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The ammonite assemblage of the planula Biohorizon (Early Kimmeridgian, Planula Zone) in the Upper Jurassic of SW Germany

Herbert Jantschke & Günter Schweigert

Abstract

The ammonite assemblage of the *planula* Biohorizon (Early Kimmeridgian, Planula Zone) is studied in detail, mainly based on bed-by-bed collected specimens from the Wohlgeschichtete-Kalke Formation of the Plettenberg Quarry near Balingen (western Swabian Alb) and some additional specimens from coeval beds of the former Schneider Quarry at Spielberg am Hahnenkamm (southwestern Franconian Alb). Within the Upper Jurassic of Southern Germany, the *planula* Biohorizon is one of the few well-characterized biohorizons of the Lower Kimmeridgian. Its ammonite assemblage comprises at least 16 ammonite taxa, most of which are typical of the Submediterranean or Mediterranean provinces; only few of them are of Subboreal affinity, whereas Boreal taxa are completely absent.

Keywords: Jurassic, ammonite diversity, biostratigraphy, correlation, Swabia, Franconia.

1. Introduction

The Upper Jurassic ("White Jurassic") of southern Germany is among the longest-studied Jurassic areas worldwide going back to the first decades of the 19th century (Reinecke 1818; Zieten 1830–1833). An over 450-m-thick succession of limestones and marly limestones as well as siliceous sponge-microbial mounds deposited during the Oxfordian, Kimmeridgian and Early Tithonian form the mountains of the Swabian and Franconian Alb (Geyer & Gwinner 1964, 1979; Schmid et al. 2005, 2008). In Swabia, the principal lithostratigraphic framework was outlined by Friedrich August Quenstedt, who also documented the marine faunal assemblages (Quenstedt 1843, 1856–1857), with a focus on ammonites (Quenstedt 1887–1888). Despite this long period of examination and contemporeaneous geological mapping activities, detailed biostratigraphic research was neglected. Quenstedt himself doubted the possibility of further subdividing the Upper Jurasic rocks by means of ammonites, and even Oppel failed to correlate precisely various European Upper Jurassic beds within his zonal scheme (Oppel 1858) due to widespread occurrences of shallow-water deposits mostly lacking age-diagnostic fossils and increasing faunal provincialism. Some recent attempts for a biostratigraphic refinement dealt with the problematic interprovincial correlations of the base of the Kimmeridgian stage and thus focussed on the boundary beds of the Impressamergel and Wohlgeschichtete-Kalke formations (e.g., Schweigert 1995, 2000; Schweigert & Callomon 1997; Jantschke 2014; Jantschke & Schweigert 2020). We here continue with an analysis of the Wohlgeschichtete-Kalke Formation.

Biostratigraphically, the Wohlgeschichtete-Kalke Formation has been very poorly studied in the past, although there exist plenty of outcrops all along the steep northern escarpment of the Swabian Alb and along the deeper valleys cutting into the Upper Jurassic rocks. The main reason for this ignorance is that the bedded mudstones of the Wohlgeschichtete-Kalke Formation are very poor in macrofossils when compared with under- and overlying formations. Ammonites are often incomplete and fragmented due to predatory activities (Hölder 1955a). The most comprehensive dataset is still to be found in a single thesis dedicated to the Wohlgeschichtete-Kalke Formation (Dieterich 1940). In the latter one, however, only few ammonites were illustrated. Unfortunately, being one of the main literature sources, this deficiency has led to erroneous correlations with other European regions and triggered the long-lasting assumption of an Oxfordian age of this formation (e.g., Arkell 1956; Geyer 1961; Geyer & Gwinner 1964, 1979; Ziegler 1987). Other relevant studies on ammonites are covering the lower part of the Upper Jurassic in Franconia (Wegele 1929; Nitzopoulos 1974; Schairer 1983, 1984, 1989) add further data to the herein described biohorizon.

2. Stratigraphy and studied sections of the Wohlgeschichtete-Kalke Formation

The Wohlgeschichtete-Kalke Formation (= Weißjura β of Quenstedt) is a rather uniform rock unit that consists of well-bedded light-coloured limestone beds. The individual limestone beds of this formation have mean thicknesses of 20–40 cm; thus, outcrops of this formation

strongly resemble an artificial wall. In general, the beds are mostly creme- or whitish coloured and are separated from each other either by very thin marly beds or by diagenetically formed styloliths. In some parts of the Swabian Alb the Wohlgeschichtete-Kalke Formation forms a wide plain with a steep escarpment towards the north and a more moderate rise towards the south; however, this is not the case in the Lochen area, where the herein studied Plettenberg Quarry is located (Fig. 1).

In the Plettenberg Quarry (Fig. 2) *c.* 30 metres of the Wohlgeschichtete-Kalke Formation are exposed. Biostratigraphically, this part of the section represents the (lower) Planula Zone (Fig. 3). The upper part of this formation, which comprises the Galar Subzone, is eroded at the Plettenberg hill. This erosion must have happened during Pleistocene times since some large boulders originating most likely from the Galar Subzone still occur along the hillsides. The subzonal index *Sutneria galar* (Oppel, 1863) itself, however, has not been recorded there (pers. comm. F. Lörcher, Dotternhausen).

In the Lochen area, the Wohlgeschichtete-Kalke Formation has a mean thickness of *c.* 45 m (Fischer 1913a); however, local thicknesses may vary significantly due to different facies development. Not far away from Plettenberg Quarry, an unusually low thickness of only 20 m was reported at Unterdigisheim, whereas even 80 m were noticed at Reichenbach am Heuberg (Schweizer & Franz 1994). Intercalated sponge-microbial bioherms may locally increase the total thickness of the formation to more than 100 m, because the biohermal lithologies underwent a very early diagenetic lithification, whereas the mudstones surrounding the bioherms suffered stronger compaction. Extremely high thicknesses may also result from erroneous inclusion of parts of the underlying Impressamergel Formation, with the Bimammatumbänke Member. Explanations for this frequently happened mistake are given by Schweigert (1995) and Schweigert & Callomon (1997).

Within the Wohlgeschichtete-Kalke Formation, ammonites are more abundant in the surroundings of small-sized sponge-microbial bioherms. The herein studied material was sampled from such an environmental situation. Even at such places, the number of recordable ammonite specimens is much lower than in other biohorizons in the Upper Jurassic of Swabia or Franconia.

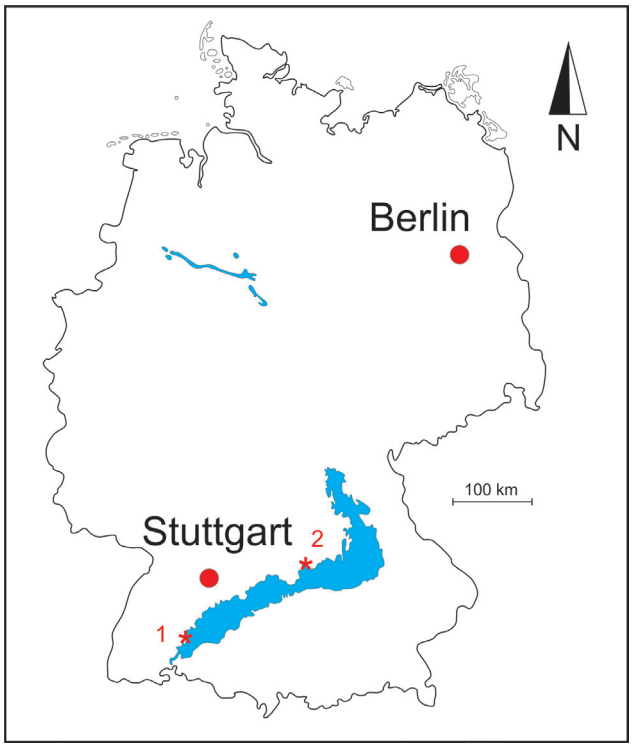

Fig. 1. Upper Jurassic outcrops in Germany with location of the sampling localities. 1: Plettenberg Quarry; 2: former Schneider Quarry.

3. Material and methods

At the northern flank of the Plettenberg Quarry, a section of the Wohlgeschichtete-Kalke Formation was measured from the lower to the middle level, wich comprises a total thickness of 15 m. Ammonites were sampled bed-by-bed. The bed numbering introduced by Jantschke & Schweigert (2020) was continued (Figs. 4, 5). The first pale limestone bed (=Bed 87) following above the gray marly interval (=beds 80–86) containing the *bauhini* Biohorizon (Schweigert & Callomon 1997) yields ammonites of the still poorly studied *tonnerrense* Biohorizon. Lithostratigraphically, Bed 87 is the lowermost bed of the Wohlgeschichtete-Kalke Formation. 8 m above follows a thicker marly layer (=Bed 96) that forms an easily detectable marker bed. 10 m above the base of the formation follows the herein studied *planula* Biohorizon. It comprises five partly spongiolithic limestone beds (=beds 102–106) with a total thickness of 2 m. The next younger *schroederi* Biohorizon, which is expected somewhat higher up in the section has not been recorded yet in the exposed section of the Plettenberg Quarry.

Bed-by-bed sampling of ammonites and other fossils in the Schneider Quarry at Spielberg am Hahnenkamm (Franconian Alb) was carried out in 1970 and 1971 as part of a dissertation thesis (Nitzopoulos 1974). The meanwhile abandoned and completely refilled quarry was located in the interfingering area between normally bedded and biohermal sponge-microbial lithologies. We here re-studied this material as an addition to our own samples.

If possible, identified ammonite taxa were compared with the survived type material. Altogether 167 specimens were collected from Plettenberg Quarry (Table 1). Both the specimens collected by Nitzopoulos at Spielberg and

Fig. 2. Aerial view of the Plettenberg Quarry (Lafarge-Holcim) taken from the South. The studied section (1) is partly located in the meanwhile recultivated northwestern area of the quarry. Photo: ANDREAS KÜCHA.

Stage	Formation	Zone	Biohorizon
Kimmeridgium	Wohlgeschichtete Kalke	Planula	*falcula*
			wenzeli
			schroederi
			planula
			tonnerrense
	Impressamergel	Bimammatum	*bauhini*
			"*tizianiformis*"
			bimammatum
Oxfordium		Hypselum	*berrense*
			semiarmatum
			semimammatum

Fig. 3. Biostratigraphy around the boundary Impressamergel Formation / Wohlgeschichtete-Kalke Formation in the Swabian Upper Jurassic (modified after SCHWEIGERT & CALLOMON 1997). The part of the section containing the herein described *planula* Biohorizon is highlighted.

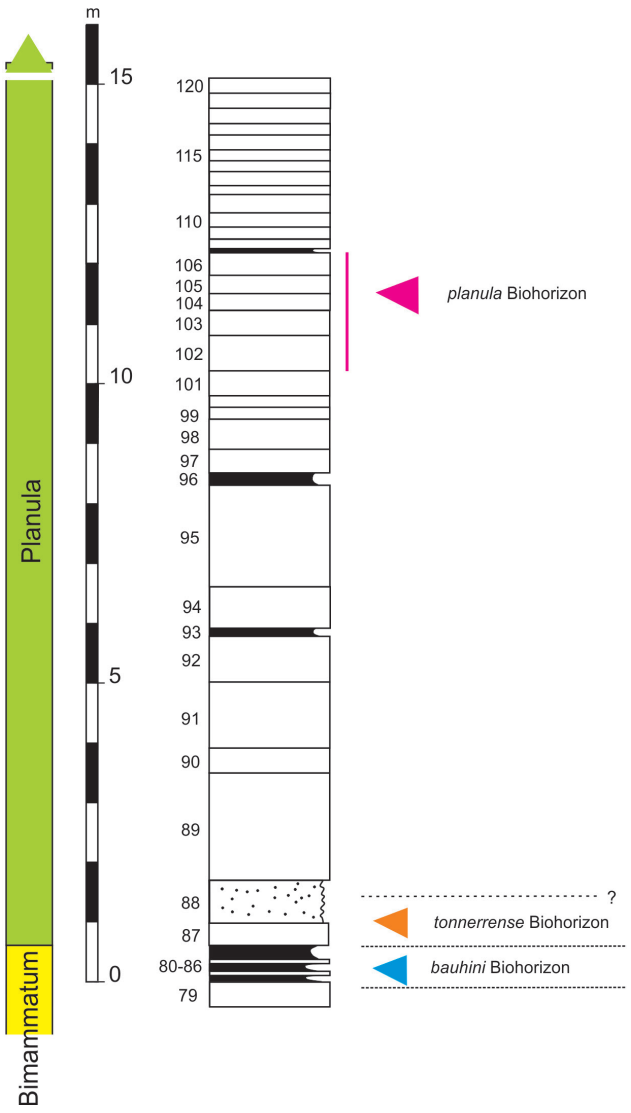

Fig. 4. Section in the uppermost part of the Impressamergel Formation and basal Wohlgeschichtete-Kalke Formation (Bimammatum Zone and Planula Zone); most important biohorizons are indicated. Section measured by Herbert Jantschke in 2019.

the newly sampled and illustrated specimens from Plettenberg Quarry are stored in the collection of the Staatliches Museum für Naturkunde in Stuttgart, Germany under the numbers given in the figure captions.

Institutional abbreviations: GPIT = Palaeontological collection of Tübingen University; SNSB-BSPG = Staatliche Naturwissenschaftliche Sammlungen Bayerns – Bayerische Staatssammlung für Paläontologie und Geologie München, Germany; SMNS = Staatliches Museum für Naturkunde Stuttgart, Germany.

Further abbreviations: [m] = microconch, [M] = macroconch, coll. = collection, leg. = legit (specimen found by …), v = vidi (specimen personally studied). An asterisk indicates the first valid introduction of a taxon to science.

4. Systematic palaeontology

Remark: The higher classification of ammonites adopted herein follows Hoffmann (2015) and Hoffmann et al. (2022).

Class Cephalopoda Cuvier, 1797

Order Ammonitida Haeckel, 1866

Suborder Ammonitina Fischer, 1882

Superfamily Haploceratoidea Zittel, 1884

Family Oppeliidae Bonarelli, 1894

Subfamily Taramelliceratinae Spath, 1928a

Genus *Taramelliceras* Del Campana, 1905

Type species: *Ammonites trachynotus* Oppel, 1863.

Taramelliceras aff. *kobyi* (Choffat, 1893) [M]
Pl. 1, Fig. 1

*1893 *Neumayria kobyi*, Choffat. – Choffat, p. 22, pl. 16, figs. 13, 14, pl. 16[bis], fig. 2.
1940 *Oppelia kobyi* Choff. – Dieterich, p. 29.
v1955b *Taramelliceras (Metahaploceras?) kobyi* (Choffat). – Hölder, pp. 125–129, Beilage 15, fig. 136.
1966 *Tar. (Metahapl.) kobyi* (Chof.). – Énay, p. 119.
non 1979 *Metahaploceras kobyi* (Choffat). – Sapunov, p. 55, pl. 12, fig. 3.
1991 *Taramelliceras (Metahaploceras?) kobyi kobyi* (Choffat). – Schlampp, p. 82, pl. 30, fig. 3.
v1994 *Taramelliceras (Metahaploceras?) kobyi kobyi* (Choffat). – Schlegelmilch, p. 38, pl. 10 fig. 7.
v1997 *Streblites kobyi* (Choffat). – Schweigert & Callomon 1997, p. 13.
v1997 *Taramelliceras kobyi* (Choffat). – Schweigert & Callomon 1997, pl. 3, fig. 2.
2010 *Taramelliceras* (*Taramelliceras*) "*kobyi* (Choffat)" sensu Dieterich (1940). – Wierzbowski et al., p. 62–63, pl. 2, fig. 3.

Lectotype: Original of Choffat 1893, pl. 16, fig. 13, repository unknown, subsequently designated by Schweigert & Callomon 1997, p. 13.

Material: Nine specimens (three each from beds 103, 104 und 105).

Remarks: The maximum diameter of *Taramelliceras kobyi* (Choffat) is *c.* 130 mm. The conch exhibits a slender whorl section with a narrow umbilicus and an overhanging umbilical edge, which is why it has been occasionally assigned to *Streblites*; however, it lacks the typical serrate septicarinate keel. The very dense falcate ribbing fades out in the adult stage. The diverging points of the ribs are not pronounced. Wide-spaced weak tubercles are present along the ventrolateral margin. In the juvenile stage the venter bears a row of densely spaced weak nodes. These ventral nodes fade out in the body-chamber of the adult stage, in contrast to *T. zelcense* Wierzbowski & Głowniak,

Fig. 5. Overview on the measured section located in the northern wall of Plattenberg Quarry.

Fig. 6. Place from where most specimens of the *planula* Biohorizon were collected, with the partly spongiolithic beds 102–106 in the lower part of the small quarry wall.

Table 1. Distribution of ammonite taxa from the measured section in the Plettenberg Quarry.

Taxon	Number of specimens per bed no.				
	102	103	104	105	106
Subnebrodites planula [m+M]	–	5	19	19	3
Subdiscosphinctes grandiplex [m+M]	–	–	2	1	–
Lithacospinctes gigantoplex [m+M]	1	–	4	5	–
Lingulaticeras lingulatum	–	2	1	3	1
Taramelliceras aff. *kobyi*	–	3	3	3	–
Lingulaticeras modestiforme	–	2	14	13	–
Metahaploceras litocerum	1	6	19	27	1
Lingulaticeras aff. *crassum*	–	–	–	1	–
Taramelliceras broilii	–	–	–	1	–
Prorasenia quenstedti	–	–	1	4	–
Pictonites perisphinctoides	–	–	1	–	–
Simosphinctes tieringensis	–	–	–	1	–
Epaspidoceras mamillanum	–	–	–	1	–
Physodoceras circumspinosum	–	–	–	1	–

2010. Hölder (1955b:129) distinguished a subspecies *T. kobyi quenstedti*, which most likely is nothing but a morphological variety. The same can be said from the material published under this name by Schairer (1983) from a sponge-microbial mound at Biburg, Franconia.

Compared with the lectotype of *T. kobyi* (Choffat, 1893), the specimens of the *planula* Biohorizon exhibit a somewhat weaker ribbing. Possibly, this difference could be interpreted as a distinctive species. Indeed, Wierzbowski et al. (2010) distinguished between an earlier occurring "true" *T. kobyi* (Choffat, 1893) and a younger *T.* "*kobyi* Choffat" sensu Dieterich (1940). In respect of the long stratigraphical range reported for *T. kobyi* (Bimammatum–Platynota zones), a specific separation ob both forms should be possible. However, Dieterich (1940) did not illustrate any specimens of his *T. kobyi* from the Planula Zone (and surely he had included material from underlying beds of the Bimammatum Zone erroneously assigned to the Wohlgeschichtete-Kalke Formation); hence, we here refrain from introducing a new species and assign our specimens to *T. kobyi* in a broader sense.

Taramelliceras broilii (Wegele, 1929) [M]

Pl. 1, Figs. 2, 4

v*1929 *Oppelia broilii* n. sp. – Wegele, p. 20, pl. 26 (2), fig. 10.
1940 *Oppelia broilii* Weg. – Dieterich, p. 29.
v1955b *Taramelliceras (Taramelliceras) broilii*. – Hölder, p. 109, Beilage 8, figs. 89, 90.
1991 *Taramelliceras costatum* (Quenstedt). – Malinowska, p. 11, pl. 7, fig. 9.
1991 *Taramelliceras rigidum* (Wegele). – Malinowska, p. 11, pl. 7, figs. 2,3.
v1994 *Taramelliceras (Taramelliceras) broilii* (Wegele 1929). – Schlegelmilch, p. 35, pl. 9, fig. 1.
v1997 *Taramelliceras broilii* (Wegele). – Schweigert & Callomon 1997, p. 9, pl. 3, figs. 7–9.

Holotype: Original of Wegele 1929, pl. 26, fig. 10 (SNSB-BSPG 1927 VII 213), here re-illustrated on Pl. 1, Fig 4a, b.

Material: One specimen (Bed 105) (leg. H. Kuschel).

Remarks: Wegele (1929) introduced his new species *Taramelliceras broilii* for relatively large, strongly sculptured taramelliceratids of the Planula Zone; all of his studied specimens were said to be compressed (Wegele 1929: 20). Subsequent authors (e.g., Dieterich 1940; Hölder 1955b) pointed out close morphological affinities to *T. costatum* (Quenstedt, 1849) and *T. hauffianum* (Oppel. 1863) from the stratigraphically older *bimammatum* and *bauhini* biohorizons, respectively. Our studied specimen of *T. broilii* has a diameter of *c.* 63 mm. It is almost complete but lacks the aperture. The shell is three-dimensionally preserved and recalls the inflated conch of *T. hauffianum*, whereas its sculpture superficially resembles that of *T. costatum*. However, the coiling is more evolute than in *T. costatum* und ventral nodes are more gracile and denser spaced. The ventromarginal tubercles are not elongated but rounded. The sculpture of our specimen is weaker than in the holotype. The ribbing is denser, weaker and less bifurcating than in *T. costatum* and the ribs cross the venter.

Genus *Metahaploceras* Spath, 1925

Type species: *Metahaploceras strombecki* Oppel, 1858.

Metahaploceras litocerum (Oppel, 1863) [M]

Pl. 1, Figs. 3, 5; Pl. 2, Figs. 1–5

*v1863 *Ammonites litocerus* Opp. – Oppel, p. 206, pl. 53, fig. 8.
v1887 *Ammonites flexuosus*. – Quenstedt, p. 915, pl. 99, fig. 15.
v1929 *Oppelia litocera* Oppel. – Wegele, p. 22 (116), pl. 27 (3), figs. 4, 5.
v1955b *Taramelliceras (Metahaploceras) litocerum* (Oppel). – Hölder, pp. 53, 122, text-figs. 10, 178.
v1966 *Taramelliceras (Metahaploceras?) wenzeli* (Oppel). – Karvé-Corvinus, pl. 26, fig. 4.
1969 *Taramelliceras litocerum* (Opp.). – Gygi, p. 60.
v1974 *Taramelliceras (Met.) litocerum* (Oppel). – Nitzopoulos, p. 60.
1978 *Taramelliceras (Metahaploceras) litocerum* (Opp.). – Wierzbowski, p. 318, pl. 2, figs. 5–7.
v1983 *Taramelliceras (Metahaploceras) litocerum* (Oppel). – Schairer, p. 36, pl. 1, figs. 1–9.
v1994 *Taramelliceras (Metahaploceras) litocerum* (Wegele). – Schlegelmilch, p. 37, pl. 10, fig. 5.

Holotype: Original of Oppel 1863, pl. 53, fig. 8 (SNSB-BSPG AS VIII 145), here re-illustrated on Pl. 1, Fig 3a, b.

Material: 54 specimens (Bed 102: one specimen; Bed 103: 6 specimens; Bed 104: 19 specimens; Bed 105: 27 specimens; Bed 106: one specimen).

Remarks: *Metahaploceras litocerum* (Oppel) is the most common ammonite of the *planula* Biohorizon. Its maximum diameter is about 45 mm. *M. litocerum* has a similar shape as *Taramelliceras kobyi* (Choffat, 1893), but is much smaller. Its sculpture is very variable and resembles that of *M. muehlheimense* Schweigert & Callomon, 1997 from the older *bauhini* Biohorizon. In most specimens of *M. litocerum* the sculpture is weaker than in *M. muehlheimense*. Distant falcate ribs arise with prorsiradiate primaries, then they diverge at mid-flank, become weakened and cross the venter of the body-chamber arcuately. Primaries, marginal ribs and diverging points of ribs can be thickened in various modifications. Occasionally this leads to varieties strongly resembling the stratigraphically younger *M. wenzeli* (Oppel, 1963) (e.g., Pl. 2, Fig. 4). The same can be said of *M. tenuinodosum* (Wegele, 1929), which shows a stronger ribbing and more pronounced ventrolateral tubercles.

The type horizon and stratigraphical range of *M. litocerum* was insufficiently known and the species itself was interpreted in various ways (Schairer 1972). When Oppel (1863) introduced this taxon, he assigned it to his "Tenuilobatus Zone", which originally had a much wider range than in later times. Dieterich (1940) placed *M. litocerum* in the poorly studied lower part of the Planula Zone. Dieterich's biostratigraphic subdivision of the Planula Zone by the phyletic succession of the taxa *litocerum*, *tenuinodosum*, *wenzeli* and *falcula* has to be taken with caution, since these all of taxa are extremely variable. When great numbers of specimens are studied, there is indeed a phyletic trend detectable starting with finely sculptured specimens to coarse-ribbed ones and back to finer ribbed ones. However, there is a great overlap of morphologies so that individual specimens are often hardly assignable to a concrete chronospecies.

The type material of *M. exopleurum* Nitzopoulos, 1974 was collected from a sponge-microbial mound in the Schneider Quarry without exact biostratigraphic control. Subsequently, Schairer (1983) considered this species being a variety of *M. litocerum*. His view may be correct but is impossible to prove.

Genus *Lingulaticeras* Ziegler, 1958

Type species: *Ammonites nudatus* Oppel, 1863.

Lingulaticeras lingulatum (Quenstedt, 1857) [m]

Pl. 2, Figs. 6–9

v*1857 *Ammonites lingulatus*. – Quenstedt, p. 619, pl. 76, fig. 17.
1866 *Ammonites Hebelianus* Opp. – Würtenberger & Würtenberger, p. 33.
1876 *Ammonites (Haploceras) Fialar*, Oppel. – Loriol, p. 25, pl. 2, fig. 4 (non fig. 3), non pl. 5, fig. 1.
v1887 *Ammonites lingulatus*. – Quenstedt, p. 847, pl. 92, figs. 31, 34.
v1887 *Ammonites lingulatus expansus*. – Quenstedt, p. 850, pl. 92, fig. 48.
v1929 *Haploceras falcula* Quenstedt. – Wegele, p. 31 (125), pl. 28 (4), fig. 5.
v1957 *Glochiceras* sp. n. aff. *tenuifalcatum* (Dumortier & Fontannes) non Neumayr. – Barthel, p. 225, pl. 16, figs. 6–8.
v1958 *Glochiceras (Lingulaticeras) lingulatum* (Quenstedt). – Ziegler, p. 131, pl. 12, figs. 1–6, text-figs. 40–43.
v1974 *Glochiceras (Lingulaticeras) lingulatum* (Quenstedt). – Nitzopoulos, p. 58.
v1984 *Glochiceras (Lingulaticeras) lingulatum* (Quenstedt). – Schairer, p. 31, pl. 2, figs. 4–8.
1991 *Glochiceras (Lingulaticeras) hebelianum* (Würtenberger). – Gygi, p. 20, pl. 7, figs. 1, 4.
1991 *Glochiceras (Lingulaticeras) lingulatum* (Quenstedt). – Gygi, p. 20, pl. 6, figs. 5, 6.
v1994 *Glochiceras (Lingulaticeras) lingulatum* (Qu. 1858). – Schlegelmilch, p. 53, pl. 16, fig. 6.

Holotype: Original of Quenstedt 1857, pl. 76, fig. 17 (= Quenstedt 1887, pl. 92, fig. 34) (GPIT-PV-51611), here re-illustrated on Pl. 2, Fig. 6a–c.

Material: Seven specimens (Bed 103: two specimens; Bed 104: one specimen; Bed 105: three specimens; Bed 106: one specimen).

Remarks: Ziegler (1958) provided an excellent diagnosis of *Lingulaticeras lingulatum*, which is a typical example of this genus. The maximum diameter is about 40 mm. Smaller specimens are hardly distinguishable from *L. modestiforme* (Oppel, 1863). A lateral sulcus is developed on the flank of the body-chamber which emerges to a long apophysis with a terminal plate. The latter is large and expands ventrally. The apertural margin is strongly retroverse towards the umbilicus, whereas the aperture expands proversely towards the venter. The weak and variable sculpture consists of densely spaced falcate ribs, which diverge at mid-flank. At longer distances these ribs can be thickened. The venter is smooth.

Schlegelmilch (1994, pl. 16, fig. 6) did not illustrate the holotype that was apparently untraceable for him, but a conspecific specimen illustrated by Quenstedt (1887, pl. 92, fig. 31). We consider *L. lingulatum* being the corresponding microconch of *Taramelliceras kobyi* (Choffat, 1893), as is suggested by dimensions, shape and co-occurrence.

Lingulaticeras aff. *crassum* Ziegler, 1958 [m]
Pl. 2, Figs. 10, 11

aff. 1893 *Oppelia nimbata* (Oppel). – Choffat, p. 21, pl. 17, fig. 5, non pl. 6, fig. 16.
aff. v*1958 *Glochiceras (Lingulaticeras) crassum* n. sp. – Ziegler, p. 129, pl. 13, figs. 3, 4, text-figs. 38, 39.
aff. 1972a *Glochiceras (Lingulaticeras) crassum* Ziegler. – Malinowska, p. 15, pl. 12, fig. 6.
non 1991 *Glochiceras (Lingulaticeras) crassum* Ziegler. – Gygi, p. 20, pl. 7, fig. 2.
aff. v1994 *Glochiceras crassum* Ziegler. – Schlegelmilch, p. 53, pl. 16, fig. 9.
aff. v1997 *Lingulaticeras crassum* Ziegler. – Schweigert & Callomon, p. 11, pl. 3, fig. 6.

Holotype: Original of Ziegler 1958, pl. 13, figs. 3, 4 (SMNS 19366; leg. E. Rebholz), here re-illustrated on Pl. 2, Fig. 10a, b.

Material: One fragmentary specimen with partly preserved aperture (Bed 105).

Remarks: This species has a maximum diameter of less than 20 mm. It has the widest whorl section of the genus. The dense ribbing is mostly restricted to the outer half of the flank. These concave secondaries arise from an indistinct lateral sulcus and terminate along the ventrolateral edge. *Lingulaticeras* aff. *crassum* Ziegler is considered as the corresponding microconchiate partner of *Taramelliceras broilii* (Wegele, 1929), which has evolved from *T. hauffianum* (Oppel, 1863). A distinction from the true *L. crassum* Ziegler (Pl. 2, Fig. 10) that originates from the older *bauhini* Biohorizon is almost impossible. It is distinguished from the still older *L. bobrownikiense* Wierzbowski & Głowniak, 2010 from the *bimammatum* Biohorizon by its much wider whorl section. The latter is considered as the dimorphic partner of *Taramelliceras costatum* (Quenstedt, 1849) (Jantschke 2014).

Lingulaticeras modestiforme (Oppel, 1863) [m]
Pl. 2, Figs. 12–15

*v1863 *Ammonites modestiformis* Opp. – Oppel, p. 192, pl. 54, fig. 5.
v1887 *Ammonites lingulatus laevis*. – Quenstedt, p. 849, pl. 92, fig. 39.
1940 *Haploceras laeve* Qu. – Dieterich, p. 31.
v1958 *Glochiceras (Coryceras) modestiforme* (Oppel). – Ziegler, p. 125, pl. 11, figs. 19–29; text-figs. 34–36.
v1974 *Glochiceras (Coryceras) modestiforme* (Oppel). – Nitzopoulos, p. 58.
v1984 *Glochiceras (Coryceras) modestiforme* (Oppel). – Schairer, p. 28, pl. 1, figs. 2–9.
1991 *Glochiceras (Coryceras) canale* (Quenstedt). – Gygi, p. 18, pl. 5, fig. 1.
1991 *Glochiceras (Coryceras) modestiforme* (Oppel). – Gygi, p. 18, pl. 5, figs. 4–6.
1991 *Glochiceras (Coryceras) modestiforme* (Oppel). – Schlampp, p. 88, pl. 32, fig. 2.
v1994 *Glochiceras (Coryceras) modestiforme* (Opp. 1863). – Schlegelmilch, p. 53, pl. 16, fig. 4
v1997 "*Lingulaticeras*" cf. *modestiforme* (Oppel). – Schweigert & Callomon 1997, p. 12, pl. 2, figs. 4, 5, 9.

Lectotype: Original of Oppel 1863, pl. 54, fig. 5 (SNSB-BSPG AS VIII 7), here re-illustrated on Pl. 2, fig. 12a, b. Ziegler (1958) considered this specimen as the holotype; however, Oppel (1863) had based his species on a series of 15 specimens, of which only the illustrated one has survived. Thus, Ziegler's taxonomic treatment can be formally taken as a lectotype designation, to which we concur.

Material: 29 specimens (Bed 103: two specimens; Bed 104: 14 specimens; Bed 105: 13 specimens).

Remarks: *Lingulaticeras modestiforme* is a small-sized species with a maximum diameter hardly exceeding 20 mm. Placed in *Coryceras* (Ziegler 1958), we here transfer this taxon to *Lingulaticeras* because of its smooth, unserrated venter. The type species of *Coryceras*, introduced by Ziegler (1958) as a subgenus of *Glochiceras*, is *Coryceras microdomus* (Oppel, 1863). The spelling "*microdomum*" is incorrect. *C. microdomus* exhibits a ventral row of nodes, which is also present in most other species assigned to this genus or subgenus. In the species *modestiforme*, however, the venter is constantly smooth (Ziegler 1958: 125). In most specimens under study, a lateral sulcus is present at mid-flank. The ornamentation of the shell is highly variable. The shell may be completely smooth; the most common morphology bears densely spaced falcate ribs. There is also a coarsely ribbed variety at the other end of the morphological range (Pl. 2, Fig. 15). Ziegler (1958) identified the latter variant as an individual species *Glochiceras (Lingulaticeras) sculptatum* and considered the lower part of the Wohlgeschichtete-Kalke Formation being its type horizon (= lower Planula Zone). *L. modestiforme* is considered the microconchiate counterpart of *Metahaploceras litocerum* (Oppel, 1863) and closely allied forms.

Superfamily Aspidoceratoidea Zittel, 1895 emend. Parent, Schweigert & Scherzinger, 2020

Family Aspidoceratidae Zittel, 1895

Subfamily Euaspidoceratinae Spath, 1931

Genus *Epaspidoceras* Spath, 1931

Type species: *Aspidoceras subdistractum* Waagen, 1875.

Epaspidoceras mamillanum (Quenstedt, 1847) [M]
Pl. 3, Figs. 1, 2

*v1847 *Ammonites perarmatus mamillanus*. – Quenstedt, p. 194, pl. 16, fig. 11.
cf. 1876 *Ammonites dornacensis*. – Favre, p. 52, pl. 5, figs. 6, 7.
v1887 *Ammonites perarmatus mamillanus*. – Quenstedt, p. 889, pl. 96, figs. 2–4.
v1929 *Aspidoceras bodeni* n. sp. – Wegele, p. 36, pl. 1, fig. 1.
cf. 1962 *Paraspidoceras suevicum* n. sp. – Zeiss, p. 31, pl. 1, fig. 11, pl. 4, fig. 11.
v1968 *Paraspidoceras mamillanum* (Qu.). – Schairer, pl. 12, figs. 1, 2.
v1974 *Epaspidoceras mamillanum* (Quenstedt). – Nitzopoulos, p. 81.
v1991 *Paraspidoceras mamillanum* (Quenstedt). – Schlampp, p. 76, pl. 23, fig. 7.

v1994 *Euaspidoceras (?) mamillanum* (Qu. 1847). – Schlegelmilch, p. 122, pl. 65, fig. 4, pl. 66, fig. 8
2009 "*Paraspidoceras*" *rupellense* (d'Orbigny 1849). – Hornung, pl. 1, figs. 1–4, pl. 2, figs. 1–4, pl. 3, fig. 1, pl. 4, fig.1
v2013 *Epaspidoceras mamillanum* (Quenstedt). – Schweigert, p. 289, fig. 1.

Holotype: Original of Quenstedt 1847, pl. 16, fig. 11 (GPIT-PV-61902), here re-illustrated on Pl. 3, Fig. 1a, b.

Material: One spine from Bed 105; one well-preserved specimen from the southern upper level of Plettenberg Quarry (leg. & coll. H. Kuschel).

Remarks: *Epaspidoceras mamillanum* is very large-growing and reaches diameters of over 400 mm. The shell is moderately involute. Along the ventromarginal edge wide-spaced, blunt tubercles occur which give rise to long outwards-directed spines. At a diameter of c. 7 cm a much weaker umbilical row of spines sets on. The spines of this inner row are arranged in pairs with the outer row. On the gently rising flank a puckering is present which thickens to bulges in the area of the spines.

Of this rare species only a small fragment with a single spine was recorded from the measured section of Plettenberg Quarry. This extremely fragmentary specimen was found in Bed 105. A well-preserved juvenile specimen was found on the top level of the southern side of the Plettenberg Quarry, where partly spongiolithic beds contain the *planula* Biohorizon as well.

E. mamillanum has a long stratigraphical range. Its acme lies in the lower part of the Platynota Zone, where the corresponding microconch (*Simosphinctes tieringensis*) is relatively abundant as well. Quenstedt's holotype from Nusplingen is the historically earliest recorded specimen of the *Epaspidoceras* lineage, but its exact locality and horizon is unknown since it originated from spongiolithic limestones lacking an age-diagnostic lithology or colour. At present, the few *Epaspidoceras* specimens from Swabia collected bed-by-bed do not allow a secure morphological distinction between older and younger chronospecies of this genus; due to nomenclatorial priority we have to use Quenstedt's taxon instead of *Ammonites rupellensis* introduced by d'Orbigny in 1849. The latter originates from age-equivalent beds of the Platynota Zone in northwestern France (Hantzpergue 1989).

The generic assignment of *Ammonites perarmatus mamillanus* has been repeatedly discussed (see Hornung 2009), and many previous authors included it either in *Paraspidoceras* or in *Euaspidoceras*. Nitzopoulos (1974) was the first to use *Epaspidoceras*. This view was often questioned because the genus *Epaspidoceras* had been introduced for an aspidoceratid from the Indo-Madagascan Province. Since *Epaspidoceras* from the Upper Jurassic of Madagascar is also accompanied by the supposed microconchiate partner *Simosphinctes* (see Schweigert 2013) and many other aspidoceratid genera and species have extremely large palaeogeographic distributions, there arise no longer doubts about this generic affiliation.

Genus *Simosphinctes* Barthel, 1957

Type species: *Perisphinctes tieringensis* Fischer, 1913b.

Simosphinctes tieringensis (Fischer, 1913b) [m]
Pl. 3, Figs. 3, 4

*v1913b *Perisphinctes tieringensis* n. sp. – Fischer, p. 50, pl. 5, fig. 20.
v1957 *Simosphinctes tieringensis* (E. Fischer). – Barthel, p. 221, pl. 16, figs. 1–5.
v1959 *Simosphinctes (Simosphinctes) tieringensis* (Fischer). – Ziegler, p. 50, pl. 1, fig. 1.
v1961 *Simosphinctes (Simosphinctes) tieringensis* (Fischer 1913). – Geyer, p. 86, pl. 6, fig. 7.
v1976 *Simosphinctes tieringensis* (Fischer). – Schairer, p. 12, pl. 1, figs. 2–6.
1977 *Simosphinctes tieringensis* Fischer 1913. – Keupp, fig. 3.
1991 *Simosphinctes (Simosphinctes) tieringensis* Fischer. – Schlampp, p. 63, pl. 15, fig. 4.
v1994 *Simosphinctes tieringensis* Fischer 1913. – Schlegelmilch, p. 73, pl. 27, fig. 2.
2009 *Simosphinctes (Simosphinctes) tieringensis* (Fischer 1913). – Hornung, p. 233, pl. 3, figs. 1, 2.
v2013 *Simosphinctes tieringensis* (Fischer). – Schweigert, p. 291, fig. 4.

Holotype: Original of Fischer 1913b, pl. 5, fig. 20 (GPIT-PV-75369), here re-illustrated on Pl. 3, Fig. 3a–c.

Material: One specimen (Bed 105).

Remarks: This small-sized, evolute ammonite with its very characteristic fading ribs caused much attention despite of its rareness and was often described in detail. The maximum diameter is about 30 mm, and the body-chamber comprises a little more than half a whorl.The herein illustrated specimen from the *planula* Biohorizon is adult and exhibits parts of its mouth-border; the apophysis and the inner whorls, however, are not preserved. At the beginning of the last whorl an injury of the shell has led to a complete loss of sculpture.

Ziegler (1959) included his newly introduced genus *Ceratosphinctes* as a subgenus of *Simosphinctes*. However, *Ceratosphinctes* is now considered a genus of Passendorferiinae Meléndez, 1989 and thus it is not closer related to the microconchiate aspidoceratid *Simosphinctes* (Énay & Howarth 2019). Due to their co-occurrence and an identical morphology of the innermost whorls, *S. tieringensis* could be identified as the microconchiate partner of *Epaspidoceras mamillanum* (Quenstedt) (see Schweigert 2013).

Subfamily Aspidoceratinae Zittel, 1895

Genus *Physodoceras* Hyatt, 1900

Type species: *Ammonites circumspinosus* Quenstedt, 1857.

Physodoceras circumspinosum (Quenstedt, 1857) [M]
Pl. 3, Figs. 5, 8, 9

v1847 *Ammonites inflatus macrocephalus*. – Quenstedt, p. 196, pl. 16, fig. 14.
*v1857 *Ammonites circumspinosus*. – Quenstedt, p. 609, pl. 75, figs. 8, 9.
1863 *Ammonites circumspinosus* Opp. – Oppel, p. 222.
1879 *Aspidoceras circumspinosum* Oppel. – Fontannes, p. 97, pl. 13, figs. 4, 5.
v1887 *Ammonites inflatus microcephalus*. – Quenstedt, p. 1019, pl. 116, fig. 9.
v1929 *Physodoceras circumspinosum* Oppel. – Wegele, p. 88 (182), pl. 11 (15), fig. 2.

1940 *Physodoceras circumspinosum* Opp. – Dieterich, p. 32.
v1974 *Physodoceras circumspinosum* (Oppel). – Nitzopoulos, p. 81.
1989 *Physodoceras circumspinosum* (Quenstedt). – Hantzpergue, p. 298.
1991 *Physodoceras circumspinosum* (Oppel). – Schlampp, p. 78, pl. 24, fig. 8.
v1994 *Physodoceras circumspinosum* (Opp. 1863). – Schlegelmilch, p. 128, pl. 70, fig. 2.

Holotype: Original of Quenstedt 1847, pl. 16, fig. 14, re-figured in Quenstedt 1887, pl. 116, fig. 9 (GPIT-PV-62132), here re-illustrated on Pl. 3, Fig. 5a–c.

Material: One specimen (found loose on the bottom level below the western quarry wall, almost certainly originating from the *planula* Biohorizon).

Remarks: *Physodoceras circumspinosum* is a species with an almost sphaerical involute conch. The maximum diameter can reach 150 mm. The umbilicus is further narrowed by inclined spines. In most cases these spines are only present with their bases due to the steinkern preservation. Apart from the spines the shell is almost smooth exept for an occasionally occurring weak striation parallel to the growth lines. The body-chamber comprises about half of a whorl.

Umbilical and whorl section width are rather variable so that many specimens previously referred to *P. altenense* (Orbigny, 1848) may fall into the variation of this species. Specimens from the Galar Subzone and Platynota Zone are less inflated than the stratigraphically older ones.

Genus *Sutneria* Zittel, 1884

Type species: *Nautilus platynotus* Reinecke, 1818.

Sutneria praecursor Dieterich, 1940 [m]
Pl. 3, Figs. 6, 7

*v1940 *Sutneria praecursor* n. sp. – Dieterich, p. 34, pl. 2, fig. 1.
v1974 *Sutneria (Enosphinctes) praecursor* Dieterich. – Nitzopoulos, p. 81, pl. 9, figs. 10, 11.
1982 *Sutneria praecursor* Dieterich. – Atrops, p. 299.
v1994 *Sutneria (Sutneria) praecursor* Dieterich 1940. – Schlegelmilch, p. 112, pl. 59, fig. 2.

Lectotype: Original of Dieterich 1940, pl. 2, fig. 1 (GPIT-PV-75264), designated by Schlegelmilch (1994), here re-illustrated on Pl. 3, Fig. 6a, b.

Material: One specimen (former Schneider Quarry at Spielberg am Hahnenkamm, Bed 105).

Remarks: Small-sized, involute species with a diameter of less than 20 mm, a trumpet-like aperture equipped with a long and narrow apophysis. In the lectotype, this apophysis is only partially preserved. The apophysis is not preserved in the illustrated specimen, either. The ribbing is fine, with bi- and tripartite rectiradiate secondaries, as in the lectotype.

The microconchs of the dimorphic couple *Sutneria*/*Physodoceras* show rapid morphological changes during its evolution, whereas the macroconchs are much more conservative and can often hardly be distinguished from each other during the evolution of this couple. In the *planula* Biohorizon, *Sutneria praecursor* Dieterich, 1940 represents the microconchiate partner of *Physodoceras circumspinosum* (Quenstedt, 1857) (see Scherzinger et al. 2018 for a discussion).

Superfamily Perisphinctoidea Steinmann in Steinmann & Döderlein, 1890

Family Aulacostephanidae, Spath, 1924

Subfamily Aulacostephaninae, Spath, 1924

Genus *Pictonites* Mesezhnikov, 1969

Type species: *Rasenia perisphinctoides* Wegele, 1929, by original designation.

Pictonites perisphinctoides (Wegele, 1929) [M]
Pl. 2, Figs. 16, 17

*v1929 *Rasenia perisphinctoides* n. sp. – Wegele, p. 81 (175), pl. 10 (14), fig. 2.
1940 *Pictonia perisphinctoides* (Weg.). – Schneid, p. 88, pl. 7, fig. 2.
v1961 *Pictonia (Pictonia) perisphinctoides* (Weg.). – Geyer, p. 116, pl. 21, fig. 7.
1969 *Pictonia (Pictonites) perisphinctoides* (Wegele). – Mesezhnikov, p. 104.
v1974 *Pictonia (Pictonia) perisphinctoides* (Weg.). – Nitzopoulos, p. 80, pl. 7, fig. 7.
v1994 *Pictonia perisphinctoides* (Wegele 1929). – Schlegelmilch, p. 103, pl. 53, fig. 4.
v1997 *Pictonia perisphinctoides* (Wegele). – Schweigert & Callomon 1997, p. 44, pl. 7, figs. 13, 14.

Holotype: Original of Wegele 1929, pl. 10, fig. 2, stored in the Bayerische Staatssammlung für Paläontologie und Geologie, Munich (SNSB-BSPG 1927 I 505), here re-illustrated on Pl. 2, Fig. 16a, b.

Material: One juvenile specimen from Bed 104.

Remarks: The juvenile specimen is moderately involute, with an oval whorl section. The prorsiradiate ribs bifurcate above mid-flank and cross the rounded venter unchanged together with numerous secondaries arising from the diverging points. Some intercalatory ribs are present as well. Previously often included in *Pictonia*, we reassign it here to *Pictonites* Mesezhnikov, 1969. It differs from true *Pictonia* by the more regular ribbing style. Due to the non-record of adult stages in southern Germany and the general rareness of this taxon it is impossible yet to decide whether this genus could be synonymous with *Vielunia* Wierzbowski & Głowniak, 2010 (see below), which forms a geographically isolated Submediterranean lineage within aulacostephanids, or with another aulacostephanid branch. In his recent approach for a deciphering of the evolution of aulacostephanids, Wierzbowski (2022) interpreteted *Pictonites* as an individual aulacostephanid offshoot triggered by palaeogeographic separation. In our view, the relationships of *Pictonites* and other coeval forms are still unclear due to the scarcity and incompleteness of the material. The corresponding microconch of *Pictonites perisphinctoides* (Wegele, 1929) could be represented by *Prorasenia quenstedti* Schindewolf, 1926, but there is another macroconchiate candidate.

Genus *Vielunia* Wierzbowski & Głowniak, 2010

Type species: *Vielunia dzalosinensis* Wierzbowski & Głowniak, 2010, by original designation.

Vielunia dzalosinensis Wierzbowski & Głowniak, 2010 [M]
Pl. 8, Fig. 2

v1970 *Ringsteadia (Ringsteadia) limosa* (Quenstedt 1888). – Wierzbowski, p. 275, p. 276, pl. 3.
v1974 *Ringstedia (Vineta) weinlandi* (Fischer). – Nitzopoulos, p. 79, pl. 10, fig. 1.
v1978 *Ringsteadia (Ringsteadia) limosa* (Quenstedt). – Wierzbowski, pl. 3, fig. 4.
v*2010 *Vielunia dzalosinensis* Wierzbowski & Głowniak sp. n. – Wierzbowski et al., pp. 70–71, pl. 8, fig. 2; pl. 9, figs. 1–4.

Holotype: Original of Wierzbowski et al. 2010, pl. 9, fig. 1, stored in the Collection of the University of Warsaw, ZI/50/4.

Material: One adult specimen from the abandoned Schneider Quarry at Spielberg am Hahnenkamm, Bed S16).

Remarks: This apparently rare species exceeds diameters of 200 mm. The shell is moderately involute, with a high-oval whorl section. In the inner whorls, the coarse and densely spaced ribs are weakly prorsiradiate. They continuously become wider-spaced and diverge ad mid-flank. In the adult stage the ribbing fades out at mid-flank. Juvenile specimens have not been recorded from southern Germany. *Vielunia limosa* (Quenstedt, 1888) is a closely related species of the Hauffianum Subzone, as deduced from the dark gray, marly rock matrix of the holotype.

Genus *Prorasenia* Schindewolf, 1926

Type species: *Prorasenia quenstedti* Schindewolf, 1926.

Prorasenia quenstedti Schindewolf, 1926 [m]
Pl. 4, Figs. 1, 2

1925 *Prorasenia Quenstedti*. – Schindewolf, p. 338 [nomen nudum].
*1926 *Prorasenia Quenstedti*. – Schindewolf, p. 505, pl. 9, fig. 1.
non v1961 *Prorasenia quenstedti* Schindewolf. – Geyer, p. 108–109, pl. 4, fig. 9; pl. 6, fig. 6; pl. 22, fig. 9.
non v1969 *Rasenia(Prorasenia) heeri quenstedti* Schindewolf. – Schairer, p. 35, pl. 1, fig. 7.
non 1991 *Rasenia (Prorasenia) quenstedti* Schindewolf. – Schlampp, p. 67, pl. 17, fig. 4.
2009 *Prorasenia quenstedti* Schindewolf. – Wright, p. 33.
2019 *Prorasenia quenstedti* Schindewolf. – Énay & Howarth, p. 93, fig. 68, fig. 3a only [re-illustration of original figure].

Holotype: Original of Schindewolf 1926, pl. 9, fig. 1 from the "Weißjura β" (? Wohlgeschichtete-Kalke Formation) at Beuren. The specimen was originally said to be stored in the palaeontological collection of Marburg University, but already Geyer (1961) was unable to trace it there; therefore, it must be considered as lost.

Material: Five specimens (Bed 104: one specimen; Bed 105: four specimens).

Remarks: *Prorasenia quenstedti* shows an evolute coiling with a rounded to ovale whorl section. The strong ribbing is slightly prorsiradiate. The primaries diverge realtively high, in the outer third of the flank, into three secondaries; in the later stage they bifurcate. The diverging point is accentuated especially in the juvenile stage; in this stage occur weak constrictions. Along the venter the ribs become weaker and may completely disappear at mid-venter; this feature is best developed around the first third of the body-chamber. The maximum diameter is about 50 mm. The body-chamber is three thirds of a whorl long and ends in a remarkable long, tongue-like apophysis, which is not preserved in the herein illustrated specimens.

Geyer (1961) (pl. 4, fig. 9; pl. 6, fig. 6; pl. 22, fig. 9), included finer-ribbed microconchiate aulacostephanids from various younger stratigraphic horizons in *P. quenstedti* and thus assumed a wide range for this taxon, from the Galar Subzone up to the Hypselocyclum Zone. His illustrated specimens, however, are much closer to the specimen illustrated by Schindewolf (1926) on his plate 9, fig. 4 (= *Prorasenioides* cf. *transitorius*) than to the type of *P. quenstedti* illustrated on the same plate as fig. 1. Apart from the finer ribbing, the diverging point of the ribs is located much deeper in his illustrated examples. In Geyer's description, he explicitely notes the change to a prorsiradiate ribbing direction at mid-flank as it was typical of the species – a character not seen in the illustration of the holotype. This confusion might have led to the erroneous interpretation of *P. quenstedti* also adopted by subsequent authors. Our studied specimens exhibit a coarse, wide-spaced ribbing style lacking prorsiradiate secondaries.

Family Perisphinctidae Steinmann in Steinmann & Döderlein, 1890

Subfamily Perisphinctinae Steinmann, 1890

Genus *Subdiscosphinctes* Malinowska, 1972b

Type species: *Perisphinctes kreutzi* Siemiradzki, 1891.

Subdiscosphinctes grandiplex (Quenstedt, 1888) [M + m]
Pl. 4, Fig. 5; Pl. 7; Pl. 8, Fig. 1; Pl. 10, Fig. 3

*v1888 *Ammonites grandiplex*. – Quenstedt, p. 936, pl. 102, fig. 1 [M].
1893 *Perisphinctes* sp. nov. aff. *mindowe* Siem. – Choffat, p. 43, pl. 10, fig. 3 [m].
non v1929 *Perisphinctes grandiplex* Quenstedt. – Wegele, p. 51 (145), pl. 2 (6), fig. 5 [M].
? 1940 *Perisphinctes grandiplex* Qu. – Dieterich, p. 37.
1944 *Ataxioceras maternum* n. sp. – Schneid, p. 28, pl. 2, fig. 3 [M].
1961 *Lithacoceras maternum* (Schneid). – Geyer, p. 28.
non v1961 *Lithacoceras (Progeronia) freybergi*. – Geyer, p. 34, pl. 8, fig. 1 [m].
non v1963 *Lithacoceras (Lithacoceras) grandiplex* (Quenstedt 1887). – Koerner, p. 367, pl. 28, fig. 1 [M].
1966 *Lithacoceras (Lithacoceras) grandiplex* (Quenst.). – Énay, p. 526.
v1974 *Lithacoceras (Lith.) grandiplex* (Quenstedt). – Nitzopoulos, p. 67.
v1974 *Lithacoceras (Lithacoceras) spielbergense* n. sp. – Nitzopoulos, p. 67, pl. 7, fig. 3 [?m].

v1974 *Perisphinctes*] *(Orthosphinctes) freybergi* (Geyer). – Schairer, p. 59, pl. 7, fig. 1 [m].
1978 *Orthosphinctes (Orthosphinctes) freybergi* (Geyer). – Wierzbowski, p. 326, pl. 8, fig. 1.
pars 1982 *Orthosphinctes (Orthosphinctes) freybergi* (Geyer). – Atrops, p. 59, pl. 15, fig. 1, 2; non pl. 19, fig. 4 [m].
1989 *Subdiscosphinctes grandiplex* (Quenstedt), 1888. – Hantzpergue, p. 87, pl. 1, figs. a–c.
v1994 *Lithacosphinctes grandiplex* (Qu. 1887). – Schlegelmilch, p. 74, pl. 27, fig. 5 [M].
1997 *Orthosphinctes grandiplex* (Quenstedt). – Matyja & Wierzbowski, pl. 8, fig. 1.
2003 *Lithacosphinctes* aff. *grandiplex* (Quenstedt, 1887) [M]. – Gygi, p. 54, figs. 49, 50 [M].

Holotype: Original of Quenstedt 1887, pl. 102, fig. 1 (GPIT-PV-31604), here re-illustrated on Pl. 7.

Material: Three juvenile specimens (Bed 104: one specimen; Bed 105: two specimens).

Remarks: In terms of a modern palaeobiological species concept, we here include microconchs and macroconchs of *Subdiscosphinctes grandiplex* in the same taxon. Inner whorls of macroconchs and microconchs are densely ribbed. The coiling is involute and shifts to evolute in later stages. In the adult stage of the macroconchs wide-spaced bulges occur. The transition to this growth stage is not abrupt but more gradual. The whorl section starts rounded and shifts to becoming higher. The body-chamber comprises little more than three quarters of a whorl. The maximum diameter of the macroconchs reaches *c.* 400 mm.

In the *planula* Biohorizon, two large-sized Perisphinctinae occur. They significantly differ from one another in their umbilical width, whorl section and ribbing density of juvenile stages. We here concur with Hantzpergue (1989), who had assigned them to the genera *Subdiscosphinctes* and *Lithacosphinctes*, respectively. An older stratigraphic age for *S. grandiplex* and a younger one for *L. gigantoplex*, as proposed by Hantzpergue (1989), is not confirmed by our observations; both taxa definitely co-occur. Atrops (1982) interpreted specimens of *Subdiscosphinctes* as belonging to *Orthosphinctes* [m] and *Lithacosphinctes* [M]; we cannot follow his view because of the strikingly different morphologies. However, the genus *Wegelea* Gygi, 2000, solely based on the poorly known *Perisphinctes gredingensis* Wegele, 1929, fits well with the concept of *Subdiscosphinctes* as adopted by Hantzpergue (1989) and is therefore considered by us just being a subjective junior synonym. Głowniak in Głowniak & Wierzbowski (2007) suggested *Wegelea* should be used for the stratigraphically later forms earlier included in *Subdiscosphinctes*. Since even the adult sculptural stage of the type species *S. kreutzi* strongly recalls the same stage as in *grandiplex* (compare Głowniak & Wierzbowski 2007: fig. 8), we do not follow this alternative generic placement.

Genus *Lithacosphinctes* Olóriz, 1978

Type species: *Ammonites evolutus* Quenstedt, 1888.

Lithacosphinctes gigantoplex (Quenstedt, 1888) [M + m]
Pl. 4, Figs. 3, 4, 6; Pl. 9; Pl. 10 Fig. 2

*v1888 *Ammonites gigantoplex*. – Quenstedt, p. 939, pl. 102, fig. 4 [M].
v1963 *Lithacoceras (Lithacoceras) grandiplex* (Quenstedt 1887). – Koerner, p. 367, pl. 28, fig. 1 [M].
? 1966 *Perisphinctes grandiplex* (Quenstedt). – Karvé-Corvinus, pp. 112–127.
non 1966 *Decipia* gr. *grandiplex* (Quenstedt). – Énay, p. 564, pl. 38, fig. 3 [M].
v1974 *Lithacoceras (Lithacoceras)* aff. *grandiplex* (Quenst.). – Schairer, p. 81, pl. 11, fig. 1 [M].
v 1979 *Progeronia* gr. *triplex* (Quenstedt). – Hantzpergue, pp. 716–721 [m].
1989 *Lithacosphinctes gigantoplex* (Quenstedt), 1887. – Hantzpergue, p. 119, pl. 6, figs. a, b [M], c [m].
v1994 *Perisphinctes (Kranaosphinctes) gigantoplex* (Qu. 1887). – Schlegelmilch, p. 60, pl. 18, fig. 4 [M].
2003 *Lithacosphinctes* cf. *gigantoplex* (Quenstedt, 1887) [M]. – Gygi, p. 46, fig. 37 [M].
2003 *Lithacosphinctes* aff. *gigantoplex* (Quenstedt, 1887) [M]. – Gygi, p. 57, fig. 52 [M].

Holotype: Original of Quenstedt 1887, pl. 102, fig. 4 (GPIT-PV-31598), here re-illustrated on Pl. 9.

Material: Ten specimens (Bed 102: one specimen; Bed 104: four specimens; Bed 105: five specimens).

Remarks: In contrast to *Subdiscosphinctes grandiplex*, *Lithacosphinctes gigantoplex* is markedly more evolute, with a more rounded whorl section. The microconch and juvenile macroconchs of *L. gigantoplex* are very coarsely sculptured making them easily distinguishable from co-occurring *S. grandiplex*. The biplicate ribs are weakly prorsiradiate; intercalated secondaries rarely occur in the preadult stage. The diverging point of the ribs is located at the outer third of the flank. Inner whorls exhibt one or two constrictions per whorl. In the adult stage, the macroconch develop wide-spaced, strong bulges, whereas the microconchs keep the intermediate ribbing style and form a tongue-like lappet at the end of the body-chamber. The body-chamber comprises about three thirds of a whorl. Macroconchs reach diameters of over 500 mm. As in *Subdiscosphinctes*, we here include microconchs and macroconchs in the same taxon, in respect of a modern palaeobiological species concept.

Genus *Subnebrodites* Spath, 1925

Type species: *Ammonites planula* Zieten, 1830.

Subnebrodites planula (Zieten, 1830) [M + m]
Pl. 5, Figs. 3, 4; Pl. 6, Figs. 1–10

*1830 *Ammonites planula* Hehl in Zieten, p. 9, pl. 7, fig. 5. [M]
v2017 *Subnebrodites planula* (Hehl in Zieten, 1830) [M + m]. – Schweigert & Kuschel, figs. 1, 3–5 (with full synonymy included).
2019 *Subnebrodites planula* Spath. – Énay & Howarth, fig. 78.3a–c [M + m].

Neotype: Original of Schweigert & Kuschel 2017, fig. 4 (SMNS 70398; leg. H. Kuschel), by original designation; here re-illustrated on Pl. 6, Fig. 1a–c.

Material: 46 specimens (Bed 103: five specimens; Bed 104: 19 specimens; Bed 105: 19 specimens; Bed 106: three specimens).

Remarks: The zonal index *Subnebrodites planula* predominates in the *planula* Biohorizon. Contrary to older taxonomic concepts, we here include both microconchs and macroconchs in the same taxon (see synonymy list in Schweigert & Kuschel 2017). In many Jurassic perisphinctids, microconchs and macroconchs are easily distinguishable by their coiling and ribbing density, when the microconchs are more evolute with wider-spaced ribs. Here, the ribbing density and especially the coiling of the shell are extremely variable, which hampers the distinction of microconchs and macroconchs in specimens lacking the aperture. Large-sized, evolute macroconchs occur as well as small involute microconchs. This phenomenon, which is probably related to a relatively late ontogenetic sexual determination, is still poorly understood and needs further study. On average, however, the shell is evolute with a high-oval whorl section. The prominent primaries bifurcate in the outer third of the flank, where they become prorsiradiate. Towards the venter, the secondaries weaken and meet in the middle by forming a chevron, thus providing a diagnostic character. In the adult stage, the ribs are often interrupted on the venter and separated by a smooth line. Usually, one or two weak constrictions per whorl are developed; after a constriction we notice an abrupt increase in whorl height. The body-chamber comprises about one whorl. The maximum diameter extends 200 mm.

5. Further ammonite taxa possibly originating from the *planula* Biohorizon

Superfamily Haploceratoidea Zittel, 1884

Family Strigoceratidae Buckman, 1924

Subfamily Strigoceratinae Buckman, 1924

Genus *Granulochetoceras* Geyer, 1960

Type species: *Ammonites (Ochetoceras) uracensis* Dietlen, 1911.

Granulochetoceras cristatum (Dieterich, 1940) [M]
Pl. 5, Figs. 1, 2

*v1940 *Ochetoceras cristatum* n. sp. – Dieterich, p. 27, pl. 1, figs. 1–3.
v1959 *Ochetoceras cristatum* Dieterich. – Berckhemer & Hölder, p. 98, pl. 23, fig. 121.
v1964 *Ochetoceras (Granulochetoceras) cristatum* Dieterich. – Höroldt, p. 81, pl. 6, figs. 1, 2.
v1994 *Ochetoceras (Granulochetoceras) cristatum* Dieterich. – Schlegelmilch, p. 49, pl. 15, fig. 5.
v2011 *Granulochetoceras cristatum* (Dieterich). – Schweigert et al., p. 280, fig. 2.

Lectotype: Original of Dieterich, pl. 1, fig. 1 (GPIT-PV-75256), subsequently designated by Höroldt (1964); here re-illustrated on Pl. 5, Fig. 2.

Remarks: This rare species differs from *Ochetoceras* spp. mainly by its vertically undulating septicarinate serrate keel. The oxyconic conch exhibits a shallow furrow located at mid-flank. Below mid-flank, the sculpture consists of straight, proverse ribs, whereas in the outer part of the flank, thick wide-spaced concave ribs occur. Towards the venter, short secondaries are developed. The stratigraphic range of this species is imprecisely known due to the few scattered specimens collected from the screw. According to the lithology of the rock matrix of these specimens an occurrence of *G. cristatum* in the *planula* Biohorizon is possible.

Superfamily Lytoceratoidea Neumayr, 1875

Suborder Lytoceratina Hyatt, 1889

Family Lytoceratidae Neumayr, 1875

Subfamily Lytoceratinae Neumayr, 1875

Genus *Protetragonites* Hyatt, 1900

Protetragonites sp.
Pl. 10, Fig. 1

v2016 *Protetragonites*? sp. – Maisch & Salfinger-Maisch, p. 187.
v2022 *Protetragonites* sp. – Schweigert & Dietze, table 1.

Remarks: A single slightly compressed specimen of a large lytoceratid is recorded from the Wohlgeschichtete-Kalke Formation of Plettenberg Quarry. Although this specimen was collected *ex situ*, its lithology clearly points to its origination from the Wohlgeschichtete-Kalke Formation, very likely from the *planula* Biohorizon. The specimen does not show any ornamentation on the body-chamber and the superimposed shell clearly demonstrates that it was completely smooth. Earlier whorls are poorly preserved and do not exhibit details. Although the suture line cannot be studied, the very evolute coiling together with the absence of any ornamentation on the body-chamber points to an assignment to *Protetragonites*. The specimen was one of only five unequivocal records of lytoceratids in the entire Upper Jurassic of Swabia (Schweigert & Dietze 2022). In the course of this study, a further lytoceratid specimen was recovered from the *planula* Biohorizon of Plettenberg Quarry.

6. Characterization and correlation of the *planula* Biohorizon

The ammonite assemblage of the *planula* Biohorizon is characterized by the great abundance of the nominal species *Subnebrodites planula* (Zieten, 1830), which makes it easily identifiable. The range of *S. planula* is restricted to this horizon. In addition, *Metahaploceras litocerum* (Oppel) and its microconchiate counterpart *Lingulaticeras modestiforme* (Oppel, 1863) are very frequently found but much less diagnostic because of highly variable closely related forms occurring both in older and younger beds. All other occurring taxa are rare or even extremely rare. In the Franconian section studied by Nitzopoulos (1974)

the *planula* Biohorizon covers the interval of the beds S14 to S20. In the area of the southern and middle Franconian Alb the ammonite assemblage of the *planula* Biohorizon occurs around Bed 1053 in the bed numbering by Schmidt-Kaler (1962). In the Randen and Klettgau regions adjacent to the western Swabian Alb and in the Aargau region of northern Switzerland the *planula* Biohorizon is recorded from the Wangental and Letzi members, respectively, of the Villigen Formation (Gygi 1969, 2000).

The next older clearly distinguishable biohorizon below the *planula* Biohorizon is the *tonnerrense* Biohorizon (Schweigert 1995). The beds belonging to this biohorizon are rather poor in ammonites. In the Plettenberg section, it is immediately overlying the *bauhini* Biohorizon and recorded from the basal bed of the Wohlgeschichtete-Kalke Formation (Schweigert & Callomon 1997). From the section "Kaserne" near Spielberg am Hahnenkamm, Nitzopoulos (1974) recorded the following ammonite assemblage of the *tonnerrense* Biohorizon (original determinations updated herein):

Praeataxioceras tonnerrense (Loriol, 1893) [m]
Lithacosphinctes grandiplex (Quenstedt, 1888) [M]
Orthosphinctes cf. *wemodingensis* (Wegele, 1929) [m]
Metahaploceras litocerum (Oppel, 1863) [M]
Lingulaticeras cf. *modestiforme* (Oppel, 1863) [m]
Physodoceras sp. [M]

In the Wieluń Upland of central Poland, the base of the Planula Zone is characterized by the sudden appearance of small-sized *Subnebrodites* along with *Amoebites* and *Vielunia* (Wierzbowski et al. 2010). This *matyjai* Biohorizon, named after *Subnebrodites matyjai* Wierzbowski & Głowniak in Wierzbowski et al., 2010 cannot be traced anywhere in southwestern Germany. We strongly suspect the presence of a hiatus at the base of the Planula Zone in the studied sections of Swabia and Franconia. In the Wieluń Upland and the Holy Cross Mountains, time-equivalents of the *planula* Biohorizon are easily detectable by the presence of *S. planula*; the same can be said from any other areas in the Submediteranean or Mediterranean where *S. planula* is recorded. Direct correlation of the *planula* Biohorizon with the Boral realm is impossible due to the absence of cardioceratids.

Above the *planula* Biohorizon, three further ammonite biohorizons assigned to the Planula Zone are distinguished in the Upper Jurassic of southwestern Germany; these are, from bottom to top, the *schroederi*, *wenzeli* and *falcula* biohorizons (Schweigert 1995, 2000). Detailed studies of the ammonite assemblages of this stratigraphic interval are still missing from southern Germany. In the *schroederi* Biohorizon, the zonal index *Subnebrodites planula* (Zieten) is replaced by the smaller-sized and denser-ribbed *Subnebrodites schroederi* (Wegele, 1929) including its minute corresponding microconch *Subnebrodites minutus* (Dieterich, 1940). This dimorphic pair is the so far youngest known representative of this ammonite genus, which apparently became extinct long before the end of the Planula Zone. The *wenzeli* and *falcula* biohorizons already belong to the Galar Subzone, which is indicated by the appearance of its easily identifyable index species *Sutneria galar* (Oppel, 1863). Recently, Wierzbowski (2020, 2022) included the Galar Subzone into the Platynota Zone. This procedure, however, was not adopted in the most recent overview on the Kimmeridgian boundary including the definition of its base (Wierzbowski et al. 2023) and needs further discussion.

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Plate 1

(1) *Taramelliceras* aff. *kobyi* (Choffat, 1893), SMNS 70670/1. (a) Lateral view; (b, c) ventral views. Plettenberg Quarry, Bed 104. Lower Kimmeridgian, Planula Zone, *planula* Biohorizon.
(2) *Taramelliceras broilii* (Wegele, 1929), SMNS 70670/2. (a, b) Lateral views; (c) ventral view. Plettenberg Quarry, bed 105. Lower Kimmeridgian, Planula Zone, *planula* Biohorizon.
(3) *Metahaploceras litocerum* (Oppel, 1863), holotype, SNSB-BPSG AS VIII 145 (original of *Ammonites litocerus* Oppel, 1863 pl. 53, fig. 8). (a) Lateral view; (b) ventral view. Planula Zone; Thalmässing, Franconian Alb.
(4) *Taramelliceras broilii* (Wegele, 1929), holotype, SNSB-BSPG 1927 VII 213 (original of *Oppelia broilii*, Wegele, 1929, pl. 26, fig. 10). (a) Lateral view; (b) ventral view. Weißjura beta, Mörsbach near Markt Titting, Franconian Alb.
(5) *Metahaploceras litocerum* (Oppel, 1863), SMNS 70670/3. (a) Lateral view; (b, c) ventral views. Plettenberg Quarry, Bed 104. Lower Kimmeridgian, Planula Zone, *planula* Biohorizon.

Beginning of body-chamber is indicated by an arrow.

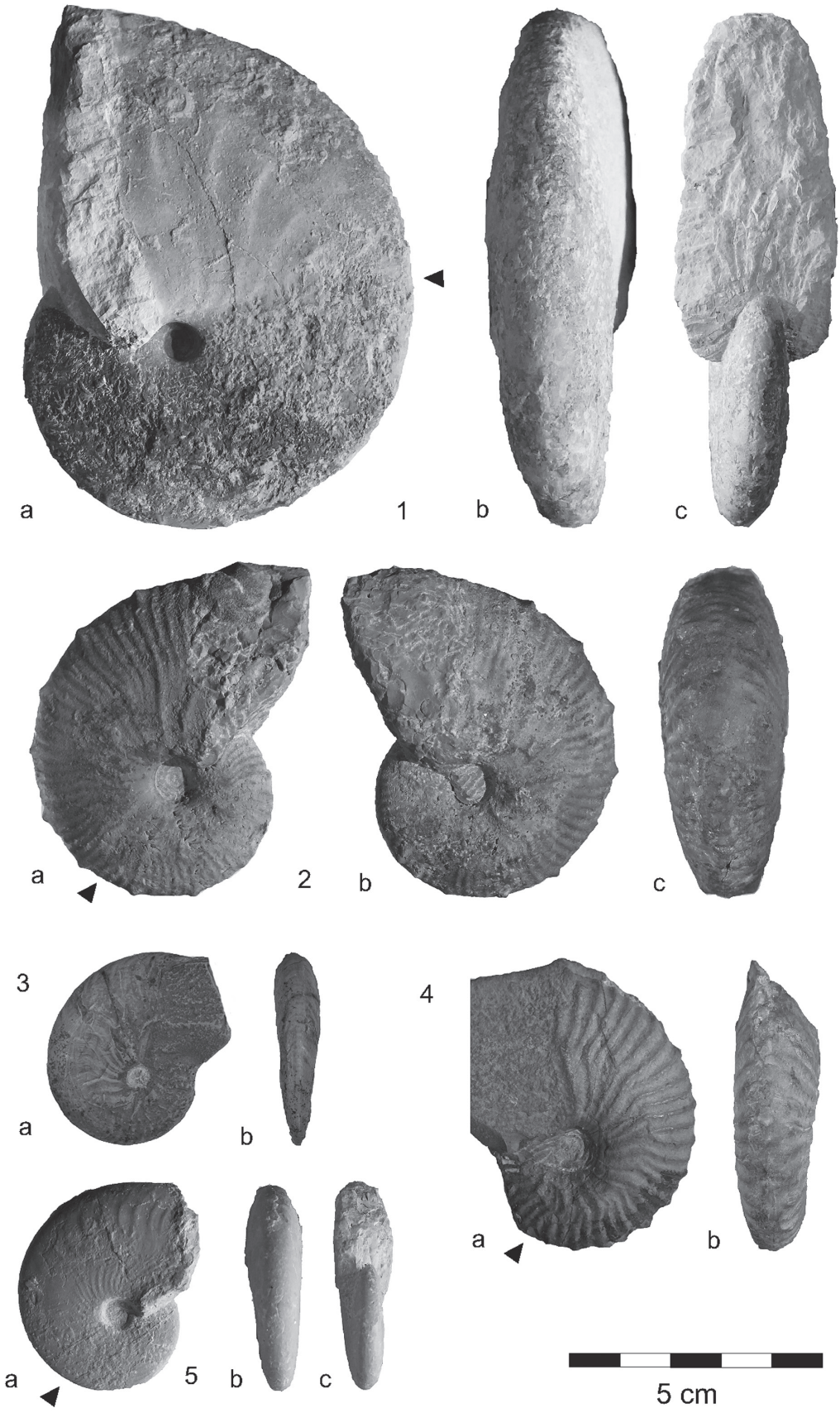

Plate 2

(1) *Metahaploceras litocerum* (Oppel, 1863), SMNS 70670/4. Plettenberg Quarry, Bed 104. Lower Kimmeridgian, Planula Zone, *planula* Biohorizon.
(2) *Metahaploceras litocerum* (Oppel, 1863), SMNS 70670/5. Plettenberg Quarry, Bed 105. Lower Kimmeridgian, Planula Zone, *planula* Biohorizon.
(3) *Metahaploceras litocerum* (Oppel, 1863), SMNS 70670/6. Plettenberg Quarry, Bed 104. Lower Kimmeridgian, Planula Zone, *planula* Biohorizon.
(4) *Metahaploceras litocerum* (Oppel, 1863), SMNS 70670/7. Plettenberg Quarry, Bed 104. Lower Kimmeridgian, Planula Zone, *planula* Biohorizon.
(5) *Metahaploceras litocerum* (Oppel, 1863), SMNS 70670/8. Plettenberg Quarry, Bed 105. Lower Kimmeridgian, Planula Zone, *planula* Biohorizon.
(6) *Lingulaticeras lingulatum* (Quenstedt, 1858), holotype, GPIT-PV-51611 (original of *Ammonites lingulatus* Quenstedt 1857, pl. 76, fig. 17). (a) Lateral view front side (b) Lateral view back side (c) Ventral view. Wohlgeschichtete-Kalke Formation, Planula Zone, Lauchheim, eastern Swabian Alb.
(7) *Lingulaticeras lingulatum* (Quenstedt, 1858), SMNS 70670/9. Plettenberg Quarry, Bed 103. Lower Kimmeridgian, Planula Zone, *planula* Biohorizon.
(8) *Lingulaticeras lingulatum* (Quenstedt, 1858), SMNS 70670/10. Plettenberg Quarry, Bed 104. Lower Kimmeridgian, Planula Zone, *planula* Biohorizon.
(9) *Lingulaticeras lingulatum* (Quenstedt, 1858), SMNS 70670/11. Plettenberg Quarry, Bed 105. Lower Kimmeridgian, Planula Zone, *planula* Biohorizon.
(10) *Lingulaticeras crassum* Ziegler, 1958, holotype, SMNS 19366 (original of *Glochiceras (Lingulaticeras) crassum* Ziegler 1958, pl. 13, figs. 3, 4). a) Lateral view; (b) ventral view. Lower Weißjura Group, *bauhini* Biohorizon, vicinity of Tuttlingen, western Swabian Alb.
(11) *Lingulaticeras* aff. *crassum* Ziegler, 1958, SMNS 70670/12. Plettenberg Quarry, Bed 105. Lower Kimmeridgian, Planula Zone, *planula* Biohorizon.
(12) *Lingulaticeras modestiforme* (Oppel, 1863), lectotype, BPSG AS VIII 7 (original of *Ammonites modestiformis* Oppel, 1863 pl. 54, fig. 5) (a) Lateral view; (b) ventral view. Werkkalke Formation, Planula Zone; Thalmässing, Franconian Alb.
(13) *Lingulaticeras modestiforme* (Oppel, 1863), SMNS 70670/13. Plettenberg Quarry, Bed 104. Lower Kimmeridgian, Planula Zone, *planula* Biohorizon.
(14) *Lingulaticeras modestiforme* (Oppel, 1863), SMNS 70670/14. Plettenberg Quarry, Bed 104. Lower Kimmeridgian, Planula Zone, *planula* Biohorizon.
(15) *Lingulaticeras modestiforme* (Oppel, 1863), SMNS 70670/15. Plettenberg Quarry, Bed 104. Lower Kimmeridgian, Planula Zone, *planula* Biohorizon.
(16) *Pictonites perisphinctoides* (Wegele, 1929), holotype, SNSB-BSPG 1927 I 505 (original of *Rasenia perisphinctoides* Wegele 1929, pl. 10 (14), fig. 2). (a) Lateral view; (b) ventral view. Weißjura beta, Planula Zone; Spielberg am Hahnenkamm, Franconian Alb.
(17) *Pictonites perisphinctoides* (Wegele, 1929), juvenile specimen, SMNS 70670/16. (a) Lateral view; (b) ventral view. Plettenberg Quarry, Bed 104. Lower Kimmeridgian, Planula Zone, *planula* Biohorizon.

Beginning of body-chamber is indicated by an arrow.

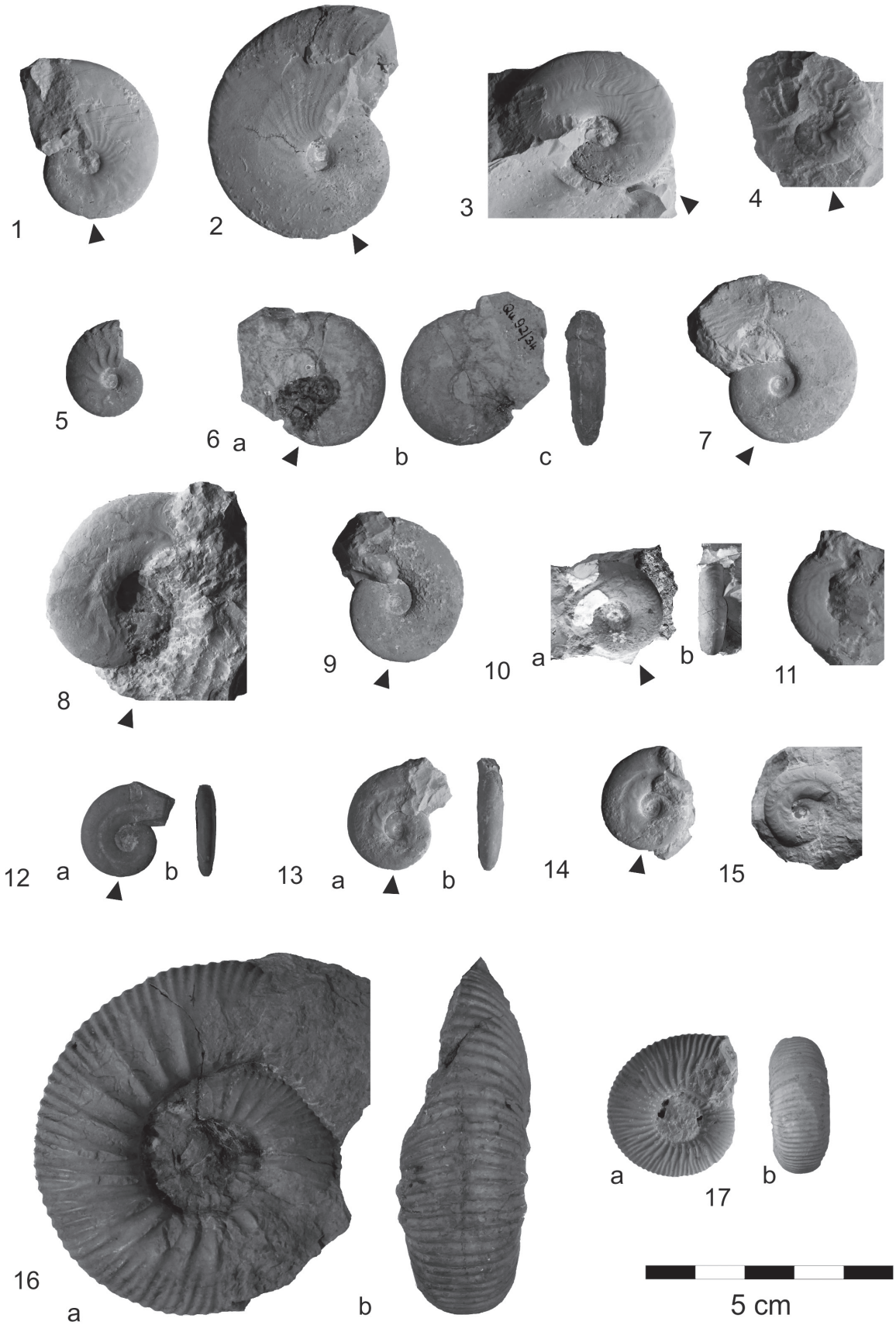

Plate 3

(1) *Epaspidoceras mamillanum* (Quenstedt, 1847), holotype, GPIT-PV-61902 (original of *Ammonites perarmatus mamillanus* Quenstedt 1847, pl. 16, fig. 11) (a) Lateral view; (b) ventral view. Oberjura-Massenkalk Formation (Lochen Member), ?Planula or Platynota Zone, Nusplingen, western Swabian Alb.
(2) *Epaspidoceras mamillanum* (Quenstedt, 1849) (leg. & coll. H. Kuschel), Plettenberg Quarry, upper level, southern side. Lower Kimmeridgian, Planula Zone, *planula* Biohorizon.
(3) *Simosphinctes tieringensis* (Fischer, 1913b), holotype, GPIT-PV-75369 (original of *Perisphinctes tieringensis* Fischer 1913b, pl. 5, fig. 20) (a) Lateral view; (b) ventral view, originally labeled as "Weißer Jura gamma". Oberjura-Massenkalk Formation (Lochen Member), Tieringen, Planula or Platynota Zone.
(4) *Simosphinctes tieringensis* (Fischer, 1913b). SMNS 70670/17. Plettenberg Quarry, Bed 105. Lower Kimmeridgian, Planula Zone, *planula* Biohorizon.
(5) *Physodoceras circumspinosum* (Quenstedt, 1857), holotype, GPIT-PV-62132 (original of *Ammonites inflatus macrocephalus* Quenstedt 1847, pl. 16, fig. 14). (a) Lateral view; (b) ventral view. Donzdorfer Steige, originally labeled as "mittlerer Weißer Jura", most likely from Wohlgeschichtete-Kalke Formation, Planula Zone, according to rock matrix.
(6) *Sutneria praecursor* (Dieterich, 1940), lectotype, GPIT-PV-75264 (original of *Sutneria praecursor* Dieterich 1940, pl. 2, fig. 1). (a) Lateral view; (b) ventral view. Wohlgeschichtete-Kalke Formation, Planula Zone; Nusplingen, western Swabian Alb.
(7) *Sutneria praecursor* (Dieterich, 1940), SMNS 28885. (a) Lateral view; (b) ventral view. Planula Zone, *planula* Biohorizon. Spielberg am Hahnenkamm; Steinbruch Schneider Quarry (Bed S20), Franconia Alb.
(8) *Physodoceras circumspinosum* (Quenstedt, 1857), SMNS 70671/1 (a) Lateral view; (b) ventral view. Planula Zone, *planula* Biohorizon; Spielberg am Hahnenkamm, Schneider Quarry (Bed S20), Franconian Alb.
(9) *Physodoceras circumspinosum* (Quenstedt, 1857), SMNS 70670/18. Plettenberg Quarry, from fallen block at lowest level of western side, most probably Planula Zone, *planula* Biohorizon.

Beginning of body-chamber is indicated by an arrow.

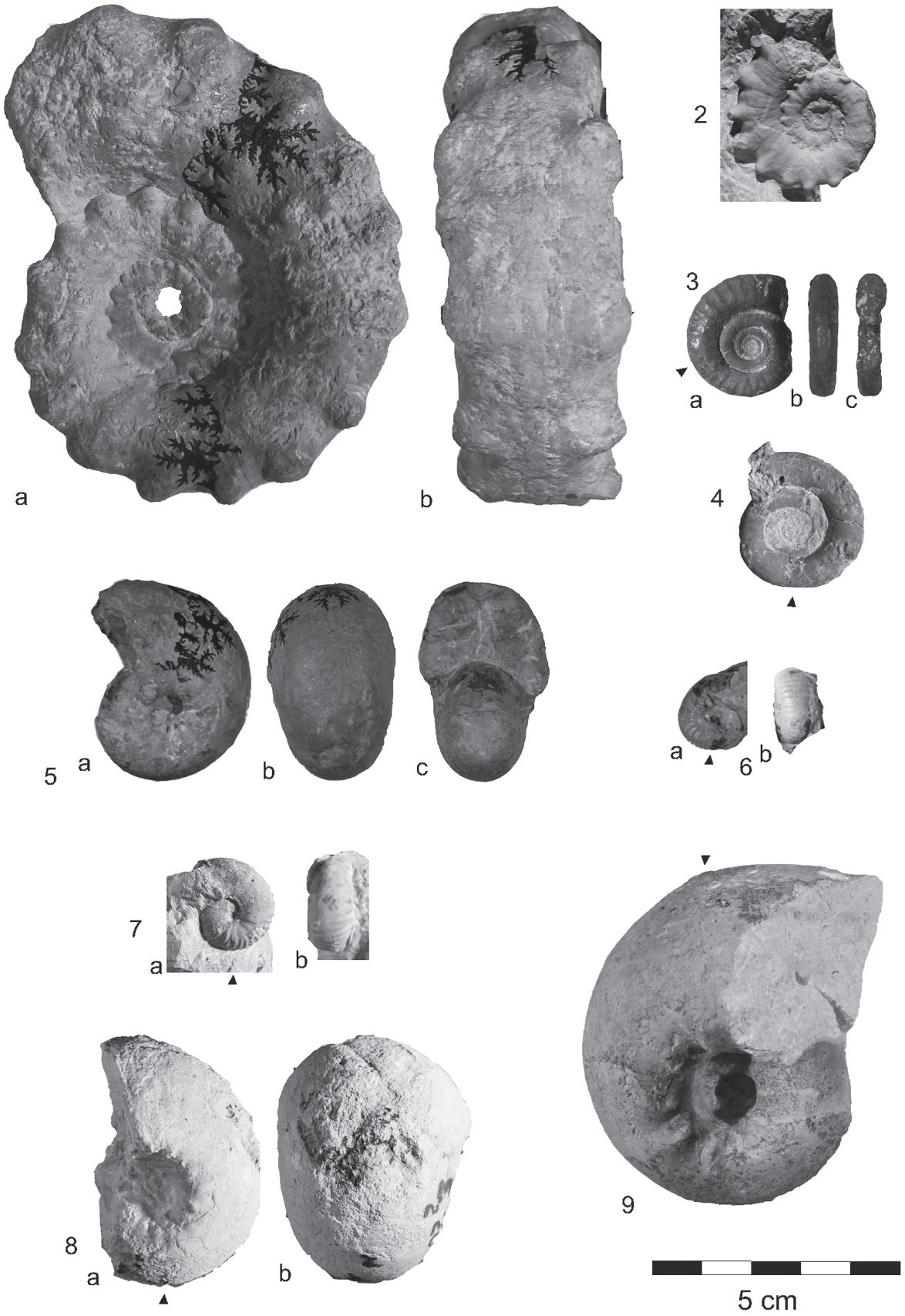

Plate 4

(1) *Prorasenia quenstedti* Schindewolf, 1926, SMNS 70670/19. (**a**) Lateral view; (**b)** ventral view. Plettenberg Quarry, Bed 105. Lower Kimmeridgian, Planula Zone, *planula* Biohorizon.
(2) *Prorasenia quenstedti* Schindewolf, 1926, SMNS 70670/20. (**a**) Lateral view; (**b)** ventral view. Plettenberg Quarry, Bed 105. Lower Kimmeridgian, Planula Zone, *planula* Biohorizon.
(3) *Lithacosphinctes gigantoplex* (Quenstedt, 1887) [m], with preserved lappets, SMNS 70670/21. (**a**) Lateral view; (**b, c)** ventral views. Plettenberg Quarry, Bed 104. Lower Kimmeridgian, Planula Zone, *planula* Biohorizon.
(4) *Lithacosphinctes gigantoplex* (Quenstedt, 1887) [M], SMNS 70670/22. Plettenberg Quarry, Bed 104. Lower Kimmeridgian, Planula Zone, *planula* Biohorizon.
(5) *Subdiscosphinctes grandiplex* (Quenstedt, 1887) [?M], SMNS 28892 (original of *Lithacoceras (Lithacoceras) spielbergense* Nitzopoulos 1974, pl. 7, fig. 3). Spielberg am Hahnenkamm, Schneider Quarry (Bed S20), Planula Zone, *planula* Biohorizon.
(6) *Lithacosphinctes gigantoplex* (Quenstedt, 1887) [?M], juvenile specimen, SMNS 70670/23. (a) Lateral view; (b) ventral view. Plettenberg Quarry, Bed 105. Lower Kimmeridgian, Planula Zone, *planula* Biohorizon.

Beginning of body-chamber is indicated by an arrow.

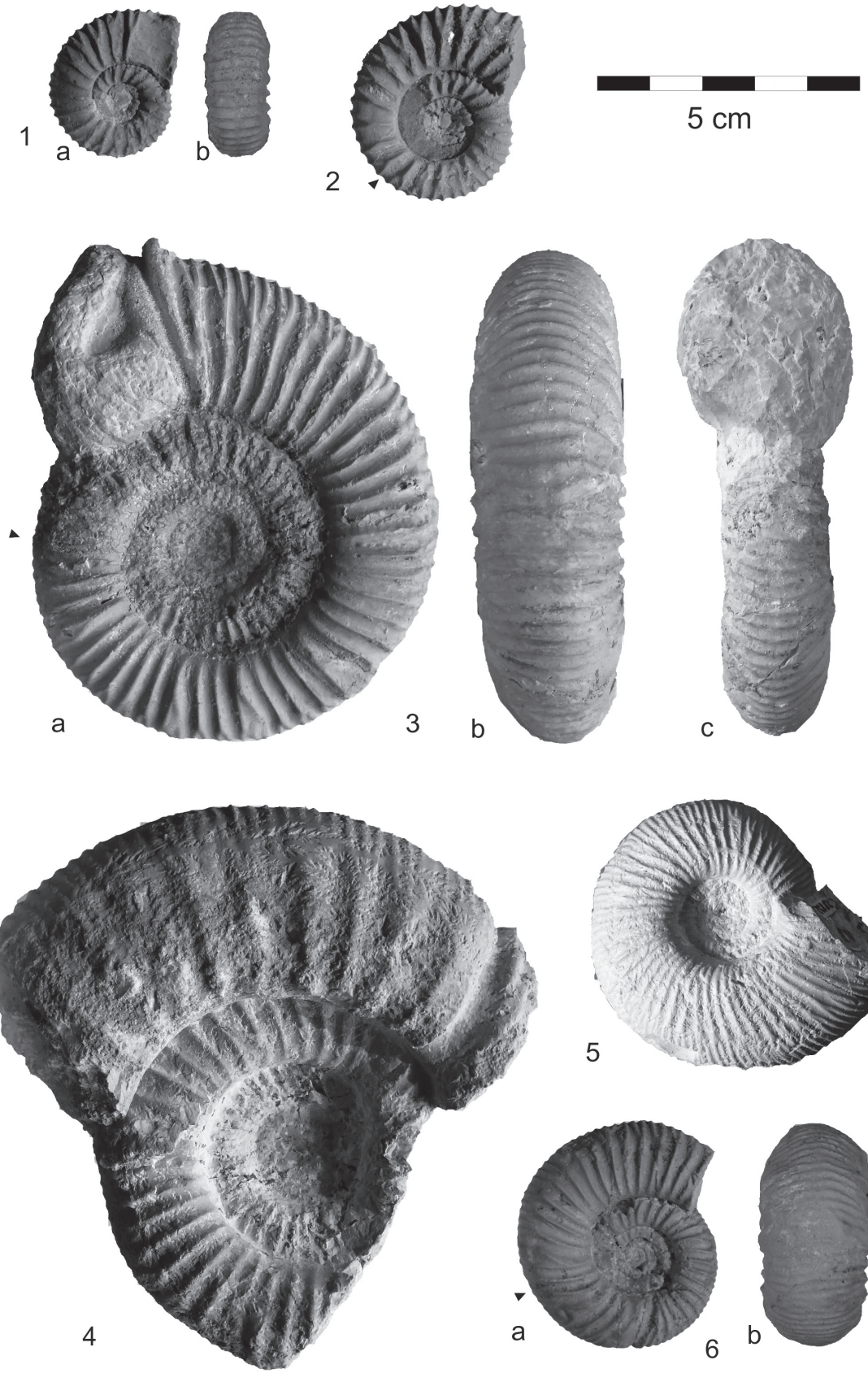

Plate 5

(1) *Granulochetoceras cristatum* (Dieterich, 1940), GPIT Ce 1101/13 (original of Berckhemer & Hölder 1959, pl. 23, fig. 121). Wohlgeschichtete-Kalke Formation, Planula Zone, possibly *planula* Biohorizon; road connecting Bad Urach and Hülben, middle Swabian Alb.
(2) *Granulochetoceras cristatum* (Dieterich, 1940), lectotype, GPIT-PV-75256 (original of Dieterich 1940, pl. 1, fig. 1). Wohlgeschichtete-Kalke Formation, Planula Zone, possibly *planula* Biohorizon; Spaichingen, western Swabian Alb.
(3) *Subnebrodites planula* (Zieten, 1830) [m], with preserved lappets, GPIT-PV-62070 (original of *Ammonites planula* Hehl in Quenstedt 1887, pl. 108, fig. 2). Wohlgeschichtete-Kalke Formation, Planula Zone; Aalen-Wasseralfingen, eastern Swabian Alb.
(4) *Subnebrodites planula* (Zieten, 1830) [M], with preserved aperture, SMNS 28923 (original of *Idoceras planula* (Hehl) in Nitzopoulos 1974, pl. 8, fig. 4). Planula Zone, *planula* Biohorizon; Spielberg am Hahnenkamm, Schneider Quarry (Bed S13), Franconian Alb.

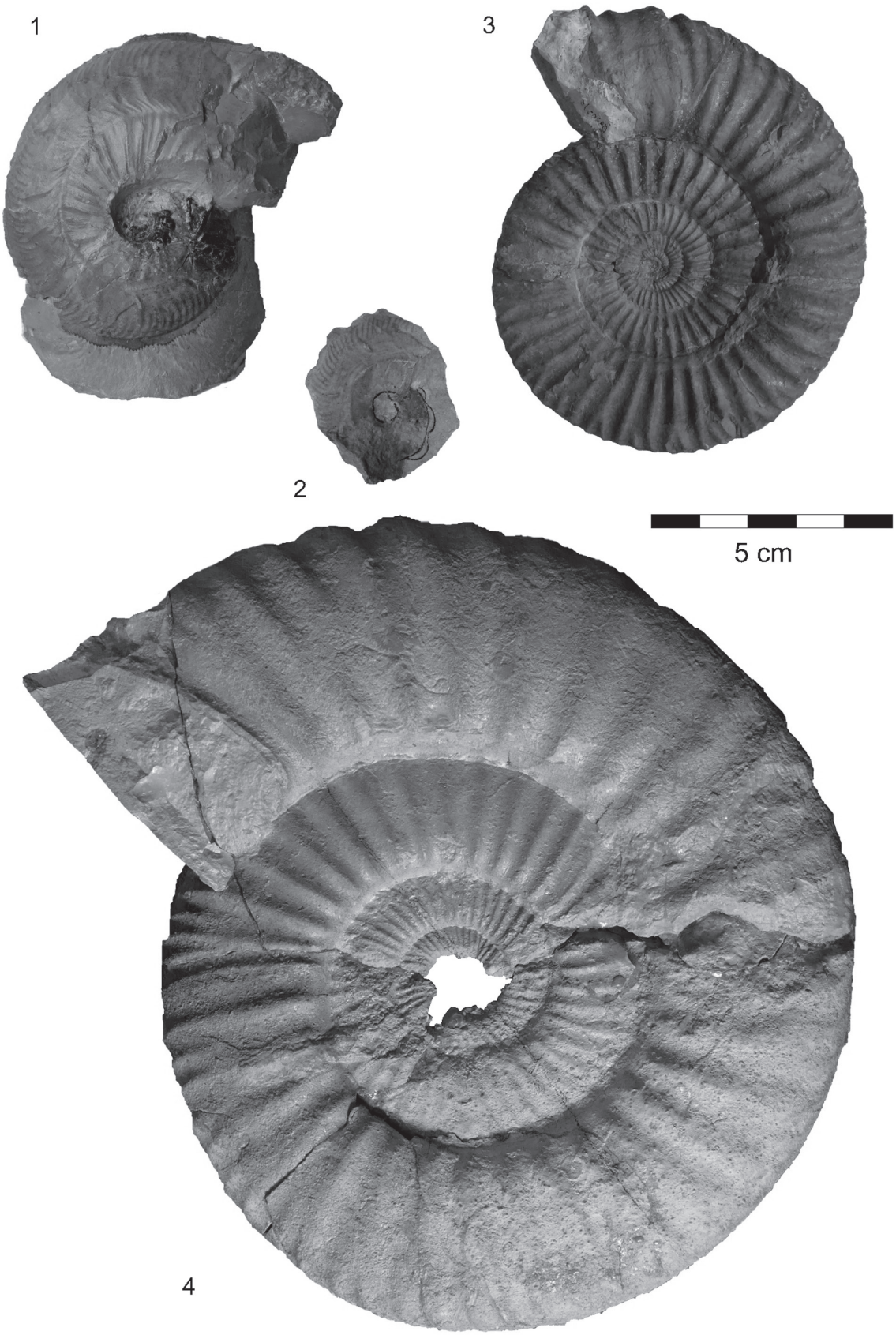

Plate 6

(1) *Subnebrodites planula* (Zieten, 1830) [M], neotype, SMNS 70398 (original of Schweigert & Kuschel 2017, fig. 4). Wohlgeschichtete Kalke Formation, Planula Zone, *planula* Biohorizon; Unterweckerstell near Donzdorf, eastern Swabian Alb.
(2) *Subnebrodites planula* (Zieten, 1830) [?M], SMNS 70670/24. Plettenberg Quarry, Bed 104. Lower Kimmeridgian, Planula Zone, *planula* Biohorizon.
(3) *Subnebrodites planula* (Zieten, 1830) [m], with partly preserved lappet, SMNS 70670/25. Plettenberg Quarry, Bed 104. Lower Kimmeridgian, Planula Zone, *planula* Biohorizon.
(4) *Subnebrodites planula* (Zieten, 1830) [?m], juvenile specimen, SMNS 70670/26. Plettenberg Quarry, Bed 105. Lower Kimmeridgian, Planula Zone, *planula* Biohorizon.
(5) *Subnebrodites planula* (Zieten, 1830) [?M], juvenile specimen, SMNS 70670/27. Plettenberg Quarry, Bed 104. Lower Kimmeridgian, Planula Zone, *planula* Biohorizon.
(6) *Subnebrodites planula* (Zieten, 1830) [m], juvenile specimen, SMNS 70670/28. Plettenberg Quarry, Bed 104. Lower Kimmeridgian, Planula Zone, *planula* Biohorizon.
(7) *Subnebrodites planula* (Zieten, 1830) [M], juvenile specimen, SMNS 70670/29. Plettenberg Quarry, Bed 104. Lower Kimmeridgian, Planula Zone, *planula* Biohorizon.
(8) *Subnebrodites planula* (Zieten, 1830) [M], with partly preserved aperture, SMNS 70669 (leg. A. Hagenlocher). Lower Kimmeridgian, Planula Zone; Bubsheim, western Swabian Alb.
(9) *Subnebrodites planula* (Zieten, 1830) [M], SMNS 70670/30. Plettenberg Quarry, Bed 105. Lower Kimmeridgian, Planula Zone, *planula* Biohorizon.
(10) *Subnebrodites planula* (Zieten, 1830) [M], with preserved aperture, SMNS 70670/31. Plettenberg Quarry, Bed 105. Lower Kimmeridgian, Planula Zone, *planula* Biohorizon.

Beginning of body-chamber is indicated by an arrow.

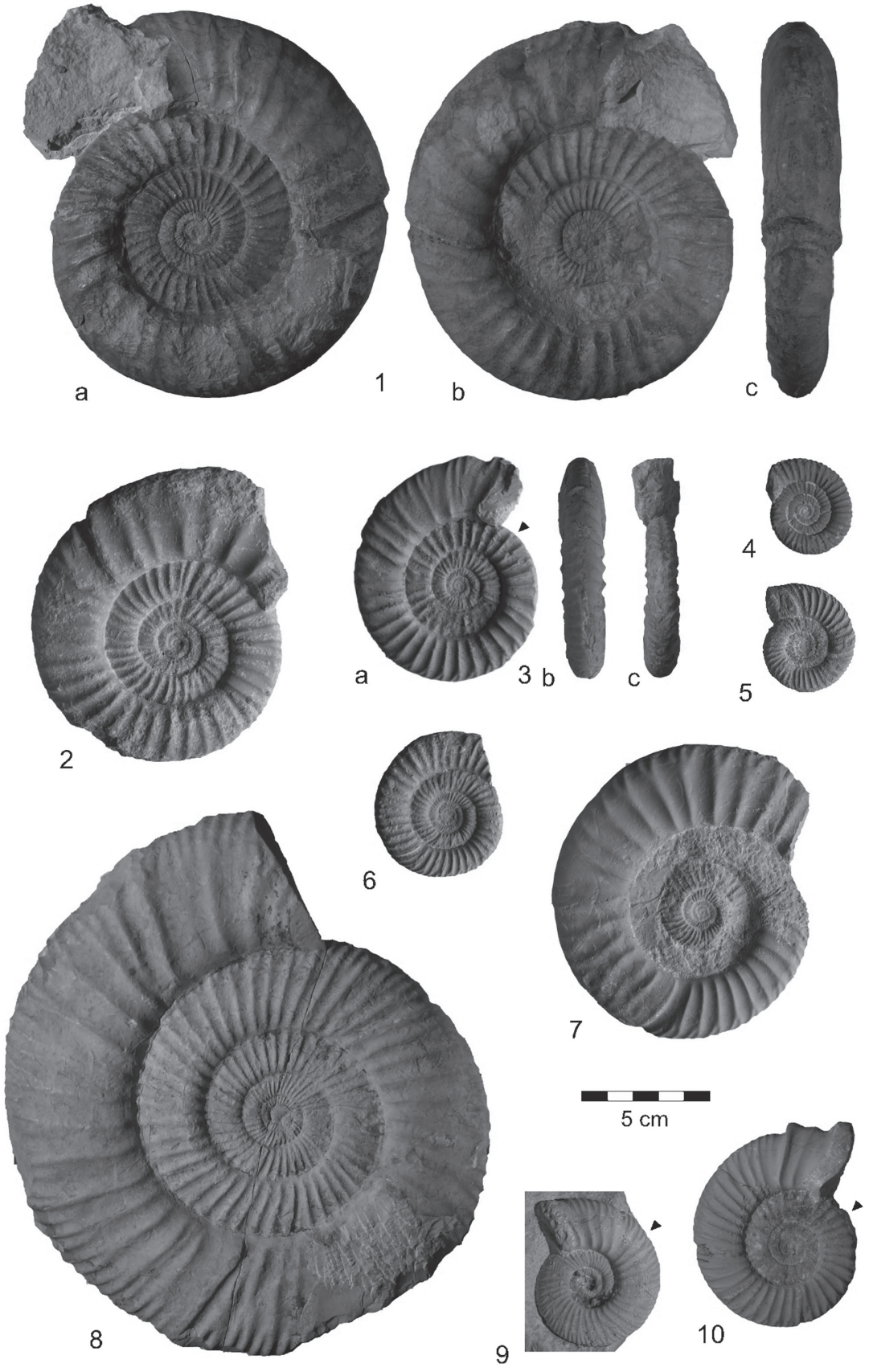

Plate 7

Subdiscosphinctes grandiplex (Quenstedt, 1887) [M], holotype, GPIT-PV-31604 (original of *Ammonites grandiplex* Quenstedt 1887, pl. 102, fig. 1). Wohlgeschichtete-Kalke Formation, Planula Zone; Ahlsberg Hill near Pfullingen, middle Swabian Alb.

Beginning of body-chamber is indicated by an arrow. Scale reduced.

Plate 8

(1) *Subdiscosphinctes grandiplex* (Quenstedt, 1887) [M], SMNS 70671/2. Planula Zone, *planula* Biohorizon; Spielberg am Hahnenkamm, Schneider Quarry (Bed S20), Franconian Alb.
(2) *Vielunia dzalosinensis* Wierzbowski & Głowniak, 2010 [M], adult specimen, SMNS 28925 (original of *Ringsteadia (V.) weinlandi* (Fischer) in Nitzopoulos 1974, pl. 10, fig. 1). Planula Zone, *planula* Biohorizon. Spielberg am Hahnenkamm, Schneider Quarry (Bed S16), Franconian Alb.

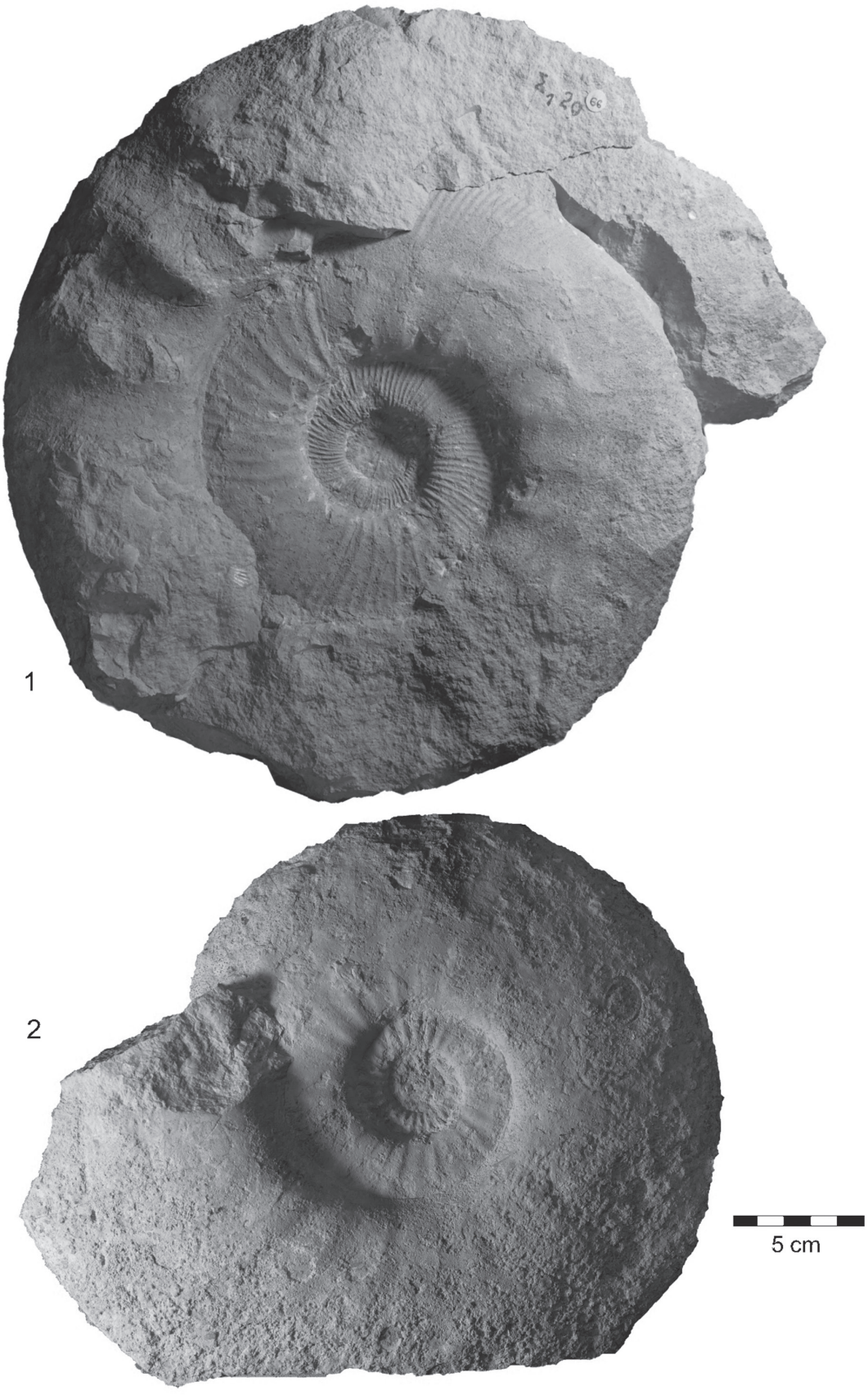

Plate 9

Lithacosphinctes gigantoplex (Quenstedt, 1887) [M], holotype, GPIT-PV-31598 (original of *Ammonites grandiplex* Quenstedt, 1887 pl. 102, fig. 4). Wohlgeschichtete-Kalke Formation, Planula Zone; Aalen-Wasseralfingen, eastern Swabian Alb.

Beginning of body-chamber is indicated by an arrow.

Plate 10

(1) *Protetragonites* sp. [M], SMNS 70670/32. Plettenberg Quarry. Lower Kimmeridgian, Planula Zone, possibly *planula* Biohorizon according to lithology of the rock matrix.
(2) *Lithacosphinctes gigantoplex* (Quenstedt, 1887) [M], SMNS 70670/33. Plettenberg Quarry, upper level, southern side. Lower Kimmeridgian, Planula Zone, *planula* Biohorizon.
(3) *Subdiscosphinctes grandiplex* (Quenstedt, 1887) [M], SMNS 70670/34. Plettenberg Quarry, upper level, southern side. Lower Kimmeridgian, Planula Zone, *planula* Biohorizon.

Beginning of body-chamber is indicated by an arrow.