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The Sauzei-/Humphriesianum zonal boundary (Lower Bajocian, Middle Jurassic) in the type area of the Gosheim Formation (W Swabian Alb, SW Germany)

Volker Dietze, Dietmar Schreiber † & Günter Schweigert

Abstract

The Bajocian ammonite faunas of the ʽOberer Blaukalk' Member (Wedelsandstein Formation) and of the lower part of the ʽHumphriesioolith' Member (Gosheim Formation) in the vicinity of Gosheim (SW Swabian Alb) are studied. At least three biohorizons of the Sauzei Zone can be distinguished: *dilatus*, *pseudocontrahens*, *macrum* and ?*carinodiscus* biohorizon, probably followed by the *deltafalcata* biohorizon of the basal Humphriesianum Zone (Pinguis Subzone). This succession is correlated with other sites in SW Germany and abroad.

Keywords: Sauzei Zone, Humphriesianum Zone, ammonite biohorizons, SW Germany, Bajocian.

In memoriam Norbert Wannenmacher (1961–2020)

1. Introduction

In the Swabian Alb, the middle part of the Braunjura Group is mostly formed by claystones and often covered by thick hillside debris from overlying Upper Jurassic limestones. An exception is the vicinity of the village of Gosheim in the western part of the Swabian Alb. There, the Braunjura forms a steep slope and an adjacent wide plane. In the Bajocian, relatively thick iron oolites occur; the iron content of which, however, is too low for successful industrial exploitation, although some attempts have been undertaken in the 19th century (see Wannenmacher 2017). Fischer (1912, 1924), Weisert (1932) and Berz (1933) analysed in detail the succession and macrofossil content of the ʽHumphriesioolith' in this area, which is today a member of the lower Bajocian Gosheim Formation (Dietze et al. 2015). Modern descriptions of the lithological succession and ammonites of the ʽHumphriesioolith' and the underlying ʽOberer Blaukalk' members can be found in Dietl (1977), Dietl & Rieber (1980), Franz (1988) and Ohmert (1990). Dietl (1978) was the first researcher, who recognized that basal parts of the ʽHumphriesioolith' Member (Fig. 1) still belong to the Sauzei Zone and not to the Humphriesianum Zone as often stated in generalized mainstream literature (e.g., Geyer & Gwinner 1984, 2011). More recently, Dietze et al. (2008) introduced the *macrum* Biohorizon (Sauzei Zone), which comprises the beds with *Skirroceras macrum* in the basal part of the ʽHumphriesioolith' Member at Gosheim. In addition to that preliminary report, we here complete our study of the complex bio- and lithostratigraphy at the Sauzei-/Humphriesianum zonal boundary in the type area of the Gosheim Formation.

2. Material and methods

Ammonites are rare in the basal part of the ʽHumphriesioolith' Member at Gosheim. Due to this scarcity, a systematic bed-by-bed sampling of specimens is almost impossible. Only by chance single ammonites can be recovered directly from temporary sections exposed in construction pits, sewer trenches or other excavations. Most outcrops were accessible only for a short time, and we were not always informed quick enough about the opening of such outcrops. The excavated material was usually transported to the local earth dump of Gosheim, where it was levelled. Reconstruction of the origination of loose material from there is only possible for material with very characteristic lithologies such as the ʽSpathulatusbank' or the ʽOberer Blaukalk' Member. Specimens that originate from higher parts of the ʽHumphriesioolith' Member collected at the earth dump can hardly be assigned precisely to the section since the lithology within this part of the member is too uniform. When sometimes the excavated material was deposited in numerous gigantic boulders, it became obvious that ammonites from the basal part of the ʽHumphriesioolith' Member are even extremely rare. Despite these enormous difficulties, several age-diagnostic ammonites could be sampled from their bed or at least with detailed information over the last 30 years. This material allowed a high-resolution biostratigraphical subdivision of the basal part of the ʽHumphriesioolith' Member into biohorizons (for methodology, see Callomon 1995). Further material originates from the same interval, but could not be assigned precisely to these biohorizons. Deciphering information from specimens and outcrops was necessary to get an idea about the complete biostrati-

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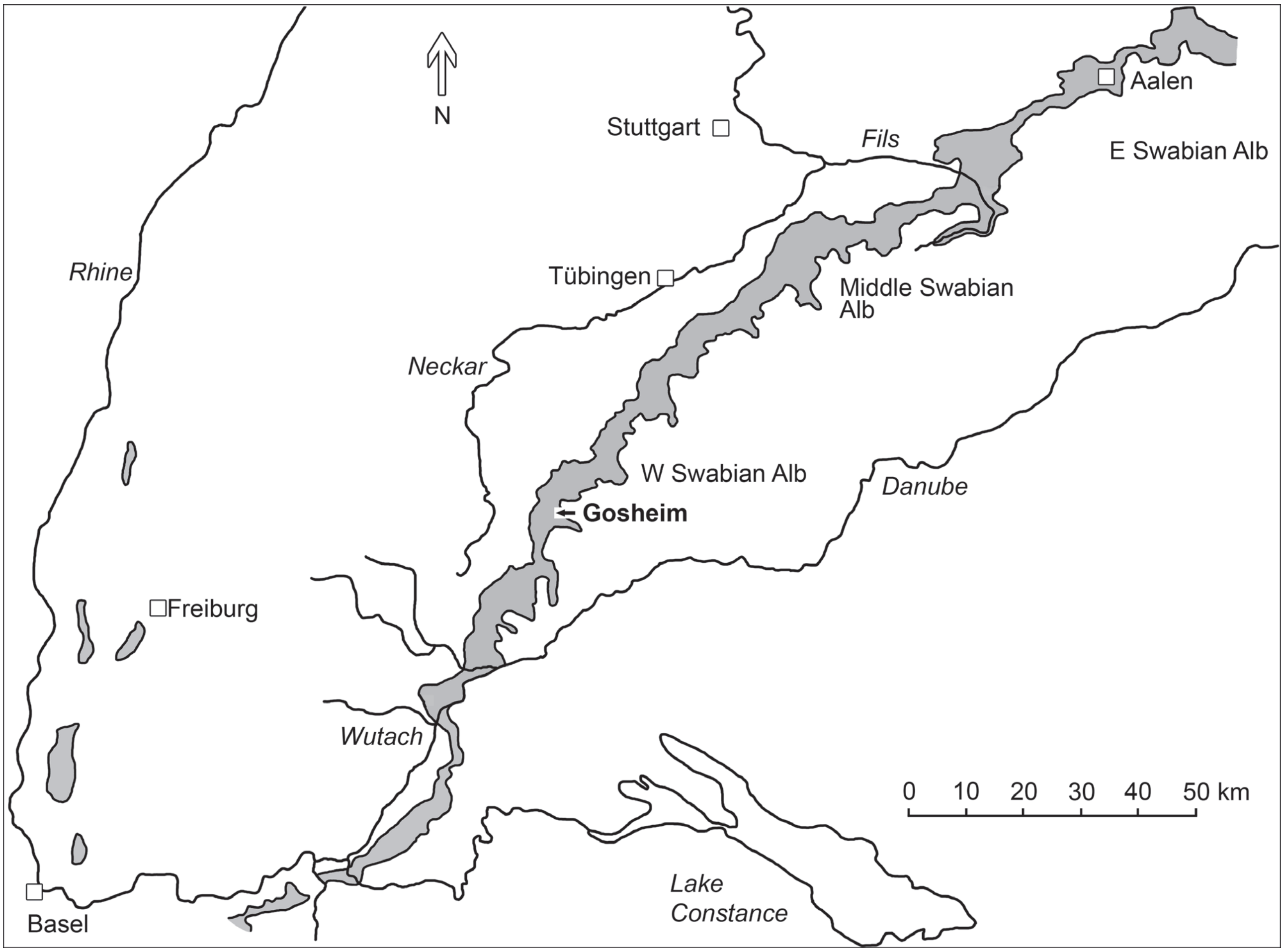

Fig. 1. Middle Jurassic beds in SW Germany. The herein studied location Gosheim in the western part of the Swabian Alb is indicated by an arrow.

graphic succession in the area. Additionally, in the basal part of the 'Humphriesioolith' Member the lithological succession and the thicknesses of individual beds change laterally rapidly. In fresh state, the 'Humphriesioolith' Member often appears as a homogenous unit; only after weathering individual beds are distinguishable. This phenomenon hampers both a detailed measuring of the sections and the correlation of individual beds.

For a better comparison among each other we illustrated all ammonites on the plates in half of their size. Only the smaller specimens of Fig. 3 were illustrated in natural size. The studied material is stored in the collection of the Stuttgart Natural History Museum (acronym SMNS).

3. Outcrops and sections

We here describe outcrops at Gosheim which had provided relevant stratigraphic data over the last decades, especially precisely collected ammonites. Additionally, we briefly describe further sections and outcrops mentioned in the literature, from where biostratigraphically relevant ammonites are stored in various collections. Since the lithological succession at Gosheim is principally similar in all outcrops except that within the industrial area Sturmbühl, we here provide a slightly idealized section (Fig. 2).

3.1. Brücklestraße (extension of Grimm Company)

In this construction pit, the 'Oberer Blaukalk' Member and the lower 4.5 m of the 'Humphriesioolith' Member were exposed. Since this succession was very heterogeneous, we do not provide a detailed description of the section. Two age-diagnostic ammonites were recovered from the bed: *Emileia vagabunda* (Pl. 1, Figs. 5, 6) and *Skirroceras* cf. *nodosum* (Pl. 6, Figs. 1, 2). Although the excavated material was deposited for months on the earth dump

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of Gosheim, only few additional specimens were collected from there: *Skirroceras nodosum* (Pl. 6, Figs. 3, 4) – after its rock matrix and preservation from the same level as the *S.* cf. *nodosum*, *S.* cf. *freycineti* (Pl. 5, Figs. 3, 4), a pathological *Skirroceras* sp. (Pl. 5, Fig. 2), *Sonninia* [„*Sonninites*"] aff. *felix* (Pl. 7, Figs. 1, 2), *Sonninia alsatica* (Pl. 9, Figs. 5, 6), *S. pseudofurticarinata* (Pl. 9, Fig. 2), and *Fissilobiceras furticarinatum*. (Pl. 9, Figs. 7, 8).

Wedelsandstein Formation

ʽ**Oberer Blaukalk' Member** (0.4–0.7 m): sandy limestone, often with a shell layer of bivalves in its middle. Ammonite: *Sonninia* sp. [visible in cross section].

Gosheim Formation

ʽ**Humphriesioolith' Member** (c. 4.5 m exposed)

Interestingly, at this construction pit the lithology of the beds in the basal part of this member changed within shortest distances. Above the basal marl (0.1–0.15 m) of the ʽHumphriesioolith' a 0.3–0.4 m thick bed was developed. In some parts of the pit this beds showed the typical lithology of the "Spathulatusbank" lacking iron ooids, whereas at other places the iron-oolitic lithology started already at the very base of this bed or even in the basal marl below. The same observation was made for the beds following above. Some of the individual beds could be laterally followed only over a distance of few metres and then they thin out.

0.1–0.15 m: reddish to gray marls, partly iron-oolitic.

Ammonite: *Emileia vagabunda* (Pl. 1, Figs. 5, 6)

0.3–0.4 m: hard, sparitic limestone (lithology of the ʽSpathulatusbank') or strongly iron-oolitic marly limestone.

c. 1.4–1.5 m: alternation of somewhat thicker calcareous marls laterally changing from iron-oolitic to ooid-free beds (thicknesses 0.15–0.4 m) and mostly thinner iron-oolitic marl to clay marl (thicknesses 0.02–0.2 m). Harder beds often rich in bivalves, partly in living position.

0.3 m: hard, bluish-gray limestone, only sporadically with accumulations of reddish iron ooids. Brachiopods and bivalves are very abundant. Ammonites: *Skirroceras* cf. *nodosum* (Pl. 6, Figs. 1, 2), *S. nodosum* (Pl. 6, Figs. 3, 4 [by matrix probably from this bed]).

c. 2.2–2.3 m: another alternation of somewhat thicker calcareous marls laterally changing from iron-oolitic to ooid-free beds (thicknesses 0.1–0.35 m) and mostly thinner iron-oolitic marl to clay marl (thicknesses 0.05–0.2 m). Some parts of this bed are very rich in fossils (oysters and other bivalves, belemnites, echinoid spines).

Higher parts of the ʽHumphriesioolith' Member were not exposed in this construction pit.

3.2. Industriestraße (extension of Hermle Company)

In the construction pit of an industrial building, the ʽHumphriesioolith' Member was largely exposed. A detailed section was not measured, but the ʽSpathulatusbank' was

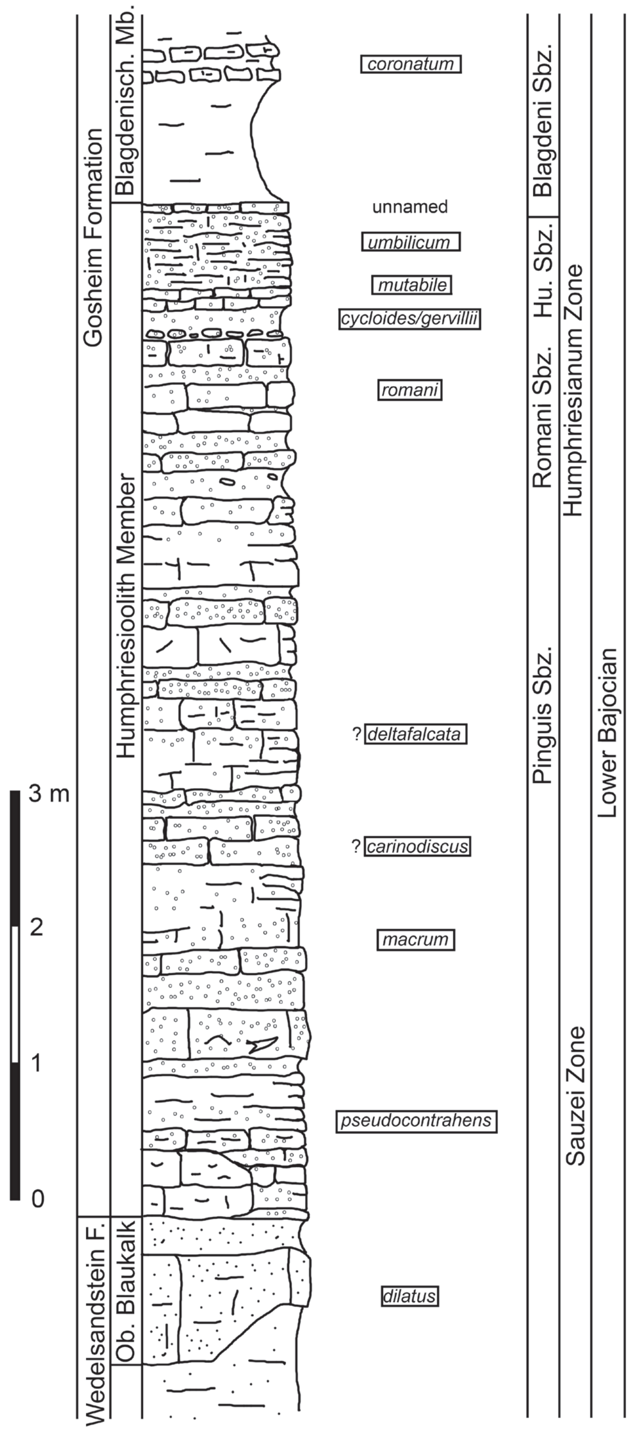

Fig. 2. Combined and slightly idealized section from the ʽOberer Blaukalk' Member up to the basis of the ʽBlagdenischichten' at Gosheim (SW Germany) (based on OHMERT 1990, fig. 7 and own observations). Abbreviations: Wedelsandstein F. = Wedelsandstein Formation; Ob. Blaukalk = ʽOberer Blaukalk' Member; Blagdenischichten Mb. = ʽBlagdenischichten' Member; Sbz. = Subzone; Hu. = Humphriesianum.

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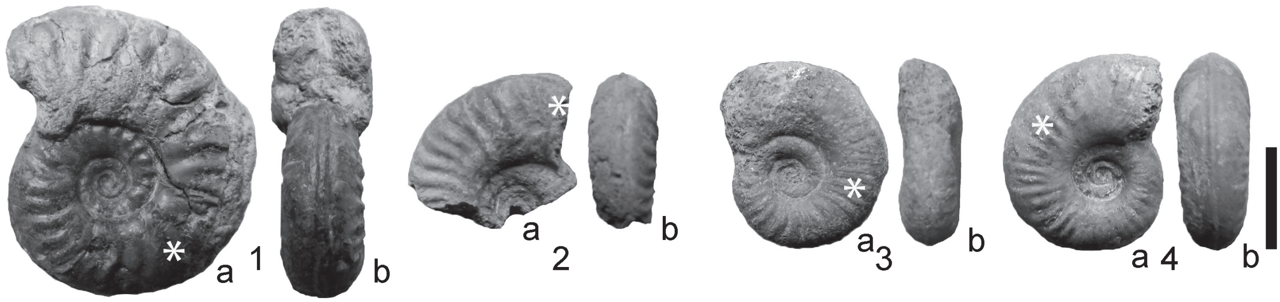

Fig. 3. Ammonites of the Gosheim Formation, ʽHumphriesioolith' Member, Lower Bajocian, Humphriesianum Zone, Pinguis Subzone, ?*deltafalcata* biohorizon, Gosheim, road near ski lift [leg. N. Wannenmacher †]. (**1**) *Pelokodites sulcatum* (Buckman, 1893), a: lateral view, b: ventral view, SMNS 70635/1. (**2**) "*Dorsetensia*" sp., a: lateral view, b: ventral view, SMNS 70635/2. (**3, 4**) "*Dorsetensia*" *punctatissima* (Haug, 1893), (3a, b) SMNS 70635/3 (4a, b) SMNS 70635/4. Scale bar equals 1 cm. All ammonites in natural size. Beginning of the body chamber is indicated by an asterisk.

recorded at the basis of the ʽHumphriesioolith' Member, followed by an alternation of rusty red to bluish, partly iron-oolitic marly limestones, calcareous marls and marls. In this construction pit, we collected two ammonites from a marly, strongly iron-oolitic horizon c. 1.8 m above the basis of the ʽHumphriesioolith' Member: *Skirroceras macrum* (Pl. 3, Figs. 1, 2) and *Sonninia* cf. *patella* (Pl. 4, Fig. 1).

3.3. Embankment of street between Hermle Company and ski lift

Unfortunately, we noticed this temporary outcrop when the sewer trench was refilled and the street was completed. Therefore, it was only possible to measure the section along the embankment of the street. The ʽHumphriesioolith' Member was remarkably thick, but its basis was no longer exposed. Most likely, however, the basis of this member was only a little below the basis of our measured section. A *Pelokodites sulcatus* specimen was collected from the screw, but close to the exposed beds assigned to the ?*deltafalcata* biohorizon. From the base to the top:

Gosheim Formation

ʽHumphriesioolith' Member

c. 3.5 m alternation of reddish to gray and gray-brown, usually strongly iron-oolitic, more or less lithified calcareous marls and marly limestones and softer iron-oolitic marls.

c. 0.6 m [?*deltafalcata* biohorizon]: soft, iron-oolitic marls with scattered marly limestone nodules. Shell fragments of *Ctenostreon* and other bivalves (*Pinna*, *Oxytoma*) and echinoid spines. Ammonites: "*Dorsetensia*" sp., "*D.*" *punctatissima*.

c. 3.10 m: alternation of iron-oolitic beds of calcareous marl, marly limestone and marl.

0.15 m [*gervillii*/*cycloides* biohorizon]: gray clayey marl with re-sedimented nodules. Ammonites: *Chondroceras* sp., *Itinsaites* sp.

0.4 m [*umbilicum* biohorizon]: irregularly bedded rusty red to brown iron-oolitic marl, rich in fossils.

Ammonites: *Stephanoceras* sp., *Itinsaites* sp.

0.3–0.4 m: three hard gray-brown to greenish iron-oolitic marly limestone beds; *Actinostreon* and belemnites abundant.

ʽBlagdenischichten' Member [*coronatum* biohorizon]

0.9 m: gray marl with *Actinostreon*, large belemnites and brachiopods.

0.1–0.12 m: gray-beige marly limestone.

0.45 m: gray marl, *Actinostreon*, belemnites.

0.1–0.12 m: gray-beige marly limestone. Ammonite: *Teloceras* sp.

3.4. Development area at Längenberg (sewer trenches and construction pits)

In this development area, the ʽOberer Blaukalk' Member and max. 1.5 m of the overlying basal ʽHumphriesioolith' Member were exposed. Higher parts of the ʽHumphriesioolith' Member are eroded here.

Wedelsandstein Formation

?ʽUnterer Blaukalk' Member, ʽObere γ-Tone' Member

In one of the sewer trenches a c. 1 m thick claystone and a 0.2 m thick limestone (?ʽUnterer Blaukalk' Member) was exposed, followed by several metres of claystone and a thin marl bed. A connection to higher parts of the section was impossible. Starting with the ʽOberer Blaukalk' Member an exact section could be measured.

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'Oberer Blaukalk' Member

0.35–0.4 m: bluish-gray calcareous sandstone, with light brown weathering crust, slightly micaceous. In the upper part a layer with flat, centimetre-sized phosphatic pebbles. At the base and at the top with abundant phosphatic body chamber fragments of *Kumatostephanus*. Ammonites: *Kumatostephanus* sp., *Emileia* sp., *Sonninia* sp.

0.18 m: gray brown clay marl, no macrofossils.

0.1–0.15 m: fossil-rich, strongly bioturbated finesandy calcareous marl with flaser bedding; on its top a hardground with belemnites, serpulids and bivalves.

Gosheim Formation

'Humphriesioolith' Member

Max. c. 1.3–1.4 m exposed. Above a reddish iron-oolitic marl (c. 0.05 m), which often laterally disappeared, a single massive limestone bed (c. 1.3 m) followed which splitted into numerous layers in weathered state. In the basal 0.45 m a typical gray to reddish sparitic 'Spathulatusbank' lithology occurs with abundant, partly densely packed bivalve shells. Above, the first iron ooids appear; from 0.7 m above the basis onwards, the ooids become more abundant but are smaller than the deeper ones. The bivalve content decreases towards the top. The lithology of the limestone is still sparitic but becomes softer, with increasing ooid content.

Ammonites [from the 'Spathulatusbank']: *Emileia schassmanni* (Pl. 2, Figs. 4, 5), *Sonninia* sp.

3.5. Industrial area Sturmbühl (development trenches, construction pits)

Since the opening of this small industrial area several decades ago, sections of the 'Oberer Blaukalk' Member and basal parts of the 'Humphriesioolith' Member were repeatedly exposed. Despite intensive sampling in some of those very big outcrops, we did not find any ammonites there. However, we noticed a few specimens collected by amateurs in their private collections, among them *Sonninia* cf. *patella* (Pl. 7, Figs. 2, 4), *S. carinodiscus* (Pl. 8, Figs. 1, 2) and *Emileia arkelli* (Pl. 2, Figs. 2, 3) as well as two moderately preserved *Skirroceras macrum* (former BERNT † collection). In contrast, ammonites are quite abundant in the higher parts of the 'Humphriesioolith' Member in the industrial area Sturmbühl (see DIETZE et al. 2015).

In 2020, during the construction of an over 2.000 m² big area with commercial garages, we intensively searched for ammonites; however, only a single specimen came to light. Since the section in the lower part of the 'Humphriesioolith' Member is distinct from sections in the village Gosheim itself, we here provide the section of this outcrop. In the shredded excavation of a nearby small construction pit we found (in 2021) only two remains of *Skirroceras macrum* or *S. nodosum* preserved in a very hard gray, sparitic limestone.

Wedelsandstein Formation

'Ober γ-Tone' Member (min. 1.5 m): gray-blue micaceous silty to sandy clay marl.

'Oberer Blaukalk' Member (0.45 m): 0.35 m sandy limestone, followed by 0.1 m gray marl.

Gosheim Formation

'Humphriesioolith' Member (c. 4.2 m exposed**)**

In the industrial area of Sturmbühl NE of Gosheim, the basal part of the 'Humphriesioolith' Member differs from all other outcrops in Gosheim. The basal part is made up here of thick gray, sparitic limestones.

0.6 m: massive gray, sparitic limestone, red-brown in weathered state.

0.25 m: hard flaser-bedded gray calcareous marl.

0.4 m: iron-oolitic calcareous marl splitting into several layers, with few *Entolium demissum*.

0.15 m: gray limestone with yellow-brown ooids.

0.17 m: soft, gray beige marl.

0.25 m: iron-oolitic marly limestone.

0.2 m: rusty red iron-oolitic marl with *Ctenostreon* and echinoid spines.

0.15 m: rusty red iron-oolitic limestone.

0.1 m: rusty red iron-oolitic limestone.

0.2 m: fine, gray beige marl.

0.15: hard gray sparitic limestone.

0.5 m: reddish, flaser-bedded ironoolithic calcareous marl/ marly limestone.

0.4 m: rusty red soft ironoolithic marl with echinoid spines, *Ctenostreon*, "*Ostrea*" *eduliformis*, molds of endobenthic bivalves, and belemnites.

0.05–0.1 m: hard ironoolithic marly limestone.

0.15 m: gray clay marl.

0.15 m: gray-brown to beige, thinly splitting marly limestone.

0.4 m: soil with rock fragments and an ammonite (*Dorsetensia liostraca*).

3.6. Autunnel (FISCHER 1924, WEISERT 1932, DIETL 1978, railway cut)

Here we repeat the section taken by DIETL (1978) at the Autunnel. The 'Humphriesioolith' Member is more or less well-exposed in the railway cut from above the Autunnel to the village Gosheim.

Wedelsandstein Formation

'Obere γ-Tone' Member (c. 3.2 m exposed): dark gray to bluish gray, fine sandy micaceous claystone or clay marl; with a marly bed c. 2.5 m below the top.

'Oberer Blaukalk' Member (0.45 m): blue-gray, slightly micaceous calcareous sandstone followed by a fine sandy, micaceous clay marl bed ("Tonmergelhorizont", c. 0.1 m).

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Gosheim Formation

'Humphriesioolith' Member

(c. 0.15–0.2 m) ['Spathulatusbank']: blue-gray, fine sandy, sparitic, slightly iron-oolitic limestone; *Entolium demissum* (Phillips) (= *Pecten spathulatus* Roemer) very abundant in layers. The bed becomes more marly towards its top. Ammonite: *Sonninia* ex gr. *patella* (see Dietl 1978).

(c. 1.3 studied): 'Fe-oolithische Kalkmergel', rusty red calcareous marl to marl, remarkably sparitic in the basal part.

3.7. Construction of the underground car park at the Kreissparkasse

A section of this outcrop has not been documented. There, the *macrum* biohorizon was relatively rich in ammonites since most specimens of *Skirroceras macrum* and *S.* cf. *macrum* in various private collections originate from this site. During the excavations, the attentive operator recovered about ten large specimens of *Skirroceras* and a *Lytoceras* sp. and sold them to a fossil collector, who subsequently sold or swapped them to other collectors (F. Fanzutti, Bisingen-Thanheim, pers. comm. September 2021). One of these specimens, a *Skirroceras* cf. *macrum*, is illustrated on Pl. 4, Fig. 2.

3.8. Denkinger Steige (Franz 1988; natural outcrop)

The section in Franz (1988) was taken along the Denkinger Steige (M. Franz, pers. comm. September 2021). The *Kumatostephanus triplicatus* specimen mentioned by Franz (1988) from the basis of the 'Oberer Blaukalk' Member is illustrated here on Pl. 1, Figs. 1, 2. At the Denkinger Steige the 'Humphriesioolith' Member has a thickness of c. 6.5 m.

3.9. Gosheim (Ohmert 1990)

Ohmert (1990: 129; fig. 7) published a continuous section from the 'Oberer Blaukalk' up to the basis of the 'Blagdenischichten' at Gosheim. It is not mentioned in his study, where exactly this section has been measured, or if it is a compound section from different places. Moreover, it is not explained on which ammonite material his biostratigraphy of the 'Humphriesioolith' Member was based. Unfortunately, no material from that section could be traced in the collection of the Geologisches Landesamt in Freiburg (M. Franz, pers. comm. October 2021). Ohmert's (1990) stratigraphy of the beds below the Romani Subzone (Humphriesianum Zone) is inconsistent and cannot be confirmed by our studies (see Fig. 2). Based on Dietl (1978), he drew the position of the Sauzei/Humphriesianum zonal boundary less than one metre above the basis of the 'Humphriesoolith' Member. He assumed the type horizon of *Skirroceras macrum* and *S. plicatum* (after Weisert 1932) to be the *frechi* biohorizon of the Pinguis Subzone ["In the section of Gosheim this horizon [= *frechi* biohorizon] may be comprised in the lower part of the Humphriesi-Oolith (4–4.5 m in fig. 7) with *Skirroceras macrum* (Quenstedt) and *Stephanoceras plicatum* (Quenstedt) (see Weisert 1932: 184, 185)"]. In contrast, in the Lörrach section, he assigned the beds with *S. macrum* to the Sauzei Zone and the bed interval from 4–4.5 m in the Gosheim section following below the *frechi* biohorizon still to the *pinguis* biohorizon (Ohmert 1990: fig. 7).

3.10. Wassersteige (Dietl & Rieber 1980; natural outcrop)

Dietl & Rieber (1980) described the section at the Wassersteige, along the road connecting the villages Wilflingen and Gosheim:

Wedelsandstein Formation

'**Oberer Blaukalk**' **Member** (0.5 m): hard calcareous sandstone followed by a few centimetres of clay marl.

Gosheim Formation

Humhriesioolith Member (c. 6.5 m): At the basis c. 0.15 m 'Spathulatusbank'. The beds following above are more or less iron-oolitic. The ooids are fine in the basal part and become coarser up-section. A specimen of *Sonnina pseudofurticarinata* from the Bernt † collection that originates from this outcrop is illustrated here (Pl. 9, Figs. 3, 4). The ammonites from the 'Humphriesioolith' Member mentioned by Dietl & Rieber (1980) originate from another place.

4. Remarks on the ammonite fauna

Since we have only few biostratigraphically significant specimens, we preferred a purely morphospecific determination of the ammonite fauna.

4.1. Family Stephanoceratidae Neumayr, 1875

4.1.1. Subfamily Kumatostephaniinae Chandler, Dietze & Whicher, 2017

In the 'Oberer Blaukalk' Member, occasionally body chambers of *Kumatostephanus triplicatus* (Renz, 1904) (Pl. 1, Figs. 1, 2) and *K.* cf. *perjucundus* Buckman, 1927 (Pl. 2, Fig. 1) occur. Both species are very close to each other; however, *K. triplicatus* exhibits a somewhat broader and lower whorl section than *K. perjucundus*. A larger

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ammonite (Pl. 1, Figs. 3, 4) with a rounded whorl section, slightly prorsiradiate and curved ribs is assigned to *K.* aff. *turgidulus* (Quenstedt, 1886). *K. turgidulus* s.str. differs by a more radiate ribbing style. *K. kumaterus* Buckman, 1922 is denser ribbed than *K.* aff. *turgidulus* and has shovel-like primaries that begin radiate from the umbilical edge onwards and become convex at a deep point of the flank.

4.1.2. Subfamily Stephanoceratinae Neumayr, 1875

Stephanoceratids of the lower part of the 'Humphriesioolith' Member are solely represented by the genus *Skirroceras* Mascke, 1907. A complete, precisely collected specimen of *Skirroceras macrum* (Quenstedt, 1886) (Pl. 3, Figs. 1, 2) corresponds perfectly to the lectotype of *Ammonites humphriesianus macer* Quenstedt, 1886 (pl. 65, fig. 11), which originates from an unknown Swabian locality. Despite the preoccupation of Quenstedt's third name, the taxon *S. macrum* has been validated (see ICZN 2005). The lectotype and all studied specimens of *S. macrum* and *S.* cf. *macrum* from Gosheim are well-preserved only on their stratinomic lower face, whereas the upper face is partly eroded. Sometimes the body chamber is more or less compressed (e.g., Pl. 4, Fig. 2). The description of *S. macrum* by Weisert (1932) is very accurate; we can only add here that the maximum diameter of this species reaches at least 38 cm.

We concur with Weisert's (1932) observation that morphological transients exist between *S. macrum* and *S. nodosum* (Quenstedt, 1857), although both taxa seem to be stratigraphically distinct from each other. The innermost whorls up to a diameter of 16–18 mm are almost identical in both species (Weisert 1932): they are trapezoidal with hardly rounded ventrolateral margin. The whorls are arranged in a strongly involute style, with short, moderately deepened flanks, which are sculptured by sharp rectiradiate ribs. At mid-flank elevated pointed nodes with a broad basis are developed which gave rise to the secondary ribs. The broad-sectioned, strongly sculptured stage persists long in ontogeny of *S. nodosum* s. str., the whorl section of *S. macrum* becomes rounded in an earlier stage, the umbilicus widens and the conch becomes disc-shaped. The umbilical wall is rounded and relatively shallow. In contrast, the whorl section of *S. nodosum* (Quenstedt, 1857) is broad (Pl. 5, Fig. 1; Pl. 6, Figs. 3, 4) and the outer whorls still have relatively steep flanks, so that the conch has the appearance of a soup plate, whereas it is disc-shaped in *S. macrum*. In *S. nodosum* prominent high nodes occur which weaken towards the body chamber (Pl. 6, Figs. 3, 4) or persist until close to the aperture in some extreme variants (Pl. 5, Fig. 1), whereas in *S. macrum* the nodes become blunter in an earlier stage and form only shallow elevations on the body chamber. The adult size of *S. nodosum* reaches little more than 30 cm; hence, it is much smaller than *S. macrum*.

The *Skirroceras* cf. *macrum* (Quenstedt, 1886) of Pl. 4, Fig. 2 retains the trapezoidal, strongly nodate stage longer than in *S. macrum* and even reiterates this character after the rounding of the umbilical edge. However, these characters are less prominently developed than in *S. nodosum*. Moreover, this specimen exhibits shovel-like nodes. The primary ribs are slightly retroradiate and continue after these nodes as rectiradiate secondaries. Although the whorl section of the ammonite illustrated on Pl. 4, Fig. 2 is less rounded in the area of the nodes than in the lectotype of *S. macrum*, this specimen is relatively evolute and does not show the typical deep umbilicus of *S. nodosum*. Maubeuge (1961, figs. on p. 121) determined a very similar specimen from the Sauzei Zone of northern Switzerland as *S.* cf. *macrum*.

Skirroceras cf. *nodosum* (Quenstedt, 1857) as illustrated on Pl. 6, Figs. 1, 2 shows inflated massive whorls and a smaller umbilicus like in *S. nodosum*, but it shares a shallowing of the nodes and the ribbing on the outer whorls with *S. macrum* without becoming disc-shaped. On the outer whorls, the umbilical wall is still rounded, but the umbilicus is depressed.

Skirroceras rochei Maubeuge, 1961 is another transitional form between *S. macrum* and *S. nodosum*. *S. thorali* Maubeuge, 1961 is based on the badly preserved incomplete holotype (Roché, 1939, pl. 5, fig. 1) and thus hardly interpretable. Most likely, this species is just an extreme variant of *S. macrum*. Other nominal species of *Skirroceras* are hardly confusable with the material from the Sauzei Zone of Gosheim.

Two further specimens not collected bed-by-bed are determined as *Skirroceras* sp. (Pl. 5, Fig. 2) und *S.* cf. *freycineti* (Pl. 5, Figs. 3, 4). Both specimens originate from the lowermost 4.5 m of the 'Humphriesioolith' Member, since higher beds were not exposed at the finding site. After their mode of preservation, they originate from a different level than that of *S. macrum* or *S. nodosum*, supposedly from somewhat higher beds. *S.* cf. *freycineti* (Pl. 5, Figs. 3, 4) differs from true *S. freycineti* (Bayle, 1878) by its wider-spaced ribbing. The nodes on the diverging points are more prominent than they appear in our illustration. The ammonite of Pl. 5, Fig. 2 exhibits a remarkably prorsiradiate ribbing with prominent nodes after a pathological stage. Due to this pathological sculpture, a specific determination of this *Skirroceras* is impossible.

4.2. Family Otoitidae Mascke, 1907

Otoitids are extremely rare in the 'Oberer Blaukalk' and in the basal 'Humphriesioolith' Member, so that every record deserves our attention:

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D. Schreiber (†) found the phosphatic body chamber of an *Emileia* sp. in the earth dump of Gosheim (extracted material from the development area at Längenberg). This ex-situ find originates from the 'Oberer Blaukalk' Member. The whereabouts of this specimen is unknown.

From the basal 'Humphriesioolith' Member (Sauzei Zone), we know of only four specifically identifiable specimens:

A specimen of *Emileia arkelli* Maubeuge, 1961 (Pl. 2, Figs. 2, 3) was collected from the screw during the development of the industrial area Sturmbühl. The specimen is preserved as a strongly iron-oolitic mold. This lithology occurs in the interval up to c. 2–3 m above the 'Spathulatusbank', which is not iron-oolitic and hence can be excluded as its finding level. In the *macrum* biohorizon of entire SW Germany, only a single large, densely ribbed *Emileia* specimen has been recorded from Ringsheim (Upper Rhinegraben) (see Dietze et al. 2009). Hence, the *E. arkelli* specimen can be most likely assigned to the *pseudcontrahens* biohorizon, and all other biohorizons can be excluded.

A very large specimen of *Emileia vagabunda* Buckman, 1927 (Pl. 1, Figs. 5, 6; maximum diameter 32 cm) is represented by a body chamber, which comprises a little more than one whorl and is slightly abraded in its anterior part. The similarly large-sized taxa *E. bulligera* Buckman, 1927 and *E. greppini* Maubeuge, 1961, occurring in the same biostratigraphic level, are surely only variants of the same palaeobiospecies. Compared with *E. vagabunda*, *E. bulligera* is coarser ribbed and exhibits a broader whorl section; in *E. greppini* the ribbing is wider-spaced and the whorl height is slightly lower. Our *E. vagabunda* specimen illustrated on Pl. 1, Figs. 5, 6 was collected from just below the basis of the 'Spathulatusbank'. Some preserved rock matrix shows the typical lithology of the 'Spathulatusbank'; however, the strongly iron-oolitic filling of the body chamber differs from that lithology.

Another very large specimen of *Emileia schassmanni* Maubeuge, 1961 (Pl. 2, Figs. 4, 5; reconstructed final diameter c. 33 cm) originates from the 'Spathulatusbank'. This ammonite shows a remarkably broad whorl section. The primary ribs are densely spaced from the inner whorls onwards up to the body chamber. This ammonite is relatively involute because of its large whorl height. A short portion of the body chamber close to the aperture is still present but so badly preserved that we omitted this part from the illustration. *E. fuellinsdorfense* Maubeuge, 1961 and *E. pseudocontrahens* Maubeuge, 1961 are similarly fine-ribbed, but with a greater whorl section. Moreover, *E. pseudocontrahens* is significantly smaller than our specimen.

Dietl (1978) identified a well-preserved historical *Emileia* specimen from Gosheim as *E.* (*E.*) cf. "*polymera*" (Waag.). After the rock matrix he assumed the lowest part of the 'Humphriesioolith' Member as the finding horizon. We concur and can add that this ammonite must originate from the interval up to max. 2.5 m above the 'Spathulatusbank', even more likely from the lower 1.5 m of this member. Three further, badly preserved specimens of *Emileia* (priv. coll. V.D., SMNS) have not been collected bed-by-bed and thus cannot be determined specifically.

4.3. Family Sonniniidae Buckman, 1892

Only a single *Sonninia* (Pl. 3, Figs. 1, 2) was exactly sampled from an exposure of the basal 'Humphriesioolith' Member at Gosheim. All other specimens originate from the screw.

A *Sonninia* cf. *patella* (Waagen, 1867) (Pl. 4, Fig. 1) originates from a level c. 1.8 m above the basis des 'Humphriesioolith' Member; this is the same level as in the case of the S*kirroceras macrum* illustrated on Pl. 3, Figs. 1, 2. A further, much better preserved *Sonninia* cf. *patella* (Pl. 7, Figs. 2, 4) and a more depressed and more evolute *S. carinodiscus* (Quenstedt, 1886) (Pl. 8, Figs. 1, 2) as well as a specimen of *S.* ("*Sonninites*") aff. *felix* (Buckman, 1923) (Pl. 7, Figs. 1, 3) originate from a not exactly known level within the interval above the 'Spathulatusbank' and max. 3–4 m higher up in the 'Humphriesioolith' Member.

Four additional sonniniids without precise information about their finding levels are determined as *S. pseudofurticarinata* Maubeuge, 1961 (Pl. 9, Figs. 1–4) and *S. alsatica* (Haug, 1885) (Pl. 9, Figs. 5, 6), respectively.

A *Dorsetensia liostraca* Buckman, 1892 (Pl. 8, Figs. 3, 4) was sampled from the lower part of the 'Humphriesioolith' Member at the Autunnel. It originates from a bed located higher than c. 3.5 m above the basis of the member and which must be assigned already to the Romani Subzone (Humphriesianum Zone). Quenstedt (1886, pl. 63, fig. 7) illustrated a nicely preserved specimen of *D. liostraca* from the 'Humphriesioolith' at the nearby town Spaichingen.

The small-sized faunule questionably assigned to the *deltafalcata* biohorizon is not easy determinable both at genus and species level. We identified the ammonites of Figs. 3.3–3.4 as *"Dorsetensia" punctatissima* (Haug, 1893). A whorl fragment (Fig. 3.2) can be only determined as "*Dorsetensia*" sp. An ammonite from the screw (Figs. 3.1) which was found very close to this small-sized faunule represents *Pelekodites sulcatum* (Buckman, 1893).

4.4. Family Hammatoceratidae Buckman, 1887

A large-sized ammonite (Pl. 9, Figs. 7, 8) collected from the interval of c. 3 m up to max. 4.5 m above the basis

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	Zone	Subzone	Biohorizons
Lower Bajocian	Humphriesianum	Blagdeni	*coronatum*
			acuticostatum
			unnamed
		Humphriesianum	*crassicosta*
			umbilicum
			mutabile
			gerivillii/cycloides
		Romani	*romani*
			cf. *complanata*
		Pinguis	? *deltafalcata*
			frechi
			pinguis
			?
	Sauzei		? *carinodiscus*
			macrum
			pseudocontrahens
			quenstedti
			dilatus

Fig. 4. Biohorizons of the Sauzei and Humphriesianum zones in SW Germany. The biohorizons recorded at Gosheim are marked in gray; uncertain records are indicated by a question mark.

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of the ʻHumphriesioolith' Member exhibits a fissilobate suture line and a high-oval whorl section with a rounded venter. Thus, we identified it as *Fissilobiceras furticarinatum* (Quenstedt, 1856). The pyritic holotype of this species (re-figured in Dietze et al. 2011, pl. 9, figs. 1, 3) originates from the Humphriesianum Zone (Pinguis or Romani Subzone) of Pfullingen near Reutlingen. A further specimen of *F. furticarinatum* illustrated by Quenstedt (1886, pl. 68, fig. 5; re-figured in Dorn 1935, pl. 20, fig. 1) from the same bed and locality shows bulging ribs like in the specimen from Gosheim (in the latter these ribs occur at the end of the phragmocone). Similar ribs occur in the lectotype of *F. fissilobatum* (Waagen, 1867; see photograph in Sadki & Dietze 2020, fig. 10.A1, A2) from the Trigonalis Subzone of the Laeviuscula Zone. *F. fissilobatum* is the type species of *Fissilobiceras* Buckman, 1919.

5. Bio-/chronostratigraphy and correlation of the Gosheim Formation

5.1. Biostratigraphy

The herein distinguished biohorizons are not recorded in every studied outcrop. It seems that some beds are not continuous over larger distances but form lenses. This is not surprising since the lower part of the ʻHumphriesioolith' Member represents a locally diversified shallow water deposit (Dietze et al. 2008). However, in cases where individual biohorizons are recorded, they occur in approximately the same vertical position within the ʻHumphriesioolith' Member. As a result, although somewhat idealized, Fig. 4 shows an update of the biostratigraphical succession in the lower part of the ʻHumphriesioolith' Member at Gosheim.

5.1.1. Laeviuscula Zone

It is unknown if the ʻUnterer Blaukalk' Member at Gosheim (c. 4 m below the ʻOberer Blaukalk') with *Emileia polyschides*, *Otoites* sp. and *Sonninia* sp. still belongs to the Laeviuscula Zone or to the Sauzei Zone, since the specimens reported by Fischer (1924) could not be traced anywhere.

5.1.2. Sauzei Zone

***dilatus* biohorizon** – The ʻOberer Blaukalk' Member yields *Kumatostephanus triplicatus*, *K.* cf. *perjucundus*, *K.* aff. *turgidulus*, *Emileia* sp. and *Sonninia* sp. and is assigned to the *dilatus* biohorizon. In SW Germany, ammonites of the genus *Kumatostephanus* are only abundant in this biohorizon (Dietze et al. 2020). However, specimens of *Emileia* and *Sonninia* sampled from this level are not specifically determinable.

***pseudocontrahens* biohorizon** – The *pseudocontrahens* biohorizon is proved by *Emileia vagabunda* and *E. schassmanni*. Both taxa occur in the interval of the only partly developed iron-oolitic basal marl layer of the ʻHumphriesioolith' and in the ʻSpathulatusbank'. Most probably, this biohorizon expands up to 1.7 m above the basis of the ʻHumphriesioolith' Member, since the oldest record of *Skirroceras macrum* appeared c. 1.8 m above this basis. Hitherto, large-sized species of *Emileia*, like *E. vagabunda* and *E. schassmanni*, have been reported from SW Germany only in the *pseudocontrahens* biohorizon. In the next-older *quenstedti* biohorizon, specimens of *Emileia* are significantly smaller and belong to different species (Dietze et al. 2020). From the next-younger *macrum* biohorizon, only a single specimen of *Emileia* has been reported from the entire area of SW Germany (Dietze et al. 2009).

***macrum* biohorizon** – The bed interval c. 1.8–2 m above the basis of the ʻHumphriesioolith' Member represents the *macrum* biohorizon. At Gosheim, this biohorizon is recorded by *Skirroceras macrum*, *S.* cf. *macrum* and *Sonninia patella*. However, it is unclear whether the herein illustrated sonniniids originate from this biohorizon as well, and we do not know if *Skirroceras nodosum* appears in this horizon or a little higher up in the section.

Weisert (1932) mentioned *Skirroceras macrum* from a section of the ʻHumphriesioolith' Member in the railroad cut at Autunnel in a position between c. 1.7 m up to max. 3.5 m above its basis. He named this part of the section "*nodosum-macrum-plicatum*-Zone". We have some doubts about the correct specific identification of *S. macrum* from higher up than c. 2 m above the basis of the ʻHumphriesioolith' Member in this section by Weisert (1932). Despite many years of fieldwork, we never found this species at this high stratigraphic position. Moreover, Weisert (1932) did not report *S. nodosum* – a species well-known to him – from the Autunnel section, which was well exposed in its time. Referring to Weisert's (1932) "*nodosum-macrum-plicatum*-Zone", Ohmert et al. (1995) suggested to use a Macrum Subzone in the top of the Sauzei Zone; however, this view was not adopted since.

? *carinodiscus* biohorizon – The *carinodiscus* biohorizon is not safely recorded at Gosheim. In the adjacent area of the Zollernalb (Dietze et al. 2020), this biohorizon is predominated by sonniniids of the variable nominal species *Sonninia carinodiscus*; only a single but typical *Skirroceras nodosum* has been recorded from this biohorizon. This is why we assign the rock interval around c. 2.3 m

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		Ringsheim	Wutach	Gosheim	Hohen-zollern	Middle Swabian Alb	E Swabian Alb
Humphriesianum Z.	Pinguis Subzone		*deltafalcata*	? *deltafalcata*[2]	?	*deltafalcata*	*deltafalcata*
						frechi	
					pinguis	*pinguis*	
				?[1]	?[1]		?[1]
Sauzei Zone			*carinodiscus*	? *carinodiscus*[2]	*carinodiscus*	?	?
		macrum		*macrum*		*macrum*	
		pseudoc.	?	*pseudoc.*		*pseudoc.*	*pseudoc.*
					quenstedti		
		dilatus		*dilatus*	*dilatus*		

Fig. 5. Correlation of the Lower Bajocian biohorizons of SW Germany. Remarks:
[1]In the Sauzei/Humphriesianum zonal boundary beds most likely a further biohorizon exists which yields *Sonninia alsatica* and related forms (see Dietze et al. 2008, 2013, 2020).
[2]The *carinodiscus* and *deltafalcata* biohorizons are uncertain at Gosheim.

above the basis of the 'Humphriesioolith' Member yielding specimens of *S. nodosum* and *S.* cf. *nodosum* with some reservation to the *carinodiscus* biohorizon. However, we cannot exclude that this interval still belongs to the *macrum* biohorizon. We cannot decide whether some of the illustrated sonniniids collected from the screw originate from this interval. At least, this seems true for the specimen determined as *Sonninia carinodiscus*, the index of this biohorizon.

5.1.3. Humphriesianum Zone, Pinguis Subzone

Unfortunately, all ammonites illustrated on Pl. 9 have not been collected bed-by-bed; otherwise the Pinguis Subzone at Gosheim would become much better dividable. Then, it would become clear, whether *Sonninia alsatica* and *S. pseudofurticarinata* represent an individual biohorizon or belong to the *pinguis* biohorizon or even the Sauzei Zone. The basis of the Pinguis Subzone, however, must be located at least c. 3.6–4.2 m above the basis of the 'Humphriesioolith' Member, because the ammonites illustrated on Pl. 9, Figs. 3–10 originate already from the Pinguis Subzone.

***?deltafalcata* biohorizon** – The interval of c. 3.6 to 4.2 m above the basis of the 'Humphriesioolith' Member with "*Dorsetensia*" sp. und "*D.*" *punctatissima* is tentatively assigned to the *deltafalcata* biohorizon. After Ohmert (1990: 123), *D. pinguis* ranges up to this biohorizon, and the type of *D. punctatissima* seems to originate from the *deltafalcata* biohorizon as well. Typical "*Dorsetensia*" specimens from the slightly older *pinguis* biohorizon (Fig. 4) show relatively narrow whorl sections (Dietze et al. 2008, fig. 4). In contrast, the small-sized "*Dorsetensia*" from the *deltafalcata* biohorizon of the middle Swabian Alb exhibit broader whorl sections (see Ohmert 1990, pl. 1, figs. 4–7). *Nannina deltafalcata* (Quenstedt, 1857), the index of the *deltafalcata* biohorizon, has not been recorded from Gosheim. The few finds from Gosheim do not allow exact biostratigraphic interpretations, but they are definitely diagnostic for the Pinguis Subzone.

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5.1.4. Humphriesianum Zone, Romani Subzone

The Romani Subzone is recorded by the *romani* biohorizon down to c. 0.6 m below the marllimestone bed containing the *gervillii*/*cycloides* biohorizon (Fig. 2; Dietze et al. 2015). However, due to the absence of precisely collected ammonites, the exact basis of the Romani Subzone could not be drawn, and we cannot decide if the illustrated *Fissilobiceras furticarinatum* originates from the Pinguis or from the Romani Subzone. After Ohmert (1990, fig. 9), the type horizon of *F. furticarinatum* in the Middle Swabian Alb lies within the Romani Subzone (*furticarinatum* biohorizon sensu Ohmert [= pars *deltafalcata* biohorizon and *romani* biohorizon in Fig. 2]). Morton (1975) illustrated specimens termed as "*Sonninia*" aff. *furticarinata* from the Hebridica Subzone (Sauzei Zone) and the Cycloides Subzone (Humphriesianum Zone) of the Isle of Skye (Scotland) that are very close to our illustrated specimen. The Hebridica Subzone *sensu* Morton correlates with uppermost parts of the Sauzei Zone and large parts of the Pinguis Subzone in SW Germany.

5.2. Age correlation

The correlation of several important localities in the upper Lower Bajocian of SW Germany with the Gosheim section is shown in Fig. 5.

Concerning the difficulties for age correlations with S England see Dietze et al. (2020). The *dilatus* biohorizon corresponds more or less to the *kumaterus*/*simulans* biohorizon, and the *pseudocontrahens* biohorizon is an approximate equivalent of the *kalum* biohorizon. The *macrum* and *carinodiscus* biohorizons are coeval with the *digbyi* and *rhytum* biohorizons in S England, respectively. The position of the *deltafalcata* biohorizon corresponds to that of the *delphinum* biohorizon (see Chandler 2019).

In France, the term 'Propinquans Zone' is used instead of the Sauzei Zone (Rioult et al. 1997). It is subdivided into the older Patella Subzone and the younger Hebridica Subzone. A correlation with the French horizons is very difficult or even impossible (see Dietze et al. 2020). The *macrum* and *carinodiscus* biohorizons partly correspond to the horizon à *Hebridica* (see Dietze et al. 2020). The *deltafalcata* biohorizon might be coeval with the horizon à *Edouardiana*.

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Plate 1

(1–4) Ammonites of the Wedelsandstein Formation, 'Oberer Blaukalk' Member (topmost bed) at Gosheim, Lower Bajocian, Sauzei Zone, *dilatus* biohorizon.
(1, 2) *Kumatostephanus triplicatus* (Quenstedt, 1886), Denkinger Steige, SMNS 70635/5 [leg. M. Franz & E. Kiefer].
(3, 4) *Kumatostephanus* aff. *turgidulus* (Quenstedt, 1886), SMNS 70635/6 [leg. N. Wannenmacher †].
(5, 6) *Emileia vagabunda* Buckman, 1927; Gosheim Formation, 'Humphriesioolith' Member (basal 0.1 m), Lower Bajocian, Sauzei Zone, *pseudocontrahens* biohorizon, Gosheim, Industriestraße, SMNS 70635/7.

Scale bar equals 10 cm. Ammonites: x0.5. Beginning of body chamber is indicated by an asterisk.

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Plate 2

(1) *Kumatostephanus* cf. *perjucundus* (Buckman, 1927), Wedelsandstein Formation, 'Oberer Blaukalk' Member (topmost bed); Lower Bajocian, Sauzei Zone, *dilatus* biohorizon, Gosheim, SMNS 70635/8 [leg. K.-H. Spieth].
(2–5) Ammonites of the Gosheim Formation, 'Humphriesioolith' Member at Gosheim; Lower Bajocian, Sauzei Zone, *pseudocontrahens* biohorizon.
(2, 3) *Emileia arkelli* Maubeuge, 1961, basal c. 2.5 m, Sturmbühl, SMNS 70635/9 [leg. F. Neubauer].
(4, 5) *Emileia schassmanni* Maubeuge, 1961, basal 0.45 m ("Spathulatusbank"), new development area at Längenberg, SMNS 70635/10 [leg. T. Ott].

Scale bar equals 10 cm. Ammonites x0.5. Beginning of body chamber is indicated by an asterisk.

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Plate 3

(1, 2) *Skirroceras macrum* (Quenstedt, 1886), Gosheim Formation, 'Humphriesioolith' Member (c. 1.8 m above base), Lower Bajocian, Sauzei Zone, *macrum* biohorizon, Gosheim, Industriestraße, SMNS 70635/11.

Scale bar equals 10 cm. Ammonite x0.5. Beginning of body chamber is indicated by an asterisk.

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Plate 4

Ammonites of the Gosheim Formation, ʻHumphriesioolith’ Member at Gosheim; Lower Bajocian, Sauzei Zone, *macrum* biohorizon.

(1) *Sonninia* cf. *patella* (Waagen, 1867), c. 1.8 m above base, Industriestraße, SMNS 70635/12.
(2) *Skirroceras* cf. *macrum* (Quenstedt, 1886), c. 1.8–2.5 m above base, *macrum* biohorizon [by preservation and matrix], Kreissparkasse, SMNS 70635/13.

Scale bar equals 10 cm. Ammonites x0.5. Beginning of body chamber is indicated by an asterisk.

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Plate 5

Ammonites of the Gosheim Formation, 'Humphriesioolith' Member at Gosheim; Lower Bajocian.

(1) *Skirroceras* cf. *nodosum* (Quenstedt, 1857), c. 1.8–2.5 m above base; Sauzei Zone, *macrum* or *carinodiscus* biohorizon, SMNS 70635/14.
(2) *Skirroceras* sp. [pathogenic], between c. 2 m and max. 4.5 m above base, upper Sauzei or lowermost Humphriesianum Zone, Brücklestraße, SMNS 70635/15.
(3, 4) *Skirroceras* cf. *freycineti* (Bayle, 1878), between c. 2 m and max. 4.5 m above base), upper Sauzei Zone or lowermost Humphriesianum Zone, Brücklestraße, SMNS 70635/16.

Scale bar equals 10 cm. Ammonites x0.5. Beginning of body chamber is indicated by an asterisk.

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Plate 6

Ammonites of the Gosheim Formation, 'Humphriesioolith' Member at Gosheim (Brücklestraße), Lower Bajocian, Sauzei Zone, ?*carinodiscus* biohorizon.

(1, 2) *Skirroceras* cf. *nodosum* (Quenstedt, 1857), c. 2.3 m above base, SMNS 70635/17.
(3, 4) *Skirroceras nodosum* (Quenstedt, 1857), c. 2.3 m above base as indicated by rock matrix and preservation, SMNS 70635/18 [leg. U. Ryck].

Scale bar equals 10 cm. Ammonites x0.5. Beginning of body chamber is indicated by an asterisk. The arrow indicates the beginning of the body chamber.

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Plate 7

Ammonites of the Gosheim Formation, 'Humphriesioolith' Member at Gosheim, Lower Bajocian.

(1, 3) *Sonninia* ["*Sonninites*"] aff. *felix* (Buckman, 1923), c. 1.5–max. 4.5 m above base, ?*carinodiscus* biohorizon, Brücklestraße, SMNS 70635/19 [leg. T. Ott].
(2, 4) *Sonninia* cf. *patella* (Waagen, 1867), c. 1.5–max. 4.5 m above base, ?*pseudocontrahens* biohorizon, Sturmbühl, SMNS 70635/20 [leg. E. Bernt †].

Scale bar equals 10 cm. Ammonites x0.5. Beginning of body chamber is indicated by an asterisk.

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Plate 8

Ammonites of the Gosheim Formation, ‘Humphriesioolith’ Member at Gosheim, Lower Bajocian.

(1, 2) *Sonninia carinodiscus* (Quenstedt, 1886), c. 1.5–max. 4.5 m above base, ?*carinodiscus* biohorizon, Sturmbühl, SMNS 70635/21 [leg. E. Bernt].
(3, 4) *Dorsetensia liostraca* Buckman, 1892, lower part of ‘Humphriesioolith’ Member, Romani Subzone (Humphriesianum Zone), Autunnel, SMNS 23697 [leg. K.-H. Spieth; specimen mentioned in Dietl 1978: 9].

Scale bar equals 10 cm. Ammonites x0.5. Beginning of body chamber is indicated by an asterisk.

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Plate 9

Ammonites of the Gosheim Formation, 'Humphriesioolith' Member at Gosheim; Lower Bajocian.

(1–4) *Sonninia pseudofurticarinata* MAUBEUGE, 1961, c. 1.5–max. 4.5 m above base, uppermost Sauzei Zone or lowermost Humphriesianum Zone, (1) SMNS 70635/22 [leg. E. GLÜCK], (2) Brücklestraße, SMNS 70635/23, (3, 4) Sturmbühl, SMNS 70635/24 [leg. E. BERNT].
(5, 6) *Sonninia alsatica* (HAUG, 1885), c. 1.5–max. 4.5 m above base, ?Pinguis Subzone (Humphriesianum Zone), Brücklestraße, SMNS 70635/25.
(7, 8) *Fissilobiceras furticarinatum* (QUENSTEDT, 1856), c. 2.5–max. 4.5 m above base, Pinguis Subzone or Romani Subzone (Humphriesianum Zone), Brücklestraße, SMNS 70635/26.

Scale bar equals 10 cm. Ammonites x0.5. Beginning of body chamber is indicated by an asterisk.

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