214 087 and 214 092. Up to D = 40-44 mm (H = 12-14 mm) the sculpture consists of radial, straight, trituberculate main ribs, of which every two are separated by 3-4 relatively thin, nontuberculate intermediate ribs. After D = 50-60 mm the number of the intermediate ribs between the main ones varies from three to five. At the end of the mature stage the main ribs approximate each other and the number of the intermediate ribs reduces to two. The ventral spines, as well as upper lateral and umbilical spines, become very prominent in the middle and late ontogenetic stages. The lateral spines are located at two-thirds of the whorl height; they are less prominent than ventrolateral ones, but better developed than the umbilical spines. All ribs cross the ventral side in a straight line.

Measurements –

№	D	H	h	W	U	H/D	W/D	U/D	H/W	H/h	K
216 515	250.0	67.0	40.5	-	150.0	0.27	-	0.60	-	1.65	0.10
214 472	230.0	72.0	36.5	-	119.0	0.31	-	0.52	-	1.97	0.11
213 760	220.0	68.0	40,8	43.5	118.0	0.31	0.20	0.54	1.33	1.67	0.12
214 474	136.0	37.0	26.4	-	72.2	0.27	-	0.53	-	1.40	0.07
214 088	119.0	31.8	23.0	-	63.2	0.27	-	0.53	-	1.38	0.06
	(52.0)	(17.0)	(10.0)		(26.5)	(0.32)		(0.51)		(1.70)	(0.13)
214 087	80.0	25.0	20.0	-	40.8	0.31	-	0.51	-	1.25	0.18
	(50.0)	(16.0)	(10.0)		(24.5)	(0.32)		(0.49)		(1.60)	(0.12)
214 495	40.2	12.0	8.5	-	20.4	0.30	-	0.51	-	1.41	0.08

Comparison – This species resembles *E. nolani* (Kilian) in the crioconic type of coiling, the type of sculpture and whorl section in the early ontogenetic stage (up to D = 40-45 mm). Yet, it clearly differs from it in the smaller number of intermediate ribs (2-4 instead of 5-8) between every two main ribs and in the absence of constrictions in the late growth stage.

Occurrence – From Upper Hauterivian *inversum* Zone up to and including upper Barremian *elegans* Zone. RGM 213 859, upper Hauterivian *inversum* Zone, Mittelland Canal, Haste. The following specimens occur in the upper Hauterivian *staffi* Zone: RGM 214 092, bed 56-58, quarry 4, near Wilhelmsdorf, Haste; RGM 214 184, Mittelland Canal, Haste; RGM 214 087, bed 53, quarry 4, Wilhelmsdorf, Haste; RGM 214 088, bed 52, quarry 4, Wilhelmsdorf, Haste; RGM 214 474, bed 102, Resse quarry, Hainholz; RGM 213 633, bed 100, Resse quarry, Hainholz; RGM 213 636, bed 56, Mittelland Canal, Haste; RGM 213 641, bed 19, S-bahn Hannover Airport; RGM 197 178, bed 30, S-bahn Hannover Airport; RGM 197 180, bed 30, S-bahn Hannover Airport. Specimens from higher zones: RGM 214 583, 216 239, upper Hauterivian *discofalcatum* Zone, Gott quarry, Sarstedt; RGM 216 515, 214 472, 213 760, lower Barremian *rarocinctum* Zone, bed 72, Gott quarry, Sarstedt; RGM 214 095, upper Barremian *elegans* Zone, U-bahn Aegidientorplatz, Hannover.

Distribution – Upper Hauterivian, northern Germany.

***Emericiceras ressense* sp. nov.**
Pl. 12, fig. 1.

Holotype – RGM 213 961.

Type locality – Resse quarry, Hainholz, about 20 km north of Hannover directly west of the road from Engelbostel to Resse, Lower Saxony, northern Germany.

Type horizon – Upper Hauterivian *staffi* Zone, bed 96.

Derivatio nominis – Named after the village of Resse.

Material – Only the holotype, showing 1.4 rather well-preserved crioconic whorls. Early whorls and the most adoral part of the body chamber are missing.

Diagnosis – The whorls of the crioconic shell moderately increase in height. The sculpture consists of straight, trituberculate main ribs and thinner, sometimes slightly curved, non-tuberculate intermediate ribs. There are in most cases 5-7, rarely less intermediate ribs to one main rib. From D = 42 mm rather wide constrictions are situated adapical of each main rib. All ribs cross the venter in a straight line without interruption.

Description – The shell consists of open crioconic whorls moderately increasing in height. The whorl section varies from subellipsoidal (up to H = 12-14 mm) to subtrapezoidal (from H = 14 mm). The sculpture consists of straight trituberculate main ribs and thinner, sometimes slightly curved, non-tuberculate intermediate ribs. The trituberculate main ribs of the earliest preserved whorl of the holotype, i.e., up to D = 35-37 mm, are rather strong and radial, and separated from each other by 5-7 simple intermediate ribs. The ventral spines are much more prominent than the umbilical and lateral tubercles. The latter are situated a little above the middle of the flanks. From D = 42 mm the constrictions alongside the main ribs are rather wide. The suture line is fragmentarily preserved at H = 9 mm. The lateral trifid lobe is deeply incised and intensely frilled, and its middle branch is significantly longer than the other two branches.

Measurements –

№	D	H	h	W	U	H/D	W/D	U/D	H/W	H/h	K
213 961	80.0	25.2	17.8	-	38.4	0.31	-	0.48	-	1.41	0.08
	(66.5)	(23.0)	(14.7)		(31.5)	(0.34)		(0.47)		(1.56)	(0.12)

Comparison – *Emericiceras ressense* resembles *E. emerici* in the general features of sculpture and it is especially close to the specimen described by Sarkar (1955, p. 77, pl. 5, fig. 13) as *Emericiceras* cf. *emerici* Lév. (forme 1). However, it differs from the latter in the slower increase in whorl height and in the absence of supplementary ventrolateral tubercles on some of the intermediate ribs. From the other specimens identified as *Emericiceras* cf. *emerici* by Sarkar (1955, pl. 2, fig. 2, pl. 3, fig. 7, pl. 4, fig. 5, pl. 5, fig. 21, pl. 9, fig. 1), and from the holotype of this species described by Léveillé (1837, p. 314, fig. 1a-b), *E. ressense* differs in having a greater number (5-7 instead of 3-4) of intermediate ribs between every two main ribs.

Emericiceras ex gr. *emerici* (Léveillé, 1837)

Pl. 12, fig. 3.

Material – One fragmentary specimen, RGM 214 556, represented as a single crioconic whorl.

Description – Rather open crioconic whorls, which slowly increase in height. The venter is rounded, the flanks are moderately convex and the dorsum is almost flat. At the first half of the whorl the cross section is subcircular, but with growth it becomes ellipsoidal with the maximum thickness at the middle of the whorl height.

The sculpture consists of trituberculate main ribs separated by 3-6 very thin, non-tuberculate intermediate ribs. On the flanks all ribs are straight and pass in a straight line over the venter. The ventrolateral and lateral spines are stronger than the umbilical ones.

Measurements –

№	D	H	h	W	U	H/D	W/D	U/D	H/W	H/h	K
214 556	45.0	15.0	8.0	-	20.0	0.33	-	0.44	-	1.87	0.13
	(35.0)	(12.0)	(7.0)		(17.5)	(0.34)		(0.50)		(1.71)	(0.14)

Remarks – This specimen resembles that identified by Sarkar (1955, p. 79, pl. 3, fig. 7) as *Emericiceras* cf. *emericii* (Léveillé) (forme 4) in the moderately increasing crioconic whorl and in the style of ribbing (main trituberculate ribs separated by 3-6 intermediate ribs). However, as we cannot judge the morphology of the earliest and later ontogenetic stages of RGM 214 556, we refer it to *E.* ex gr. *emerici*.

Occurrence – Hauterivian-Barremian boundary bed 72 (= boundary between *discofalcatus* and *rarocinctum* zones), Gott quarry near Sarstedt, northern Germany.

***Emericieras sornayiforme* sp. nov.**
Pl. 12, fig. 2.

Holotype – RGM 213 917.

Type locality – Quarry Gott, Sarstedt (northern Germany).

Type horizon – Lower Barremian, beds 83, *rarocinctum* Zone.

Derivatio nominis – Named after *Crioceras sornayi* Sarkar, 1955, which has a similar appearance.

Material – Only the rather well-preserved holotype showing 2.5 whorls.

Diagnosis – The whorls of the crioconic shell rapidly increase in height. The sculpture of the early whorls consists of simple, straight non-tuberculate ribs. From D = 15-16 mm appear trituberculate main ribs, at first with only 1-2 intermediate ribs between them and, later, with 3-5 intermediate ribs to one main one. The latter appearance goes together with the disappearance of the lateral and, in some places, the ventrolateral tubercles. From D = 52 mm every umbilical tubercle gives rise to two ribs (fasciculation), one thick and one thin.

Description –Crioconic shell with whorls that rather rapidly increase in height. The whorls leave a large umbilical perforation. The first whorl is almost in touch with the second, but then coiling becomes typically crioconic. The last portion of the last whorl of holotype was crioconic despite it being in contact with the previous whorl due to deformation. Whorl section of the early ontogenetic stage is circular, but with growth becomes subtrapezoidal.

The sculpture of the early whorls (up to D = 15-16 mm) consists of simple, straight, radiate, non-tuberculate ribs. Ventrolateral and lateral tubercles appear later on the main ribs, and still later (D = 38 mm) umbilical tubercles also. At first there are only one or two intermediate ribs to one main rib, but from D = 52 mm their number augments

to 3-5. From D = 55 mm, all lateral tubercles and some ventrolateral tubercles disappear. The sculpture consists of bundles of two slightly flexuous ribs, departing from prominent umbilical tubercles and separated by 3-5 intermediate ribs. Every bundle harbours one thick main rib and one thin intermediate rib, and the main rib may or may not have a ventrolateral tubercle. All ribs cross the venter in a straight line.

Measurements –

№	D	H	h	W	U	H/D	W/D	U/D	H/W	H/h	K
213 917	54.3	21.4	11.0	16.2	23.0	0.39	0.30	0.42	1.32	1.94	0.19

Comparison – The specimen differs from *C. sornayi* Sarkar (1955, p. 50, pl. 1, fig. 4) in having only simple ribs up to D = 16 mm. It resembles this species in its rather tightly coiled crioconic whorls, in the bundles of ribs, and in the disappearance of the lateral and some of ventral tubercles in the later whorls.

***Emericieras serpentinum* sp. nov.**

Pl. 13.

1997a *Crioceratites strombecki* (von Koenen); Mutterlose, p. 66, fig. 41, 3.

Holotype – RGM 214 085.

Type locality – Mittelland Canal near Wilhelmsdorf, Haste.

Type horizon – Upper Hauterivian *staffi* Zone.

Derivatio nominis – *Serpentinus* (Latin) means 'like a snake.'

Material – Three specimens, RGM 214 083, 214 085 (holotype) and 214 496, two of which are fairly well-preserved.

Diagnosis – Very open crioconic shell. Whorls slowly increasing in height. Sculpture consists of trituberculate main ribs and non-tuberculate intermediate ribs. Ventrolateral spines long, while the lateral spines and umbilical tubercles are small.

Description – Inner whorls moderately increase in height, but from D= 60 mm only slowly so. The dorsum is flat. The venter and flanks are rounded, but from D = 25-30 mm they become almost flat, so that the whorl section changes from subellipsoidal to subtrapezoidal.

The trituberculate main ribs bear long ventrolateral spines, short lateral spines and weak umbilical tubercles. The main ribs are separated by three, rarely one or two, intermediate ribs. On the flanks all ribs are slightly prorsiradiate, but pass straight over the venter.

Measurements –

№	D	H	h	W	U	H/D	W/D	U/D	H/W	H/h	K
214 085	136.5	32.5	21.0	-	83.3	0.24	-	0.6	-	1.55	0.08
	(83.5)	(21.0)	(17.2)		(47.2)	(0.25)		(0.56)		(1.22)	(0.04)
214 496	129.5	32.4	24.0	-	73.6	0.25	-	0.57	-	1.35	0.06
214 083	79.0	22.0	16.3	-	41.5	0.27	-	0.52	-	1.34	0.07
	(52.0)	(16.0)	(10.2)		(27.3)	(0.30)		(0.52)		(1.56)	(0.11)

Remarks – The species differs from *E. strombecki* (von Koenen, 1902) in the slower increment in the height of the whorls during ontogeny, and in the rather small umbilical and lateral spines.

Occurrence – RGM 214 083, 214 085, upper Hauterivian *staffi* Zone, bed 53, quarry 4 along Mittelland Canal, Wilhelmsdorf, Haste; RGM 214 496, upper Hauterivian *staffi* Zone, Mittelland Canal, Haste.

***Emericieras subtilicostatum* sp. nov.**

Pls. 14, 15; Fig. 2.

Holotype – RGM 213 859.

Type locality –Mittelland Canal near Haste, Lower Saxony, northern Germany.

Type horizon – Upper Hauterivian, *staffi* Zone.

Derivatio nominis – *Subtilis* (Latin) = fine, *costa* (Latin) = rib.

Material – Three further well-preserved specimens, RGM 213 858, 213 867 and 214 177.

Diagnosis – Rather open crioconic whorls. Early whorls moderately increase in height, but the later whorls increase only slowly in height. On the early whorls the sculpture consists of trituberculate main and non-tuberculate intermediate ribs. The number of intermediate ribs to one main ribs is commonly high, but varies between two and nine. Later, but still in the early growth stage, the lateral and umbilical spines disappear, and the sculpture consists of thin, equal ribs, with rather strong ventrolateral spines on some of them. The base of each spine embraces two or three ribs at the same time. In later whorls the sculpture consists of main ribs with ventrolateral spines and of 3-8 intermediate ribs without spines between every two main ribs. Constrictions are well expressed on the late whorls.

Description – The shell has rather widely crioconic whorls in the mature stage. The venter, flanks and dorsum of the early whorls are rounded, but later the dorsum becomes flattened. The cross section of the earliest whorl is subcircular, but later it becomes subellipsoidal and still later subtrapezoidal, with the maximum thickness at the lower quarter of the whorl height.

On the early whorls the number of intermediate to main ribs is 2-9. The main ribs are slightly thicker than the intermediate ones on the adapical side bordered by distinct constriction. Later, but still in the early growth stage, the umbilical and lateral spines disappear. Periodically, rather long and rounded ventrolateral spines develop, each of which embraces two, rarely three ribs. In this stage all ribs are equally thin, irrespective of whether they bear a spine or not. From D = 70-80 mm main ribs develop; only these bear ventrolateral spines. At one or two sides of each main rib broad, more or less distinct constrictions are present. Between every two main ribs there are 5-8, rarely 3-4, thin, wide-spaced intermediate ribs to one main rib, which very rarely bifurcate in the upper quarter of the flanks. On the flanks all ribs are slightly flexuous; they cross the venter as well as the dorsum with a forward curve.

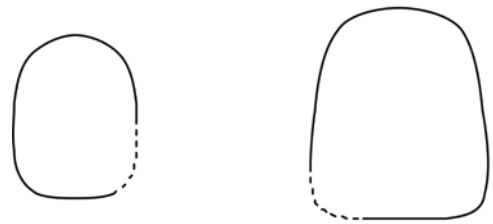

Fig. 2. Whorl sections of *Emericiceras subtilicostatum* sp. nov., RGM 213 867. × 1.

Measurements –

№	D	H	h	W	U	H/D	W/D	U/D	H/W	H/h	K
213 867	87.0	26.0	18.3	-	46.0	0.30	-	0.53	-	1.42	0.08
	(48.0)	(16.5)	(10.0)		(22.3)	(0.34)				(1.65)	(0.13)
213 859	51.5	16.4	11.3	-	26.2	0.32	-	0.51	-	1.45	0.09
213 858	48.4	15.5	9.3	10.8	24.0	0.32	0.22	0.50	1.43	1.67	0.12

Comparison – *Emericiceras subtilicostatum* sp. nov. differs from other species of *Emericiceras* in having a middle ontogenetic stage in which all ribs are equally thin and only ventrolateral spines are present, each of which sits on two or three ribs together. Only in the adult stage does a differentiation in thick main ribs with ventrolateral spines and thin non-tuberculate intermediate ribs reappear.

Occurrence – RGM 213 858, 213 859, upper Hauterivian *staffi* Zone, bed 56, Mittelland Canal, Haste; RGM 213 867, upper Hauterivian *inversum-staffi* zonal boundary beds, bed 44, quarry 4 along Mittelland Canal near Wilhelmsdorf, Haste; RGM 214 177, upper Hauterivian *staffi* Zone, bed 49, Mittelland Canal, Haste.

***Emericiceras sparsicosta* (von Koenen, 1902)**

Pl. 16; Pl. 17, fig. 1.

1902 *Crioceras sparsicosta* von Koenen, p. 284, pl. 40, fig. 1a, b.
1942 *Crioceras sparsicosta* von Koenen; Dacqué, pl. 15, fig. 5, 5a (= von Koenen, 1902, pl. 40, fig. 1a, b).
1974 *Paracrioceras sparsicosta* von Koenen; Kaever *et al*., p. 222, pl. 2, fig. 2 (= von Koenen, 1902, pl. 40, fig. 1b).
1997a *"Crioceras" sparsicosta* von Koenen; Mutterlose *et al*., figs. 44.5, 44.6, 45.2.

Holotype – Fixed by monotypy. The specimen figured by von Koenen (1902, p. 284, pl. 40, fig. 1a-b) from the upper Barremian near Braunschweig, northern Germany.

Material – Eight specimens, RGM 213 759, 213 906, 213 908, 213 909, 213 911, 213 913A, 213 913B and 213 913C. The morphology of the earliest whorls (RGM 213 913A) of this species is documented here for the first time.

Description – The shell is very large and consists of rather closely coiled crioconic whorls. The early whorls slowly increase in height, but the later whorls exhibit a moderate increment in height. The venter is rounded. The flanks of the early whorls are convex, but from D = 80-90 mm the flanks become flattened. Up to D = 30 mm the dorsum is rounded, but from this diameter it gradually flattens. The cross section of the early whorls is subcircular, but from D = 40-50 mm it becomes subellipsoidal. The umbilical perforation is very wide.

The sculpture of the first post-embrional whorl (RGM 213 913A) consists of strongly prorsiradiate tuberculate main ribs; between each pair of them, there are one or two non-tuberculate intermediate ribs. First appear the ventrolateral and lateral tubercles, whereas the umbilical tubercles appear rather late. On the early whorls the bases of the umbilical, lateral and ventrolateral tubercles are slightly stretched in the direction of the ribbing. From D = 30-35 mm the number of the intermediate ribs between every two main ribs increases to 3-4, rarely to 5-6. In addition, the main ribs are markedly distant and thicker than the intermediate ones. The lateral and ventrolateral tubercles are probably the bases of small spines.

The suture line is well visible on the early whorl (RGM 213 913); the lateral lobe (L) is comparatively broad and trifid; the middle branch of the lateral lobe is slightly deeper than the ventral (E) lobe.

Measurements –

№	D	H	h	W	U	H/D	W/D	U/D	H/W	H/h	K
213 906	119.0	37.0	24.2	-	60.5	0.31	-	0.51	-	1.53	0.11
213 909	106.5	34.0	18.3	-	57.0	0.32	-	0.53	-	1.86	0.14
213 759	93.0	30.2	17.5	-	47.0	0.32	-	0.50	-	1.72	0.14
213 908	92.0	31.5	21.6	-	42.0	0.34	-	0.46	-	1.46	0.11
213 913A	27.5	7.2	4.8	7.1	17.0	0.26	0.26	0.61	1.01	1.50	0.08

Comparison – *Emericiceras sparcicosta* (von Koenen) resembles *E. annulatum* (von Koenen) in the closely coiled crioconic whorls and in the great distance of the main ribs, but differs in having a much greater number of intermediate ribs between the main ribs and in the cross section of the late whorls being subellipsoidal instead of subtrapezoidal.

Occurrence – RGM 213 759, 213 906-213 909, 213 913A-C, upper Barremian *sparsicosta* Zone, beds 130-131, Gott quarry, Sarstedt, northern Germany.

Distribution – Upper Barremian *sparsicosta* Zone, northern Germany.

***Emericiceras gotti* sp. nov.**
Pl. 17, fig. 2; Pl. 18; Pl. 19, fig. 1; Fig. 3.

Holotype – RGM 214 476.

Type locality – Gott quarry, Sarstedt, northern Germany.

Type horizon – Upper Hauterivian *discofalcatus* Zone.

Derivatio nominis – Named for Otto Gott, after whom the quarry has been named.

Material – Two specimens (RGM 214 476, 197 186) of which the holotype is the most complete, showing early, middle and late ontogenetic stages. The second specimen has better preserved early whorls, but the late whorls are missing.

Diagnosis – Very large crioconic shells. The sculpture of the early whorls consists of simple ribs, with rows of ventrolateral and lateral spines. Umbilical tubercles appear at about D = 50 mm. In this stage there are 3-4 non-tuberculate intermediate ribs between every two tuberculate main ribs. In a later stage the main ribs become stronger and are provided with rows of umbilical and lateral spines. On the venter, between D = 70-80 mm, one row of the ventrolateral spines gradually disappears, whereas the other row gradually shifts to a mid-ventral position, so that in the mature stage there is only a single mid-ventral row of spines.

Description – The shell has a diameter of more than 300 mm. The earliest whorls are almost contiguous, whereas from D = 4.5-5.0 mm the whorls are crioconic. In the mature stage the shell is represented by rather widely coiled crioconic whorls, which slowly increase in height. The flanks are convex and the venter is relatively narrow, but the dorsum is wide and flat. With growth, the dorsum becomes wider still and is provided with a shallow depression, but subsequently the dorsum becomes flat again. The whorl section changes from suboval to subtriangular, with the maximum thickness at the lower quarter of the flank.

Fig. 3. Whorl sections of *Emericiceras gotti* sp. nov., RGM 214 476 (holotype). × 1.

The sculpture can be traced down to D = 3 mm (RGM 197 186). Approximately from D = 5 mm it consists of simple ribs, with two rows of spines, viz. the ventrolateral and lateral ones, and between every two tuberculated main ribs there are one or two non-tuberculate intermediate ribs. From about D = 25 mm the ventrolateral and lateral spines become very long. Small umbilical spines appear from D = 47 mm. Between each pair of thick main ribs there are 3-4 thinner, non-tuberculate intermediate ribs. Between D = 70-80 mm, a remarkable trait develops, i.e., on the ventral side of the whorl one row of ventrolateral spines shifts into a mid-ventral position, whereas the other row diminishes and has disappeared by D = 80 mm, so that instead of rows of ventrolateral spines on both sides of the venter, there is only a single row of mid-ventral spines. Thus, in the mature stage the main ribs of both sides are strong and provided with two rows of umbilical tubercles and lateral spines, but on the venter there is only one row of mid-ventral spines. Up to D =135 mm the mid-ventral and lateral spines are significantly longer than the umbilical ones. But later (D > 135 mm) the umbilical spines also become long, though still shorter than the

mid-ventral and lateral ones. All ribs cross the venter in a straight line, whereas they are equally thin and convex on the flat dorsum.

The morphological features described here can be well traced on the holotype. RGM 197 186 is a young individual (D = 60 mm) that is partly embedded in the rock and the transition described above from a sex-tuberculate type into a quinque-tuberculate type has not yet started.

Only parts of the strongly frilled dorsal (I) and lateral (L) lobes of the suture line are visible in the holotype; the lateral lobe is trifid and its median incision is slightly longer than those of the other two lobes.

Measurements –

№	D	H	h	W	U	H/D	W/D	U/D	H/W	H/h	K
214 476	297	79	48.5	79	165	0.27	0.27	0.56	1	1.63	0.1
	(215)	(68)	(40)	(68)	(120)	(0.31)	(0.31)	(0.59)	1	(1.7)	(0.1)
197 186	60.5	17.5	11.5	-	32.3	0.29	-	0.53	-	1.52	0.1

Comparison – *Emericiceras gotti* differs from the specimen figured by Neumayer & Uhlig (1881, p. 187, pl. 55) as *E. roemeri* in having more open crioconic coiling, lesser increment in the whorl height, subrounded whorl section and in the slightly earlier origin (between D = 70-80) of the quique-tuberculated type of sculpture in the ontogeny (in *E. roemeri* between D = 80-90, if the drawing is correct).

Remarks – Heteromorphic ammonite genera with five rows of spines have not been recorded hitherto. So, we may ask ourselves whether the phenomenon of transformation from a six-spined to a five-spined type of sculpture was due to a pathology or if it has a genotypical reason. If this transformation is an expression of genotype, then five-spined forms may be grouped into a new genus. As there are only two species known, viz. *E. gotti* and *E. roemeri*, we need more and better-preserved material to solve this question. Hence we provisionally assign these species to the genus *Emericiceras*.

Occurrence – RGM 214 476, upper Hauterivian *discofalcatus* Zone, Gott quarry near Sarstedt; RGM 197 186, upper Hauterivian *staffi* Zone, bed 30, S-Bahn, Hannover Airport, northern Germany.

Distribution – Upper Hauterivian, northern Germany.

***Emericiceras wermbteri* (von Koenen, 1902)**

Pl. 19, fig. 3; Pls. 20-24; Pl. 25, fig. 1.

1902 *Crioceras Wermbteri* von Koenen, p. 292, pl. 43, fig. 4.

Lectotype – The specimen figured by von Koenen (1902, pl. 43, fig. 4) from the lower Hauterivian *radiatus* Zone near Kirchwehren, northern Germany. Designated herein.

Material – Nineteen rather well to well-preserved specimens, RGM 197 084, 213 511, 213 612, 213 618-213 622, 213 624, 213 625, 213 862, 214 377, 214 378, 214 380, 214 381, 214 383, 214 387, 214 390, 214 497.

Description – Large shell with early whorls that nearly touch each other. From D = 10-12 mm coiling becomes crioconic with whorls that slowly or moderately increase in height. The flanks are slightly convex, the venter is rounded and the dorsum is flattened. The whorl section is subellipsoidal, becoming subtrapezoidal at a late ontogenetic stage.

The sculpture of the early whorls consists of simple, straight, equally thin ribs. From D = 15-17 mm it differentiates into strong main ribs with ventrolateral spines and thinner non-tuberculate intermediate ribs. There are 4-6, rarely 7-8, intermediate ribs between every two main ones, but from D = 150-160 mm the number of intermediate ribs reduces to 4-3 and in the latest ontogenetic stage to two. In addition to the simple intermediate ribs there are also short intercalatory ribs, which start at four-fifths of the whorl height, and like the other intermediate ribs they cross the venter in a straight line. Ventrolateral spines become stronger. Umbilical and lateral spines appear late, approximately from D = 100-110 mm. From D = 125-130 mm all three spines are prominent. In the adult stage of the holotype constrictions are present adapically of the main ribs.

Measurements –

№	D	H	h	W	U	H/D	W/D	U/D	H/W	H/h	K
214 380	230.0	61.0	41.2	56.5	129.0	0.26	0.24	0.56	1.08	1.48	0.08
	(86.0)	(26.2)	(14.7)	-	(50.0)	(0.30)	-	(0.58)	-	(1.78)	(0.13)
214 377	202.0	52.6	39.0	47.2	120.0	0.26	0.23	0.59	1.11	1.35	0.06
	(115.0)	(39.0)	(20.0)	-	(58)	(0.34)	-	(0.50)	-	(1.95)	(0.16)
197 084	182.0	50.4	35.4	-	97.0	0.28	-	0.53	-	1.42	0.13
213 862	116.2	32.0	22.3	-	63.3	0.27	-	0.54	-	1.43	0.07
214 381	102.0	31.5	18.0	-	55.0	0.31	-	0.54	-	1.75	0.13
214 497	48.4	12.2	10.7	-	21.4	0.25	-	0.44	-	1.14	0.03

Comparison – *Emericiceras wermbteri* resembles *E. strombecki* in the type of coiling and sculpture in the adult stage. However, it clearly differs from the latter in having non-tuberculate sculpture on the early whorls up to D = 15-16 mm and only ventrolateral spines up to D = 100-110 mm. From this diameter umbilical and lateral tubercles appear.

Occurrence – RGM 214 862, upper Hauterivian *inversum-staffi* zonal boundary beds, quarry 4, bed 44, along the Mittelland Canal near Wilhelmsdorf, Haste; RGM 213 511, 214 497, upper Hauterivian *staffi* Zone, bed 56, Mittelland Canal, Haste; RGM 197 084, 213 612, 213 618-213 622, 213 624, 213 625, 214 377, 214 378, 214 380, 214 381, 214 383, 214 387, 214 390: upper Hauterivian *staffi* Zone, bed 26, S-Bahn, Hannover Airport, northern Germany.

Distribution – Upper Hauterivian, northern Germany.

***Emericiceras hannoverense* sp. nov.**

Pl. 19, fig. 2; Pl. 25, fig. 2; Pls. 26-29; Pl. 30, fig. 1; Fig. 4.

Holotype – RGM 214 379.

Type locality – S-Bahn Hannover Airport, Lower Saxony, northern Germany.

Type horizon – Upper Hauterivian *staffi* Zone, bed 26.

Derivatio nominis – Named after the type locality.

Material – Thirteen well-preserved specimens, RGM 213 590, 213 593, 213 617, 213 633, 213 640, 213 865, 213 977, 214 021, 214 022, 214 375, 214 376, 214 379 (holotype), 214 382.

Diagnosis – Rather tightly coiled crioconic whorls, moderately increasing in height. The sculpture of the early whorls consists of very thin, non-tuberculate, uniform ribs. From D = 40-50 mm, main ribs with rather strong ventrolateral spines develop. On early whorls, the number of intermediate ribs between every two main ribs varies from 7-11, on later whorls 4-6. In later ontogenetic stages umbilical tubercles appear on the main ribs and, later still, also lateral tubercles. Constrictions develop along some main ribs.

Description – The early whorls moderately increase in height; in the adult stage (RGM 214 376) the last whorl increases only slowly in height. The venter is rounded, the flanks are flattened, and the dorsum is broad and flat. The cross section of the early whorls is subellipsoidal, but from D = 30-35 mm it becomes subtrapezoidal with the greatest thickness at the lower quarter of the whorl height.

A few weak constrictions are present between the very thin, closely spaced, radiate, uniform ribs on the early whorls. From D = 40-50 mm, a differentiation in main and intermediate ribs sets in. At first, the main ribs are only slightly stronger than the intermediate ribs and provided with small ventrolateral spines; the latter become stronger with growth. The number of intermediate ribs to one main rib is 7-11, but from D = 100-105 mm it decreases to 4-6. In a later ontogenetic stage umbilical spines appear and, later still, also lateral spines. Distinct constrictions develop adapical (rarely adoral) of some of the main ribs. On the flanks of the early whorls the ribs, especially the intermediate ones, are slightly flexuous or straight, but they are generally straight in later growth stages. All ribs pass straight over the venter. On the dorsum the ribs are equally thin and convex. The sculpture of the adult stage is not preserved.

The suture line is preserved on RGM 213 640; the lateral (L) lobe is trifid and long, whereas the umbilical (U_1) one (also trifid) is markedly short.

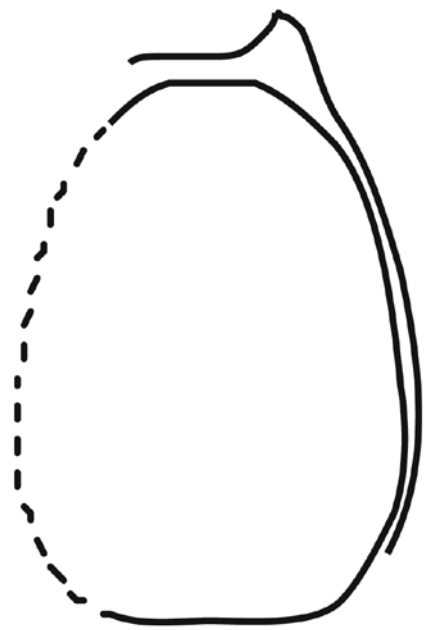

Fig. 4. Whorl section of *Emericiceras hannoverense* sp. nov., RGM 214 376. × 1.

Measurements –

№	D	H	h	W	U	H/D	W/D	U/D	H/W	H/h	K
213 882	143.5	42.4	27.3	-	78.2	0.29	-	0.54	-	1.55	0.10
214 375	121.0	39.0	24.0	-	62.0	0.32	-	0.51	-	1.62	0.12
214 376	108.0	30.0	20.8	-	60.0	0.28	-	0.55	-	1.44	0.08
	(70.0)	(20.8)	(13.5)		(38.5)	(0.30)		(0.55)		(1.54)	(0.10)
213 590	106.0	31.0	20.0	-	58.5	0.29	-	0.55	-	1.55	0.10
213 640	97.0	29.0	18.8	-	52.3	0.30	-	0.54	-	1.54	0.10
213 593	96.0	31.3	18.7	-	48.0	0.32	-	0.50	-	1.67	0.13
214 379	93.0	30,5	19.0	-	47.5	0.32	-	0.51	-	1.60	0.12
214 022	89.0	27.0	17.5	-	46.4	0.30	-	0.52	-	1.54	0.10
214 021	70.0	21.3	14.0	-	38.0	0.30	-	0.54	-	1.52	0.10
213 633	49.5	14.3	10.0	-	25.0	0.29	-	0.50	-	1.43	0.08

Comparison – *Emericiceras hannoverense* sp. nov. resembles *E. wermbteri* in the shape of the cross section and in the type of sculpture on the early whorls, but differs from it in having more tightly coiled crioconic whorls, in having a greater number of intermediate ribs between every two main ribs, in having distinct constrictions and in lacking intercalatory ribs.

Occurrence – RGM 213 865, upper Hauterivian *inversum-staffi* zonal boundary beds, quarry 4, bed 44, near Wilhelmsdorf, Haste; RGM 213 590, 213 593, 213 617, 213 640 (bed 20), 214 021, 214 022, 214 375, 214 376, 214 379, 214 382, upper Hauterivian *staffi* Zone, bed 26, S-Bahn Hannover Airport; RGM 213 633 and 213 977, upper Hauterivian *staffi* Zone, beds 100 and 102, respectively, Resse quarry, Hainholz, northern Germany.

***Emericiceras kemperi* sp. nov.**

Pls. 69-72; Pl. 73, fig. 2.

Holotype – RGM 213 639.

Type locality – S-Bahn Hannover Airport, northern Germany.

Type horizon – Upper Hauterivian *staffi* Zone, bed 19.

Derivatio nominis – In honour of Dr. Edwin Kemper.

Material – Five further fairly well-preserved specimens, RGM 197 176, 213 637, 213 642, 214 019 and 214 023.

Diagnosis – The early whorls are contiguous and moderately increasing in height. The later whorls gradually become tightly crioconically uncoiled. The cross section is subellipsoidal. The sculpture of the contiguous early whorls consists of an alternation of slightly flexuous main ribs, and long and short intermediate ribs. Small umbilical spines first appear on the main ribs. Ventrolateral spines appear with the beginning of crioconic uncoiling, whereas the smaller lateral spines appear later. The ventrolateral and lateral spines are stronger than the umbilical ones. The number of non-tuberculate intermediate ribs to one main rib is one on the early whorls, later increasing to two.

Description – Up to D = 130-170 mm the large shell consists of contiguous planispiral whorls, which moderately increase in height. From this diameter the whorls gradually become tightly crioconic. The venter is rounded and the flanks are slightly convex, but the dorsum is broad and almost flattened. The subellipsoidal cross section is markedly higher than wide.

The sculpture of the early contiguous whorls consists of slightly flexuous main and intermediate ribs. Then appear umbilical thickenings, which with growth develop into rather strong umbilical spines. Between every two main ribs there is only one intermediate or intercalatory rib; the latter arise at one third of the whorl height. The ventrolateral spines appear at D = 80-85 mm, the lateral spines appear at D = 140-145 mm. The ventrolateral and lateral spines become longer than the umbilical ones. The bases of all spines are stretched in the direction of ribbing. Between every two main ribs there are two non-tuberculate intermediate ribs. All ribs cross the venter in a straight line, whereas on the dorsum they are convex.

Mesurements –

№	D	H	h	W	U	H/D	W/D	U/D	H/W	H/h	K
213 639	205.0	69.0	46.0	58.2	97.0	0.34	0.28	0.47	1.18	1.50	0.11
	(133.0)	(46.0)	(31.5)	(36.3)	(60.5)	(0.34)	(0.27)	(0.45)	(1.26)	(1.46)	(0.10)
213 642	241.0	81.0	50.0	-	109.0	0.34	-	0.45	-	1.62	0.13
214 019	159.0	58.5	36.4	-	72.0	0.37	-	0.45	-	1.60	0.14
213 637	125.0	42.0	30.2	-	59.0	0.33	-	0,47	-	1.39	0.09
197 176	77.0	27.2	17.4	-	33.5	0.35	-	0.43	-	1.56	0.13

Comparison – *Emericiceras kemperi* resembles *Paracrioceras stadtlaenderi* (Müller) in its general shell shape (contiguous early whorls and very tight crioconic coiling of late whorls), in its subellipsoidal cross section in the early and middle growth stages, and in the presence of intercalatory ribs, but differs from it in having denser ribbing and a greater number of intermediate ribs between every two trituberculate main ribs.

Occurrence – RGM 213 639, 214 019, 214 023, 197 176, 213 642, 213 637, upper Hauterivian *staffi* Zone, bed 19, S-Bahn Hannover Airport, northern Germany.

Genus *Crioceratites* Léveillé, 1837

Type species – *Crioceratites Duvalii* Léveillé, 1837, by subsequent designation of Diener (1925, p. 192). France (Basses-Alpes), Hauterivian.

Diagnosis – Crioconic shells of which the whorls slowly to moderately increase in height. The cross section of the early whorls is subcircular. Later it may be subellipsoidal, subtrapezoidal, subrectangular or suboval. The sculpture of the earliest whorls consists of simple, thin, non-tuberculate ribs; rarely, weak constrictions may be present. In later growth stages a differentiation into main and intermediate ribs develops. In some species intercalatory or bifurcate ribs may occur. In later ontogenetic stages ventrolateral spines and/or umbilical tubercles may appear on the main ribs. Distinct constrictions adapically or adorally of some of the main ribs. Ventrolateral spines may disappear towards the mature growth stage.

Remarks – As noted above, we follow Vermeulen (2004) in distigushing the artificial group of "*C.*" *nolani* from the artificial group of *C. duvali*, although the precise number of included species of both groups is under discussion. The difference in the type of sculpture between these two artificial groups is marked.

Distribution – Hauterivian. western and central Europe, Crimea, Caucasus, North Africa, South America.

***Crioceratites hastensis* sp. nov.**

Pl. 30, fig. 2; Pl. 31; Pl. 32, fig. 2; Pl. 33; Pl. 34, fig. 1; Fig. 5.

Holotype – RGM 214 089.

Type locality – Mittelland Canal near Wilhelmsdorf, Haste.

Type horizon – Upper Hauterivian *staffi* Zone.

Derivatio nominis – The species is named after the village of Haste.

Material – Five further faily well-preserved specimens, RGM 197 182, 213 505, 213 514, 213 516 and 213 866, and several fragments.

Diagnosis – Crioconic shell with whorls that moderately increase in height. The whorl section is subellipsoidal. The sculpture of the early whorls consists of closely spaced, rather thin, slightly flexuous, simple ribs. In a later growth stage the ribbing differentiates into main (with ventrolateral spines) and intermediate (non-tuberculate) ribs. There are constrictions adapical of some main ribs. The intermediate ribs are slightly thinner than the main ones and there are 3-7 intermediate ribs to one main rib. All ribs cross the venter in a straight line, but on the dorsum they make a convex curve. On the flanks the ribs are slightly flexuous.

Description – Criocone with whorls that are rather approximate, but from D = 100-120 mm the shell becomes more open crioconic. The whorls moderately increase in height. The flanks of the early whorls are slightly convex, but from D = 35 mm they flatten. The venter is narrow and rounded. The dorsum is flattened and broad; later, it has a shallow depression. The whorl section is subellipsoidal.

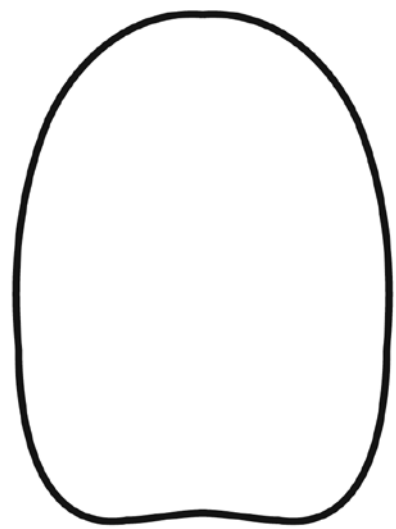

Fig. 5. The whorl section of *Crioceratites hastensis* sp. nov., RGM 213 514. × 1.

The sculpture of the early whorls consists of closely spaced, adorally concave, simple ribs. Main ribs with ventral spines and non-tuberculate intermediate ribs gradually appear from D = 20 mm. In the early ontogenetic stage there are 5-7 intermediate ribs to one main rib. On the last whorl there are additional short intercalatory ribs, which start at three-quarters of the whorl height or slightly lower. There are also very few bifurcating ribs. Bifurcation starts below the middle of the whorl height. The main ribs bear ventrolateral spines, which become rather prominent on the last whorl of the holotype. At the umbilical margin some of main ribs have tubercle-like thickenings. There are constrictions behind the main ribs, which are very clear on the last whorl. The main ribs are slightly thicker than the intermediate ones. All ribs cross the venter in a straight line, they are slight flexuous on the flanks, and on the dorsum all ribs are equally thin and convex.

Measurements –

№	D	H	h	W	U	H/D	W/D	U/D	H/W	H/h	K
213 866	101.4	34.5	21.5	-	47.0	0.34	-	0.46	-	1.60	0.12
214 089	90.0	30.0	18.9	-	44.5	0.33	-	0.49	-	1.59	0.12
197 182	90.0	31.5	21.0	-	46.5	0.35	-	0.52	-	1.57	0.11
213 516	73.0	25.2	16.0	19.3	34.5	0.34	0.26	0.47	1.30	1.57	0.12
213 514	71.4	25.2	16.6	19.2	30.0	0.35	0.26	0.42	1.31	1.51	0.12

Comparison – This species resembles *C. loryi* Sarkar, 1955 (see Thieuloy, 1972, p. 41, pl. 5, figs. 1-5) in the crioconic whorls that moderately increase in height and in the type of sculpture of the adult ontogenetic stage, i.e., slightly flexuous intermediate ribs, which tend to become as strong as the main ribs. But it differs from *C. loryi* in the absence of umbilical tubercles, and in the flexuous fasciculated ribs on the early and middle ontogenetic stages. The inner whorls of a very large specimen, RGM 197 182 (Pl. 32, fig. 1), resemble those of *C. hastensis*, but, unlike the latter species, it has a loosely coiled crioconic last whorl which slowly increases in height. We therefore prefer to refer to it as *C.* aff. *hastensis* (Pl. 32, fig. 1).

Occurrence – RGM 213 505, upper Hauterivian *inversum* Zone, quarry 2, Mittelland Canal near Wilhelmsdorf, Haste; RGM 213 866, upper Hauterivian *staffi* Zone, quarry 4, bed 56, along the Mittelland Canal near Wilhelmsdorf, Haste; RGM 214 089, same locality, but without bed number. RGM 213 514, 213 516, upper Hauterivian *staffi* Zone, Mittelland Canal, Haste; RGM 197 182, upper Hauterivian *staffi* Zone, bed 30, S-Bahn Hannover Airport, northern Germany.

***Crioceratites subisocostatus* sp. nov.**

Pl. 34, fig. 2; Pl. 35; Pl. 36, fig. 1.

Holotype – RGM 197 181.

Type locality – S-Bahn Airport Hannover, northern Germany.

Type horizon – Upper Hauterivian, *staffi* Zone, bed 19.

Derivatio nominis – *Sub* as prefix (Latin) = somewhat, nearly; *isos* (Greek) = equal; *costa* (Latin) = rib; because of almost equal thickness of main and secondary ribs.

Material – Five further specimens, RGM 197 176, 197 191, 197 192, 213 864, 214 023.

Diagnosis – Very large shell, with contiguous or almost contiguous early whorls, which slowly increase in height. Later whorls become crioconic. The sculpture of the early whorls consists of straight to slightly curved, non-tuberculate ribs. They pass over the venter without broadening. In a later growth stage there appear ventrolateral spines on some ribs and, simultaneously, coiling becomes more crioconic. The tuberculate main ribs have the same thickness as those of the intermediate ribs. Still later the main ribs become slightly stronger than the intermediate ones.

Description – The shell is very large (D > 190 mm). At D = 65-110 mm, the contiguous whorls become crioconic, slowly increasing in height. The venter of the early whorls is rounded and the flanks are slightly convex. The dorsum is flat, but from D = 100-110 mm it has a shallow depression (RGM 197 196). In a later ontogenetic stage, the venter becomes broader and almost flat; the dorsum and flanks also are flat. The cross section changes from subellipsoidal (up to D = 105-110 mm) to suboctagonal (D > 110 mm).

The sculpture of the early whorls (H = 6.5-10 mm) consists of straight, simple, distant, equal, non-tuberculate ribs. The width of the interspaces is twice the breadth of the ribs. Intermediate ribs appear later. In this stage all ribs are equal and slightly flexuous on the flanks, while they pass straight over the venter without broadening. On the dorsum the ribs are thin and slightly convex. From D = 60-70 mm ventrolateral spines appear on some ribs; these are the main ribs. There are 3-4 non-tuberculate intermediate ribs to one main rib. Only after D = 140 mm do the main ribs become stronger than the intermediate ones.

Measurements –

№	D	H	h	W	U	H/D	W/D	U/D	H/W	H/h	K
217 181	185.0	51.5	37.7	-	100.0	0.28	-	0.54	-	1.37	0.08
197 191	144.0	41.0	29.0	-	76.8	0.28	-	0.53	-	1.41	0.08
	(67.5)	(22.2)	(17.0)		(28.0)	(0.33)		(0.41)		(1.30)	(0.07)
213 864	102.0	36.5	25.5	-	47.0	0.36	-	0.46	-	1.43	0.11
197 192	98.0	36.0	22.5	-	42.0	0.37	-	0.43	-	1.60	0.14

Comparison – *Crioceratites subisocostatus* differs from congeneric species in having contiguous whorls up to D = 65-110 mm, which become crioconic only in the later ontogenetic stage, and in having equally thick main (with ventral tubercles) and intermediate (non-tuberculate) ribs up to D = 140 mm.

Occurrence – RGM 197 176, 197 181, 197 191, 197 192, upper Hauterivian *Staffi* Zone, bed 30, S-Bahn, Hannover Airport, Hannover; RGM 214 023, same locality, bed 19; RGM 213 864, upper Hauterivian *staffi* Zone, quarry 4, beds 56-58, along Mittelland Canal near Wilhelmsdorf, Haste, northern Germany.

***Crioceratites vermiformis* sp. nov.**
Pl. 36, figs. 2-4.

Holotype – RGM 197 188A.

Type locality – S-Bahn Hannover Airport, northern Germany.

Type horizon – Upper Hauterivian, *staffi* Zone, bed 30.

Derivacio nominis – Referring to the worm-like shape.

Material – Two further fairly well-preserved specimens, RGM 197 185 and 197 194.

Diagnosis – Widely open crioconic whorls. The early whorls moderately increase in height, but the later ones only slowly do so. The venter and flanks are rounded, the dorsum is flattened. The cross section changes from subcircular to subellipsoidal. The sculpture consists of main and thinner intermediate ribs. The main ribs bear ventrolateral spines. There are 3-4 non-tuberculate intermediate ribs to one main rib. In the mature stage the thickness of the main and intermediate ribs becomes equal.

Description – A moderately-sized shell. Up to D = 30-35 mm the whorls moderately increase in height, but later coiling becomes very open and the whorls only slowly increase in height. The cross section changes with age from subcircular to subellipsoidal.

The sculpture of the early whorls consists of straight to slightly curved, simple ribs. The space between the ribs is equal to their thickness, but after D = 10-12 mm the ribs become more widely-spaced and the main ribs bear strong ventral spines. The slightly thinner intermediate ribs remain non-tuberculate and there are 3-4 to one main rib. On the flanks the ribs are slightly prorsiradiate, but they pass straight over the venter. On the dorsum all ribs are equally thin and convex. In the mature stage the main and intermediate ribs become equal and ventral spines gradually disappear.

Measurements –

№	D	H	h	W	U	H/D	W/D	U/D	H/W	H/h	K
197 188A	54.5	12.0	8.5	-	36.0	0.22	-	0.67	-	1.41	0.06
	(32.5)	(8.5)	(5.0)		(21.0)	(0.26)		(0.66)		(1.70)	(0.11)
197 185	40.5	10.4	7.5	-	23.5	0.25	-	0.58	-	1.39	0.07
197 194	39.8	11.4	6.2	-	23.5	0.28	-	0.59	-	1.83	0.13

Comparison – This species differs from congeneric species in having very open crioconic whorls that slowly increase in height.

Occurrence – RGM 197 185, 197 188a, 197 194: upper Hauterivian *staffi* Zone, bed 30, S-Bahn Hannover Airport, Lower Saxony, northern Germany.

Genus *Fissicostaticeras* gen. nov.

Type species – *Hamites (Ammonites) fissicostatus* Roemer, 1841 (p. 94, pl. 13, fig. 13), lower Barremian, Yorkshire, England.

Derivatio nominis – The genus is named after the bundled (or fasciculate) ribs in the early ontogenetic stage: *fissus* (Latin) = split, *costa* (Latin) = rib, thus *fissicostatus* = with split ribs.

Diagnosis – The earliest whorls may be contiguous or near-contiguous. Later, the shell consists of rather tightly coiled crioconic whorls which moderately increase in height. In the adult growth stage the whorls may become almost contiguous again. The cross section is variable and may be subcircular, subellipsoidal, subtrapezoidal or oval. The sculpture of the earliest whorls consists of closely-spaced, straight or flexuous, simple ribs; later umbilical tubercles appear. Besides single ribs there are now bundled ribs, i.e., two or three ribs arise from the umbilical tubercles, which pass, as do the single ribs, over the venter without interruption. In a later growth stage lateral and ventrolateral tubercles or clavi appear, and the sculpture consists of strong, simple trituberculate main ribs with 2-6 intermediate ribs to one main rib. Some intermediate ribs may bear small ventrolateral tubercles. Rarely, intercalatory ribs may occur. In the adult growth stage the intermediate ribs may be totally absent.

Remarks – Spath (1924) included two different groups of species in the genus *Hoplocrioceras*.

1. Group of *Hoplocrioceras phillipsi* (Phillips), which is characterized by small shells with planispiral whorls, which are either crioconic (such as *H. laeviusculum* (von Koenen)) or in contact (like *H. phillipsi* (Phillips)), followed by a curved shaft and a long hook.

2. Group of *"Crioceratites" fissicostatus* (Roemer), with typical crioconic whorls, sculptured by single ribs and by bundles of two, or rarely three, ribs arising from umbilical tubercles. In the later growth stage, lateral and ventrolateral tubercles appear, and the sculpture consists of trituberculate main and non-tuberculate intermediate ribs.

The "group of *fissicostatus* (Roemer)" is regarded herein as an independent genus, *Fissicostaticeras* gen. nov. It clearly differs from the genus *Hoplocrioceras*, here restricted to the group of *Hoplocrioceras phillipsi*, in the absence of a shaft and a hook, and in having bundled ribs arising from umbilical tubercles in early ontogenetic stages. This group was previously included in *Crioceratites (Paracrioceras*) Spath (see Rawson, 1975; Rawson & Mutterlose, 1983) or in *Crioceratites (Crioceratites*) Léveillé (Immel, 1978). A detailed study of the ontogeny of the representatives of this group shows that it approaches *Emericiceras* as well as *Paracrioceras* only by its mode of crioconic coiling, and the presence of trituberculate main and non-tuberculate intermediate ribs in middle growth stages. However, this group clearly differs from *Paracrioceras* and *Emericiceras* in the characteristic type of sculpture in early growth stages, viz. in having bundled ribs arising from umbilical tubercles, in the markedly later appearance of ventrolateral and lateral tubercles, and in the absence of constrictions.

The new genus represents an independent phylogenetic lineage. It branched off from the "*nolani*" group (Immel, 1978, p. 71, fig. 12), presumedly during the early Barremian, and comprises six species (see below).

Distribution – Barremian; northern Germany, England, northern Caucasus, Morocco(?).

***Fissicostaticeras fissicostatum* (Roemer, 1841)**

Pls. 37, Pl. 38; Pl. 39, fig. 1; Pl. 40, fig. 1.

non 1829 *Ammonites fissicostatus* Phillips, p. 123, pl. 2, fig. 49 [= *Deshayesites fissicostatus*] (specimen lost).
1841 *Hamites (Ammonites) fissicostatus* Phillips; Römer, p. 94, pl. 13, fig. 13a, b.
1881 *Crioceras fissicostatum* Römer; Neumayr & Uhlig, p. 185, pl. 56, figs. 1, 1a.
1902 *Crioceras fissicostatum* Römer; von Koenen, p. 233, pl. 12, fig. 2, pl. 22, figs. 1, 2.
1902 *Crioceras fissicostatum* var. *minor*; von Koenen, p. 236, pl. 23, figs. 1a, b, 2.
1938 *Hoplocrioceras fissicostatum* Neumayr & Uhlig; Roman, p. 354, pl. 35, fig. 333 [= Neumayr & Uhlig, 1881, pl. 56, fig. 1].
1942 *Crioceras (Hoplocrioceras) fissicostatum* (Römer); Dacqué, pl. 1, figs. 12, 12a [= Neumayr & Uhlig, 1881, pl. 56, fig. 1, 1a].
1957 *Hoplocrioceras fissicostatum* (Römer); Arkell *et al.*, p. L208, fig. 237:7 [= von Koenen, 1902, pl. 22, fig. 2].
1967 *Hoplocrioceras fissicostatum* (Römer); Dimitrova, p. 78, text-fig. 34 [= von Koenen, 1902, pl. 22, fig. 2].
1974 *Hoplocrioceras fissicostatum* (Römer); Kaever *et al.*, p. 221, pl. 1, fig. 5a, b [= von Koenen, 1902, pl. 22, figs. 1, 2].
1978 *Crioceratites (Crioceratites) fissicostatus* (Römer); Immel, p. 62, text-fig. 11b [= Neumayr & Uhlig, 1881, pl. 56, fig. 1].
1980 *Crioceratites (Crioceratites) fissicostatus* (Römer); Immel & Mutterlose, p. 250, pl. 5, figs. 1, 5.
1980 *Crioceratites (Crioceratites) fissicostatus – aequicostatus*; Immel & Mutterlose, p. 255, pl. 5, fig. 3.
non 1983 *Crioceratites (Paracrioceras) fissicostatum* (Römer, *non* Phillips); Rawson & Mutterlose, p. 139, fig. 3d-g.
1995 *Crioceratites (Hoplocrioceras)* cf. *fissicostatum* (Römer); Mutterlose, pl. 8, figs. 2, 3.
1997a *Hoplocrioceras fissicostatum*; Mutterlose *et al.*, figs. 46.3, 46.4.

Holotype – The specimen figured by Roemer (1841, p. 94, pl. 13, fig. 13), Yorkshire, England, Speeton Clay Formation, lower Barremian.

Material – Three fairly well-preserved specimens, RGM 214 002, 214 003 and 214 020.

Description – The large shell, RGM 214 003 (D > 160 mm), consists of rather tightly coiled crioconic whorls. Up to D = 100-150 mm the whorls increase moderately in height, but from this diameter they slowly do so. The early ontogenetic stage is visible from H = 8 mm in RGM 214 002. The flanks of the whorls are flat. The venter of the early whorls is convex, but later it becomes flattened. The dorsum is flat and has a shallow depression in a late ontogenetic stage. The cross section changes from subellipsoidal to subtrapezoidal.

The sculpture of the early whorls (D = 12-15 mm) consists of closely spaced, thin ribs. Besides the single ribs, there are slightly flexuous bundled ribs; 2 or 3 branches arise from rather strong umbilical tubercles and, like the single ribs, they pass straight

over the venter. In this growth stage, ventrolateral and lateral tubercles are not yet present, and on the venter all ribs are equal. At about D > 130-150 mm, lateral and ventrolateral tubercles appear, so that the sculpture consists of rather strong trituberculate main ribs with 2-3 thin, non-tuberculate intermediate ribs to one main rib. With growth the number of the intermediate ribs between the two main ribs decreases to one, but on the body chamber there are simple, distant trituberculate main ribs only.

Measurements –

№	D	H	h	W	U	H/D	W/D	U/D	H/W	H/h	K
214 020	360.0	108.0	88.5	-	170.0	0.30	-	0.47	-	1.22	0.05
214 003	160.0	60.8	37.0	46.0	70.0	0.38	0.29	0.44	1.32	1.64	0.14
214 002	153.5	54.0	33.0	45.5	67.0	0.35	0.30	0.44	1.19	1.67	0.13

Comparison and remarks – This species resembles *F. aequicostatum* (von Koenen, 1902) in the bundling of ribs from the umbilical tubercles. It differs in the markedly late appearance of ventrolateral and lateral tubercles, and in the more rapid increase of the height of the early crioconic whorls.

The small number of specimens does not permit the assessment of the intraspecific variabilities of *F. fissicostatum* and *F. aequicostatum*. We agree with the opinion of Immel & Mutterlose (1980, p. 253) that these two 'groups' may be regarded as one species, but it is still impossible to prove it.

Occurrence – RGM 214 002, 214 003, 214 020, lower Barremian *fissicostatum* Zone, bed 6, Subway Aegidientor Square, Hannover, northern Germany.

Distribution – Lower Barremian *fissicostatum* Zone of northern Germany; upper Barremian *Elegans* Zone of Speeton, England; Barremian of Morocco (?); lowermost Barremian of northern Caucasus.

***Fissicostaticeras* ex gr. *fissicostatum* (Roemer, 1841)**

Pl. 39, figs. 2-4; Pl. 40, fig. 2.

Material – Four rather well-preserved specimens, RGM 213 897, 213 898, 214 015 and 216 245, represented by early and middle growth stages.

Description – The early whorls are contiguous, while later whorls exhibit a tight crioconic coiling. The cross section changes from subellipsoidal to subtrapezoidal. Up to D = 25 mm the sculpture consists of simple non-tuberculate ribs. From this diameter onward appear umbilical swellings, which in a later growth stage develop into rather strong umbilical tubercles. From these tubercles arise 2 or 3 ribs. Between every pair of such bundles are 3-6 single intermediate ribs. All ribs pass straight over the venter. On the venter all ribs are equal. The sculpture of the late ontogenetic stage is not known.

Portions of the suture line are visible in RGM 216 245; the lateral lobe (L) is long and asymmetrically trifid. It is markedly larger than the ventral (E) bifid lobe. The first and second lateral saddles (E/L, L/U_1) have approximately the same height.

Measurements –

№	D	H	h	W	U	H/D	W/D	U/D	H/W	H/h	K
216 245	121.0	48.7	28.8	35.6	46.0	0.40	0.29	0.38	1.37	1.69	0.16
214 015	52.0	21.0	11.8	-	20.7	0.40	-	0.40	-	1.77	0.17

Remarks – These specimens resemble *F. fissicostatum* in the bundles of ribs arising from the umbilical tubercles in the early ontogenetic stage, but differ from it in the much narrower umbilicus, in the early whorls being contiguous and in the more rapid increase of whorl height. Since we do not know the morphology of the later ontogenetic stages, these specimens are referred to as *F.* ex gr. *fissicostatum.*

Occurrence – RGM 216 245, lower Barremian *fissicostatum-elegans* zonal boundary bed 7, Subway Aegidientor Square, Hannover; RGM 214 015, lower Barremian *fissicostatum* Zone, bed 6, same locality; RGM 213 897, 213 898, lower Barremian *rarocinctum* Zone, bed 83, Gott quarry near Sarstedt, northern Germany.

***Fissicostaticeras aequicostatum* (von Koenen, 1902)**

Pl. 41, fig. 1.

1902 *Crioceras aequicoastatum* von Koenen, p. 240, pl. 21, figs. 1, 2.
1902 *Crioceras aequicostatum* von Koenen var. *subtilis*; von Koenen, p. 240, pl. 30, fig. 3.
? 1969 *Hoplocrioceras aequicostatum* (von Koenen); Hiltermann & Kemper, pl. 2, fig. 8.
1978 *Crioceratites (Crioceratites) aequicostatus* (von Koenen); Immel, p. 63, pl. 1, fig. 1.
1980 *Crioceratites (Crioceratites) aequicostatus* (von Koenen); Immel & Mutterlose, p. 255, figs. 2, 4.
non 1997 *Crioceratites aequicostatus* (von Koenen); Mutterlose *et al.*, p. 71, fig. 46.2.

Holotype – The specimen figured by von Koenen (1902, pl. 21, fig. 2) from the upper Barremian *elegans* Zone, Hildesheim, northern Germany.

Material – One well-preserved specimen, RGM 214 487.

Description – The shell consists of crioconic whorls, which moderately increase in height. Up to D = 30 mm the flanks of the whorl are slightly convex; from this diameter they flatten. The venter of the early whorls is rounded, but from D = 80 mm it gradually flattens. The dorsum is flat with a shallow depression in the adult growth stage. The cross section changes from subcircular to subellipsoidal, but later, from D = 80 mm it is subtrapezoidal.

The sculpture of the early whorls (up to D = 20 mm) consists of dense, straight or slightly flexuous, simple ribs. From this diameter also appear fasciculate ribs. The point of splitting into two ribs is at the umbilical margin. Approximately at D = 40-45 mm, umbilical tubercles appear at the points of splitting. There are also single main ribs originating from the umbilical tubercles; these ribs are markedly thicker than the non-tuberculate intermediate ribs. The number of the latter between every two main ribs is 4-5 on the early whorls, but after D = 90 mm their number decreases to one. The ventrolateral spines appear at D = 70 mm and the lateral tubercles at D = 80 mm.

Measurements –

№	D	H	h	W	U	H/D	W/D	U/D	H/W	H/h	K
214 487	110.0	36.2	23.5	-	53.5	0.33	-	0.49	-	1.54	0.11
	(66.5)	(23.5)	(15.0)		(30.0)	(0.35)		(0.45)		(1.57)	(0.12)

Comparison – This species resembles *F. fissicostatum*; a comparison between the two is given in the description of the latter.

Occurrence – Upper Barremian *elegans* Zone, Subway Aegidientor Square, Hannover.

Distribution – Lower Barremian *fissicostatum* Zone, northern Germany; upper Barremian, *elegans* Zone.

***Fissicostaticeras claviferum* sp. nov.**

Pl. 41, fig. 2; Fig. 6.

Holotype – RGM 213 931, represented by one and a half planospiral whorls of the early ontogenetic stage (D = 45 mm). The only specimen known.

Type locality – Gott quarry near Sarstedt, Lower Saxony, northern Germany.

Type horizon – Lower Barremian *rarocinctum* Zone, bed 83.

Derivatio nominis – *clavus* (Latin) = nail; *fero* (Latin) = to bear; because the shell bears ventrolateral tubercles, which are elongated in the direction of coiling (clavi).

Diagnosis – The early crioconic whorls show a small gap, but in later growth stages they become almost contiguous. The cross section changes from ellipsoidal to oval. From D = 25 mm umbilical thickenings appear, which gradually develop into umbilical tubercles. From each umbilical thickening/tubercle two ribs arise of which one bears a distict ventrolateral clavus.

Description – The holotype is of moderate size, with tight crioconic coiling of the first whorl, while the last preserved part of the outer whorl almost touches the foregoing one. The flanks are slightly convex, the venter is narrow and rounded, and the dorsum broad and flat. The cross section of the first whorl is ellipsoidal, but from D = 20 mm it becomes oval, with the maximum thickness at one third of the whorl height.

The sculpture consists of slightly flexuous ribs, which pass straight over the venter without broadening. On the dorsum the ribs are very thin and convex. From D = 25 mm appear tubercle-

Fig. 6. Whorl sections of *Fissicostaticeras claviferum* sp. nov., RGM 213 931(holotype). × 1.

like thickenings at the umbilical edge, which with growth develop into rather strong umbilical tubercles. From each umbilical tubercle arises two ribs, one of which bears a distinct ventrolateral clavus. This is the main rib. There are 3-4, rarely 5-6, intermediate ribs to one main rib, most of which bear small ventrolateral tubercles with a rounded basis.

Measurements –

№	D	H	h	W	U	H/D	W/D	U/D	H/W	H/h	K
213 931	43.5	17.2	10.0	14.6	18.5	0.39	0.33	0.42	1.18	1.72	0.16

Comparison – *Fissicostaticeras claviferum* resembles *F. fissicostatum* and *F. aequicostatum* in having simple flexuous ribs, and fasciculate ribs arising from the umbilical tubercles, but it differs from these species in having ventrolateral clavi.

***Fissicostaticeras aequicostatoides* sp. nov.**
Pl. 41, fig. 3; Pl. 42; Pl. 43, fig. 1.

Holotype – RGM 216 204.

Type locality – Subway Aegidientor square in Hannover.

Type horizon – Barremian, at the boundary of the *fissicostatum* and *elegans* zones, bed 7.

Derivatio nominis – Named because it shows some similarities with *F. aequicostatum* (von Koenen).

Material – One further fairly well-preserved specimen, RGM 214 018.

Diagnosis – The large shell shows single and fasciculate ribs; the latter originate from umbilical tubercles. Usually, one of the two fasciculate ribs bears a lateral and ventrolateral tubercle. From D > 70-80 mm, the sculpture consists of strong, simple, trituberculate main ribs and 1-3 very thin, non-tuberculate intermediate ribs between every two main ribs. Intermediate ribs are absent in the adult growth stage.

Description – The crioconic whorls moderately increase in height. The flanks of the early whorls are slightly convex, although with growth they become flattened. The venter is rounded and the dorsum flat. The cross section is subellipsoidal. The sculpture consists of closely spaced, slightly flexuous, single and fasciculated ribs up to D = 30-35 mm; the latter originate in pairs from umbilical tubercles. The single ribs and some of the fasciculate ribs bear ventrolateral tubercles. The lateral tubercles are situated at three quarters of the whorl height, but on the mature body chamber at four-fifths. From D = 70-80 mm the sculpture changes; it consists of simple, straight, strong, trituberculate main ribs with very thin, non-tuberculate intermediate ribs between every two main ribs. Rarely, short intercalatory ribs may occur. The bases of the ventrolateral tubercles are slightly elongated in the direction of coiling, but those of the lateral and umbilical tubercles are slightly elongated in the rib direction. All ribs pass straight over the venter, but on the dorsum they are all thin and strongly convex.

Measurements –

№	D	H	h	W	U	H/D	W/D	U/D	H/W	H/h	K
216 204	160.0	52.2	36.0	-	78.0	0.33	-	0.49	-	1.45	0.10
	(100)	(35.0)	(22.0)		(45.0)	(0.35)		(0.45)		(1.59)	(0.13)
	(70.0)	(27.0)	(14.0)		(35.0)	(0.38)		(0.50)		(1.92)	(0.18)
214 018	69.0	24.7	12.7	19.2	34.0	0.36	0,28	0.49	1.29	1.94	0.17

Comparison – This new species resembles *F. aequicostatum* in the general shape of the shell, in the bundles of two ribs arising from the umbilical tubercles, and in the mode of alternation of main and intermediate ribs. However, it clearly differs from it in the presence of ventrolateral and lateral tubercles in earlier growth stage.

Occurrence – RGM 214 018, lower Barremian *fissicostatum* Zone, bed 6, Subway Aegidientor square, Hannover; RGM 216 204, lower Barremian *fissicostatum-elegans* zonal boundary bed 7, Subway Aegidientor Square, Hannover, northern Germany.

***Fissicostaticeras rarocinctum* (von Koenen, 1902)**

Pl. 43, fig. 2; Pls. 44-49.

1902 *Crioceras rarocinctum* von Koenen, p. 245, pl. 40, fig. 3.
1974 *Hoplocrioceras rarocinctum* (von Koenen); Kaever *et al.*, p. 221, pl. 1, fig. 4 [= von Koenen, 1902, pl. 40, fig. 3].
? 1983 *Crioceratites (Paracrioceras)* cf. *rarocinctum* (von Koenen); Rawson & Mutterlose, p. 139, text-fig. 2a, b.
1997 *Hoplocrioceras rarocinctum* (von Koenen); Mutterlose *et al.*, figs. 42.1, 42.2, 43.1, 43.2.
non 1997 *Hoplocrioceras* cf. *rarocinctum* (von Koenen); Mutterlose *et al.*, p. 67, fig. 42.3 [= *F. rarocinctoides* sp. nov.].

Lectotype – The specimen figured by von Koenen (1902, p. 245, pl. 40, fig. 3), upper Hauterivian *Olcostephanus phillipsi* Zone, quarry at the Bohnenkamp near Querum, northern Germany. Deposited in the Geologisch-Paläontologisches Institut Göttingen.

Material – Twelve fairly well preserved specimens, RGM 212 863, 212 864, 213 758, 213 800, 214 151, 214 505, 214 524-214 527, 214 535 and 216 238, and several fragments of crioconic whorls.

Description – The shell consists of whorls that moderately (early whorls) or slowly (later whorls) increase in height. The early whorls are contiguous, but in later ontogenetic stages they are crioconic. The flanks are slightly convex, the venter is rounded and the dorsum flattened. The cross section of the early whorls is subellipsoidal. But simultaneous with the start of crioconic coiling it becomes low-ellipsoidal, i.e., slightly higher than wide.

The sculpture on the early contiguous whorls consists of straight simple ribs. The intercostal space is equal to the rib thickness. From the start of crioconic coiling the sculpture consists of strong, straight or flexuous main ribs, provided with rather strong umbilical tubercles. From some umbilical tubercles arise two fasciculate ribs. The ventrolateral and lateral tubercles appear much later and may become rather

strong. Between every two main trituberculate ribs there are 2-4, rarely 2, comparatively thin, non-tuberculate intermediate ribs. All ribs pass straight over the venter.

Measurements –

№	D	H	h	W	U	H/D	W/D	U/D	H/W	H/h	K
216 238	380.0	107.5	75.0	99.0	210.0	0.28	0.26	0.55	1.08	1.43	0.08
214 505	427.0	120.0	88.0	122.0	230.0	0.28	0.28	0.53	0.98	1.36	0.07
214 151	364.0	116.5	74.0	-	190.0	0.32	-	0.52	-	1.57	0.11
212 864	180.0	61.0	45.2	-	76.0	0.34	-	0.42	-	1.35	0.08
213 800	168.0	53.5	39.0	-	82.0	0.32	-	0.48	-	1.37	0.08
214 526	120.0	42.2	37.3	46.0	54.5	0.35	0.38	0.45	0.92	1.13	0.04
214 525	112.5	42.0	24.7	-	50.0	0.37	-	0.44	-	1.70	0.15
214 535	93.0	35.0	19.0	32.0	42.0	0.37	0.34	0.45	1.09	1.84	0.17
214 524	65.5	25.3	13.8	-	27.5	0.38	-	0.42	-	1.83	0.17

Remarks – The specimen figured by Mutterlose *et al*. (1997, p. 67, fig. 42.3) clearly differs from the holotype of *F. rarocinctum* in having trituberculate main ribs in the early ontogenetic stage, whereas the trituberculation in the holotype and in other specimens starts with the beginning of crioconic uncoiling.

Occurrence – All RGM specimens discussed herein are from the lower Barremian *rarocinctum* Zone, bed 83, Gott quarry near Sarstedt, northern Germany.

Distribution – Lower Barremian, northern Germany; lower (?) Barremian, England.

***Fissicostaticeras rarocinctoides* sp. nov.**
Pls. 50-54; Pl. 55, fig. 1.

1997 *Hoplocriocera* cf. *rarocinctum* (von Koenen); Mutterlose *et al*., p. 67, fig. 42.3.

Holotype – RGM 213 797.

Type locality – Gott quarry near Sarstedt, Lower Saxony, northern Germany.

Type horizon – Lower Barremian *rarocinctum* Zone, bed 83.

Derivatio nominis – named after its resemblance to *F. rarocinctum*.

Material – Six fairly well-preserved specimens, RGM 212 862, 213 797 (holotype), 213 798A, 213 884, 214 536 and 214 537.

Diagnosis – Very large shell with crioconic whorls, which moderately increase in height. The cross section in the mature growth stage is suboval (only slightly higher than wide), with the maximum thickness at one-fifth of the whorl height. Up to D = 85-90 mm, the sculpture consists of trituberculate main ribs and 3-7 non-tuberculate intermediate ribs to one main rib. From some umbilical tubercles arise two fasciculate ribs.

The ventrolateral and lateral tubercles disappear earlier than the umbilical ones. Rarely intercalatory ribs may be present and all ribs pass straight over the venter. On the dorsum the ribs are thin and convex.

Description – The shell is very large (D > 220 mm) and consists of crioconic whorls, which moderately increase in height. The venter is rounded, the flanks are slightly convex, and the dorsum is broad and flat. Up to D = 90-95 mm, the whorl section is ellipsoidal (slightly higher than wide), but it becomes suboval with growth with the maximum thickness at one-fifth of the whorl height.

The sculpture of the earliest two whorls is not preserved, but later, up to D = 90-95 mm, it consists of trituberculate main ribs and 3-7 non-tuberculate intermediate ribs to one main rib. The ventrolateral spines are long and their tips are in contact with the dorsum of the next whorl. Looped ribs may rarely occur between the umbilical and lateral tubercles. From some umbilical tubercles arise two fasciculate ribs. After D = 90-95 mm, the ventrolateral spines and lateral tubercles disappear; the umbilical tubercles disappear later (at D = 125 mm, RGM 214 536). There are also rare intercalatory ribs, which arise at the lower third of the whorl height. All ribs pass straight over the venter, but on the dorsum the ribs are equally thin and curved forward.

The suture line is visible at H = 45 mm (RGM 213 884). The lateral (L) and umbilical (U_1) lobes are trifid. The siphonal saddle is high and divides the ventral lobe (E) into two symmetric branches. The middle branch of the lateral lobe is clearly longer than the ventral lobe and its other two branches are as long as the ventral lobe.

Measurements –

№	D	H	h	W	U	H/D	W/D	U/D	H/W	H/h	K
213 797	222.0	70.6	48.0	66.0	112.0	0.31	0.30	0.50	1.06	1.47	0.10
213 884	150.0	49.0	34.5	47.5	74.0	0.33	0.32	0.49	1.03	1.42	0.10
214 537	130.5	43.8	23.8	-	67.0	0.33	-	0.51	-	1.81	0.15
214 536	117.0	40.0	-	38.0	54.0	0.34	0,32	0.46	1.05	-	-
213 798A	104.0	32.0	20.3	-	52.0	0.30	-	0.50	-	1.60	0.11

Comparison – This new species resembles *F. rarocinctum* in the tightly coiled crioconic whorls that moderately increase in height and in the type of sculpture in the mature growth stage, but the new species differs in having trituberculate main and non-tuberculate intermediate ribs on the early whorls up to D = 90-95 mm.

Occurrence – All RGM specimens discussed herein are from lower Barremian *rarocinctum* Zone, bed 83, Gott quarry near Sarstedt, Lower Saxony, northern Germany.

Genus *Paracrioceras* Spath, 1924

Type species – *Ammonites (Crioceras) occultum* Seeley, 1865, p. 246, pl. 10. fig. 1a, upper Barremian, Yorkshire, England.

Diagnosis – In the early growth stage the whorls are slightly crioconic and almost contiguous, with an umbilical perforation. Later, with the development of ventrolateral spines, the whorls become less tightly coiled, while in the mature stage the whorls of

most species are contiguous again. In the early growth stage the sculpture consists of simple non-tuberculate ribs. With growth trituberculate (ventrolateral, lateral and umbilical tubercles) main ribs appear and 1-2, uncommonly 3 and rarely more, markedly thinner intermediate ribs between every two main ribs. Rarely, intercalatory ribs may be present. The ventrolateral spines are stronger than the lateral and umbilical tubercles. Looped ribs between the lateral and umbilical tubercles may also occur. In some species the intermediate ribs bear weak ventrolateral and sometimes also lateral tubercles. The spines disappear in the mature stage (rarely earlier) and the sculpture consists of strong, distant, simple ribs.

Distribution – Barremian of England, Germany, France, Bulgaria, Romania, Italy, northern Caucasus, Turkey, Morocco, South Africa and Colombia. Upper Hauterivian-lower Barremian, Crimea.

***Paracrioceras stadtlaenderi* (Müller, 1892)**

Pl. 55, fig. 2; Pls. 56, 57; Pl. 58, fig. 1; Pl. 59, figs. 1, 2.

1892 *Crioceras Stadtländeri* Müller, p. 19.
1902 *Crioceras Stadtlaenderi* Müller; von Koenen, p. 268, pl. 12, fig. 1a-d, pl. 43, fig. 5(?).
1978 *Crioceratites (Crioceratites) stadtlaenderi* (Müller); Immel, p. 65, pl. 7, fig. 3a, b, text-fig. 12b.

Lectotype – Immel (1978, p. 65) designated the specimen figured by von Koenen (1902, p. 268, pl. 12, fig. 1) to be lectotype; this specimen was collected and identified by G. Müller as *C. Stadtlaenderi* and deposited at the Geologisch-Paläontologisches Institut Göttingen 457-59.

Material – Six moderately well-preserved specimens, RGM 214 013, 214 094, 214 419 and 216 178-216 180.

Description – The early whorls are contiguous, but leave open a wide umbilical perforation. In a later stage, with the appearance of small ventrolateral tubercles, the whorls begin to separate from each other. The flanks of the early whorls are slightly convex, and the venter and dorsum are rounded. The cross section up to D = 30 mm is subcircular, but later it becomes subellipsoidal and then suboval.

The sculpture on the early whorls consists of thin, closely spaced, simple non-tuberculate ribs. Trituberculate ribs appear from D = 20 mm, which alternate irregularly with thin, non-tuberculate intermediate ribs. All ribs pass over the venter and dorsum without interruption. Short thick intercalatory ribs appear later, which regularly alternate (1:1) with tuberculate main ribs. On the venter all ribs are slightly convex. On the dorsum the ribs are thin and also convex. The ventrolateral and lateral tubercles are stronger than the umbilical ones. The ventrolateral and lateral tubercles become weak in the adult growth stage (from D = 125-130 mm), whereas the umbilical tubercles become weak in a later growth stage. From D = 230-240 mm, the sculpture consists of rather strong, non-tuberculate ribs (RGM 214 094).

The suture line is fragmentarily preserved on RGM 214 094. The first lateral lobe (L) is trifid, rather wide and long.

Measurements –

№	D	H	h	W	U	H/D	W/D	U/D	H/W	H/h	K
214 094	280.0	89.0	64.0	-	136.0	0.31	-	0.48	-	1.39	0.09
	(185.0)	(63.5)	(42.5)		(90.0)	(0.34)		(0.49)		(1.49)	(0.11)
216 178	123.5	42.3	25.5	38.0	60.5	0.34	0.31	0.49	1.11	1.66	
216 180	100.0	33.4	24.0	-	49.0	0.33	-	0.49	-	1.39	0.09
	(66.4)	(24.0)	(13.5)		(32.0)	(0.36)		(0.48)		(1.78)	(0.16)
214 013	95.3	31.2	21.5	-	47.0	0.33	-	0.49	-	1.52	0.11
214 419	60.8	19.1	11.5	15.4	31.5	0.31	0.25	0.52	1.24	1.66	0.12
216 179	57.0	18.6	9.8	-	30.0	0.33	-	0.53	-	1.90	0.15

Comparison – *Paracrioceras stadtlaenderi* resembles *P. crassispina* (von Koenen, 1902) in the general shape of the shell, especially in the morphology of the early whorls, but differs from it in having less distant ribs, and a regular alternation (1:1) of the main and intercalated ribs in the adult growth stage, whereas the short intercalatory ribs do not occur in *P. crassispina*.

Occurrence – RGM 214 094, 216 178-216 180: upper Barremian *denckmanni* Zone, Subway Hildesheimerstrasse, Hannover; RGM 214 013: upper Barremian *fissicostatum-elegans* zonal boundary bed 7, Subway Aegidientor square, Hannover; RGM 214 419: Barremian, Flemming quarry near Berenbostel, northern Germany.

Distribution – Upper Barremian, northern Germany, England(?); upper Barremian, *Hemihoplites soulieri* Zone, Georgia.

***Paracrioceras* aff. *stadtlaenderi* (Müller, 1892)**

Pl. 58, fig. 2; Pl. 59, fig. 3; Pl. 60; Fig. 7.

Material – Three specimens, of which RGM 213 900 preserving a 1.2 planispiral whorl with fragmentarily preserved sculpture. RGM 213 901 and 213 902 are small fragments of planispiral whorls.

Description – Large shell (D > 170 mm). In the mature ontogenetic stage the whorls are contiguous and moderately increase in height. The flanks and dorsum are flattened. At D = 70 mm, the venter is slightly rounded, but in a later growth stage it becomes flat. The cross section is subtrapezoidal in the mature stage.

The sculpture consists of equal, rather dense and strong ribs.The breadth of the ribs is equal to the width of the interspaces. In the late ontogenetic stage the

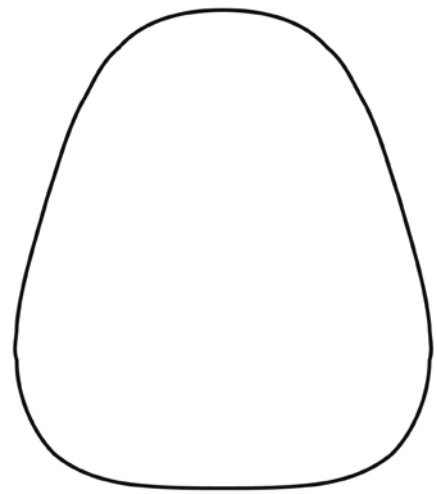

Fig. 7. Whorl section of *Paracrioceras* aff. *stadtlaenderi* (Müller), RGM 213 900. × 1.

ribs become wider and more distant. The ribs are mostly simple, but on the early part of the last whorl (RGM 213 900) there are also several bifurcating ribs. The bifurcation point is situated at a quarter of the whorl height. All ribs pass in a straight line and without broadening over the venter, whereas they become equally thin and convex on the dorsum. Some ribs are provided with tubercle-like ventrolateral swellings. In the latest ontogenetic stage (D > 140 mm) the sculpture consists of strong, rather distant, simple ribs, with ventrolateral tubercle-like swellings.

Measurements –

№	D	H	h	W	U	H/D	W/D	U/D	H/W	H/h	K
213 900	140.4	53.8	35.2	38.0	53.8	38.3	27.0	38.3	1.42	1.53	0.13

Remarks – These specimens resemble *H. rude* (von Koenen, 1902) in the morphology of the whorls and in the distant, straight simple ribs in the mature growth stage. However, owing to the poor preservation of the early whorls in all three specimens, it is impossible to determine their specific status confidently. Hence, they are referred to as *P.* aff. *stadtlaenderi* (Müller).

Occurrence – RGM 213 900, 213 902, upper Barremian *rude* Zone, bed 137, Gott quarry near Sarstedt; RGM 213 901, upper Barremian, Gott quarry near Sarstedt, northern Germany.

***Paracrioceras denckmanni* (Müller, 1892)**

Pls. 61, 62; Pl. 63, fig. 1.

1892 *Crioceras Denckmanni* Müller, p. 18.
1902 *Crioceras Denckmanni* Müller; von Koenen, p. 261, pl. 11, figs. 1a- c, 2a, b, pl. 21, fig. 5, pl. 29, fig. 1a, b(?).
? 1902 *Crioceras aequipartitum;* von Koenen, p. 260, pl. 30, fig. 2a, b.
1902 *Crioceras Muelleri;* von Koenen, p. 264, pl. 11, fig. 3a, b.
? 1930 *Crioceras Denkmanni* (Müller); Roch, p. 341, pl. 21, fig. 1.
1942 *Crioceras (Paracrioceras) denckmanni* (Müller); Dacqué, 11, figs. 2, 2a [= von Koenen, 1902 pl. 29, fig. 1a, b].
non 1971 *Hoplocrioceras* aff. *denckmanni* (Müller); Kemper, pl. 6, fig. 3a, b.
1978 *Crioceratites (Crioceratites) denckmanni* (Müller); Immel, p. 64, pl. 4, fig. 1a-c, text-fig. 12a [= von Koenen, 1902, pl. 11, fig. 1a].
1981*Paracrioceras denckmanni* (Müller); Kakabadze, pl. 2, fig. 1.
1995 *Crioceratites (Paracrioceras) denckmanni* (Müller); Mutterlose, pl. 7, fig. 1.

Lectotype – Immel (1978, p. 64, pl. 4, fig. 1a-c) designated as lectotype the specimen figured by von Koenen (1902, pl. 11, fig. 1) from the upper Barremian Denkmanni Zone, Mellendorf, northern Germany. Deposited in the Geologisch-Paläontologisches Institut Göttingen.

Material – Seven moderately preserved specimens, RGM 214 012, 214 093, 216 176, 216 177, 216 183, 216 184 and 216 197.

Description – The shell is large and consists of contiguous whorls, which moderately

increase in height. The morphology of the earliest whorls is not known. From H = 3 mm the venter is rounded, the flanks are slightly convex and the dorsum is flat. The cross section of the early whorls is subellipsoidal, but in later growth stages it becomes suboval, with the maximum thickness at one quarter of the whorl height.

The sculpture of the early whorls (up to D = 20 mm) is visible in RGM 216 176. It consists of widely spaced, straight, simple ribs, provided with umbilical and lateral tubercles. The ventrolateral tubercles are not visible because of the poor preservation of the earliest whorls. The lateral tubercles disappear very early (D = 25-28 mm), whereas the umbilical tubercles are retained up to a late growth stage. There are one, rarely two, thin intermediate or intercalatory ribs between every two strong main ribs. All ribs pass straight over the venter.

Measurements –

№	D	H	h	W	U	H/D	W/D	U/D	H/W	H/h	K
214 093	180.0	63.2	46.3	59.0	80.0	0.35	0.33	0.44	1.07	1.36	0.09
216 197	170.0	60.0	42.0	54.0	69.0	0.35	0.32	0.40	1.11	1.43	0.10
216 177	112.5	44.2	29.8	-	44.0	0.39	-	0.39	-	1.48	0.13
214 012	104.5	38.5	26.0	-	43.5	0.37	-	0.42	-	1.48	0.12
216 184	85.0	30.0	19.0	-	38.5	0.35	-	0.45	-	1.57	0.13
216 183	71.0	25.2	15.4	-	32.3	0.35	-	0.45	-	1.63	0.14
216 176	53.3	17.8	12.2	17.0	22.3	0.33	0.32	0.41	1.05	1.46	0.10

Comparison – *Paracrioceras denckmanni* resembles *P. stadtlaenderi* in the contiguous whorls and in the sculpture of the mature stage, but differs from it in having much thinner, distant ribs with lateral and umbilical tubercles, and in lacking ventrolateral tubercles. Moreover, *P. denckmanni* does not have intermediate ribs in the early growth stage.

Occurrence – RGM 216 176, 216 177, 216 183, 216 184, 216 197, 214 093, upper Barremian *denckmanni* Zone, Subway Hildesheimerstrasse, Hannover; RGM 214 012, upper Barremian *fissicostatum-elegans* zonal boundary bed, Subway Aegidientor Square, Hannover, northern Germany.

Distribution – Upper Barremian *denkmanni* Zone, northern Germany, England; upper Barremian *Hemihoplites soulieri* Zone, west Georgia; upper Barremian, western Morocco.

Paracrioceras tuba **(von Koenen, 1902)**

Pl. 63, fig. 2; Pl. 64; Pl. 65, fig. 1.

1902 *Crioceras tuba* von Koenen, p. 257, pl. 9, fig. 7, pl. 17, figs. 1, 2.
? 1902 *Crioceras Andreae* von Koenen, p. 272, pl. 21, figs. 3, 4.
? 1902 *Crioceras pingue* von Koenen, p. 308, pl. 51, figs. 3, 4, pl. 52, figs. 1, 2.
1942 *Crioceras pingue* (von Koenen); Dacqué, pl. 10, figs. 5, 5a [= von Koenen, 1902, pl. 51, fig. 3].
1978 *Crioceratites (Crioceratites) tuba* (von Koenen); Immel, p. 60, pl. 7, figs. 1, 2, text-fig. 10d.
1980 *Crioceratites (Crioceratites) tuba* (von Koenen); Immel & Mutterlose, p. 250, fig. 4.2.
? 1983 *Crioceratites (Paracrioceras) tuba* (von Koenen); Rawson & Mutterlose, p. 139, fig. 4e-f.
1997a *Crioceratites tuba* (von Koenen); Mutterlose *et al.*, figs. 45.3, 45.4.
2002 *Crioceratites* juv. cf. *tuba* (von Koenen); Richter, p. 18, pl. 25, fig. 1.

Holotype – The specimen figured by von Koenen (1902, p. 257, pl. 17, figs. 1, 2), *denckmanni* Zone, Hildesheim, northern Germany. Deposited in the Geologisch-Paläontologisches Institut Göttingen.

Material – Four specimens, RGM 216 175, 216 185, 216 189 and 283 497.

Description – The shell consists of very tightly coiled crioconic whorls with a very wide umbilical perforation. The whorls increase moderately in height. The cross section of the early whorls is circular, later becoming subellipsoidal.

The sculpture of the earlier whorl (H = 2-2,5 mm) is apparent in RGM 283 497 and consists of straight, dense, simple, non-tuberculate ribs. Soon main trituberculate ribs appear, which alternate (1:1) with the thin non-tuberculate intermediate ribs. First to appear are the ventrolateral tubercles and, slightly later, the umbilical and lateral tubercles. On the next whorl the number of intermediate ribs between two main ribs is in most cases one, rarely two; this remains so up to D = 140 mm, but the ribs become stronger, more distant and are slightly projected. From D = 100 mm the tubercles gradually disappear. The holotype still has ventrolateral tubercles at D = 140 mm.

Measurements –

№	D	H	h	W	U	H/D	W/D	U/D	H/W	H/h	K
216 175	99.0	32.0	20.5	-	49.0	0.32	-	0.49	-	1.56	0.11
216 185	95.5	32.0	20.0	-	46.0	0.33	-	0.48	-	1.60	0.12
216 189	85.5	26.0	18.6	-	45.5	0.30	-	0.53	-	1.40	0.09
283 497	44.0	10.5	4.5	-	31.5	0.24	-	0.71	-	2.33	0.13

Comparison – *Paracrioceras tuba* resembles *P. crassispina* (von Koenen, 1902) in its tight crioconic coiling, distant ribbing, and the mode of alternation of the main and intermediate ribs. But *P. tuba* differs from *P. crassispina* in having a higher ellipsoidal cross section, stronger trituberculate ribbing and in having ribs that are slightly convex in the adult ontogenetic stage.

Occurrence – RGM 216 175, 216 185, 216 189, upper Barremian, *denckmanni* Zone, Subway Hildesheimerstrasse, Hannover; RGM 283 497, upper Barremian(?), Gott quarry near Sarstedt, northern Germany.

Distribution – Upper Barremian, northern Germany, England.

***Paracrioceras elegans* (von Koenen, 1902)**

Pl. 65, figs. 2, 3; Pls. 66, 67; Fig. 8.

1902 *Crioceras elegans* von Koenen, p. 295, pl. 24, figs. 1, 2a, b, 3a, b, pl. 29, fig. 3.
1902 *Crioceras*? aff. *elegans* von Koenen, pl. 27, fig. 1a, b.
1942 *Crioceras elegans* (von Koenen); Dacqué, pl. 15, figs. 6, 6a [= von Koenen, 1902, pl. 24, fig. 3a, b].
1957 *Paracrioceras elegans* (von Koenen); Arkell *et al.*, p. L208, fig. 238:3 [= von Koenen, 1902, pl. 24, fig. 3a].

1974 *Paracrioceras elegans* (von Koenen); Kaever *et al.*, p. 222, pl. 2, fig. 1 [= von Koenen, 1902, pl. 24, fig. 3a].
1976 *Paracrioceras* aff. *elegans* (von Koenen); Obata & Ogawa, text-fig. 6, nr. 2a-c, pl. 1, figs. 2a, b, 4.
? 1977 *Paracrioceras* cf. *elegans* (von Koenen); Myczyński, p. 158, pl. 5, fig. 9, pl. 6, fig. 1.
1978 *Crioceraites (Crioceratites) elegans* (von Koenen); Immel, p. 56, pl. 3, fig. 4, text-fig. 9b [= von Koenen, 1902, pl. 24, fig. 3a].
1979 *Crioceratites (Crioceratites) elegans* (von Koenen); Immel, pl. 2, fig. 3.
1980 *Crioceratites (Crioceratites) elegans* (von Koenen); Immel & Mutterlose, p. 250, fig. 4.1a, b.
1983 *Crioceratites (Paracrioceras) elegans* (von Koenen); Rawson & Mutterlose, p. 139, fig. 4a, b.
1995 *Crioceratites (Paracrioceras) elegans* (von Koenen); Mutterlose, pl. 8, fig. 1.

Lectotype – Immel (1978) designated the specimen figured by von Koenen (1902, p. 295, pl. 24, fig. 3a-b) as lectotype, from the upper Barremian *elegans* Zone, Hildesheim, Lower Saxony, northern Germany. Deposited in the Geologisch-Paläontologisches Institut Göttingen.

Material – Nine moderately well-preserved specimens, RGM 214 004, 214 005, 214 009, 214 095A, 214 095B, 214 484, 214 485, 214 486 and 216 181.

Description – Very large shells with crioconic whorls, which moderately increase in height; only the last whorl of the gerontic stage increases slowly in height. The morphology of the earliest whorls is not known. Up to D = 40 mm the flanks are slightly convex, the venter is rounded and the dorsum flat. From this diameter the flanks gradually become flattened, the venter remains rounded, but the dorsum becomes broad and flat. Up to D = 35-40 mm the cross section is subellipsoidal. From this diameter it gradually becomes suboval, with the maximum thickness at the lower quarter of the whorl height, but later still it is again subellipsoidal.

The sculpture on the early whorls (up to D = 14-16 mm) consists of thin, straight, simple non-tuberculate ribs, which pass straight over the venter (RGM 214 095). Later, trituberculate main ribs appear. Between the first main ribs there are four thin, non-tuberculate intermediate ones, but with growth the number of intermediate ones between every two main ribs decreases to 1-2. Intermediate ribs are absent between the main ribs in some cases. On the dorsum the ribs are thin and convex. On the flanks they are straight, but beginning from the lateral spines they slightly prorsiradiate. On the venter, between the ventrolateral spines, they are slightly curved forward. In the mature stage (within interval D = 45-90 mm) ventrolateral, lateral and umbilical spines are equally strong. Later, the ventrolateral spines become stronger than the umbilical and lateral ones. From D = 145-150 mm all ribs cross the venter in a straight line.

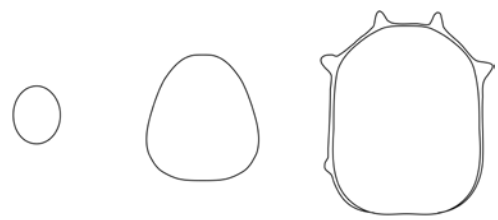

Fig. 8. Whorl sections of *Paracrioceras elegans* (von Koenen), RGM 214 004. × 1.

Measurements –

№	D	H	h	W	U	H/D	W/D	U/D	H/W	H/h	K
214 484	250.0	78.3	60.0	57.0	112.0	0.31	0.23	0.44	1.37	1.30	0.07
	(158.0)	(60.0)	(39.0)	-	(65.0)	(0.38)	-	(0.41)	-	(1.54)	(1.4)
214 004	200.0	58.3	39.0	50.0	117.0	0.29	0.25	0.58	1.17	1.49	0.09
	(122.0)	(39.0)	(25.0)	(36.0)	(64.0)	(0.32)	(0.29)	(0.52)	(1.08)	(1.56)	(0.11)
214 486	180.0	64.0	38.5	-	79.5	0.35	-	0.44	-	1.66	0.14
214 485	170.0	61.0	35.0	-	85.0	0.36	-	0.50	-	1.74	0.15
214 005	109.0	39.0	21.4	-	54.0	0.36	-	0.49	-	1.82	0.16
214 095A	40.0	13.4	8.8	-	19.5	0.33	-	0.49	-	1.52	0.11
214 095B	30.5	10.0	7.0	-	15.0	0.33	-	0.49	-	1.43	0.10

Comparison – *Paracrioceras elegans* resembles *Fissicostaticeras fissicostatum* in the general shape of the shell and in the cross section, but differs from it in the absence of fasciculate ribs that arise from umbilical tubercles.

Occurrence – RGM 214 004, 214 005 and 214 009, upper Barremian, in the *fissicostatum-elegans* zonal boundary bed 7; RGM 214 095A, 214 095B, 214 484-214 486, upper Barremian *elegans* Zone, Subway Aegidientor Square, Hannover; RGM 216 181, upper Barremian *denckmanni* Zone, Subway Hildesheimerstrasse Hannover, northern Germany.

Distribution – Barremian, northern Germany, England, Japan, Cuba(?).

***Paracrioceras crassispina* (von Koenen, 1902)**

Pl. 68.

1902 *Crioceras crassispina* von Koenen, p. 274, pl. 9, fig. 6a-c.
1955 *Crioceras crassispina* von Koenen; Sarkar, p. 97.
1978 *Crioceratites (Crioceratites) crassispina* (von Koenen); Immel, p. 66, pl. 8, fig. 3a, b, text-fig. 12c [= von Koenen, 1902, pl. 9, fig. 6a].

Holotype – The specimen figured by von Koenen (1902, p. 274, pl. 9, fig. 6a, b) from the upper Barremian *denckmanni* Zone, Hildesheim, Lower Saxony, northern Germany. Deposited in the Geologisch-Paläontologisches Institut Göttingen.

Material – One specimen, RGM 216 188.

Description –The whorls are contiguous up to D = 60 mm and increase moderately in height. Later, in the mature stage the whorl is slightly crioconic and increases slowly in height (K = 0.07). The venter is rounded, the flanks are slightly convex and the dorsum is flat. Up to D = 90 mm the cross section is ellipsoidal, but from this diameter onward it gradually becomes subcircular.

The sculpture up to D = 30-32 mm consists of straight, strong, simple, non-tuberculate ribs. From this diameter it consists of strong trituberculate main ribs and thinner non-tuberculate intermediate ribs. The number of intermediate ribs between two main ribs is commonly 1, rarely 2. From the beginning of the mature stage (D > 80 mm) there

are only simple main ribs, with very weak ventrolateral, lateral and umbilical tubercles. All ribs pass straight over the venter.

Measurements –

№	D	H	h	W	U	H/D	W/D	U/D	H/W	H/h	K
216 188	95.0	28.0	21.5	27.3	48.0	0.29	0.28	0.50	1.02	1.30	0.07
	(64.0)	(21.5)	(13.2)	(18.0)	(33.0)	(0.33)	(0.28)	(0.51)	(1.19)	(1.63)	(0.12)

Remarks – The holotype of *Paracrioceras crassispina* is characterized by a rather wide umbilical perforation (Immel, 1978, p. 66, pl. 8, fig. 3a), which is not preserved in the specimen described.

Comparison – *Paracrioceras crassispina* resembles *P. stadtlaenderi* (Müller). See the description of the latter species for a fuller discussion.

Occurrence – RGM 216 188, upper Barremian *denckmanni* Zone, Subway Hildesheimerstrasse, Hannover, northern Germany.

Distribution – Upper Barremian *denckmanni* Zone, northern Germany.

***Paracrioceras kleini* sp. nov.**
Pl. 73, fig. 1.

Holotype – RGM 214 007, the only specimen known.

Type locality – Subway Aegidientor Square, Hannover, Lower Saxony, northern Germany.

Type horizon – Barremian *fissicostatus-elegans* zonal boundary bed 7.

Derivatio nominis – In honour of palaeontologist Jaap Klein.

Diagnosis – The whorls of the crioconic shell moderately increase in height. The slightly convex flanks of the early whorls gradually flatten from D = 50. The widely spaced trituberculate ribs are separated by 1-3 non-tuberculate intermediate ribs. There are looped ribs between the small umbilical and lateral tubercles. The ventrolateral tubercles are the strongest and stretched in the direction of coiling. The rectiradiate ribs pass straight over the rounded venter. On the flat dorsum the ribs are thin and convex.

Description – The shell consists of crioconic whorls, which moderately increase in height. The venter is rounded, and the dorsum is broad and flat. The flanks are slightly convex up to D = 35-40 mm, but from this diameter they gradually become flattened. The cross section of the early whorl is ellipsoidal, but from D = 50 mm it becomes subtrapezoidal, with the maximum thickness at the lower quarter of the whorl height.

The sculpture of the earliest whorls is not known. Beginning from D = 30 mm, it consists of simple, very distant trituberculate main ribs. There are 1-2, rarely 3, very

thin, non-tuberculate intermediate ribs between every two main ribs. There are looped ribs, viz. from the umbilical tubercle arise two thin ribs that join again in the lateral tubercle. On the flanks the ribs are rectiradiate or slightly rursiradiate, but they pass straight over the venter. On the dorsum the ribs are equal, very thin and convex. The ventrolateral and lateral tubercles appear slightly earlier than the umbilical ones, which are smaller as well. The ventrolateral tubercles are the stongest and have their bases stretched in the direction of coiling.

The suture line is visible in the holotype. The ventral lobe (E) is symmetrically bifid and markedly smaller than the lateral (L) lobe. The lateral and umbilical (U_1) lobes are small and asymmetrically trifid.

Measurements –

№	D	H	h	W	U	H/D	W/D	U/D	H/W	H/h	K
214007	95.3	32.3	20.7	-	45.3	0.34	-	0.47	-	1.56	0.12
	(63.0)	(24.0)	(11.0)		(30.0)	(0.35)		(0.47)		(2.0)	(0.20)

Comparison – *Paracrioceras kleini* resembles *P. elegans* (von Koenen) in the general shape of the shell, and in the ellipsoidal and subtrapezoidal whorl section of the preadult growth stage. But *P. kleini* clearly differs from the latter in having markedly widely spaced main ribs, of which some may be looped, and in having very thin intermediate ribs. Moreover, the bases of the ventrolateral tubercles of *P. kleini* are streched in the direction of coiling.

***Paracrioceras* sp.**

Pl. 74; Fig. 9.

Material – One fragmentary specimen, RGM 216 242, represented by 1.3 whorls.

Description – The tightly coiled crioconic whorls moderately increase in height. The venter is rather broad and rounded. The flanks of the early whorls are slightly convex, but later become flattened. The dorsum is flat with a shallow depression in the late growth stage. The cross section changes from ellipsoidal to low suboctagonal (wider than high).

The sculpture consists of straight, strong, trituberculate main ribs, generally separated by one (in the early growth stage) or 2-3 (in the later growth stage) thin, non-tuberculate intermediate ribs. The ventrolateral and lateral spines on the early whorls are stronger than the umbilical ones, but later all spines are equally strong.

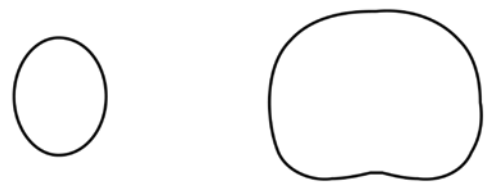

Fig. 9. Whorl sections of *Paracrioceras* sp., RGM 216 242. × 1.

Measurements –

№	D	H	h	W	U	H/D	W/D	U/D	H/W	H/h	K
216 242	67.3	21.2	13.8	22.5	35.0	0.31	0.33	0.52	0.94	1.54	0.11

Comparison and remarks – This specimen resembles *P. tuba* in the tightly coiled crioconic whorls, which moderately increase in height, and in the one-to-one alternation of the trituberculate main and non-tuberculate intermediate ribs in the early growth stage. However, it clearly differs from *P. tuba* in having a greater number (2-3) of intermediate ribs to one main rib in the later growth stage and in having a broader suboctagonal whorl section, which is wider than high.

The incompleteness of the specimen described, such as the lack of the earliest and latest whorls, does not permit the study of all morphological features of the species. Hence, it is referred to as *Paracrioceras* sp.

Occurrence – Upper Barremian *fissicostatum-elegans* zonal boundary bed 7, Subway Aegidientor Square Hannover, Lower Saxony, northern Germany.

Subfamily *Ancyloceratinae* Gill, 1871
Genus *Hoplocrioceras* Spath, 1924

Type species – *Hamites Phillipsi* Phillips, 1829, p. 124, pl. 1, fig. 30; lower Barremian, Yorkshire, England.

Diagnosis – Small to medium-sized shell. Early whorls are crioconic or even in contact, followed by a more or less curved shaft of variable length. The shaft terminates in a variably curved hook. Between the first embryonic whorl and the following second whorl there is a perforation. The sculpture of the planispiral whorls consists of simple ribs without tubercles. On the last planispiral whorls, and on the shaft and hook, there are also fasciculated and intermediate ribs. Constrictions may occur. Very weak tubercle-like swellings along the dorsolateral margin (= homologous to the umbilical rim in ammonites with contiguous whorls) of the last portion of the shaft may be present. The suture line is of the ancyloceratid type.

Remarks – This genus encompasses two subgenera: *Hoplocrioceras (Hoplocrioceras)* Spath, 1924, and *Hoplocrioceras (Aspinoceras)* Anderson, 1938 (type species *Aspinoceras hamlini* Anderson, 1938, p. 207, pl. 60, figs. 1, 2). The principal differences between these two taxa are that, in *H. (Hoplocrioceras)*, after the umbilical perforation the planispiral whorls are crioconic or contiguous and have equal ribs without real constrictions. The subgenus *H. (Aspinoceras)* is characterized by typical crioconic whorls in the planispiral stage with clearly distinct main and intermediate ribs, and constrictions in the late ontogenetic stage (shaft, hook).

Spath (1924) united two groups of heteromorph ammonites (groups of *H. phillipsi* and *H. fissicostatum*) into one genus *Hoplocrioceras* Spath. Later it became clear (Rawson, 1975; Immel, 1978; Wright *et al*., 1996) that in *Hoplocrioceras* only the species of the group *Hoplocrioceras phillipsi* (Phillips) should be left, because they differ from the group of *'fissicostatus* (Roemer)' in having another type of sculpture in the early planispiral growth stage as well as in presence of shaft and hook. As to the group *'fissicostatus* (Roemer)', we consider it to be an independent genus *Fissicostaticeras* gen. nov.

Distribution – Upper Valanginian? to lower Barremian, northern Germany, England, USA (California), Canada, Japan, Russia (Far East), Indonesia(?).

Hoplocrioceras (*Hoplocrioceras*) *phillipsi* (Phillips, 1829)

Pls. 75-78; Fig. 10.

1829 *Hamites Phillipsi* Phillips, p. 124, pl. 1, fig. 30.
1962 *Hoplocrioceras phillipsi* (Phillips); Howarth, p. 130, pl. 18, fig. 3a, b [= Phillips, 1829, pl. 1, fig. 30].
1975 *Hoplocrioceras phillipsi* (Phillips); Rawson, p. 278, pl. 43, figs. 7, 8, text-figs. 1c, d [= Phillips, 1829, pl. I, fig. 30], 2.
1983 *Hoplocrioceras* cf. *phillipsi* (Phillips); Rawson & Mutterlose, p. 139, fig. 3h, i.
? 1989 *Hoplocrioceras* sp.; Skwarko & Thieuloy, p. 30, pl. 3, figs. 9, 10.
1996 *Hoplocrioceras phillipsi* (Phillips); Wright *et al.*, p. 223, fig. 175:3a [= Howarth, 1962, pl. 18, fig. 3a], 3b-d [= Rawson, 1975, text-fig. 2, pl. 43, figs. 7, 8].
1997 *Hoplocrioceras phillipsi* (Phillips); Mutterlose *et al.*, p. 69, figs. 44.8, 44.9.
non 1997 *Hoplocrioceras phillipsi* (Phillips); Mutterlose *et al.*, p. 69, fig. 44.10.

Holotype – The specimen redescribed and figured by Howarth (1962, pl. 18, fig. 3), Speeton Clay Formation, lower Barremian, Yorkshire, England.

Material – Forty-three fairly well-preserved specimens, RGM 212 867-212 869, 213 761, 213 762, 213 885, 213 886, 213 889, 213 891, 213 893-213 896, 213 899, 213 914-213 916, 213 918, 213 920-213 930, 213 932, 214 532-214 534, 214 538-214 540, 214 565, 214 567, 214 568, 214 570, 283 495 and 283 496.

Description – Small shells. The first embryonic whorl is not visible. The second whorl is strongly uncoiled leaving a rather wide umbilical perforation (RGM 213 891, 213 894, 213 899, 213 920, 214 532), whereas the following whorls are contiguous. The planispiral whorls moderately increase in height. The venter and flanks of the initial whorls are rounded, and the dorsum is slightly flattened, so that the whorl section is subcircular. Later, the flanks become slightly flattened, the dorsum flat and the venter rounded. Accordingly, the whorl section becomes subellipsoidal. The transition of the last planispiral whorl into the shaft is gradual. The moderately curved shaft is followed by a rather wide arc-like hook.

The sculpture of the planispiral whorls consists of single, straight, radial, non-tuberculate ribs. There are 23-24 ribs on the last planispiral whorl. The thickness of the ribs is equal to or slightly less than the interspaces. All ribs are equal on the venter and pass straight over it without broadening, whereas on the dorsum they are thinner and convex. Several fasciculated ribs are present on the last portion of the planispiral whorl and on the shaft, which fork near the area of the dorso-lateral margin; in many cases the two fasciculating ribs fork from very weak tubercle-like swellings. On the shaft there are also several ribs that split at the upper third of the whorl height (such as RGM 213 932). There are also several ribs splitting at the lower third of the flank height or at mid flank. The ribs are radial, but strongly prorsiradiate on the final part of the shaft. Constriction-like furrows are present on the last portion of the shaft and on the hook of some specimens (such as RGM

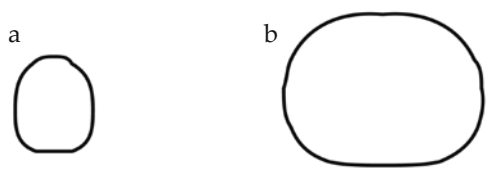

Fig. 10. Whorl sections of *Hoplocrioceras (H.) phillipsi* (Phillips). (a) On the second planispiral whorl (RGM 213 891). (b) On the shaft (RGM 213 762). Both × 1.

213 762). There are also several intercalated ribs on the hook, which originate in the lower third or quarter of the flank height. The suture line is of a typical ancyloceratid type.

Measurements –

№	D	H	h	W	U	H/D	W/D	U/D	H/W	H/h	K
213 889	49.0	17.0	8.2	-	16.3	0.35	-	0.33	-	2.07	0.18
214 568	48.0	18.6	12.3	-	19.0	0.39	-	0.39	-	1.51	0.13
213 893	31.2	12.0	5.7	-	14.0	0.38	-	0.44	-	2.1	0.20
214 538	30.0	12.0	7.1	-	12.2	0.40	-	0.41	-	1.69	0.16
213 762	30.0	10.6	6.0	-	12.4	0.35	-	0.41	-	1.77	0.15
214 540	28.7	11.5	6.6	9.0	10.8	0.40	0.31	0.38	1.28	1.74	0.17
218 761	28.0	12.2	6.8	-	10.0	0.43	-	0.35	-	1.79	0.19
213 932	27.5	10.8	5.8	-	11.2	0.39	-	0.41	-	1.86	0.18
214 570	27.0	10.8	6.8	-	10.5	0.40	-	0.39	-	1.59	0.15
213 885	25.7	10.0	5.5	-	10.5	0.39	-	0.41	-	1.82	0.17
214 533	25.5	9.9	5.8	-	9.5	0.38	-	0.37	-	1.73	0.16
213 891	24.0	8.5	4..6	-	11.0	0.35	-	0.45	-	1.85	0.16
213 899	23.5	10.0	5.3	-	8.6	0.42	-	0.36	-	1.88	0.20
213 894	23.0	9.5	5..2	-	8.6	0.41	-	0.37	-	1.83	0.19
213 896	21.7	8.8	5.0	-	9.2	0.41	-	0.42	-	1.76	0.17
213 895	20.5	7.6	4.4	-	9.0	0.37	-	0.44	-	1.73	0.15
214 534	18.0	7.0	3.5	-	7.5	0.39	-	0.42	-	2.0	0.19

Remarks – In the Wiedenroth Collection, *Hoplocrioceras (Hoplocrioceras) phillipsi* is represented by numerous specimens, which allows us to study the intraspecific variation. The following variations have been found.

1. The diameter of the umbilical perforation varies between 5 and 6.5 mm.
2. The fasciculation of two ribs may be very rare, but in most specimens it is common (such as RGM 213 891).
3. There are great variations in the dimensions of the shell, and in the morphology of the shaft and hook.

It is remarkable that almost all studied specimens of *H. (H.) phillipsi* were collected by Wiedenroth in bed 83 of the *raricostatum* Zone in the Gott quarry near Sarstedt. This occurrence supports the idea that these specimens can be considered to represent a natural population.

Occurrence – Nearly all specimens are derived from the Lower Barremian *rarocinctum* Zone, bed 83, Gott quarry near Sarstedt. Only RGM 214 418 is from the banks of the River Leine near Marienwerder, Hannover, northern Germany.

Distribution – Lower Barremian; England, northern Germany.

Hoplocrioceras (Hoplocrioceras) laeviusculum **(von Koenen, 1902)**

Pl. 79, fig. 1.

1902 *Ancyloceras laeviusculum* von Koenen, p. 350, pl. 28, figs. 4a, b, 5, 6a, b.

Lectotype – The specimen figured by von Koenen (1902, p. 350, pl. 28, fig. 4) from the

lower Barremian *Fissicostatum* Zone, Hildesheim, designated herein. Deposited in the Geologisch-Paläontologisches Institut Göttingen.

Material – Only one specimen, RGM 214 017, with two well-preserved last planispiral whorls, shaft and hook.

Description – Small shell. The planispiral whorls are crioconic and moderately increase in height. The shaft is very short and the transition between the planispiral whorl and the shaft is so gradual that it is hardly possible to indicate where the shaft begins. The flanks, dorsum and venter of the planispiral whorls are rounded. Only from the beginning of the last portion of the planispiral whorl up to the end of the hook do the flanks appear almost flattened; the venter remains rounded, but the dorsum gradually becomes flat and in the last part of the hook it is concave. The section of the planispiral whorls changes from suboval to subellipsoidal. The section of the shaft remains subellipsoidal, but on the hook it becomes subtrapezoidal.

The sculpture is characterized by very thin, closely spaced, non-tuberculate ribs. On the earliest part of the first planispiral whorl a smooth stage (without ribs) is preserved. After this stage very thin, projected, closely spaced, simple ribs gradually appear, which become stronger on the second whorl. On the short final portion of the planispiral whorl and on the shaft there are single ribs as well as several fasciculated ribs, which become numerous towards the hook. The splitting occurs in the lower third of the whorl height. All ribs are equal on the venter. On the shaft ribs are slightly convex, but they cross the venter in a straight line. On the dorsum the ribs are equally thin and describe a convex curve. On the hook ribs become stronger and the last three single ribs are rather distant.

Measurements –

№	D	H	h	W	U	L	H_1	W_1	H_2	H_3	W_3	D_1	H/D	W/D	U/D	H/W	H/h	K
214 017	35.0	12.8	6.0	-	15.0	60.5	16.2	-	26.5	-	22.0	66.5	0.36	-	0.43	-	2.13	0.19

Comparison – *Hoplocrioceras laeviusculum* differs from all congeners in having a very short shaft and very fine, dense ribbing.

Occurrence – RGM 214 017, lower Barremian *fissicostatum* Zone, bed 6, Subway Aegidientorsquare, Hannover, northern Germany.

Distribution – Lower Barremian, northern Germany, England.

Genus *Acrioceras* Hyatt, 1900

Type species – *Acrioceras tabarelli* Astier, 1851, p. 449 (19), pl. 21 (7), fig. 9, Barremian, southeast France.

Diagnosis – Shell of small or moderate size with crioconic early whorls, which may become contiguous later. Between the first embryonic whorl and the following second whorl there is a perforation. Transition into the shaft is more or less gradual. The shaft

is short or long, straight or curved, followed by a terminal hook. The sculpture of the planispiral whorls consists of single trituberculate (ventral, upper lateral and umbilical spines) main ribs, with 1-3 (maybe more) non-tuberculate intermediate ones per one main rib. Bifurcate and, rarely, looped ribs (between the umbilical and upper lateral tubercles) may also occur. The trituberculate type of sculpture might be present on the shaft and also on the hook. In some species tubercles are absent on shaft and hook. The suture line is of the ancyloceratid type.

Remarks – This genus comprises two subgenera (Klein *et al.*, 2007): *Acrioceras* (*Acrioceras*) Hyatt, 1900, and *Acrioceras* (*Paraspinoceras*) Sarkar, 1955 (type species *Ancyloceras pulcherrimum* d'Orbigny, 1842, p. 495, pl. 121, figs. 3-7). The principal difference between them is that *A.* (*Acrioceras*) is characterized by the presence of trituberculate ribs on shaft and hook, while in *A.* (*Paraspinoceras*) tuberculate ribs are absent in this region.

Distribution – Hauterivian-lower Aptian, Western and central Europe, Crimea, Caucasus, Madagascar, Africa, Antarctica, Australia, Japan, USA (California).

***Acrioceras (Acrioceras) sarstedtense* sp. nov.**
Pl. 79, fig. 2.

Holotype – RGM 213 886, the only specimen known, consisting of three quarters of the last planispiral whorl, the shaft and the hook.

Type locality – Gott quarry, Sarstedt, northern Germany.

Type horizon – Lower Barremian *rarocinctum* Zone, bed 83.

Derivatio nominis – Named after the town of Sarstedt, Lower Saxony, northern Germany.

Diagnosis – The last planispiral whorl, which increases slowly in height and has a circular cross section, passes into a straight shaft and a wide arc-like hook. The costal cross section of the planispiral whorl and the shaft is subquadrate. The cross section of the hook is subtrapezoidal. The widely spaced trituberculate main ribs are separated by four straight non-tuberculate intermediate ones, on the shaft by two. All ribs pass straight over the venter, but are convex on the dorsum. Halfway the shaft tuberculation stops. The second half of the shaft and the arched segment of the hook have short, prorsiradiate ribs which split into two subparallel secondary ribs, but also has simple and intercalated ribs. On the straight terminal part of the hook only occur thick simple ribs separated by constrictions.

Description – The last planispiral whorl increases slowly in height. The shaft is straight and the terminal hook is characterized by a wide arc-like form. The flanks and venter are slightly convex, and the dorsum is flattened. The cross section of the planispiral whorl between two ribs is subcircular, but its costal section is subquadrate. Approximately the

same subquadrate cross section continues up to the final portion of the shaft. On the hook the cross section becomes subtrapezoidal (slightly higher than wide) with the maximum thickness at the lower third of the whorl height.

The sculpture on the last planispiral whorl consists of straight, widely-spaced, thick trituberculate main ribs. Between them there are four, rarely three, straight, thinner, wide-spaced, non-tuberculate intermediate ribs. All ribs pass straight over the venter, but on the dorsum they are convex. The trituberculate ribs gradually disappear halfway up the shaft; in the first half the number of the non-tuberculate intermediate ribs to one main is reduced to two. The second half of the shaft is sculptured by comparatively thin prorsiradiate ribs that split into two near-parallel secondary ribs at one-fifth of the flank height. Simple ribs and intercalated ribs, which originate at or just below mid-flank, also occur. A similar sculpture occurs on the arched segment of the hook. Besides simple ribs, intercalated ribs also occur in this segment and on the straight terminal part of the hook; they arise at the lower third of the flank height. In the straight terminal part of the hook the simple ribs become thicker and are separated by rather wide constrictions. All ribs pass straight over the venter without reduction in strength.

Fragments of the intricately frilled suture line are preserved in the planispiral whorl and in the first half of the shaft. The lateral (L) lobe is large, asymmetrically trifid and significantly longer than the umbilical (U_1) lobe.The body chamber begins approximately halfway down the shaft.

Measurements –

№	D	H	h	W	U	H/D	U/D	H/h	K	L	H_1	W_1	H_2	H_3	D_1
213 886	35.5	9.5	7.0	-	18.8	0.27	0.53	1.79	0.07	90.0	14.0	-	-	-	-

Comparison – The new species resembles *Acrioceras (Acrioceras) tabarelli* (Astier) in the type of coiling and also somewhat in the shape of the cross section. *Acrioceras (Acrioceras) sarstedtense* clearly differs from *A. (A.) tabarelli* in having very widely spaced main ribs and a smaller number of intermediate ribs on the last planispiral whorl and on the first half of the shaft. That is, between every two main ribs on the planispiral whorl there are 3-4 intermediate ribs, and on the shaft only 2, whereas in the same ontogenetic stage of *A.(A.) tabarelli*, there are 5-8 intermediate ribs between every two main ribs.

Acrioceras (*Acrioceras)* aff. *monopujaae yvanii* Sarkar, 1955

Pl. 79, fig. 3.

1997a *Hoplocrioceras* sp.; Mutterlose, figs. 44.1, 44.2.

Material – One incomplete specimen, RGM 214 573, consisting of the second half of the last planispiral whorl, the shaft and the hook. The terminal part of the hook is missing.

Description – Small hoplocrioconic shell (L_1 = 66 mm), with planispiral whorls that slowly increase in height. Transition from the last whorl to the shaft is gradual. The

shaft is curved and terminates with a hook, which makes a 75-80° angle with the shaft. The cross section of the planispiral whorl is not visible, but on the shaft and hook it is subellipsoidal.

The sculpture on the last planispiral whorl is poorly preserved, but rather closely spaced, thick trituberculate main ribs with one or two thin intermediate ones between every two of them can be seen. On the shaft there are thick trituberculate main ribs with 3-4, rarely two, thin, non-tuberculate intermediate ones. In the early part of the shaft only one intermediate rib bears a ventrolateral spine (= degenerated main rib). In the terminal part of the shaft all ribs are prorsiradiate and there are 3-4 intermediate ribs to one main. Here, the main ribs bear umbilical and ventrolateral spines, whereas the lateral spines have already disappeared. On the hook tuberculation is absent. In the arched part of the hook are three intercalatory to one main ribs; in each interval one intercalatory is short. In the straight terminal part of the hook there are also three intermediate ribs to one main. Moreover, there are constrictions along the main ribs.

Remarks – The specimen described shows resemblance to *A. (Acrioceras) monopujaae yvanii* in the morphology of the shell, in its moderately increasing height of the planispiral whorl and shaft, and in having tuberculate main ribs up to the beginning of the hook. But it clearly differs from it in the absence of the trituberculate main ribs in the straight terminal part of the hook and in the significantly smaller number of intermediate ribs to one main one.

Occurrence – RGM 214 573, upper Hauterivian *discofalcatus* Zone, Gott quarry near Sarstedt, northern Germany.

Acrioceras (*Acrioceras*) *sarasini* Sarkar, 1955

Pl. 81, fig. 3.

1902 *Crioceras Tabarelli* (Astier); Sarasin & Schöndelmayer, p. 127, pl. 15, fig. 3.
1955 *Acrioceras tabarelli* sp. var. *sarasini* nov.; Sarkar, p. 103 [= Sarasin & Schöndelmayer, 1902, pl. 15, fig. 3].
1957 *Acrioceras tabarelli* Astier: Arkell *et al.*, p. L211, fig. 239:1 [= Sarasin & Schöndelmayer, 1902, pl. 15, fig. 3].
1964 *Acrioceras tabarelli* Sarkar; Nikolov, p. 123, pl. 3, fig. 2a, b.
1966 *Acrioceras tabarelli sarasini* Sarkar; Breskovski, p. 79, pl. 1, fig. 2.
1967 *Acrioceras tabarelli sarasini* Sarkar; Dimitrova, p. 53, pl. 20, fig. 2 [= Breskovski, 1966, pl. 1, fig. 2].
1990 *Acrioceras (Acrioceras) sarasini sarasini* Sarkar; Thomel *et al.*, p. 86, pl. 5, figs. 1, 2 [= Sarasin & Schöndelmayer, 1902, pl. 15, fig. 3], 4, 8-10, pl. 6, figs. 1, 2, 6, 7, pl. 7, figs. 8, 10, pl. 9, fig. 6.
1990 *Acrioceras* sp. gr. *sarasini* Sarkar; Thomel *et al.*, pl. 5, fig. 7.
1990 *Acrioceras* sp. aff. *sarasini* Sarkar; Thomel *et al.*, pl. 8, fig. 9.
1990 *Acrioceras* entre *sarasini* et *tabarelli*; Thomel *et al.*, p. 87, pl. 4, figs. 1, 3, pl. 6, figs. 4, 5.
1990 *Acrioceras* cf. *sarasini* Sarkar; Thomel *et al.*, pl. 5, figs. 3, 5, pl. 6, fig. 3.
1990 *Acrioceras* gr. *sarasini* Sarkar; Thomel *et al.*, pl. 5, fig. 11, pl. 7, figs. 1, 4, 5, pl. 9, fig. 8.
1990 *Acrioceras* sp. (?nov. sp.), intermédiaire entre *sarasini* et *terveri*: Thomel *et al.*, p. 87, pl. 7, figs. 5-7, pl. 8, fig. 2.
1996 *Acrioceras (Acrioceras) tabarelli* Sarkar; Wright *et al.*, p. L223, fig. 173:1 [= Sarasin & Schöndelmayer, 1902, pl. 15, fig. 3].
2000 *Acrioceras sarasini* Sarkar; Delanoy *et al.*, fig. on p. 17, fig. on p. 28 [= Thomel *et al.*, pl. 6, figs. 6, 7].
2001 *Acrioceras* sp. ex gr. *A. sarasini* Sarkar; Avram *et al.*, p. 17, pl. 1, fig. 5.

Holotype – The specimen figured by Sarasin & Schöndelmayer (1902, pl. 15, fig. 3) from the Neocomian of Switzerland. Muséum d'Histoire Naturelle de Genève.

Material – One fairly well preserved specimen, RGM 214 529, represented by the last one and a half planispiral whorls and the beginning of the shaft.

Description – The last one and a half planispiral whorls preserved are contiguous and increase moderately in height. The transition from the last planispiral whorl to the shaft is gradual. The flanks and venter are slightly convex and rounded, respectively. The dorsum is flattened.

The sculpture on the penultimate planispiral whorl consists of slightly prorsiradiate simple ribs, which are provided with weak ventrolateral and upper lateral tubercles. The last part of the planispiral whorl is sculpted with main ribs with ventrolateral, lateral and umbilical spines, and non-tuberculate intermediate ribs. In the early part of the planispiral whorl there are one or two intermediate ribs between two main ones, but the number of intermediate ribs increases to four. On the shaft all three tubercles remain rather strong. All ribs pass straight over the venter.

Measurements –

№	D	H	h	W	U	H/D	U/D	H/h	K	L	H_1	W_1	H_2	H_3	D_1
214 529	28.5	10.3	5.2	-	11.2	0.36	0.43	1.98	0.18	12.3	14.0	-	-	-	-

Remarks – This specimen resembles *A. (Acrioceras) sarasini* in the morphology of the planispiral whorls and the gradual transition into the shaft, and in the ontogenetic development of the distribution of the main and intermediate ribs. The variability of this species is rather great, as was demonstrated by Thomel *et al.* (2003). RGM 214 529 is particularly similar to the specimen figured by Thomel *et al.* (2003, pl. 7, fig. 8). It differs from *A. (Acrioceras) tabarelli* in having a greater number of intermediate ribs between every two main ribs, and in the stronger umbilical, lateral and ventrolateral spines on the shaft.

Occurrence – RGM 214 529, lower Barremian *rarocinctum* Zone, bed 83, Gott quarry near Sarstedt, northern Germany.

***Acrioceras* (*Acrioceras*) *crassicostatum* sp. nov.**

Pl. 80; Pl. 81, fig. 1.

Holotype – RGM 214 016.

Type locality – Subway Aegidientor Square in Hannover, Lower Saxony, northern Germany.

Type horizon – Lower Barremian *fissicostatum* Zone, bed 6.

Derivatio nominis – *Crassum* (Latin) = thick; *costatum* (Latin) = ribbed. Because of the thick main ribs.

Material – Two further specimens, RGM 214 008 and 214 014, consist of the last planispiral whorl, the shaft and the hook.

Diagnosis – Medium-sized shell with crioconic whorls that moderately increase in height, with a slightly curved shaft and a rather widely open hook. The sculpture of the last crioconic whorl and first half of the shaft consists of straight, simple, strong trituberculate main ribs, and one or two non-tuberculate intermediate ribs to one main rib. The same sculpture continues on the early part of the shaft, but later the number of intermediate ribs between every two main ribs diminishes and they finally disappear.

Description – The last crioconic whorl moderately increases in height. The slightly curved shaft gradually passes into a rather widely open hook. The flanks of the crioconic whorl are slightly convex, the venter is rounded, but the dorsum is flattened. Consequently, the cross section of the crioconic whorl is subellipsoidal. The cross section of the hook gradually becomes subquadrate.

The sculpture of the last crioconic whorl consists of strong, straight, simple trituberculate ribs, in most cases regularly alternating with one thinner, non-tuberculate intermediate ribs. Only on the last part of the crioconic whorl are there two intermediate ribs between every two main ribs. On the last part of the shaft the intermediate ribs become rare and on the last straight portion of the hook there are only simple, trituberculate main ribs. There are several looped ribs between the umbilical and lateral tubercles on the planispiral whorl and shaft. On the last part of the shaft and on the hook there are only simple trituberculate ribs. The ventrolateral tubercles are stronger than the lateral ones, but the umbilical tubercles are weaker than the lateral ones and persist up to the aperture.

Measurements –

№	D	H	h	W	U	H/D	U/D	H/h	K	L	H_1	W_1	H_2	H_3	D_1
214 014	47.0	14.0	9.0	-	27.2	0.30	0.58	1.55	0.10	90.5	16.0	14.2	25.3	25.0	70.0
214 016	42.2	12.0	7.4	-	23.2	0.28	0.55	1.62	0.10	89.0	18,0	-	-	-	-
214 008	42.0	12.0	-	10.8	23.2	0.28	0.55	-	-	78.6	16.5	-	25.0	24.0	71.0

Comparison – *Acrioceras crassicostatum* differs from congeners in the type of sculpture on the last crioconic whorl and on the shaft, viz. in having strong trituberculate ribs with 1 or 2 rather thinner non-tuberculate intermediate ones and in the presence of looped ribs.

Occurrence – RGM 214 014, 214 016, lower Barremian *fissicostatum* Zone, bed 6, Subway Aegidientor Square Hannover; RGM 214 008, lower Barremian *fissicostatum-elegans* boundary bed 7, Subway Aegidientor Square Hannover, northern Germany.

***Acrioceras* (*Acrioceras*) *angulosum* (von Koenen, 1902)**

Pl. 81, fig. 2.

1902 *Ancyloceras angulosum* von Koenen, p. 340, pl. 28, figs. 1a-c, 2.
non 1902 *Ancyloceras angulosum* von Koenen, p. 340, pl. 28, fig. 3a-c.

Lectotype – The specimen figured by von Koenen (1902, pl. 28, fig. 1a-c) from the lower Barremian *fissicostatum* Zone, Hildesheim, Lower Saxony, northern Germany. Designated herein. Deposited in the Geologisch-Paläontologisches Institut Göttingen.

Material – One specimen, RGM 216 250, represented by one and a half planispiral whorls and the first half of the shaft with well-preserved sculpture.

Description – The crioconic last whorl rapidly increases in height. Its transition to the shaft is rather sharp. The venter of the planispiral whorl and shaft is rounded, and the flanks are slightly convex. The dorsum of the early part of the planispiral whorl is rounded, but in the last part and on the shaft it is flattened. The cross section of the planispiral whorl changes from subcircular to the ellipsoidal.

The sculpture of the penultimate planispiral whorl consists of thin, straight, simple non-tuberculate ribs, after which main and intermediate ribs gradually appear. The main ribs bear ventrolateral tubercles, but also, at the beginning of the shaft, very small lateral and umbilical tubercles appear. All ribs are thin, but the intermediates are thinner than the main ones. Between each two main ribs there are 1-2 intermediate ribs. All ribs pass straight over the venter, where their differentiation into main and intermediate ribs remains clearly distinct. On the dorsum ribs are equal and strongly convex.

Measurements –

№	D	H	h	W	U	H/D	U/D	H/h	K
216 250	26.4	10.5	4.2	8.0	14.8	0.40	0.56	8.5	0.24

Comparison – *Acrioceras (Acrioceras) angulosum* clearly differs from all other known species of *A.* (*Acrioceras*) in the presence of dense, equal, non-tuberculate simple ribs up to the end of the first half of the last planispiral whorl (D = 21 mm). It is also distinct in having closely spaced, thin, trituberculate main ribs, every two of which are separated by 1-2 very thin, non-tuberculate intermediate ribs at the end of the planispiral whorl and on the first part of the shaft.

Occurrence – Lower Barremian, at the *fissicostatum-elegans* zonal boundary bed 7, Subway Aegidientor Square Hannover, northern Germany.

***Acrioceras* (*Acrioceras*) aff. *incumbens* (von Koenen, 1902)**

Pl. 81, fig. 4.

Material – One specimen, RGM 214 010.

Description – Typical crioconic whorls which moderately increase in height. The transition to the shaft is gradual. The shaft is curved, short and terminates in a hook. The cross section is subellipsoidal on the planispiral worls, the shaft and the hook.

The sculpture of the early planispiral whorls consists of equal, closely spaced, straight or slightly curved, simple ribs, which pass straight over the venter. After D = 20 mm, two fasciculated ribs arise from widely spaced umbilical tubercles. Between the

fascicules are 4-5 intermediate ribs. Umbilical tubercles are more closely spaced at the end of the last planispiral whorl and from each of them arise two fasciculated ribs. However, between the fascicules are 1-2 non-tuberculate intermediate ribs. All ribs are equal on the flanks and pass straight over the venter. On the shaft and on the hook there are only simple, strong, widely spaced trituberculate ribs.

Measurements –

№	D	H	h	W	U	H/D	U/D	H/h	K	L	H_1	W_1	H_2	W_2	D_1
214 010	42.0	15.0	8.3	-	21.0	0.36	0.5	1.81	0.16	75.5	22.0	-	-	-	-

Remarks – This specimen resembles *Acrioceras* (*Acrioceras*) *incumbens* (von Koenen, 1902, pl. 27, fig. 2) in the mode of coiling, in absence of clearly distinct main and intermediate ribs in the crioconic whorls, and in the ribbing on the shaft and hook. However, it differs from *A.* (*A.*) *incumbens* in the sculpture on the planispiral whorl, viz. in having umbilical tubercles from which two branches arise. On the basis of these differences we refer to it as *A.* (*A.*) aff. *incumbens*.

Occurrence – RGM 214 010, upper Barremian *fissicostatum-elegans* boundary bed 7, Subway Aegidientor Square, Hannover, northern Germany.

Acrioceras (*Acrioceras*) *nodulosum* (von Koenen, 1902)

Pl. 82, fig. 1.

1902 *Ancyloceras nodulosum* von Koenen, p. 344, pl. 28, fig. 7a-c.
1980 *Acrioceras* cf. *nodulosum* (von Koenen); Immel & Mutterlose, p. 255, pl. 8, fig. 2.

Lectotype – The specimen figured by von Koenen (1902, pl. 28, fig. 7a-c) from the lower Barremian *fissicostatum* Zone, Hildesheim. Designated herein. Deposited in the Geologisch-Paläontologisches Institut Göttingen.

Material – Six well preserved specimens, RGM 214 011, 216 241 (= aff. *nodulosum*; Pl. 82, fig. 2), 216 252, 216 255, 216 256 and 214 011.

Description – Crioconic whorls moderately increase in height. The transition to the shaft is gradual. The shaft is curved and the hook is very wide. The flanks of the crioconic whorls are moderately convex, whereas the venter and dorsum are rounded. The dorsum becomes flat and the flanks almost flat at the end of the last crioconic whorl and on the shaft, but the venter remains rounded. The cross section of the early crioconic whorl is subcircular. At the end of the crioconic coiling and on the shaft, the cross section is subellipsoidal.

The sculpture of the early planispiral whorls (up to D = 23 mm) consists of closely spaced, straight, equal simple ribs, which pass straight over the venter. From this diameter of the last planispiral whorl the sculpture consists of main trituberculate and thin intermediate non-tuberculate ribs. The number of the latter between every two main ribs is 2-3, rarely 1. The ventrolateral spines are always stronger than the lateral and umbilical ones. All ribs are equally thin and convex on the dorsum. On the shaft every

two thick main ribs are separated by a single thin intermediate one; on the hook there are only thick widely spaced trituberculate main ribs.

Measurements –

№	D	H	h	W	U	H/D	U/D	H/h	K	L	H_1	W_1	H_2	H_3	D_1
216 241	51.0	18.8	9.6	-	25.0	0.37	0.49	1.96	0.18	-	-	-	-	-	-
216 252	47.2	16.4	8.2	-	22.3	0.35	0.47	2.00	0.17	-	-	-	-	-	-
214 011	45.0	14.0	10.5	-	22.0	0.31	0.49	1.33	0.17	86.0	21.5	-	28.0	24.0	86.0

Comparison – *Acrioceras (Acrioceras) nodulosum* resembles *A. (Acrioceras) undatum* (von Koenen, 1902) in the type of coiling and the sculpture on the planispiral whorls, but clearly differs from it in that the planispiral whorls more rapidly increase in height and in the absence of intermediate ribs on the shaft.

Occurrence – RGM 214 011, lower Barremian *fissicostatum-elegans* boundary bed 7, Subway Aegidientor Square in Hannover; RGM 216 241 (= aff. *nodulosum*), 216 252, 216 255, 216 256, lower Barremian *fissicostatum* Zone, bed 6, Subway Aegidientor Square, Hannover, northern Germany.

***Acrioceras* (*Acrioceras*) *aegidii* sp. nov.**

Pl. 83, fig. 1.

Holotype – RGM 214 008, the only specimen known, represented by the last half of the crioconic whorl, the shaft and the hook.

Type locality – Subway Aegidientor Square Hannover, northern Germany.

Type horizon – Barremian, in the *fissicostatum-elegans* zonal boundary bed 7.

Derivatio nominis – The species is named after Aegidius after which the square at Hannover is named.

Diagnosis – Hoplocrioconic medium-sized shell with planispiral whorls, which increase slowly in height; it has a very short shaft and a widely open, arclike hook. The sculpture consists of strong, simple, straight, trituberculate main ribs. Only at the transition from planispire to shaft contains every space between two main ribs one thin intermediate rib.

Description – The medium-sized shell is hoplocrioconic. The planispiral whorl, shaft and hook all increase slowly in height. The shaft is very short and curved. The hook has a wide arc-like shape and it seems that the dorsal side of the aperture was almost in contact with the ventral side of the planispiral whorl. The flanks of the last planispiral whorl, shaft and hook are all flattened. The venter is rounded, but the dorsum is broad and flat. At the end of the planispiral whorl and on the shaft, the cross section is subrectangular, but on the hook it gradually becomes subtrapezoidal, with maximum thickness at a quarter of the whorl height.

The sculpture of the last planispiral whorl and of the first half of the shaft consists of strong, simple, trituberculate ribs. There is one intermediate rib to one main one. On the other parts of the shell there are rather strong trituberculate, widely spaced ribs, without intermediate ribs. Only at the end of the hook is there one intermediate rib. All ribs pass straight over the venter.

Measurements –

№	D	H	h	W	U	H/D	U/D	H/h	K	L	H_1	H_2	H_3	D_1
214 008	43.5	12.0	10.3	10.4	22.0	0.27	0.50	1.16	0.03	79.0	16.4	24.0	19.5	70.0

Comparison – *Acrioceras (Acrioceras) aegidii* resembles *A.(A.) nodulosum* in the type of coiling, particularly the very short shaft and widely curved hook, and in the strong trituberculate ribs, but it differs from the latter in the slower increase in height of the whorl and in the absence of intermediate ribs between every two main ribs on shaft and hook.

Acrioceras (*Acrioceras*) *meriani* (Ooster, 1860)

Pl. 83, fig. 2.

1860 *Ancyloceras Meriani* Ooster, p. 35, pl. 39, figs. 1-5.
? 1860 *Ancyloceras Meriani* variété plus massive, Ooster, p. 35, pl. 39, figs. 6, 7.
? 1860 *Ancyloceras Meriani* varietas? Ooster, p. 36, pl. 50, fig. 1.
1902 *Crioceras Meriani* Ooster variété 1; Sarasin & Schöndelmayer, pl. 16, fig. 3 [= Ooster, 1860, pl. 39, fig. 2].
? 1902 *Crioceras Meriani* Ooster variété 2; Sarasin & Schöndelmayer, p. 133, pl. 17, fig. 1 [= Ooster, 1860, pl. 39, fig. 6].
1910 *Crioceras Meriani* Ooster; Kilian, p. 272.
? 1914 *Crioceras* cf. *Meriani* Ooster; Zwierzycki, p. 77, pl. 10, fig. 4.
1955 *Acrioceras meriani* Ooster; Sarkar, p. 121.
1955 *Acrioceras* cf. *meriani* Ooster; Sarkar, p. 122, pl. 7, fig. 23, text-fig. 20.
1964 *Acrioceras* sp. (ex gr. *A. meriani*); Fülop, p. 93, pl. 16, fig. 11.
1990 A*crioceras (Acrioceras)* cf. *meriani* Ooster; Thomel *et al.*, p. 77, pl. 1, fig. 2.
? 1990 *Acrioceras (Acrioceras) meriani* Ooster; Thomel *et al.*, p. 77, pl. 1, figs. 3, 4 [= Ooster, 1860, pl. 39, figs. 6, 7].
1990 *Acrioceras (Acrioceras)* entre *meriani* en *tabarelli*; Thomel *et al.*, p. 78, pl. 1, fig. 1.
1990 *Acrioceras (Acrioceras)* aff. *meriani*; Thomel *et al.*, p. 77, pl. 1, fig. 6.
1992 *Acrioceras meriani* Ooster; Klinger & Kennedy, p. 121.
? 1993 *Acrioceras* sp. aff. *A. merianae*; Aguirre-Urreta, p. 70, pl. 7, figs. 3, 4.
1998 *Acrioceras* cf. *meriani* Ooster; Cecca *et al.*, p. 96, pl. 3, fig. 24.
2003 *Mesocrioceras meriani* (Ooster); Busnardo *et al.*, p. 76, pl. 7, figs. 4-6 [= Ooster, 1860, pl. 39, fig. 2].

Lectotype – The specimen figured by Ooster (1860, pl. 39, fig. 6), from the Neocomian of Châtel-Saint-Denis (Switzerland), was designated lectotype by Thomel *et al.* (1990, p. 77) and illustrated by Sarasin & Schöndelmayer (1902, p. 133, pl. 17, fig. 1). Naturhistorisches Museum Bern

Material – One moderately preserved specimen, represented by the last one and one third planispiral whorl, shaft and hook, RGM 213 798.

Description – Medium-sized shell of which the last planispiral whorl moderately increases in height. Transition from the planispiral whorl to the shaft is gradual and takes place at H = 12.8 mm. The shaft is slightly curved and the transition to the hook is also gradual; the hook forms a rather wide arch. The flanks of the last planispiral whorl are slightly convex, the venter is rounded and the dorsum slightly flattened. The dorsum of the shaft and hook is broad and flat; the flanks and venter are rounded. The cross section of the last planispiral whorl is subellipsoidal, but that of the shaft and hook becomes subtrapezoidal with the maximum width at one-sixth of the whorl height.

The sculpture of the planispiral whorl consists of rather thick, straight, closely spaced ribs. The majority of them are single, but there are also bundles of two ribs originating at the umbilical margin. All ribs pass straight over the venter and all are equal. The first part of the last planispiral whorl exhibits the remains of ventrolateral and lateral spines. On the shaft the ribs become more widely spaced, but their thickness remains the same. On the whole, the shaft is sculptured with single ribs. Only at the transition between the shaft and hook are most ribs fasciculated by two. There are also a few intercalatory ribs, which start at mid-flank, whereas the fasciculated ribs originate from elongated bullae. On the terminal straight part of the hook there are both single and fasciculated ribs. All ribs pass straight over the venter, where they are distantly spaced and equally strong. On the dorsum all ribs are equally thin and convex.

The suture line is only fragmentarily preserved. The lateral trifid lobe (L) is very wide and deeper that the ventral (E) lobe. It should be noted that the last suture is situated below the middle of the shaft.

Measurements –

№	D	H	h	W	U	H/D	U/D	H/h	K	L	L_1	H_1	H_2	D_1
214 529	33.6	12.5	7.3	-	14.0	0.37	0.41	1.71	0.15	68.0	87.6	18.8	20.7	62.0

Remarks – This species resembles *Acrioceras (A.) pulcherrimum* (d'Orbigny, 1842) in the sculpture of the shaft and hook. However, it differs from it in the presence of tuberculate ribs up to the last portion of the planispiral whorl, as well as in the absence of constrictions on the, and having a more widely open, hook.

Occurrence – RGM 213 798, lower Barremian *rarocinctum* Zone, bed 83, Gott quarry near Sarstedt, northern Germany.

Distribution – Lower Barremian, France and northern Germany.

***Acrioceras* (*Acrioceras*) *longum* sp. nov.**
Pl. 84, fig. 1.

Holotype – RGM 212 866.

Type locality – Gott quarry, Sarstedt, northern Germany.

Type horizon – Lower Barremian, *rarocinctum* Zone, bed 83.

Derivatio nominis – *Longus* (Latin) = long; referring to its long shaft.

Material – Two specimens, RGM 212 866 (holotype) and 214 542. The holotype consists of the last planispiral whorl, the shaft and the hook.

Diagnosis – The crioconic spiral passes into a long shaft and a rather wide open hook. The sculpture of the last whorl consists of weakly trituberculate main ribs, separated by non-tuberculate intermediate ribs. The main and intermediate ribs have the same thickness. In a few cases two ribs may unite in one ventrolateral tubercle (fibulation). The shaft and hook are sculptured with closely spaced, uniform single and fasciculated ribs.

Description – The crioconic whorls moderately increase in height. The transition from the last planispiral whorl to the shaft is gradual. The shaft is long, slightly curved and gradually passes into the hook, which has a rather wide, arc-like shape. The flanks of the planispiral whorls, shaft and hook are slightly convex; the venter is rounded and the dorsum flattened. The cross section of the last planispiral whorl changes from subcircular to subellipsoidal (slightly higher than wide), and remains subellipsoidal on the shaft and hook.

The sculpture of the last planispiral whorl consists of main trituberculate and non-tuberculate intermediate ribs; the number of the latter to one main rib is 2-3. The main ribs are usually provided with ventrolateral and rather weak lateral tubercles. Umbilical tubercles are in most cases absent and, if present, they are very weak. In a few cases two ribs converge to one ventrolateral tubercle (fibulation). All ribs are equal on the flanks. The shaft is sculpted with closely spaced, single and fasciculated ribs. The thickness of the ribs is greater than the interspaces. The fasciculated ribs are more common on the second part of the shaft and on the hook. The fasciculated ribs split at one-sixth of the flank height. All ribs pass straight over the venter, where they are of equal thickness. On the dorsum they are equally thin and convex.

Measurements –

№	D	H	h	W	U	H/D	U/D	H/h	K	L	H_1	W_1	H_2	H_3	D_1
212 866	32.6	12.7	7.0	-	14.0	0.39	0.43	1.81	0.17	83.5	19.0	-	-	-	-

Comparison – These specimens differ from other known species of *Acrioceras* (*Acrioceras*) in that in a few cases two ribs converge to one ventrolateral tubercle (fibulation), and in the equal thickness of the main and intermediate ribs on the last planispiral whorl. A comparison with the morphologically nearest species, *A.* (*A.*) *astrictum* sp. nov., is given below.

Occurrence – RGM 212 866 and 214 542, lower Barremian *Rarocinctum* Zone, bed 83, Gott quarry near Sarstedt, Lower Saxony, northern Germany.

***Acrioceras* (*Acrioceras*) *astrictum* sp. nov.**

Pl. 84, fig. 2; Fig. 11.

1997a *Hoplocrioceras phillipsi* (Phillips); Mutterlose, fig. 44.10.

Holotype – RGM 213 915A, the only specimen known, very well-preserved and represented by planispiral whorls, shaft and hook.

Type locality – Subway Aegidientor Square in Hannover, northern Germany.

Type horizon – *Fissicostatum-elegans* zonal boundary bed 7, Barremian.

Derivatio nominis – *Astrictum* (Latin) = tightened.

Diagnosis – Small shell has subcircular planispiral whorls, which touch each other and increase moderately in height, followed by a short curved shaft and a broad curved hook, the dorsum of which nearly touches the venter of the last planispiral whorl. The simple main ribs obtain three tubercles at the beginning of the second whorl; the umbilical tubercles disappear in the first half of the second whorl, the lateral ones at the end of that whorl and the small ventrolateral spines on the third whorl. There are 1-2 non-tuberculate intermediate ribs to each main one and all ribs have the same thickness. The shaft has uniform simple ribs. On the terminal straight part of the hook are several fasciculated ribs. On the dorsum of shaft and hook the ribs are convex.

Description – The small shell consists of crioconic whorls, which are touching and increase moderately in height; the umbilical perforation is rather wide. The spiral is followed by a short curved shaft and a broad hook. The shaft is curved and very short. It ends in a widely curved hook, so that the dorsum of it is nearly in contact with the ventral side of the last planispiral whorl. The flanks of the planispiral whorls, shaft and hook are slightly convex, the venter is rounded and the dorsum flat. The cross section of the early planispiral whorls is subcircular, but in the last planispiral whorl and shaft it becomes subellipsoidal (slightly higher than wide). At the last straight portion of the hook the cross section is suboval, with maximum thickness at the lower third of the flank height.

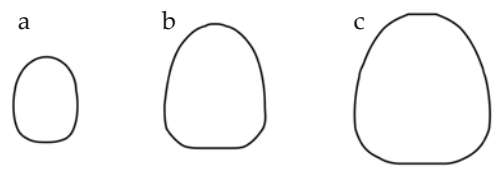

Fig. 11. Whorl section of *A.* (*Acrioceras*) *astrictum* sp. nov., RGM 213915A (holotype). (a) At the end of the planispiral stage. (b, c) On the hook. × 1.

The sculpture of the first planispiral whorl consists of distant, simple ribs. Ventrolateral, lateral and umbilical tubercles appear on the main ribs of the second whorl. The umbilical tubercles are very small and disappear in the first half of the second whorl. The lateral tubercles are a little longer, but are still smaller than the ventrolateral ones. Lateral tubercles disappear later, viz. at the end of the second whorl. The small pointed ventrolateral spines are strong and wedge-like; they disappear on the third planispiral whorl. There are 1-2 non-tuberculate intermediate ribs to one tuberculate main rib. The main and intermediate ribs have the same thickness. On the shaft the ribbing consists of uniform simple ribs, which pass straight over the venter. On the terminal straight part of the hook there are several fasciculated ribs, which split at the lower fifth of the whorl height. On the dorsum of the shaft and hook all ribs are equally thin and convex.

Measurements –

№	D	H	h	W	U	H/D	U/D	H/h	K	L	H_1	W_1	H_2	W_2	D_1
213 915B	33.2	13.1	7.3	11.0	15.6	0.39	0.47	1.79	0.14	71.0	17.5	-	26.0	23.1	68.0

Comparison – *Acrioceras (Acrioceras) astrictum* resembles *A.* (*A.*) *longum* (see above) in mode of coiling of the planispiral whorls, but differs from it in having a very short shaft, a widely open hook and a terminal part that is in contact with the last planispiral whorl. Moreover, in a few cases two ribs unite in one ventrolateral tubercle (fibulation) in the planispiral stage of *A.* (*A.*) *longum.*

***Acrioceras* (*Acrioceras*) sp.**
Pl. 84, fig. 3.

Material – One incomplete specimen, RGM 214 563.

Description – Last planispiral whorl slowly increases in height. The transition to the shaft is gradual. The shaft is straight and terminated by narrowly curved hook.

The sculpture of the last part of the planispiral whorl and transition to the shaft consists of very wide-apart, strong, straight main ribs and slightly weaker short intermediate ones, which regularly alternate (1:1) with the trituberculate main ribs. However, on the first half of the shaft are 2-3 thin intermediate ribs between every trituberculate main rib. The tubercles are well visible at the end of the planispiral whorl and on the first part of the shaft. The specimen is damaged from halfway up the shaft to the last straight part of the hook. On the last part of the hook the sculpture consists of straight non-tuberculate main ribs and 1-2 thin intermediate ribs between every two main ones. Intermediate ribs are absent on the terminal part of the hook.

Measurements –

№	D	H	h	W	U	H/D	U/D	H/h	K	L	H_1	W_1	H_2	W_2	D_1
214 563	24.5	6.0	4.0	-	8.5	0.24	0.34	1.5	0.08	67.0	-	-	15.0	-	42.0

Remarks – On the basis of the morphology of the crioconic whorls, the shaft and the hook, and the type of sculpture, this specimen undoubtedly belongs to *Acrioceras* (*Acrioceras*). Owing to the poor preservation it is impossible to propose a specific identification.

Occurrence – RGM 214 563, upper Hauterivian *discofalcatus* Zone, bed 72, Gott quarry near Sarstedt, northern Germany.

Genus *Uhligia* von Koenen, 1904

Type species – *Crioceras minutum* Neumayr & Uhlig, 1881, p. 195, pl. 42, fig. 6, lower Barremian of Drispenstedt near Hildesheim, Lower Saxony, northern Germany.

Diagnosis – The small to medium-sized shell consists of two shafts that are well separated. The construction of the earliest part of the shell is not known. The first shaft is

slightly curved, and passes into a moderately open U-shaped bend, which connects it with a rather long straight or slightly curved second shaft. The latter terminates in a wide open hook. In the early and middle growth stages the sculpture consists of comparatively strong, single or fasciculated main ribs, and fine, occasionaly bundled secondary ribs.

Distribution – Lower Barremian, northern Germany.

Uhligia minuta (Neumayr & Uhlig, 1881)

Pl. 85, figs. 1, 2.

1881 *Crioceras minutum* Neumayr & Uhlig, p. 195, pl. 42, fig. 6.
1902 *Hamites minutus* Neumayr & Uhlig; von Koenen, p. 389, pl. 25, figs. 2a-c, 3, 4.
non 1902 *Hamites minutus* Neumayr & Uhlig; von Koenen, p. 389, pl. 25, figs. 5, 6.
1957 *Uhligia minutus* Neumayr & Uhlig; Arkell *et al.*, p. L211, fig. 240:2a-c [= von Koenen, 1902, pl. 25, figs. 2a, b, 3].
1996 *Uhligia minuta* Neumayr & Uhlig; Wright *et al.*, p. L227, figs. 178:1a-c [= von Koenen, pl. 25, figs. 2a, b, 3].

Holotype – The specimen figured by Neumayr & Uhlig (1881, p. 195, pl. 42, fig. 6) from the lower Barremian of Drispenstedt near Hildesheim, Lower Saxony, northern Germany.

Material – One well preserved specimen, RGM 216 200, and three fragments of the first shaft, RGM 216 215, 216 219 and 216 220.

Description – Medium-sized shell. The first shaft has a horn-like shape and is connected with the second shaft by a wide 180° bend. The second shaft is straight and almost parallel to the first shaft. It terminates in a moderately wide hook. The sculpture of the first shaft consists of simple ribs, which pass straight over the venter with slight broadening; on the dorsum they are thin and convex. The ribs describe convex curves on the flanks. The second shaft is sculptured with straight, closely spaced, equal ribs (5-6 ribs on 10 mm length). On the terminal hook the ribs become stronger and equal, and pass straight over the venter.

The suture line is visible on the first shaft (RGM 216 215). It is of the ancyloceratid type, with bifid symmetric ventral lobe and trifid lateral, umbilical and dorsal lobes.

Measurements –

№	L	H_2	H_2	H_3	H_4
216 200	70.0	8.0	17.5	20.0	21.0

Remarks – Neumayr & Uhlig (1881, p. 195, 42, fig. 6) had only a very incomplete specimen (a fragment of the first shaft) at their disposal, which is unsuitable as type of *U. minuta*. A more complete specimen showing both shafts and the hook was figured by von Koenen (1902, pl. 25, fig. 2). The other two specimens described and figured by von Koenen (1902, pl. 25, figs. 5, 6), are clearly different from *U. minuta* in the general shape of the shell and sculpture. They are described below as new species, *Uhligia aegidii* sp. nov.

Occurrence – RGM 216 200, 216 215, 216 219, 216 220, lower Barremian *fissicostatum* Zone, bed 6, Subway Aegidientor Square Hannover.

Distribution – Lower Barremian, northern Germany.

***Uhligia aegidii* sp. nov.**

Pl. 85, fig. 5.

pars 1902 *Hamites minutus* Neumayr & Uhlig; von Koenen, pl. 25, figs. 5, 6 [*non* figs. 2a-c, 3, 4].

Holotype – RGM 216 199.

Type locality – Subway Aegidientor Square in Hannover, northern Germany

Type horizon – Lower Barremian *fissicostatum* Zone, bed 6.

Derivatio nominis – Named after the Aegidientor Square at Hannover.

Material – One fairly well-preserved specimen, RGM 216 199 (holotype), and two fragments of the first shafts, RGM 216 211 and 216 216.

Diagnosis – Medium-sized shell with a rather long, curved first shaft, which makes an angle of 80-90° with the second shaft. The latter is short and gradually passes into the terminal hook. The angle between the second shaft and terminal hook is 40-45°. The sculpture on the first shaft and on the first part of the second consists of bundles of very fine, closely spaced ribs, which pass straight and over the venter and dorsum, whereas on the flanks they describe a convex curve. On the remainder of the second shaft, the sculpture consists of equal, straight, distantly spaced ribs. On the last part of the hook the ribs are simple, slightly stronger and more distant with 1-3 thin intermediate ribs to one main one.

Description – The medium-sized shell consists of a first shaft, second shaft and terminal hook. The first shaft is long, slightly curved and passes into the second one with a very widely open curve with an angle of 80-90°. The second shaft is shorter than the first and passes into the terminal hook with an angle of 40-45°. The flanks of the two shafts are slightly convex and the venter is rounded, but the dorsum is slightly flattened. The flanks and venter become flat in the final straight part of the hook. The cross section of the two shafts is subellipsoidal; that of the terminal hook it is suboctagonal (higher than wide).

The sculpture of the initial part of the first shaft is visible from H = 5 mm; it consists of bundles of very thin, closely spaced ribs. The ribs become slightly thicker on the venter, but on the dorsum they remain thin. The ribs are adapically convex on the flanks, but pass straight over the venter and dorsum. A similar sculpture continues halfway up the second shaft, but thereafter it changes into equal, straight, widely spaced, simple ribs. The interspaces between the ribs are 3 or 4 times wider than the width of the ribs. The ribs pass straight over the venter without thickening, whereas they cross the dorsum

convexly. On the final part of the hook there are strong, simple, main and thin intermediate ones. Some of main ribs bifurcate at one-sixth of the whorl height. The number of the intermediate ribs between two main ones varies from one to three.

Measurements –

№	L	H_1	H_3	H_4	W_3
216 199	59.0	8.7	17.5	18.2	5.5

Comparison – *Uhligia aegidii* differs from *U. minuta* in the general shape of the shell and the sculpture. The angle between the first and second shafts of *U. aegidii* is 80-90°, whereas in *U. minuta* it is 180°. Moreover, the first shaft and first half of the second are sculpted by bunches of thin ribs, which are convex on the flanks, and pass straight over the venter and dorsum. In *U. minuta* the sculpture of the first shaft consists of strong, simple ribs, which become distinctly stronger on the venter.

Occurrence – RGM 216 199, 216211 and 216 216, lower Barremian *fissicostatum* Zone, bed 6, Subway Aegidientor Square, Hannover, northern Germany.

***Uhligia*? sp. indet.**

Pl. 85, figs. 3, 4.

Material – Two incomplete specimens, RGM 216 213 and 216 214, represented by the shaft and terminal hook.

Description – The shell is small. The first shaft passes into the terminal hook with an U-shaped bow; there is no second shaft. The sculpture of the shaft is only poorly visible in RGM 216 214 and consists of simple ribs which pass straight over the venter. On the terminal part of the hook (RGM 216 213) are simple, distant main ribs, with a decreasing number (from five to two) of short intermediate ribs between every two main ribs.

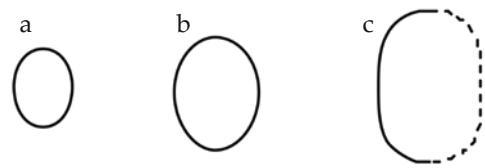

Fig. 12. Cross section of *Uhligia aegidii* sp. nov., RGM 216 199. (a) At the first shaft. (b) At the second shaft. (c) At the terminal hook. × 1.

Measurements –

№	H_2	H_3	H_4
216 213	7.3	12.0	10.0
216 214	6.0	11.0	9.9

Remarks – These specimens are insufficiently well-preserved to permit specific identification. We conditionally refer them to *Uhligia* because of the general shape of the shaft and terminal hook, which are characteristics of this genus.

Occurrence – RGM 216 213 and 216 214, lower Barremian *fissicostatum* Zone, bed 6, Subway Aegidientor Square, Hannover, northern Germany.

Genus *Audouliceras* Thomel, 1964

Type species – *Ancyloceras audouli* Astier, 1851, p. 452, pl. 20 (6), fig. 12, pl. 21 (7), fig. 12bis. Barremian, France.

Diagnosis – Crioconic early whorls are followed by a long shaft and a terminal hook. The sculpture of the crioconic whorls consists of equal, closely spaced main ribs, periodically with ventrolateral, lateral and umbilical spines, which may irregularly embrace several ribs. Between the main ribs are intermediate ribs without tubercles. Short intercalatory ribs with ventrolateral spines may also occur. The spines disappear on the shaft and at least part of the shaft is characterized by the absence of trituberculate main ribs. On the first part of the hook the main ribs bear very strong ventrolateral, lateral and umbilical spines again, but on the terminal part of the hook spines disappear.

Distribution – Upper Barremian-lower Aptian, Western and central Europe, Caucasus, Mozambique, South Africa (Zululand), USA (California).

Audouliceras cf. *urbani* (Neumayr & Uhlig, 1881)

Pl. 86.

Material – One specimen, RGM 214 415, represented by the last part of the shaft and an incomplete hook.

Description – The shell is large. The shaft is straight and the hook is moderately open. The flanks of the shaft and hook are convex, the venter is slightly rounded, but the dorsum is almost flat. The cross section of the shaft is subcircular (slightly wider than high). On the hook it becomes subellipsoidal (markedly greater in width).

The sculpture on the shaft and the arch of the hook consists of strong, distant, spinose main ribs and *non*-spinose, much thinner intermediate ribs. On the shaft the ribs are prorsiradiate. The main ribs bear strong umbilical and lateral spines, the bases of which are elongated in the direction of the ribs. On the shaft, the number of intermediate ribs between every two main ribs varies from 4 to 8, but on the hook the number is commonly 2-3. The intermediate ribs are thin and non-spinose. They cross the venter in a slight convex curve. On the shaft-hook transition, and additional to the umbilical and lateral spines, the main ribs are also provided with ventrolateral spines, the bases of which are also elongated in the direction of the ribs. There is one intermediate rib with a small ventrolateral tubercle-like thickening. On the dorsum all ribs are equally thin. On the shaft the dorsal ribs are slightly concave, whereas on the hook they cross the dorsum with a slight adorally convex curve. From some umbilical spines arise 2 or 3 thin dorsal ribs, which cross the dorsum with the same curvature as the intermediate ribs.

The suture line is too fragmentary to describe its characteristic features. Remarkably, the last suture line is situated in the latest part of the shaft, which indicates that the adult body chamber occupied the hook and only the last part of the shaft.

Comparison – This specimen resembles the specimens identified by von Koenen (1902, p. 258, pl. 42, fig. 1, pl. 43, fig. 2) as *A. urbani* Neumayr & Uhlig in the morphology

of the U-shaped hook, of the cross section of the shaft and in the morphology of the intermediate ribs, but differs from it in the absence of ventral spines on the last part of the shaft and the initial part of the hook. Moreover, it has a greater number of intermediate ribs between every two main ribs. Our specimen resembles the lectotype of *A. urbani* (Neumayr & Uhlig, 1881, p. 190, pl. 49, fig. 3) in the morphology of the shaft and hook, and in its strong umbilical and lateral spines, but differs from it in the absence of ventrolateral spines in the shaft-hook transition, in having markedly thinner intermediate ribs, and in the greater number of them between every two main ribs.

Occurrence – RGM 214 415, uppermost Barremian, quarry near Gross Latterde, Lower Saxony, northern Germany.

Acknowledgements

With sincere gratitude the authors note that the study of the Wiedenroth collection was financially supported by the NNM ("Naturalis") and by NATO grant from the Netherlands Organization of Scientific Research. The photographs were made by Mr. Adri 't Hooft.

References

Adamiková, G., Michalík, J. & Vašíček, Z. 1983. Composition and ecology of the "Pseudothurmanniafauna", lower Barremian of the Krizna-Nappe in the Strazovske Vtchy Mts. Geologicky zbornik. *Geologica Carpathica*, **34**: 591-615.

Aguirre-Urreta, M.B. 1993. Neocomian ammonite biostratigraphy of the Andean basins of Argentina and Chile. *Revista Española de Paleontologia*, **8**: 57-74.

Aguirre-Urreta, M.B. & Ramos, V.A. 1981. Estratigrafia y paleontologïa de la alta cuenca del Río Roble, Cordillera Patagónica – Provincia de Santa Cruz. *Congreso Geológico Argentino III, Actas*, **8**: 101-138.

Anderson, F.M. 1938. Lower Cretaceous deposits in California and Oregon. *Geological Society of America, Special Papers*, **16**: x+340 pp.

Arkell, W.J., Kummel, B. & Wright, C.W. 1957. Mesozoic Ammonoidea. *In*: Moore, R.C. (ed.), *Treatise on Invertebrate Paleontology, Part L, Mollusca 4, Cephalopoda, Ammonoidea.* Geological Society of America & University of Kansas Press, New York & Lawrence: xxii+L80-L490 pp.

Astier, J.E. 1851. Catalogue descriptif des *Ancyloceras* appartenant à l'étage Néocomien d'Escragnolles et des Basses-Alpes. *Annales des Sciences Physiques et Naturelles d' Agriculture et d'Industrie* (série 2), **3**: 435-456.

Avram, E. 1995. Lower Cretaceous (Valanginian-Early Aptian) ammonite succession in the Svinita region (SW Romania). *Géologie Alpine, Mémoire Hors Série*, **20** (for 1994): 113-167.

Avram, E., Bordea, S., Cociuba, I., Huza, R. & Preda, I. 2001. Ammonite assemblages of the Ecleja Formation (northern Apuseni Mts., Romania). *Romanian Journal of Stratigraphy*, **79**: 13-20.

Breskovski, S. 1966. Biostratigrafia na barema juzno ot s. Brestak, Varnensko. [Biostratigraphy of the Barremian to the south of Brestak, Varna region.] *Trudove verkhu geologijata na B'lgarija. Series Paleontologija, Stratigrafija io Litologija*, **8**: 71-121. [In Bulgarian.]

Busnardo, R., Charollais, J., Weidmann, M. & Clavel, B. 2003. Le Crétacé inférieur de la Veveyse de Châtel (Ultrahelvétique des Préalpes externs; Canton de Fribourg, Suisse). *Revue Paléobiologique*, **22**: 1-174.

Cecca F., Faraoni P. & Marini, A. 1998. Latest Hauterivian (Early Cretaceous) ammonites from Umbria-Marcha Apennines (central Italy). *Palaeontographia Italica*, **85**: 61-110.

Dacqué, E. 1942. Wirbellose der Kreide. *In*: Gürich, G. (ed.), *8. Lieferung, Leitfossilien*: 1-10. Berlin-Zehlendorf, Borntraeger.

Delanoy, G., Guimar, M., Pagés, J.-P. & Thomel, G. 2000. *Barrême: passionnément géologique*. Bernard Vial, Château – Arnoux: 36 pp.

Diener, C. 1925. Ammonoidea neocretacea. *In*: Diener, C. (ed.), *Fossilium Catalogus. 1. Animalia Pars 29*: 1-244. W. Junk, Berlin.

Dimitrova, N. 1967. Cephalopoda (Nautiloidea et Ammonoidea). *In*: Tzankov, V. (ed.), *Les fossiles de Bulgarie. IV, Crétacé inférieur.* Académie Bulgare des Sciences, Sofia: 424 pp.

Drushchits, V.V. 1960. Ammoniti (Ammonites). *In*: Drushchits, V.V. & Kudrjavtsev, M.P. (eds), *Atlas Nizhnemelovoj fauni Severnogo Kavkaza I Kryma.* [*Atlas of the Lower Cretaceous fauna of the Northern Caucasus and Crimea.*] Vsesojuznyi Nauchno-Issledovatelskyi Institut prirodnikh Gasov, Moskva: 249-354. [In Russian.]

Faraoni, P., Marini, A. & Palini G. 1995. The Hauterivian ammonite succession in the Central Apennines, Maiolica Formation (Petrano Mt., Cagli-PS). Preliminary results. *Palaeopelagos*, **2**: 227-236.

Fülöp, J. 1964. A Bakonyhegység alsó-kréta (Beriazi-Apti) képződményei. [Lower Cretaceous deposits (Berriasian-Aptian) of the Bakony Mountains.] *Geologica Hungarica, Series Geologica,* **13**: 194 pp.

Gauthier, H. avec la collaboration de R. Busnardo, R. Combémorel, G. Delanoy, J.-C. Fischer, S. Guérin-Franiatte, B. Joly, W.J. Kennedy, J. Sornay & H. Tintant. 2006. Publication dirigée par Jean-Claude Fischer. Premiere Partie. *In*: *Révision critique de la Paléontologie française d'Alcide d'Orbigny, volume IV, Céphalopodes Crétacé*. Backhuys, Leiden: 662 pp.

Gerhardt, K. 1897. Beitrag zur Kenntniss der Kreideformation in Colombien. *Neues Jahrbuch für Mineralogie, Geologie und Paläontologie* (Beilage-Band), **11**: 118-208.

Gill, T. 1871. Arrangement of the families of mollusks. *Smithsonian Miscellaneous Collections*, **227**: xvi + 49 pp.

Hiltermann, H. & Kemper, E. 1969. Vorkommen von Valangin, Hauterive und Barrême auf Helgoland. *Bericht der Naturhistorischen Gesellschaft zu Hannover*, **113**: 15-37.

Hoedemaeker, Ph.J. 1995. Ammonite distribution around the Hauterivian-Barremian boundary along the Río Argos (Caravaca, SE Spain). *Géologie Alpine, Mémoire Hors Série*, **20** (for 1994): 219-277.

Howarth, M. 1962. The Yorkshire type ammonites and nautiloids of Young and Bird, Phillips and Martin Simpson. *Palaeontology,* **5**: 93-136.

Hyatt, A. 1900. Cephalopoda. *In*: Zittel, K.A. von, *Textbook of Palaeontology*: 502-592. English edition. Macmillan, London.

Immel, H. 1978. Die Crioceratiten (Ancyloceratina, Ammonoidea) der Mediterranen und Borealen Hauterive-Barreme (Unterkreide). *Palaeontographica*, **A163**: 1-84.

Immel, H. 1979. Die Ammonitengliederung des mediterranen und borealen Hauterive und Barreme unter besonderer Berücksichtigung heteromorpher Ammoniten der Gattung *Crioceratites* Léveillé. *Newsletters on Stratigraphy*, **7**: 121-141.

Immel, H. & Mutterlose, J. 1980. Barreme-Cephalopoden aus dem kretazischen Untergrund des Stadtgebietes Hannover (NW-Deutschland). *Palaeontologische Zeitschrift*, **54**: 241-266.

Kaever, M., Oekentorp, K. & Siegfried, P. 1974. Fossilien Westfalens Teil I: Invertebraten der Kreide. *Münstersche Forschungen zur Geologie und Paläontologie*, **33/34**: 364 pp.

Kakabadze, M.V. 1981. Antsilotseratidy yuga SSSR i ikh stratigraphicheskoe znachenie. [Ancyloceratids of the south of the USSR and their stratigraphical significance.] *Trudy Geologicheskogo Instituta Akademii Nauk GSSR* (novaya seriya), **71**: 195 pp. [In Russian, summary in English.]

Kakabadze, M.V. 2004. Intraspecific and intrageneric variabilities and their implication for the systematics of Cretaceous heteromorph ammonites. *Scripta Geologica*, **128**: 17-37.

Kazansky, P.A. 1914. *Description d'une collection des Céphalopodes des terrains Crétacés du Daghestan*. Tomsk: 127 pp.

Kemper, E. 1971. *Geologischer Führer durch die Grafschaft Bentheim und die angrenzenden Gebiete.* Vierte Auflage. Heimatverein der Grafschaft Bentheim Nordhorn: 172 pp.

Kemper, E. 1976. *Geologischer Führer durch die Grafsxhaft Bentheim und die angrenzenden Gebiete mit einem Abrisz der emsländischen Unterkreide*. Fünfte Auflage. Das Bentheimer Land, **64**: 206 pp.

Kemper, E. 1992. *Die tiefe Unterkreide im Vechte-Dinkel-Gebiet (westliches Niedersächsisches Becken). Mit einem palaeobotanischen Beitrag J. van der Burgh*: Het Staringmonument, Losser: 95 pp.

Kemper, E., Mutterlose, J. & Wiedenroth, K. 1987. Die Grenze Unter-/Ober-Hauterive in Nordwestdeutschland, Beispiel eines stratigraphisch zu nutzenden Klima-Umschwungs. *In* Kemper, E, (ed.), *Das Klima der Kreidezeit*. Geologisches Jahrbuch, **A96**: 209-218.

Kilian, W. 1907-1913. Unterkreide (Palaeocretacicum), Leiferung 1-3. *In*: Frech, F. (ed.), *2. Teil: Das Mesozoicum; 3. Band: Kreide; Erste Abteilung*. E. Schweizerbart'schen Verlagsbuchhandlung (E. Nägele), Stuttgart: 398 pp.

Klein, J., Busnardo, R., Company, M, Delanoy, G., Kakabadze, M., Reboulet, S., Ropolo, P, Vašíček, Z. & Vermeulen, J. 2007. Lower Cretaceous Ammonites III Bochianotoidea, Protancyloceratoidea, Ancyloceratoidea, Ptychoceratoidea. *In*: Riegraf, W. (ed.), *Fossilium Catalogus I: Animalia, Pars 144*: 381 pp. Backhuys, Leiden.

Klinger, H.C. & Kennedy, W.J. 1992. Cretaceous faunas from Zululand and Natal, South Africa. Barremian representatives of the ammonite family Ancyloceratidae Gill, 1871. *Annals of the South African Museum*, **101**: 71-138.

Koenen, A. von. 1902. Die Ammonitiden des norddeutschen Neocom (Valanginien, Hauterivien, Barremien und Aptien). *Abhandlungen der Königlich-Preussischen Geologischen Landesanstalt und Bergakademie* (Neue Folge), **24**: 451 pp. + atlas.

Koenen, A. von. 1904. Über die untere Kreide Helgolands und ihre Ammonitiden. *Abhandlungen der Königlichen Geselschaft der Wissenschaften zu Göttingen* (Neue Folge), **3**: 1-62.

Koenen, A. von. 1908. Bemerkungen zur Gliederung der unteren Kreide. *Centralblatt für Mineralogie, Geologie und Paläontologie*, **1908**: 289-293.

Léveillé, Ch. 1837. Description de quelques nouvelles coquilles fossiles du Département des Basses-Alpes. *Mémoires de la Société Géologique de France*, **10:** 313-315.

Lukeneder, A. & Aspmair, Ch. 2006. Stratigraphic implications of a new Lower Cretaceous ammonoid fauna from the Puez area (Valanginian-Aptian, Dolomites, Southern Alps, Italy). *Geo.Alp*, **3**: 55-83.

Mandov, G. 1976. L'étage Hauterivien dans les Balkanides occidentales (Bulgarie de l'ouest) et sa faune d'ammonites. *Annuaire de l'Université de Sofia, Livre 1, Géologie*, **67**: 11-99.

Müller, G. 1892. Über das Vorkommen von *Ancyloceras gigas*-Schichten bei Mellendorf nördlich Hannover. *Jahrbuch der Preussischen Geologischen Landesanstalt*, **13**: 16-22.

Mutterlose, J. 1989. Faunal and floral distribution in Late Hauterivian. Rhythmic bedded sequences and their implications. *Proceedings, 3rd International Cretaceous Symposium*: 691-713.

Mutterlose, J. 1995. Die Bio- und Lithofazies der Unterkreide im Raum Hannover. *In*: Boetzkes, M. & Vespermann, J. (eds), *65. Jahrestagung der Paläontologischen Geselschaft Hildesheim, 25. bis 30. September 1995, Exkursionsführer*. Terra Nostra, **5**: 153-186.

Mutterlose, J. 1997a. Gott clay-pit near Sarstedt. *In*: Mutterlose J., Wippich M.G. & Geisen M. (eds.), *Cretaceous Depositional Environments of NW Germany*. Bochumer Geologische und Geotechnische Arbeiten, **46**: 63-82.

Mutterlose, J. 1997b. Resse clay-pit. *In*: Mutterlose, J., Wippich, M.G. & Geisen, M. (eds.), *Cretaceous Depositional Environments of NW Germany*. Bochumer Geologische und Geotechnische Arbeiten, **46**: 97-104.

Mutterlose, J. 1998. Hauterivian of Sarstedt (Moorberg section). *In*: Mutterlose, J, Bornemann, A, Rauer S., Spaeth, C. & Wood C.J. (eds.), *Key localities of the Northwest Europeran Cretaceous.* Bochumer Geologische und Geotechnische Arbeiten, **48**: 81-91.

Mutterlose, J. & Bornemann, A. 2002. North Germany: the Early Cretaceous gateway between the Tethys and the Boreal Realm. *In*: Michalik, J. (ed.), *Tethyan/Boreal Cretaceous Correlation*, 213-234. Veda Publishing House of the Slovak Academy of Sciences, Bratislava.

Mutterlose, J. & Wiedenroth, K. 1996. Faunenführung und Biostratigraphie des tiefen Ober-Hauterive (Unter-Kreide) im Grossraum Hannover. *Bericht der Naturhistorischen Geselschaft zu Hannover*, **138**: 113-131.

Mutterlose, J., Wippich, M.G. & Geisen, M. (eds.). 1997. *Cretaceous Depositional Environments of NW Germany.* Bochumer Geologische und Geotechnische Arbeiten**, 436**: 134 pp.

Myczyński, R. 1977. On the ammonites of the Speeton Clay and the subdivisions of the Neocomian. *Geological Magazine*, **61**: 73-89.

Neumayr, M. & Uhlig, V. 1881. Über Ammonitiden aus den Hilsbildungen Norddeutschlands. *Palaeontographica*, **A27**: 129-203.

Nikolov, T.G. 1964. Barremian ammonites from north-eastern Bulgaria. *Comptes rendus de l'Académie Bulgare des Sciences*, **19**: 839-841.

Nolan, H. 1894. Sur les *Crioceras* du groupe du *Crioceras duvali*. *Bulletin de la Société Géologique de France*, (série 3), **22**: 183-196.

Obata, I. & Ogama, Y. 1976. Ammonite biostratigraphy of the Cretaceous Arida Formation, Wakayama Prefecture. *Bulletin of the National Science Museum* (series C, Geology), **2**: 93-110. [In Japanese with English summary.]

Ooster, W.A. 1860. Pétrifications remarquables des Alpes suisses. Catalogue des Céphalopodes fossiles des Alpes suisses. *Nouveaux Mémoires de la Société helvétique des Sciences naturelles*, **18** (4 + 5): 60 + 100 pp.

Orbigny, A. d' 1840-1842. *Description zoologique et géologique de tous les animaux mollusques et rayonnés fossiles de France*. *Paléontologie Française. Terrains Crétacés*, **1**, *Céphalopodes*. Alcide d'Orbigny & Arthus-Bertrand, Paris: 662 pp.

Philips, J. 1829. *Illustrations of the Geology of Yorkshire; or Description of the Strata and Organic Remains of the Yorkshire Coast.* Wilson & Sons, York: xvi+192 pp.

Pictet, F.-J. & Campiche, G. 1861-1864. Description des Fossiles du terrain Crétacé. Environs de Sainte-Croix. Deuxième partie. *Matériaux pour la Paléontologie Suisse* (série 3), **1861-1864**: 752 pp.

Rawson, P.F. 1975. Lower Cretaceous ammonites from north-east England: the Hauterivian heteromorph *Aegocrioceras*. *Bulletin of the British Museum* (*Natural History*) (Geology series), **26**: 129-159.

Rawson, P. F. & Mutterlose, J. 1983. Stratigraphy of the Lower B and basal Cement Beds (Barremian) of the Speeton Clay, Yorkshire, England. *Proceeding of the Geological Association*, **94**: 133-146.

Richter, U. 2002. Gewebeansatz-Strukturen auf pyritisierten Steinkernen. Ammonoideen. *Geologische Beiträge Hannover*, **4**: 113 pp.

Roemer, F.A. 1841. *Die Versteinerungen des norddeutsches Kreidegebirges.* Part 2. Hannover, Hahn: iii-iv + 49-145.

Roch, E. 1930. Études géologiques dans la région méridionale du Maroc occidental. *Notes et Mémoires du Service des Mines et Carte géologique de Maroc*, **9**: 542 pp.

Roman, F. 1938. *Les ammonites Jurassiques et Crétacées. Essai de Genera*. Masson & Cie, Paris: 554 pp.

Ropolo, P. 1995. Implications of variation in coiling in some Hauterivian (Lower Cretaceous) heteromorph ammonites from the Vocontian Basin, France. *Memorie Descrittivi della Carta Geologica d'Italia,* **51:** 137-165.

Sarasin, Ch. & Schöndelmayer, Ch. 1902. Étude monographique des ammonites du Crétacique inférieur de Châtel-Saint-Denis. *Mémoires de la Société Paléontologique Suisse*, **28**: 95-195.

Sarkar, S.S. 1954. Some new genera of uncoiled ammonites from the Lower Cretaceous. *Science et Culture,* **19**: 618-620.

Sarkar, S.S. 1955. Revision des ammonites déroulées du Crétacé inférieur du Sud-est de la France. *Mémoires de la Société Géologique de France*, **72**: 176 pp.

Seeley, H. 1865. On ammonites from the Cambridge Greensand. *Annals & Magazine of Natural History* (series 3), **94**: 225-247.

Skwarko, S.K. & Thieuloy, J.-P. 1989. Early Barremian (Early Cretaceous) Mollusca from the western Irian Jaya, Indonesia. *Publication of the Geological Research & Development Centre* (paleontology series), **6**: 26-43.

Spath, L.F. 1924. On the ammonites of the Speeton Clay and the subdivisions of the Neocomian. *Geological Magazine*, **61**: 73-89.

Thieuloy, J.-P. 1972. Biostratigraphie des lentilles à Péregrinelles (Brachiopodes) de l'Hauterivien de Rottier (Drôme, France). *Geobios*, **5**: 5-53.

Thomel, G. 1964. Contribution à la connaissance des Céphalopodes Crétacés du Sud-Est de la France. Note sur les ammonites déroulées du Crétacé inférieur vocontien. *Mémoires de la Société Géologique de France* (nouvelle série), **43**, *Mémoire* **101**: 5-78.

Thomel, G., Delanoy, G., Coullet, P., Davoux, J., Fuhr, F., Fuhr, M., Gazel, L., Giverso, J., Joullian, H., Levan, G., Mascarelli, E., Maurel, L., Poupon, A. & Salomon M. 1990. Le genre *Acrioceras* Hyatt, 1900

dans le Barrémien du sud-est de la France. *Annales du Muséum d'Histoire Naturelle de Nice*, **7**: 20-149.

Vašíček, Z. 2002. Lower Cretaceous Ammonoidea in the Podbranč quarry (Pieniny Klippen Belt, Slovakia). *Bulletin of the Czech Geological Survey*, **77**: 187-200.

Vermeulen, J. 2004. Vers une nouvelle classification à fondement phylogénétique des ammonites hétéromorphes du Crétacé inférieur méditerraneen. Le cas des Crioceratidae Gill, 1871, *nom. correct*. Wright, 1952, des Emericiceratidae fam. nov. et des Acrioceratidae fam. nov. (Ancyloceratacea Gill, 1871). *Riviéra Scientifique*, **88**: 69-92.

Vermeulen, J. 2005. Boundaries, ammonite fauna and main subdivisions of the stratotype of the Barremian. *Géologie Alpin*, *série spéciale "Colloques et Excursions,"* **7**: 147-173.

Vermeulen, J. 2006. Nouvelle classification à fondement phylogénétique des ammonites hétéromorphes du Crétacé inférieur. *Annals du Muséum d'Histoire Naturelle de Nice*, **21**: 137-178.

Wiedmann, J. 1962. Unterkreide-Ammoniten von Mallorca 1. Lieferung: Lytoceratina, Aptychi. *Akademie der Wissenschaften und der Literatur. Abhandlungen der Mathematisch-Naturwissenschaftlichen Klasse*, **1962**: 148 pp.

Wiedmann, J. 1966. Stammesgeschichte und System der Posttriadischen Ammonoideen. *Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen*, **127**: 13-81.

Wright, C.W., Callomon, J.H. & Howarth, M.K. 1996. *Treatise on Invertebrate Paleontology, Part L, Mollusca 4 (Revised), Volume 4: Cretaceous Ammonoidea*. Geological Society of America & University of Kansas Press, Boulder & Lawrence: xx+362 pp.

Zittel, K.A.von. 1884. Cephalopoda. *In*: Zittel, K.A.von., *Handbuch der Palaeontologie, Band 1, Abteilung 2, Lieferung 3*: 329-522. Oldenburg, Munich & Leipzig.

Zwierzycki, J. 1914. Die Cephalopodenfauna der Tendaguru-Schichten in Deutsch-Ostafrika. *Archiv für Biontologie*, **3**: 96 pp.

Explanation of plates

Plate 1
Fig. 1. *Parancyloceras aegoceras* (von Koenen, 1902), uppermost Barremian *bidentatum* zone, Gott quarry near Sarstedt, RGM 213 796. (a) Right lateral view. (b) Apertural view. (c) Ventral view. All × 0.75.

Plate 2
Fig. 1. *Parancyloceras aegoceras* (von Koenen, 1902), uppermost Barremian *bidentatum* zone, Gott quarry near Sarstedt, RGM 214 475. (a) Right lateral view. (b) Ventral view. Both × 0.5.
Fig. 2. *Emericiceras nolani* (Kilian, 1910), upper Hauterivian *staffi* zone, Mittelland Canal near Wilhelmsdorf (Haste), RGM 213 634. × 0.5.

Plate 3
Fig. 1. *Emericiceras nolani* (Kilian, 1910), upper Hauterivian *inversum* zone, Mittelland Canal near Wilhelmsdorf (Haste), RGM 213 860. (a) Right lateral view. (b) Ventral view. Both × 1.

Plate 4
Fig. 1. *Emericiceras nolani* (Kilian, 1910), upper Hauterivian *inversum* zone, Mittelland Canal near Wilhelmsdorf (Haste), RGM 213 861. × 1.
Fig. 2, 3. *Emericiceras woeckeneri* (von Koenen, 1902).
Fig. 2. Upper Hauterivian *staffi* zone of Quarry 2 along the Mittelland Canal near Wilhelmsdorf (Haste), RGM 213 508. × 1.
Fig. 3. Upper Hauterivian *staffi* zone, bed 38, S-Bahn Hannover Airport, RGM 216 604. × 1.

Plate 5
Fig. 1. *Emericiceras woeckeneri* (von Koenen, 1902), upper Hauterivian *staffi* zone, bed 53 of quarry 4 along the Mittelland Canal near Wilhelmsdorf (Haste), RGM 214 091. (a) Right lateral view. (b) Left lateral view. (c) Ventral view. All × 1

Plate 6
Fig. 1. *Emericiceras strombecki* (von Koenen, 1902), upper Hauterivian *staffi* zone, bed 56, Mittelland Canal, Haste, RGM 213636. (a) Right lateral view. (b) Ventral view. Both × 0.5.

Plate 7
Figs. 1, 2. *Emericiceras strombecki* (von Koenen, 1902).
Fig. 1. Upper Hauterivian *Staffi* zone, bed 19, S-Bahn Hannover Airport, RGM 213 641. (a) Left lateral view. (b) Apertural view. Both × 0.5.
Fig. 2. Upper Hauterivian *discofalcatus* zone, Gott Quarry near Sarstedt, RGM 216 239. × 0.5.

Plate 8
Figs. 1, 2. *Emericiceras strombecki* (von Koenen, 1902).
Fig. 1. Lower Barremian *rarocinctum* zone, bed 72, Gott quarry near Sarstedt. RGM 213 760. (a) Left lateral view. (b) Ventral view. Both × 0.5.
Fig. 2. Upper Hauterivian *staffi* zone, bed 52, quarry 4 along the Mittelland Canal near Wilhelmsdorf (Haste), RGM 214 088. × 0.5.

Plate 9
Figs. 1, 2. *Emericiceras strombecki* (von Koenen, 1902).
Fig. 1. Upper Hauterivian *staffi* zone, bed 53, quarry 4 along the Mittelland Canal near Wilhelmsdorf (Haste), RGM 214 087. × 0.5.
Fig. 2. Lower Barremian *rarocinctum* zone, bed 72, Gott quarry near Haste, RGM 214 472. × 0.5.

Plate 10
Figs. 1, 2. *Emericiceras strombecki* (von Koenen, 1902).
Fig. 1. Upper Hauterivian *staffi* zone, bed 56-58, quarry 4 along the Mittalland Canal near Wilhelmsdorf (Haste), RGM 214 092. × 0.5.
Fig. 2. Upper Hauterivian *discofalcatus* zone, Gott quarry near Sarstedt, RGM 214 583. × 0.5.

Plate 11
Fig. 1. *Emericiceras Strombecki* (von Koenen, 1902), lower Barremian *rarocinctum* zone, bed 72, Gott quarry near Sarstedt, RGM 216 515**.** × 0.5.

Plate 12
Fig. 1. *Emericiceras resseensis* sp. nov., upper Hauterivian *staffi* zone, bed 96, Resse quarry, Hainholz, holotype, RGM 213 961. × 1.
Fig. 2. *Emericiceras sornayiforme* sp. nov., lower Barremian *rarocinctum* zone, bed 83, Gott quarry near Sarstedt, holotype, RGM 213 917. (a) Left lateral view. (b) Ventral view. Both × 1.
Fig. 3. *Emericiceras* ex gr. *emerici* (Léveillé, 1837), Hauterivian-Barremian boundary bed 72, Gott quarry near Sarstedt, RGM 214 556. (a) Ventral view. (b) Left lateral view. (c) Apertural view. All × 1.

Plate 13
Fig. 1-3. *Emericiceras serpentinum* sp. nov.
Fig. 1. Upper Hauterivian *staffi* zone, bed 53, quarry 4 along the Mittelland Canal near Wilhelmsdorf (Haste), RGM 214 083. × 1.
Fig. 2. Upper Hauterivian *staffi* zone, Mittelland Canal, Haste, RGM 214 496. × 0.5.
Fig. 3. Upper Hauterivian *staffi* zone, bed 53, quarry 4 along the Mittelland Canal near Wilhelmsdorf, Haste, holotype, RGM 214 085. × 0.5.

Plate 14
Figs. 1, 2. *Emericiceras subtilicostatum* sp. nov.
Fig. 1. Upper Hauterivian *inversum* zone, bed 44, quarry 4 along the Mittelland Canal near Wilhelmsdorf (Haste), RGM 213 867. (a) Left lateral view. (b) Ventral view. Both × 1.
Fig. 2. Upper Hauterivian *staffi* zone, bed 56, Mittelland Canal, Haste, RGM 213 858. × 1.

Plate 15
Figs. 1, 2. *Emericiceras subtilicostatum* sp. nov.
Fig. 1. Upper hauterivian *staffi* zone, bed 56, Mittelland Canal, Haste, holotype, RGM 213 859. (a) Left lateral view. (b) Ventral view. Both × 1.
Fig. 2. Upper Hauterivian *inversum* zone, bed 44, quarry 4 along the Mittelland Canal near Wilhelmsdorf, Haste, RGM 214 177**.** (a) Left lateral view. (b) Ventral view. × 1.

Plate 16
Figs. 1-3. *Emericiceras sparsicosta* (von Koenen, 1902), upper Barremian *sparsicosta* zone, beds 130-131, Gott quarry near Sarstedt.
Fig. 1. RGM 213 909. × 1.
Fig. 2. RGM 213 913A. (a) Right lateral view. (b) Ventral view. Both × 1.
Fig. 3. RGM 213 913B. (a) Left lateral view. (b) Apertural view. (c) Ventral view. All × 1.

Plate 17
Fig. 1. *Emericiceras sparsicosta* (von Koenen, 1902), upper Barremian *sparsicosta* zone, beds 130-131, Gott quarry near Sarstedt, RGM 213 759. (a) Left lateral view. (b) Ventral view. Both × 1.
Fig. 2. *Emericiceras gotti* sp. nov., upper Hauterivian *staffi* zone, bed 30, S-Bahn Hannover Airport, RGM 197 186. × 1.

Plate 18
Fig. 1. *Emericiceras gotti* sp. nov., upper Hauterivian *discofalcatus* zone, Gott quarry near Sarstedt, left lateral view, holotype, RGM 214 476. × 0.5. (See also P. 19, fig. 1).

Plate 19
Fig. 1. *Emericiceras gotti* sp. nov., apertural view showing four medioventral spines at the beginning of the last whorl (same specimen as on Pl. 18), holotype, RGM 214 476. × 0.5.
Fig. 2. *Emericiceras hannoverensis* sp. nov., upper Hauterivian *Staffi* zone, bed 100, Resse quarry, Hainholz, RGM 213 633. × 1.
Fig. 3. *Emericiceras wermbteri* (von Koenen, 1902), upper Hauterivian *staffi* zone, bed 26, S-Bahn Hannover Airport, RGM 213 624. (a) Left lateral view. (b) Ventral view. Both × 0.5.

Plate 20
Figs. 1, 2. *Emericiceras wermbteri* (von Koenen, 1902), upper Hauterivian *staffi* zone, bed 26, S-Bahn Hannover Airport.
Fig. 1. RGM 197 084. × 0.5.
Fig. 2. RGM 214 387. × 0.5.

Plate 21
Figs. 1, 2. *Emericiceras wermbteri* (von Koenen, 1902).
Fig. 1. Upper Hauterivian *staffi* zone, bed 26, S-Bahn Hannover Airport, RGM 213 622. × 1.
Fig. 2. Upper Hauterivian *staffi* zone, bed 56, Mittelland Canal, Haste, RGM 213 511. × 1.

Plate 22
Figs. 1, 2. *Emericiceras wermbteri* (von Koenen, 1902), upper Hauterivian *staffi* zone, bed 26, S-Bahn Hannover Airport.
Fig. 1. RGM 213 612. × 1.
Fig. 2. RGM 213 621. (a) Right lateral view. (b) Ventral view. Both × 0.5.

Plate 23
Figs. 1, 2. *Emericiceras wermbteri* (von Koenen, 1902), upper Hauterivian *staffi* zone, bed 26, S-Bahn Hannover Airport, Hannover.
Fig. 1. RGM 214 377. × 0.5.
Fig. 2. RGM 214 378. × 0.5.

Plate 24
Figs. 1, 2. *Emericiceras wermbteri* (von Koenen, 1902), upper Hauterivian *staffi* zone, bed 26, S-Bahn Hannover Airport, Hannover.
Fig. 1. RGM 214 390. × 1.
Fig. 2. RGM 214 380. × 0.5.

Plate 25
Fig. 1. *Emericiceras wermbteri* (von Koenen, 1902), upper Hauterivian *staffi* zone, bed 26, S-Bahn Hannover Airport, RGM 214 383. × 0.5.
Fig. 2. *Emericiceras hannoverense* sp. nov., upper Hauterivian *staffi* zone, bed 26, S-Bahn Hannover Airport, RGM 213 593. × 1.

Plate 26
Figs. 1, 2. *Emericiceras hannoverense* sp. nov., upper Hauterivian *staffi* zone, bed 26, S-Bahn Hannover Airport.
Fig. 1. RGM 214 376. × 0.75.
Fig. 2. RGM 214 375. × 0.5.

Plate 27
Fig. 1. *Emericiceras hannoverense* sp. nov., upper Hauterivian *staffi* zone, bed 26, S-Bahn Hannover Airport, RGM 213 617. (a) Left lateral view. (b) Ventral view. Both × 0.5.

Plate 28
Figs. 1-3. *Emericiceras hannoverense* sp. nov.
Fig. 1. Upper Hauterivian *staffi* zone, bed 20, S-Bahn Hannover Airport, RGM 213 640. (a) Right lateral view. (b) Ventral view. Both × 1.
Fig. 2. Upper Hauterivian *staffi* zone, bed 26, S-Bahn Hannover Airport, RGM 214 382. × 0.5.
Fig. 3. Upper Hauterivian *staffi* zone, bed 102, Resse quarry, Hainholz, RGM 213 977. × 1.

Plate 29
Fig. 1. *Emericiceras hannoverense* sp. nov., upper Hauterivian *staffi* zone, bed 26, S-Bahn Hannover Airport, RGM 213 590. × 1.

Plate 30
Fig. 1. *Emericiceras hannoverense* sp. nov., upper Hauterivian *staffi* zone, bed 26, S-Bahn Hannover Airport, holotype, RGM 214 379. (a) Left lateral view. (b) Apertural view. Both × 1.
Fig. 2. *Crioceratites hastensis* sp. nov., upper Hauterivian *staffi* zone, Mittelland Canal, Haste, RGM 213 514. (a) Left lateral view. (b) Ventral view (see also Pl. 31, fig. 1). Both × 1.

Plate 31
Figs. 1, 2. *Crioceratites hastensis* sp. nov.
Fig. 1. Upper Hauterivian *staffi* zone, Mittelland Canal, Haste, RGM 213 514, right lateral view (see also pl. 30, fig. 2). × 1.
Fig. 2. Upper Hauterivian *staffi* zone, quarry 2, Mittelland Canal near Wilhelmsdorf (Haste), RGM 213 505. × 1.

Plate 32
Fig. 1. *Crioceratites* aff. *hastensis* sp. nov., upper Hauterivian *staffi* zone, bed 30, S-Bahn Hannover Airport, RGM 197 182. × 0.5.
Fig. 2. *Crioceratites hastensis* sp. nov., upper Hauterivian *staffi* zone, Mittelland Canal, Haste, RGM 213 516. (a) Left lateral view. (b) Apertural view. (c) Ventral view. All× 1.

Plate 33
Figs. 1, 2. *Crioceratites hastensis* sp. nov.
Fig. 1. Upper Hauterivian *inversum* zone, quarry 4, bed 56, along the Mittelland Canal near Wilhelmsdorf, Haste, RGM 213 866. × 1.
Fig. 2. Upper Hauterivian *inversum* zone, quarry 4, along the Mittelland Canal near Wilhelmsdorf, Haste, holotype, RGM 214 089, ventral view (see also Pl. 34 fig. 1). × 1.

Plate 34
Fig. 1. *Crioceratites hastensis* sp. nov., upper Hauterivian *inversum* zone, quarry 4, along Mittelland Canal near Wilhelmsdorf, Haste, holotype, RGM 214 089, left lateral view (see also Pl. 33, fig. 2). × 1.
Fig. 2. *Crioceratites subisocostatus* sp. nov., upper Hauterivian *staffi* zone, bed 30, S-Bahn, Hannover Airport, RGM 197 192. (a) Left lateral view. (b) Ventral view. Both × 1.

Plate 35
Fig. 1. *Crioceratites subisocostatus* sp. nov., upper Hauterivian *Staffi* zone, bed 30, S-Bahn, Hannover Airport, RGM 197 191. × 1.

Plate 36
Fig. 1. *Crioceratites subisocostatus* sp. nov., upper Hauterivian *staffi* zone, bed 30, S-Bahn, Hannover Airport, holotype, RGM 197 181. × 0.5.
Figs. 2-4. *Crioceratites vermiformis* sp. nov. Upper Hauterivian *staffi* zone, bed 30, S-Bahn Hannover Airport.
Fig. 2. Holotype, RGM 197 188A. × 1.
Fig. 3. RGM 197 194. × 1.
Fig. 4. RGM 197 185. × 1.

Plate 37
Fig. 1. *Fissicostaticeras fissicostatum* (Roemer, 1841), lower Barremian *fissicostatum* zone, Subway Aegidientor Square Hannover, RGM 214 020. × 0.5.

Plate 38
Fig. 1. *Fissicostaticeras fissicostatum* (Roemer, 1841), lower Barremian *fissicostatum* zone, subway Aegidientorsquare Hannover, RGM 214 002, right lateral view (see also Pl. 39, fig. 1). × 1.

Plate 39
Fig. 1. *Fissicostaticeras fissicostatum* (Roemer, 1841), lower Barremian *fissicostatum* zone, subway Aegidientorsquare Hannover, RGM 214 002, ventral view (see also Pl. 38, fig. 1). × 1.
Fig. 2-4. *Fissicostaticeras* ex gr. *fissicostatum* (Roemer, 1841).
Fig. 2. Lower Barremian *fissicostatum* zone, bed 83, Gott quarry near Sarstedt, RGM 213 897. × 1.
Fig. 3. Same locality, same bed, RGM 213 898. × 1.
Fig. 4. Lower Barremian *fissicostatum* zone, bed 6, same locality; RGM 214 015. × 1.

Plate 40
Fig. 1. *Fissicostaticeras fissicostatum* (Roemer, 1841), lower Barremian *fissicostatum* zone, Subway Aegidientor Square Hannover, RGM 214 003. × 0.75.
Fig. 2. *Fissicostaticeras* ex gr. *fissicostatum* (Roemer, 1841), lower Barremian *fissicostatum-elegans* zonal boundary bed 7, Subway Aegidientor Square Hannover, RGM 216 245. × 1.

Plate 41
Fig. 1. *Fissicostaticeras aequicostatum* (von Koenen, 1902), upper Barremian *elegans* zone, Subway Aegidientor Square in Hannover, RGM 214 487. × 1.
Fig. 2. *Fissicostaticeras claviferum* sp. nov., lower Barremian *rarocinctum* zone, bed 83, Gott quarry near Sarstedt, holotype, RGM 213 931. (a) Right lateral view. (b) Apertural view. (c) Ventral view. (d) Left lateral view. All × 1.
Fig. 3. *Fissicostaticeras aequicostatoides* sp. nov., lower Barremian *fissicostatum* zone, bed 6, Subway Aegidientor Square Hannover, RGM 214 018. (a) Right lateral view. (b) Left lateral view (see also Pl. 42, fig. 2). Both × 1.

Plate 42
Figs. 1, 2. *Fissicostaticeras aequicostatoides* sp. nov.
Fig. 1. Lower Barremian *fissicostatum-elegans* boundary bed 7, Subway Aegidientor Square, Hannover, holotype, RGM 216 204, right lateral view (see also Pl. 43, fig. 1). × 1.
Fig. 2. Lower Barremian *fissicostatum* zone, bed 6, Subway Aegidientor Square Hannover, RGM 214 018, ventral view (see also Pl. 41, fig. 3). Both × 1.

Plate 43
Fig. 1. *Fissicostaticeras aequicostatoides* sp. nov., lower Barremian *fissicostatum-elegans* boundary bed 7, Subway Aegidientor Square, Hannover, holotype, RGM 216 204. Ventral view (see also Pl. 42, fig. 1). × 1.
Fig. 2. *Fissicostaticeras rarocinctum* (von Koenen, 1902), lower Barremian *rarocinctum* zone, bed 83, Gott quarry near Sarstedt, RGM 212 864. (a) Left lateral view. (b) Ventral view. Both × 0.5.

Plate 44
Fig. 1. *Fissicostaticeras rarocinctum* (von Koenen, 1902), lower Barremian *Rarocinctum* zone, bed 83, Gott quarry near Sarstedt, RGM 212 863. × 0.5.

Plate 45
Fig. 1. *Fissicostaticeras rarocinctum* (von Koenen, 1902), lower Barremian *rarocinctum* zone, bed 83, Gott quarry near Sarstedt, RGM 213 758. (a) Right lateral view. (b) Ventral view. Both × 1.

Plate 46
Fig. 1. *Fissicostaticeras rarocinctum* (von Koenen, 1902), lower Barremian *rarocinctum* zone, bed 83, Gott quarry near Sarstedt, RGM 214 527. (a) Right lateral view. (b) Apertural view. (c) Ventral view. All × 0.75.

Plate 47
Fig. 1. *Fissicostaticeras rarocinctum* (von Koenen, 1902), lower Barremian *rarocinctum* zone, bed 83, Gott quarry near Sarstedt, RGM 214 526. (a) Right lateral view. (b) Apertural view. Both × 1.

Plate 48
Fig. 1, 2. *Fissicostaticeras rarocinctum* (von Koenen, 1902), lower Barremian *rarocinctum* zone, bed 83, Gott quarry near Sarstedt.
Fig. 1. RGM 214 505.(a) Left lateral view. (b) Apertural view. Both × 0.25.
Fig. 2. RGM 213 800. × 1.

Plate 49
Fig. 1. *Fissicostaticeras rarocinctum* (von Koenen, 1902), lower Barremian *rarocinctum* zone, bed 83, Gott quarry near Sarstedt, RGM 216 238. (a) Left lateral view. (b) Ventral view. Both × 0.25.

Plate 50
Fig. 1. *Fissicostaticeras rarocinctoides* sp. nov., lower Barremian *rarocinctum* zone, bed 83, Gott quarry near Sarstedt, RGM 214 536. (a) Left lateral view. (b) Ventral view. Both × 1.

Plate 51
Fig. 1. *Fissicostaticeras rarocinctoides* sp. nov., lower Barremian *rarocinctum* zone, bed 83, Gott quarry near Sarstedt, RGM 214 537. (a) Left lateral view. (b) Ventral view. Both × 1.

Plate 52
Fig. 1. *Fissicostaticeras rarocinctoides* sp. nov., lower Barremian *rarocinctum* zone, bed 83, Gott quarry near Sarstedt, RGM 213 884. Right lateral view (see also Pl. 53, fig. 1). × 1.

Plate 53
Figs. 1, 2. *Fissicostaticeras rarocinctoides* sp. nov., lower Barremian *rarocinctum* zone, bed 83, Gott quarry near Sarstedt.
Fig. 1. RGM 213 884. Ventral view (see also Pl. 52, fig. 1). × 1.
Fig. 2. RGM 212 862. Apertural view (see also Pl. 54, fig. 1) × 0.5.

Plate 54
Fig. 1. *Fissicostaticeras rarocinctoides* sp. nov., lower Barremian *rarocinctum* zone, bed 83, Gott quarry near Sarstedt, RGM 212 862. Left lateral view (see also Pl. 53, fig. 2) × 0.5.

Plate 55
Fig. 1. *Fissicostaticeras rarocinctoides* sp. nov., lower Barremian *Rarocinctum* zone, bed 83, Gott quarry near Sarstedt, holotype, RGM 213 797. (a) Right lateral view. (b) Ventral view. Both × 0.5.
Fig. 2. *Paracrioceras stadtlaenderi* (Müller, 1892), Barremian, Flemming quarry near Berenbostel, RGM 214 419. (a) Right lateral view. (b) Ventral view. (c) Apertural view. All × 1.

Plate 56
Fig. 1. *Paracrioceras stadtlaenderi* (Müller, 1892), upper Barremian *fissicostatum-elegans* zonal boundary bed 7, Subway Aegidientor Square, Hannover, RGM 214 013. (a) Right lateral view. (b) Ventral view. (c) Apertural view. All × 1.

Plate 57
Fig. 1. *Paracrioceras stadtlaenderi* (Müller, 1892), upper Barremian *denckmanni* zone, Subway Hildesheimerstrasse Hannover, RGM 216 178. (a) Right lateral view. (b) Apertural view. × 1.

Plate 58
Fig. 1. *Paracrioceras stadtlaenderi* (Müller, 1892), upper Barremian *denckmanni* zone, Subway Hildesheimerstrasse Hannover, RGM 216 180. × 1.
Fig. 2. *Paracrioceras* aff. *stadtlaenderi* (Müller, 1892), upper Barremian, Gott quarry near Sarstedt, RGM 213 901. Lateral view (see also Pl. 59, fig. 3). × 1.

Plate 59
Fig. 1, 2. *Paracrioceras stadtlaenderi* (Müller, 1892), upper Barremian *denckmanni* zone, Subway Hildesheimerstrasse Hannover.
Fig. 1. RGM 214 094. × 0.5.
Fig. 2. RGM 216 179. × 1.
Fig. 3. *Paracrioceras* aff. *stadtlaenderi* (Müller, 1892), upper Barremian, Gott quarry near Sarstedt, RGM 213 901. Apertural view (see also Pl. 58, fig. 2). × 1.

Plate 60
Fig. 1. *Paracrioceras* aff. *stadtlaenderi* (Müller, 1892), upper Barremian *rude* zone, bed 137, Gott quarry near Sarstedt, RGM 213 900. × 1.

Plate 61
Figs. 1-3. *Paracrioceras denckmanni* (Müller, 1892).
Fig. 1. Upper Barremian *fissicostatum-elegans* zonal boundary bed 7, Subway Aegidientor Square, Hannover, RGM 214 012. (a) Right lateral view. (b) Ventral view. Both × 1.
Fig. 2. Upper Barremian *denckmanni* zone, Subway Hildesheimerstrasse, Hannover, RGM 216 183. × 1.
Fig. 3. Same locality, RGM 216 184. × 1.

Plate 62
Figs. 1, 2. *Paracrioceras denckmanni* (Müller, 1892), upper Barremian *denckmanni* zone, Subway Hildesheimerstrasse, Hannover.
Fig. 1. RGM 214 093. × 0.5.
Fig. 2. RGM 216 176. × 1.

Plate 63
Fig. 1. *Paracrioceras denckmanni* (Müller, 1892), upper Barremian *denckmanni* zone, Subway Hildesheimerstrasse, Hannover, RGM 216 197. × 0.5.
Fig. 2. *Paracrioceras tuba* (von Koenen, 1902), upper Barremian *denckmanni* zone, Subway Hildesheimerstrasse Hannover, RGM 216 175. × 1.

Plate 64
Figs. 1, 2. *Paracrioceras tuba* (von Koenen, 1902), upper Barremian *denckmanni* zone, Subway Hildesheimerstrasse in Hannover.
Fig. 1. RGM 216 185. × 1.
Fig. 2. RGM 216 189. × 1.

Plate 65
Fig. 1. *Paracrioceras tuba* (von Koenen, 1902), upper Barremian, Gott quarry near Sarstedt, RGM 283 497. × 1.
Figs. 2, 3. *Paracrioceras elegans* (von Koenen, 1902).
Fig. 2. Upper Barremian *Elegans* zone, Subway Aegidientor Square Hannover, RGM 214 485. Right lateral view (see also Pl. 66, fig. 2). × 0.5.
Fig. 3. Upper Barremian *fissicostatum-elegans* zonal boundary bed 7, Subway Aegidientor Square Hannover, RGM 214 009. × 1.

Plate 66
Figs. 1, 2. *Paracrioceras elegans* (von Koenen, 1902).
Fig. 1. Upper Barremian *fissicostatum-elegans* zonal boundary bed 7, Subway Aegidientor Square Hannover, RGM 214 005. (a) Left lateral view. (b) Ventral view. Both × 1.
Fig. 2. Upper Barremian *elegans* zone, Subway Aegidientor Square Hannover, RGM 214 485. Ventral view (see also Pl. 65, fig. 2). × 1.

Plate 67
Fig. 1. *Paracrioceras elegans* (Von Koenen, 1902), upper Barremian *Fissicostatum-Elegans* zonal boundary bed 7, Aegidientor square in Hannover, RGM 214 004. (a) Left lateral view. (b) Apertural view. (c) Ventral view. All × 0.5.

Plate 68
Fig. 1. *Paracrioceras crassispina* (von Koenen, 1902), upper Barremian *denckmanni* zone, Subway Hildesheimerstrasse Hannover, RGM 216 188. (a) Right lateral view. (b) Apertural view. (c) Ventral view. All × 1.

Plate 69
Fig. 1. *Emericiceras kemperi* sp. nov., upper Hauterivian *staffi* zone, bed 19, S-Bahn Hannover Airport, RGM 213 642. (a) Left lateral view. (b) Apertural view. (c) Ventral view. × 0.5.

Plate 70
Fig. 1. *Emericiceras kemperi* sp. nov., upper Hauterivian *staffi* zone, bed 19, S-Bahn Hannover Airport, holotype, RGM 213 639. (a) Right lateral view. (b) Left lateral view (see also Pl. 71, fig. 2). Both × 1.

Plate 71
Figs. 1, 2. *Emericiceras kemperi* sp. nov., upper Hauterivian *staffi* zone, bed 19, S-Bahn Hannover Airport.
Fig. 1. RGM 214 019. (a) Right lateral view. (b) Ventral view. Both × 0.75.
Fig. 2. Holotype, RGM 213 639. Apertural view (see also Pl. 70, fig. 1). × 1.

Plate 72
Figs. 1, 2. *Emericiceras kemperi* sp. nov., upper Hauterivian *staffi* zone, bed 19, S-Bahn Hannover Airport.
Fig. 1. RGM 197 176. × 1.
Fig. 2. RGM 214 023. Right lateral view (see also Pl. 73, fig. 2). × 1.

Plate 73
Fig. 1. *Paracrioceras kleini* sp. nov., lower Barremian *fissicostatum-elegans* zonal boundary bed 7, Subway Aegidientor Square Hannover, holotype, RGM 214 007. (a) Left lateral view. (b) Ventral view. Both × 1.
Fig. 2. *Emericiceras kemperi* sp. nov., upper Hauterivian *staffi* zone, bed 19, S-Bahn Hannover Airport, 214 023. Ventral view (see also Pl. 72, fig. 2). × 1.

Plate 74
Fig. 1. *Paracrioceras* sp., lower Barremian Fissicostatus-*Elegans* zonal boundary bed 7, Subway Aegidientor Square Hannover, RGM 216 242. (a) Left lateral view. (b) Right lateral view. (c) Ventral view. All × 1.

Plate 75
Figs. 1-6. *Hoplocrioceras (Hoplocrioceras) phillipsi* (Phillips, 1829), lower Barremian *rarocinctum* zone, bed 83, Gott quarry near Sarstedt.
Fig. 1. RGM 213 914. × 1.
Fig. 2. RGM 213 915B. × 1.
Fig. 3. RGM 283 495. × 1.
Fig. 4. RGM 213 916. × 1.
Fig. 5. RGM 283 496. × 1.
Fig. 6. RGM 213 924. × 1.

Plate 76
Figs. 1-7. *Hoplocrioceras (Hoplocrioceras) phillipsi* (Phillips, 1829), lower Barremian *rarocinctum* zone.
Figs. 1-5, 7. Bed 83, Gott quarry near Sarstedt.
Fig. 1. RGM 213 929. × 1.
Fig. 2. RGM 213 928. × 1.
Fig. 3. RGM 213 925. × 1.
Fig. 4. RGM 214 533. × 1.
Fig. 5. RGM 213 922. × 1.
Fig. 7. RGM 213 891. × 1.

Fig. 6. Bank of River Leine near Marienwerder, Hannover, RGM 214 418. × 1.

Plate 77
Figs. 1-4. *Hoplocrioceras (Hoplocrioceras) phillipsi* (Phillips, 1829), lower Barremian *rarocinctum* zone, bed 83, Gott quarry near Sarstedt.
Fig. 1. RGM 213 921. × 1.
Fig. 2. RGM 213 918. × 1.
Fig. 3. RGM 213 919. (a) Right lateral view. (b) Ventral view. × 1.
Fig. 4. RGM 214 567. × 1.

Plate 78
Figs. 1-7. *Hoplocrioceras (Hoplocrioceras) phillipsi* (Phillips, 1829), lower Barremian *rarocinctum* zone, bed 83, Gott quarry near Sarstedt.
Fig. 1. RGM 214 540. × 1.
Fig. 2. RGM 213 885. × 1.
Fig. 3. RGM 213 920. × 1.
Fig. 4. RGM 213 762. × 1.
Fig. 5. RGM 212 867. × 1.
Fig. 6. RGM 212 869. × 1.
Fig. 7. RGM 213 761. × 1.

Plate 79

Fig. 1. *Hoplocrioceras (Hoplocrioceras) laeviusculum* (von Koenen, 1902), lower Barremian *fissicostatum* zone, bed 6, Subway Aegidientor Square, Hannover, RGM 214 017, (a) Right lateral view. (b) Ventral view. Both × 1.

Fig. 2. *Acrioceras (Acrioceras) sarstedtense* sp. nov., lower Barremian *rarocinctum* zone, bed 83, Gott quarry, Sarstedt, holotype. RGM 213 886. (a) Apertural view. (b) Right lateral view. Both × 1.

Fig. 3. *Acrioceras (Acrioceras)* aff. *monopujaae yvanii* Sarkar, 1955, upper Hauterivian *discofalcatus* zone, Gott quarry near Sarstedt, RGM 214 573. (a) Right lateral view. (b) Left lateral view. Both × 1.

Plate 80

Figs. 1. *Acrioceras (Acrioceras) crassicostatum* sp. nov., lower Barremian *fissicostatum* zone bed 6, Subway Aegidientor Square, Hannover, RGM 214 014. (a) Left lateral view. (b) Ventral view. (c) Right lateral view. (d) Apertural view. All × 1.

Plate 81

Fig. 1. *Acrioceras (Acrioceras) crassicostatum* sp. nov., lower Barremian *fissicostatum* zone bed 6, Subway Aegidientor Square, Hannover, holotype, RGM 214 016. × 1.

Fig. 2. *Acrioceras (Acrioceras) angulosum* (Von Koenen, 1902), lower Barremian *fissicostatum-elegans* boundary bed 7, Subway Aegidientor Square Hannover, RGM 216 250. × 1.

Fig. 3. *Acrioceras (Acrioceras) sarasini* Sarkar, 1955, lower Barremian *rarocinctum* zone, bed 83, Gott quarry near Sarstedt, RGM 214 529. × 1.

Fig. 4. *Acrioceras (Acrioceras)* aff. *incumbens* (von Koenen, 1902), upper Barremian *fissicostatum-elegans* boundary bed 7, Subway Aegidientor Square Hannover RGM 214 010. (a) Right lateral view. (b) Ventral view. Both × 1.

Plate 82

Fig. 1. *Acrioceras (Acrioceras) nodulosum* (von Koenen 1902), lower Barremian *fissicostatum-elegans* zonal boundary bed 7, Subway Aegidientor Square Hannover, RGM 214 011. × 1.

Fig. 2. *Acrioceras (Acrioceras)* aff. *nodulosum* (von Koenen 1902), lower Barremian *fissicostatum* zone, bed 6, Subway Aegidientor Square Hannover, RGM 216 241. × 1.

Plate 83

Fig. 1. *Acrioceras (Acrioceras) aegidii* sp. nov., Barremian *fissicostatum-elegans* zonal boundary bed 7, Subway Aegidientor Square Hannover, holotype, RGM 214 008. (a) Left lateral view. (b) Ventral view. (c) Apertural view. Both × 1.

Fig. 2. *Acrioceras (Acrioceras) meriani* (Ooster, 1860), lower Barremian *rarocinctum* zone, bed 83, Gott quarry near Sarstedt, RGM 213 798. (a) Left lateral view. (b) Apertural view. Both × 1.

Plate 84

Fig, 1. *Acrioceras (Acrioceras) longum* sp. nov., lower Barremian *rarocinctum* zone, bed 83, Gott quarry near Sarstedt, holotype, RGM 212 866. × 1.

Fig. 2. *Acrioceras (Acrioceras) astrictum* sp. nov., lower Barremian *rarocinctum* zone, bed 83, Gott quarry near Sarstedt, holotype, RGM 213 915A. (a) Right lateral view. (b) Ventral view. Both × 1.

Fig. 3. *Acrioceras (Acrioceras)* sp., upper Hauterivian *discofalcatus* zone, bed 72, Gott quarry near Sarstedt, RGM 214 563. × 1.

Plate 85

Fig. 1, 2. *Uhligia minuta* (Neumayr & Uhlig, 1881), lower Barremian *fissicostatum* zone, bed 6, Subway Aegidientor Square in Hannover.
Fig. 1. RGM 216 200. × 1.
Fig. 2. RGM 216 215. × 1.
Fig. 3, 4. *Uhligia* sp. indet., lower Barremian *fissicostatum* zone, bed 6, Subway Aegidientor Square Hannover.
Fig. 3. RGM 216 214. × 1.
Fig. 4. RGM 216 213. × 1.
Fig. 5. *Uhligia aegidii* sp. nov., lower Barremian *fissicostatum* zone, bed 6, Subway Aegidientor Square Hannover, holotype, RGM 216 199. × 1.

Plate 86

Fig. 1. *Audouliceras* cf. *urbani* (Neumayr & Uhlig, 1881), uppermost Barremian, quarry near Latterde, RGM 214415. (a) Right lateral view of the hook. (b) Ventral view of the hook. Both × 0.5.

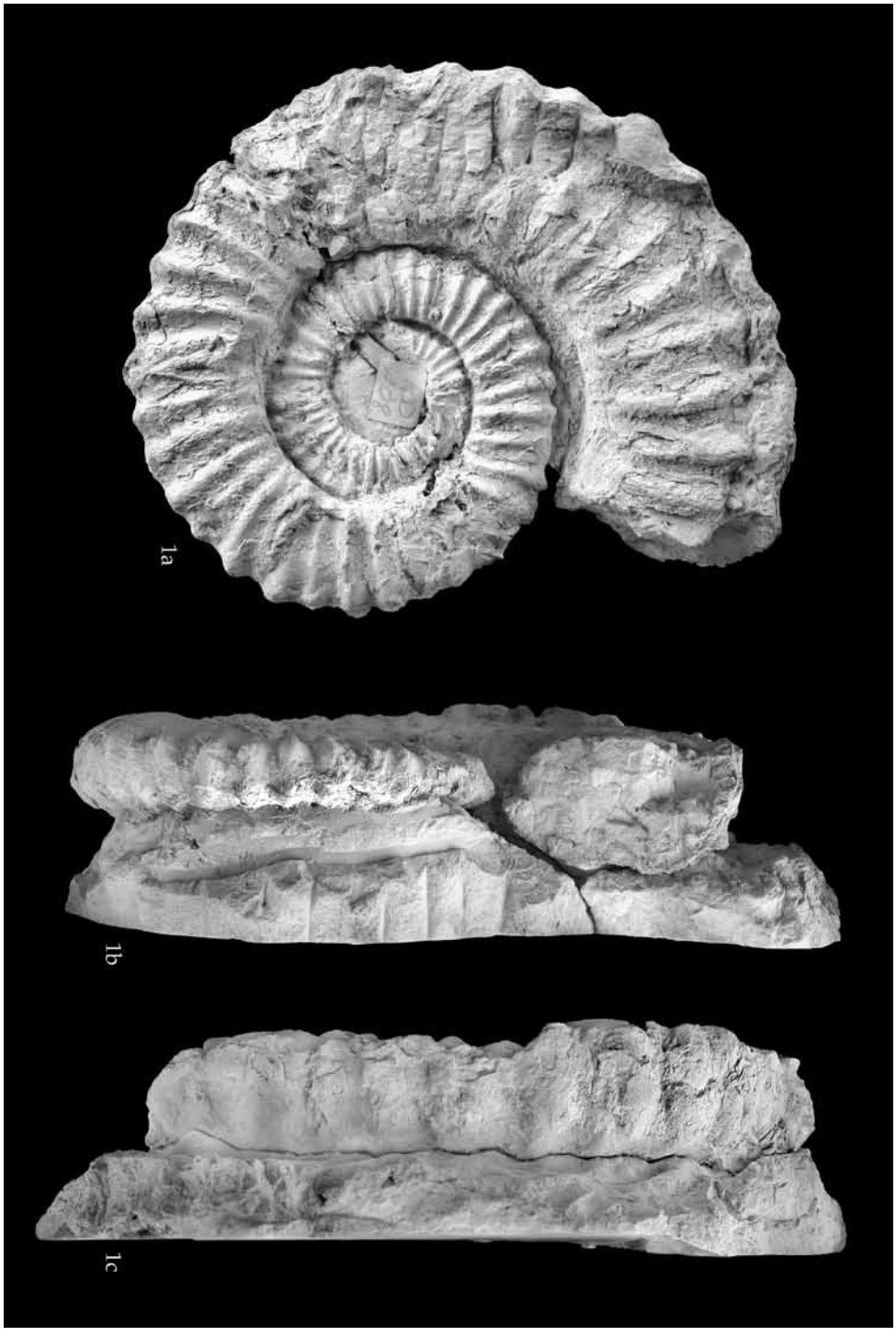

Plate 1

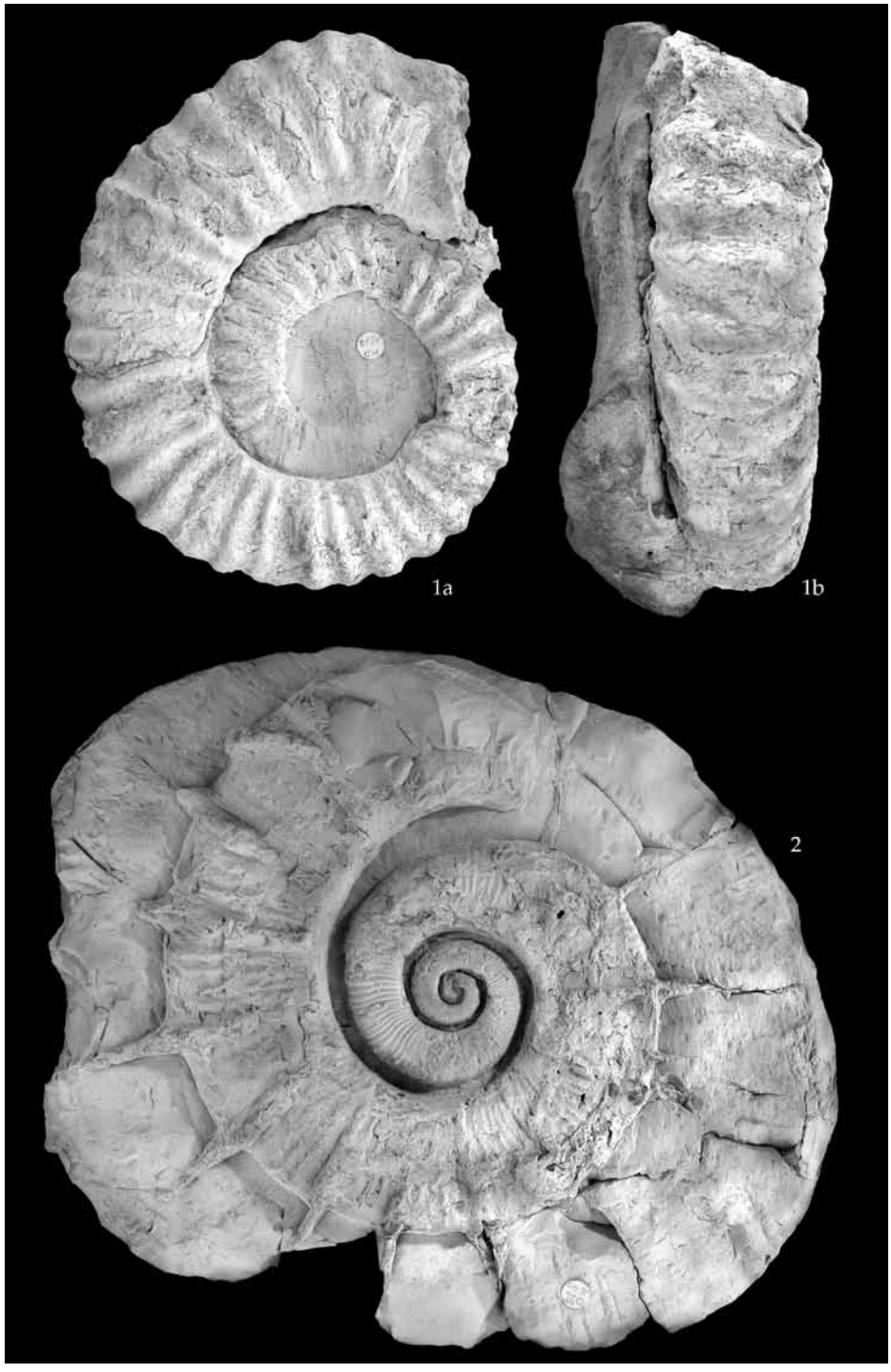

Plate 2

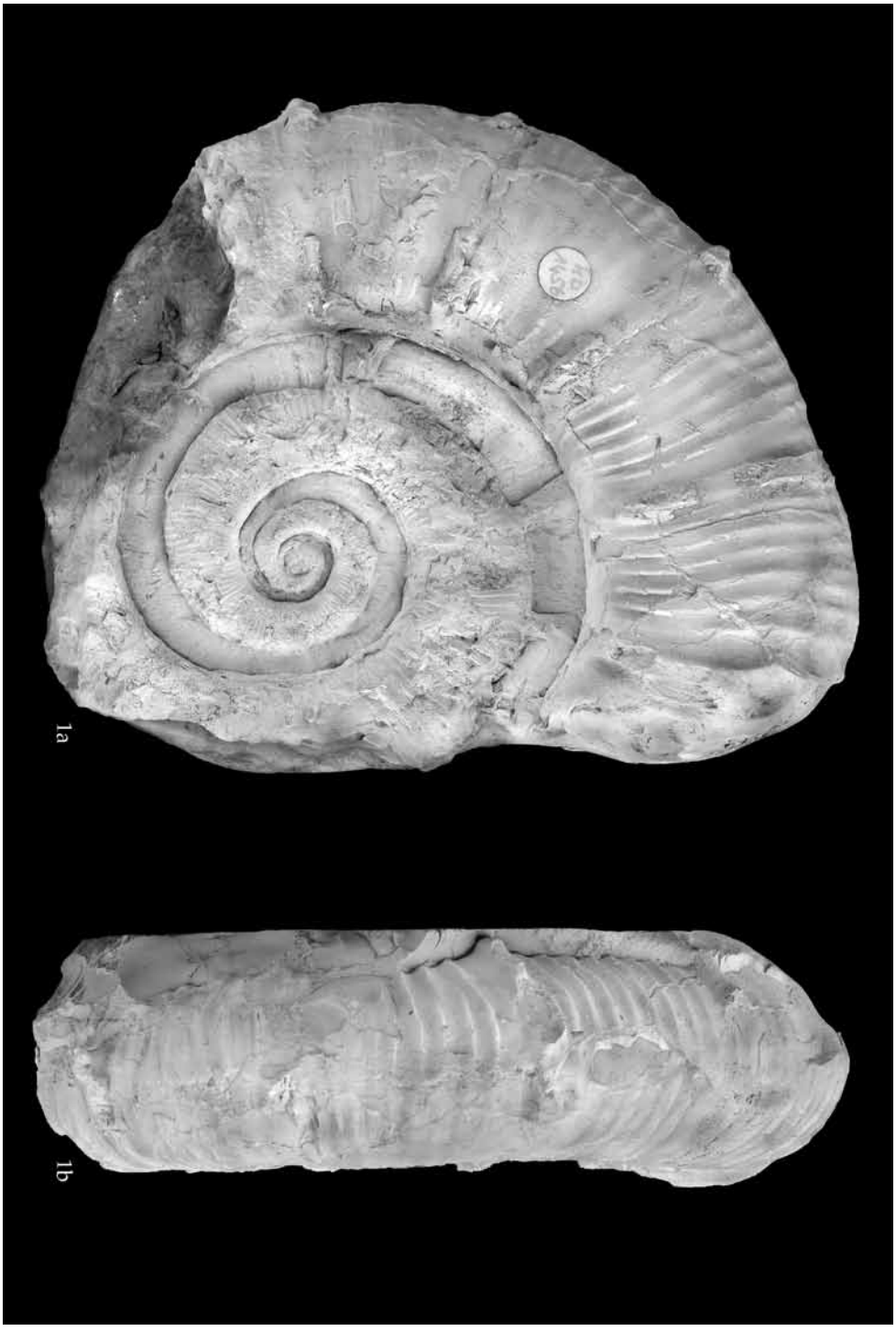

Plate 3

Plate 4

Plate 5

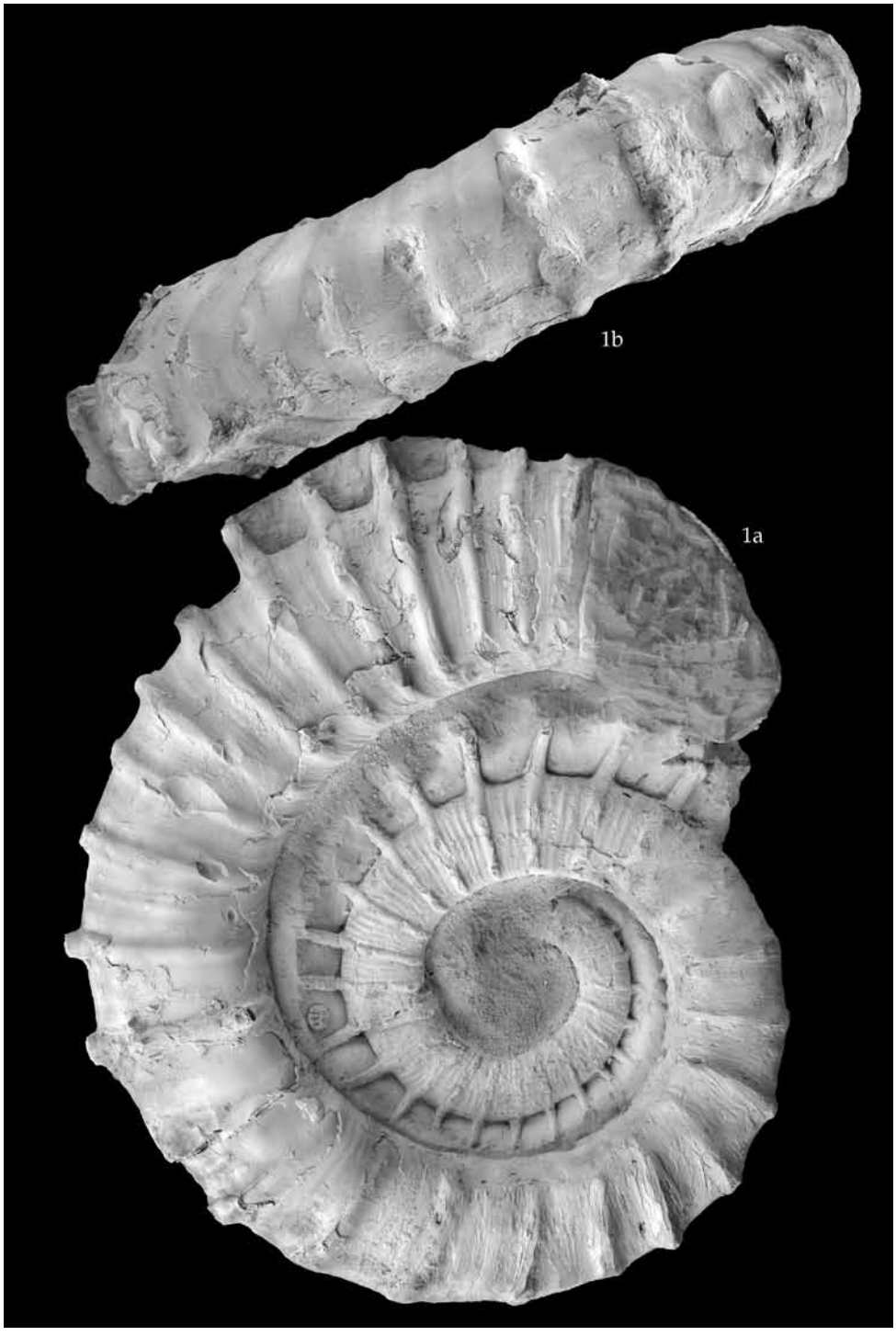

Plate 6

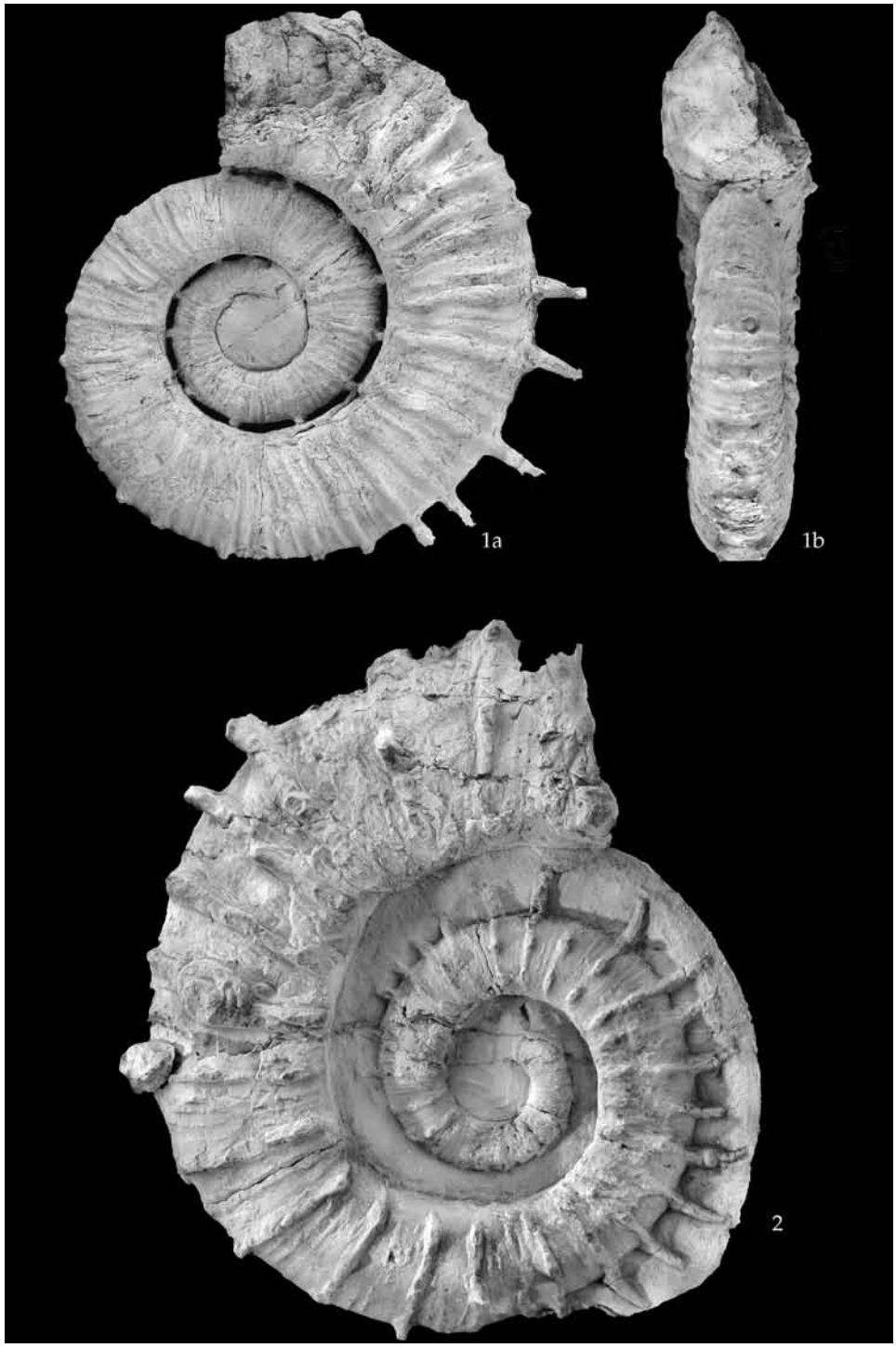

Plate 7

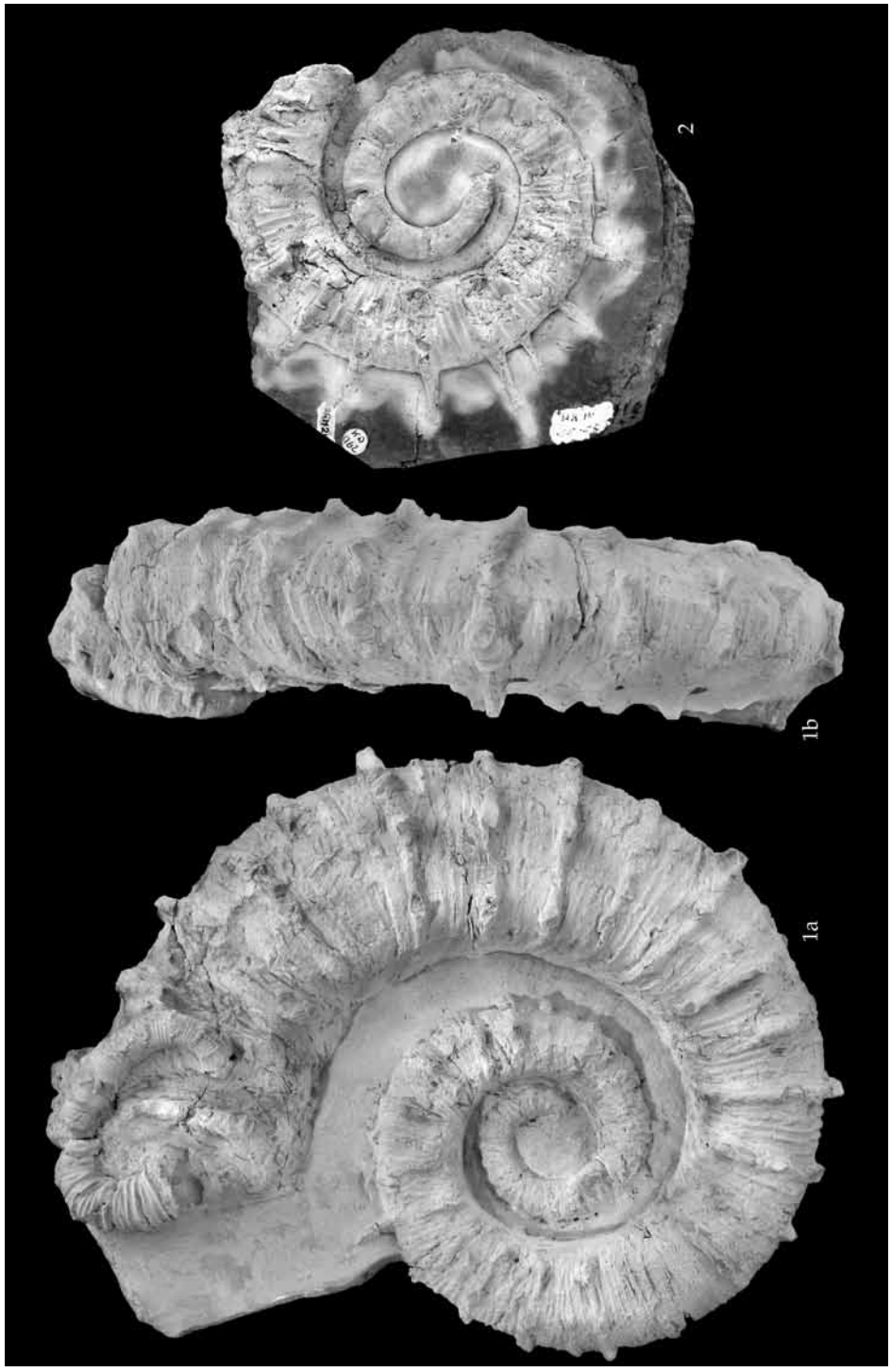

Plate 8

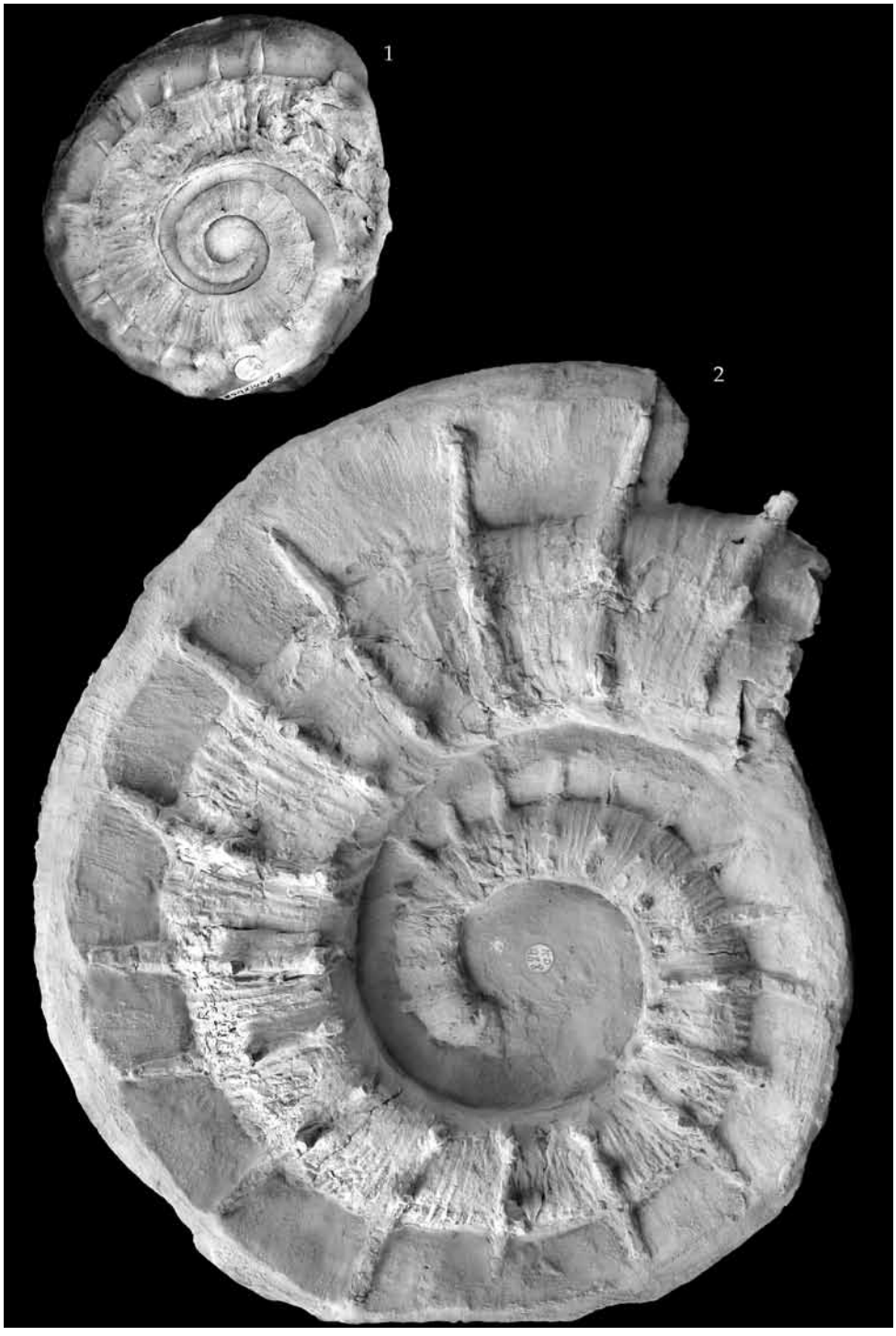

Plate 9

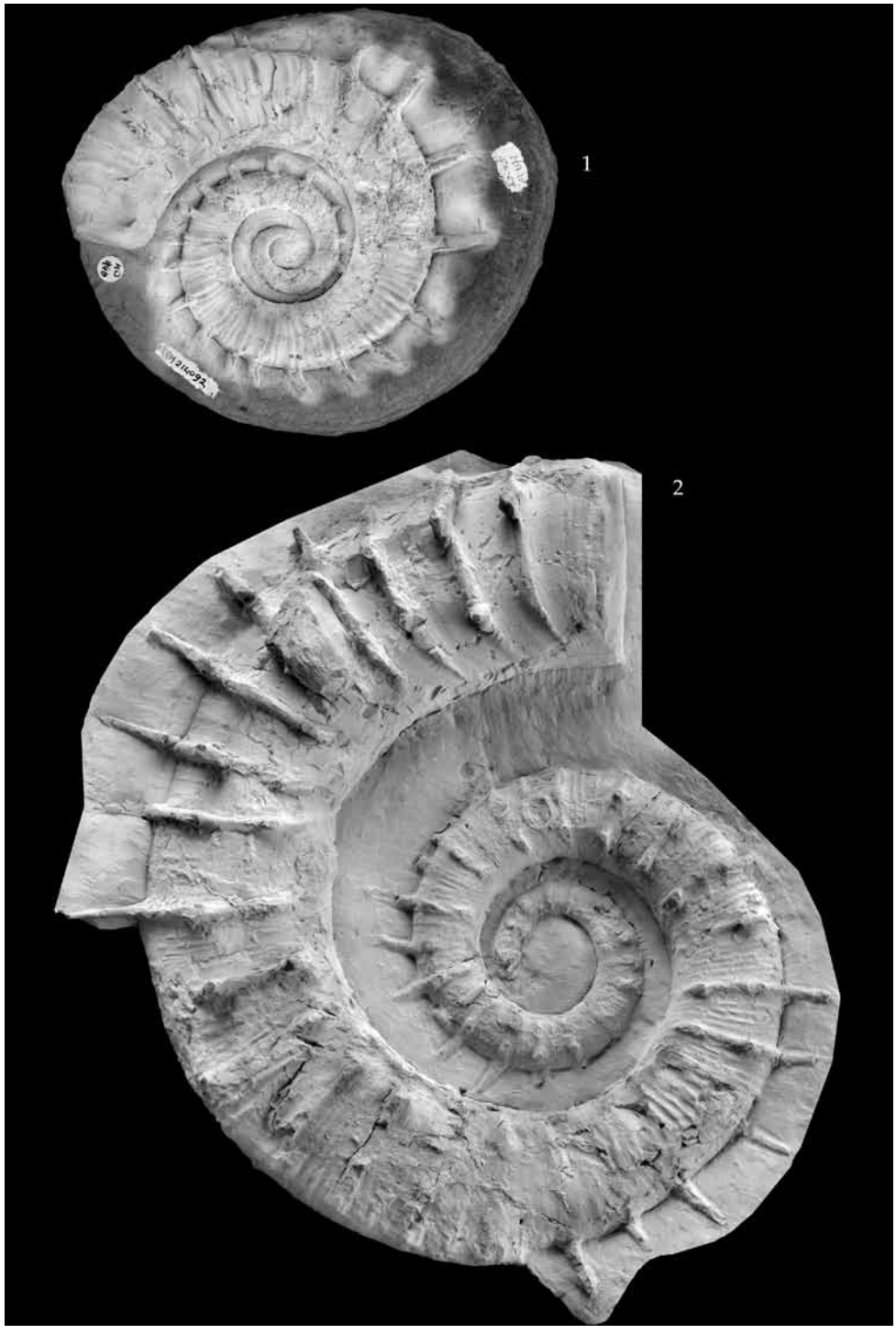

Plate 10

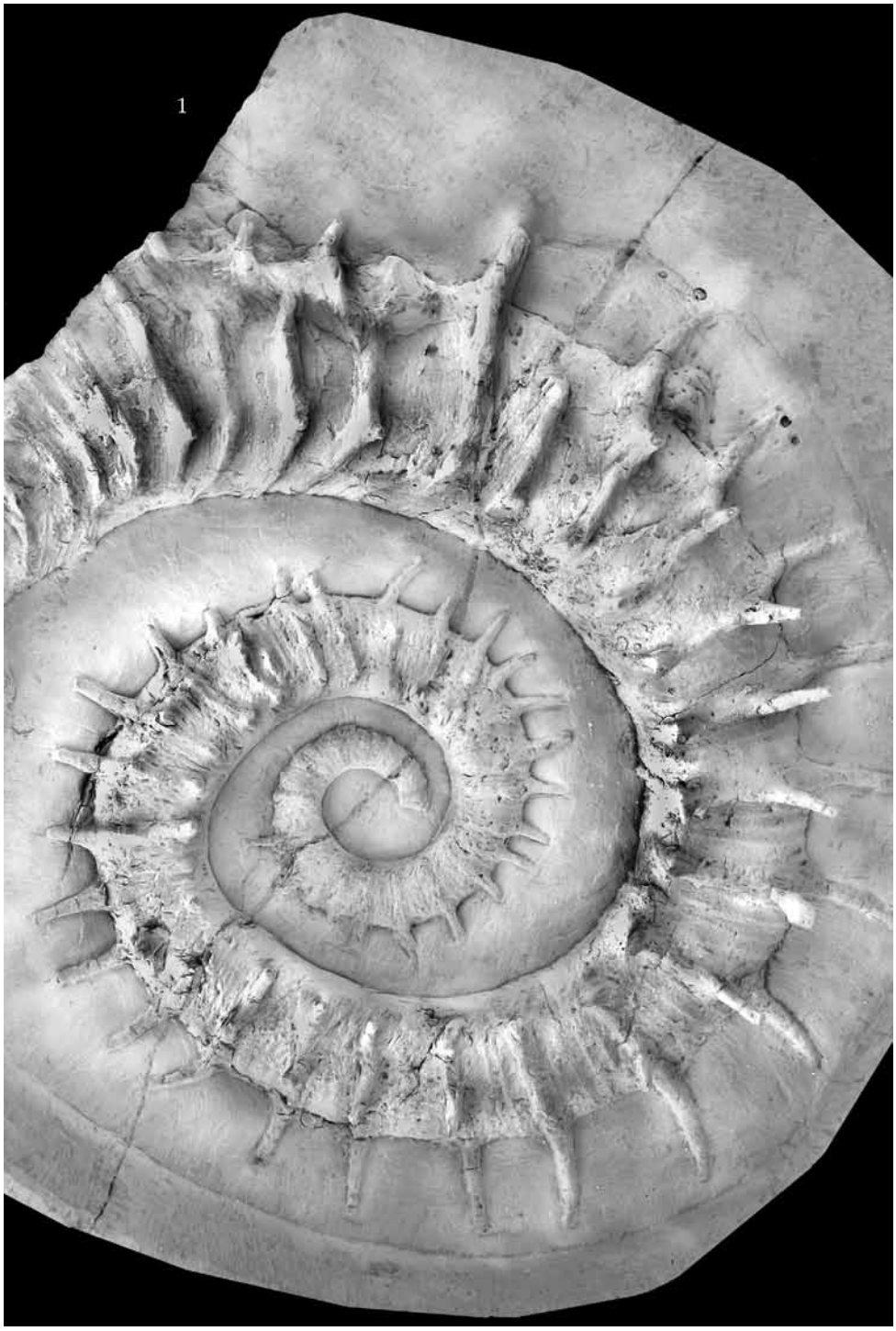

Plate 11

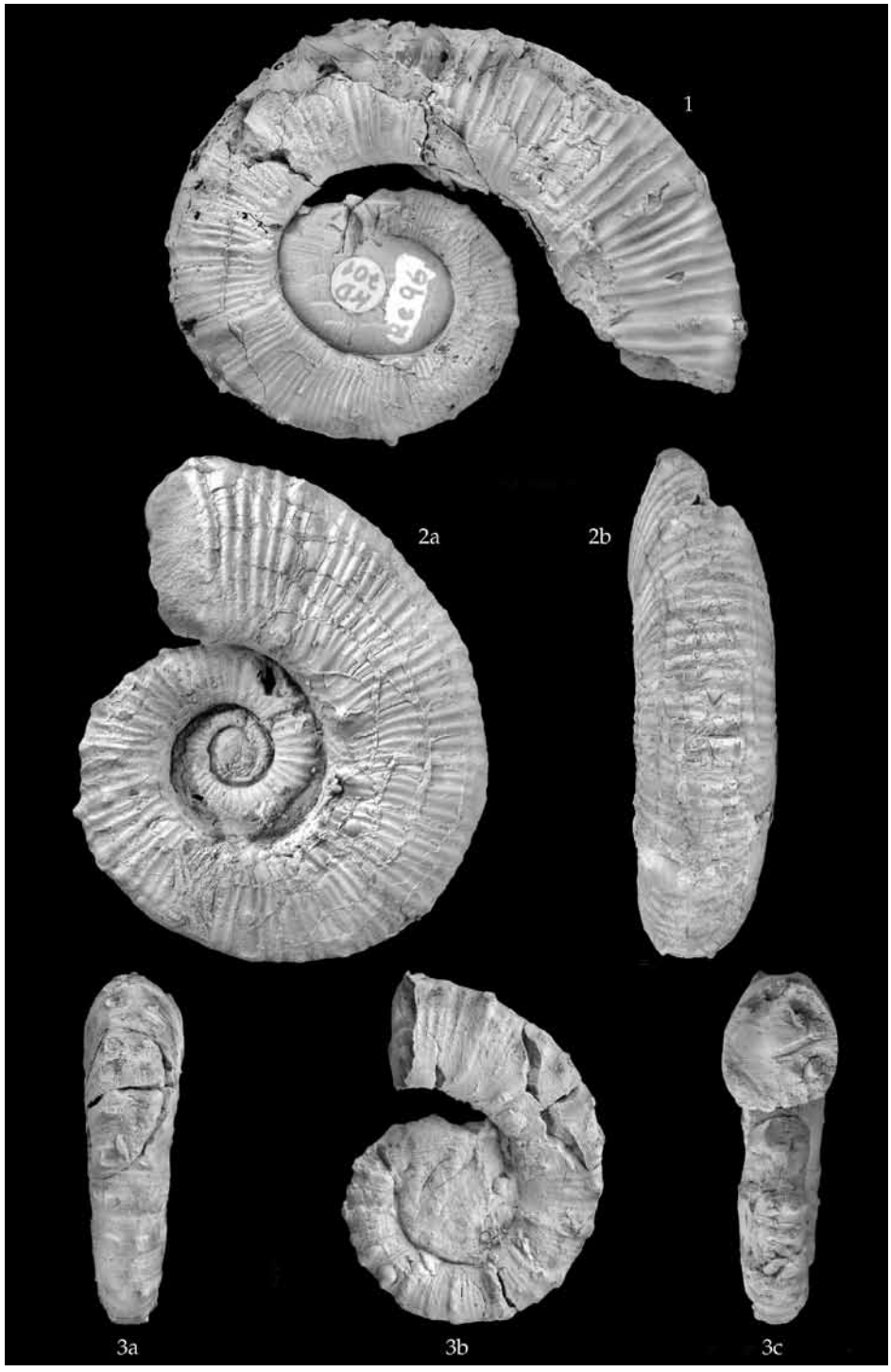

Plate 12

Plate 13

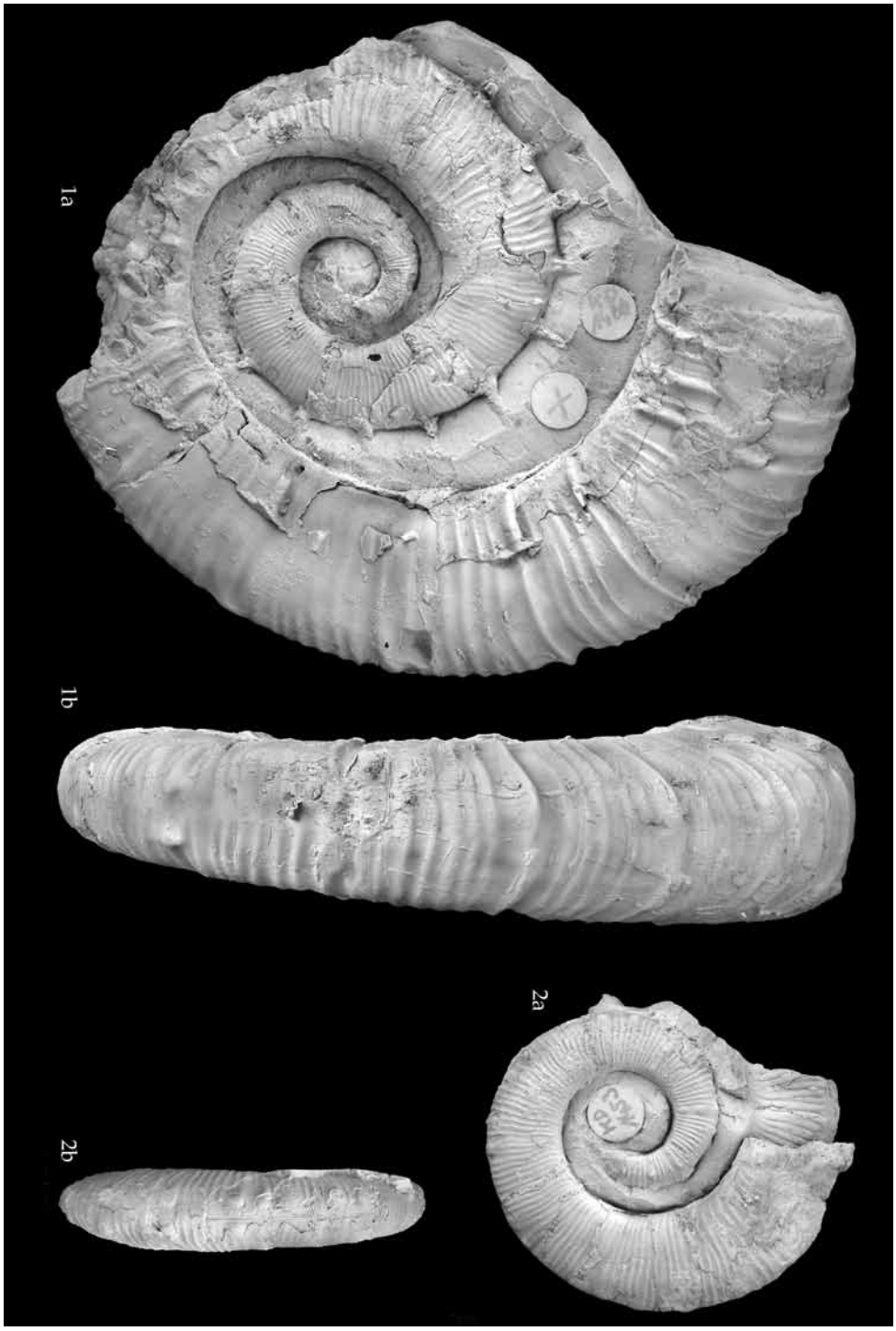

Plate 14

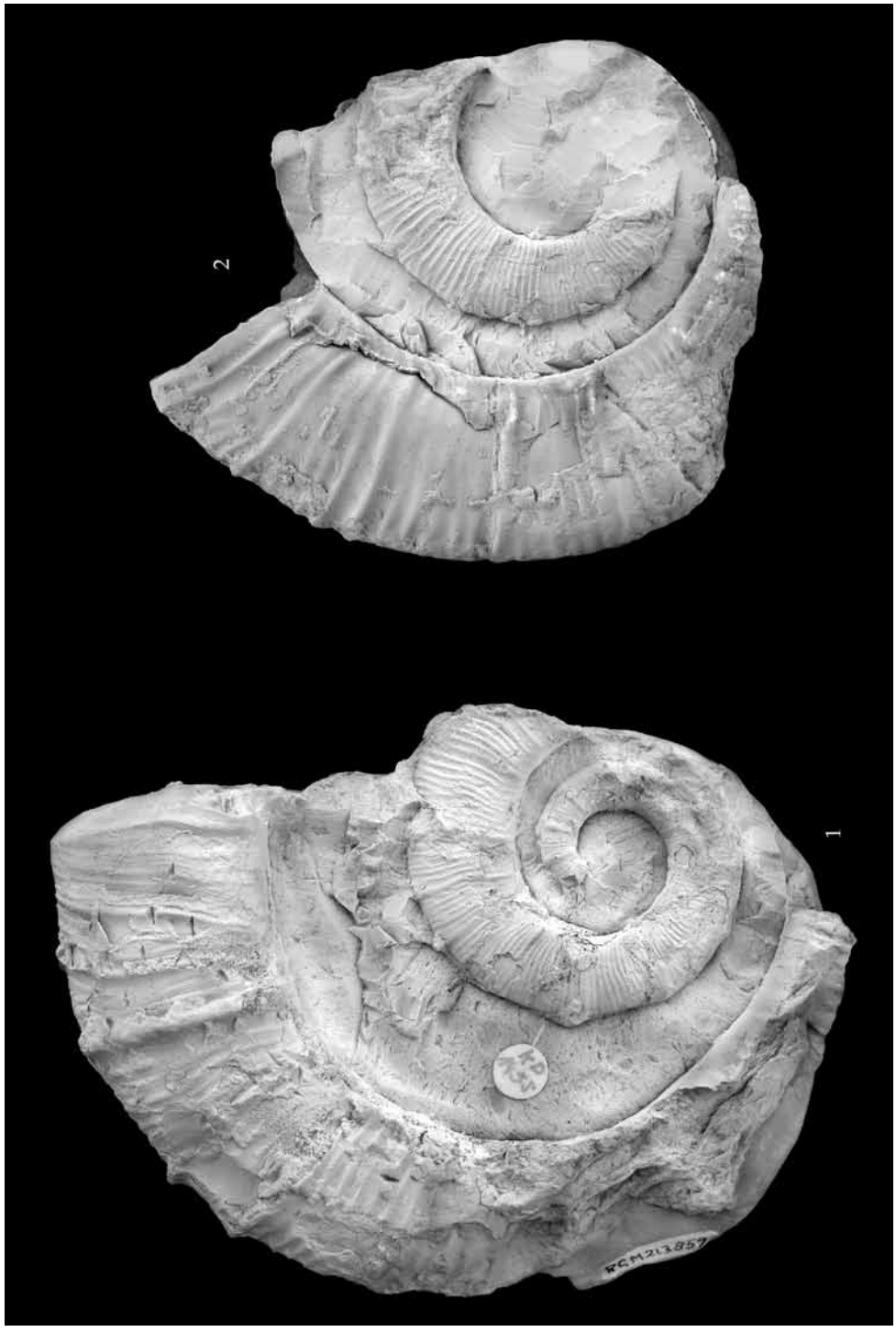

Plate 15

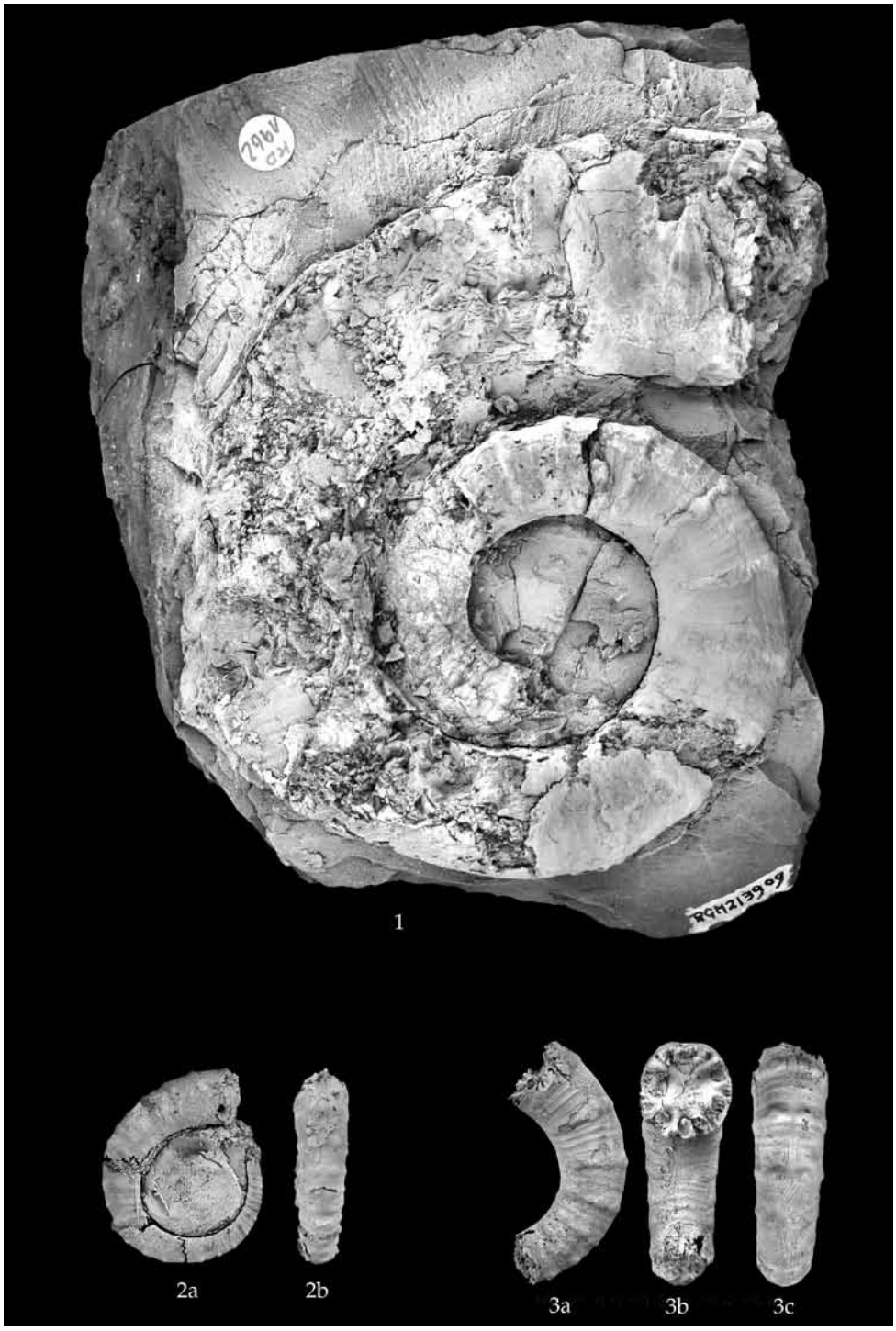

Plate 16

Plate 17

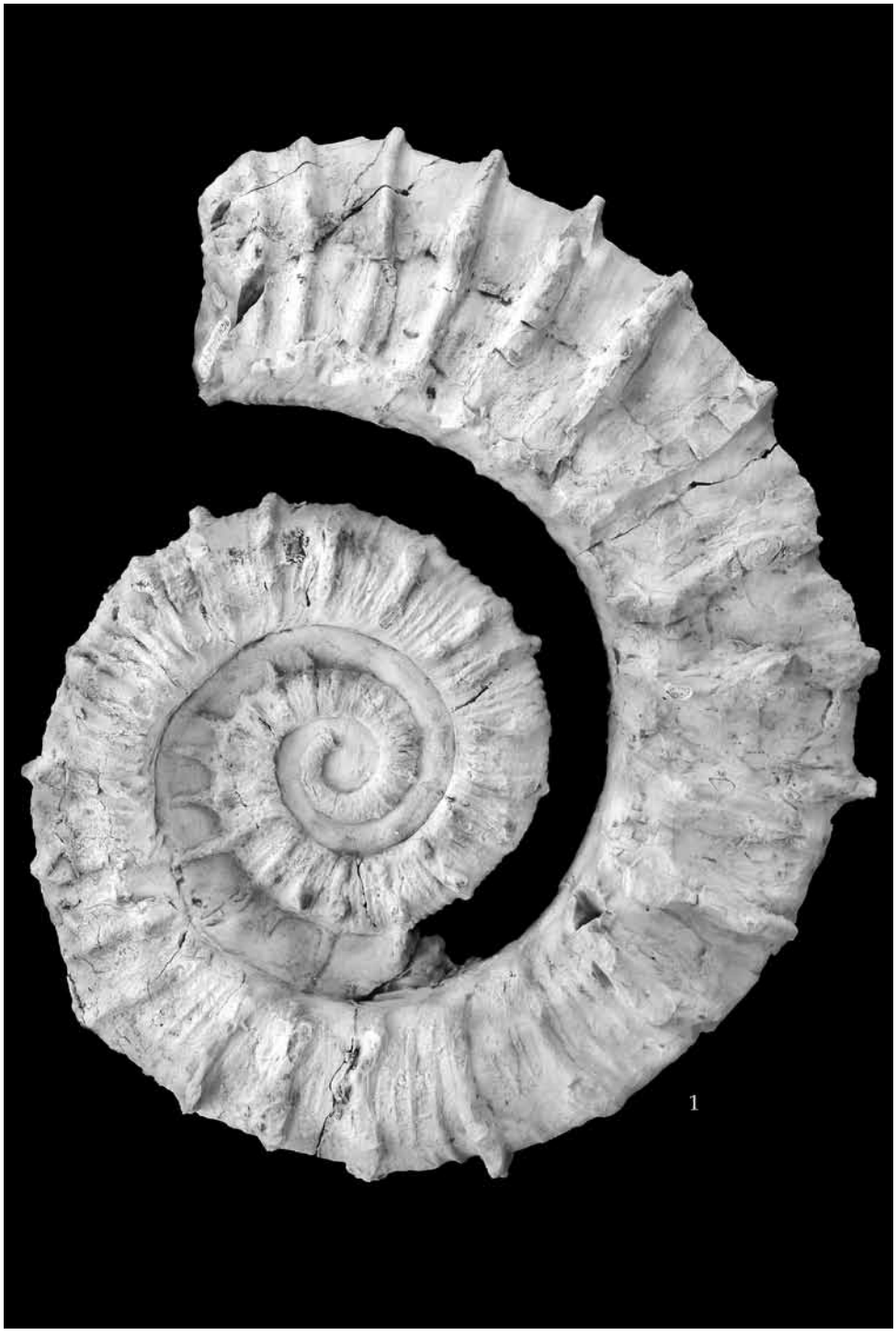

Plate 18

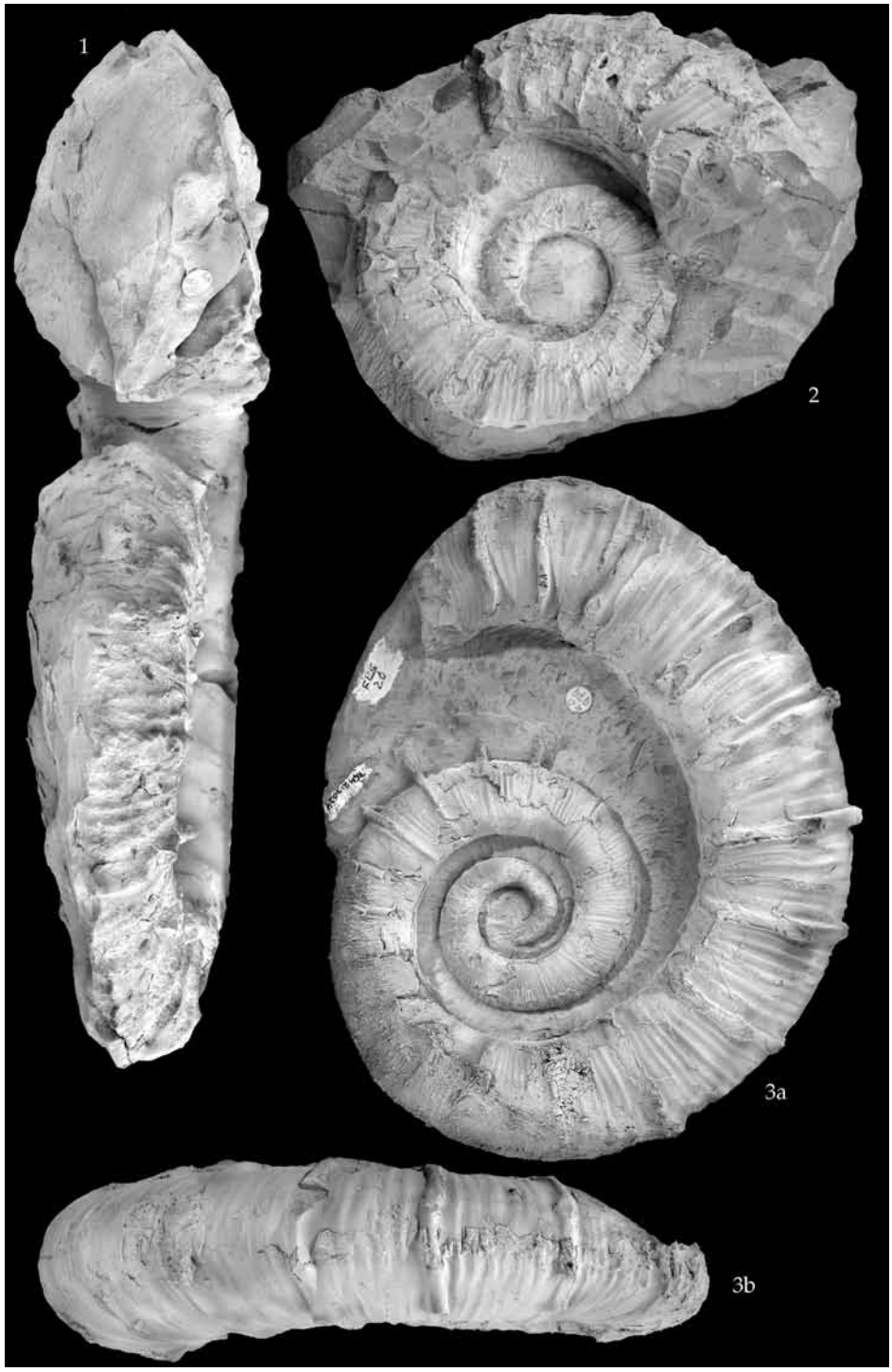

Plate 19

Plate 20

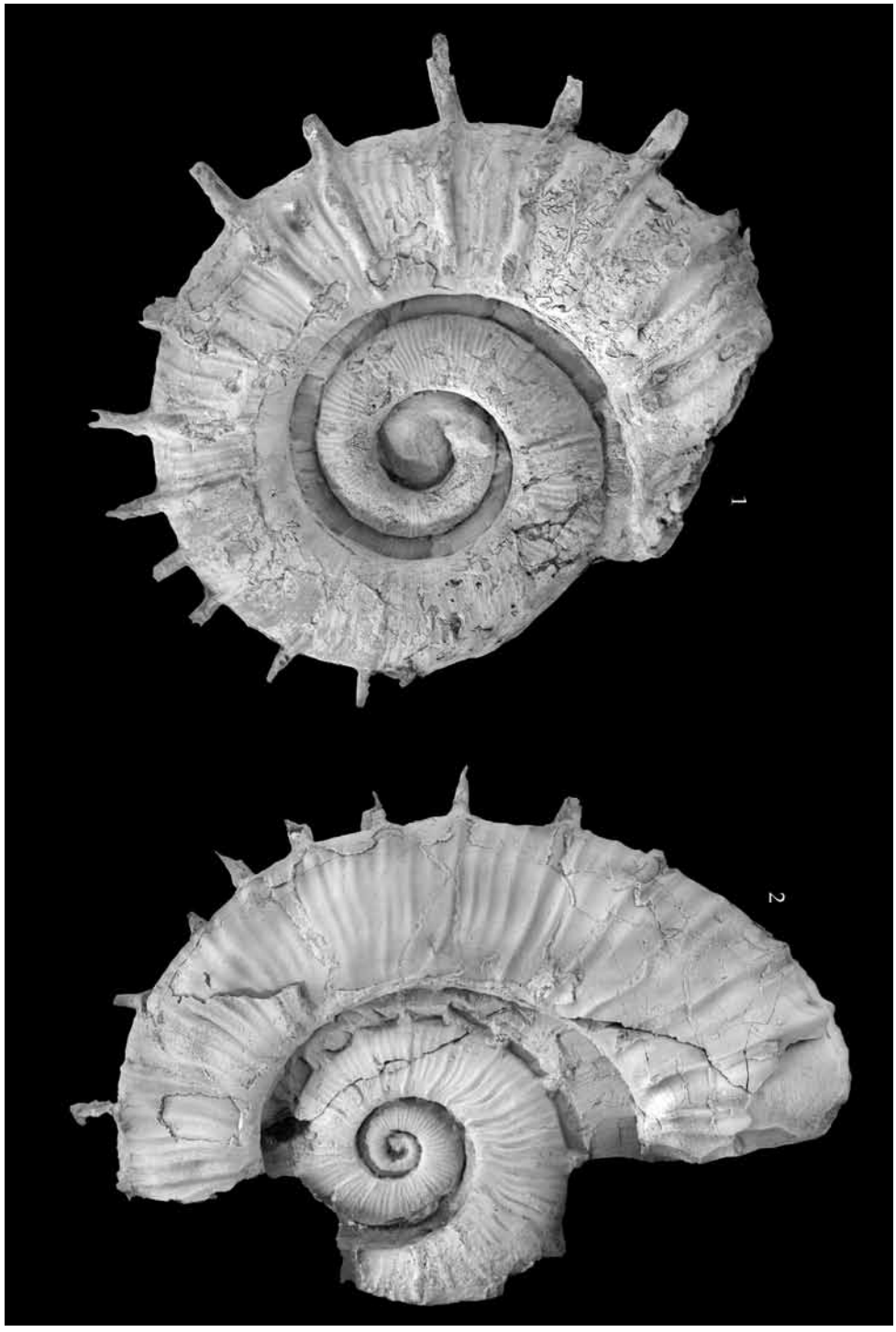

Plate 21

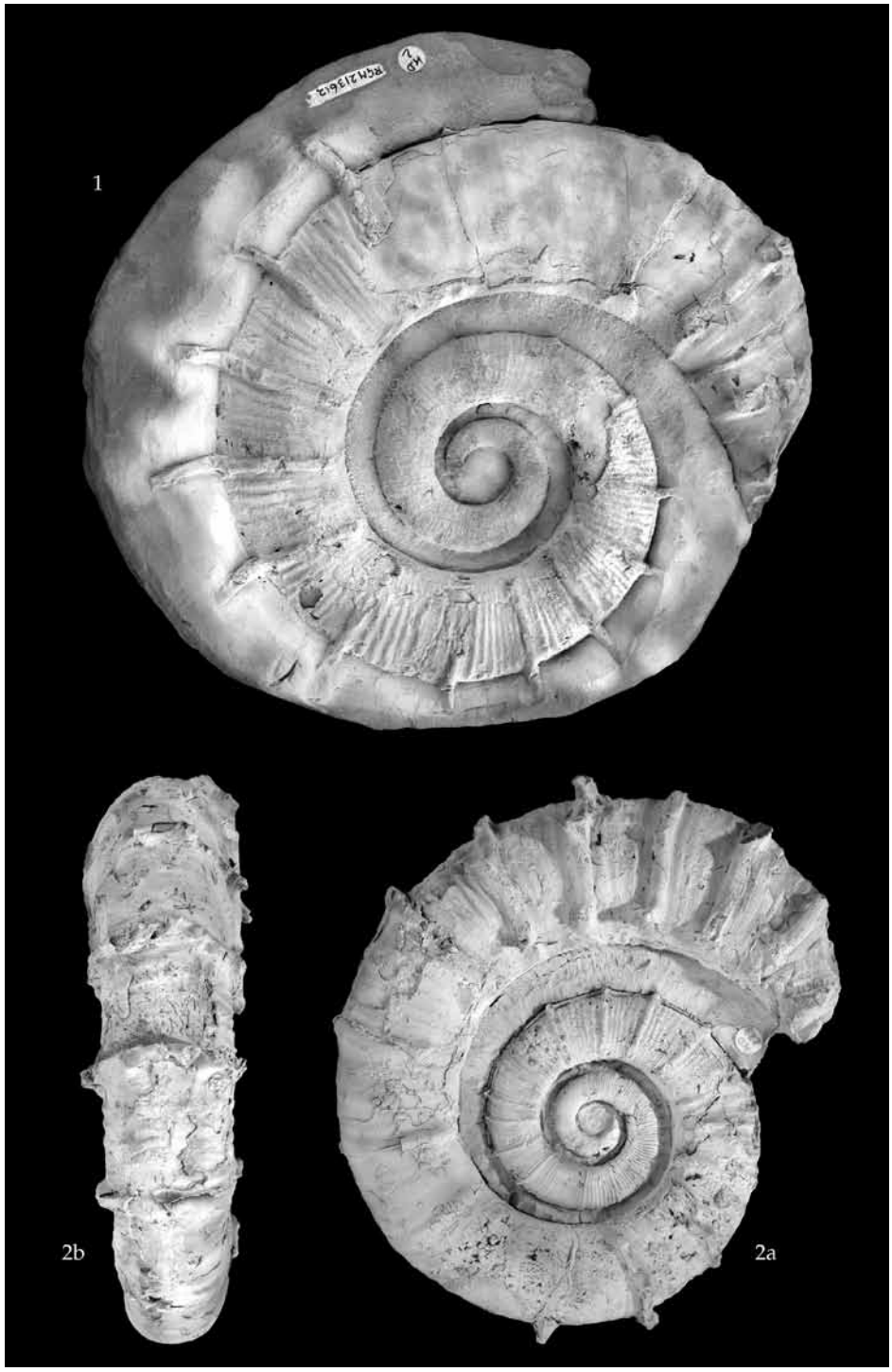

Plate 22

Plate 23

Plate 24

Plate 25

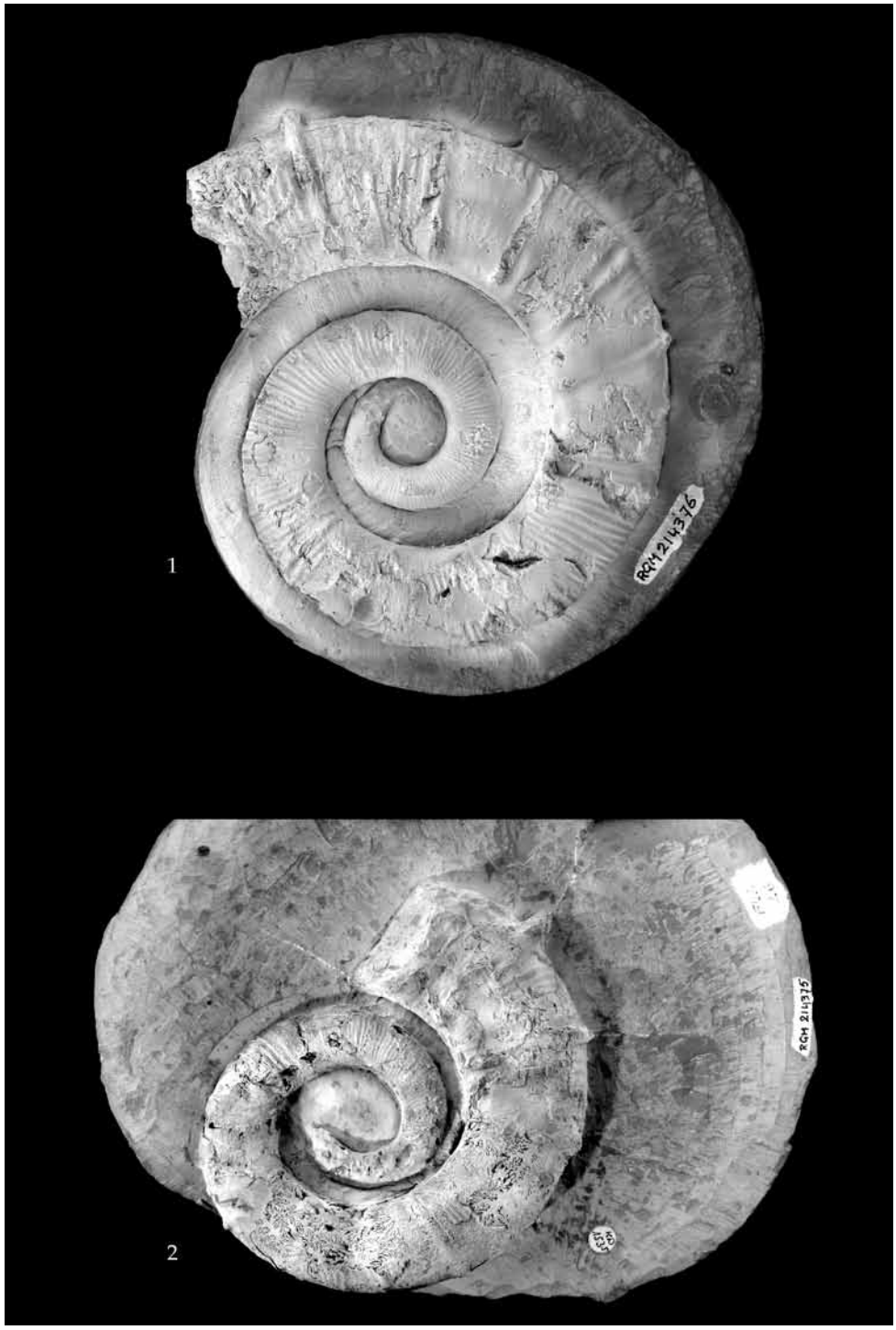

Plate 26

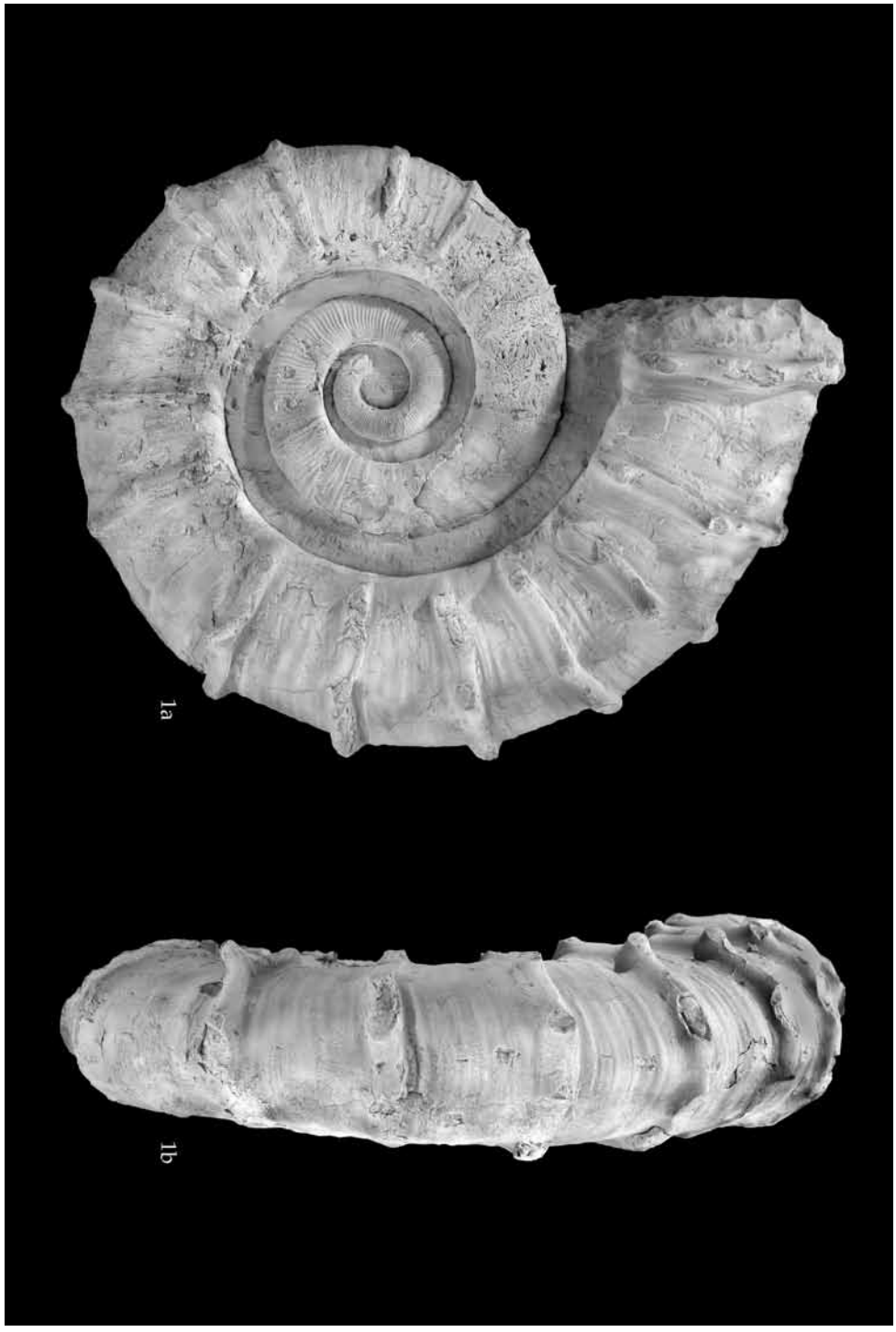

Plate 27

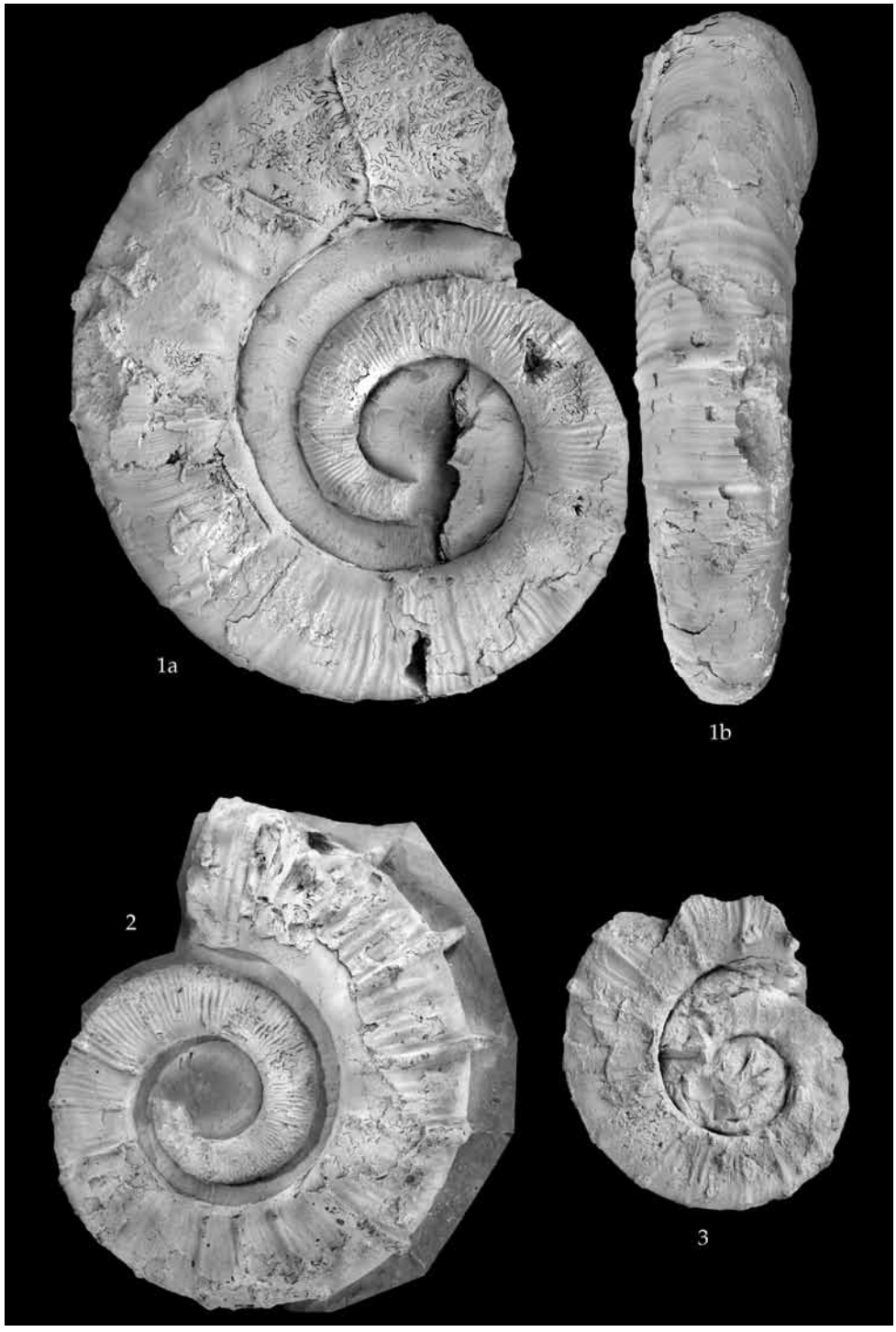

Plate 28

Plate 29

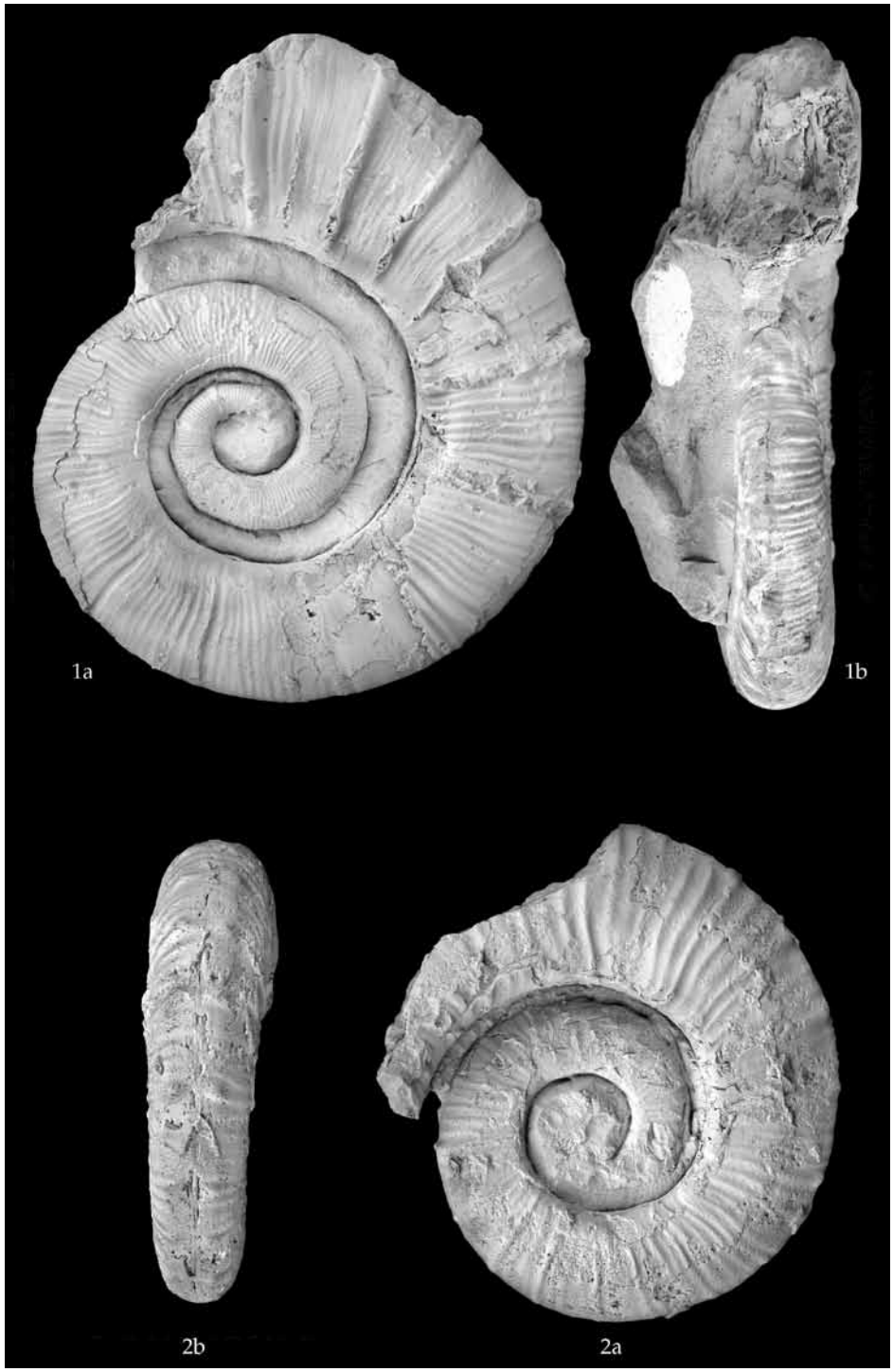

Plate 30

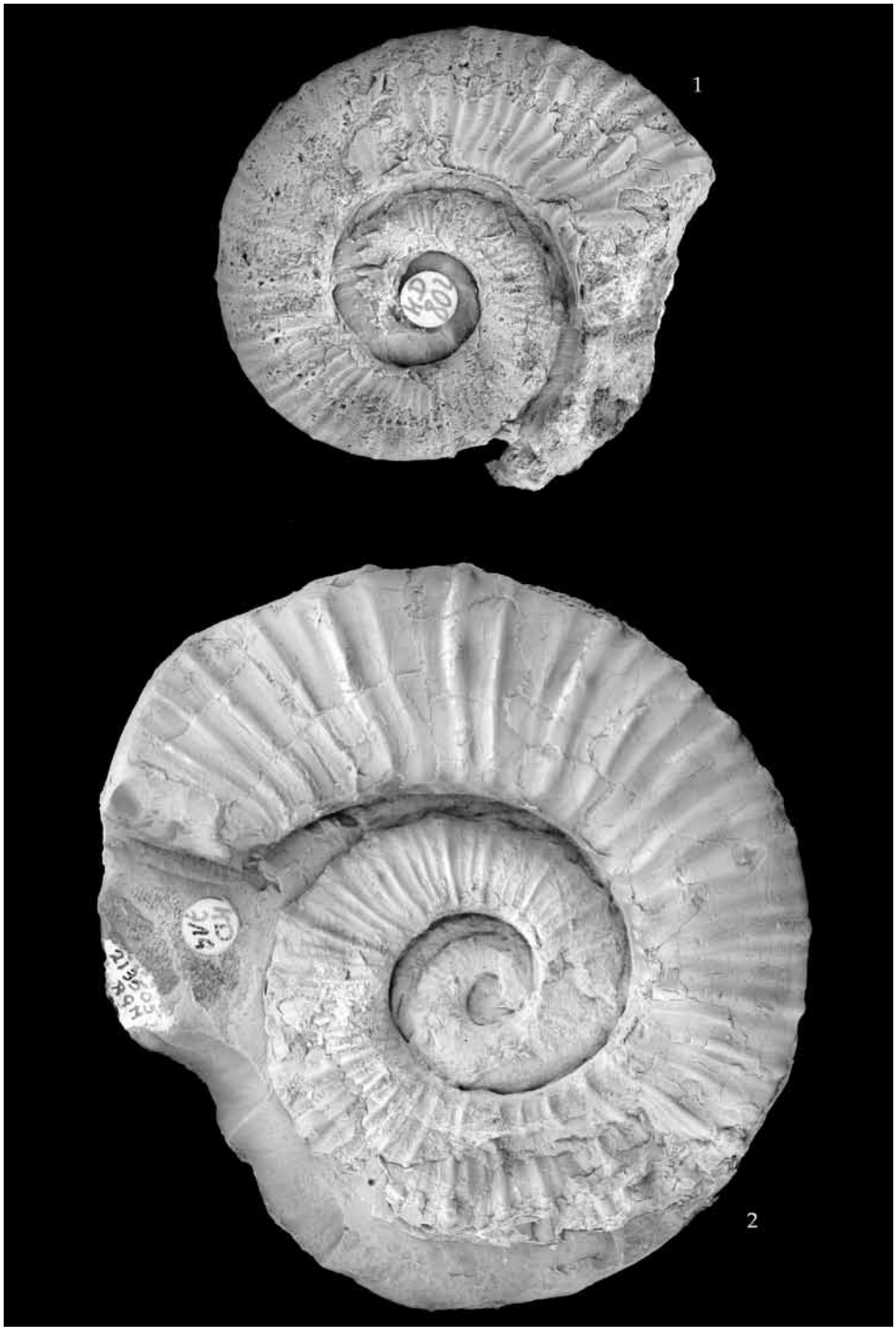

Plate 31

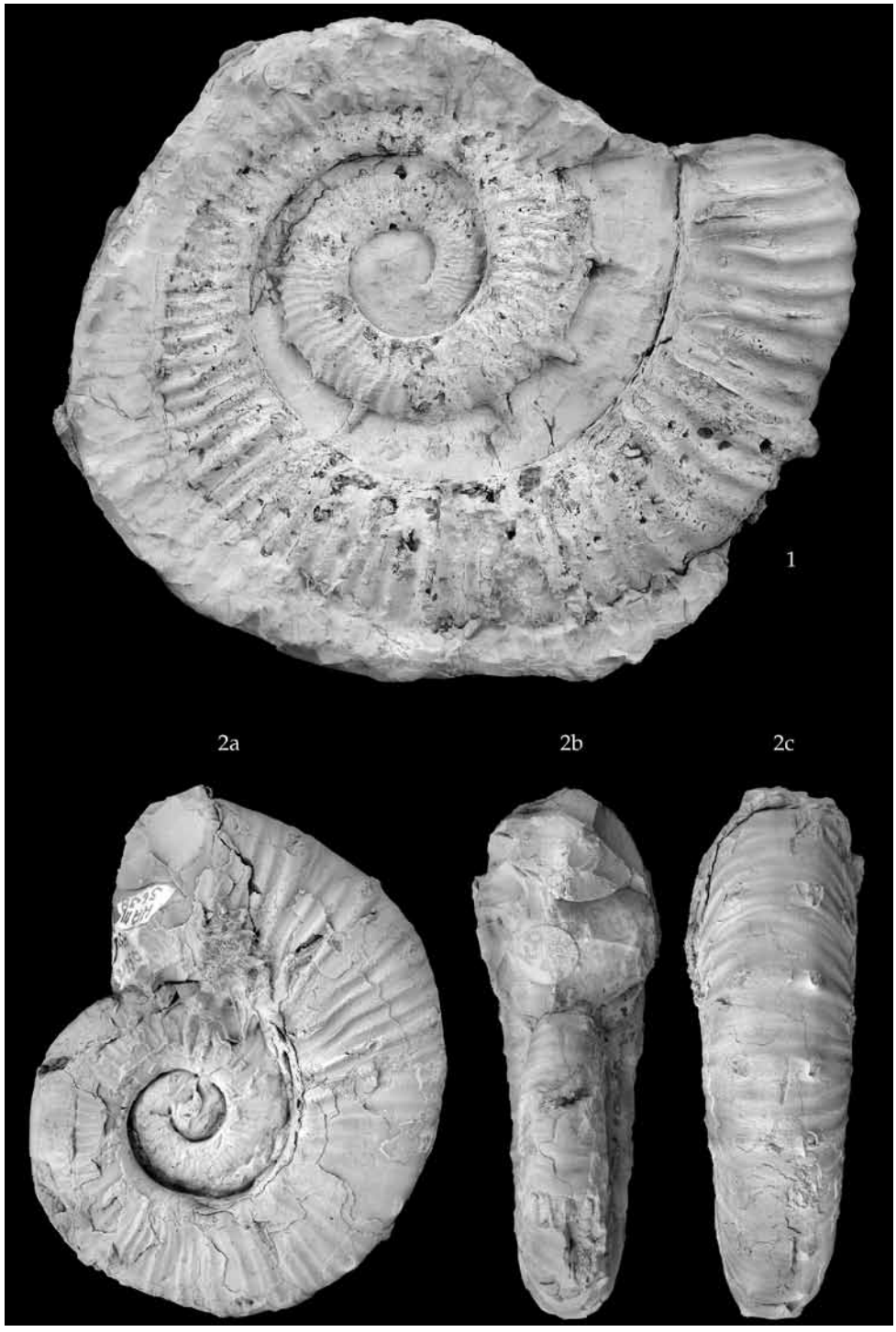

Plate 32

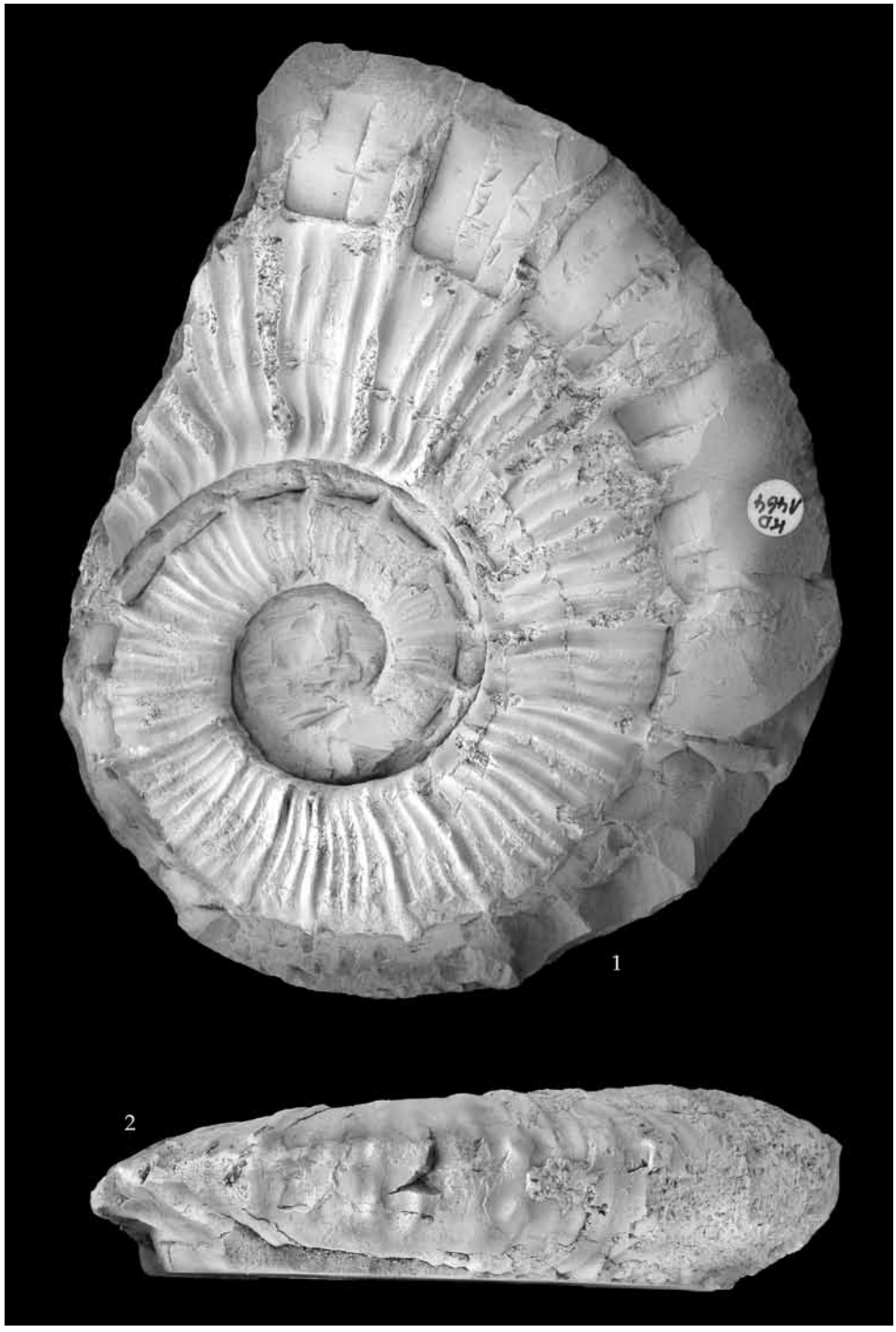

Plate 33

Plate 34

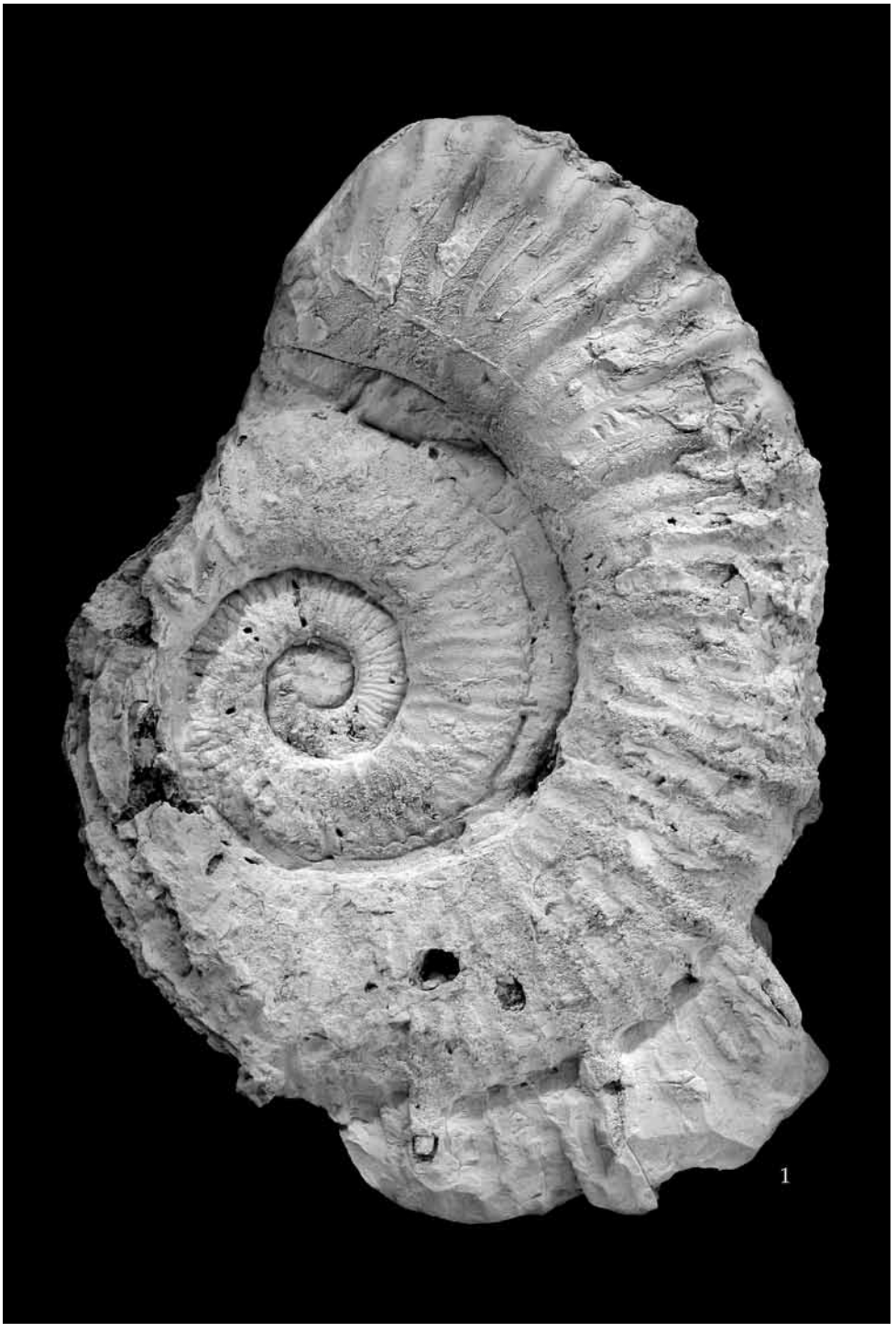

Plate 35

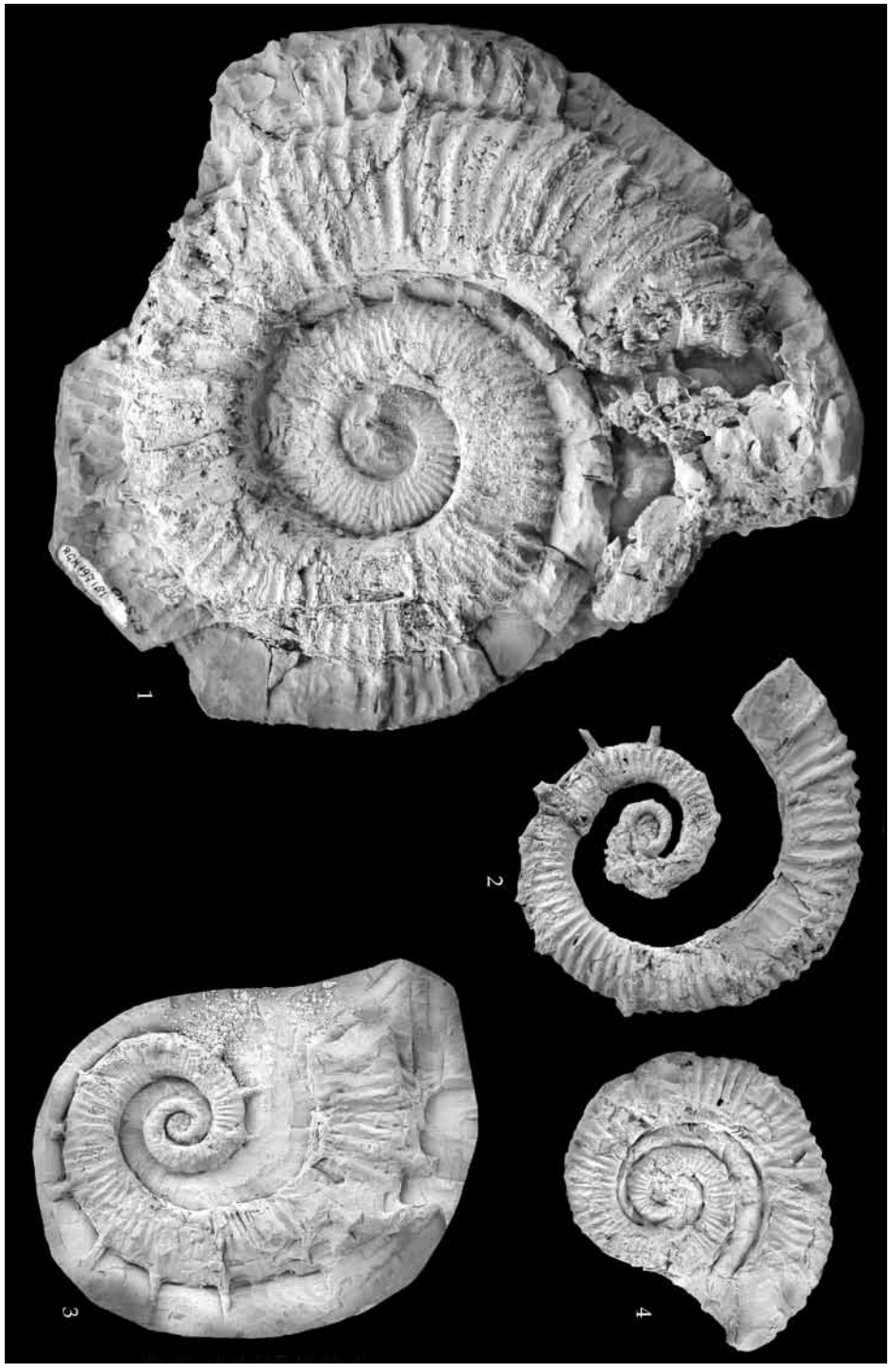

Plate 36

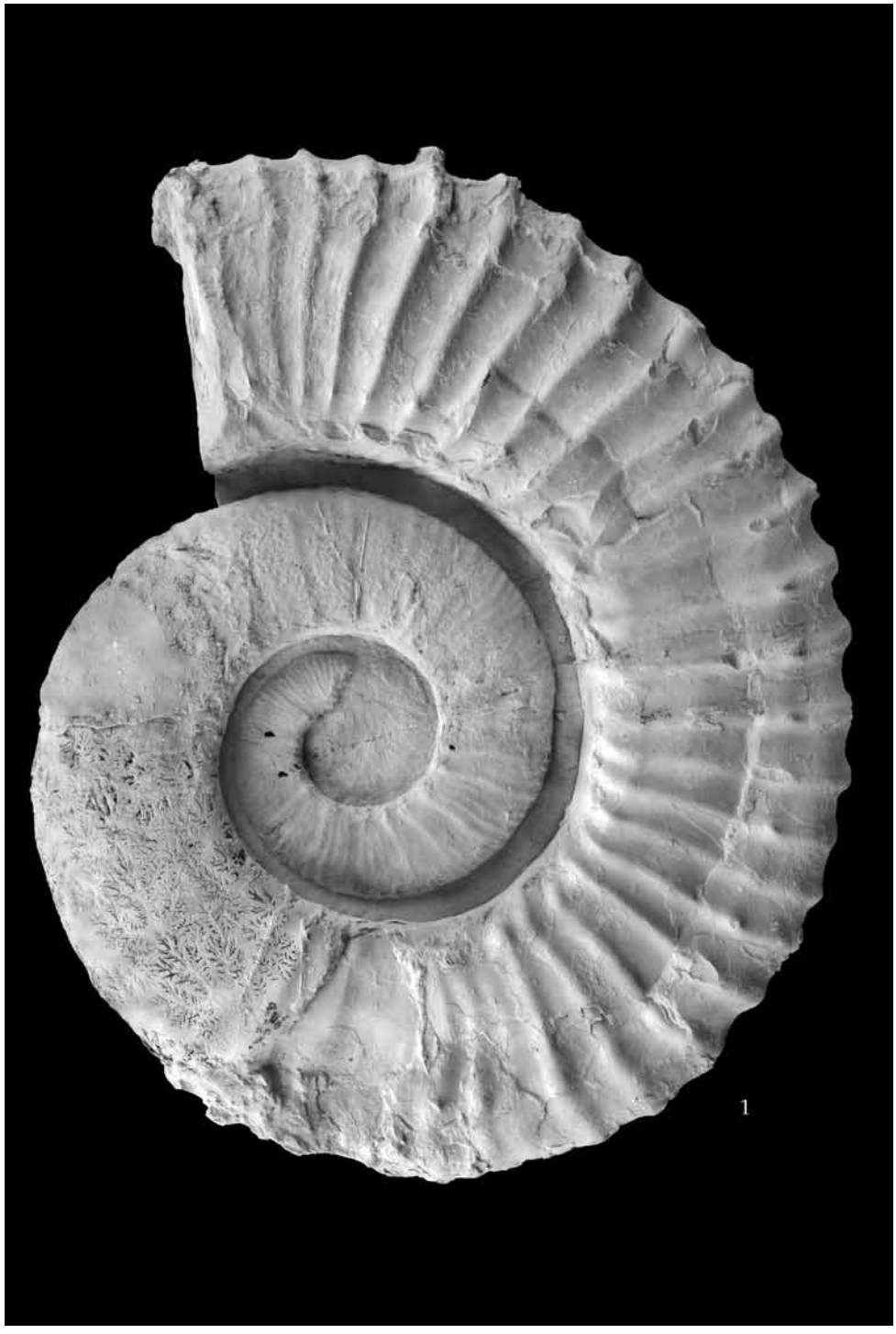

Plate 37

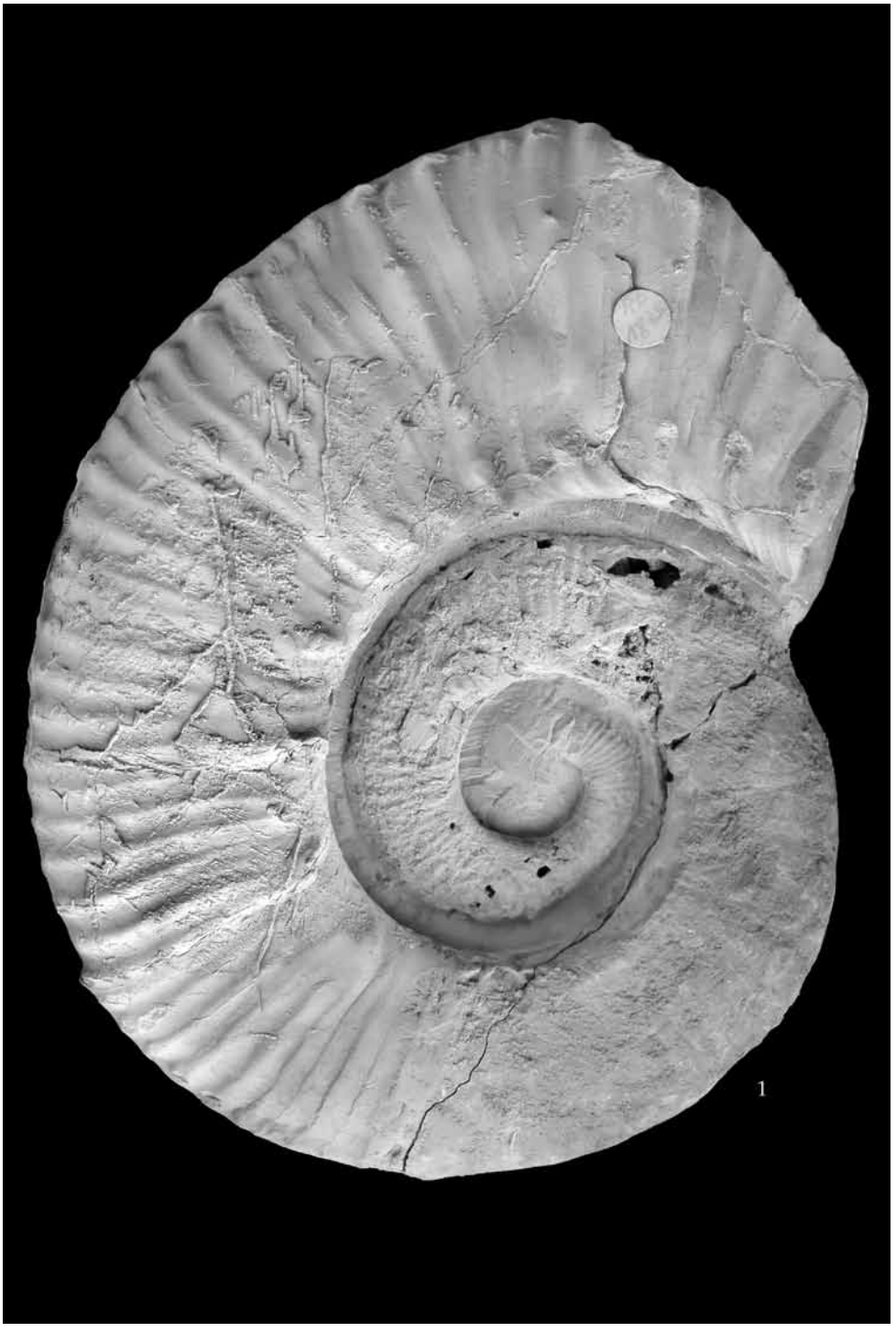

Plate 38

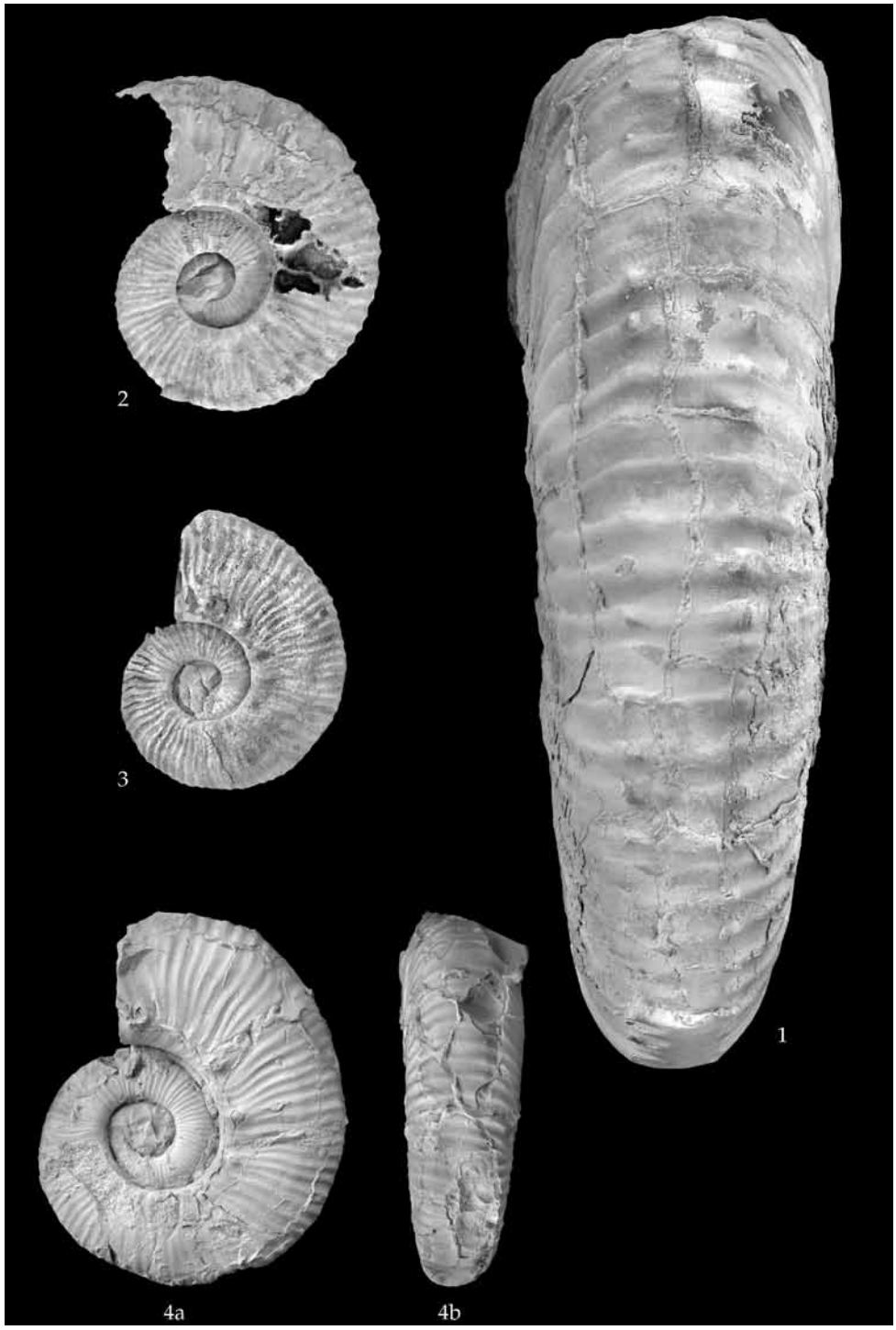

Plate 39

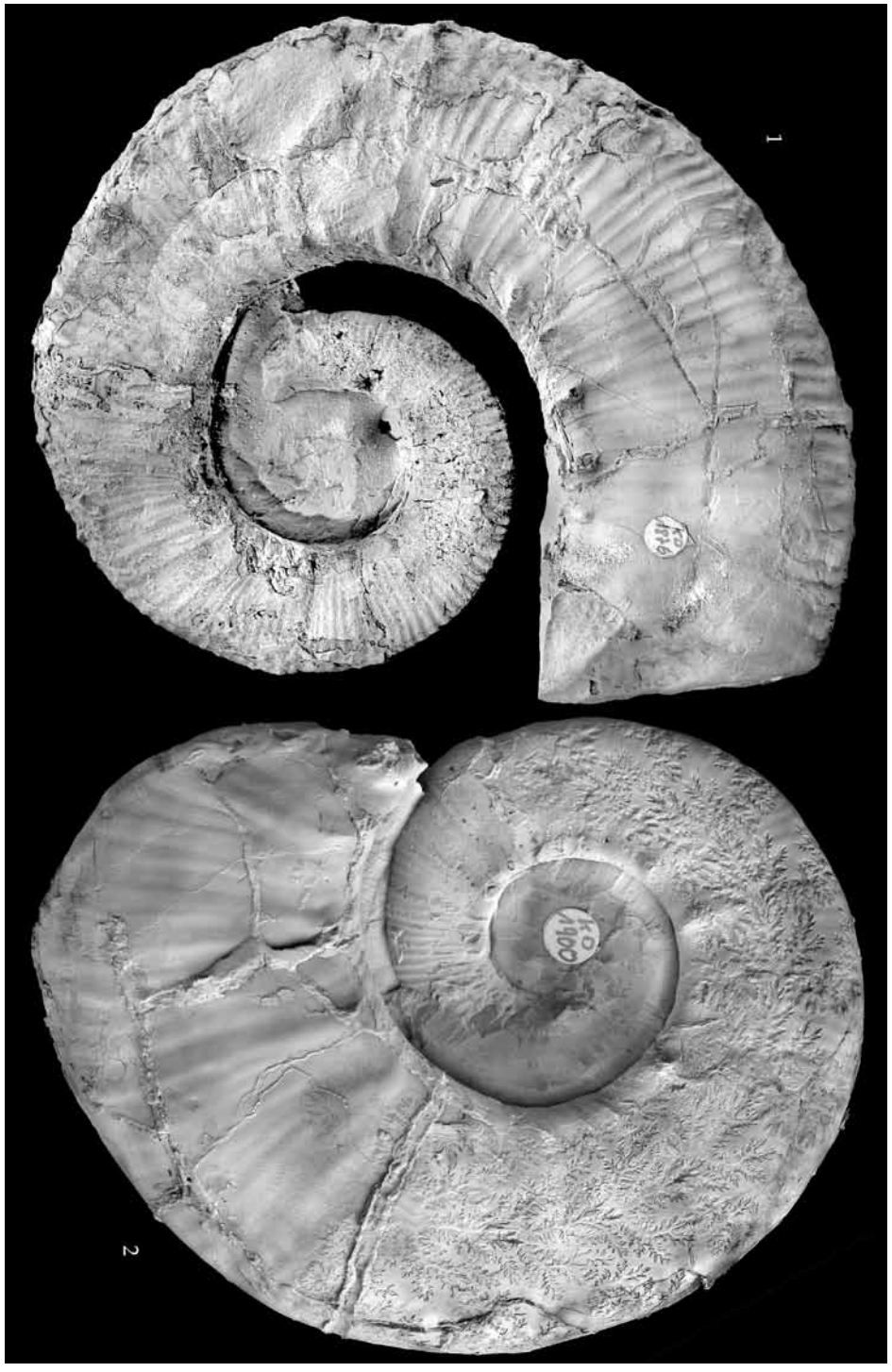

Plate 40

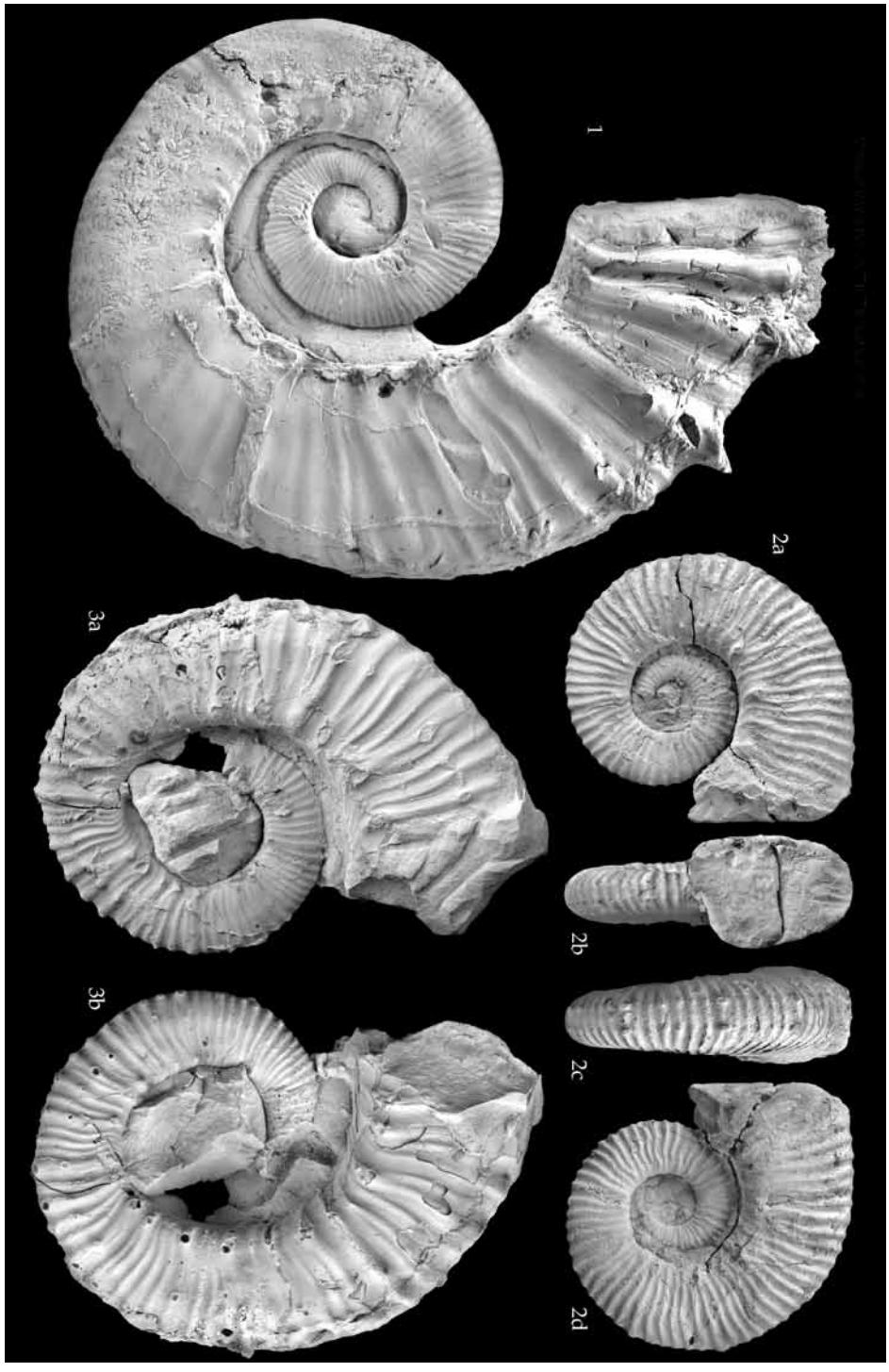

Plate 41

Plate 42

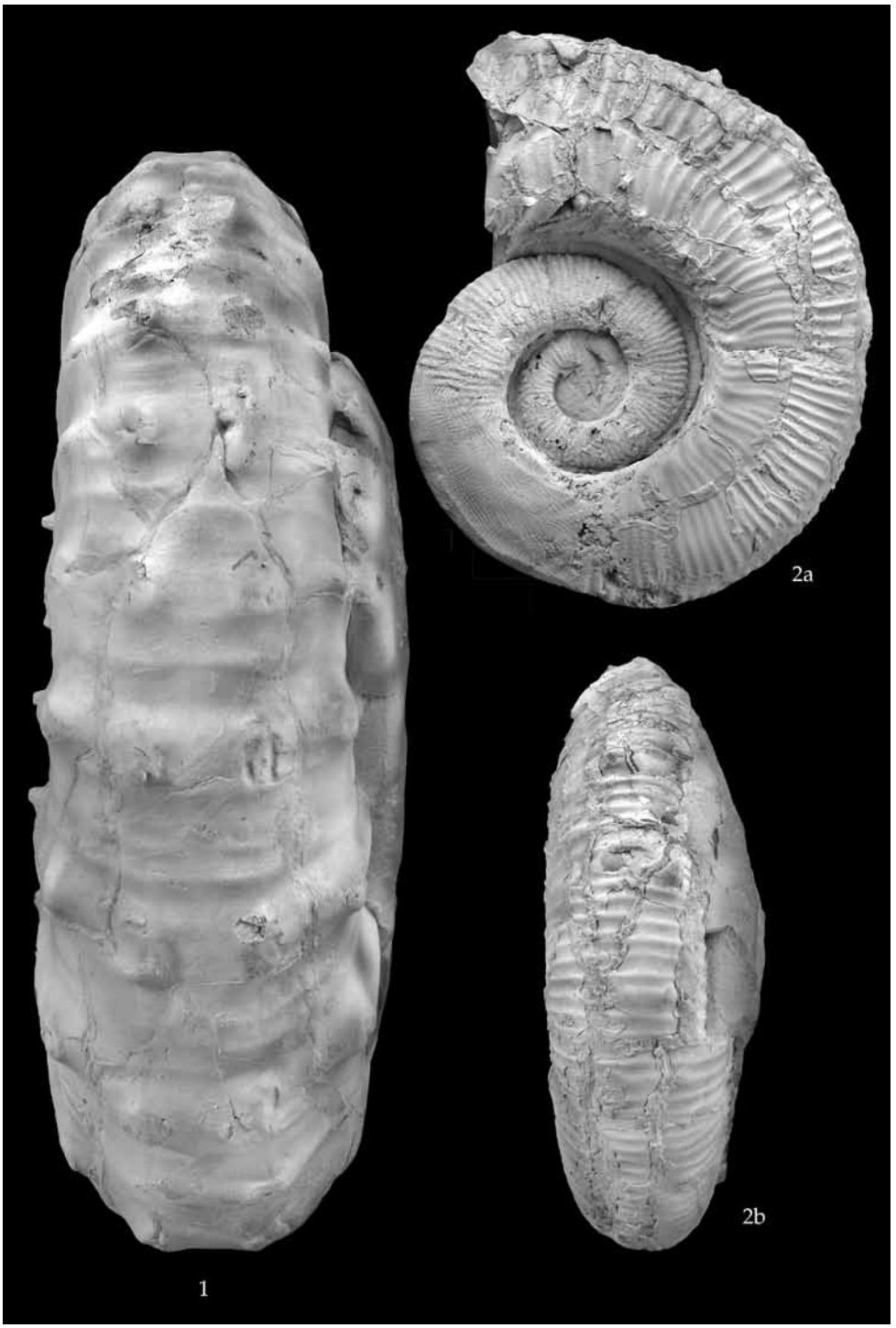

Plate 43

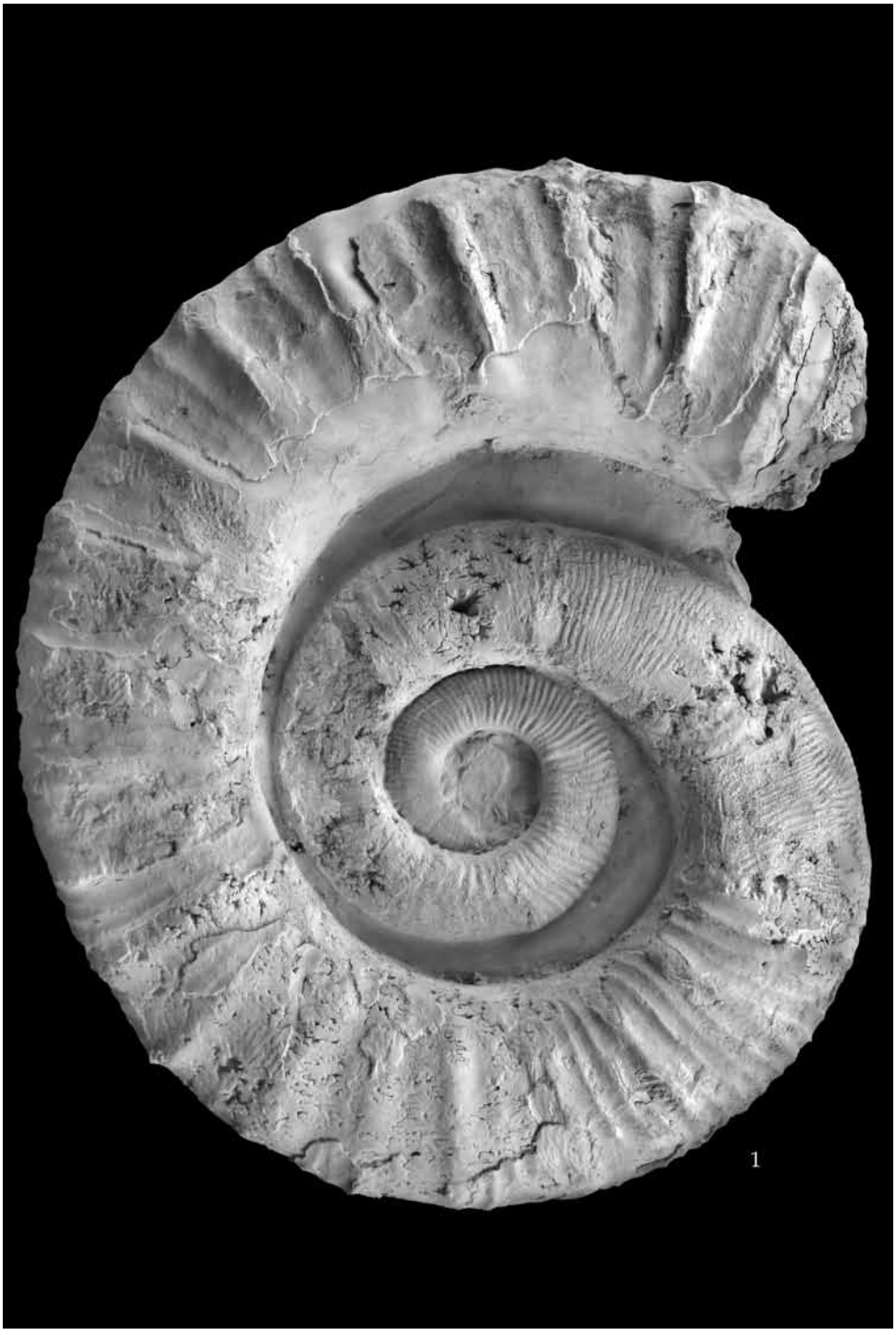

Plate 44

Plate 45

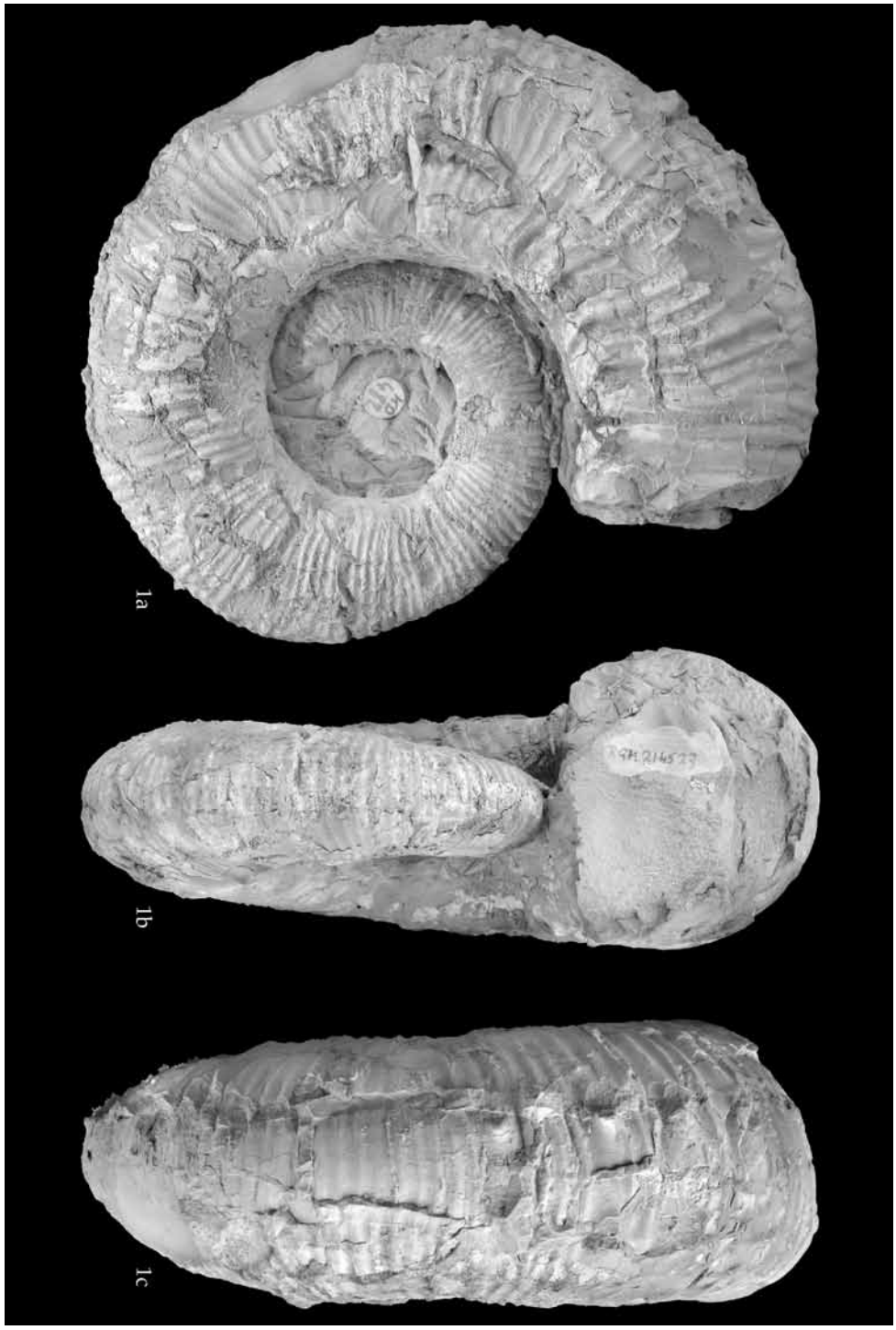

Plate 46

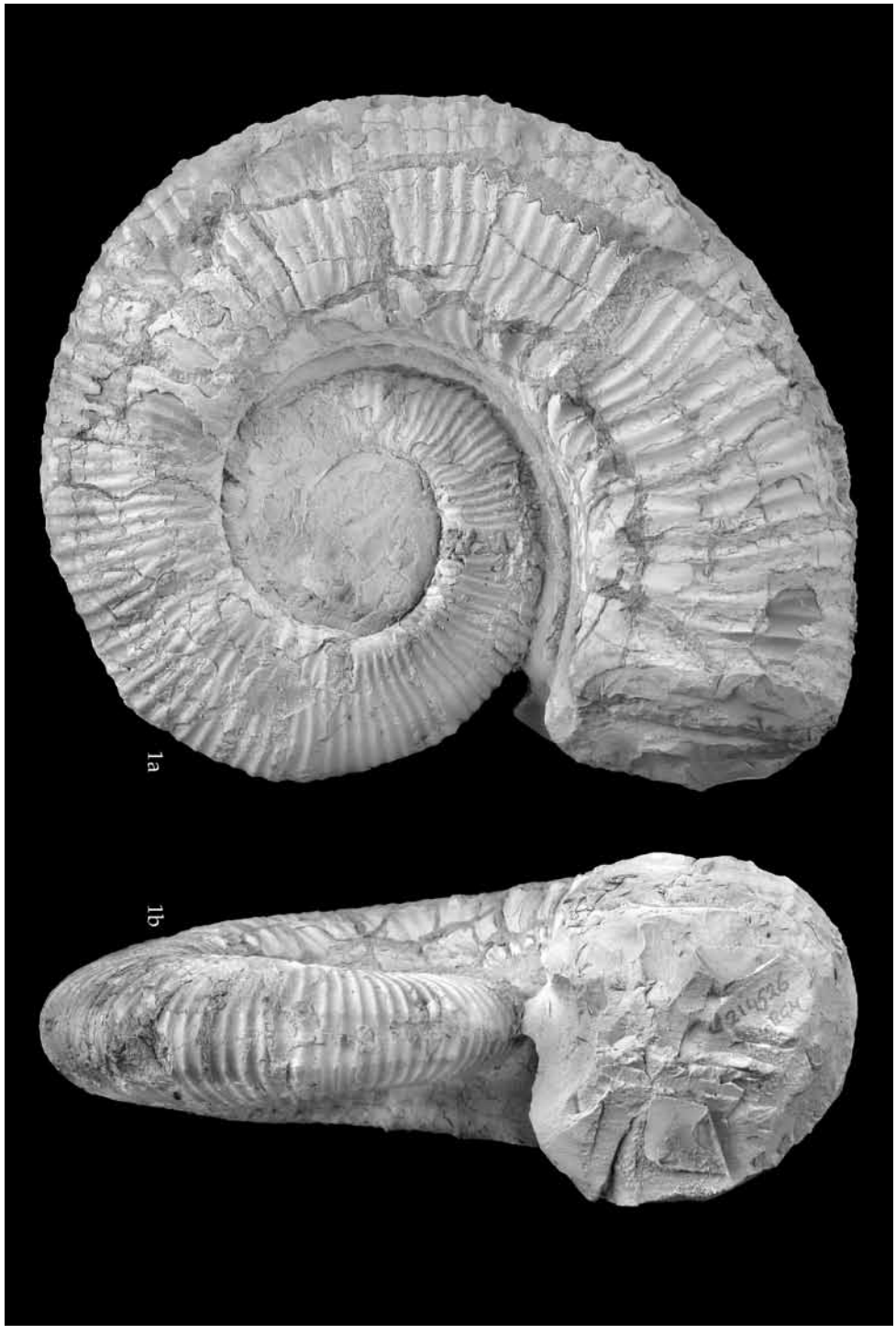

Plate 47

Plate 48

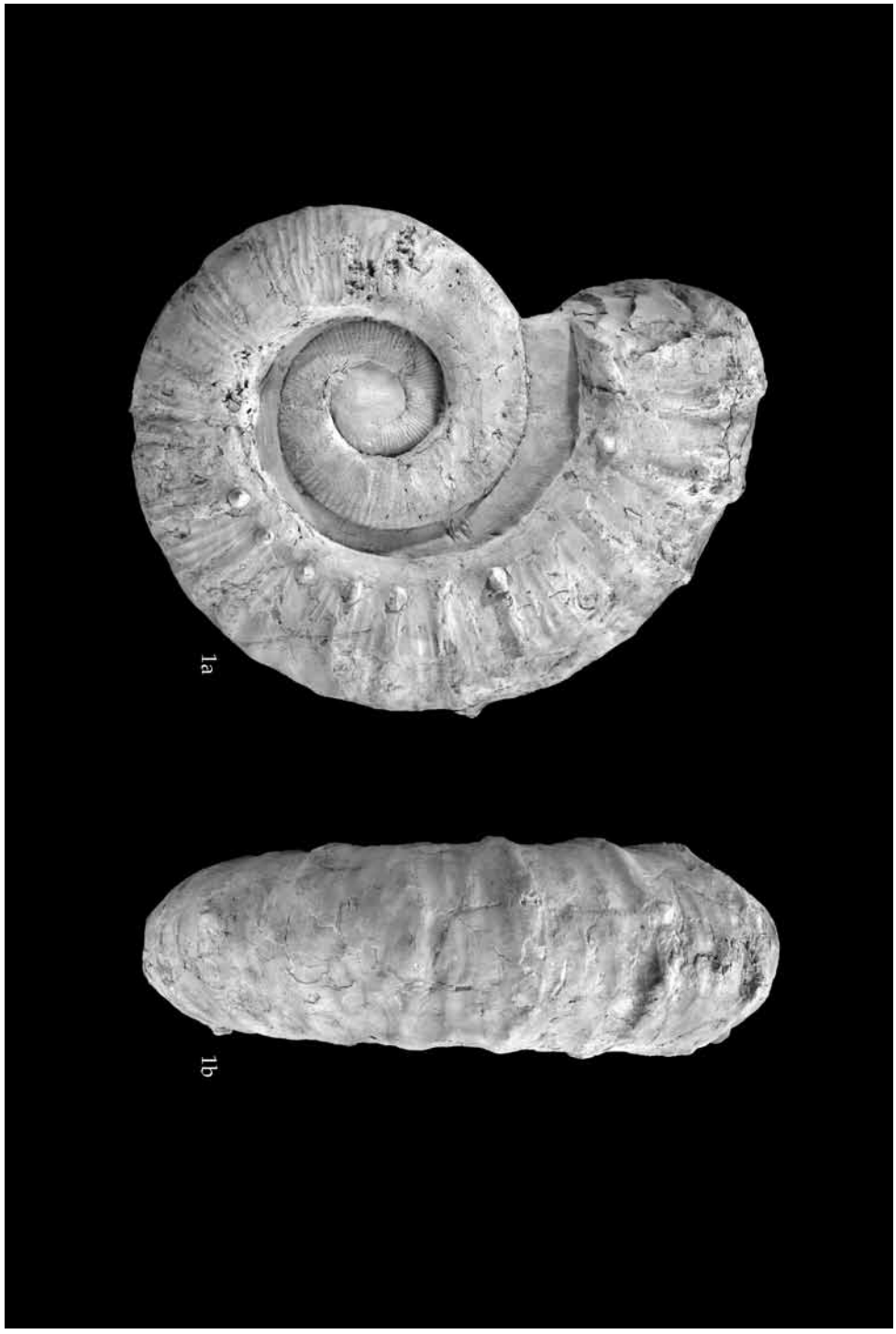

Plate 49

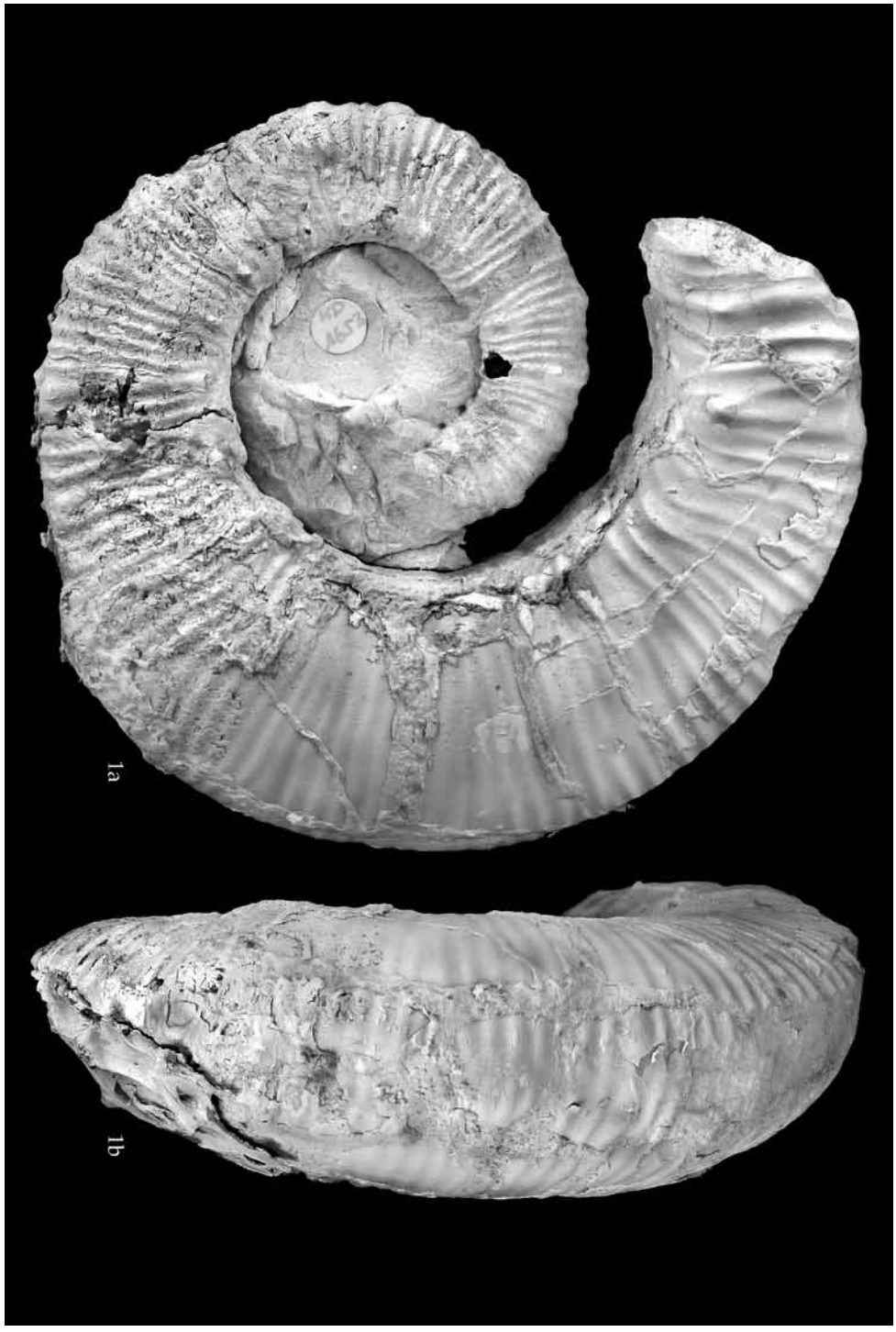

Plate 50

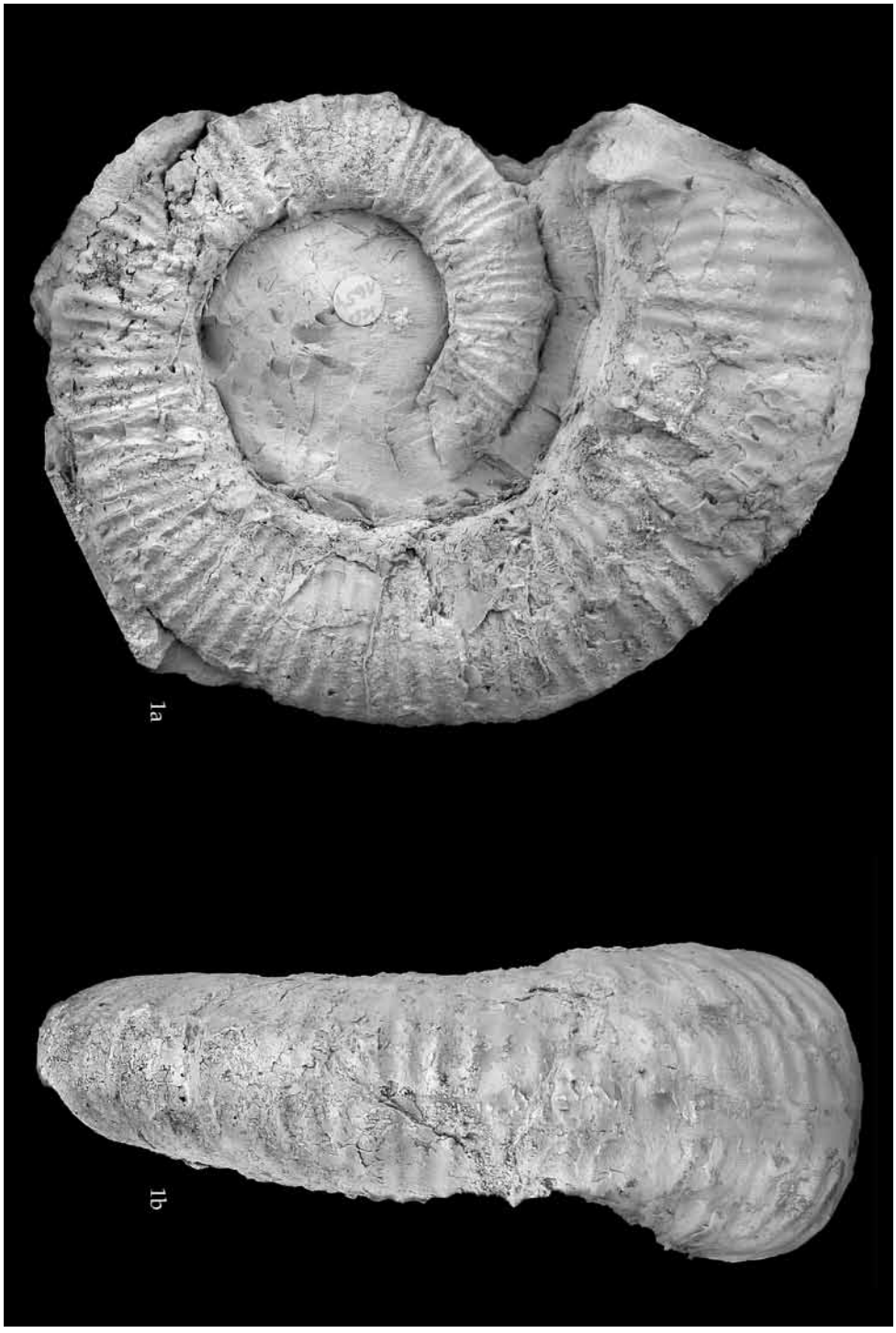

Plate 51

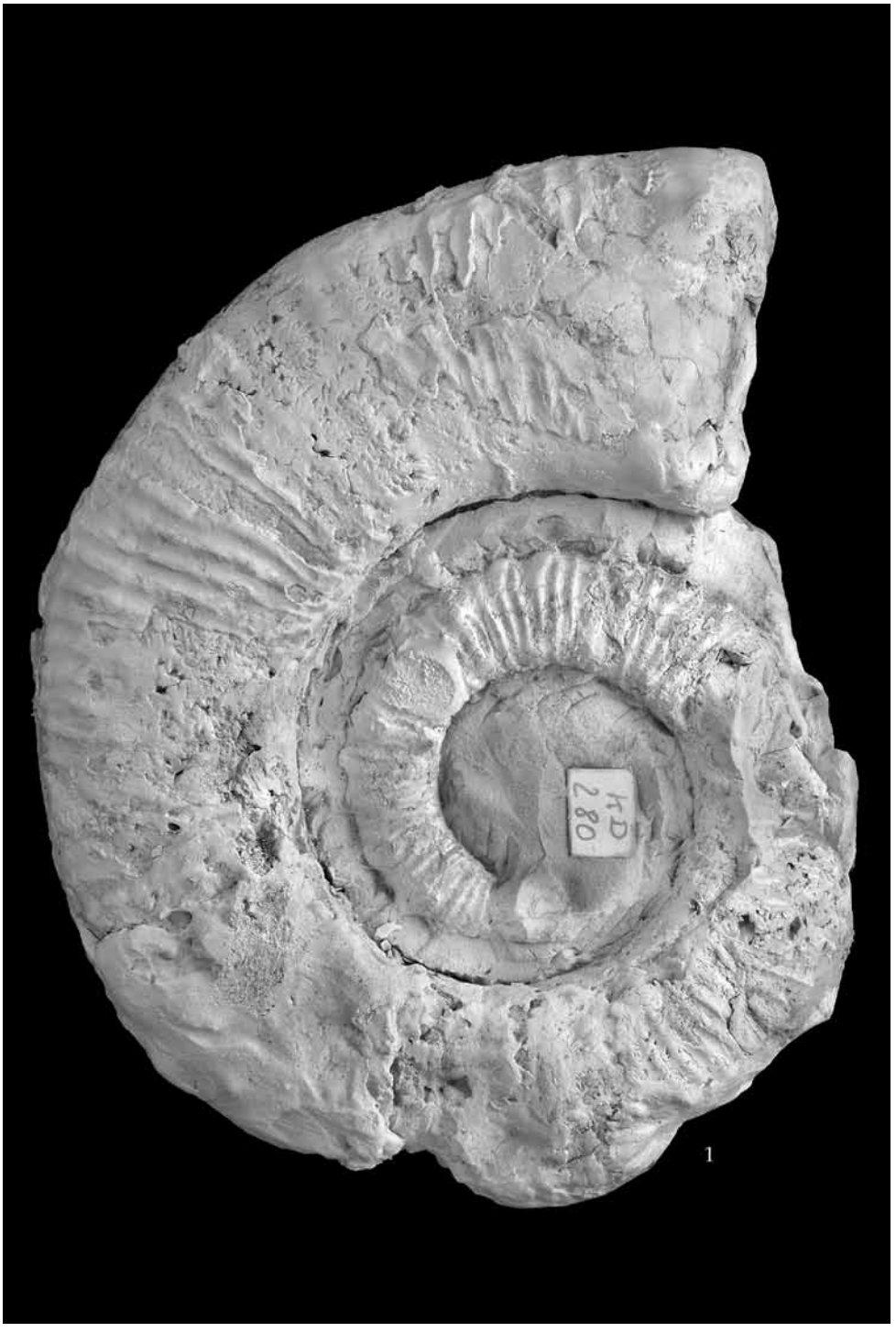

Plate 52

Plate 53

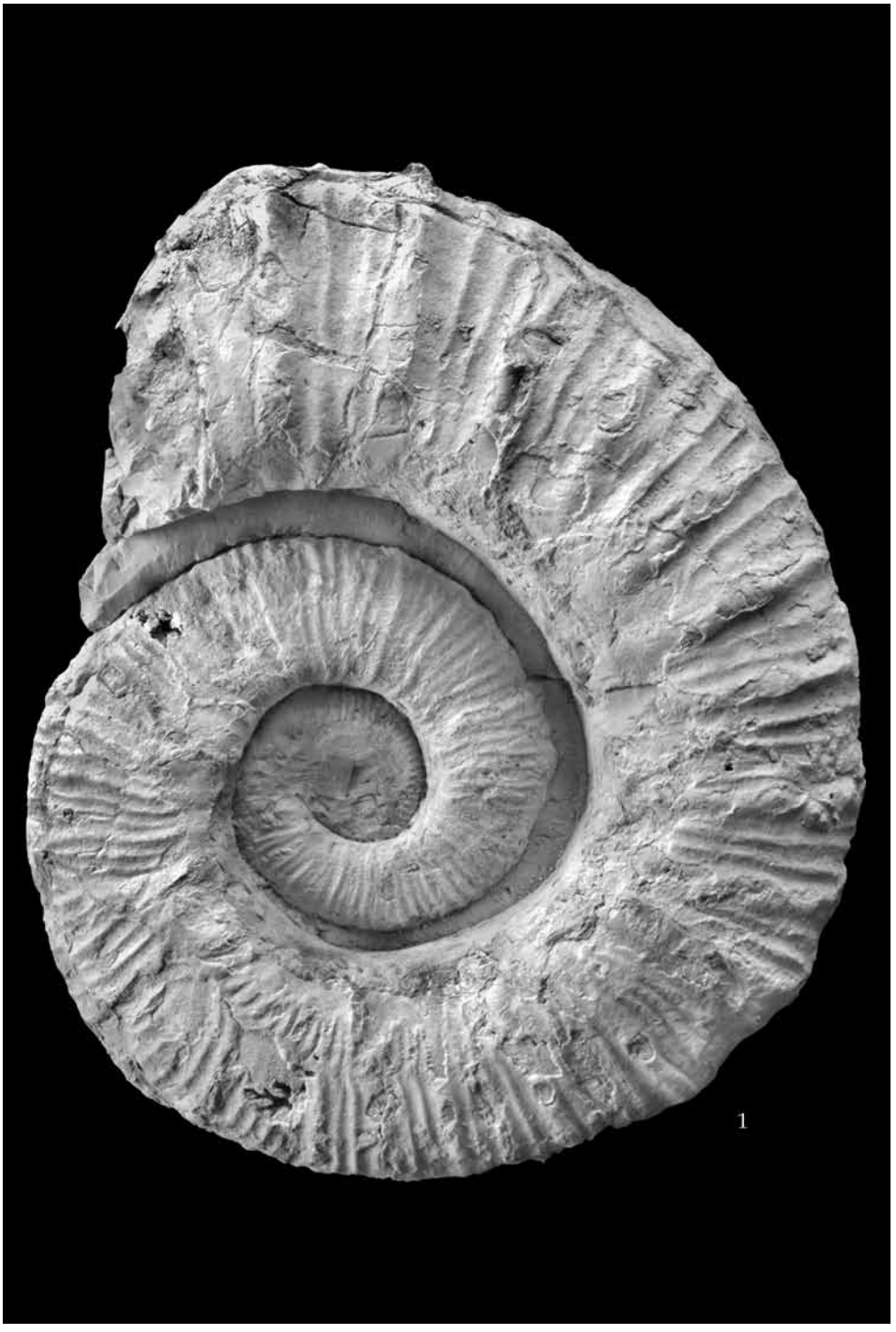

Plate 54

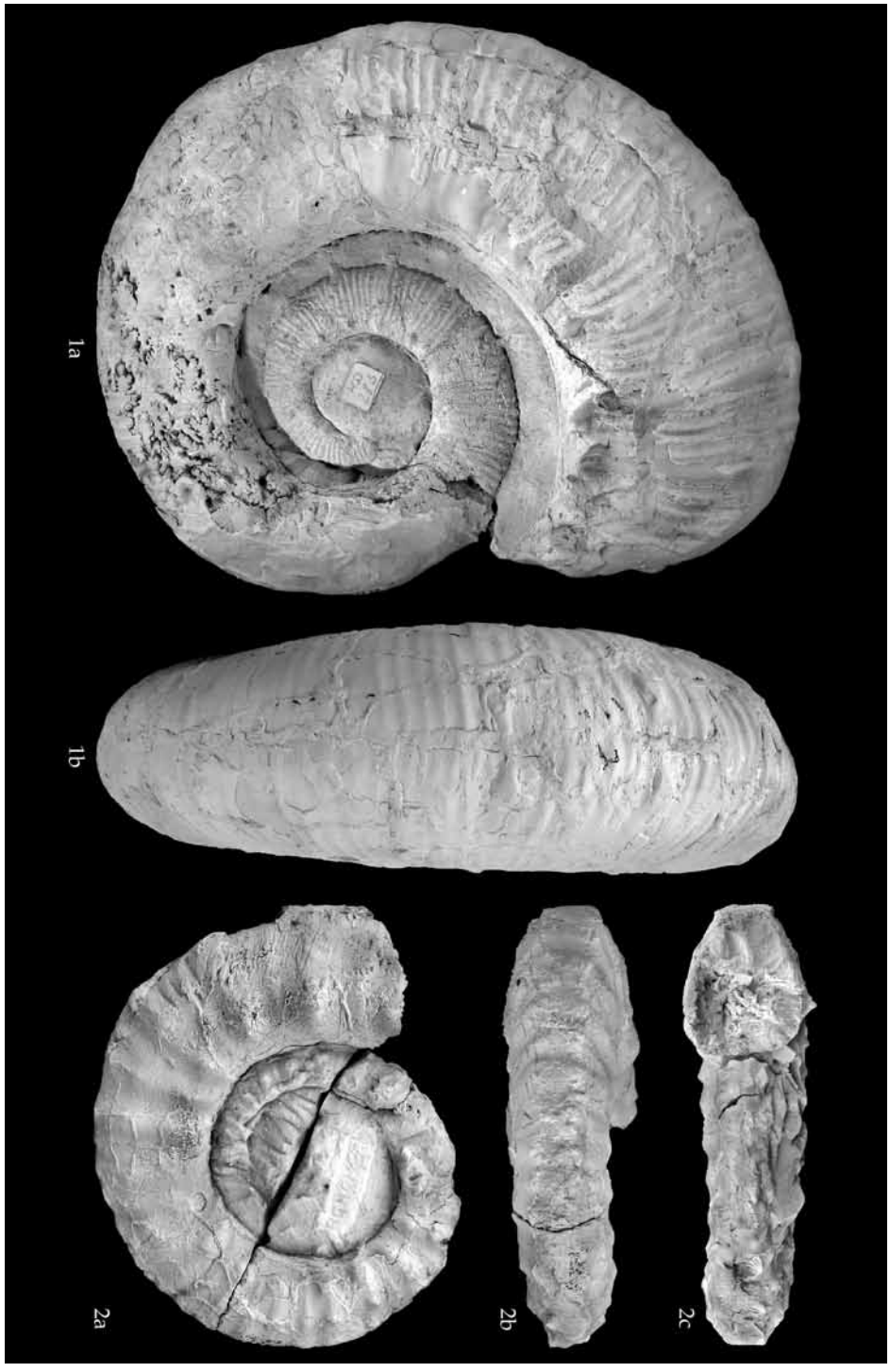

Plate 55

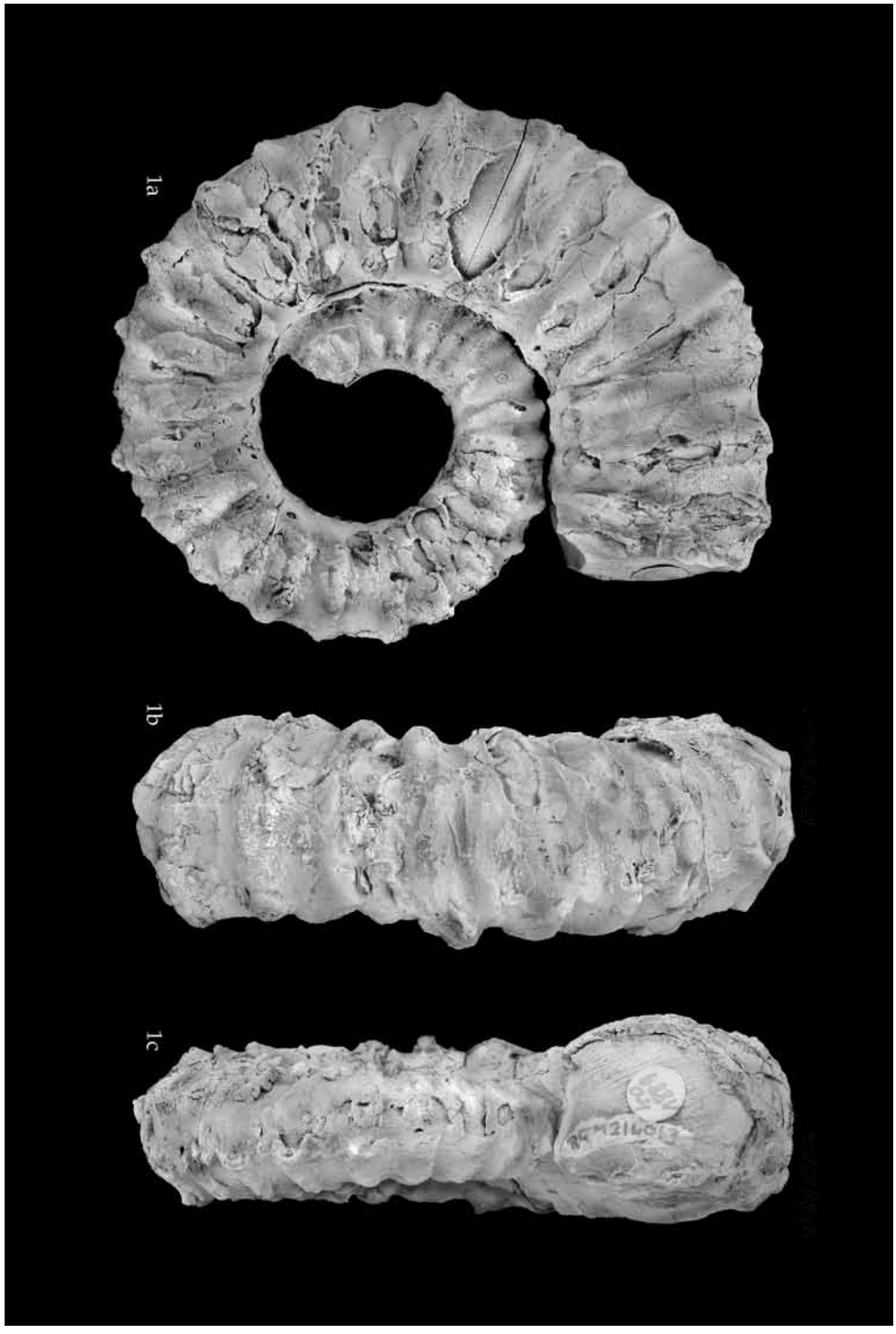

Plate 56

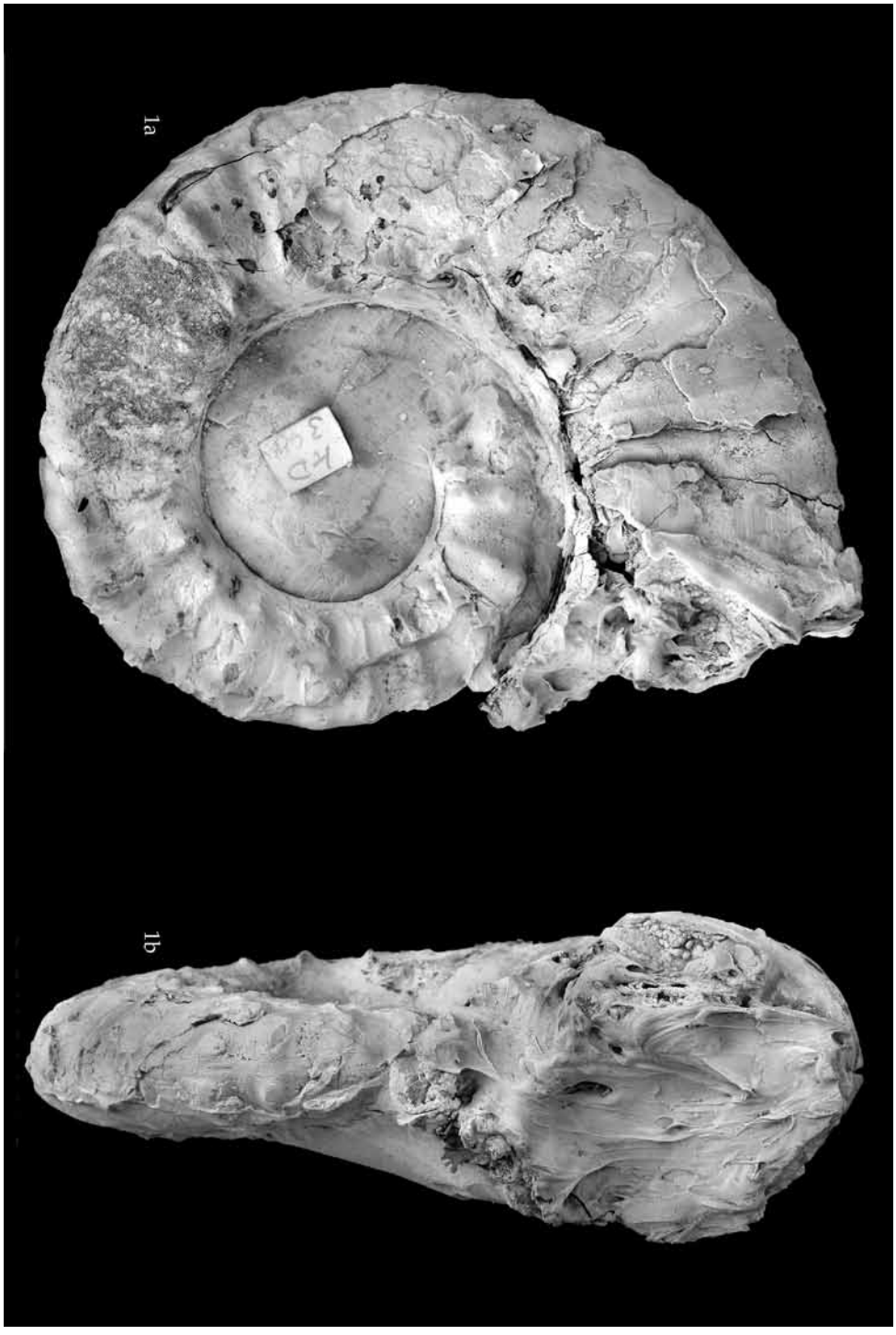

Plate 57

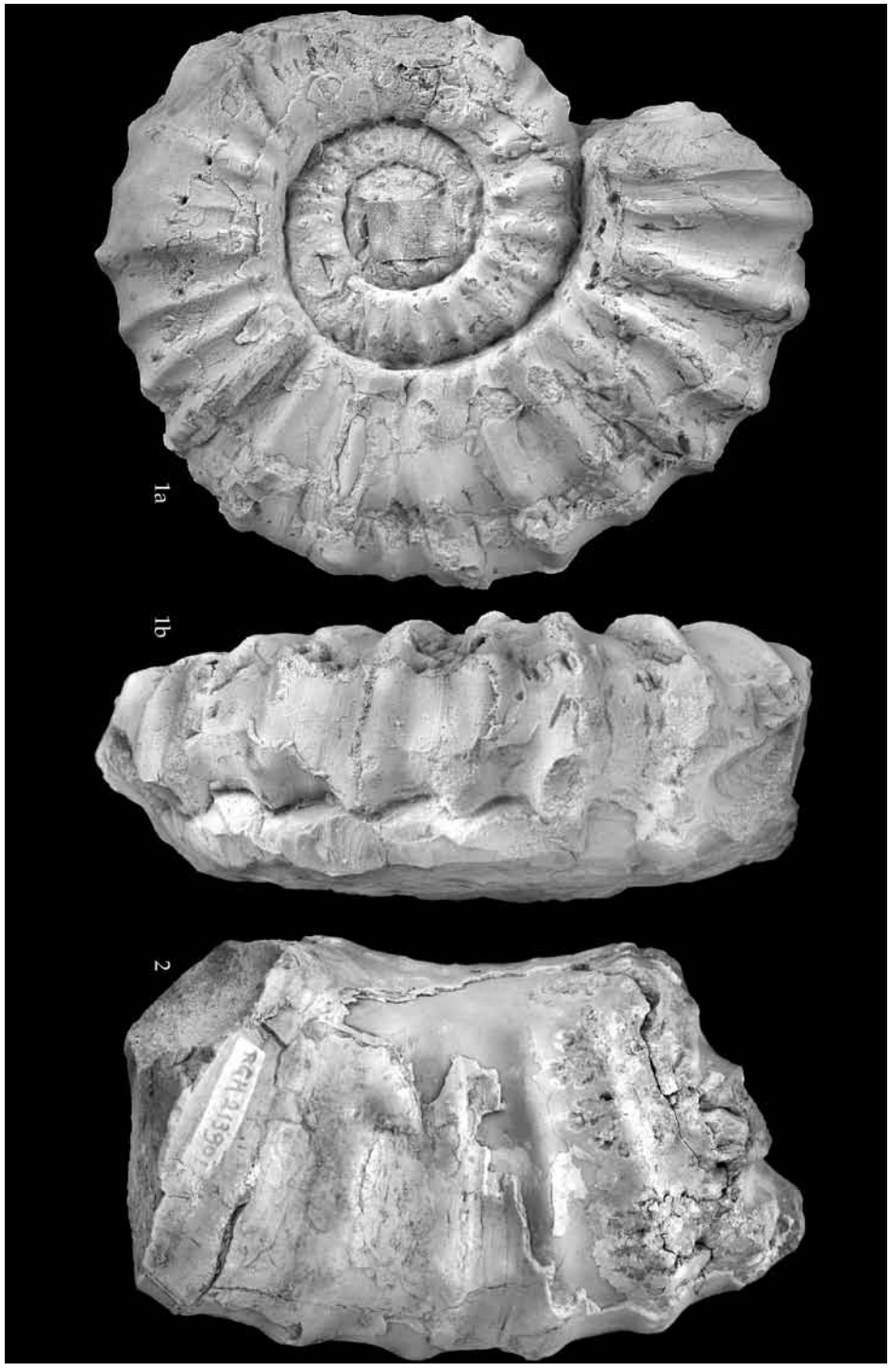

Plate 58

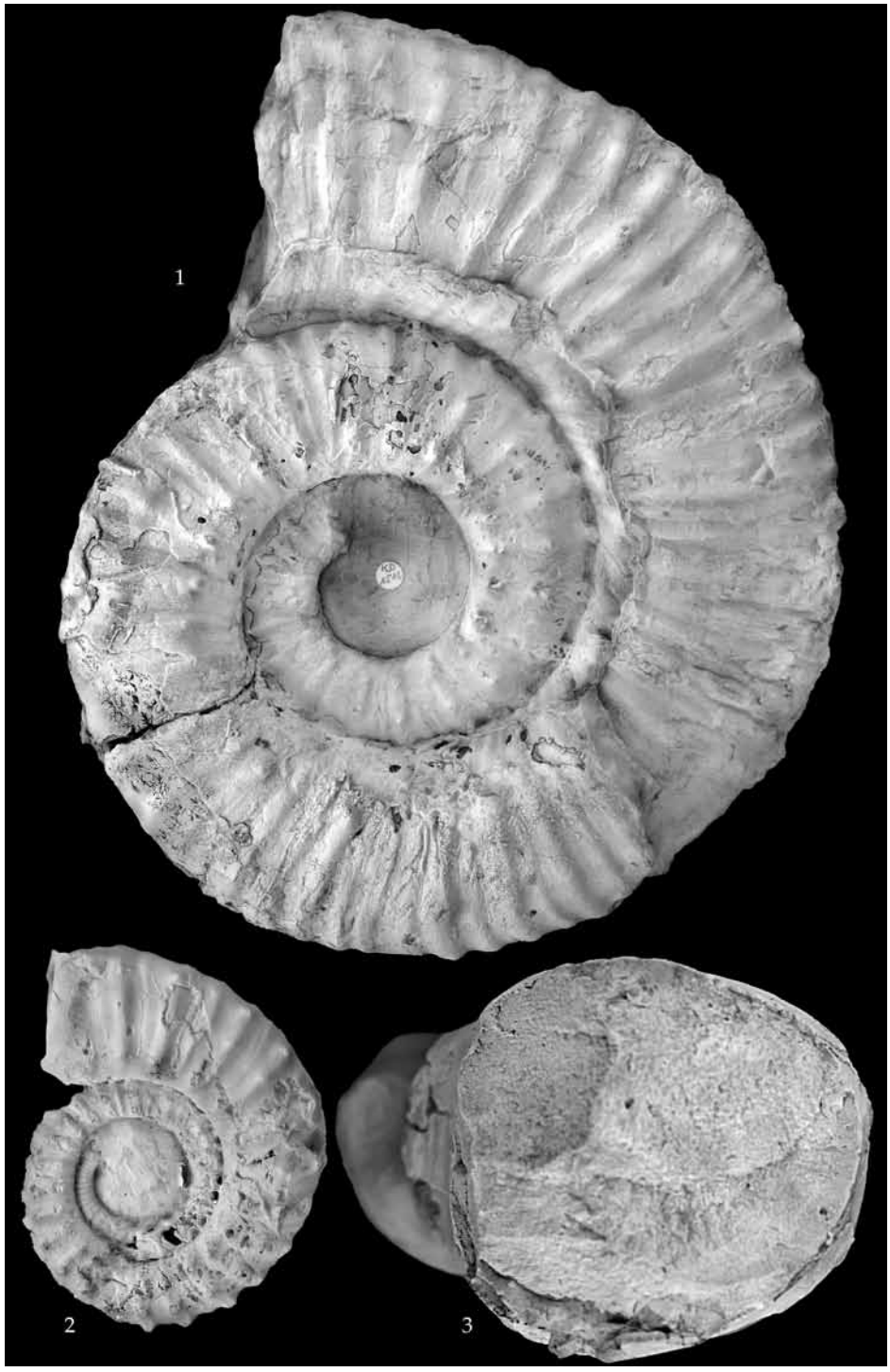

Plate 59

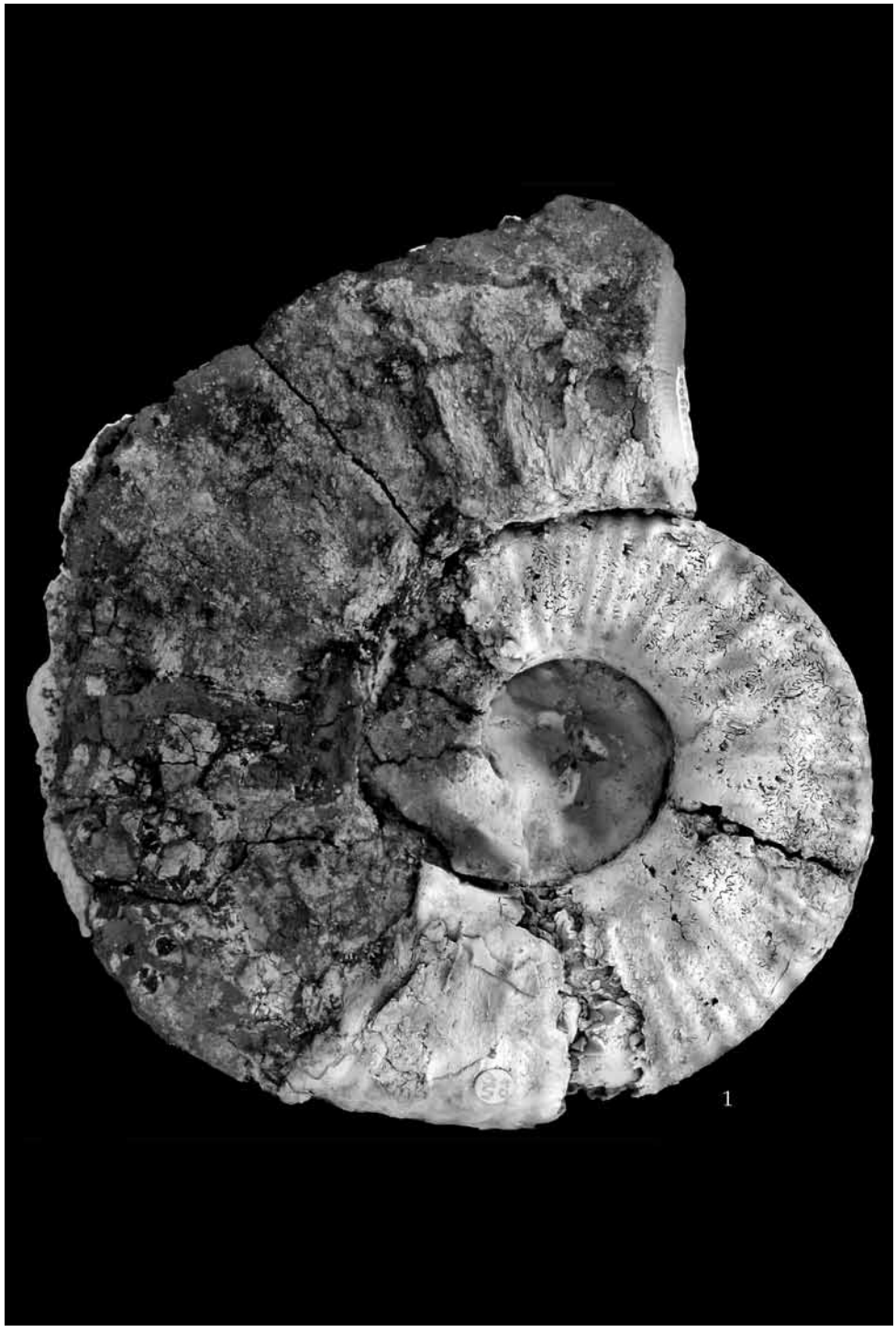

Plate 60

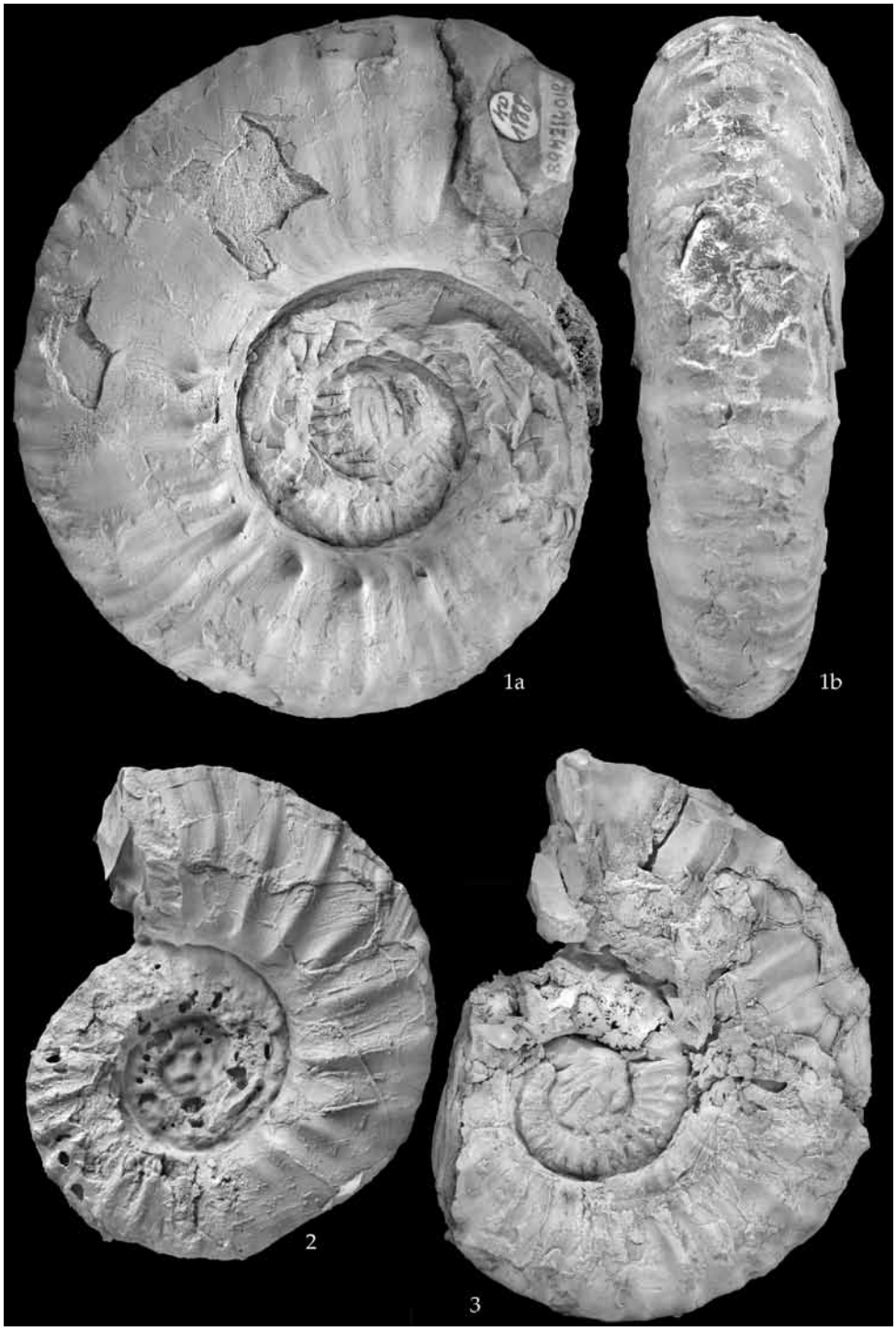

Plate 61

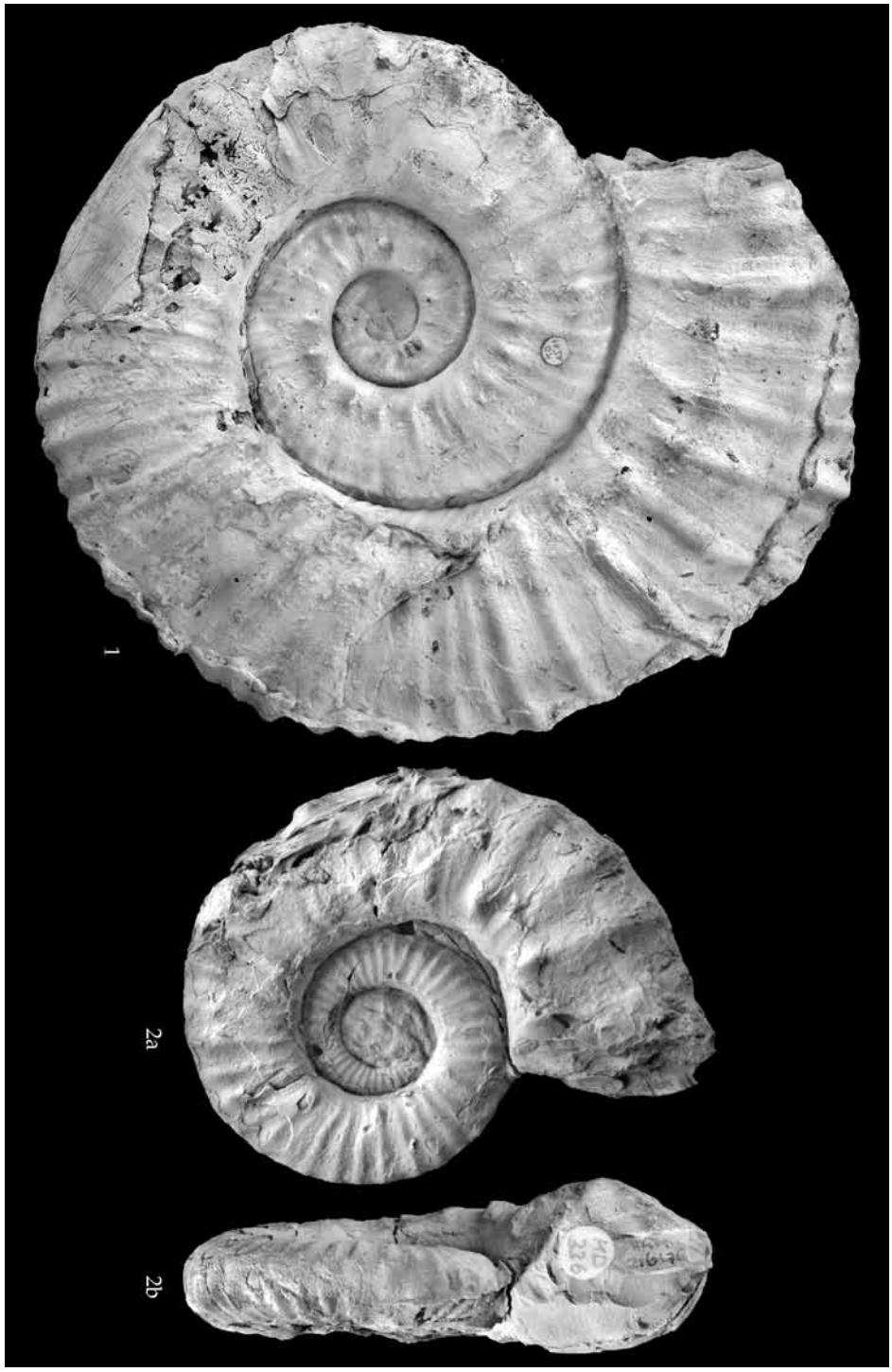

Plate 62

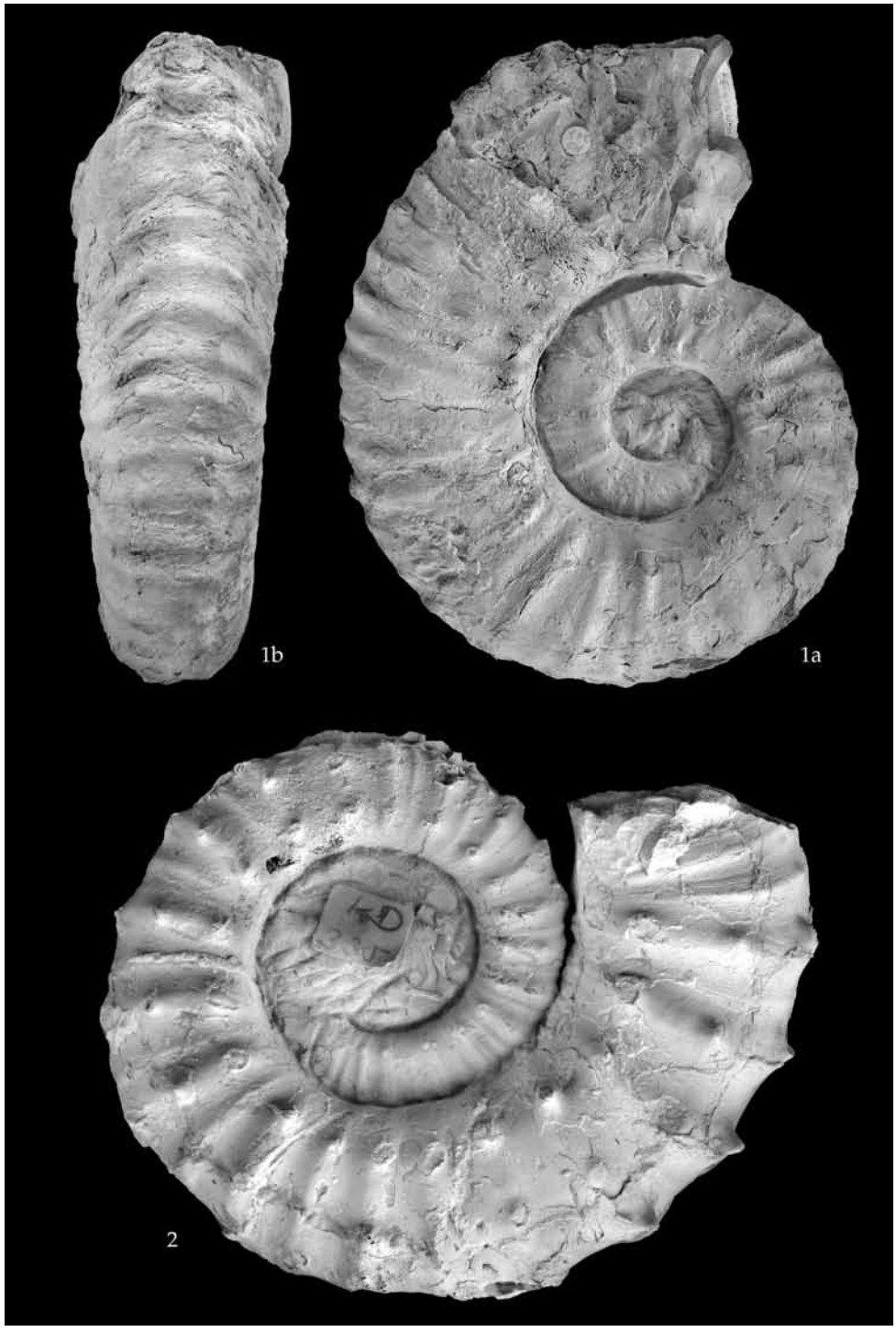

Plate 63

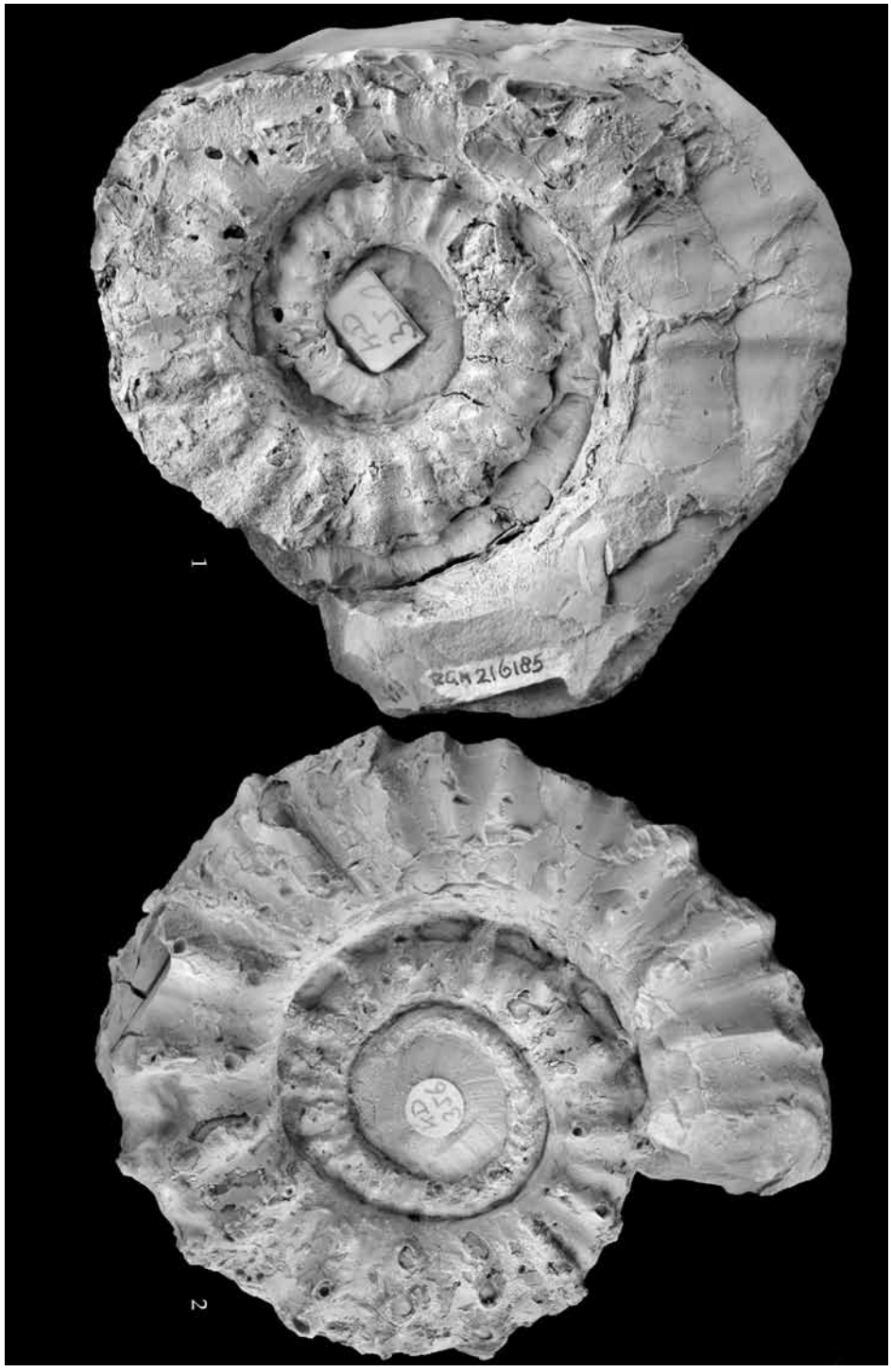

Plate 64

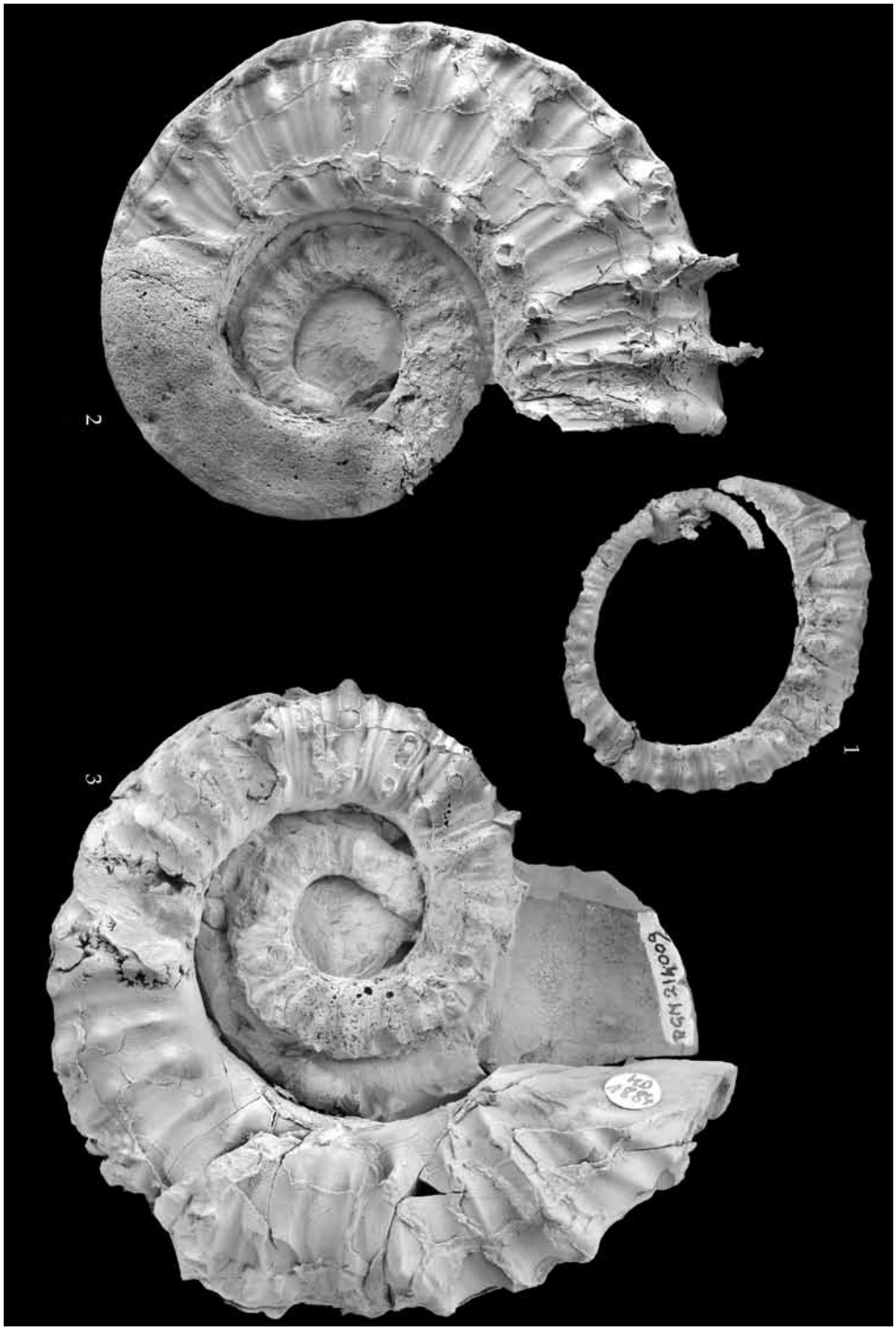

Plate 65

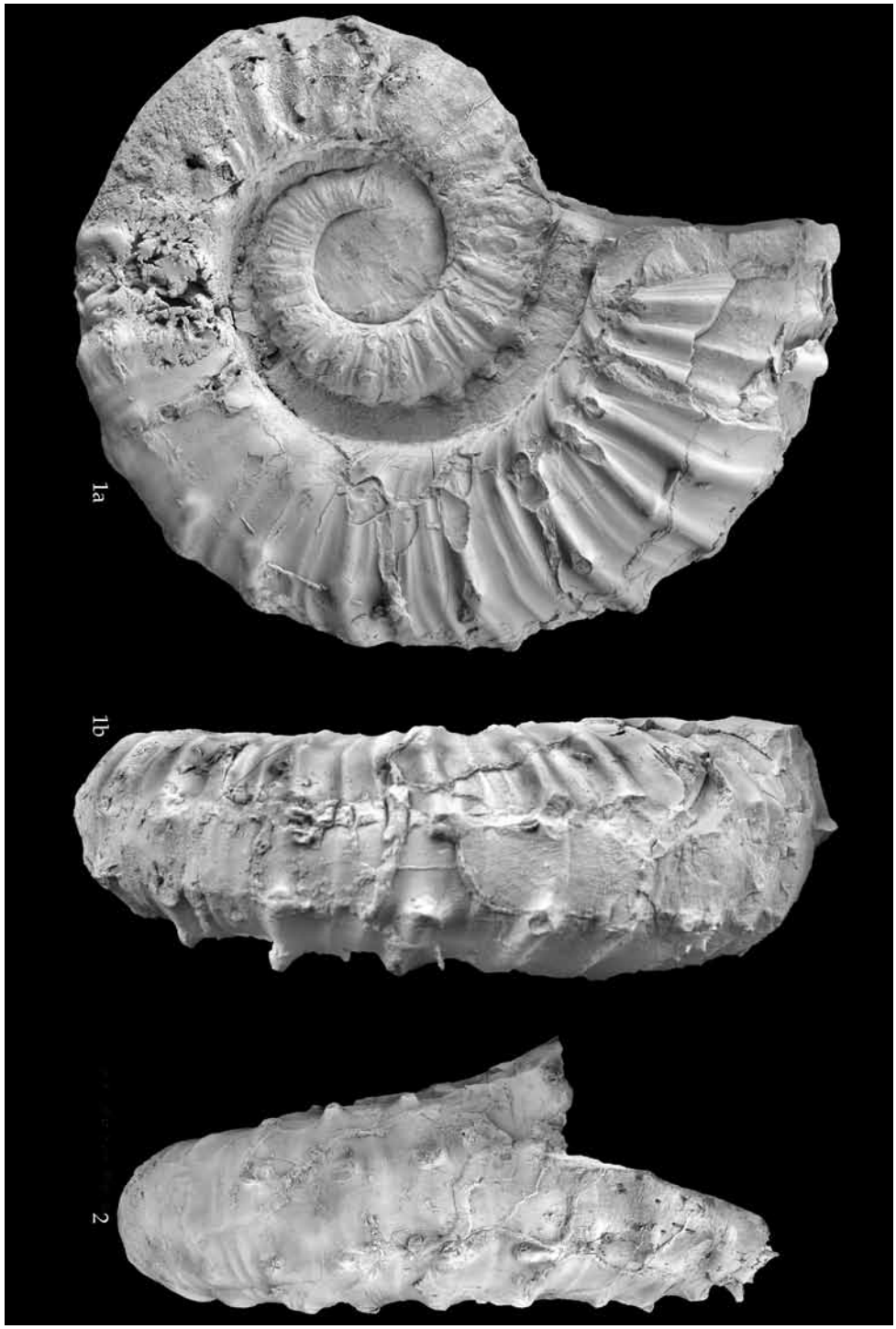

Plate 66

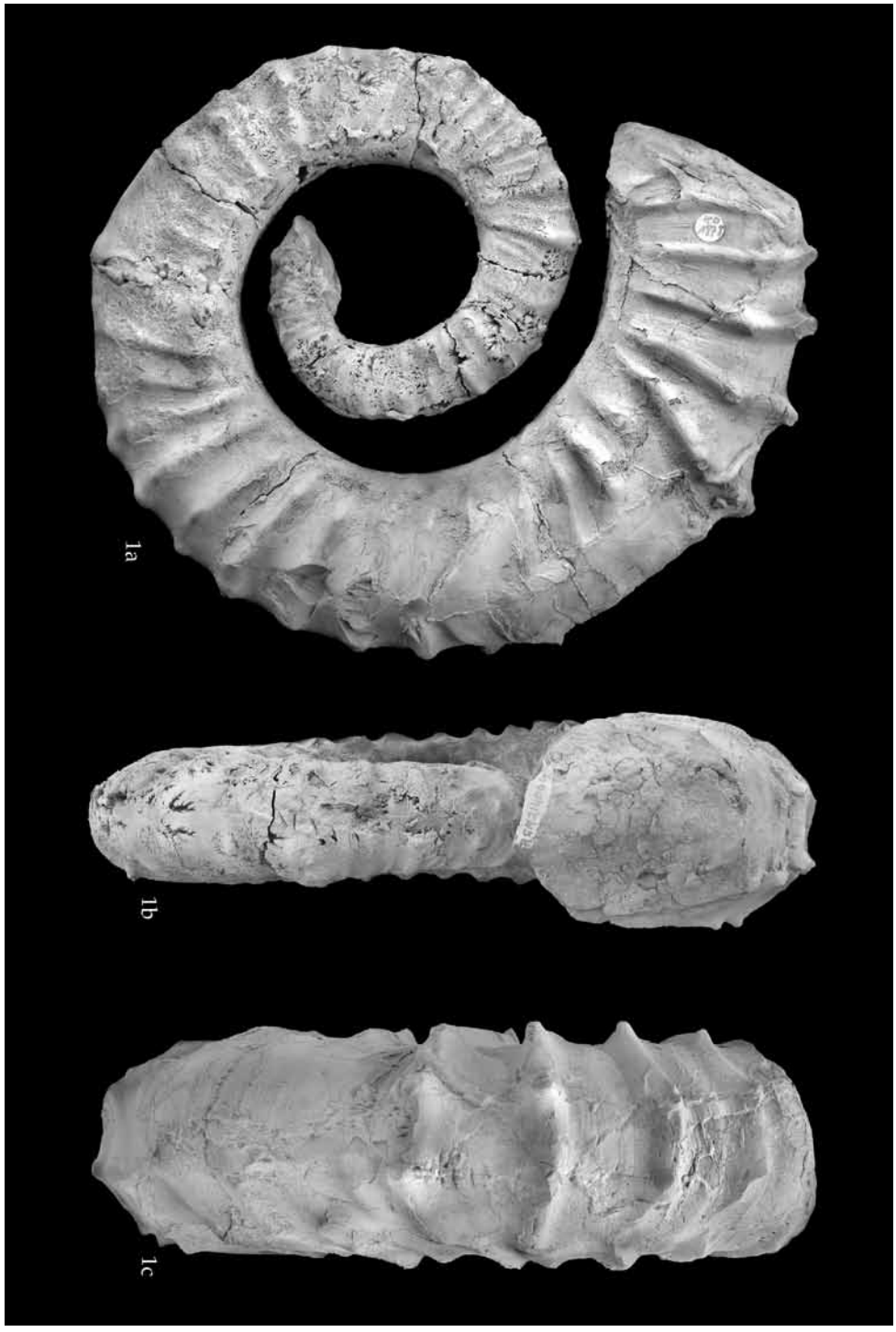

Plate 67

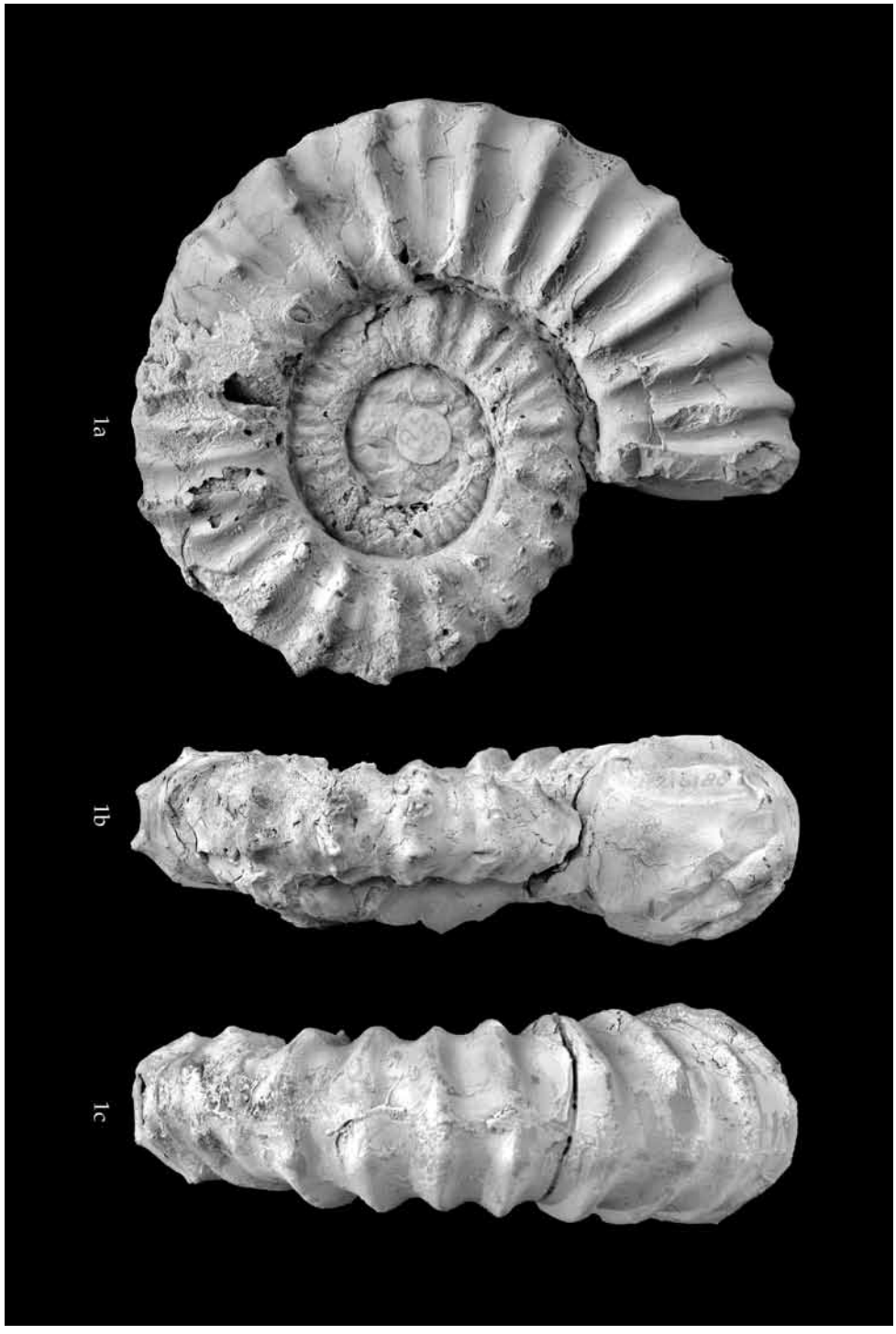

Plate 68

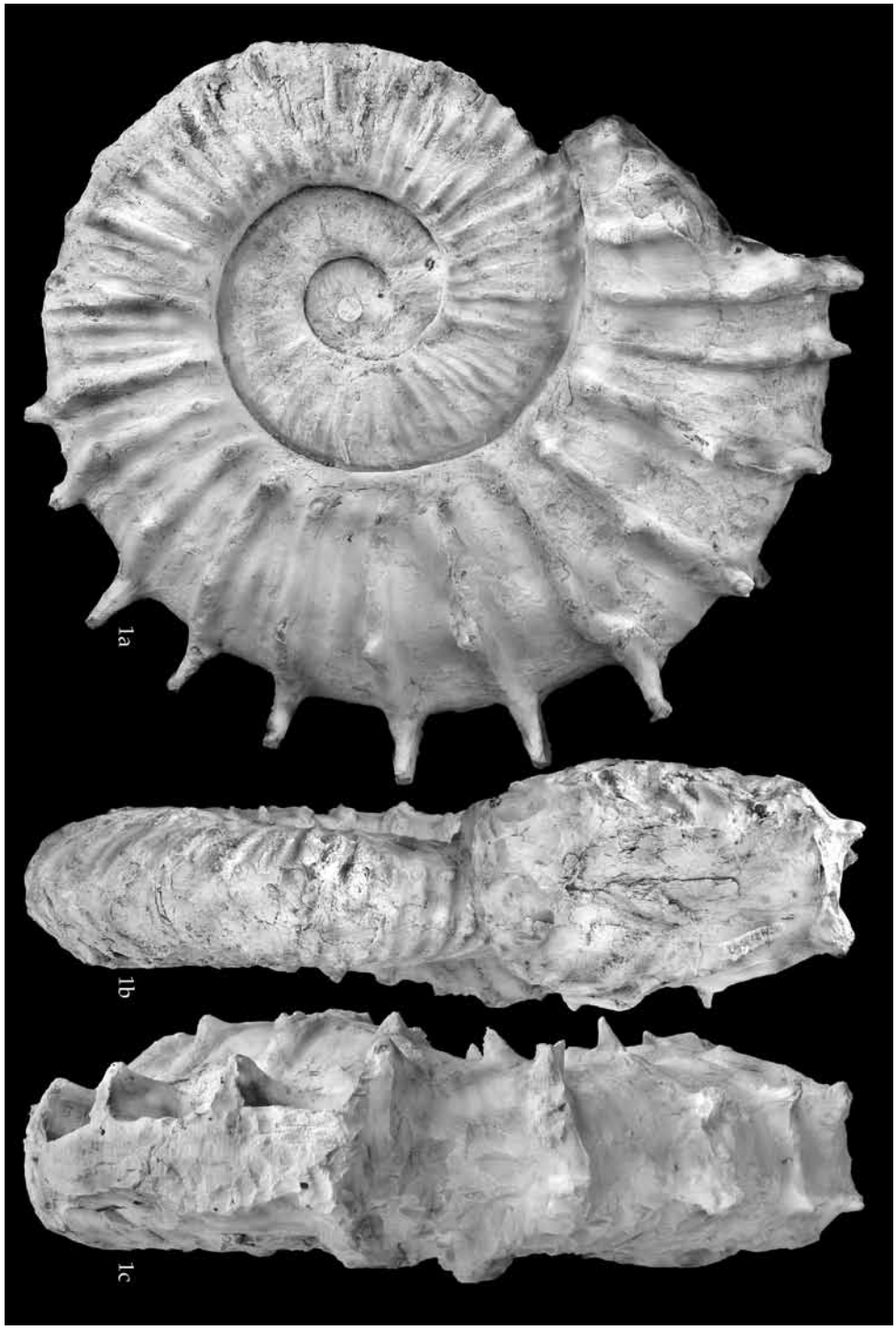

Plate 69

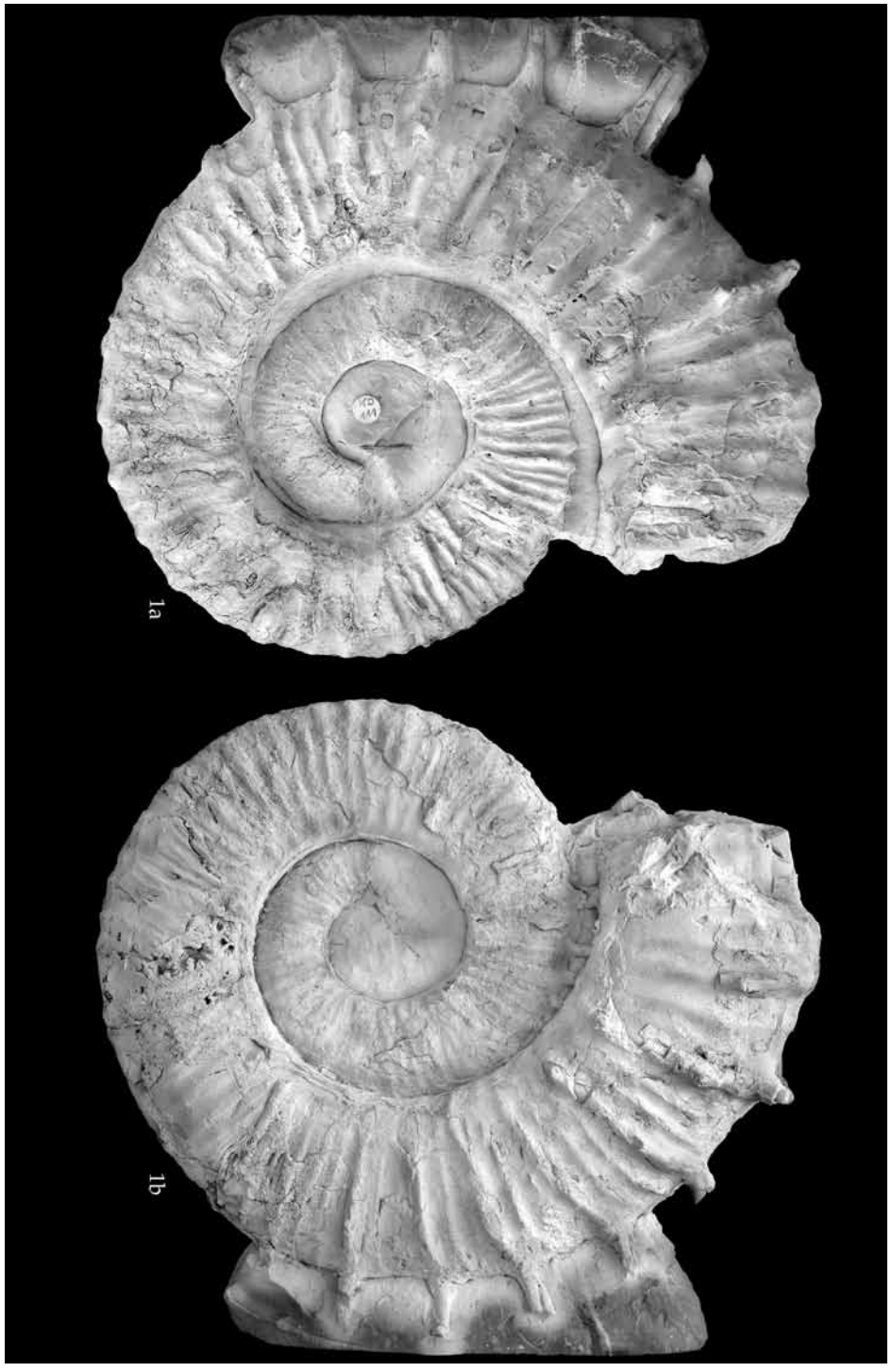

Plate 70

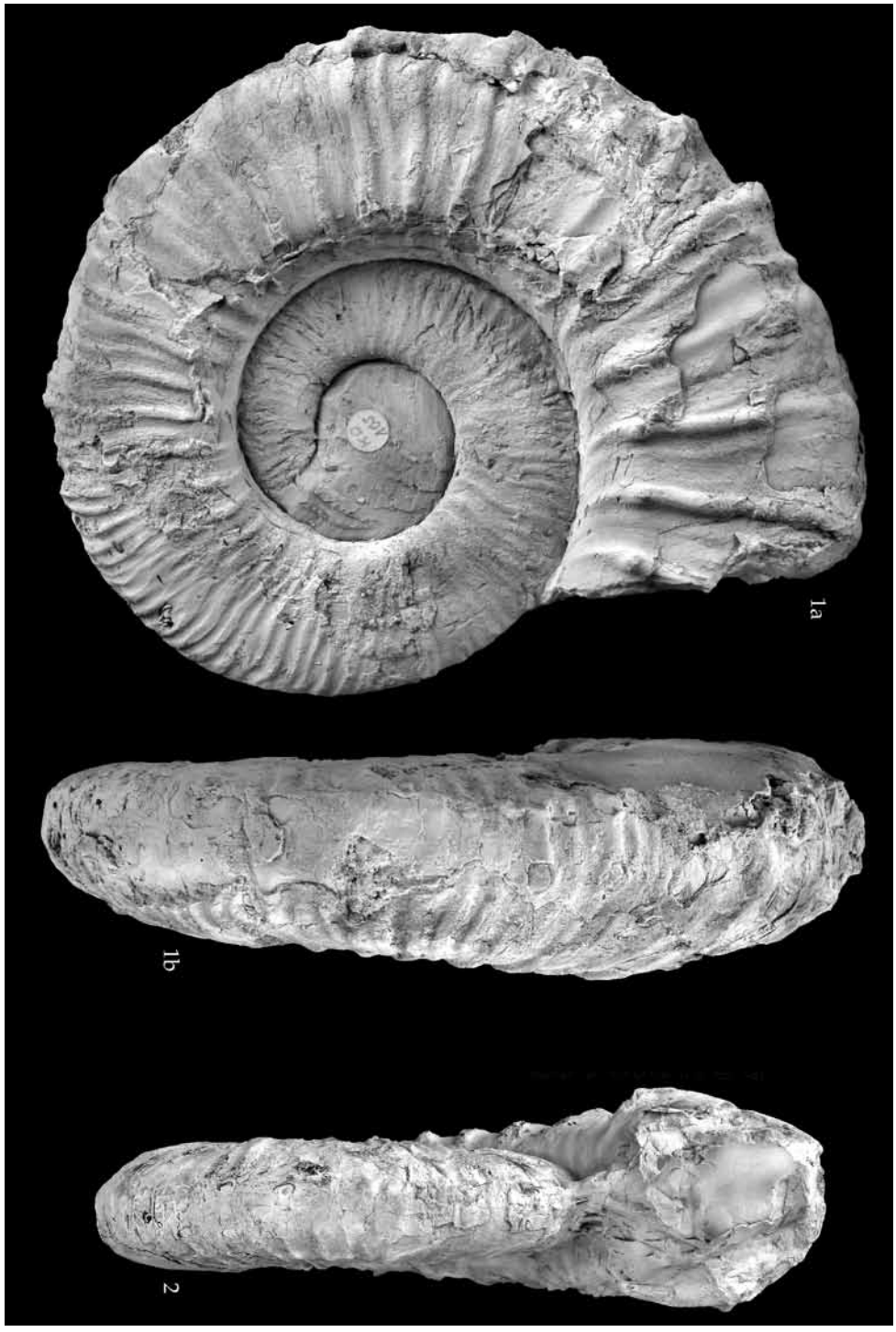

Plate 71

Plate 72

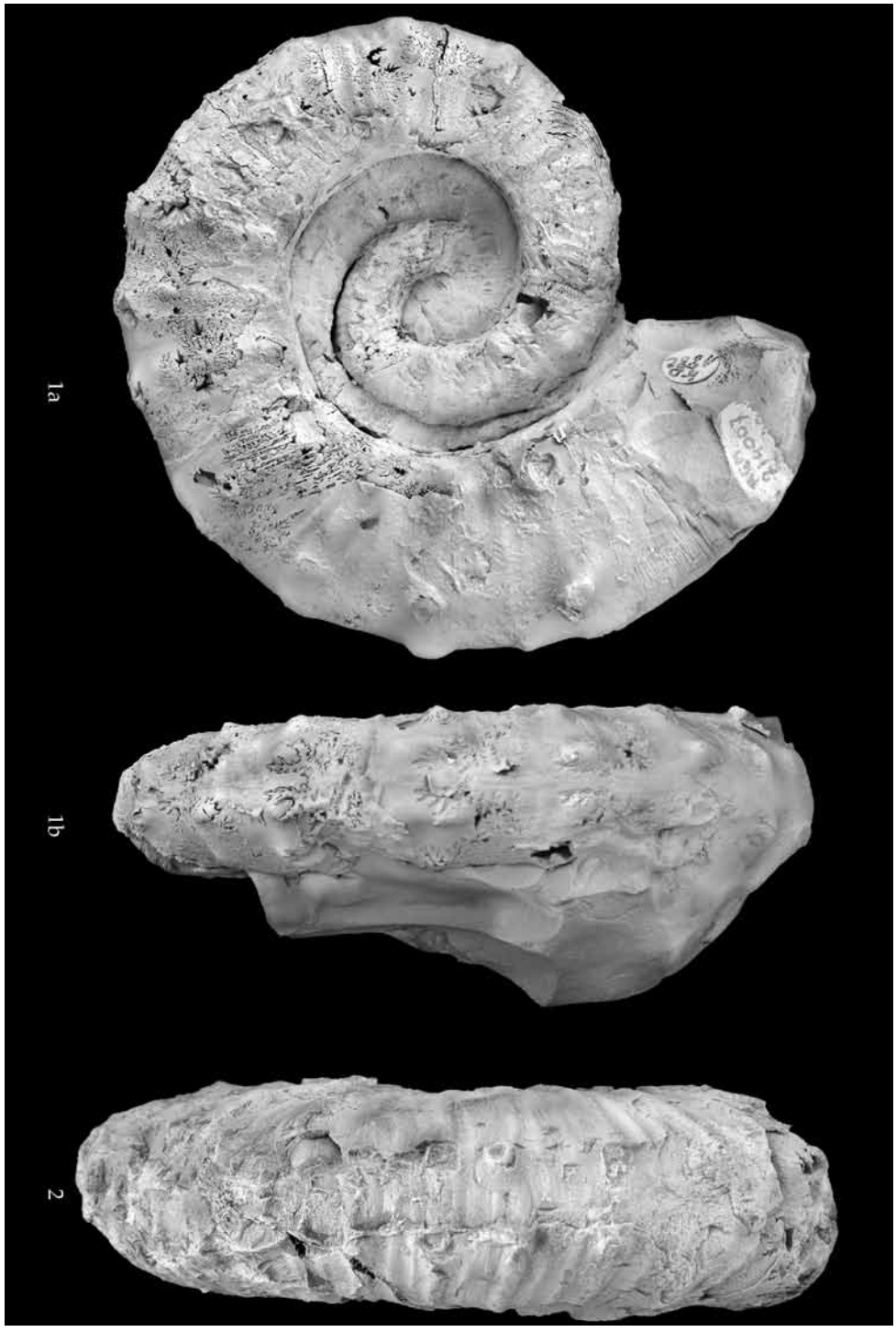

Plate 73

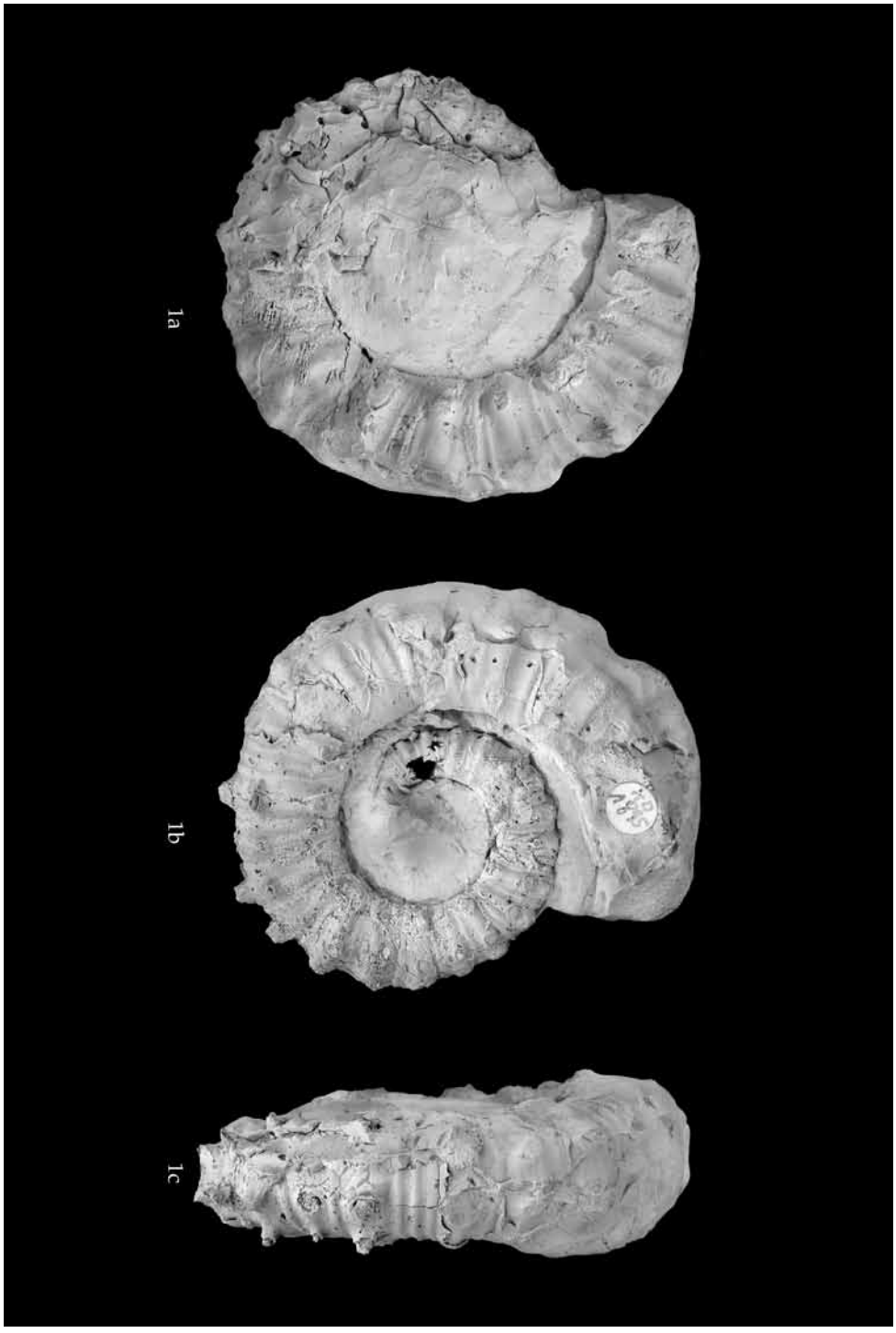

Plate 74

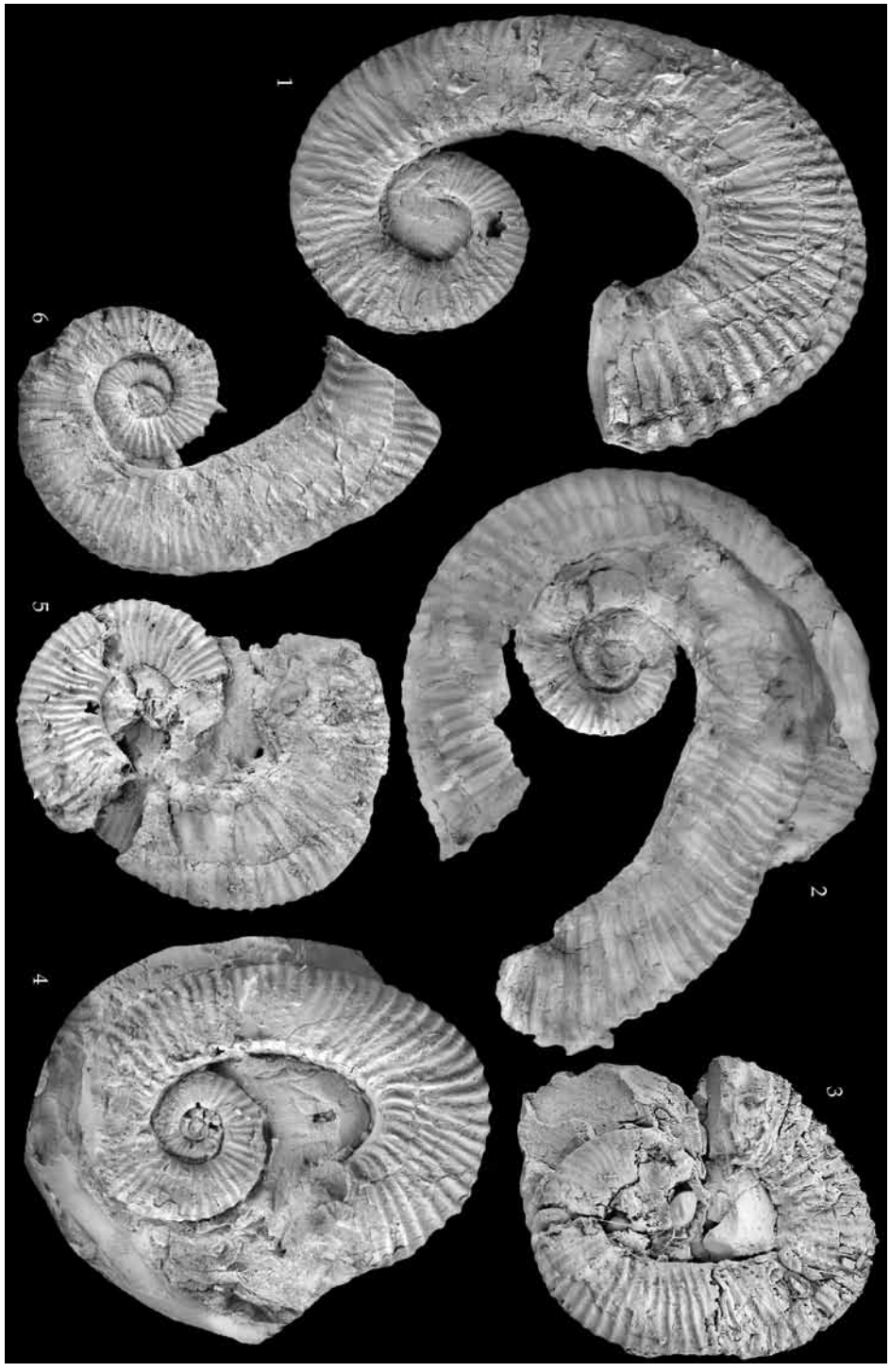

Plate 75

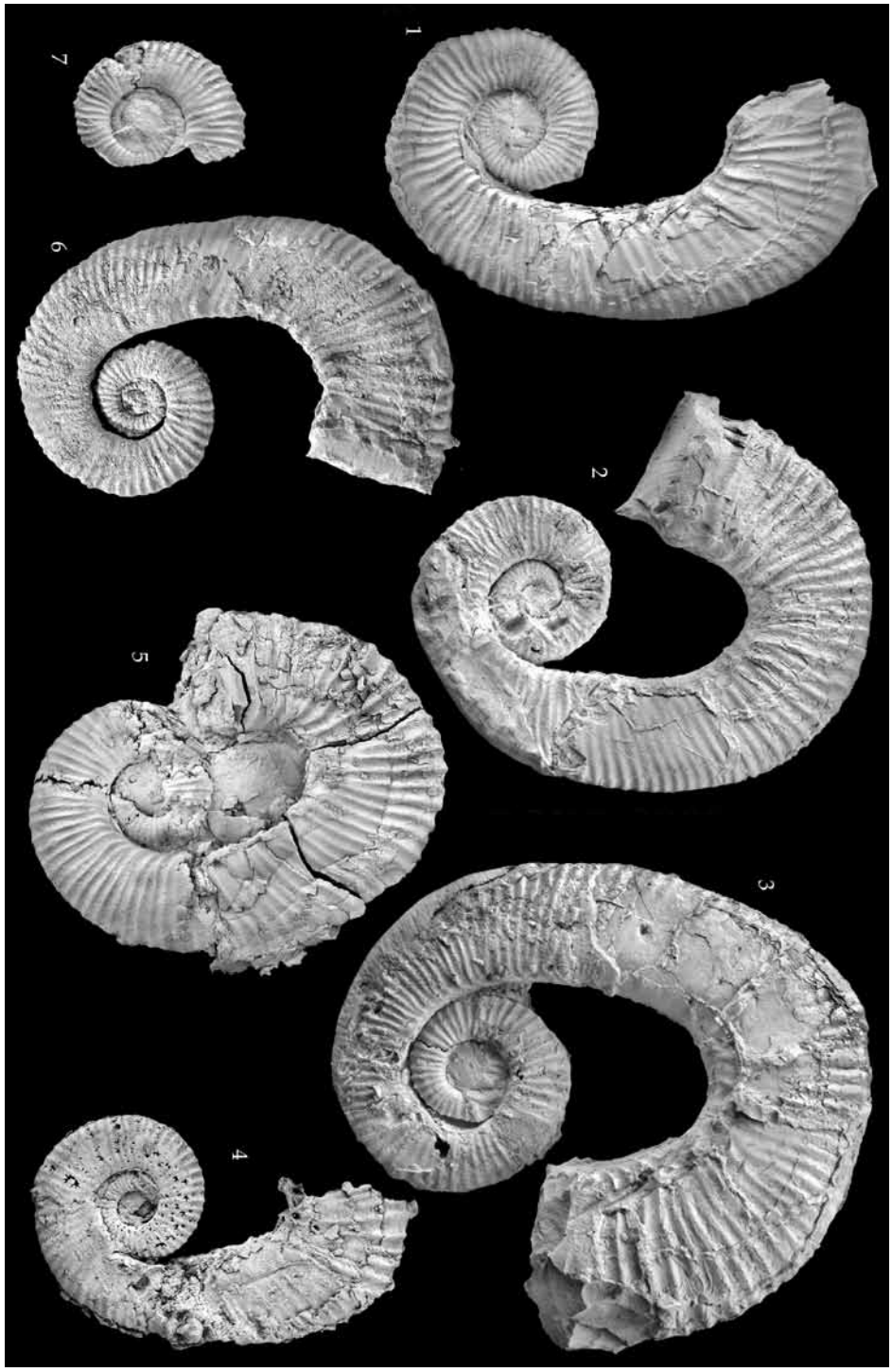

Plate 76

Plate 77

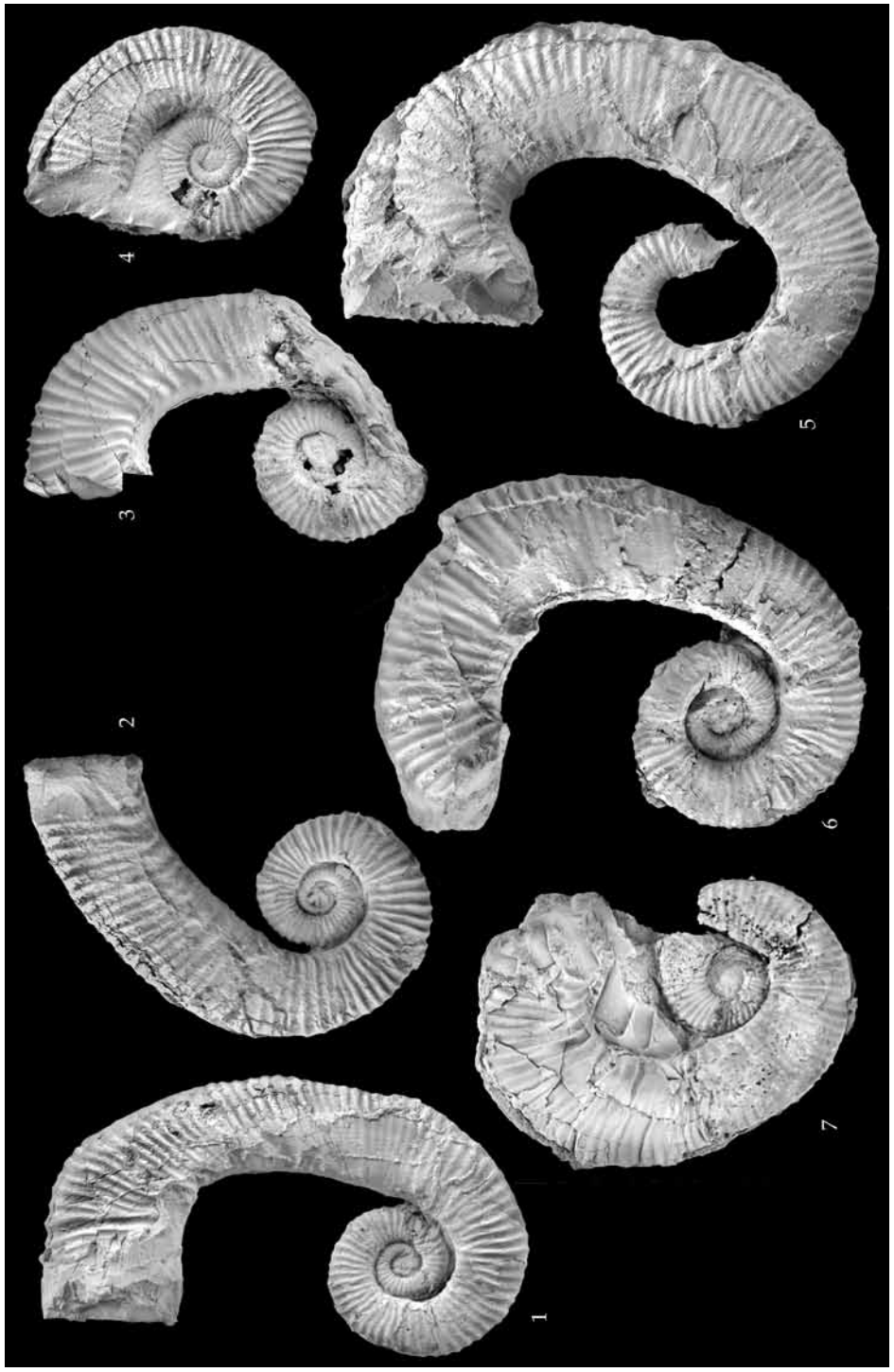

Plate 78

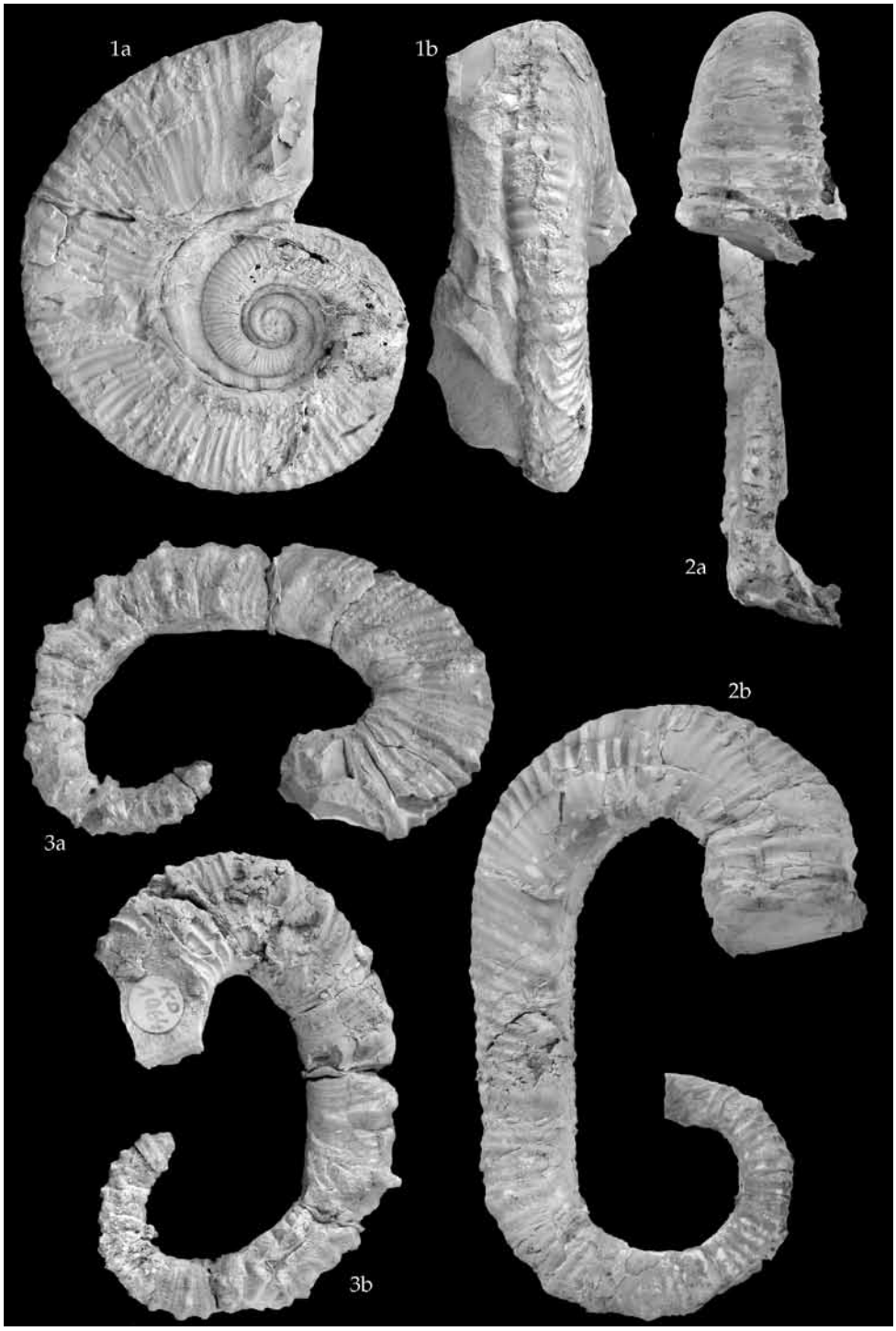

Plate 79

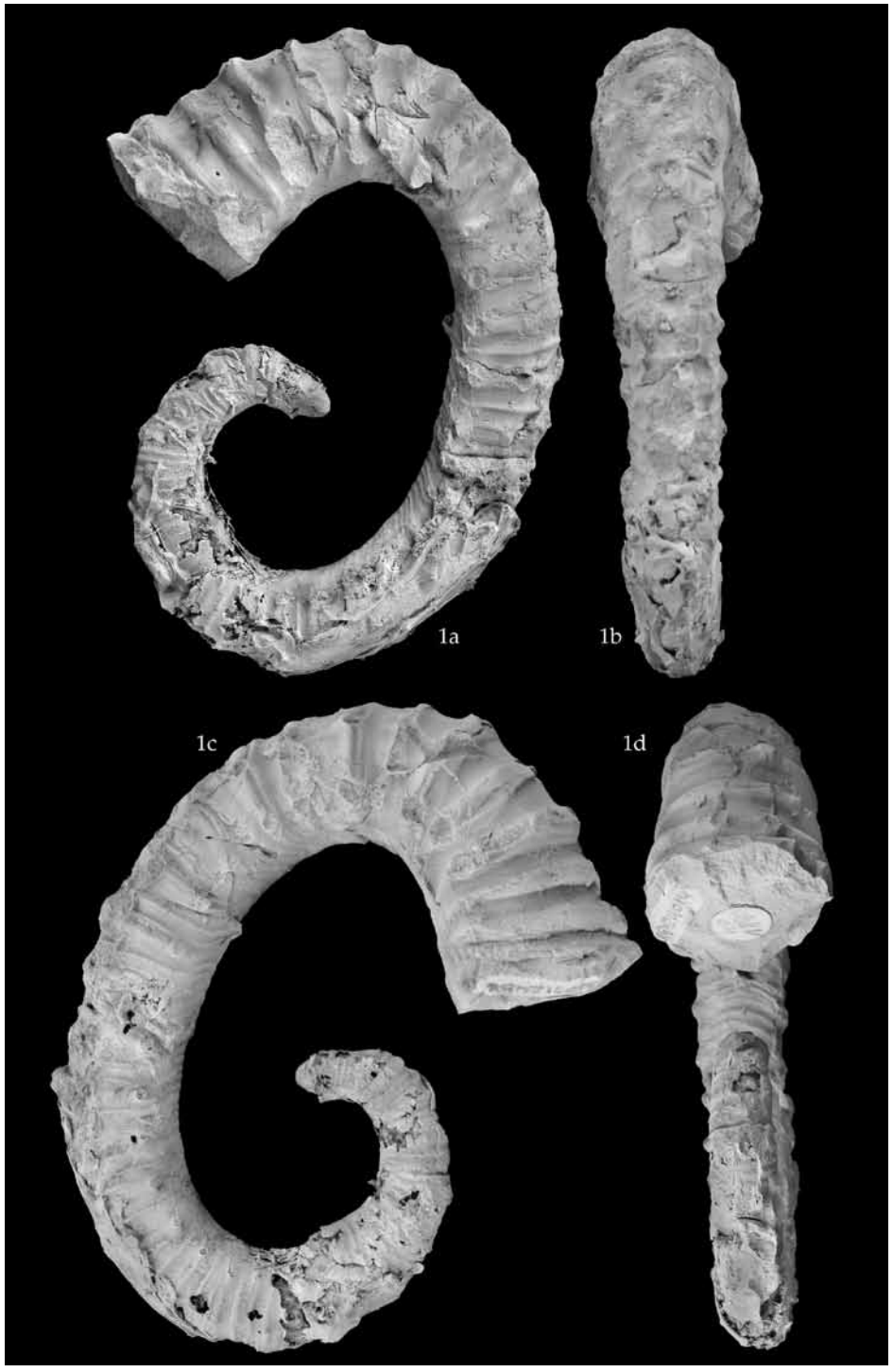

Plate 80

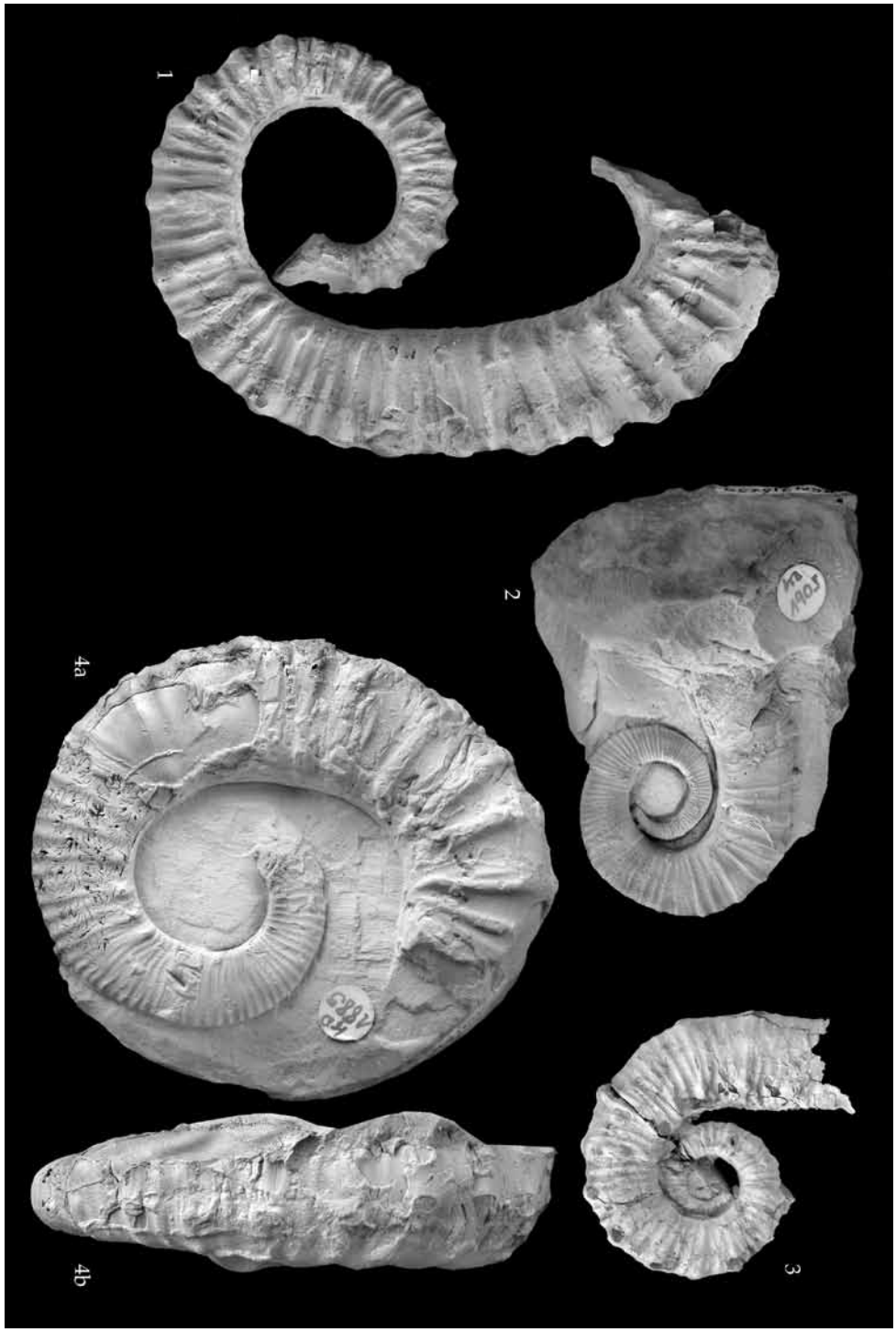

Plate 81

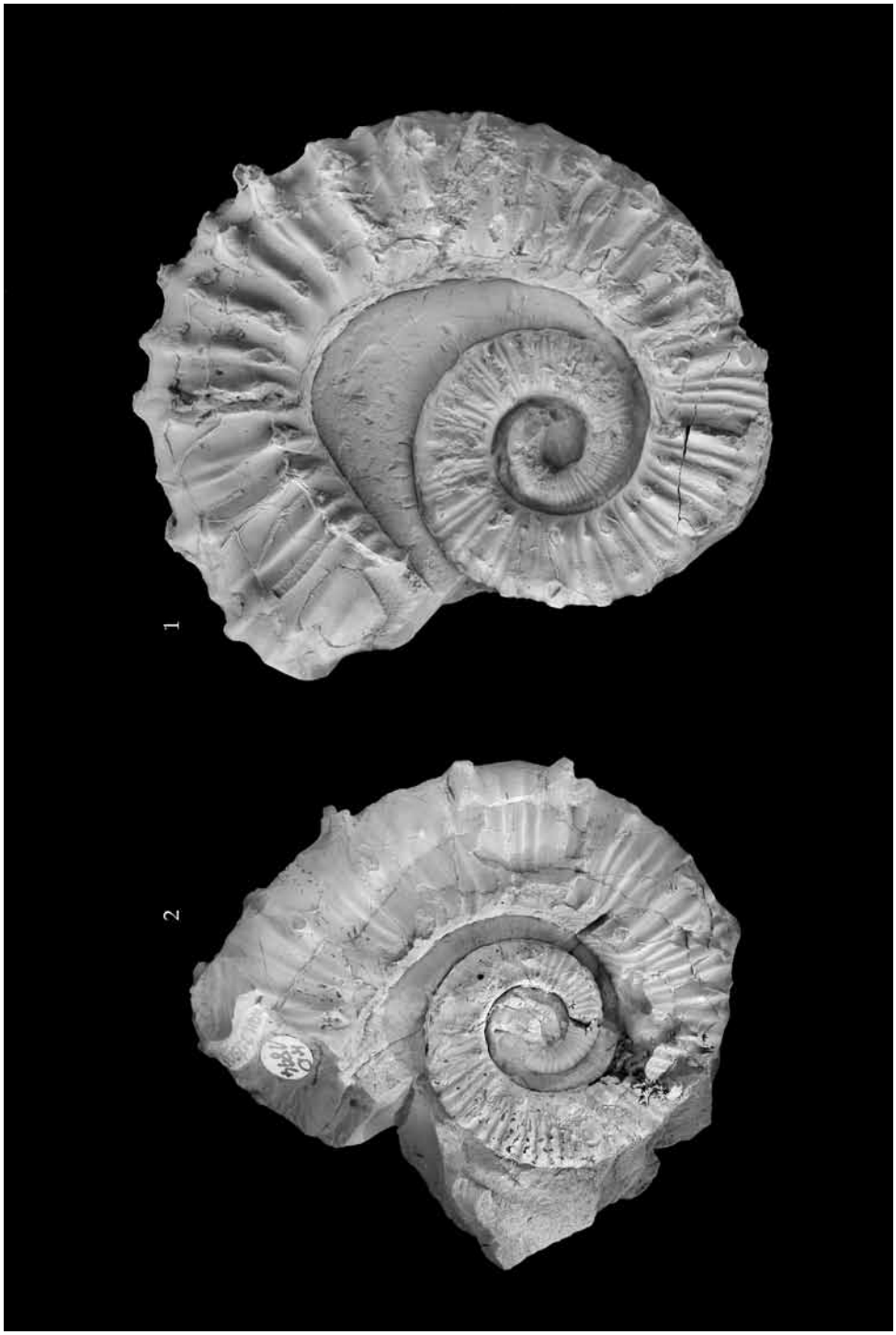

Plate 82

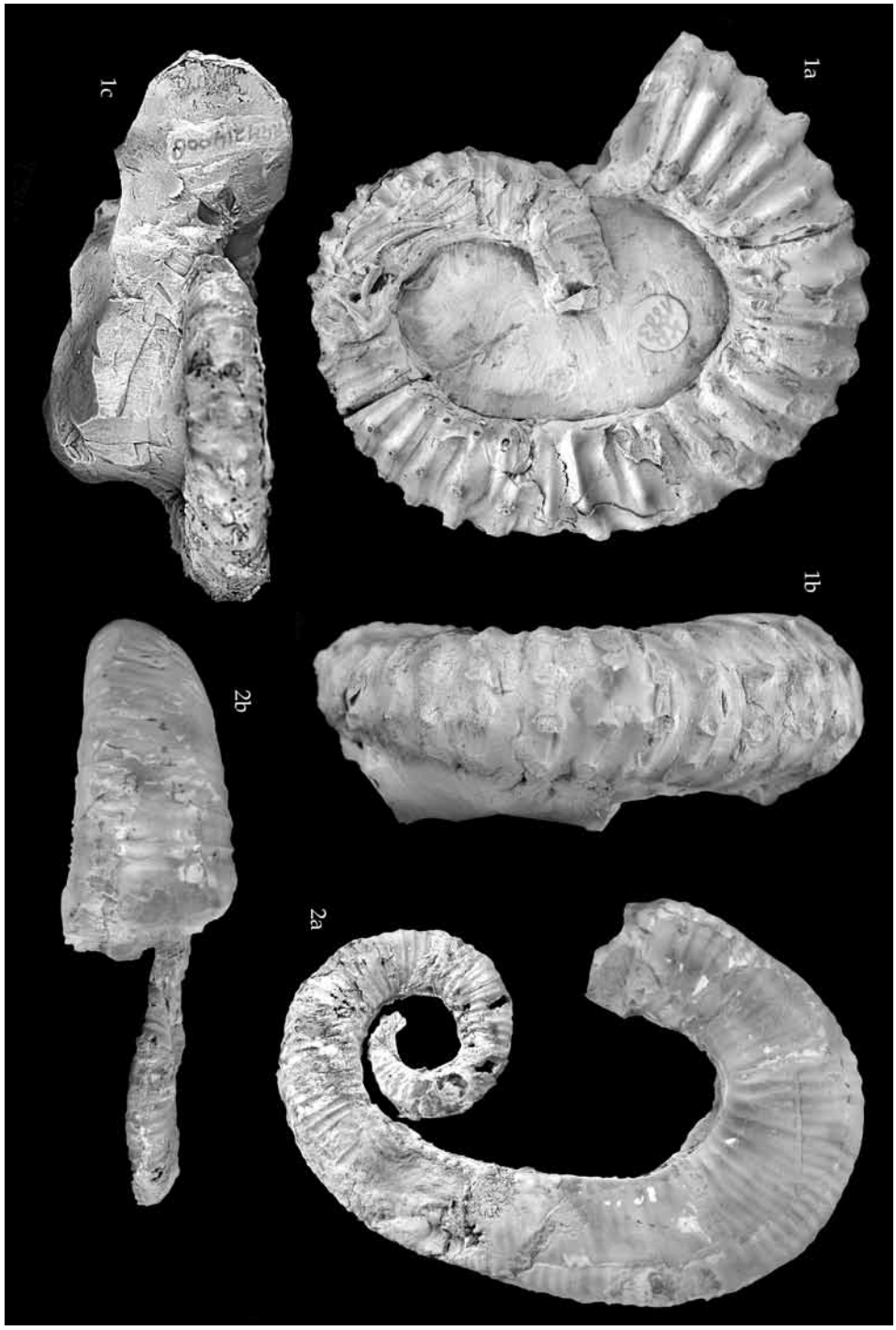

Plate 83

Plate 84

Plate 85

Plate 86