The *semimammatum* and *semiarmatum* ammonite biohorizons (Late Oxfordian, Hypselum Zone) in the Upper Jurassic of Southwestern Germany

**Herbert Jantschke & Günter Schweigert**

**Abstract**

The Late Oxfordian ammonite faunas of the *semimammatum* and *semiarmatum* biohorizons are described, mostly based on material from the Impressamergel Formation of the Plettenberg Quarry near Dotternhausen (western Swabian Alb). 21 ammonite are recorded, including some previously undescribed from the Upper Jurassic of SW Germany. Previously, the *semimammatum* Biohorizon has been studied in Franconia, Western France and central Poland and the *semiarmatum* Biohorizon only in Western France, respectively. Compared to the *semimammatum* Biohorizon, the *semiarmatum* Biohorizon is characterized by a significant increase of Submediterranean and Tethyan taxa and a total decline of Subboreal ones. This phenomenon is interpreted as the result of a seawater warming trend towards the above following *bimammatum* Biohorizon, which correlates with the recently suggested Oxfordian/Kimmeridgian stage boundary. This article summarizes the current state of knowledge of the Hypselum Zone in SW Germany. A lectotype is designated for *Richeiceras lochense* (Oppel, 1863).

**Key words:** Ammonites, biostratigraphy, Submediterranean Province, palaeoclimate.

1. Introduction

Both scientific palaeontological and stratigraphical research on the Jurassic stratigraphy and palaeontology of the Swabian Alb started in the first third of the 19th Century (Stahl 1824; Buch 1831; Zieten 1830–1833). Soon after, Quenstedt entered a professorship for geology and stratigraphy (“Geognosie”) at Tübingen University and focused his lifelong research activities on the Jurassic of this area (e.g., Quenstedt 1843, 1856–1857, 1885, 1887–1888, among others). Fundamental studies towards a refinement of the Jurassic time scale were conducted by his student Albert Oppel (e.g., Oppel 1856–1858, 1862–1863) and many later authors. In the Upper Jurassic, the study of the rocks and their fossils was more complicated than in the Lower and Middle Jurassic because of the contemporaneous formation of different lithologies due to the development of sponge-microbial bioherms alongside normally bedded limestones and marls. Initially, this lead to severe confusion and subsequent misidentifications concerning the age of certain spongiolithic rocks, which had been considered as belonging to the middle part (‘Weißjura γ’) instead of to the lower part (‘Weißjura α’) of the Upper Jurassic (Quenstedt 1843, 1857). This was especially the case with the spongiolithic limestones of the locality “Lochen” near Balingen (Fig. 1), in the southwestern part of the Swabian Alb (see below). Geological mapping activities by Jakob Hildenbrand corrected the initially erroneous stratigraphic placement (Quenstedt 1877; Fischer 1913); however, precise biostratigraphical data about the locality “Lochen” have never been published.

Palaeobiogeographically, the Upper Jurassic of Southern Germany is part of the Submediterranean Province. This faunal province links the faunas from the Subboreal/Boreal seas in the north with those of the Tethys Ocean in the south. In the Oxfordian, this region became a moderately shallow carbonate ramp at the northern margin of the Tethys Ocean lacking any geographical barriers towards the south. The Rhenish and Bohemian massifs in the north and east sheltered the region towards the Boreal Sea; a marine connection between these massifs, the ‘Hesse Strait’ existed and allowed some exchange of marine faunas at least during times of sealevel highstands.

In the last decades, numerous detailed studies of Upper Oxfordian and Lower Kimmeridgian rocks and their fossil content in other European regions (Poland, United Kingdom, France, Spain) have provided substantial refinements of biostratigraphical data and correlations (see Wierzbowski et al. 2016 for a recent compilation). In Swabia, comparable studies of this interval focused on the Bimammatum Zone and the correlation problems related to the position of the base of the Kimmeridgian in various Jurassic faunal provinces (Schweigert & Callomon 1997; Schweigert 2000; Jantschke 2014). These studies are here continued with a re-assessment of the Late Oxfordian Hypselum Zone. At present, the Hypselum Zone comprises three ammonite biohorizons, from bottom to the top: *semimammatum*, *semiarmatum*, and *berrense* (Bonnot et al. 2009). The faunas of the first two are described here; the last one could not yet be recorded. The beds following above the *semiarmatum* Biohorizon, which possibly might represent the *berrense* Horizon, are very poor in fossils in the studied section.
2. The historical type locality “Lochen” near Balingen

Siliceous sponge-microbial bioherms form the lower part of the Oberjura-Massenkalk Formation (Lochen Member). Such bioherms are widespread in the south-western part of the Swabian Alb, namely in the area from the town of Balingen in the north to the Danube valley in the south. Towards the east, bedded marlstones and limestones of the Impressmergel Formation predominate and sponge bioherms are almost absent, thus suggesting a deeper environment in the central and eastern part of the Swabian Alb. Within the area with abundant bioherms, the mountain pass “Lochen” near Balingen (Fig. 1) is often mentioned as a highly fossiliferous locality in the palaeontological literature of the Swabian Upper Jurassic, thus becoming a ‘classical’ fossil site (Engel 1908; Geyer & Gwinner 1984; SauerBörn 1995). Numerous ammonites have been described from this locality,

Fig. 1. Upper Jurassic outcrops in Germany, with a detailed map of the study area in the southwestern part of the Swabian Alb. Localities: 1 – Plettenberg Quarry; 2 – historical type locality “Lochen”.
besides sponges, bivalves, gastropods, brachiopods, echinoids, crinoids, crustaceans and numerous others (e.g., Buch 1831; Queustedt 1856–1857, 1883, 1887–1888; Oppel 1862–1863; Engel 1908; Fischer 1913; Ziegler 1977, 1987, among others). The outcrop situation in the first half of the 19th century is not precisely known, since the ancient road crossing the mountain pass was newly constructed in the years 1848–1852. Today, the rocks exposed at this location still yield fossils, but the continuous sampling of students and amateur collectors has made findings becoming rare. The creamy to reddish coloured marly rocks exposed at the western hillside of the pass (“Lochengründle”) represent the upper part of the Bifurcatus Zone, as indicated by numerous specimens of the zonal index ammonite (SMNS collection). The greyish rocks formerly exposed at the eastern hillside are mostly covered nowadays, but from sampling in the early 1990ies it is known they contain the semimammatum Biohorizon (G.S., own observation) and possibly the semiarmatum Biohorizon as well. Several hundreds of metres further to the south of the mountain pass, the basalmost limestones and marls of the Impressamergel Formation yielded a few biostratigraphically important ammonites of the genus Gregoryceras indicating a mid-Oxfordian age (Krautter 1984); however, this section is no longer accessible. A section that represents the bimammatum Biohorizon is exposed in an abandoned quarry (now used as tennis yard of the nearby Lochen youth hostel) and no longer accessible, either. The “Lochenstein” hill itself is made up of massive spongolithic limestones of the Lochen Member. There, the stratigraphical range of this member expands at least to the Lower Kimmeridgian Platynota Zone or even somewhat higher up (equivalents of the Lacunosamergel Formation) (cf. Schädel 1957).
3. Geological setting of the studied section

Since the spongiolithic limestones and marls at the historical type locality “Lochen” do not allow for precise bed-by-bed sampling, a well-exposed section inside the nearby Plettenberg Quarry on the top of the Plettenberg Mountain was studied. The Plettenberg forms an outlier of Upper Jurassic rocks separated from the mountains of the Swabian Alb by deeply incised valleys (Fig. 2). The limestone quarry was opened in 1909. Today, the Plettenberg Quarry is property of the Lafarge-Holcim Cement Company and still active. It covers an area of about 1 x 0.5 kilometres, with a vertical range of about 60 metres, subdivided by three quarry floors. The succession of limestones and marlstones exposed in the quarry ranges from the uppermost part of the Bifurcatus Zone to the middle part of the Planula Zone (Fig. 3). The marly lower part of the succession is made up by the Impressamergel Formation, with a more calcareous member (‘Bimammatumbänke’) in its top. In the very top of this formation, there is a narrow marly interval yielding the ammonite fauna of the well-studied bauhini Biohorizon (Schweigert & Callomon 1997; Schweigert & Jantschke 2001; Schweigert & Kapitza 2018). This marker bed is abruptly followed by whitish to cream-coloured sublithographic limestones of the Wohlgeschichtete-Kalke Formation. The Impressamergel and Wohlgeschichtete-Kalke formations are interfingering with massive sponge-microbial bioherms of the Lochen Member, with the fossiliferous ‘Lochenschichten’ – equivalent to those at the historical type locality “Lochen” – in a transitional position (Ziegler 1977, 1987).

The studied section covers nearly the entire Hypselum Zone as well as the lower part of the Bimammatum Zone above the second floor (Fig. 4). The section starts at the first quarry floor with biostromal beds containing the semimammatum Biohorizon (beds 3–7). In the steep quarry wall between the first and the second floor, four sequences of marlstone/limestone beds divided by grey claystone can be observed (Fig. 5). The first sequence contains the semimammatum Biohorizon, while the following semiararmatum Biohorizon is limited to the top of the second sequence forming a layer only 10–15 cm thick. The third or fourth sequence is expected to contain the berrense Biohorizon, but due to the rareness of macrofossils within these beds this biohorizon could not yet be definitely recorded. Higher-up strata are well accessible above the second floor of the quarry. The section was measured up to the onset of the bimammatum Biohorizon (bed 1), which has been previously recorded in detail (Jantschke 2014).

The preparation of the sampled ammonites was done mechanically. All illustrated and measured material is stored in the collection of the Stuttgart Natural History Museum (SMNS), unless otherwise stated.

4. Systematic palaeontology

Order Ammonitida Fischer, 1882
Suborder Phylloceratina Arkell, 1950
Family Phylloceratidae Zittel, 1884
Subfamily Calliphylloceratinae Spath, 1927
Genus Sowerbyceras Parona & Bonarelli, 1895

Type species: Ammonites tortisulcatus Orbigny, 1841.

Sowerbyceras tortisulcatus (Orbigny, 1841) Pl. 1, Fig. 1

Fig. 3. Biostratigraphical zonation around the boundary Impressamergel Formation/Wohlgeschichtete-Kalke Formation in the Swabian Alb (modified from Schweigert & Callomon 1997). Hyps. = Hypselum; Bim. = Bimammatum.

Abbreviations: Dm = diameter, Uw = umbilical width, Wh = whorl height, Ww = whorl width, Pr = number of primary ribs on last whorl, Sr = number of secondary ribs on last whorl; [m] = microconch, [M] = macroconch; HT = holotype; LT = lectotype; SNSB-BSPG = Bayerische Staatssammlung für Paläontologie und Geologie, Munich, Germany, GPT = Geologisch-Paläontologisches Institut der Universität Tübingen, Germany, NHMB = Naturhistorisches Museum Bern, Switzerland, SMNS = Staatliches Museum für Naturkunde Stuttgart, Germany.

*1841 Ammonites tortisulcatus. – Orbigny, p. 162, pl. 51, figs. 4–6.
1849 Ammonites tortisulcatus. – Quenstedt, p. 506, pl. 189, figs. 1–3.
Fig. 4. View upon the lower part of the Upper Jurassic section in the Plettenberg Quarry. Note the occurrence of four limestone sequences in the Impressamergerl Formation, each subdivided by gray claystones. Towards the left, siliceous sponge/microbial bioherms (Lochen Member of Oberjura-Massenkalk Formation) are developed.
1887 *Ammonites tortisulcatus*. – Quenstedt, p. 898, pl. 97, figs. 1–5.
1994 *Sowerbyceras protortisulcatum* (Pompecki). – Schlegelmilch, p. 21, pl. 1, fig. 2.

**Lectotype:** Original of Orbigny 1849, pl. 189, figs. 1–3, stored in the Institut de Paléontologie du Muséum Paris, R. 505 and 3534F (Orbigny Collection), subsequently designated by Atrops (in Fischer 1994: 166).

**Material:** One specimen, *semiarmatum* Biohorizon (Plettenberg section, bed 10).

This small-sized ammonite is ornamented with four to six deep sinuous constrictions per whorl crossing the venter. The suture lines show phylloid saddles typical of phylloceratids as well as a characteristic delicate midline in its ventral symmetry plane. Whorl section trapezoidal; umbilicus moderately wide.

*Sowerbyceras tortisulcatum* is generally rare in the Oxfordian of Swabia and indicates a Tethyan influx. Although we have not recorded *Sowerbyceras tortisulcatum* from the *semiarmatum* Biohorizon of the Plettenberg section, it cannot be excluded that it occurs in that biohorizon as well.

**Fig. 5.** Section in the upper part of the Impressamergerl Formation of the Plettenberg Quarry, with the biohorizons recorded. The position of the Hypselum/Bimammatum zonal boundary is uncertain, since the *berrense* Biohorizon in the top of the Hypselum Zone has not been recorded there.
Suborder Ammonitina Fischer, 1882

Superfamily Stephanoceratoidea Neumayr, 1875

Family Cardioceratidae Siemiradzki, 1891

Subfamily Cardioceratinae Siemiradzki, 1891

Genus Amoeboceras Hyatt, 1900

Type species: Ammonites alternans Buch, 1831.

Amoeboceras alternans (Buch, 1831) [m]

*1831 Ammonites alternans. – Buch, pl. 7, fig. 4.
1849 Ammonites alternans ovalis. – Quenstedt, p. 96, pl. 5, fig. 8.
1857 Ammonites alternans. – Quenstedt, p. 617, pl. 76, fig. 14.
1887 Ammonites alternans oblongus. – Quenstedt, p. 824, pl. 91, figs. 1, 2.
1887 Ammonites alternans. – Quenstedt, p. 824, pl. 91, figs. 6, 13.
1907 Cardioceras alternans (Buch). – Oppenheimer, p. 239.
1915 Cardioceras ovale (Quenstedt). – Salfeld, p. 80, pl. 16, figs. 1, 2, 8, 9.
1915 Cardioceras alternans (Buch). – Salfeld, pl. 16, fig. 6.
1930 Cardioceras ovale (Quenstedt). – Dorn, p. 80, pl. 24, figs. 25–27.
1930 Cardioceras alternans (Buch). – Dorn, p. 81, pl. 25, figs. 3–5.
1963 Cardioceras (Amoeboceras) alternans (Buch). – Koerner, p. 344.
1963 Cardioceras (Amoeboceras) ovale (Quenstedt). – Koerner, p. 344.
1977 Amoeboceras alternans. – Ziegler, p. 20, pl. 9, fig 1.
1981 Amoeboceras alternans. – Klieber, p. 281, fig. 9.
1987 Amoeboceras alternans. – Ziegler, p. 9, pl. 9, fig. 1.
1994 Amoeboceras (Amoeboceras) alternans (Buch). – Schlegel-Milch, p. 29, pl. 7, fig. 2.

1994 Amoeboceras (Amoeboceras) ovale (Quenstedt). – Schlegel-Milch, p. 30, pl. 7, fig. 3.
2000 Amoeboceras (Amoeboceras) ovale (Quenstedt). – Matyja & Wierzbowski, fig. 5.1–5.7.
2000 Amoeboceras alternans (Buch). – Schwegert, p. 204, pl. 1, fig. 4.
2000 Amoeboceras ovale (Quenstedt). – Schwegert, p. 204, pl. 1, fig. 5.
2003 Amoeboceras alternans (Buch). – Schairer & Schlamp, p. 18, pl. 1, figs. 1, 2.

Type material and remarks: Neotype of Amoeboceras alternans: GPIT CP 18600; holotype of Amoeboceras ovale: GPIT CP 17609.

The holotype of Ammonites alternans comes from the locality “Lochen” near Balingen. This specimen, which was part of the Schlotheim collection in Berlin, became apparently lost soon after its description. Quenstedt (1849) illustrated a specimen from the same locality with a narrower umbilicus and a denser ribbing as Ammonites alternans ovalis, but later he clearly stated (Quenstedt 1857: 617) that he had not intended to establish a new subspecies and pointed to the great intraspecific variation (Quenstedt 1887: 824). Later, however, Salfeld (1915) separated the material of Quenstedt into the two taxa alternans and ovale, in which he was subsequently followed by numerous authors. The sole specimen illustrated by Quenstedt (1849, pl. 5, fig. 8) is regarded as the holotype of Amoeboceras ovale; whereas the specimen illustrated by Quenstedt (1887, pl. 91, fig. 6) was subsequently suggested as the neotype of Amoeboceras alternans (Srokes & Callomon 1979: 864). This neotype substantially differs from the holotype in showing a wider umbilicus, a wider-spaced ribbing and the presence of faint spines at the bifurcations of the ribs. Koerner (1963) mentioned the occurrence of transitional morphologies linking A. alternans and A. ovale. Later, Klieber (1981) observed a sample of 72 specimens from Franconia with statistical methods. He was unable to find any bimodal distribution between the two morphospecies A. alternans and A. ovale, which is why he favoured their synonymisation. We have studied another sample of 63 specimens from the seminammatum Biohorizon (Figs. 7, 8). Our material confirms a broad intraspecific variation. The conch morphology of the holotype of Amoeboceras ovale lies within the centre of variation, as well as the holotype of A. alternans, if the illustration was correct. The position of the neotype of Amoeboceras alternans lies still within the variation, but closer to the margin. Comparison of the number of ribs leads to the same conclusion, except for the number of secondaries in the Amoeboceras alternans holotype (see Appendix). However, this number might be erroneous, since the lateral and ventral views of Buch’s (1831) illustration do not match in this point. Consequently, we follow Klieber (1981) and consider Amoeboceras ovale (Quenstedt, 1849) as a subjective junior synonym of Amoeboceras alternans (Buch, 1831). A. alternans is not restricted to the seminammatum Biohorizon, but is already present in the underlying Bifurcatus Zone (Schwegert 2000).

Material studied: 212 specimens, all from the seminammatum Biohorizon.

Amoeboceras alternans (Buch, 1831) is a small, highly variable ammonite. The biggest specimens rarely reach more than 40 mm in diameter. The most common morph has a discoidal conch shape. It is weakly compressed, with nearly parallel flanks, a high whorl expansion rate and a moderate to narrow umbilical width. The retroradiate to rectiradiate ribbing is prominent, with frequent bifurcations above mid-flank and some intercalary
Some extreme morphologies show spine-like thickenings at the point of bifurcation. All ribs end median with a protruding thickening. The venter exhibits a densely serrate keel. As this keel is prominent, the knobs do not reach the conch body, which is the case in younger chronospecies of *Amoeboceras* except *A. praebauhini* (SalFeld, 1913). The ribs never touch the keel, which is a significant difference to the older genus *Cardioceras*.

The body chamber comprises about 2/3 of the last whorl. The aperture is not preserved in our studied material.

*Amoeboceras regulare* (SpaTh, 1935) [M]

Pl. 1, Fig. 13

1930 *Cardioceras* cf. *nathorsti* Lundgren. – Frebold, p. 75, pl. 26, figs. 2, 3 (LT).
1935 *Amoeboceras (Prionodoceras) regulare*. – SpaTh, p. 25.
1967 *Amoeboceras (Prionodoceras) regulare* SpaTh. – MezeHnikov, p. 117, pl. 1, fig. 2.
1979 *Amoeboceras regulare* SpaTh. – Sykes & Callomon, p. 881, pl. 118, figs. 9 [LT], 10.

*Amoeboceras regulare* SpaTh, 1935 is supposed to be the macroconchiate partner of *Amoeboceras alternans* (Buch, 1831), since it exhibits a very similar shape and ornamentation, except of a significantly larger size. Macroconchs are extremely rare in the Late Oxfordian of the Submediterranean Province. A sole fragment is reported here; it has been found on the lowest floor of the Plettenberg Quarry, most likely coming from beds containing the *semimammatum* Biohorizon.

Superfamily Haploceratoidea Zittel, 1884

Family Oppeliidae Bonarelli, 1894

Subfamily Taramelliceratinae SpaTh, 1928

Genus *Richeiceras* Jeannet, 1951

Type species: *Oppelia richei* LoRIol, 1898.

*Richeiceras lochense* (Oppel, 1863) [M]

Pl. 1, Figs. 15–17; Pl. 2, Figs. 1–3

* 1863 *Ammonites lochensis*. – Oppel, p. 207, pl. 54, fig. 1.
1887 *Ammonites lochensis*. – QuenStedt, p. 859, pl. 93, figs. 28, 29.
1887 *Ammonites pichleri*. – QuenStedt, p. 858, pl. 93, figs. 17, 18.
1930 *Neumayriceras lochense* (Oppel). – Dorn, p. 50, pl. 13 (29), figs. 4, 9, 10.
1955 *Taramelliceras lochense* (Oppel). – Hölder, p. 124, supplement 18, fig. 162.8.
1973 *Taramelliceras (Richeiceras) lochense* (Oppel). – Ziegler, p. 30.
1994 *Taramelliceras (Proscaphites) lochense* (Oppel). – Schlegelmilch, p. 33, pl. 7, fig. 17.
2003 *Taramelliceras (?) lochense* (Oppel). – Schairer & Schlamp, p. 19, pl. 1, fig. 4.

Type: Oppel (1863) mentioned 20 syntypes from the Lochen and Streitberg sites, of which the illustrated specimen from Lochen (Oppel 1863, pl. 54, fig. 1) was erroneously considered as the holotype by Schlegelmilch (1994). We here designate that specimen (SNSB-BSPG AS VIII 175) as the lectotype.

Material: 263 specimens (two from bed 2; 19 from bed 3; nine from bed 5; seven from bed 7; one from bed 8; 191 from bed 10; four from bed 11; three from bed 13; 2 from bed 18, and 25 from Wassergraben)

Oppel (1863) introduced two rather similar oppeliid species coming from his Bimammatum Subzone, *Ammonites lochensis* Fig. 7. Conch morphology of a sample (63 specimens) of *Amoeboceras alternans* (Buch, 1831) from the *semimammatum* Biohorizon of Plettenberg Quarry, compared with the type specimens of *Amoeboceras alternans* (Buch, 1831) and *Amoeboceras ovale* (Quenstedt, 1849). Ratios of Ww/Uw versus Dm [in %].

Fig. 8. Rib density of a sample of 63 specimens of *Amoeboceras alternans* (Buch, 1831) from the *semimammatum* Biohorizon compared with the type specimens of *Amoeboceras alternans* (Buch, 1831) and *Amoeboceras ovale* (Quenstedt, 1849).
and Ammonites pichleri (see Pl. 1, Fig. 14), which have been frequently recorded in this interval (now divided into the Hypselum and Bimammatum zones). It seems that Richeiceras pichleri is just a little bit more strongly sculptured than R. lochense and otherwise identical. However, since the holotype of R. pichleri comes from Streitberg in Bavaria, with no precise indication about its exact type horizon, the usage of the taxon R. lochense instead of R. pichleri is preferred here.

Richeiceras lochense (Oppel) rarely exceeds 35 mm in diameter. Its involute conch is discoidal and strongly depressed. While this general shape is rather constant, the sculpture is widely variable. Beginning with an almost smooth nucleus, the ornamentation sets on with a row of fine and densely spaced knobs on the venter and weak falcid ribbing. The ribs are dense, with abundant bifurcations and thickenings at mid-flank. On the body chamber, such thickenings are absent and occasionally the projecting ribs are weakly crossing the venter. Above mid-flank many intercalatory ribs occur. The body chamber length comprises slightly more than half a whorl.

A small quantity of specimens exhibits ornamentations similar to Richeiceras tricristatum (Oppel), a larger-sized species of the bimammatum Biohorizon which may represent a phyletic descendant of R. lochense. Together with its microchonchiate partner Coryceras canale (Quenstedt), R. lochense is one of the predominant taxa of the two described biohorizons, especially of the semiarmatum Biohorizon. Like in Amoeboceras alternans (Buch), mass occurrences of R. lochense are always situated close to sponge-microbial bioherms.

Genus Taramelliceras Del Campana, 1905

Type species: Ammonites trachynotus Oppel, 1863.

Taramelliceras externnodosum (Dorn, 1930) [M]

Fig. 9a; Pl. 2, Figs. 4–7, 13

* 1930 Neumayriceras externnodosum. – Dorn, p. 49, pl. 13 (29), fig. 8, 11, 12.
1955 Taramelliceras (Strebliticeras) externnodosum (Dorn). – Hoelder, p. 91, supplement 3, figs. 51–55.
1991 Taramelliceras externnodosum. – Schlampp, p. 82, pl. 29, fig 4 and cover.
1994 Streblites externnodosus (Dorn). – Schlegelmilch, p. 43, pl. 12, fig. 11.
2003 Taramelliceras (?) externnodosum. – Schairer & Schlampp, p. 19, pl. 1, figs. 7, 10, 11.
2009 Taramelliceras externnodosum Dorn. – Bonnot et al., pl. 6, fig. 23.

Fig. 9. (a) Taramelliceras externnodosum (Dorn, 1930), SMNS 70538/3, Plettenberg Quarry, Impressamerger Formation, bed 10, Upper Oxfordian, Hypselum Zone, semiarmatum Biohorizon. (b) Taramelliceras costatum (Quenstedt, 1849). Plettenberg Quarry, Impressamerger Formation, lowermost Kimmeridgian, Bimammatum Zone, bimammatum Biohorizon. Scale bar equals 10 mm.
**Lectotype:** Original of Dorn 1930, pl. 13 (29), fig. 8; not traceable and apparently lost.

**Material:** 67 specimens (one from bed 1; 11 from bed 3; two from bed 7; one from bed 8; 45 from bed 10; one from bed 11; one from bed 13; one from bed 18; four from Wassergraben).

*Taramelliceras externnodosum* (Dorn) shows about the same conch shape as *R. lochense* (Oppel), with a tendency towards a bigger whorl width. The adult size considerably exceeds that of *R. lochense* (Oppel), with the largest specimen from the Plettenberg section having a diameter of 55 mm and the largest one recorded from Graflenberg (Franconia) even reaching a diameter of 139 mm (pers. comm. V. Schlamp). The sculpture of *T. externnodosum* (Dorn) is more prominent than that of *R. lochense* (Oppel) and rib swellings at mid-flank are well developed. Stronger ornamented specimens of *T. externnodosum* (Dorn) somewhat recall *T. costatum* (Quenstedt, 1849) from the younger *bimammatum* Biohorizon of the basal Kimmeridgian (Fig. 9b). In *T. costatum* (Quenstedt) looped ribs connecting the rib swellings at the bifurcation points with the terminal nodes along the ventrolateral margin are common. *T. costatum* (Quenstedt), however, has a higher whorl section, and in *T. externnodosum* (Dorn) looped ribs are totally absent. Another difference is obvious in the ventral denticles, which are densely spaced in *T. externnodosum* (Dorn) (see Fig. 9).

Some authors (Schlegel-Milch 1994; Schweigert & Callomon 1997) have assigned *T. externnodosum* (Dorn) to *Streblites*, but is has neither a continuously serrated floored keel nor an oxyconic conch shape characteristic for that genus. Hölder (1955: 90) mentioned the presence of conellae-filled hollow nodes on the venter as an argument in favour of such a placement. Since there is a huge stratigraphical gap until the sudden occurrence of *Streblites tenuilobatus* (Oppel) in the Early Kimmeridgian Hypselocyclum Zone and the ancestry of this genus is still unknown, the species *externnodosum* is here preliminarily kept in *Taramelliceras*.

Although being much less abundant than *R. lochense* (Oppel), *T. externnodosum* (Dorn) is a typical element of the *semimammatum* and *semiaarmatum* biohorizons.

**Genus Coryceras Ziegler, 1958**

**Type species:** *Ammonites microdomus* Oppel, 1863.

*Coricyeras canale* (Quenstedt, 1848) [m]

**Holotype:** Original of Quenstedt 1848, pl. 9, fig. 17 (= Quenstedt 1887, pl. 92, fig. 41), stored in the Palaeontological Collection of Tübingen University (GPIT CP 17618).

**Material:** 109 specimens (two from bed 3; one from bed 5; 14 from bed 7; 73 from bed 10; two from bed 11; 17 from Wassergraben).

A very small-sized ammonite with adult specimens rarely reaching diameters of 20 mm. In the last part of the phragmocone and in the beginning of the adult body chamber fine denticles frequently occur on the venter, but in some specimens these may be absent. Towards the aperture the venter becomes smooth. Apart from these ventral denticles there is no further ornamentation. On the flanks no significant lateral depression is developed. Dorsolaterally, the aperture meets the inner whorl in a straight to slightly inclined position. Ventrally, the mouth border is inclined as well. The long lappets end in an elongated plate. This plate, however, is rarely preserved.

*Coricyeras canale* (Quenstedt) is the most common small ammonite of the *semimammatum* and *semiaarmatum* biohorizons. It is regarded here as the microconchiate partner of *Richeiceras lochense* (Oppel), since both taxa have the same stratigraphical ranges and fit well in their size relations and ventral aspects.

**Coryceras microdomus** (Oppel, 1863) [m]

**Pl. 2, Figs. 14–16**

*1863 Ammonites microdomus.* – Oppel, p. 204, pl. 53, fig. 5.

*1887 Ammonites lingulatus canalis.* – Quenstedt, p. 850, pl. 92, figs. 46, 47.

*1887 Ammonites microdomus.* – Quenstedt, pp. 851, 859, pl. 92, fig. 50; pl. 93, fig. 27.

*1958 Glochiceras (Coryceras) microdomum* (Oppel). – Ziegler, p. 122, pl. 11, figs. 12–14.

*1991 Glochiceras (Coryceras) microdomum* (Oppel). – Gygi, p. 17, pl. 3, figs. 2–5.

*1994 Glochiceras (Coryceras) microdomum* (Oppel). – Schlegel-Milch, p. 33, pl. 16, fig. 2.

*2009 Glochiceras microdomum* (Oppel). – Bonnot et al., pl. 6, figs. 4, 6–12.

**Holotype:** Original of Oppel 1863, pl. 53, fig. 5; SNSB-BSPG AS VIII 6/5.

**Material:** 38 specimens (one from bed 1; one from bed 2; eight from bed 3; one from bed 5; two from bed 7; 18 from bed 10; seven from Wassergraben).

*Coryceras microdomus* (Oppel) is somewhat similar to the above described *C. canale* (Quenstedt), but notably bigger. In optimal preservation, a fine, prorsiradiate ribbing is developed on the body chamber which has been nicely illustrated by Oppel (1863). Ventral denticles are less common than in *C. canale* (Quenstedt).

*Coryceras microdomus* is abundant both in the *semimammatum* and *semiaarmatum* biohorizons. It is regarded as the microconch partner of *Taramelliceras externnodosum* (Dorn) due to the co-occurrence and similarities in early growth stages of both taxa.
Subfamily Glochiceratinae Hyatt, 1900

Genus Trimarginites ROLLIER, 1909

Type species: Ammonites trimarginatus Oppel, 1857.

Trimarginites trimarginatus (Oppel, 1857) [M]
Pl. 5, Fig. 8

* 1857 Ammonites trimarginatus. – Oppel, p. 687.
1863 Ammonites trimarginatus. – Oppel, p. 159, pl. 50, fig. 2.
1887 Ammonites complanatus. – Quenstedt, p. 833, pl. 91, figs. 33, 34.
1961 Trimarginites arolicus (Oppel). – Christ, p. 283, pl. 16, figs. 2, 3.
1991 Trimarginites trimarginatus (Oppel). – Schlampp, p. 92, pl. 34, fig. 2.
1994 Trimarginites trimarginatus (Oppel). – Schlegelmilch, p. 47, pl. 14, fig. 6.
2009 Trimarginites trimarginatus (Oppel). – Bonnot et al., pl. 6, fig. 26, 27.

Lectotype: Although this species is based on three synotypes (Oppel 1863), Christ (1961) regarded the single illustrated specimen (Oppel 1863, pl. 50, fig. 2; SNSB-BSPG AS VIII 39) as the type specimen. This is accepted here as a subsequent lectotype designation. The lectotype comes from the Impressamergel Formation of Hundsrücken near Balingen-Streichen, probably from the bauhini Biohorizon.

Material: Three specimens (one from beds 3–7, one from bed 17, one from bed 18).

This taxon is extremely discoidal in cross section, with a narrow umbilicus. Except from the three-keeled venter, there is no further ornamentation. T. trimarginatus (Oppel) has been found only once ex situ at the foot of the studied section, but the finding locality and the rock matrix indicate an origin from the beds 3–7. Two further records, a juvenile and a fragmentary one, come from higher strata. From the well-studied profile in the Deuerlein Quarry in Gräfenberg (Franconia), T. trimarginatus (Oppel) is known as a very rare element of the semiammatum Biohorizon (Victor Schlampp, pers. comm.). Hitherto, it has not been found in beds of the semiarmatum Biohorizon, and its microconchiate partner Trimarginites aff. stenorhynchus (Oppel, 1863) is yet unrecorded in both biohorizons.

Genus Ochetoceras Haug, 1900

Type species: Ammonites canaliculatus Buch, 1831.

Ochetoceras basseae Fradin, 1947 [M]
Pl. 6, Figs. 3–7

* 1947 Ochetoceras basseae. – Fradin, pl. 13, figs. 1, 2.
2009 Ochetoceras basseae Fradin. – Bonnot et al., pl. 5, fig. 10.

Holotype: Original of Fradin 1947, pl. 13, figs. 1, 2.

Material: 40 specimens (three from bed 3; 20 from bed 5; four from bed 7; five from bed 10; eight from Wassergraben).

Species with narrow umbilical width and a flat, oxycone conch, showing a keel with fine denticles. The frilled keel is only preserved under favorable conditions. The prominent ornamentation is two-faced: at mid-flank a deep spiral groove is developed. Dorsolaterally from the groove, the strong ribs are prorsiradiate, while above the groove a denser ribbing starts retroradiate with a tendency to swing forward at the median end. Below and above the groove the ribs may develop a slight thickening. Bifurcations are rare and only present above the groove. The ornamentation starts at a diameter of about 15 mm. The longest recorded specimen, still wholly septate, measures 63 mm. Ochetoceras basseae Fradin is present in the semiarmatum Biohorizon, but less abundant than in the semiammatum Biohorizon (especially in the middle part). Horoldt (1964: 65) interpreted O. basseae as a subjective junior synonym of O. hispidiforme (Fontannes, 1879); however, the bulk of our studied specimens represent a morphology typical of O. basseae. Bonnot et al. (2009: 380) reported both taxa from exactly the same layer and hence supposed that these taxa represent different morphologies of a single species. Since our material does not allow a statistical analysis, which could support a unification of both taxa, we prefer keeping both separate.

A remarkable number of specimens have broad whorl sections and are strongly sculptured, thus closely resembling O. hispidum (Oppel, 1863). Oppel had reported this species from the Transversarium Zone, but the holotype comes from the vicinity of Balingen, where strata of the Transversarium Zone were only rarely exposed. Quenstedt’s specimens (1887, pl. 92, figs. 9–11) assigned to O. hispidum (Oppel, 1863) come from the “Lochen” site and most likely from one of the herein described biohorizons.

Genus Glochiceras Hyatt, 1900

Type species: Ammonites nimbutus Oppel, 1863.

Glochiceras tectum Ziegler, 1958 [m]
Pl. 6, Figs. 1–2

*1958 Glochiceras (Glochiceras) tectum. – Ziegler, p. 109, pl. 10, fig. 6.
1994 Glochiceras (Glochiceras) tectum Ziegler. – Schlegelmilch, p. 51, pl. 15, fig. 15.
2009 Glochiceras tectum Zeiss [sic]. – Bonnot et al., pl. 5, figs. 7, 13.
2014 Glochiceras (Glochiceras) tectum Ziegler. – Jantschke, p. 220, pl. 2, fig. 4.

Holotype: Original of Ziegler 1958, pl. 10, fig. 6; SMNS 19346.

Material: Eight specimens (two from bed 3, one from bed 7; three from bed 10; two from Wassergraben).

Glochiceras tectum is an almost smooth-shelled, small- to very small-sized species with a narrow umbilicus. The flattened conch exhibits a fastigate venter, sometimes with a keel-like appearance. On the body chamber, a shallow lateral depression is developed. At the aperture, there is a ventral hook. Long, spoon-like lappets are developed. Dorsolaterally, the aperture is drawn backwards. The body chamber comprises about three quarters of the last whorl. This taxon occurs both in the semiammatum Biohorizon and in the semiarmatum Biohorizon, but it is never common.
Superfamily Aspidoceratoidea Zittel, 1895 emend. Parent, Schweigert & Scherzinge, 2020

Family Aspidoceratidae Zittel, 1895

Subfamily Epipeltoceratinae Donovan, Callomon & Howarth, 1981

Genus Epipeltoceras Spåth, 1924

Type species: Ammonites bimammatus Quenstedt, 1857.

Epipeltoceras semimammatum (Quenstedt, 1887) [m]

Pl. 3, Figs. 4–8

*1887 Ammonites semimammatus. – Quenstedt, p. 885, pl. 95, fig. 20.
1907 Peltoceras bimammatum. – Oppenheimer, p. 241, pl. 21, figs. 5–7.
1907 Peltoceras uhligi. – Oppenheimer, p. 241, pl. 21, figs. 10–12.
1930 Peltoceras uhligi. – Dorn, p. 71, pl. 18 (34), figs. 10–23.
1930 Peltoceras retrocostatum. – Dorn, p. 72, pl. 18 (34), fig. 7.
1930 Peltoceras circumcostatum. – Dorn, p. 73, pl. 17 (33), figs. 13, 14.
1937 Peltoceras stromeri. – Prieser, p. 64, fig. 12c.
1962 Epipeltoceras semimammatum semimammatum (Quenstedt). – Énay, p. 61, pl. 4, figs. 6.7, 8, 12.
1962 Epipeltoceras semimammatum uhligi (Oppenheimer). – Énay, p. 66, pl. 4, figs. 9, 10.
1962 Epipeltoceras semimammatum stromeri Prieser. – Énay, p. 66, pl. 4, figs. 13, 15.
1994 Epipeltoceras semimammatum (Quenstedt). – Schlegelmilch, p. 67, Taf. 23, Fig. 7.
2003 Epipeltoceras semimammatum (Quenstedt). – Schairer & Schlappe, p. 20, pl. 2, fig. 4.
2009 Epipeltoceras semimammatum (Quenstedt). – Bonnot et al., pl. 8, figs. 1–8; pl. 9, figs. 11–15.

Holotype: Original of Quenstedt 1887, pl. 95, fig. 19; SMNS 14486.

Material: 19 specimens (four from bed 3; seven from bed 5; four from bed 7; four from Wassergraben).

Quenstedt (1887: 885) originally interpreted E. semimammatum as a variety of E. semimammatum and since he had only little material, he “did not want to flaunt with new names”. However, as this name was published, later on, several authors regarded this as a new species. Oppenheimer (1907) introduced E. uhligi as a new species based on material from Brno (nowadays Czech Republic), but his specimens are well within the variation of E. semimammatum (see Énay 1962). The same is true for E. circumcostatum (Dorn, 1931), E. retrocostatum (Dorn, 1931) and E. stromeri (Prieser, 1937), which are therefore considered here as junior subjective synonyms.

The small index species of the semimammatum Biohorizon is not abundant. Its conch shape and rib density are quite constant. The umbilical width is moderate to wide; the whorl expansion rate is low. The whorl section is rounded. The ribs are mostly simple and widely spaced. Bifurcations are rare, and, if present, located close to the umbilical edge. Starting rectiradiate, the ribs tend to become retroradiate, especially on the body chamber. While the ribs cross the venter in the juvenile state, they later end at the ventrolateral margin in a weak nodule, leaving the venter smooth. Only in few extreme variants ribs may cross the venter also in the adult stage. The height of the venter mostly exceeds the height of the nodules. The latest one to three ribs often do not start at the umbilical edge but at mid-flank. The body chamber comprises one half of a whorl. The aperture bears long, tongue-like lappets.

Epipeltoceras semiarmatum (Quenstedt, 1887) [m]

Pl. 3, Figs. 3, 9, 12, 13

*1887 Ammonites semiarmatus. – Quenstedt, p. 885, pl. 95, fig. 19.
1962 Epipeltoceras semiarmatum (Quenstedt). – Énay, p. 59, pl. 4, figs. 1, 11, 16.
1994 Epipeltoceras semiarmatum (Quenstedt). – Schlegelmilch, p. 67, pl. 23, fig. 6.
2009 Epipeltoceras semiarmatum (Quenstedt). – Bonnot et al., pl. 8, figs. 9–15; pl. 9, figs. 16–20.

Holotype: Original of Quenstedt 1887, pl. 95, fig. 19, stored in the Palaeontological Collection of Tübingen University (GPIT CP 18692).

Material: 56 specimens (all from bed 10).

When Quenstedt (1887: 885) established this species based on material from the Lochen site, he already noticed some relationship to what is now identified as Clambites hypselus (Oppel).

This species is similar to the older E. semimammatum, but some differences are obvious. The main difference is the adult size. In E. semimammatum, the maximum diameter is 21–25 mm, where in E. semiarmatum it ranges from 27 to 36 mm. The ribbing shows a tendency to project backwards as well, but it is more constant, with hardly any bifurcations and exhibits a smooth venter, especially on the body chamber. The height of the more prominent rib nodules is equal or a little bit higher than the venter itself.

Genus Clambites Rollier, 1922

Type species: Ammonites clambus Oppel, 1863.

Clambites hypselus (Oppel, 1863) / Clambites aff. hypselus (Oppel, 1863) [M]

Pl. 3, Fig. 11; Pl. 4, Fig. 1, 2; Pl. 5, Figs. 1–7

*1863 Ammonites hypselus. – Oppel, p. 229, pl. 64, fig. 2.
1887 Ammonites perarmaatum. – Quenstedt, p. 888, pl. 96, fig. 1.
1994 Clambites hypselus (Oppel). – Schlegelmilch, p. 120, pl. 63, fig. 1.
2000 Euaspidoceras hypselus (Oppel). – Gygi, pl. 10, fig. 1.
2009 Euaspidoceras hypselus (Oppel). – Bonnot, pl. 7, figs. 3, 5, 11.

Holotype: Original of Oppel 1863, pl. 64, fig. 2; SNSB-BSPG AS VIII 61.

Material: 16 specimens from the semimammatum Biohorizon (three from bed 3; three from bed 5; four from bed 7; four from Wassergraben); 53 specimen from the semiarmatum Biohorizon (all from bed 10).
The holotype of this species is a phragmocone; a maximum diameter of about 170 mm can be estimated for the complete specimen. The conch is subevolute to evolute in shape with a wide whorl and minor overlap. The simple ornamentation consists of widely spaced rectiradiate ribs with a prominent knob on both the umbilical and median endings. The knobs are therefore paired from a juvenile state of about 20 mm onwards. All of these knobs carry hollow spines, which are normally not preserved. At very small diameters widespread prorsiradiate ribs are crossing the venter. At a diameter of about 10 mm the outer knobs begin. In these early states occasionally looped ribs and fine, dense intercalations occur. The venter is smooth and rounded. The body chamber comprises about one half of the last whorl.

_Clambies hypselus_ (Oppel) has been regarded in the past as the corresponding macroconch to _Epipeltoceras semiammatum_ (Quenstedt), which would demand a different species as counterpart for the younger taxon _Epipeltoceras semiammatum_ (Quenstedt). But as the variation is great and the number of adult specimens is still low, no differences can be pointed out between specimens from the _semiammatum_ Biohorizon and others from the _semiammatum_ Biohorizon. The latter specimens are termed here as _Clambites aff. hypselus_. Possibly, this taxon corresponds to _Clambites eucyphus_ (Oppel, 1863), which, according to the illustration, exhibits a slightly narrower whorl section and is more weakly sculptured than our material. Dorn (1930) had splitted his material from Franconia into 30 individual species. He almost ignored any possibility of intraspecific variation. Even taken into account that his material was not collected from a single bed and locality, only his “_Aspidoceras_ lenki”, some late _Euaspidoceras_ spp. and a form leading to _Epaspodoceras mamillanum_ (Quenstedt) seem to be specifically different from _C. hypselus_.

Superfamily Perisphinctoidea Steinmann, 1890

Family Aulacostephanidae Spath, 1924

Subfamily Aulacostephaninae Spath, 1924

Genus Prorasenia Schindewolf, 1925

_Type species_: _Prorasenia quenstedti_ Schindewolf, 1925.

_Porasenia microbiplex_ (Quenstedt, 1887) [m]

Pl. 6, Figs. 8, 10, 11; Pl. 7, Figs. 1, 2

*1887 Ammonites microbiplex._ – Quenstedt, p. 876, pl. 94, fig. 36.

1898 _Perisphinctes microbiplex._ – Sieradzkzi, p. 192.

1907 _Perisphinctes divergens._ – Oppenheimer, p. 253, pl. 22 (3), fig. 13.

1907 _Perisphinctes procedens._ – Oppenheimer, p. 254, pl. 22 (3), fig. 3.

1907 _Perisphinctes guebhardi._ – Oppenheimer, p. 254, pl. 22 (3), fig. 10.

1930 _Perisphinctes microbiplex._ – Dorn, p. 160, pl. 27 (13), fig. 5.

1930 _Perisphinctes monteiroi._ – Dorn, p. 161, pl. 27 (13), fig. 4.

1936 _Microbioplices microbiplex._ – Arkell, p. xli.

1973 _Microbioplices microbiplex._ – Ziegler, p. 31.

1994 _Microbioplices microbiplex_ (Quenstedt). – Schlegelmilch, p. 62, pl. 21, fig. 3.

2003 _Microbioplices microbiplex_ (Quenstedt). – Schairer & Schlamp, p. 20, pl. 2, figs. 7, 8.

2003 _Prorasenia sp._ 1. – Schairer & Schlamp, p. 24, pl. 2, figs. 11.

2003 _Prorasenia sp._ 2. – Schairer & Schlamp, p. 24, pl. 2, figs. 12.

2003 _Prorasenia sp._ 3. – Schairer & Schlamp, p. 24, pl. 2, figs. 12.

_Holotype_: Original of Quenstedt 1887, pl. 94, fig. 36; stored in the Palaeontological Collection of Tübingen University (GPIT CP 18679). Arkell (1936) based his newly introduced genus _Microbioplices_ on this specimen, but it seems unnecessary to split the microconchiate genus _Prorasenia_ further, especially for material from the Submediterranean Province.

_Material:_ 16 specimens from the _semiammatum_ Biohorizon (five from bed 3; one from bed 5; six from bed 7; four from Wassergraben).

A species with a wide umbilicus and rounded whors, reaching more than 40 mm in adult size. Microconch of _Ringsteadia salfeldi_ (Dorn) (cf. Sykes & Callomon 1979). The ribbing is strong and slightly prorsiradiate, with bifurcation points not far from the median edge. At juvenile stages rare trifurcations occur at this point; also intercalations crossing the venter start from here. One to two shallow constrictions per whorl are present, especially at younger stages. The ribbing starts densely and gets continuously wider. The bi- and trifurcation points are not visible in the inner whors. Note that the ribbing is wider and more prominent compared to the younger _P. bathyschista_ Koerner, 1963. The body chamber takes about ¾ of the last whorl. The aperture shows a long, tongue-like apophysis. Remarkably, _Prorasenia microbiplex_ (Quenstedt) and its supposed macroconchiate partner _Ringsteadia salfeldi_ (Dorn) are virtually absent in beds of the _semiammatum_ Biohorizon.

_Genus Ringsteadia Salfeld, 1913_

_Type species:_ _Ammonites pseudocordatus_ Blake & Hudleston, 1877.

_Ringsteadia salfeldi_ (Dorn, 1925) [M]

Pl. 7, Figs. 3–5

1925 _Ringsteadia salfeldi._ – Dorn, p. 531, pl. 22, figs. 1–3.

1994 _Ringsteadia flexuoides_ (Quenstedt). – Schlegelmilch, p. 99.

2003 _Ringsteadia salfeldi_ (Dorn). – Schairer & Schlamp, p. 28, pl. 3, fig. 6.

_Types:_ Originals of Dorn 1925, pl. 22, figs. 1–3.

_Material:_ Five specimens from the _semiammatum_ Biohorizon (two from bed 3; one from bed 5; one from bed 7; one from Wassergraben).

This discoidal ammonite has a narrow to moderately wide umbilicus and an oval whorl section. The ribbing is slightly prorsiradiate, with bifurcations occurring above mid-flank. Together with many intercalating ribs starting at the hight of the bifurcation points, they cross the rounded venter unchanged. In the juvenile stage, two or three shallow constrictions per whorl
are developed. The adult size is expected to reach diameters of more than 100 mm; however, such adult specimens have not yet been recorded. One typical specimen was found ex situ at the foot of the studied section, but its rock matrix indicates an origin from the interval of beds 3–7. Ringsteadia salfeldi has been only recorded from the semiammammat Biohorizon. A small specimen from bed 17 shows a much denser ribbing and a narrower umbilicus as usual; in this respect, it is closer to Ringsteadia flexuoides (QUENSTEDT, 1888) from the bimammammat Biohorizon (see JANTSCHKE 2014).

Family Perisphinctidae STEINMANN in STEINMANN & DÖDERLEIN, 1890

Subfamily Ataxioceratinae BUCKMAN, 1921

Genus Orthosphinctes SCHINDEWOLF, 1925

Type species: Ammonites tiziani OPPEL, 1863.

Orthosphinctes fontannesi (CHOFFAT, 1893) [m]
Pl. 7, Figs. 6–9

1893 Ammonites fontannesi. – CHOFFAT, p. 40, pl. 9, fig. 1. pars 1994 Orthosphinctes (Orthosphinctes) polygyratus (QUENSTEDT). – SCHLEGELMILCH, p. 64.

2009 Orthosphinctes fontannesi (CHOFFAT). – BONNOT et al., pl. 1, fig. 2.

Holotype: Original of CHOFFAT 1893, pl. 9, fig. 1.

Material: 61 specimens from the semiammammat Biohorizon (16 from bed 3; eight from bed 5; 23 from bed 7; 14 from Wassergraben); 40 specimens from the semiammarum Biohorizon (all from bed 10).

This species is characterized by a wide umbilicus, rounded whorls and a large whorl width. The dense, slightly prorsiradiate ribbing becomes more widely spaced with size. Ribs are mostly bipartite, with a relatively high but inconstant bifurcation point. Simple and polygyrate ribs are present as well. In the latter there is a tendency to form a thickening at the lower bifurcation point. In addition, median parabolic nodes and looped ribs occur. One or two constrictions per whorl, sometimes only weakly developed, occur. Complete lappeted specimens are expected to reach diameters of about 90 mm, but they have not yet been found. Orthosphinctes is regarded as the microconchiate partner of Pseudorthosphinctes (SCHWEERT & CALLOMON 1997).

Genus Pseudorthosphinctes ÉNAY, 1966

Type species: Pseudorthosphinctes alternans ÉNAY, 1966.

Pseudorthosphinctes aff. girardoti ÉNAY, 1966 [M]
Pl. 8, Fig. 1; Pl. 9, Fig 1

aff. 1966 Decipia girardoti. – ÉNAY, p. 559 ff., pl. 39, figs. 1, 3; pl. 40, fig. 2.

2009 Lithacosphinctes cf. girardoti ÉNAY. – BONNOT et al., pl. 3, fig. 1; ? pl. 4, fig. 1.

Holotype: Original of ÉNAY 1966, pl. 39, fig. 1 from Chaumont (Dpt. Jura, France), stored in the collection of University Lyon-Villeurbanne, no. 75.586.

Material: Four specimens (two from bed 3, Plettenberg). Pseudorthosphinctes aff. girardoti is the biggest-sized ammonite species of the two described biohorizons, with diameters of more than 300 mm in adult specimens. Its coiling is evolute; the whorl section is rounded, becoming oval in the later stages. The ribbing starts slightly prorsiradiate and later becomes rectiradiate. Due to unfavourable preservational conditions, only four specimens of this species have been recorded. The largest one was found ex situ and broken into numerous parts. The body chamber is almost smooth, but this might result from poor preservation. Another specimen was recovered just below a thin layer containing numerous Amoeboceras alternans (BUCH, 1831) which clearly indicates bed 7.

Subfamily Perisphinctinae STEINMANN, 1890

Genus Subdiscosphinctes MALINOWSKA, 1972

Type species: Perisphinctes kreuzti SIEMIRADZKI, 1891.

Subdiscosphinctes sp. [m, M]
Pl. 7, Figs. 10–12

2003 Subdiscosphinctes (Subdiscosphinctes) sp. – SCHAIRER & SCHLampp, p. 40, pl. 4, fig. 2.

Material: Seven specimens (one from bed 8; six from bed 10).

This rare species recalls the stratigraphically older Subdiscosphinctes lucingae (ÉNAY, 1875) from the Transversarium Zone. Compared with the more abundant Orthosphinctes fontannesi (CHOFFAT, 1893), the umbilicus is narrower in Subdiscosphinctes, while the whorl height is larger. The sharp ribs are more densely spaced and generally prorsiradiate. Constrictions are rare; polygyrate ribs have not been observed.

Subfamily Passendorferiinae MÉLÉNDEZ, 1989

Genus Graefenbergites SCHAIRER & SCHLampp, 2003

Type species: Perisphinctes idoceroides DORN, 1930.

Graefenbergites cf. arancensis (MÉLÉNDEZ, 1989) [m, M]
Pl. 9, Figs. 2–4

1966 ?Praeidoceras n. sp. – ÉNAY, p. 572, pl. 40, fig. 7. cf. 1989 Passendorferia (Enayites) arancensis. – MÉLÉNDEZ, pl. 12, fig. 18.

2003 Graefenbergites arancensis (MÉLÉNDEZ). – SCHAIRER & SCHLampp, pl. 7, figs. 1, 3, 4.

2008 Graefenbergites arancensis [m]. – SCHLampp, fig. 3.

2009 Passendorferia (Enayites) arancensis MÉLÉNDEZ. – BONNOT et al., pl. 2, fig. 6.

2018 Graefenbergites cf. arancensis (MÉLÉNDEZ). – MAISCH & MATZKE, fig. 1.
5. Discussion and conclusions

The two studied Late Oxfordian ammonite biohorizons exhibit a large specific diversity (Table 1). Oppeliids hardly show any differences in their morphology and variation when comparing the material from both biohorizons. For Submediterranean and Mediterranean perisphinctids, future work is necessary since adult macroconchs are very rare in the studied section. The dimorphic couple Orthosphinctes/Pseudorthosphinctes appears to be represented by the same taxon in both biohorizons; the same is true for Graefenbergites and Barthelticeras. The Subboreal genera Amoeboceras and Prorasenia/Ringsheadia are virtually absent in the semiarumatum Biohorizon (Fig. 10). This is remarkable, since Amoeboceras makes up more than one third of the ammonite fauna of the semiammatum Biohorizon below (Fig. 10). Coupled with a much higher abundance of oppeliids in the semiarumatum Biohorizon, the temporal disappearance of Subboreal taxa points to severe environmental changes during the Hypselum Zone, possibly caused by an increase of water temperature. This hypothesis might be supported by measurements of O isotopic data of belemnite rostra and calcitic shells from those levels (C. Körte, Copenhagen, work in progress).

Another major difference between the two biohorizons can be observed in aspidoceratids, where the dimorphic couple Clambites/Epipeltoceras is diagnostic. Adult specimens of Clambites are quite rare in both horizons and do not show significant differences in their sizes; however, C. hypselus is markedly thicker and more pronouncedly ornamented than C. schwabi of the stratigraphically younger Bimammatum Zone; thus, it strongly recalls its ancestors from a mid-Oxfordian euaspidoceratin stock. Macroconchs reach their adult size at diameters of 170–180 mm in all biohorizons, whereas the corresponding microconchs increase in size from ca. 20 mm in E. semiammatum to ca. 60 mm in E. bimammatum (Pls. 3–5). Finally, Clambites/Epipeltoceras became suddenly extinct after the bimammatum Biohorizon.

In general, the ammonite faunas recovered from coeval Upper Oxfordian beds of Western France (Bonnot et al. 2009) are well comparable with those from the herein described semiammatum and semiarumatum biohorizons, but they lack any Boreal and Subboreal taxa. Instead, the French faunas contain Lissoceratidae and more Mediterranean perisphinctids like Passendorferia, both of which are typical of the Tethyan Realm. These palaeobiogeographical differences are surely caused by closer connections of the French Jurassic Sea to the Tethys by favourable currents.

Future fieldwork is needed for the berrense Biohorizon, which has not been safely identified in the Impressa-mergel Formation of the study area. Possibly, this interval is generally poor in ammonites (and other fossils), but hopefully other places will provide better evidence.

Acknowledgements

This article would not have been possible without the help of a great number of individuals; in particular, we wish to thank Annette Schmidt-Röhl and Sabine Schädle (Lafarge Holcim AG Süd, Dotternhausen) for providing permanent access to the Plettenberg Quarry, Ingrid Wernerburg (Tübingen), Alexander Nützel and Winfried Werner (both Munich), and Bernhard Hostettler (Bern) assisted in the palaeontological collections under their care. Victor Schlampp (Rednitzchemnitz) introduced us in his splendid ammonite collection, allowed us to illustrate specimens and discussed problems of ammonite classification. Christian Schultbert (Erlangen) searched in the palaeontological collection of the University Erlangen-Nürnberg. Michael Maisch (Albstadt-Tailfingen) is thanked for providing access to his collection from the semiammatum Biohorizon and fruitful discussions as well as for his sound review. We also acknowledge the valuable comments of Alain Bonnot (Dijon). Horst Kuschel (Göppingen-Faurndau) permitted the inclusion of several specimens of his private collection for this study. Gerald Stappenbeck (Horb), Norbert Wannenmacher (Bisingen-
Table 1. Distribution and relative abundance of ammonite taxa in the two studied biohorizons of SW Germany.

| Taxa                                              | semimammatum Biohorizon | semiarmatum Biohorizon |
|---------------------------------------------------|--------------------------|-------------------------|
| Sowerbyceras tortisulcatum (Orbigny, 1841)        | ?                        | ●                       |
| Amoeboceras alternans (Buch, 1831)                | ●●●                      | –                       |
| Amoeboceras regulare (Spath, 1935)                | ●                        | –                       |
| Richeiceras lochense (Oppel, 1863)                | ●●●                      | ●●●                     |
| Taramelliceras externnodosum (Dorn, 1930)         | ●                        | ●                       |
| Coryceras canale (Quenstedt, 1848)                | ●                        | ●                       |
| Coryceras microdomus (Oppel, 1863)                | ●                        | ●                       |
| Trimarginites trimarginatus (Oppel, 1857)         | ●                        | –                       |
| Ochetoceras basseae Fradin, 1947                  | ●●                       | ●                       |
| Glochiceras tectum Ziegler, 1958                  | ●                        | ●                       |
| Epipeltoceras semimammatum (Quenstedt, 1887)      | ●                        | –                       |
| Epipeltoceras semiarmatum (Quenstedt, 1887)       | –                        | ●●                      |
| Clambites hypselus / aff. hypselus (Oppel, 1863)  | ●                        | ●                       |
| Prorasenia microbiplex (Quenstedt, 1887)         | ●                        | –                       |
| Ringsteadia salfeldi (Dorn, 1925)                 | ●                        | –                       |
| Orthosphinctes fontannesi (Chopart, 1893)         | ●●                       | ●●                      |
| Pseudorthosphinctes aff. girardoti Enay, 1966     | ●                        | ?                       |
| Subdiscosphinctes sp.                             | ●                        | ●                       |
| Graefenbergites cf. arancensis (Miléndez, 1989)   | ●                        | ●                       |
| Barthelticeras enayi Schairer, 1989               | ●                        | ?                       |

Fig. 10. Distribution of ammonite genera in the two investigated biohorizons. Left: *semimammatum* Biohorizon; right: *semiarmatum* Biohorizon. Red: oppelids (*Taramelliceras*, *Richeiceras*, *Coryceras*, *Glochiceras*, *Ochetoceras*); blue: Boreal and Subboreal taxa (*Amoeboceras*, *Prorasenia*, *Ringsteadia*); yellow: perisphinctids; green: aspidoceratids (*Clambites*, *Epipeltoceras*).
Thanheim) and Jürgen Wieland (Marbach) kindly donated rare specimens. Andreas Köcha (Schemmerhofen-Altheim) is thanked for the aerial photograph of the Plettenberg Quarry.

7. References

Arkell, W. J. (1936): A monograph of the ammonites of the English Corallian beds, part 2. – Palaeontographical Society Monographs, 89: xx–xxxviii, 1–162.

Arkell, W. J. (1950): A classification of the Jurassic ammonites. – Journal of Paleontology, 24: 354–364.

Blake, J. F. & Huddleston, W. H. (1877): On the Corallian rocks of England. – Quarterly Journal of the Geological Society, London, 33: 260–405.

Bonarelli, G. (1894): Hecticoceras, novum genus Ammoni-darum. – Bolletino della Societa Malacologia italiana, 18: 73–108.

Bonnot, A., Marchand, D., Courville, P., Ferchaud, P., Queirelliac, P. & Boursicot, P.-Y. (2009): Le genre Epipel-toceras (Ammonitina, Perisphinctaceae, Aspidoceratidae) sur le versant parisien du seuil du Poitou (France): faunes ammonitiques, biostratigraphie et biozonation de la zone à Bimammatus pars (Oxfordien supérieur). – Revue de Paléobiologie, 28 (2): 371–411.

Buch, L. v. (1831): Recueil de planches de pértrifications remarquables. Berlin (Académie Royale des Sciences).

Buckman, S. S. (1909–1930): Yorkshire Type Ammonites. Vols. 1–2. Type Ammonites. Vols. 3–7. London (Welton & Wesley).

Choffat, P. (1893): Description de la faune Jurassique du Portugal, Première série: Ammonites du Lusitanien de la Contrefe de Torres-Vedras. 82 pp.; Lisbonne (Direction des Travaux Géologiques du Portugal).

Christ, H. (1961): Über Campylites und Trimarginites (Ammonoidea, Jura). – Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen, 111: 274–325.

Del Campana, D. (1905): Faunula del Giura superior di Collalto di Solagna (Bassano). – Bolletino della Società Geologica Italiana, 23: 239–269.

Donovan, David T., Callomon, J. H. & Howarth, M. K. (1981): Classification of the Jurassic Ammonitina. In: House, M. R. & Senior, J. R. (eds.): The Ammonoida. – The Systematics Association, Special Volumes, 18: 101–155; London (Academic Press).

Dorn, P. (1925): Das Auftreten der Gattung Ringsteadia im unteren Malm der nördlichen Frankenalb. – Zeitschrift der Deutschen Geologischen Gesellschaft, 77: 529–534.

Dorn, P. (1930): Die Ammoniten des untersten Malm der Frankenalb. – Palaeontographica, 73: 107–171; 74: 1–92.

Énay, R. (1962): Contribution à l’étude paléontologique de l’Oxfordien supérieur de Trept. – Travaux du Laboratoire de Géologie de la Faculté des Sciences de Lyon, nouvelle série, 8: 5–81.

Énay, R. (1966): L’Oxfordien dans la moitié-sud du Jura français: étude stratigraphique. – Nouvelles Archives du Muséum d’Histoire naturelle de Lyon, 8 (1): 1–624.

Engel, T. (1908): Geognostischer Wegweiser durch Württem-berg (3rd edition). xxx + 645 pp.; Stuttgart (Schweizerbart).

Favre, E. (1875): Description des fossiles du terrain jurassique de la Montagne des Voirons (Savoie). – Mémoires de la Société paléontologique Suisse, 2: 1–78.

Favre, E. (1876): Description des fossiles du terrain Oxfordien des Alpes Fribourgeoises. – Mémoires de la Société paléontologique Suisse, 3: 1–76.

Fischer, E. (1913): Geologische Untersuchung des Lochengebiets bei Balingen. – Geologisch-Paläontologische Abhand- lungen, Neue Folge, 11: 267–335.

Fischer, J.-C. (1994): Révision critique de la Paléontologie fran-çaise, Volume 1: Céphalopodes jurassiques. Paris, Milan & Barcelona (Masson).

Fischer, P. H. (1882): Manuel de conchyliologie et de paléontolo- gie conchyliologique. 1369 pp.; Paris (Savy).

Fontannes, F. (1879): Description des Ammonites des calcaires du Château de Crussol, Ardèche. xi + 122 pp.; Lyon & Paris (Georg & Savy).

Franj, J. (1947): Application de méthodes graphiques à l’étude de l’espèce chez les Ochetoceras argovii du Poitou. – Bulletin de la Société géologique de la France, (5), 17: 411–424.

Freybold, H. (1930): Verbreitung und Ausbildung des Mesozoikums in Spitzbergen. – Skrifter om Svalbard og Ishavet, 31: 1–120.

Geyer, O. F. & Gwinner, M. P. (1984): Die Schwäbische Alb und ihr Vorland. – Sammlung geologischer Führer, 67: 275 pp.; Berlin & Stuttgart (Borntraeger).

Győr, R. A. (1991): Die vertikale Verbreitung der Ammoniten- gattungen Glochiceras, Creniceras und Bukowskites im Späten Jura der Nordschweiz und im angrenzenden Süddeutsch-land. – Stuttgarter Beiträge zur Naturkunde, (B), 179: 1–41.

Győr, R. A. (2000): Integrated stratigraphy of the Oxfordian and Kimmeridgian (Late Jurassic) in northern Switzerland and adjacent southern Germany. – Denkschriften der Schweizerischen Akademie der Naturwissenschaften, 104: 1–151.

Holder, H. (1955): Die Ammoniten-Gattung Taranelliceras im südwestdeutschen Unter- und Mittelmalm. – Palaeontographica, (A), 106: 37–153.

Horoldt, U. (1964): Morphologie und Systematik der weißjuraischen Ammoniten-Gattungen Streblites und Ochetoceras unter besonderer Berücksichtigung des Hohlkiels. Dissertation Universität Tübingen. 105 pp.; Tübingen (published by the author).

Hyatt, A. (1900): Cephalopoda. In: Zittel, K. A. v. & Eastman, C. R. (eds.): Textbook of Palontology: 502–604; London (Macmillan & Co.).

Jantschke, K. (2014): Ammoniten aus dem bimammat-um-Faunenhorizont im Weißjura (Malm, Oxfordium) der Schwäbischen Alb. – Jahreshefte der Gesellschaft für Natur- kunde in Württemberg, 170: 205–243.

Kleiber, D. (1981): Zum Problem der Abgrenzung von Amoe- boceras alternans (v. Buch 1831) und Amoeboceras ovale (Quenstedt 1849). – Geologische Blätter für Nordost-Bay- ern und angrenzende Gebiete, 31: 271–284.

Koerner, U. (1963): Beitrag zur Stratigraphie und Ammoniten- fauna der Weißjura α/β-Grenze (Oberoxford) auf der west-lichen Schwäbischen Alb. – Jahreshefte des Geologischen Landesamtes Baden-Württemberg, 6: 337–394.

Krautter, M. (1994): Gregoryceras aus dem Weißjura Jura α (Oxfordium) vom “Lochen” bei Balingen (Schwäbische Alb) auf der westlichen Schwäbischen Alb. – Jahreshefte des Geologischen Landesamtes Baden-Württemberg, 6: 337–394.

Lorio, P. de (1898): Etude sur les mollusques et brachiopodes de l’Oxfordien inférieur ou Zone à Ammonites renggeri du Jura bernois. – Mémoires de la Société paléontologique Suisse, 25: 1–115.

Mächt, M. W. & Matzke, A. T. (2018): First record of the ammonite genus Graffenbergesites (Perisphinctoidea: Pas- sendorferiinae) from the late Oxfordian of the Swabian Alb (SW Germany). – Palaeodiversity, 11: 167–172.
MALINOWSKA, L. (1972): The Middle Oxfordian Perisphinctidae of Zawodzie near Częstochowa (Poland). – Acta Palaeontologica Polonica, 17 (2): 167–242.

MAYIA, B. A. & WIERZBOWSKI, A. (2000): Biological response of ammonites to changing environmental conditions: an example of Boreal Amoeboceras invasions into Submediterranean Province during Late Oxfordian. – Acta Geologica Polonica, 50 (1): 45–54.

MELENDEZ, G. (1989): El Oxfordiense en el sector central de la Cordillera Iberica (Provincias de Zaragoza y Teruel). 418 pp.; Zaragoza & Teruel (Instituto Estudios Turolenses).

MEZEHNÍKOV, M. S. (1967): A new ammonite zone of the Upper Oxfordian and the position of Oxfordian and Kimmeridgian boundary in northern Siberia. In: SCHACH, V.N. (ed.): Problems of palaeontological substantiation of detailed stratigraphy of Siberia and Far East: 110–130; Leningrad (Nauka).

NEUMAYR, M. (1875): Die Ammoniten der Kreide und die Systematik der Ammoniten. – Zeitschrift der Deutschen Geologischen Gesellschaft, 27 (4): 854–942.

OPPEL, A. (1856–1858): Die Juraforschung Englands, Frankreichs und des südwestlichen Deutschlands: nach ihren einzelnen Gliedern eingetheilt und verglichen. – Jahreshefte des Vereins für vaterländische Naturkunde in Württemberg, 12 (1856): 121–556, 13 (1857): 141–396, 14 (1858): 129–291.

OPPEL, A. (1862–1863): Neues Jahrbuch für Paläontologie und Geologie Öster­reich-Ungarns und des Orients, 1: 127–262.

OPPENHEIMER, J. (1907): Der Malm der Schwedenschanze bei Brünn. – Beiträge zur Paläontologie und Geologie Österreich-Ungarns und des Orients, 20: 221–271.

ORGONY, A. d’ (1841): Paléontologie française. Tome premier, Terrains Crétacés, Céphalopodes. Livraison 15: 161–176; Paris (Masson).

PARENT, H., SCHWEIGERT, G. & SCHERZINGER, A. (2020): A review of the classification of Jurassic aspidoceratid ammonites – the Superfamily Aspidoceratoidea. – Volumina Jurassica, 18 (1): 47–52.

PARONA, C. F. & BONARELLI, G. (1895): Sur la faune de Callovien inférieur de Savoie. – Mémoires de l’Académie des sciences, belles-lettres et arts de Savoie, 4 (6): 1–179.

PRIESE, T. (1937) Beitrag zur Systematik und Stammesgeschichte der europäischen Peltoceraten. – Palaeontographica, (A), 86: 1–114.

ROLLIER, L. (1909): Phyllogénie des principaux genœs des Ammonoïdes de l’Oolithe (Dogger) et de l’Oxfordien. – Archives des Sciences Physiques et naturelles, Genève, 4 (28): 611–622.

ROLLIER, L. (1922): Phyllogénie des Ammonoïdes. – Ecologie geologicae Helvetiae, 17 (3): 358–360.

QUENSTEDT, F. A. (1843): Das Flözgebirge Würtembergs. Mit besonderer Rücksicht auf den Jura. 558 pp.; Tübingen (Laupp).

QUENSTEDT, F. A. (1845–1849): Petrefaktenkunde Deutschlands. I. Abt. Vol. 1. Cephalopoden. – 580 pp. [pp. 1–104 (1845); pp. 105–184 (1846); pp. 185–264 (1847); pp. 265–472 (1848); pp. 473–580 (1849)]. Tübingen (Fues).

QUENSTEDT, F. A. (1856–1857): Der Jura. 842 pp.; Tübingen (Laupp).

QUENSTEDT, F.A. (1877): Begleitworte zu der geognostischen Spezialkarte von Württemberg, Atlasblätter Balingen und Ebingen. 47 pp.; Stuttgart (Kohlhammer).

QUENSTEDT, F. A. (1885): Handbuch der Petrefaktenkunde (3rd edition). viii + 1239 pp.; Tübingen (Laupp).

QUENSTEDT, F. A. (1882–1885): Die Ammoniten des Schwäbischen Jura. 1. Der Schwarze Jura (Lias): 1–48 (1882), 49–96 (1883), 97–144 (1884), 145–240 (1884), 241–441 (1885); Stuttgart (Schweizerbart).

QUENSTEDT, F. A. (1886–1887): Die Ammoniten des Schwäbischen Jura. 2. Der Braune Jura: 441–608 (1886), 619–815 (1887); Stuttgart (Schweizerbart).

QUENSTEDT, F. A. (1887–1888): Die Ammoniten des Schwäbischen Jura 3. Der Weiße Jura: 817–994 (1887), 945–1140 (1888); Stuttgart (Schweizerbart).

SALFELD, H. (1915): Monographie der Gattung Cardioceras. – Zeitschrift der Deutschen Geologischen Gesellschaft, 67: 149–204.

SAUERBORN, U. (1995): Lochen bei Balingen. Schwammmriffe aus dem Weißjura. In: WEIDERT, W. K. (ed.): Klassische Fundstellen der Paläontologie, 3: 106–115; Korb (Goldschneck-Verlag).

SCHAIER, G. (1989): Ammoniten aus dem Brauen und Weißen Jura von Sengenthal. – Mitteilungen der Bayerischen Staats­sammlung für Paläontologie und historische Geologie, 29: 109–131.

SCHÄDEL, K. (1957): Ein geologisches Profil durch den Lochenstein bei Balingen. – Jahreshefte des Geologischen Landesamtes Baden-Württemberg, 2: 175–178.

SCHAIER, G. & SCHLAMPP, V. (2003): Ammoniten aus dem Ober­Oxfordium von Gräfenberg/Ofr. (Bimammatum-Zone, Hyspelum-Subzone, semimammatum Horizont). – Zitelliana, A43: 17–43.

SCHINDWOLF, O. H. (1925): Entwurf einer Systematik der Per­pinschiten. – Neues Jahrbuch für Mineralogie, Geologie und Paläontologie, Beilage-Bände, (B), 52: 309–343.

SCHLAMPP, V. (1991): Malm-Ammoniten. 184 pp.; Korb (Gold­scheck-Verlag).

SCHLAMPP, V. (2008): Beitrag zur Kenntnis der Gattung Graefen­bergites aus dem Oberjura der Fränkischen Alb. – Der Aufschluss, 59: 367–372.

SCHLEGELMILCH, R. (1994): Die Ammoniten des süddeutschen Malms. vii + 297 pp.; Stuttgart, Jena & New York (G. Fischer).

SCHWEIGERT, G. (2000): Immigration of Amoeboceratids into the Submediterranean Upper Jurassic of SW Germany. – In: HALL, R. L. & SMITH, P. (eds.): Advances in Jurassic Research 2000. – GeoResearch Forum, 6: 203–210.

SCHWEIGERT, G. & CALLOMON, J. H. (1997): Der bauhini-Faunen­horizont und seine Bedeutung für die Korrelation zwischen tethyalem und subborealem Oberjura. – Stuttgarter Beiträge zur Naturkunde, (B), 247: 1–69.

SCHWEIGERT, G. & JANTSCHEK, H. (2001): Erstnachweis von Sub­oxydisiscites Poulton, Zeiss & Jeletzky (Ammonitina, Oppe­liidae) im Schwäbischen Oberjura (Hauffianum-Subzone, bauhini-Horizont). – Neues Jahrbuch für Geologie und Paläontologie, Monatshefte, 2001: 659–668.

SCHWEIGERT, G. & KAPITZKE, M. (2018): Neopetitclercia, a new ammonite genus (Strigoceratidae: Phlycticeratinae) from the lower Kimmeridgian (Upper Jurassic) of SW Germany. – Neues Jahrbuch für Geologie und Paläontologie, Monatshefte, 288 (2): 121–127.

SEMIRADZKI, J. (1891): Fauna kopalna warstw oxfordzkich i kimerdyckich w okręgu krakowskim i przyległych częściach Królestwa Polskiego. Cz. I, Głownogi. Kraków (Nakładem Akademii Umiejętności).

SEMIRADZKI, J. (1898): Monographische Beschreibung der Ammoniten-Gattung Perisphinctes. – Palaeontographica, 45: 69–296.
Spath, L. F. (1924): On the Blake Collection of Ammonites from Kachh, India. – Palaeontologica Indica, New Series, 9 (1): 1–29.

Spath, L. F. (1927–1933): Revision of the Jurassic cephalopod fauna of Kachh (Cutch). Parts I–VI. – Memoirs of the Geological Survey of India, Palaeontologia Indica, new series, 9 (2): part I, p. 1–71, pls. 1–7 [1927]; part II, p. 72–161, pls. 8–19 [1928a]; part III, p. 162–278, pls. 20–47 [1928b]; part IV, p. 279–550, pls. 48–102 [1931a]; part V, p. 551–658, pls. 103–124 [1931b]; part VI, p. 659–945, pls. 125–130 [1933].

Spath, L. F. (1935): The Upper Jurassic invertebrate faunas of Cape Leslie, Milne Land. I. Oxfordian and Lower Kimmeridgian. – Meddelelser om Gronland, 99: 1–82.

Stahl, C. F. (1824): Uebersicht über die Versteinerungen Würtembergs nach dem gegenwärtigen Standpunkte der Petrefaktenkunde. 91 pp.; Stuttgart & Tübingen (Cotta’sche Buchhandlung).

Steinmann, G. & Döderlein, L. (1890): Elemente der Palaeontologie. 848 pp.; Leipzig (Engelmann).

Sykes, R. M. & Calamont, J. H. (1979): The Amoeboceras zonation of the Boreal Upper Oxfordian. – Palaeontology, 22 (4): 839–903.

Wegele, L. (1929): Stratigraphische und faunistische Untersuchungen im Oberoxford und Unterkimmeridgische Mittelfränkens. – Palaeontographica, 71: 117–210, 72: 1–94.

Address of the authors:

HERBERT JANTSCHEK, Aichhalde 8/1, 72116 Mössingen-Talheim, Germany; e-mail: herbert.jantschke@gmx.de.

GUENTER SCHWEIGERT, Staatliches Museum für Naturkunde, Rosenstein 1, 70191 Stuttgart, Germany; e-mail: guenter.schweigert@smns-bw.de

Manuscript received: 7 June 2020, revised version accepted: 7 August 2020.
Plate I

Fig. 1. Sowerbyceras tortisulcatum (OrBigny, 1841). SMNS 70534. Plettenberg, bed 10. Upper Oxfordian, Hypselum Zone, semiar-matum Biohorizon.

Fig. 2. Amoeboceras alternans (Buch, 1831), illustration of the holotype. (a) Lateral view; (b) ventral view. “Lochenberg” near Balingen. Lochen Member. Upper Oxfordian.

Fig. 3. Amoeboceras alternans (Buch, 1831), holotype of Ammonites alternans ovalis Quenstedt, 1849, pl. 5, fig. 8. Re-figured in Quenstedt 1887, pl. 91, fig. 1 as “Ammonites alternans oblongus”; (a) lateral view; (b, c) ventral views. GPIT CP 17609. “Lochen” near Balingen. Lochen Member. Upper Oxfordian.

Fig. 4. Amoeboceras alternans (Buch, 1831), neotype, original of Ammonites alternans Quenstedt 1887, pl. 5, fig. 8. Re-figured in Quenstedt 1887, pl. 91, fig. 6. (a) Lateral view; (b, c) ventral views. GPIT CP 18600. “Lochen” near Balingen. Lochen Member.

Fig. 5. Amoeboceras alternans (Buch, 1831). (a) Lateral view; (b, c) ventral views. SMNS 70535/42. Plettenberg Quarry, bed 7. Upper Oxfordian, Hypselum Zone, semimammatum Biohorizon.

Fig. 6. Amoeboceras alternans (Buch, 1831). SMNS 70535/43. Plettenberg Quarry, bed 7. Upper Oxfordian, Hypselum Zone, semimammatum Biohorizon.

Fig. 7. Amoeboceras alternans (Buch, 1831). SMNS 70535/6. Plettenberg Quarry, bed 7. Upper Oxfordian, Hypselum Zone, semimammatum Biohorizon.

Fig. 8. Amoeboceras alternans (Buch, 1831). SMNS 70535/48. Plettenberg Quarry, bed 7. Upper Oxfordian, Hypselum Zone, semimammatum Biohorizon.

Fig. 9. Amoeboceras regulare (Spath, 1935). (a) Lateral view; (b) ventral view. SMNS 70536 (leg. J. Wieland). Plettenberg Quarry. Upper Oxfordian, Hypselum Zone, semimammatum Biohorizon.

Fig. 10. Richeiceras pichleri (Oppel, 1863), holotype; original of Ammonites pichleri Oppel 1863, pl. 51, fig. 4. (a) Lateral view; (b, c) ventral views. SNSB-BSPG AS I 1126. Streitberg, Bavaria. Upper Oxfordian.

Fig. 11. Richeiceras lochense (Oppel, 1863), lectotype; original of Ammonites lochensis Quenstedt, 1887, pl. 93, fig. 1. (a) Lateral view; (b, c) ventral views. GPIT CP 18650. “Lochen” near Balingen. Lochen Member. Upper Oxfordian.

Fig. 12. Richeiceras lochense (Oppel, 1863); original of Ammonites pichleri in Quenstedt 1887, pl. 93, fig. 17. (a) Lateral view; (b) ventral views. GPIT CP 18647. “Lochen” near Balingen. Lochen Member. Upper Oxfordian.

Beginning of body chamber is indicated by an arrow.
Plate 2

Fig. 1. *Richeiceras lochense* (OPPEL, 1863). (a) Lateral view; (b) ventral view. SMNS 70537/2. Plettenberg Quarry, bed 10. Upper Oxfordian, Hypselum Zone, *semiarmatum* Biohorizon.

Fig. 2. *Richeiceras lochense* (OPPEL, 1863). (a) Lateral view; (b, c) ventral views. SMNS 70537/3. Plettenberg Quarry, bed 10. Upper Oxfordian, Hypselum Zone, *semiarmatum* Biohorizon.

Fig. 3. *Richeiceras lochense* (OPPEL, 1863). SMNS 70537/1. Plettenberg Quarry, Wassergraben (beds 3–7). Upper Oxfordian, Hypselum Zone, *semimammatum* Biohorizon.

Fig. 4. *Taramelliceras externnodosum* (DORN, 1930), phragmocone. (a) Lateral view; (b, c) ventral views. SMNS 70538/1. Plettenberg Quarry, bed 3. Upper Oxfordian, Hypselum Zone, *semimammatum* Biohorizon.

Fig. 5. *Taramelliceras externnodosum* (DORN, 1930). SMNS 70538/2. Plettenberg Quarry, Wassergraben (beds 3–7). Upper Oxfordian, Hypselum Zone, *semimammatum* Biohorizon.

Fig. 6. *Taramelliceras externnodosum* (DORN, 1930). SMNS 70538/4. Plettenberg Quarry, bed 10. Upper Oxfordian, Hypselum Zone, *semiarmatum* Biohorizon.

Fig. 7. *Taramelliceras externnodosum* (DORN, 1930). SMNS 70538/5. Plettenberg Quarry, bed 10. Upper Oxfordian, Hypselum Zone, *semiarmatum* Biohorizon.

Fig. 8. *Coryceras canale* (QUENSTEDT, 1848), holotype, original of *Ammonites lingulatus canalis* QUENSTEDT, 1887, pl. 92, fig. 41. (a) Lateral view; (b, c) ventral views. GPIT CP 17618. “Lochen” near Balingen. Lochen Member. Upper Oxfordian.

Fig. 9. *Coryceras canale* (QUENSTEDT, 1848). SMNS 70539/3. Plettenberg Quarry, bed 10. Upper Oxfordian, Hypselum Zone, *semiarmatum* Biohorizon.

Fig. 10. *Coryceras canale* (QUENSTEDT, 1848), showing ventral dentition. (a) Lateral view; (b) ventral view. SMNS 70539/7. Plettenberg Quarry, bed 10. Upper Oxfordian, Hypselum Zone, *semiarmatum* Biohorizon.

Fig. 11. *Coryceras canale* (QUENSTEDT, 1848). SMNS 70539/5. Plettenberg Quarry, bed 10. Upper Oxfordian, Hypselum Zone, *semiarmatum* Biohorizon.

Fig. 12. *Coryceras canale* (QUENSTEDT, 1848). SMNS 70539/2. Plettenberg Quarry, Wassergraben (beds 3–7). Upper Oxfordian, Hypselum Zone, *semimammatum* Biohorizon.

Fig. 13. *Taramelliceras externnodosum* (DORN, 1930), original of SCHAI RER & SCHLAMPP 2003, pl. 1, fig. 11. (a) Lateral view; (b) ventral view. SNSB-BSPG 2003 V 4. Gräfenberg, Deuerlein Quarry, Franconia. Upper Oxfordian, Hypselum Zone, *semimammatum* Biohorizon.

Fig. 14. *Coryceras microdomus* (OPPEL, 1863), holotype, original of *Ammonites microdomus* OPPEL, 1863, pl. 53, fig. 5. (a) Lateral view; (b, c) ventral views. SNSB-BSPG AS VIII 6/5. “Lochen” near Balingen. Upper Oxfordian.

Fig. 15. *Coryceras microdomus* (OPPEL, 1863). SMNS 70540/3. Plettenberg Quarry, bed 10. Upper Oxfordian, Hypselum Zone, *semiarmatum* Biohorizon.

Fig. 16. *Coryceras microdomus* (OPPEL, 1863). SMNS 70540/2. Plettenberg Quarry, Wassergraben (beds 3–7). Upper Oxfordian, Hypselum Zone, *semimammatum* Biohorizon.

Beginning of body chamber is indicated by an arrow.
Plate 3

Fig. 1. *Epipeltoceras bimammatum* (Quenstedt, 1857), holotype, phragmocone; original of Quenstedt 1887, pl. 95, fig. 2. (a) Lateral view; (b, c) ventral views. GPIT CP 18688-1. “Lochen” near Balingen. Lochen Member. Lowermost Kimmeridgian.

Fig. 2. *Epipeltoceras bimammatum* (Quenstedt, 1857), original of Quenstedt 1887, pl. 95, fig. 8; GPIT CP 18688-2. (a) Lateral view; (b, c) ventral views. “Grat” near Laufen an der Eyach, Impressamergel Formation, lowermost Kimmeridgian.

Fig. 3. *Epipeltoceras semiarmatum* (Quenstedt 1887), lectotype, phragmocone; original of Quenstedt 1887, pl. 95, fig. 19. (a, b) Lateral views; (c) ventral view. GPIT CP 18692. “Lochen” near Balingen. Upper Oxfordian.

Fig. 4. *Epipeltoceras semimammatum* (Quenstedt 1887), holotype, original of Quenstedt 1887, pl. 95, fig. 20. (a, b) Lateral views; (c) ventral view. SMNS 14486. “Lochen” near Balingen.

Fig. 5. *Epipeltoceras semimammatum* (Quenstedt, 1887). (a) Lateral view; (b) ventral view. SMNS 70544/1. Plettenberg Quarry, bed 3. Upper Oxfordian, Hypselum Zone, *semimammatum* Biohorizon.

Fig. 6. *Epipeltoceras semimammatum* (Quenstedt, 1887). SMNS 70544/3. Plettenberg Quarry, bed 7. Upper Oxfordian, Hypselum Zone, *semimammatum* Biohorizon.

Fig. 7. *Epipeltoceras semimammatum* (Quenstedt, 1887). (a) Lateral view; (b) ventral view. SMNS 70544/4. Plettenberg Quarry, bed 7. Upper Oxfordian, Hypselum Zone, *semimammatum* Biohorizon.

Fig. 8. *Epipeltoceras semimammatum* (Quenstedt, 1887). Gräfenberg, Deuerlein Quarry, Franconia (priv. coll. Victor Schlampp, Rednitzhembach). Upper Oxfordian, Hypselum Zone, *semimammatum* Biohorizon.

Fig. 9. *Epipeltoceras semiarmatum* (Quenstedt, 1887). SMNS 70545/1. Plettenberg Quarry, bed 10. Upper Oxfordian, Hypselum Zone, *semiarmatum* Biohorizon.

Fig. 10. *Epipeltoceras berrense* (Favre, 1876), lectotype, original of Favre 1876, pl. 4, fig. 8; NHMB br1 5015135. (a) Lateral view; (b, c) ventral views. La Roche (FR), Switzerland. Upper Oxfordian.

Fig. 11. *Clambites hypselus* (Oppel, 1863), original of Ammonites perarmatus, Quenstedt 1887, pl. 96, fig. 1; GPIT CP 18702. Impressamergel Formation of an ancient landslide near Ratshausen, Upper Oxfordian.

Fig. 12. *Epipeltoceras semiarmatum* (Quenstedt 1887). SMNS 70545/2. Plettenberg Quarry, bed 10. Upper Oxfordian, Hypselum Zone, *semiarmatum* Biohorizon.

Fig. 13. *Epipeltoceras semiarmatum* (Quenstedt 1887). SMNS 70545/3. Plettenberg Quarry, bed 10. Upper Oxfordian, Hypselum Zone, *semiarmatum* Biohorizon.

Beginning of body chamber is indicated by an arrow.
Plate 4

**Fig. 1.** *Clambites hypselus* (Oppel, 1863), holotype, original of Oppel 1863, pl. 64, fig. 2; SNSB-BSPG AS VIII 61. (a) Lateral view; (b) ventral view. Vicinity of Balingen, Impressamergel Formation, Upper Oxfordian.

**Fig. 2.** *Clambites aff. hypselus* (Oppel, 1863), complete specimen, last whorl partly restored. SMNS 70546/2. Plettenberg Quarry, bed 10. Upper Oxfordian, Hypselum Zone, *semiarmatum* Biohorizon.

Beginning of body chamber is indicated by an arrow.
Plate 5

Fig. 1. Clambites hypselus (Oppel, 1863). SMNS 70546/3. Plettenberg Quarry, bed 5. Upper Oxfordian, Hypselum Zone, semiammatum Biohorizon.

Fig. 2. Clambites aff. hypselus (Oppel, 1863). (a) Lateral view; (b) ventral view. SMNS 70546/4. Plettenberg Quarry, bed 10. Upper Oxfordian, Hypselum Zone, semiarmatum Biohorizon.

Fig. 3. Clambites aff. hypselus (Oppel, 1863), juvenile stage. SMNS 70546/5. Plettenberg Quarry, bed 10. Upper Oxfordian, Hypselum Zone, semiarmatum Biohorizon.

Fig. 4. Clambites aff. hypselus (Oppel, 1863), juvenile stage with onset of umbilical spines. SMNS 70546/6. Plettenberg Quarry, bed 10. Upper Oxfordian, Hypselum Zone, semiarmatum Biohorizon.

Fig. 5. Clambites aff. hypselus (Oppel, 1863); body chamber showing looped ribs. (a) Lateral view; (b, c) ventral views. SMNS 70546/9. Plettenberg Quarry, bed 10. Upper Oxfordian, Hypselum Zone, semiarmatum Biohorizon.

Fig. 6. Clambites aff. hypselus (Oppel, 1863), example of the most common morphology. (a) Lateral view; (b, c) ventral views. SMNS 70546/8. Plettenberg Quarry, bed 10. Upper Oxfordian, Hypselum Zone, semiarmatum Biohorizon.

Fig. 7. Clambites aff. hypselus (Oppel, 1863). Body chamber with looped ribs. SMNS 70546/10. Plettenberg Quarry, bed 10. Upper Oxfordian, Hypselum Zone, semiarmatum Biohorizon.

Fig. 8. Trimarginites trimarginatus (Oppel, 1863). (a) Lateral view; (b) ventral view. SMNS 70541. Plettenberg Quarry, beds 3–7. Upper Oxfordian, Hypselum Zone, seminammatum Biohorizon.

Beginning of body chamber is indicated by an arrow.
Plate 6

Fig. 1. *Glochiceras tectum* Ziegler, 1958. SMNS 70543/2. Plettenberg Quarry, bed 10. Upper Oxfordian, Hypselum Zone, *semimammatum* Biohorizon.

Fig. 2. *Glochiceras tectum* Ziegler, 1958. SMNS 70543/1. Plettenberg Quarry, bed 10. Upper Oxfordian, Hypselum Zone, *semimammatum* Biohorizon.

Fig. 3. *Ochetoceras basseae* Fradin, 1947, phragmocone. SMNS 70542/5. Plettenberg Quarry, Wassergraben (beds 3–7). Upper Oxfordian, Hypselum Zone, *semimammatum* Biohorizon.

Fig. 4. *Ochetoceras basseae* Fradin, 1947, phragmocone. (a) Lateral view; (b) ventral view. SMNS 70542/6. Plettenberg Quarry, bed 10. Upper Oxfordian, Hypselum Zone, *semimammatum* Biohorizon.

Fig. 5. *Ochetoceras basseae* Fradin, 1947, with partially preserved keel. (a) Lateral view; (b) ventral view. SMNS 70542/3. Plettenberg Quarry, Wassergraben (beds 3–7). Upper Oxfordian, Hypselum Zone, *semimammatum* Biohorizon.

Fig. 6. *Ochetoceras basseae* Fradin, 1947, phragmocone with partially preserved keel. (a) Lateral view; (b) ventral view. SMNS 70542/1. Plettenberg Quarry, bed 3. Upper Oxfordian, Hypselum Zone, *semimammatum* Biohorizon.

Fig. 7. *Ochetoceras basseae* Fradin, 1947. SMNS 70542/4. Plettenberg Quarry, Wassergraben (beds 3–7). Upper Oxfordian, Hypselum Zone, *semimammatum* Biohorizon.

Fig. 8. *Prorasenia microbiplex* (Quenstedt, 1887), holotype, original of Quenstedt 1887, pl. 94, fig. 36. (a) Lateral view; (b, c) ventral views. GPIT CP 18679. Lochengründle near Balingen, Lochen Member. Upper Oxfordian.

Fig. 9. *Clambites schwabi* (Oppel, 1863); nearly complete specimen with slight deformation. SMNS 70554. Plettenberg Quarry. Lowermost Kimmeridgian, Bimammatum Zone, *bimammatum* Biohorizon.

Fig. 10. *Prorasenia microbiplex* (Quenstedt, 1887). SMNS 70547/2. Plettenberg Quarry, bed 7. Upper Oxfordian, Hypselum Zone, *semimammatum* Biohorizon.

Fig. 11. *Prorasenia microbiplex* (Quenstedt, 1887). (a) Lateral view; (b) ventral view. SMNS 70547/4. Plettenberg Quarry, bed 7. Upper Oxfordian, Hypselum Zone, *semimammatum* Biohorizon.

Beginning of body chamber is indicated by an arrow.
Plate 7

Fig. 1. *Prorasenia microbiplex* (Quenstedt, 1887). (a) Lateral view; (b) ventral view. SMNS 70547/6. Plettenberg Quarry, Wassergraben (beds 3–7). Upper Oxfordian, Hypselum Zone, *semimammatum* Biohorizon.

Fig. 2. *Prorasenia microbiplex* (Quenstedt, 1887). (a) Lateral view; (b, c) ventral views. SMNS 70547/7 (leg. G. Stappenbeck). Plettenberg Quarry, Wassergraben (beds 3–7). Upper Oxfordian, Hypselum Zone, *semimammatum* Biohorizon.

Fig. 3. *Ringsteadia salfeldi* (Dorn, 1925). SMNS 70548/1. Plettenberg Quarry, bed 3. Upper Oxfordian, Hypselum Zone, *semimammatum* Biohorizon.

Fig. 4. *Ringsteadia salfeldi* (Dorn, 1925). SMNS 70548/5. Plettenberg Quarry, Wassergraben (beds 3–7). Upper Oxfordian, Hypselum Zone, *semimammatum* Biohorizon.

Fig. 5. *Ringsteadia salfeldi* (Dorn, 1925). (a) Lateral view; (b, c) ventral views. SMNS 70548/3. Plettenberg Quarry, beds 3–7. Upper Oxfordian, Hypselum Zone, *semimammatum* Biohorizon.

Fig. 6. *Orthosphinctes fontannesi* (Chořfát, 1893). SMNS 70549/1. Plettenberg Quarry, bed 3. Upper Oxfordian, Hypselum Zone, *semimammatum* Biohorizon.

Fig. 7. *Orthosphinctes fontannesi* (Chořfát, 1893). (a) Lateral view; (b, c) ventral views. SMNS 70549/2. Plettenberg Quarry, bed 7. Upper Oxfordian, Hypselum Zone, *semimammatum* Biohorizon.

Fig. 8. *Orthosphinctes fontannesi* (Chořfát, 1893). SMNS 70549/3. Plettenberg Quarry, Wassergraben (beds 3–7). Upper Oxfordian, Hypselum Zone, *semimammatum* Biohorizon.

Fig. 9. *Orthosphinctes fontannesi* (Chořfát, 1893). SMNS 70549/4. Plettenberg Quarry, bed 10. Hypselum Zone, *semiarmatum* Biohorizon.

Fig. 10. *Subdiscosphinctes* sp., original of Schairer & Schlampp 2003, pl. 4, fig 2; SNSB-BSPG 2003 V 77. Gräfenberg, Deuerlein Quarry, Franconia. Upper Oxfordian, Hypselum Zone, *semimammatum* Biohorizon.

Fig. 11. *Subdiscosphinctes* sp. (a) Lateral view; (b, c) ventral views. SMNS 70551/1. Plettenberg Quarry, bed 8. Upper Oxfordian, Hypselum Zone, *semimammatum* Biohorizon.

Fig. 12. *Subdiscosphinctes* sp., SMNS 70551/2. Plettenberg Quarry, bed 10. Upper Oxfordian, Hypselum Zone, *semiarmatum* Biohorizon.

Beginning of body chamber is indicated by an arrow.
Plate 8

Fig. 1. *Pseudorthosphinctes aff. girardoti* ÉNAY, 1966; specimen with partial body chamber; outer whorl partly reconstructed. SMNS 70550. Upper Oxfordian, Plettenberg Quarry, Hypselum Zone.

Beginning of body chamber is indicated by an arrow. Note reduced scale.
HERBERT JANTSCHKE & GÜNTER SCHWEIGERT: SEMIMAMMATUM AND SEMIARMATUM AMMONITE BIOHORIZONS IN THE OXFORDIAN OF GERMANY
Plate 9

Fig. 1. *Pseudorthosphinctes* aff. *girardoti* Énay, 1966, nearly complete, but inadult specimen. NHMB, FPJ 27265. Plettenberg Quarry, bed 7. Upper Oxfordian, Hypselum Zone, *semimammatum* Biohorizon.

Fig. 2. *Graefenbergites* cf. *arancensis* (MeLéndeZ, 1989), original of Schairer & Schlamp 2003, pl. 8, fig 1. (a) Lateral view; (b) ventral view. SNSB-BSPG 2003 V 69. Gräfenberg, Deuerlein Quarry, Franconia. Upper Oxfordian, Hypselum Zone, *semimammatum* Biohorizon.

Fig. 3. *Graefenbergites* cf. *arancensis* (MeLéndeZ, 1989), juvenile stage. SMNS 70552/2. Plettenberg, bed 10. Upper Oxfordian, Hypselum Zone, *semiarmatum* Biohorizon.

Fig. 4. *Graefenbergites* cf. *arancensis* (MeLéndeZ, 1989). SMNS 70552/1. Plettenberg Quarry, Wassergraben (beds 3–7). Upper Oxfordian, Hypselum Zone, *semiarmatum* Biohorizon.

Fig. 5. *Barthelticeras enayi* Schairer, 1989; complete specimen (priv. coll. V. Schlamp [leg. J. Schwarz], Rednitzhembach). Gräfenberg, Deuerlein Quarry, Franconia. Upper Oxfordian, Hypselum Zone, *semimammatum* Biohorizon.

Fig. 6. *Barthelticeras enayi* Schairer, 1989. SMNS 70553/1. Plettenberg Quarry, bed 5. Upper Oxfordian, Hypselum Zone, *semiarmatum* Biohorizon.

Fig. 7. *Barthelticeras enayi* Schairer, 1989; specimen with partial body chamber (priv. coll. H. Kuschel, Göppingen-Faurndau). Plettenberg Quarry, Wassergraben (beds 3–7). Upper Oxfordian, Hypselum Zone, *semimammatum* Biohorizon.

Fig. 8. *Barthelticeras enayi* Schairer, 1989; specimen with partial body chamber, inner whorls restored. SMNS 70553/2 (leg. G. Stappenbeck). Plettenberg Quarry, Wassergraben (beds 3–7). Upper Oxfordian, Hypselum Zone, *semimammatum* Biohorizon.

Beginning of body chamber is indicated by an arrow.
Appendix – Measurements of studied specimens

Measurements for *Sowerbyceras tortisulcatum* (OrBigny, 1841):

| Specimen | Dm | Uw | Wh | Ww | Pr | Sr |
|----------|----|----|----|----|----|----|
| SMNS 70534, bed 10, Pl.1, Fig. 1 | 37 | 7 | 17 | 14 | – | – |

Measurements for *Amoeboceras alternans* (Buch, 1831) [m]:

| Specimen | Dm | Uw | Wh | Ww | Pr | Sr |
|----------|----|----|----|----|----|----|
| HT *alternans* [illustration] | 30 | 11 | 12 | 9 | 26 | 37 |
| NT *alternans*, GPIT CP 18600 | 33 | 13 | 12 | 9 | – | 51 |
| HT *ovale*, GPIT CP 17609 | 31 | 9 | 12 | 9 | 27 | 48 |
| SMNS 70535/1, bed 3, no. 1 | 23 | 6 | 10 | 6 | 35 | 43 |
| SMNS 70535/2, bed 3, no. 2 | 14 | 4 | 6 | 5 | 29 | 44 |
| SMNS 70535/3, bed 3, no. 3 | 19 | 5 | 9 | 6 | – | – |
| SMNS 70535/4, bed 3, no. 4 | 26 | 8 | 11 | 7 | 30 | 42 |
| SMNS 70535/5, bed 3, no. 5 | 22 | 6 | 9 | 7 | – | – |
| SMNS 70535/6, bed 3, no. 6, Pl. 1, Fig. 7 | 31 | 9 | 13 | 10 | 34 | 62 |
| SMNS 70535/7, bed 3, no. 7 | 22 | 7 | 9 | 7 | 35 | 44 |
| SMNS 70535/8, bed 3, no. 8 | 20 | 7 | 9 | 6 | – | – |
| SMNS 70535/9, bed 3, no. 9 | 24 | 7 | 10 | 8 | 30 | 54 |
| SMNS 70535/10, bed 3, no. 10 | 25 | 8 | 11 | – | 28 | 51 |
| SMNS 70535/11, bed 3, no. 11 | 25 | 8 | 10 | 7 | 29 | 55 |
| SMNS 70535/12, bed 3, no. 12 | 21 | 6 | 9 | 6 | 33 | 50 |
| SMNS 70535/13, bed 3, no. 13 | 19 | 5 | 9 | 6 | – | – |
| SMNS 70535/14, bed 3, no. 14 | 20 | 6 | 8 | 6 | 28 | 46 |
| SMNS 70535/15, bed 3, no. 15 | 17 | 5 | 7 | 5 | 27 | – |
| SMNS 70535/16, bed 3, no. 16 | 15 | 4 | 7 | 5 | – | – |
| SMNS 70535/17, bed 3, no. 17 | 11 | 3 | 5 | 4 | 24 | 40 |
| SMNS 70535/18, bed 7, no. 1 | 32 | 10 | 13 | 8 | 33 | 62 |
| SMNS 70535/19, bed 7, no. 2 | 38 | 12 | 14 | 8 | 41 | 64 |
| SMNS 70535/20, bed 7, no. 3 | 20 | 6 | 8 | 6 | 30 | 49 |
| SMNS 70535/21, bed 7, no. 4 | 21 | 8 | 9 | 6 | 23 | 37 |
| SMNS 70535/22, bed 7, no. 5 | 28 | 10 | 10 | 7 | 35 | – |
| SMNS 70535/23, bed 7, no. 6 | 31 | 11 | 12 | 7 | – | – |
| SMNS 70535/24, bed 7, no. 7 | 25 | 7 | 11 | 8 | 35 | 62 |
| SMNS 70535/25, bed 7, no. 8 | 17 | 5 | 9 | 6 | 26 | 45 |
| SMNS 70535/26, bed 7, no. 9 | 24 | 9 | 9 | 7 | 34 | – |
| SMNS 70535/27, bed 7, no. 10 | 25 | 8 | 10 | 7 | 33 | – |
| SMNS 70535/28, bed 7, no. 11 | 15 | 4 | 6 | 4 | 28 | 51 |
| SMNS 70535/29, bed 7, no. 12 | 13 | 4 | 6 | 4 | 27 | – |
| SMNS 70535/30, bed 7, no. 13 | 21 | 8 | 9 | 6 | 36 | 62 |
| SMNS 70535/31, bed 7, no. 14 | 24 | 8 | 10 | 7 | 32 | 54 |
| SMNS 70535/32, bed 7, no. 15 | 24 | 7 | 10 | 6 | 33 | 51 |
| SMNS 70535/33, bed 7, no. 16 | 20 | 6 | 10 | 7 | 34 | 54 |
| SMNS 70535/34, bed 7, no. 17 | 17 | 5 | 7 | 5 | 29 | 60 |
| SMNS 70535/35, bed 7, no. 18 | 11 | 2 | 5 | 3 | 24 | 43 |
| SMNS 70535/36, bed 7, no. 19 | 14 | 4 | 6 | 5 | 33 | 55 |
| SMNS 70535/37, bed 7, no. 20 | 18 | 5 | 8 | 6 | 25 | 41 |
| SMNS 70535/38, bed 7, no. 21 | 18 | 5 | 8 | 6 | 28 | 45 |
| SMNS 70535/39, bed 7, no. 22 | 19 | 6 | 8 | 5 | 27 | 44 |
| SMNS 70535/40, bed 7, no. 23 | 17 | 5 | 7 | 5 | 29 | 52 |
| SMNS 70535/41, bed 7, no. 24 | 20 | 6 | 8 | 6 | 28 | 51 |
| Specimen | Dm | Uw | Wh | Ww | Pr | Sr |
|----------|----|----|----|----|----|----|
| SMNS 70535/42, bed 7, no. 25, Pl.1, Fig. 5 | 30 | 11 | 12 | 9  | 34 | 63 |
| SMNS 70535/43, bed 7, no. 26, Pl.1, Fig. 6 | 43 | 14 | 17 | 11 | 40 | 86 |
| SMNS 70535/44, bed 7, no. 27, Pl. 1, Fig. 10 | 22 | 8  | 9  | 6  | 33 | 52 |
| SMNS 70535/45, bed 7, no. 28 | 17 | 5  | 7  | 5  | 25 | 45 |
| SMNS 70535/46, bed 7, no. 29 | 18 | 6  | 7  | 5  | 31 | 48 |
| SMNS 70535/47, bed 7, no. 30, Pl. 1, Fig. 11 | 22 | 6  | 10 | 7  | 29 | 49 |
| SMNS 70535/48, bed 7, no. 31, Pl. 1, Fig. 8 | 19 | 7  | 8  | 5  | 26 | 42 |
| SMNS 70535/49, bed 7, no. 32, Pl. 1, Fig. 9 | 19 | 4  | 8  | 6  | 37 | 54 |
| SMNS 70535/50, Wassergr. 1 | 30 | 9  | 13 | 9  | 37 | 52 |
| SMNS 70535/51, Wassergr. 2 | 26 | 8  | 10 | 7  | 32 | 62 |
| SMNS 70535/52, Wassergr. 3 | 21 | 6  | 9  | 6  | 37 | 68 |
| SMNS 70535/53, Wassergr. 4 | 26 | 8  | 10 | 7  | 32 | –  |
| SMNS 70535/54, Wassergr. 5 | 24 | 7  | 10 | 7  | 31 | 50 |
| SMNS 70535/55, Wassergr. 6 | 25 | 8  | 10 | 7  | 39 | –  |
| SMNS 70535/56, Wassergr. 7 | 23 | 6  | 10 | 7  | 31 | 55 |
| SMNS 70535/57, Wassergr. 8 | 24 | 7  | 10 | 7  | 37 | 58 |
| SMNS 70535/58, Wassergr. 9 | 19 | 6  | 8  | 6  | 31 | –  |
| SMNS 70535/59, Wassergr. 10 | 19 | 6  | 8  | 6  | 27 | 48 |
| SMNS 70535/60, Wassergr. 11 | 18 | 6  | 7  | 6  | 41 | 60 |
| SMNS 70535/61, Wassergr. 12, Pl. 1, Fig. 12 | 28 | 9  | 12 | 9  | 39 | 64 |
| SMNS 70535/62, Wassergr. 13, Text-Fig. 6a | 23 | 7  | 10 | 6  | 35 | 52 |
| SMNS 70535/63, Wassergr. 14, Text-Fig. 6b | 20 | 7  | 8  | 9  | 24 | 48 |

Measurements for *Richeiceras lochense* (Oppel, 1863) [M]:

| Specimen | Dm | Uw | Wh | Ww | Pr | Sr |
|----------|----|----|----|----|----|----|
| HT, SNSB-BSPG AS VIII 175 | 26 | 3  | 14 | 8  | –  | –  |
| QUENSTEDT 1887, pl. 93, fig. 29, IGPT CP 18650 | 32 | 4  | 17 | 9  | –  | –  |
| QUENSTEDT 1887, pl. 93, fig. 17, IGPT CP 18647 | 25 | 3  | 14 | 7  | –  | –  |
| SMNS 70537/1, Wassergrab, Pl. 2, Fig. 3 | 31 | 4  | 18 | 9  | –  | –  |
| SMNS 70537/2, bed 10, no. 1, Pl. 2, Fig. 1 | 37 | 4  | 21 | 10 | –  | –  |
| SMNS 70537/3, bed 10, no. 2, Pl. 2, Fig. 2 | 33 | 3  | 18 | 10 | –  | –  |

Measurements for *Taramelliceras externnodosum* (Dorn, 1930) [M]:

| Specimen | Dm | Uw | Wh | Ww | Pr | Sr |
|----------|----|----|----|----|----|----|
| BSPG 2003 V4 | 105 | 12 | 48 | 18 | –  | –  |
| SMNS 70538/1, bed 3, Pl. 2, Fig. 4 | 51 | 5  | 28 | 16 | –  | –  |
| SMNS 70538/2, Wassergrab, Pl. 2, Fig. 5 | 53 | 5  | 31 | 16 | –  | –  |
| SMNS 70538/3, bed 10, no. 1, Text-Fig. 11a | 40 | 4  | 23 | 14 | 11 | 53 |
| SMNS 70538/4, bed 10, no. 2, Pl. 2, Fig. 6 | 30 | 4  | 15 | 9  | –  | 40 |
| SMNS 70538/5, bed 10, no. 3, Pl. 2, Fig. 7 | 36 | 5  | 19 | 12 | 15 | 39 |

Measurements for *Coryceras canale* (Quenstedt, 1848) [m] (only complete specimens):

| Specimen | Dm | Uw | Wh | Ww | Pr | Sr |
|----------|----|----|----|----|----|----|
| HT, GPIT CP 17618 | 18 | 5  | 8  | 5  | –  | –  |
| SMNS 70539/1, bed 7 | 19 | 5  | 8  | 5  | –  | –  |
| SMNS 70539/2, Wassergrab, Pl. 2, Fig. 12 | 15 | 4  | 6  | 4  | –  | –  |
| SMNS 70539/3, bed 10, no. 1, Pl. 2, Fig. 9 | 13 | 4  | 5  | 4  | –  | –  |
| SMNS 70539/4, bed 10, no. 2 | 15 | 4  | 6  | 4  | –  | –  |
| SMNS 70539/5, bed 10, no. 3, Pl. 2, Fig. 11 | 14 | 4  | 6  | 4  | –  | –  |
| SMNS 70539/6, bed 10, no. 4 | 16 | 4  | 7  | 5  | –  | –  |
Measurements for *Coryceras microdomus* (Oppel, 1863) [m]:

| Specimen                               | Dm | Uw | Wh | Ww | Pr | Sr |
|----------------------------------------|----|----|----|----|----|----|
| HT, SNSB-BSPG AS VIII 6/5              | 24 | 6  | 10 | 7  | –  | –  |
| SMNS 70540/1, bed 3                    | 27 | 8  | 11 | 7  | –  | –  |
| SMNS 70540/2, Wassergraben, Pl. 2, Fig. 16 | 28 | 8  | 11 | 8  | –  | –  |
| SMNS 70540/3, bed 10, no. 1, Pl. 2, Fig. 15 | 32 | 10 | 12 | 9  | –  | –  |
| SMNS 70540/4, bed 10, no. 2            | 25 | 6  | 11 | 7  | –  | –  |

Measurements for *Trimarginites trimarginatus* (Oppel, 1857) [M]:

| Specimen                               | Dm | Uw | Wh | Ww | Pr | Sr |
|----------------------------------------|----|----|----|----|----|----|
| SMNS 70541, beds 3–7, Pl. 5, Fig. 8   | 32 | 3  | 8  | 6  | –  | –  |

Measurements for *Ochetoceras basseae* Fradin, 1947 [M]:

| Specimen                               | Dm | Uw | Wh | Ww | Pr | Sr |
|----------------------------------------|----|----|----|----|----|----|
| SMNS 70542/1, bed 3, Pl. 6, Fig. 6    | 36 | 7  | 19 | 13 | 17 | –  |
| SMNS 70542/2, bed 5                   | 62 | 9  | 33 | 16 | 17 | –  |
| SMNS 70542/3, Wassergr. 1, Pl. 6, Fig. 5 | 54 | 9  | 29 | 17 | 14 | 45 |
| SMNS 70542/4, Wassergr. 2, Pl. 6, Fig. 7 | 38 | 7  | 20 | 11 | 13 | 49 |
| SMNS 70542/5, Wassergr. 3, Pl. 6, Fig. 3 | 27 | 6  | 14 | 8  | 8  | 22 |
| SMNS 70542/6, bed 10, Pl. 6, Fig. 4   | 42 | 8  | 22 | 12 | 17 | 42 |

Measurements for *Glochiceras tectum* Ziegler, 1958 [m]:

| Specimen                               | Dm | Uw | Wh | Ww | Pr | Sr |
|----------------------------------------|----|----|----|----|----|----|
| HT, SMNS 19346                         | 28 | 8  | 11 | 6  | –  | –  |
| SMNS 70543/1, bed 7, Pl. 6, Fig. 2    | 19 | 4  | 9  | 6  | –  | –  |
| SMNS 70543/2, bed 10, Pl. 6, Fig. 1   | 24 | 6  | 11 | 7  | –  | –  |

Measurements for *Epipeltoceras semimammatum* (Quenstedt, 1887) [m] (only lappeted specimens):

| Specimen                               | Dm | Uw | Wh | Ww | Pr | Sr |
|----------------------------------------|----|----|----|----|----|----|
| HT, SMNS 14486                         | 23 | 9  | 8  | 8  | 23 | 29 |
| SMNS 70544/1, bed 3, Pl. 3, Fig. 5    | 21 | 9  | 7  | 7  | 27 | 29 |
| SMNS 70544/2, bed 5                   | 21 | 9  | 7  | 7  | 23 | 28 |
| SMNS 70544/3, bed 7, Pl. 3, Fig. 6    | 23 | 10 | 7  | 8  | 24 | 28 |
| SMNS 70544/4, bed 7, Pl. 3, Fig. 7    | 22 | 10 | 6  | 7  | 23 | 25 |
| SMNS 70544/5, Wassergr., no. 1       | 25 | 11 | 9  | 8  | 24 | 29 |
| SMNS 70544/6, Wassergr., no. 2       | 22 | 9  | 7  | 7  | 23 | 28 |

Measurements for *Epipeltoceras semiarmatum* (Quenstedt, 1887) [m] (only lappeted specimens):

| Specimen                               | Dm | Uw | Wh | Ww | Pr | Sr |
|----------------------------------------|----|----|----|----|----|----|
| HT, GPIT CP 18692                      | 27 | 10 | 10 | –  | 25 | 25 |
| SMNS 70545/1, bed 10, no. 1, Pl. 3, Fig. 9 | 31 | 13 | 11 | 10 | 28 | 30 |
| SMNS 70545/2, bed 10, no. 2, Pl. 3, Fig. 12 | 34 | 14 | 11 | 10 | 27 | 28 |
| SMNS 70545/3, bed 10, no. 3, Pl.3, Fig. 13 | 32 | 14 | 10 | 9  | 27 | 28 |
| SMNS 70545/4, bed 10, no. 4            | 31 | 13 | 11 | 9  | –  | –  |
| SMNS 70545/5, bed 10, no. 5            | 28 | 12 | 9  | 8  | 28 | –  |
| SMNS 70545/6, bed 10, no. 6            | 29 | 12 | 10 | 9  | –  | –  |
| SMNS 70545/7, bed 10, no. 7            | 27 | 11 | 9  | 9  | 27 | 28 |
| SMNS 70545/8, bed 10, no. 8            | 32 | 14 | 10 | 9  | 27 | 29 |
| SMNS 70545/9, bed 10, no. 9            | 36 | 17 | 12 | 11 | 29 | –  |
Measurements for *Clambites hypselus* (Oppel, 1863) / *Clambites aff. hypselus* (Oppel, 1863) [M]:

| Specimen | Dm  | Uw  | Wh  | Ww  | Pr  | Sr  |
|----------|-----|-----|-----|-----|-----|-----|
| HT, BSPG AS VIII 61 | 119 | 47  | 40  | 50  | 19  | 19  |
| QUENSTEDT 1887, pl. 96, fig. 1, GPT CP 18702 | 93  | 44  | 28  | 30  | 19  | 19  |
| SMNS 70546/1, bed 3 | 27  | 11  | 10  | 10  | 21  | 21  |
| SMNS 70546/2, bed 5, Pl. 5, Fig. 1 | 160 | 67  | 52  | –   | 21  | 21  |
| SMNS 70546/2, bed 10 no. 1, Pl. 4, Fig. 2 | 165 | 65  | 55  | –   | 15  | 15  |
| SMNS 70546/3, bed 10 no. 2 | 120 | 46  | 45  | 54  | 15  | 15  |
| SMNS 70546/4, bed 10 no. 3, Pl. 5, Fig. 2 | 31  | 12  | 11  | 21  | 18  | 18  |
| SMNS 70546/5, bed 10 no. 4, Pl. 5, Fig. 3 | 12  | 3   | 5   | 6   | 17  | 17  |
| SMNS 70546/6, bed 10 no. 5, Pl. 5, Fig. 4 | 19  | 7   | 7   | –   | 19  | 19  |
| SMNS 70546/7, bed 10 no. 6 | 32  | 13  | 13  | 16  | 22  | 22  |
| SMNS 70546/8, bed 10 no. 7, Pl. 5, Fig. 6 | 28  | 10  | 11  | 13  | 21  | 21  |
| SMNS 70546/9, bed 10 no. 8, Pl. 5, Fig. 5 | 26  | 8   | 11  | 13  | 20  | 20  |
| SMNS 70546/10, bed 10 no. 9, Pl. 5, Fig. 7 | 28  | 10  | 12  | 13  | 27  | 27  |

Measurements for *Prorasia microbiplex* (Quenstedt, 1887) [m]:

| Specimen | Dm  | Uw  | Wh  | Ww  | Pr  | Sr  |
|----------|-----|-----|-----|-----|-----|-----|
| HT, IGPT CP 18679 | 30  | 15  | 8   | 10  | –   | –   |
| SMNS 70547/1, bed 3 | 38  | 19  | 11  | 11  | 30  | –   |
| SMNS 70547/2, bed 7, no. 1, Pl. 6, Fig. 10 | 40  | 17  | 14  | 14  | 22  | –   |
| SMNS 70547/3, bed 7, no. 2 | 35  | 16  | 12  | 12  | 24  | 48  |
| SMNS 70547/4, bed 7, no. 3, Pl. 6, Fig. 11 | 33  | 16  | 10  | 11  | 27  | 57  |
| SMNS 70547/5, bed 7, no. 4 | 32  | 14  | 11  | 13  | 26  | 53  |
| SMNS 70547/6, Wassergraben, Pl. 7, Fig. 1 | 36  | 17  | 12  | 13  | 26  | 50  |
| SMNS 70547/7, Wassergraben, Pl. 7, Fig. 2 | 48  | 24  | 14  | 13  | 35  | 67  |

Measurements for *Ringsteadia salfeldi* (Dorn, 1925) [M]:

| Specimen | Dm  | Uw  | Wh  | Ww  | Pr  | Sr  |
|----------|-----|-----|-----|-----|-----|-----|
| SMNS 70548/1, bed 3, Pl. 7, Fig. 3 | 38  | 11  | 16  | 12  | 25  | –   |
| SMNS 70548/2, bed 5 | 34  | 13  | 13  | 11  | –   | –   |
| SMNS 70548/3, beds 3–7, Pl. 7, Fig. 5 | 41  | 13  | 17  | 16  | 25  | –   |
| SMNS 70548/4, bed 7 | 28  | 10  | 12  | 10  | 27  | 70  |
| SMNS 70548/5, Wassergraben, Pl. 7, Fig. 4 | 40  | 14  | 17  | 15  | –   | –   |

Measurements for *Orthosphinctes fontannesi* (Choef, 1893) [m]:

| Specimen | Dm  | Uw  | Wh  | Ww  | Ir  | Or  |
|----------|-----|-----|-----|-----|-----|-----|
| SMNS 70549/1, bed 3, Pl. 7, Fig. 6 | 59  | 17  | 21  | 20  | 45  | 83  |
| SMNS 70549/2, bed 7, Pl. 7, Fig. 7 | 52  | 24  | 18  | 17  | 36  | –   |
| SMNS 70549/3, Wassergraben, Pl. 7, Fig. 8 | 50  | 23  | 19  | 19  | 43  | 87  |
| SMNS 70549/4, bed 10, Pl. 7, Fig. 9 | 41  | 16  | 15  | 14  | 38  | 80  |

Measurements for *Pseudorthosphinctes aff. girardoti* Enay, 1966 [M]:

| Specimen | Dm  | Uw  | Wh  | Ww  | Pr  | Sr  |
|----------|-----|-----|-----|-----|-----|-----|
| SMNS 70550, Pl. 8 | 280 | 138 | 77  | 55  | –   | –   |
| NHMB FPJ 27265, bed 7 | 137 | 66  | 42  | 32  | 54  | 112 |

Measurements for *Subdiscosphinctes* sp.:

| Specimen | Dm  | Uw  | Wh  | Ww  | Pr  | Sr  |
|----------|-----|-----|-----|-----|-----|-----|
| BSPG 2003 V 77 | 58  | 23  | 22  | 15  | –   | –   |
| SMNS 70551/1, bed 8, Pl. 7, Fig. 11 | 51  | 18  | 23  | 14  | 54  | 97  |
| SMNS 70551/2, bed 10, Pl. 7, Fig. 12 | 48  | 19  | 18  | 13  | 56  | 105 |
Measurements for *Graefenbergites* cf. *arancensis* (Meléndez, 1989) [m, M]:

| Specimen                                      | Dm | Uw | Wh | Ww | Pr | Sr |
|-----------------------------------------------|----|----|----|----|----|----|
| BSPG 2003 V69                                 | 69 | 38 | 18 | 15 | 45 | 85 |
| SMNS 70552/1, Wassergraben, Pl. 9, Fig. 4     | 65 | 34 | 19 | 14 | –  | –  |
| SMNS 70552/2, bed 10, Pl. 9, Fig. 3           | 25 | 15 | 6  | 7  | 42 | –  |

Measurements for *Barthelticeras* *enayi* Schairer, 1989 [m]:

| Specimen                                      | Dm | Uw | Wh | Ww | Pr | Sr |
|-----------------------------------------------|----|----|----|----|----|----|
| SMNS 70553/1, bed 5, Pl. 9, Fig. 6             | 50 | 25 | 14 | 12 | –  | –  |
| priv. coll. H. Kuschel, beds 3–7, Pl. 9, Fig. 7| 40 | 18 | 13 | 11 | –  | –  |