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Arietites solarium (Quenstedt, 1883) – a diagnostic ammonite species in the Lower Jurassic (Early Sinemurian, Bucklandi Zone) of SW Germany

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Abstract. The coarse-ribbed and big-sized *Arietites solarium* (Quenstedt, 1883) is one of the largest-grown and most iconic ammonite taxa in the entire Swabian Lower Jurassic; however, despite previous revisions including the designation of a lectotype, there has been some confusion concerning its correct identification, and its type horizon within the Lower Sinemurian Arietenkalk Formation was not exactly known. *Arietites solarium* characterises the herein introduced *solarium* Biohorizon of the upper Bucklandi Zone of the Sinemurian. For nomenclatorial stability, we designate a neotype based on the only surviving specimen of Quenstedt's original type series. In addition, we provide a preliminary succession of recognized biohorizons in the Lower Sinemurian of Swabia, which will make correlations with other areas more reliable.

INTRODUCTION

The fossils from the Lower Jurassic deposits of southern Germany have been studied since the earliest beginnings of scientific palaeontology (*e.g*., Reinecke, 1818; Stahl, 1824; Zieten, 1830–1833; Buch, 1839). The bulk of ammonite taxa occurring in this area were described in the monographs of Quenstedt (1845–1849, 1856–1857, 1883–1885), Oppel (1856, 1862) and Reynès (1879), followed by a few early revisions and studies (Hyatt, 1889; Pompeckj, 1893–1896, 1901; Dietz, 1922; Schmidt, 1925; Jaworski, 1931). This long tradition suggests that the biostratigraphic data of the described taxa are available and that there should exist a well-known biostratigraphic resolution of the lithostratigraphic succession. The Sinemurian Arietenkalk Formation – named after the abundance of big-sized ammonites of the family Arietitidae – is partly very rich in ammonites and other invertebrates. However, the collecting of these impressive fossils has never focused on their exact stratigraphical horizons but mostly on aesthetic criteria. Major attempts at providing detailed biostratigraphic schemes for the Lower Sinemurian deposits were undertaken first by Fiege (1926, 1929) and later by Walliser (1956a). At that time, numerous small quarries were still active, where the limestone beds were exploited for local building stones or road metal. Subsequently, all of these quarries were abandoned and filled in, and today the Arietenkalk Formation is exposed only temporarily and in a few natural outcrops along streams (Fig. 1). Only very few further data have been published, mostly focussing on rare or newly recorded taxa (*e.g*., Hölder, 1936; Hoffmann, 1964; Schlatter, 1976, 1983, 1984, 1988; Gebhard, Schlatter, 1977; Bloos, 1979, 1988, 2014; Schweigert *et al*., 2011). Further publications have interjected nomenclatorial revisions without accompanying fieldwork (Blind, 1963; Hengsbach,

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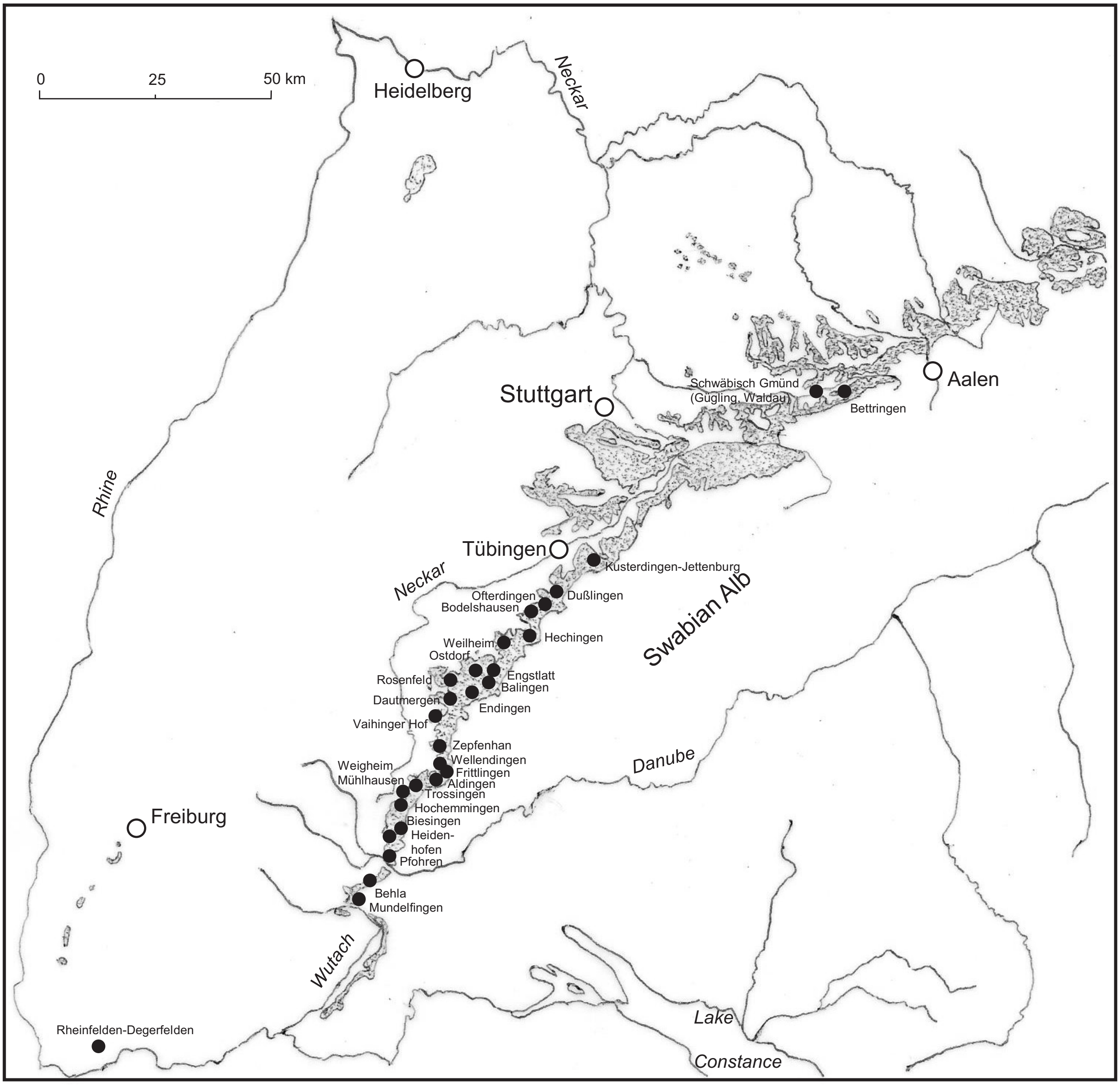

Fig. 1. Studied localities in the Lower Jurassic of SW Germany

1986a, b) or have provided palaeoenvironmental interpretations without exact biostratigraphical data (Grüner, 1997). If we compare the biostratigraphical data of Swabia with those of the same time interval in France (Corna, 1985, 1987; Corna *et al.*, 1997) or in England (Page, 2003, 2010), the state of the art is rather unsatisfactory. Step-by-step we try here to establish a higher biostratigraphical resolution of the Arietenkalk Formation based on ammonite biohorizons. In addition, the natural systematic relationships of the Sinemurian ammonite genera *Coroniceras*, *Arietites* and *Paracoroniceras* can be cleared up only when considering their dimorphism (at present microconchs of these genera are included in *Arnioceras* s.l.).

MATERIAL AND METHODS

Several sections of temporarily exposed outcrops and natural outcrops along streams were measured and ammonites were collected bed-by-bed, even taking account their position within a bed (Fig. 2). This is important since some beds are diagenetically merged in some sections, whereas

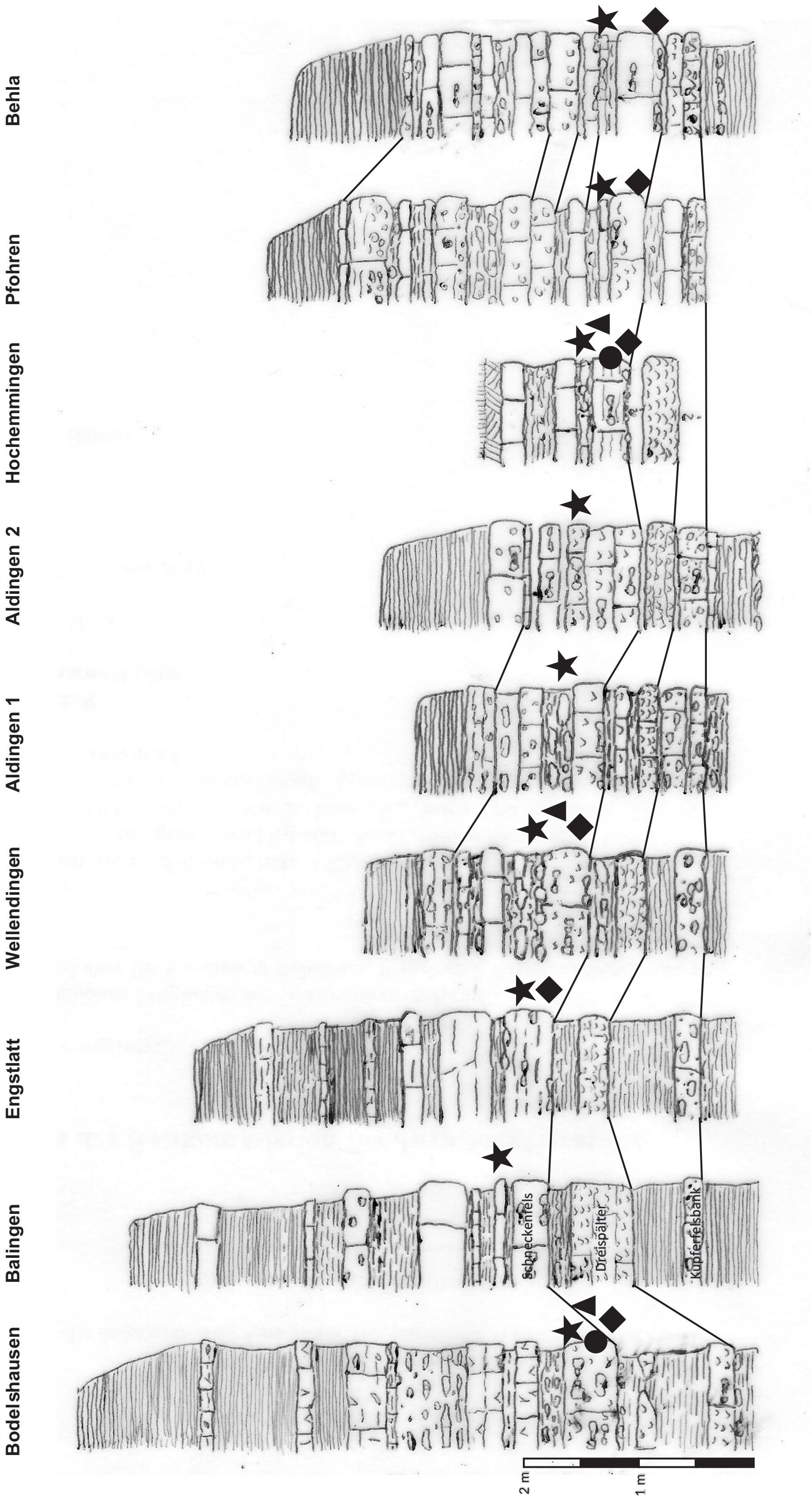

Fig. 2. Studied sections of the Arietenkalk Formation and their lithostratigraphic correlation (for location see Fig. 1)

Symbols: square = *Arietites* cf. *pinguis* (Quenstedt); spot = *Arietites pinguis* (Quenstedt); triangle = *Arietites* "*solarium*" Quenstedt, 1883, pl. 8: 3; asterisk = *Arietites solarium* (Quenstedt) they are developed as individual beds in others. This makes previous lithological correlations lacking this biostratigraphical control somewhat unreliable (*e.g.*, Vollrath, 1924; Frank, 1930; Walliser, 1956b). Gaps in the sedimentological record as well as reworking and condensation have to be considered. Apart from lithological correlations, in addition the taphonomy of the fossil content was documented. By means of the lithology of type specimens described from the study area we try to identify their type horizons. In addition to the newly collected material we have studied specimens in various public and private collections.

The illustrated material is stored in the palaeontological collections of Tübingen University (GPIT) and in the collection of the Staatliches Museum für Naturkunde Stuttgart (SMNS). A few additional specimens studied for comparison come from the private collections of Edmunt Bernt (Weissach-Flacht), Stefan Gräbenstein (Bodelshausen), Magdalene and Manfred Piperek (Albstadt-Ebingen), and Patrick Reger (Tuttlingen).

Abbreviations: [m] = microconch; [M] = macroconch.

THE LOWER SINEMURIAN BUCKLANDI SUBZONE IN SOUTHWESTERN GERMANY

The Arietenkalk Formation consists of an up to 22 metres (in most sections between 2.5–6.0 metres) thick set of biodetritic limestones with intercalated marly layers and occasional bituminous shales in its upper part. It overlies the Angulatensandstein or Angulatenton formations and is followed by the predominantly clayey Obtususton Formation. The lower part of the Arietenkalk Formation is Early Sinemurian in age; its higher parts are already Late Sinemurian in age (Schlatter, 1976; Bloos, 1984; Bloos *et al*., 2005). Lithologically, the lower boundary of the Arietenkalk Formation is drawn with the base of the Kupferfelsbank, an ironoolithic limestone bed of the Conybeari and Rotiforme subzones of the Bucklandi Zone. Here we focus on the third subzone of the Bucklandi Zone, the Bucklandi Subzone.

In the area of the Baar and in the adjacent foreland of the western Swabian Alb there is an easily recognizable thick limestone bed in the lower, but not lowermost Arietenkalk Formation. This bed often splits into three thinner beds, which is why it was called "Dreispälter" by the local quarrymen (*e.g.*, Wilhelm, 1926; Walliser, 1956b). In some localities (Aldingen 1, Trossingen) the base of this bed yields coarsely ribbed *Arnioceras* sp. and *Coroniceras* ex gr. *caprotinum* (d'Orbigny, 1844) / *Coroniceras planicosta* Blind, 1963. Locally in the lower part of this bed also *Coroniceras* ex gr. *hyatti* Donovan, 1952 (Rosenfeld, Balingen, Balingen-Engstlatt, and Rheinfelden-Degerfelden in the Dinkelberg area) and *Coroniceras coronaries* (Quenstedt, 1883) (Trossingen) exist. Above follows a very distinct ammonite fauna, in which *Vermiceras scylla* (Reynès, 1879) predominates by far, accompanied by rare *Angulaticeras ventricosum* (Sowerby, 1816) and the exotic Tethyan *Canavarites meisteri* Schweigert, Kapitzke et Schreiber, 2011. After Corna (1985), Page (2003, 2010) and Schweigert *et al*. (2011), this *scylla* Biohorizon is characteristic for the basal Bucklandi Subzone. Hence, the boundary between the Rotiforme and Bucklandi subzones must be located within the "Dreispälter" limestone bed.

The top of the Bucklandi Subzone is better traceable in the southern Baar area (Pfohren, Behla) than in the foreland of the western Swabian Alb. There, above a well-developed "Schneckenfels" bed with abundant *Arietites* cf. *pinguis* (Quenstedt, 1883) at the base and a thinner limestone bed with *Arietites solarium* (Quenstedt, 1883) follows a prominent marlstone bed with some fragmentary *Paracoroniceras* ex gr. *lyra* Hyatt. Then follows a *ca.* 20 cm thick, light gray limestone with *Paracoroniceras* ex gr. *charlesi* Donovan. This bed and the underlying marlstone belong to the Semicostatum Zone. At Behla, we recovered a few incomplete specimens of *Paracoroniceras* ex gr. *lyra* from the base of this bed, but unfortunately, there is no record of *Paracoroniceras* ex gr. *charlesi* in the top. Further sampling in the study area allowed us to distinguish six ammonite biohorizons within the Bucklandi Subzone (see Table 1). Compared with published data from the Bucklandi Subzone of France and England (Corna, 1985; Page, 2003, 2010) it appears that in these areas the sections are more complete at the base (*scylla* Biohorizon) and in the top (three biohorizons) of this Subzone. The biohorizons of the middle part of the Bucklandi Zone, which are recorded in SW Germany, are missing in French and English references. Whether this non-record points to a gap in the rock record or results from collecting biases cannot be cleared up without further studies in England and France. In this context it seems important to define the exact horizon of the zonal index *Arietites bucklandi* (Sowerby, 1816), the neotype of which comes from Keynsham in Somerset (Donovan, 1952). Donovan (1952) and Dean *et al*. (1961) figured two further specimens of "*Arietites bucklandi*" from the Manor Road Quarry at Keynsham. In our opinion, the latter specimens do not represent *Arietites bucklandi* (Sowerby, 1816), since both lack the striking strongly curved ribbing style of the neotype. Unfortunately, the two specimens are too incomplete for a more precise determination. In consequence, the English material needs a fundamental revision, also to get an idea about the taxonomic status of *Arietites scunthorpense* (Spath, 1924 = *Ammonites bucklandi* in Wright, 1878, pl. 1: 1, holotype) and of *Arietites quadratum* Donovan, 1952. Guérin-Franiatte (1966, pl. 2) figured a specimen of a typical *Arietites buck-*

Table 1

Preliminary results about the succession of ammonite biohorizons in the Lower Sinemurian of SW Germany

Zone	Subzone	Horizon	Locality
Buckl. (pars)	Bucklandi	*solarium*	Behla, Pfohren, Hochemmingen, Mühlhausen, Aldingen, Frittlingen, Wellendingen, Vaihingerhof, Endingen, Engstlatt, Balingen, Bodelshausen, Ofterdingen
		cf. *solarium*	Hochemmingen, Trossingen, Ostdorf, Engstlatt
		"*solarium*"	Trossingen, Wellendingen, Endingen, Hechingen
		pinguis	Hochemmingen, Mühlhausen, Trossingen, Wellendingen, Bodelshausen
		cf. *pinguis*	Degerfelden, Behla, Pfohren, Hochemmingen, Mühlhausen, Weigheim, Trossingen, Aldingen, Frittlingen, Wellendingen, Endingen, Engstlatt, Balingen, Hechingen, Bodelshausen, Ofterdingen
		scylla	Pfohren, Biesingen/Baar, Heidenhofen, Hochemmingen, Mühlhausen, Weigheim, Trossingen, Aldingen, Frittlingen, Wellendingen, Zepfenhan, Dautmergen, Endingen, Balingen, Weilheim

landi (Sowerby, 1816) from St.-André-en-Terre-Plaine (Yonne, France).

In our opinion, *A. bucklandi* must be expected in beds not earlier than near the top of the middle part of the Bucklandi Subzone according to the phyletic trends of the genus *Arietites* (for more details see below). Considering the entire phyletic lineage of the genus, the type horizon of *Arietites bucklandi* is most likely only a little bit older than that of *Arietites solarium* (Quenstedt). We here focus on the bed containing *Arietites solarium*.

TAXONOMIC HISTORY OF *ARIETITES SOLARIUM*

Quenstedt (1883: 59) explained that the local quarrymen in the area between Balingen and Hechingen named the special limestone bed containing *Ammonites solarium* the "Uhrenfels" (= "rock with clocks"), after the shape of these ammonites resembling giant dials. This gives us a relatively precise hint where to look for the type horizon of this species. However, Quenstedt (1883, p. 63) stated that there exist transitional forms between his new taxon *solarium* (pl. 8: 1) and the long-known *Ammonites bucklandi* Sowerby, 1816 even at the same locality. Moreover, he obviously took the "Uhrenfels" and the "Schneckenpflaster", both limestone beds with giant arietitids, at least partly as synonymous (Quenstedt, 1883, p. 41).

Some authors (Schmidt, 1914; Donovan, 1952; Arkell, 1956; Guérin-Franiatte, 1966; Schlegelmilch, 1976) accepted *Arietites solarium* as a valid species, whereas others (Joly, 1936) interpreted *Arietites solarium* as a junior subjective synonym of *Arietites bucklandi*. For a solid definition of the taxon *Ammonites solarium* we have to go back to the original description by Quenstedt (1883).

When Quenstedt introduced the name for his new taxon, he mentioned or described eight specimens, all of them coming from the foreland of the western Swabian Alb and adjacent Baar:

1. A very big specimen with a diameter of about 60 cm and 21 [22] ribs on the outer whorl; from the area between Hechingen and Balingen, exact locality not mentioned, unfigured.
2. A specimen with a diameter of 49 cm and 21 ribs on the last whorl, from Balingen-Endingen (Quenstedt, 1883, pl. 8: 1).
3. A specimen from Trossingen, with a diameter of 40 cm and 24 ribs on the last whorl (Quenstedt, 1883, pl. 8: 2).
4. A specimen from the "Schneckenpflaster" of the Steinlach river at Dußlingen near Tübingen, with a diameter of 48 cm and 24 ribs on the last whorl (Quenstedt, 1883, pl. 8: 3).
5. A specimen from Balingen-Endingen, diameter 55 cm, 26 ribs on the last whorl, unfigured.
6. A specimen from Balingen-Endingen, diameter 49 cm, 27 ribs on the last whorl, unfigured.
7. A specimen from Kusterdingen-Jettenburg near Tübingen, diameter 58 cm, 31 ribs on the last whorl, unfigured.
8. A specimen from Schwäbisch Gmünd, diameter 63 cm, 30 ribs on the last whorl, unfigured.

Following Quenstedt himself, of his three figured specimens only the first one (specimen 2, see above) is a typical *solarium*, whereas the two others were said to be somewhat transitional to *Arietites bucklandi*. Subsequently, Donovan (1952, p. 720) designated specimen (2) as the lectotype of *Arietites solarium*, followed by Guérin-Franiatte (1966). Both authors mentioned that the specimens illustrated on plate 8: 2, 3 were missing. However, since Guérin-Franiatte (1966: 110, 111) had measured a diameter of 58.5 cm for the presumed lectotype; this specimen was most likely misidentified, because this diameter is not at all the diameter given for Quenstedt's figure 1, but it fits with that of the unfigured specimen (1). Today, none of the figured specimens could be traced in the palaeontological collection of Tübingen University. The only specimen that had survived in the collection until now is the previously unfigured specimen (1). It was identified by the remains of a labelling with ink indicating that it is a Quenstedt original and the only one that fits quite well with Quenstedt's description. Since it is not sure whether Donovan (1952) had really studied the specimen he declared as the lectotype, we here designate the sole surviving specimen of Quenstedt's type series as the neotype of *Ammonites solarium*.

THE HORIZON OF *ARIETITES SOLARIUM* IN THE ARIETENKALK FORMATION

In all of our studied sections, *Arietites solarium* follows above the occurrence of *Arietites* ex gr. *bucklandi* and closely related forms, which are in need of a revision (Table 1). The ammonite fauna of the *solarium* horizon yields only the following taxa: *Arietites solarium* (Quenstedt) [M], *Arnioceras* sp. [m].

In some of the studied sections the *solarium* Biohorizon is recorded in a limestone bed either completely merged with the underlying "Schneckenfels" bed or separated from the latter by a thin marly layer only (*e.g.*, sections Mühlhausen, Aldingen 1, Bodelshausen, Engstlatt in Gebhard, Schlatter 1977, fig. 1). Locally, this bed forms a knotty limestone within a marlstone bed with abundant *Gryphaea arcuata* Lamarck, 1801 (Wellendingen, Behla). This situation corresponds with Quenstedt's description of limestone concretions within marly beds just above the "Schneckenfels" bed yielding giant ammonites. However, locally the lithology of the bed containing *Arietites solarium* can change over a distance of only 20 to 30 metres. It is either represented by a well-developed limestone bed with a thickness of 20 to 25 cm (*e.g.*, Mühlhausen, Hochemmingen, Wellendingen, Aldingen 1), by a thin knobby limestone layer (*e.g.*, Wellendingen, Aldingen 2, Behla, Pfohren), or represented by occasional limestone nodules only (*e.g.*, Behla). Walliser (1956a, b) did not mention *Arietites solarium* from any of his studied sections. A reason could be that Fiege (1929) had interpreted *Arietites solarium* as a synonym of *Arietites pinguis* (Quenstedt, 1883) and indeed the specimen of Quenstedt's pl. 8: 2 from Trossingen could belong to the latter species or is closely related. In the Wutach area, a fragmentary specimen was recorded as *Arietites solarium* by v. Reis (1981) from the Arietenkalk section of the Mundelfingen waterfall, however, lacking exact data about its position within that section. In our opinion, this specimen represents a stratigraphically earlier species of this genus because of its dense, regular ribbing style.

Riek (1966) studied the Arietenkalk Formation in the foreland of the middle Swabian Alb including the Filder area south of Stuttgart. Hitherto, there are indeed no records of *A. solarium* from that area, either due to collection biases or – more likely – to a hiatus in the stratigraphical record. In eastern Swabia (*e.g.*, Gügling, Waldau, Bettringen near Schwäbisch Gmünd; Coll. E. Bernt, Weissach-Flacht and Coll. H. Schöne, GPIT) only forerunners of *A. solarium* have been recorded yet.

In the foreland of the western Swabian Alb (*e.g.*, Wellendingen) the horizon with *Arietites solarium* is often followed by a knotty limestone bed which contains usually badly preserved *Paracoroniceras* sp. In other localities (*e.g.*, Aldingen, Trossingen, Balingen-Engstlatt) it seems this bed is developed as a thicker limestone bed with giant *Paracoroniceras* ex gr. *charlesi*. This gives us a hint that at least the latter bed or the marlstone just below belongs to the Semicostatum Zone. In the section Aldingen 2 the "Schneckenfels" bed is followed by three well-developed limestone beds of the Bucklandi Zone and probably of the Semicostatum Zone (Fig. 2). The transition between the Bucklandi and Semicostatum zones is diversely developed in the study area showing rapid lateral lithological changes.

Fig. 3. ***Arietites solarium*** **(Quenstedt)**

Specimen GPIT/CP/10346, neotype, in ventral (A) and lateral views (B), SW Germany; Arietenkalk Formation, Lower Sinemurian, Bucklandi Zone, Bucklandi Subzone, *solarium* Biohorizon. Scale bar = 10 cm

SYSTEMATIC PALAEONTOLOGY

Family Arietitidae Hyatt, 1874

Subfamily Arietitinae Hyatt, 1874

Genus *Arietites* Waagen, 1869

Arietites solarium (Quenstedt, 1883)

pars 1883. *Ammonites solarium* – Quenstedt, p. 59, pl. 8: 1 (cf.), non figs. 2, 3.

1914. *Arietites solarium* Quenstedt – Schmidt, p. 9, pl. 1: 1.

pars 1936. *Ammonites solarius* F. Quenstedt – Joly, p. 52.

pars 1952. *Arietites solarium* (Quenstedt) – Donovan, p. 719.

1956. *Arietites solarium* (Qu.) – Arkell, p. 130.

1966. *Arietites solarium* (Quenstedt, 1883) – Guérin-Franiatte, p. 110, pl. 4; text-figs. 20, 21.

non 1976. *Arietites solarium* (Qu.) – Schlegelmilch, p. 138, pl. 14: 3 (forerunner of *A. solarium*).

non 1981. *Arietites* (*Arietites*) *solarium* (Quenstedt) – v. Reis, pl. 2: 1.

Neotype. Designated herein, the specimen mentioned by Quenstedt (1883: 59), GPIT/CP/10346, illustrated for the first time on Figure 3.

Type locality. Foreland of the western Swabian Alb in the area between the towns of Hechingen and Balingen, Baden-Wuerttemberg, southern Germany. Exact locality unknown.

Type horizon. Lower part of Arietenkalk Formation, a limestone bed directly overlying the "Schneckenfels" bed (Bucklandi Zone, Bucklandi Subzone, *solarium* Horizon).

Description. *Arietites solarium* (Figs. 3–5) is a large- to giant-sized species of the genus characterized by a relatively involute coiling and an extremely wide-spaced constant radiate ribbing (*ca.* 21–23 per whorl) in the preadult and adult stages; only inner whorls denser ribbed. Whorl section subquadratic.

Occurrences. Within the Early Sinemurian Bucklandi Zone/Bucklandi Subzone, *Arietites solarium* seems to be restricted to a thin limestone bed biostratigraphically representing the *solarium* Biohorizon. In southwestern Germany, *A. solarium* is frequently recorded from the Baar area and the adjacent foreland of the western Swabian Alb (Behla, Pfohren, Hochemmingen, Mühlhausen near Schwenningen,

Fig. 4. *Arietites solarium* (Quenstedt)

Specimen SMNS 60956, Balingen-Endingen, SW Germany; Arietenkalk Formation, Lower Sinemurian, Bucklandi Zone, Bucklandi Subzone, *solarium* Biohorizon. Scale bar = 10 cm

Fig. 5. *Arietites solarium* (Quenstedt)

Specimen SMNS 70526, Hochemmingen, SW Germany; Arietenkalk Formation, Lower Sinemurian, Bucklandi Zone, Bucklandi Subzone, *solarium* Biohorizon. Scale bar = 10 cm

Aldingen, Frittlingen, Wellendingen, Vaihinger Hof, Balingen-Endingen, Balingen-Engstlatt, Bodelshausen, Ofterdingen). Besides southern Germany, *Arietites solarium* occurs in northern Germany (Bad Harzburg: Schmidt, 1914) and in France (Troutry, Cote d'Or: Guérin-Franiatte, 1966). Most likely, there exist further records from several other French localities (Guérin-Franiatte, 1966), but none of them has yet been illustrated. Moreover, Donovan (1952, 1956) mentioned a sole specimen from the Saltford railroad cutting near Bath which he identified as *Arietites solarium*; however, the latter specimen was not illustrated either.

DISCUSSION AND CONCLUSIONS

Early species of *Arietites* (*A. pinguis* and forerunners) and transitional forms between *A. bucklandi* and *A. solarium* are restricted to the "Schneckenfels" bed and do not occur higher up in the section. Quenstedt's specimen illustrated on his pl. 8: 2 corresponds to early representatives of *Arietites* ex gr. *bucklandi*, a form that we have recorded frequently from the basal part of the "Schneckenfels" bed at numerous localities (*e.g.*, Hochemmingen, Trossingen, Pfohren, Wellendingen) here classified as *Arietites* cf. *pinguis* [M]. It is accompanied by *Arietites costosum* (Quenstedt, 1883) [M], *Arnioceras subgeometricum* Jaworski, 1931 [m], *Eucoroniceras* sp. [M + m], and *Tmaegoceras crassiceps* Pompeckj, 1901 [m]. The same fauna is recorded also from Rheinfelden-Degenfelden (Hagenbacher Hof, Dinkelberg).

Quenstedt's specimen of his pl. 8: 3 differs from that of pl. 8: 2 by its thicker and wider spaced ribs; this morphology occurs in the middle part of the "Schneckenfels" bed (*e.g.*, Hochemmingen, Wellendingen, Balingen-Endingen, Hechingen). This form is very close to the neotype of *Arietites bucklandi* from Keynsham, Avon, England (The Natural History Museum, BMNH C.41796) (see *e.g.*, Arkell, 1956; Guérin-Franiatte, 1966; Howarth, 2013), but the inner whorls exhibit straight, wide-spaced ribs, in contrast to true *A. bucklandi*, in which strongly curved ribs appear already in the inner whorls.

In the higher part of the "Schneckenfels" bed occur specimens of *Arietites* ex gr. *bucklandi* with a thick, rounded whorl section and thick, wider spaced ribs in the final stage. Like in *Arietites solarium*, the ribs are slightly prorsiradiate, but they still lack the stage with typically raised ventral ribs already at low diameters, and the inner whorls exhibit a significantly denser ribbing. This form can be interpreted as a phyletic forerunner of *Arietites solarium*.

This adds to the biostratigraphical frame of biohorizons under study by the authors (Table 1). The type horizon of *A. solarium* is located above beds with *Arietites* ex gr. *pinguis* and *Arietites* ex gr. *bucklandi*. Since, as discussed above, these taxa are linked by transitional forms from various layers of the "Schneckenfels" bed, they can be interpreted as members of a phyletic lineage, with *A. solarium* as the terminal form:

1. *A.* cf. *pinguis* (Quenstedt, 1883): More evolute coiling, dense, straight ribs in the inner whorls, curved ribs on the outer whorl; big specimens with higher whorl section and wide-spaced coarse, curved ribs. Distribution: base of the "Schneckenfels" bed (Hochemmingen, Mühlhausen near Schwenningen, Trossingen, Bodelshausen, Ofterdingen).
2. *A. pinguis* (Quenstedt, 1883): More evolute coiling, dense, straight ribs in the inner whorls; stage of straight ribs changes earlier in the curved ribbing stage than in the previous form, this curved stage begins in the second last whorl, where the ribbing is coarser than in the forerunners. Coiling is a little more involute in the last two whorls. Distribution: lower part of the "Schneckenfels" bed, above the level of *A.* cf. *pinguis* (Mühlhausen near Schwenningen, Hochemmingen, Wellendingen).
3. *A*. "*solarium*" sensu Quenstedt, 1883, pl. 8: 3: Innermost whorls with dense, straight ribbing; the coarse, but still straight ribbing stage starts in the third last whorl with coarse curved ribs in the outer whorls. Distribution: higher part of the "Schneckenfels" bed, above the level of *A. pinguis* (Wellendingen, Trossingen, Balingen-Endingen, Hechingen).
4. *A*. cf. *solarium*: A large- to giant-sized species of the genus characterized by a relatively involute coiling, dense ribbing in the juvenile stage only and an extremely wide-spaced constant ribbing (*ca.* 21–23 per whorl) in the preadult and adult stages. Prominent, slightly curved shovel-like ribs in the adult stage (straight ribs in true *A. solarium*). Whorl section subquadratic in the adult stage, more rounded in the inner whorls. Distribution: higher part of the "Schneckenfels" bed, above the level of *A.* "*solarium*" sensu Quenstedt, 1883, pl. 8: 3 and immediately below the level of *A. solarium* (Hochemmingen, Trossingen, Balingen-Ostdorf, Balingen-Engstlatt).
5. *A*. *solarium* (Quenstedt, 1883, neotype designated herein). Description and distribution see above.

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