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BIO-AND LITHOSTRATIGRAPHIC STUDY ON THE LOWER KIMMERIDGIAN OF THE SWABIAN AND FRANCONIAN ALB (GERMANY)

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Abstract. Correlation between Lower Kimmeridgian marly Lacunosamergel Formation of Swabia and the limestone-dominated Arzberg Formation of Franconia was recently carried out successfully. Correlation difficulties in the past were encountered in the *Hypselocyclum* Zone and in the *Divisum* Zone ("Balderum-Bank"). Base and top of the *Hypselocyclum* Zone, sensu Atrops: the *Hippolytense* Subzone and *Perayensis* horizon respectively, were correlated with numerous finds of *Cymaceras guembeli* (Oppel) on the base, and *Ardescia perayensis* Atrops on the top throughout Franconia and Swabia.

For the first time several *Aspidoceras* (*Pseudhimalayites*) *uhlandi* (Oppel) were found in the Swabian Alb above the "Balderum-Bank". These finds help to correct misinterpretations based on the presumed limited vertical range of *A. uhlandi* in Swabia and the lack of finds of *Idoceras balderum* (Oppel) in some sections of S Franconia. Now, the widened range of *Aspidoceras (P.) uhlandi* allows long-distance correlation with the Western Mediterranean Domain sensu Olóriz.

Riassunto. La correlazione tra la Formazione marnosa di Lacunosamergel del Kimmeridgiano inferiore della Svevia e la Formazione calcarea di Arzberg della Franconia è stata recentemente effettuata con successo. Le passate difficoltà di correlazione erano state incontrate nella Zona ad Hypselocyclum e nella Zona a Divisum ("Banco a Balderum"). La base e la sommità della Zona ad Hypselocyclum, sensu Atrops: rispettivamente la Sottozona ad Hippolytense e l'orizzonte a Perayensis, erano correlati con numerosi ritrovamenti di *Cymaceras guembeli* (Oppel) alla base, ed *Ardescia perayensis* Atrops alla sommità attraverso tutta la Franconia e la Svevia.

Per la prima volta molti *Aspidoceras* (*Pseudhimalayites*) *uhlandi* (Oppel) sono stati trovati nell'Alb Svevo sopra al "Banco a Balderum". Questi ritrovamenti aiutano a correggere le interpretazioni basate sulla presunta distribuzione verticale limitata di *A. uhlandi* in Svevia e sulla mancanza di ritrovamenti di *Idoceras balderum* (Oppel) in alcune sezioni della Franconia meridionale. Ora, la più ampia distribuzione di *Aspidoceras* (*P.*) *uhlandi* permette correlazioni a lunga distanza con il Dominio Mediterraneo Occidentale sensu Olóriz.

Introduction

The Upper Jurassic rocks of the Swabian Alb and the Franconian Alb covers an area of about 400 km in length and averages 30-40 km in width in S Germany (Fig. 1). Both regions are geographically divided in three parts each. The Swabian Alb in a Western, Central and Eastern and the Franconian Alb in a Northen, Central and Southern Alb (Fig. 1). In recent years the deposits of the Lower Kimmeridgian, Quenstedt's "Weissjura γ", now renamed in Swabia as "Lacunosamergel-Formation" (Lm-Fm), were studied in more than 70 outcrops and quarries of the two neighbouring Albs. A large number of sections were recorded, accompanied with a bed-by-bed collection of ammonites. The study was carried out in the so called "Bankfazies", not in the siliceous sponge facies. Some of the results will be presented herein.

Lower Kimmeridgian rocks of the Lacunosamergel-Formation of the Swabian Alb vary in thickness from approx. 20 m to 70 m. In the Central Swabian Alb thickness is highest, whereas in the W Alb merely 20 m and in the E Swabian Alb 35 m are recorded. These beds consist mainly of marlstones with intercalated marly limestones, slightly nodular, and a few bedsets of more densely packed limestones (Geyer & Gwinner 1984).

Lower Kimmeridgian rocks of the Franconian Alb, there called "Malm γ", mount up to a maximum of approx. 30-35 (40) m in the N Alb, where marly facies dominates. Fazies and its stacking pattern are similar to those in the Swabian Alb. An even further increase in thickness in the "Dornig-Formation", of the northernmost Franconian Alb, is doubtful and, until now, not well documented (Hegenberger & Schirmer 1967; Freyberg 1967).

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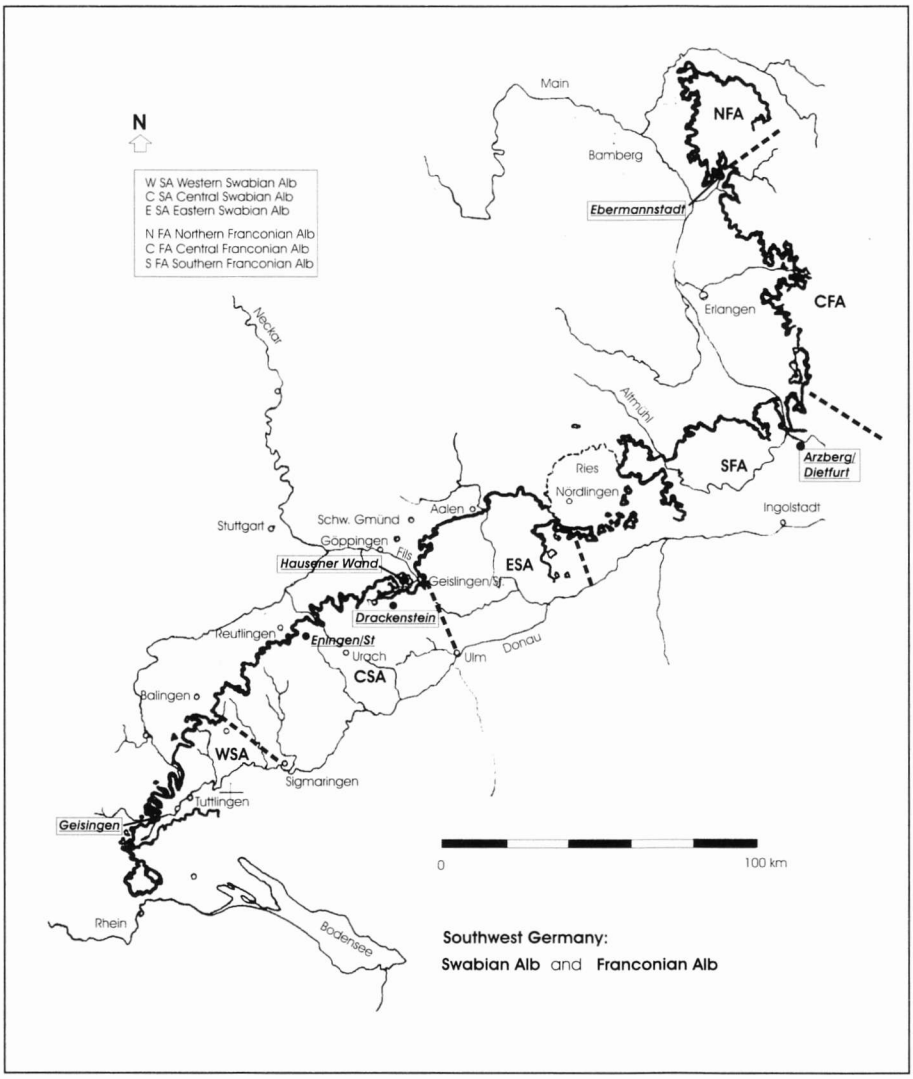


Fig. 1 - Upper Jurassic outcrops of the Swabian and Franconian Alb. Location map-underlined outcrops are mentioned in the text. Dotted lines mark geographic boundaries.

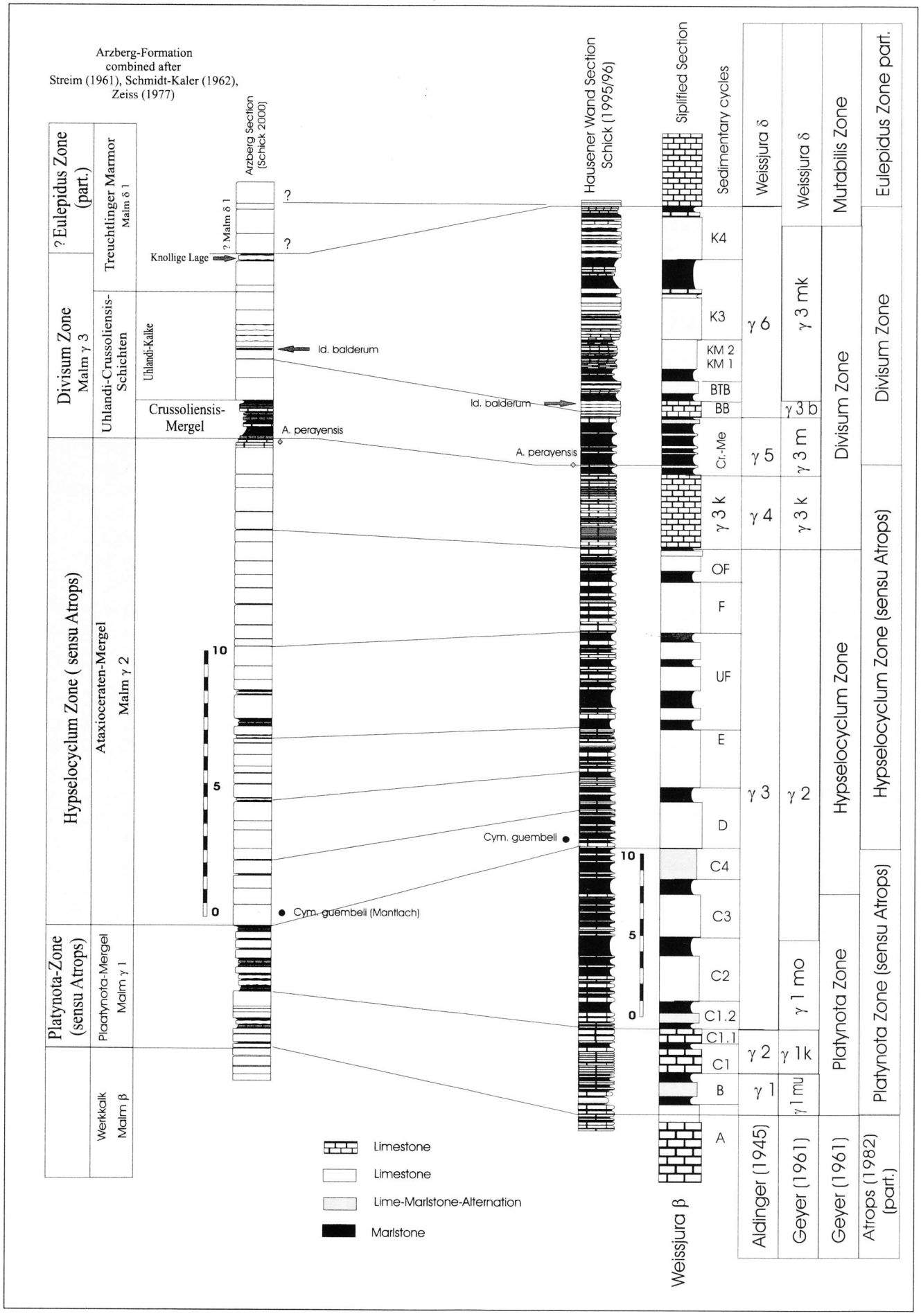
A major change of facies occurs in the Central and S Franconian Alb. Sedimentary rock consists mainly of thickly bedded limestones, slightly marly, with either thinly intercalated or completely missing marlstones. The series of evenly bedded limestones covers vast areas. It can be traced over tens of kilometres without much changing its facies or thickness. These limestone sections are interrupted at the base by the marly, 4-5 m thick "Platynota-Mergel", and in the upper third by the intercalated "Crussoliensis-Mergel", measuring 1-2 m (Fig. 2). Thickness in the S Alb reaches up to approx. 28-32 m, whereas in the Central Franconian Alb thickness of the Malm γ averages ~ 3-5 m less; it may even be reduced below 20 m (Kaulich et al. 2000; Meyer & Schmidt-Kaler 1992, 1995).

Reference section for the Lacunosamergel Formation (Lm-Fm) of the Swabian Alb

A reference section for the Lm-Fm has been established in the Central Swabian Alb, at the "Hausener Wand", nearby Hausen (Schick 1996). This marlstone-dominated section has a thickness of approx. 54-56 m (Fig. 2). About 12 m of the uppermost section is supplemented by a partial section of a nearby outcrop opposite the village of Drackenstein, because at the Hausener Wand this upper region is either not exposed or consists of spongiolithic limestones. The stacking pattern of this stratotype section houses a series of beds, bedsets and parasequences, which reflect most likely climatic changes ("Milankovitch-cycles"). These "Sedimentary Cycles" ("SC") allow a detailed subdivision, helping to improve resolution of the lithological framework (Fig. 2).

Former lithological frameworks, introduced by Aldinger (1945) and Geyer (1961a), are also shown in Fig. 2. Their resolution allows a rough orientation in the field, but is not high enough for detailed correlations. In fact, their subdivision centered around three major limestone-dominated "SC", such as "γ 1k", "γ 3k" and "γ 3b" (sensu Geyer). The central, marly dominated part (γ 3 of Aldinger), representing about 50 % of the total thickness of the section, was regarded as not divisible by these authors. This means that the upper half of the *Platynota* Zone plus the entire *Hypselocyclum* Zone had no "bench marks". Ammonites collected in these beds

Fig. 2 - Complete Lower Kimmeridgian sections of Arzberg, (S Franconian Alb) and Hausen, (Central Swabian Alb), showing the different zonal schemes, lithological subdivisions and sedimentary cycles of Aldinger (1945), Atrops (1982), Geyer (1961a), Schick (1996), Schmidt-Kaler (1962), Zeiss (1977).


Arzberg-Formation
combined after
Streim (1961), Schmidt-Kaler (1962),
Zeiss (1977)
Arzberg Section
(Schick 2000)
Hausener Wand Section
Schick (1995/96)
Siplified Section
Sedimentary cycles
? Eulepidus Zone
(part.)
Treuchtlinger Marmor
Malm δ 1
Divisum Zone
Malm γ 3
Uhlandi-Crussoliensis-
Schichten
Uhlandi-Kalke
Crussoliensis-
Mergel
Hypselocyclum Zone (sensu Atrops)
Ataxioceraten-Mergel
Malm γ 2
Platynota-Zone
(sensu Atrops)
Platynota-Mergel
Malm γ 1
Werkkalk
Malm β
? Malm δ 1
Knollige Lage
Id. balderum
A. perayensis
Cym. guembeli (Mantlach)
Cym. guembeli
K4
K3
KM 2
KM 1
BTB
BB
Cr.-Me
OF
F
UF
E
D
C4
C3
C2
C1.2
C1.1
C1
B
A
Weissjura δ
γ 6
γ 5
γ 4
γ 3
γ 2
γ 1
γ 3 mk
γ 3 b
γ 3 m
γ 3 k
γ 2
γ 1 mo
γ 1k
γ 1 mu
Mutabilis Zone
Divisum Zone
Hypselocyclum Zone
Platynota Zone
Eulepidus Zone part.
Divisum Zone
Hypselocyclum Zone (sensu Atrops)
Platynota Zone (sensu Atrops)
Limestone
Limestone
Lime-Marlstone-Alternation
Marlstone
Weissjura β
Aldinger (1945)
Geyer (1961)
Geyer (1961)
Atrops (1982)
(part.)

have had no "home address", they could not be traced back to a certain bedset, because no lithological subdivision existed. This deficiency does not exist any more thanks to the new subdivision. Most of these Sedimentary Cycles can be followed and correlated throughout the Swabian and N Franconian Alb from the Hypselocyclum Zone on upward (Fig. 2). Some flooding surfaces, e.g. such as the one atop the parasequence "γ 3k", allow even long-distance correlations, beyond Swabian and Franconian Alb and beyond the adjacent N Switzerland, down to the outcrops of the Ardèche region in SE France.

Historical aspects of the recent zonal schemes

The zonal scheme of the Lower Kimmeridgian, nowadays in use as a standard zonation of the Submediterranean Domain, was proposed by Geyer (1961a) to be employed in S Germany for the deposits of the Swabian and Franconian Alb. In the first place it was an attempt to combine litho- and biostratigraphic aspects. The problem was that the lithofacies of the Central Swabian Alb, where this scheme was established, is entirely different from that in the Central and S Franconian Alb (see above). This means that only the two calcareous sedimentary cycles of γ 1k and γ 3k could be correlated. As a result, the lithological concept of Geyer's scheme was hence not suitable for the application for most of the Franconian Lower Kimmeridgian deposits – and likewise for the westernmost part of the Swabian Alb too.

Lithological framework for the Central and Southern Franconian Alb

Amongst others, Streim (1961), Schmidt-Kaler (1962) and Freyberg (1962) published various sections of the Upper Jurassic of the Central and S Franconian Alb. Schmidt-Kaler's subdivisions of Lower Kimmeridgian rocks considered primarily the lithological changes and secondarily the fossil content (see Fig. 2). Thus he integrated the marlstone-bedsets with their natural boundaries in his framework-chart, producing a threefold subdivision too, γ 1 = "Platynota-Mergel", γ 2 = "Ataxioceraten-Schichten" and γ 3 = "Crussoliensis-Uhlandi-Schichten", which are ideally suitable for this region. The only problem was that they did not match the γ 1, γ 2, γ 3 of Geyer. None of these boundaries were coincidental, except the one on the base of γ 1, which also marks the Base of the *Platynota* Zone, with the first occurrence datum

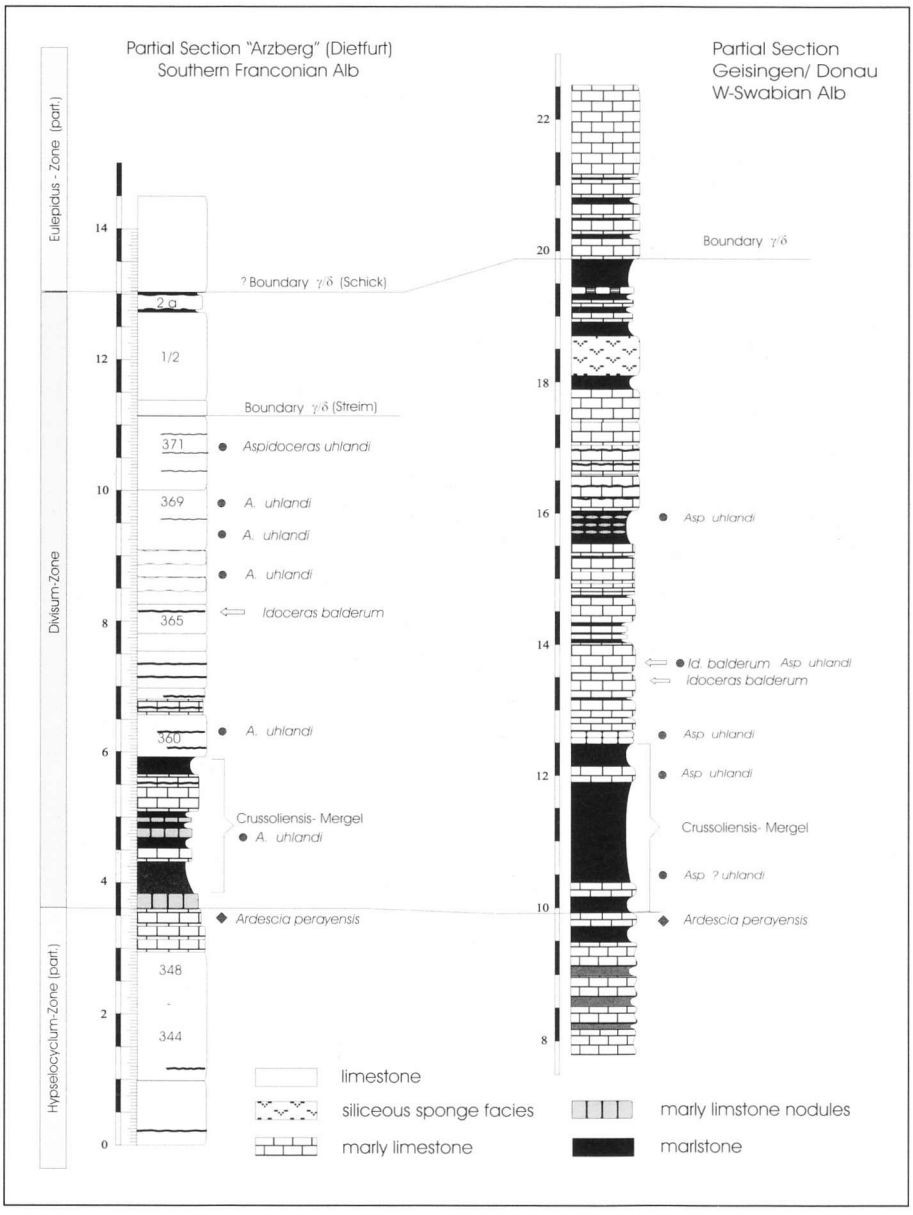


Fig. 3 - Partial sections from Arzberg/ Dietfurt (S Franconian Alb) and Geisingen/Donau (W Swabian Alb), indicating the distribution of *Aspidoceras (P.) uhlandi, Idoceras balderum, Ardescia perayensis* within the Divisum Zone.

SE-France				Franconian & Swabian Alb			S-Spain		
Atrops (1982)				Schick (2002)			Olóriz (1978)		
Upp. Kim.	Zones	Subzones	Horizons	Horizons	Subzones	Zones	Horizons	Subzones	Zones
						Mutabilis/ Eulepidus			Compsum
Lower Kimmeridgian	Acanthicum					Divisum		Uhlandi	Divisum
			Balderum	Balderum	Uhlandi		Balderum		
	Divisum								
	Hypselocycl.	Lothari	Perayensis	Perayensis		Hypselocyclum/ Strombecki			Hypselocycl. / Strombecki
			Semistriatum						
			Hypselocyclum						
			Discoidale						
		Hippolytense	Hippolytense						
			Lussasense	Guembeli					
	Platynota	Guilherandense	Guilherandense			Platynota			Platynota
			Thieuloyi						
		Desmoides	Desmoides						
			Enayi						
		Orthosphinctes							
			Amoeboceras						
	Planula	Galar				Galar			Bimamm/ Planula

Fig. 4 - Zonal scheme of the Lower Kimmeridgian of the Ardèche region, SE France, Swabian and Franconian Alb, SW Germany and Zona Subbetica, S Spain. Stippled frames contain the newly introduced zonal elements to the SW German Upper Jurassic.

of *Sutneria platynota* (Reinecke) (FOD) in the so called "Ammonitenbreccie". Until recently in SW Germany the Lower Kimmeridgian deposits of the two Albs were subdivided in three sections each, using the same abbreviations γ 1, γ 2, γ 3, but meaning partially different beds and bedsets. The *Platynota* Zone here was not identical with the *Platynota* Zone there.

Biostratigraphic research in the Central and S Franconian Alb was also carried out by the above mentioned authors, about forty years ago. Streim (1961) had investigated in detail the γ 3 = *Divisum* Zone, plus parts of the "Treuchtlinger Marmor" in the Arzberg region. Schmidt-Kaler (1962) had sampled the "Treuchlinger Marmor" (*Mutabilis* and *Eudoxus* Zones) in the surroundings of Treuchtlingen. Schairer (1967, 1974) had studied the "Platynota-Mergel" in quarries of the Southern and Central Franconian Alb. His work revealed, amongst other results, that the total vertical occurrence of *Sutneria platynota*, the TRZ (Taxon Range Zone), was almost identical with the lithological unit of the "Platynota-Mergel", with a FOD in the "Ammonitenbreccie", and a last occurrence datum (LOD) just ~ 0.5 m below the more calcareous "Ataxioceraten-Schichten". Streim (1961) had accomplished the same results years before in Arzberg. Unfortunately, no one has studied in detail the *Hypselocyclum* Zone recently. Previous information is based on the work by Wegele (1929-1930) and Schneid (1939-1940, 1944), with the disadvantage that their described ammonite fauna was not collected "bed-by-bed".

The relevance of studies outside SW Germany

Further research in the Lower Kimmeridgian deposits was done e.g. in France and Spain, resulting in the zonal charts by Atrops (1982) and Olóriz (1978), which had a direct impact on the studies here. Atrops (1982) took over the standard zonal scheme from Geyer (1961a, b) for the Lower Kimmeridgian in SE France and subdivided the three existing *Platynota*, *Hypselocyclum* and *Divisum* Zones furthermore to subzones and faunal horizons. The result was a shift in zonal boundaries too (Fig. 4).

The application of the zonation of Atrops (1982) in SW-Germany was not done in detail before. Doing so it reveals some corresponding and differing aspects in the Swabian and Franconian Alb. For example, the *Platynota* Zone sensu Atrops is a TRZ, therefore it has identical boundaries with the one in Franconia, but there is no conformity with the upper boundary in Swabia. Geyer (1961a) had laid the upper boundary of his *Platynota* Zone in a bed with a *Platynota* acme, once proposed by Veit (1936), and not above the LOD of *S. platynota*, hence its position lays several metres below (Fig. 2).

The same applies for the upper boundary of the *Hypselocyclum* Zone of Atrops, which is almost identical with the vertical extension of the γ 2 = "Ataxioceraten-Mergel" in Franconia, whereas in Swabia the boundary of Atrops lays several metres higher than the boundary introduced by Geyer (1961a). Geyer has laid his *Hypselocyclum-Divisum* boundary at the base of γ 3k, and Atrops (1982) lays it just above it. The best way out of all the

zonation differences is to apply the *Platynota* and *Hypselocyclum* zonation sensu Atrops (1982) in SW Germany, because it serves best the lithological reality and the biostratigraphical data from Franconia and Swabia. Doing so, the *Divisum* Zone has to be defined newly, because the first occurrence of *Crussoliceras divisum* (Quenstedt) in Swabia lays even below the base of γ 3k.

Some further changes in the zonal scheme

The introduction of the *Guembeli* horizon

One of the problems in the search of unified boundaries can be solved by introducing the faunal horizon of *Cymaceras guembeli* in S Germany. In the sections of the Central Swabian Alb there is this prominent sedimentary cycle, named "D", which occurs approx. one third up in the marly, central part of the section. The basal layer of "D" is more calcareous as the following layers and varies in thickness between 25 and 40 cm (Fig. 2). This distinctive sedimentary cycle and its prominent basal bed can be followed throughout the entire Franconian and Swabian Alb, only in the westernmost part of the W Alb it can not be traced. It has an erosive base and yields a considerable amount of ammonite fragments. Completely preserved specimens are rather rare. It contains reworked material, mostly of the subgenus *Ardescia* Atrops, 1982.

This basal layer represents not only a sedimentary transition between the most marly interval of the section and a more calcareous one, it also contains ammonites with changing ribbing-pattern. There is a change from tripartite and/or polygyrate ribbing into the polyplocoid pattern which means a transition from the genera *Orthosphinctes/Ardescia* to *Ataxioceras/Parataxioceras* sensu Atrops (1982). This transitional fauna is not easy to determine, hence this work is only partly done so fare. But in the undetermined part of the fauna some specimens can be determined as *Parataxioceras hippolytense* Atrops and *Schneidia lussasense* Atrops, *Ardescia inconditum* (Fontannes) and *Parataxioceras pseudoeffrenatum* (Wegele). Some of these ammonites mark the beginning of the *Hippolytense* Subzone within the *Hypselocyclum* Zone. Two layers above, *Taramelliceras* (*Metahaploceras*) *strombecki* (Oppel) and *Parataxioceras* ex gr. *lothari* (Oppel) are located. *M. strombecki* is another important guide fossil in the Mediterranean and Submediterranen realms. Karvé-Corvinus (1966) used it as an index fossil for her *Strombecki* Zone.

In the marly intercalation above the basal layer of the Sedimentary Cycle "D", and in the following bed, the dimorph pair of *Cymaceras* (*Cymaceras*) *guembeli* (Oppel, 1863) and *Cymaceras* (*Trochiskioceras*) *bidentosum* (Quenstedt, 1857) has been located. Formerly, regarded as one of the rarest finds in the entire Swabian and Franconian Alb, it is nowadays found by the hundreds, thus the position of this "*Cymaceras* bed" is precisely known to collectors. When Oppel first described *Ammonites guembeli* in 1863, he could observe only 6 specimens altogether, which were collected in Franconian and Swabian Alb and N Switzerland. Wegele (1930) had still a small number of 31 specimens to work with, and Ziegler (1979) ~ 10 specimens of (*Trochiskioceras*) *bidentosum*. Lately Schlampp (1999) has collected about 400 specimens of *Cymaceras* exclusively in this one locality of Mantlach (Central Franconian Alb).

Not only the number of finds has increased, the knowledge of its geographical distribution also. Finds beyond the "classical region" of N Switzerland and S Germany are recorded as well. Geyer (1959) mentions a *Cymaceras* (?) *guembeli* find in Slovakia which is reported by Rakus (1959). Wendt (1971) found *C. guembeli* in Sicily. The knowledge of its exact stratigraphical position has gained on precision with the increasing number of outcrops and careful sampling. Formerly, this was not very clear. Finds from the *Platynota* and from the *Hypselocyclum* Zone were reported likewise. Thanks to the works of Schairer & Schlampp (1991, 2000), Schlampp (1987, 1991) and Gradl & Schairer (1997) in recent years, its stratigraphical position in the lowest *Hypselocyclum* Zone has been confirmed. I have found this dimorph pair over the past years in 12 different localities in the SA and FA with its FOD always at the same position as described above, and never in the *Platynota* Zone.

The vertical range of *Cymaceras* may vary from a few centimetres to 20-30 cm, and the LOD lies very rarely up to ~ 60 cm above the FOD. Some of the finds are seen in Plate 1, Figs. 5-8. *Trochiskioceras bidentosum* bears lappets, if the specimen is complete, and is hence regarded as the microconch. It grows up to a size of about 10-12 mm (see Pl. 1, Fig. 2). From the macroconch of *Cymaceras* 3 species are distinguished: *C guembeli* (Oppel, 1863), *C. perundatum* Wegele, 1930 and *C. franziskae* Schairer, 1991. Their size can reach approx. 35 mm (Pl. 1, figs. 1, 3, 4).

PLATE 1

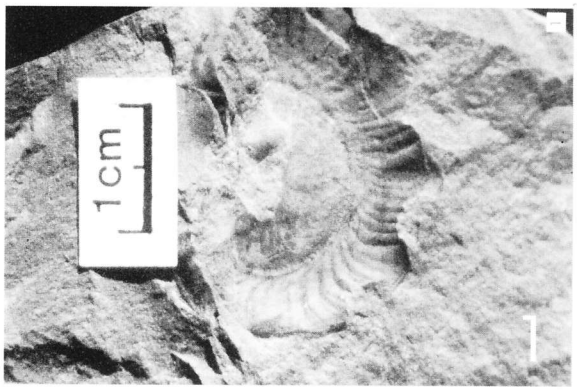
Fig. 1, 3, 4: *Cymaceras* (*Cymaceras*) *guembeli*, in different growth stages, showing intraspecific variations.

Fig. 2: *Cymaceras* (*Trochiskioceras*) guembeli. All specimens were collected in the *Guembeli* horizon at the Hausener Wand (Central Swabian Alb).

Fig. 5-8: *Orthosphinctes* (*Ardescia*) *perayensis* Atrops, 1982. The *Perayensis* horizon of the W Swabian Alb yielded the shown specimens.

Fig.5: microconch, D = 40 mm, Geisingen/D.;

Fig. 6-8: from Mahlstetten. Fig. 6: macroconch, D = 80 mm; Fig. 7: D = 55, most likely macroconch; Fig. 8: likely macroconch, D = 45. All specimens (Fig. 1-8) housed in the SMNS (Stuttgart).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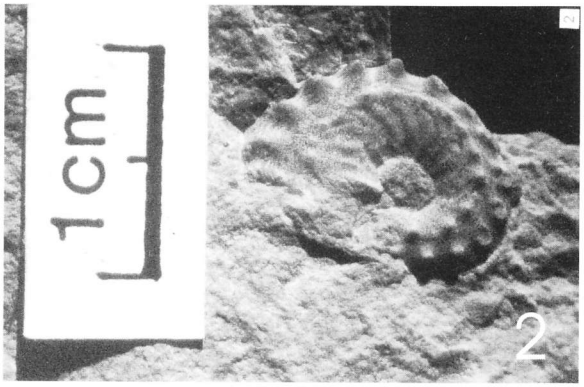
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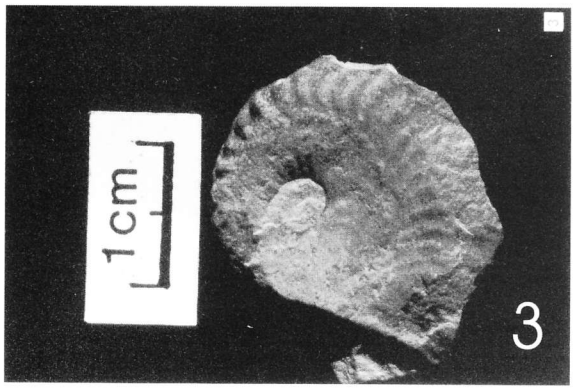
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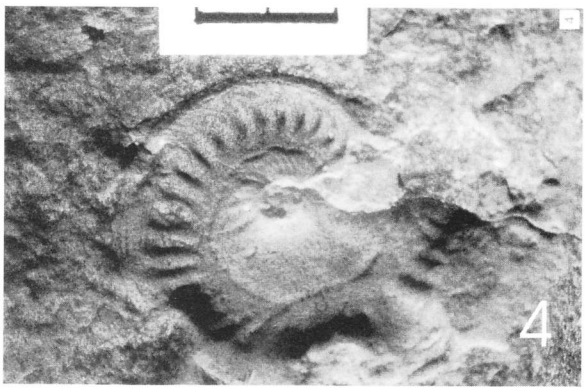
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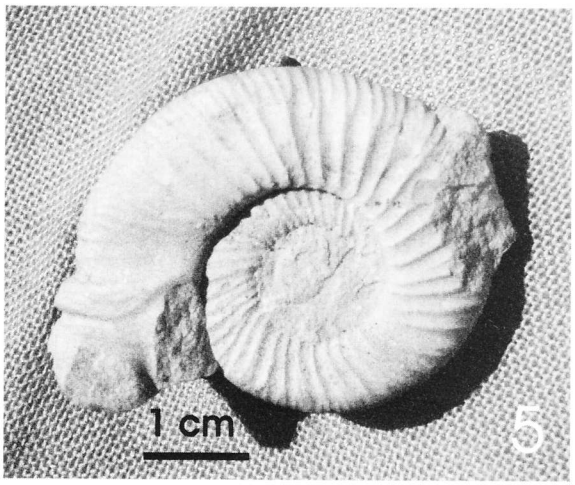
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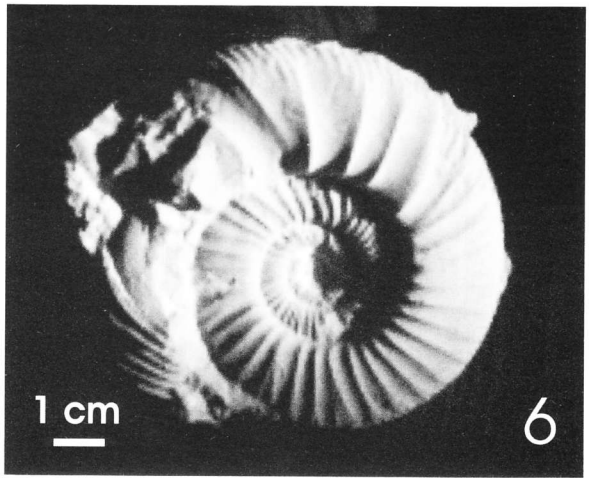
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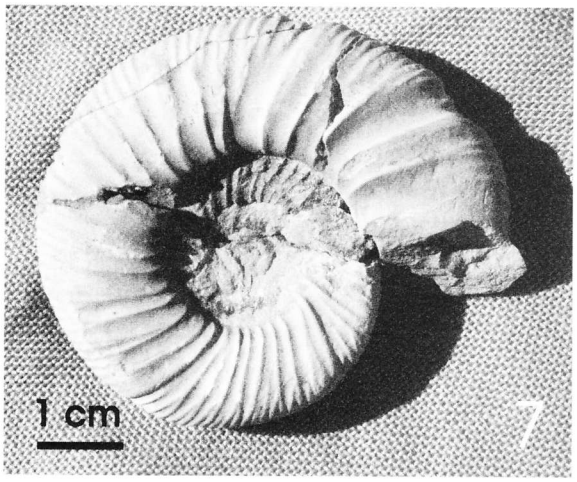
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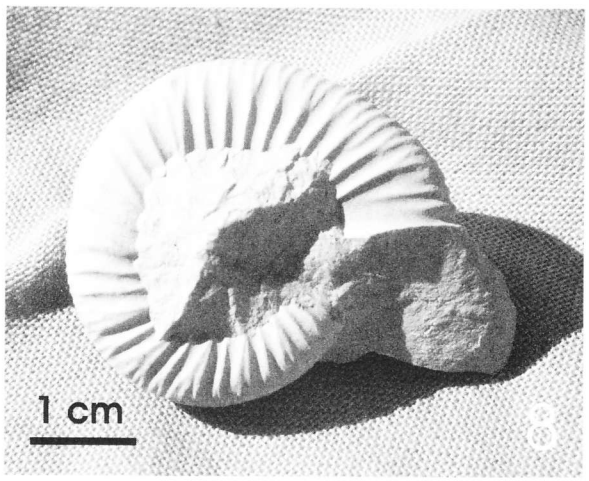
1 cm
8

It was Veit (1936), who proposed for the first time, to use *Cymaceras* as an index fossil in the Lower Kimmeridgian. The present knowledge on *Cymaceras* and its wide geographical distribution justifies the introduction of the *Guembeli* horizon.

The advantage of the *Guembeli* horizon is obvious, this index fossil is easy to determine, amongst the Ataxioceratinae in transition, it is of limited vertical range, and it is quite common at least in SW Germany.

The confirmation of the *Perayensis* horizon in S Germany

Orthosphinctes (Ardescia) perayensis was chosen by Atrops (1982, p. 115) as an index fossil for his *Perayensis* horizon in SE France. It represents the uppermost horizon of the *Hypselocyclum* Zone. This small ammonite bears lappets and is therefore regarded as a microconch. In size it ranges between 40 and 50 mm in diameter (see Plate 1, figs. 5,6,7). *Ardescia perayensis* was encountered by Atrops also in S Germany in a few outcrops. In many outcrops of the Swabian Alb it is very abundant. It occurs on top of Sedimentary Cycle γ 3k, which is the thickest marly limestone bedset within the Lower Kimmeridgian of the Swabian Alb, a true parasequence sensu Kamola & van Wagoner (1995). In Franconia this ammonite is not too frequent, but in the N Alb it occurs already in the marlstone bed intercalating γ 3k and the thicker bed above. In the Central and S Franconian Alb it appears in an identical position, although no intercalating marlstone beds separate the thinly bedded, slightly marly limestones atop γ 3k. *Ardescia perayensis* is also found in the Lower Kimmeridgian of N Poland (Matyja & Wierzbowski 2000). It supports there the correlation between the lowermost part of the *Mutabilis* Zone of the Boreal realm sensu Birkelund et al. (1983) and the uppermost part of the *Hypselocyclum* Zone of the Submediterranenan realm sensu Atrops (1982).

Not too often one finds a microconch with its lappets (Pl. 1, fig. 5). Adult macroconchs are even rarer. I have collected various specimens of macroconchs in the W Swabian Alb at Geisingen and Mahlstetten. Unfortunately not one single specimen bears an undamaged bodychamber (Pl. 1, fig. 6, D = 80 mm). The *Perayensis* horizon in Swabia is often condensed. It also yields echinoids, brachiopods, belemnitids, pelecypods, etc., and a great number of other ammonite genera too, such as: *Streblites, Taramelliceras, Glochiceras, Creniceras, Prorasenia, Eurasenia, Nebrodites, Crussoliceras, Garnierisphintes.*

This remarkable bed, the present *Perayensis* horizon, was already known to famous Swabian geologists/paleontologists in the 19th Century: Quenstedt, Engel, Fraas and others, under the name „Monotisbank". Note: at certain spots the Monotisbank may yield mass occurrences of the bivalve *Aulacomyella similis* (formerly named *Monotis similis*).

The Subzone of *Aspidoceras uhlandi* and the horizon of *Idoceras balderum*

Notes on *Orthaspidoceras uhlandi* versus *Pseudhimalayites uhlandi*. Schweigert (1997, p. 8) explains plausibly that the type species of the genus *Orthaspidoceras* (*Ammonites orthocera* d'Orbigny) is an ammonite which possesses a row of large tubercles near the umbilicus, but no ribs at all. The morphological features of *Aspidoceras uhlandi* are quite different. *A. uhlandi* bears pronounced ribs and a row of lateral tubercles on the flanks, hence it belongs to a rib-bearing group of Aspidoceratinae. Schweigert suggests the genus *Pseudhimalayites* Spath, 1925.

Idoceras balderum occurs in Swabia within the *Divisum* Zone in a prominent limestone bed or bedset called "Balderum-Bank" or "Balderum-Bänke" (BB). Its vertical range is rather limited, less than one metre. It appears in relative abundance in an acme in the upper part of the BB, but it can also be found a few decimetres below and/or above, in the "Balderum-Twin-Bank" (BTB) (Fig. 2, 3). These two outstanding bedsets, above the "Crussoliensis-Mergel", can be followed throughout the Swabian Alb. Hence the index fossil *I. balderum* and the two bedsets are of outstanding correlation value. A few other genera, mostly fragmented, co-occur with the dominating *I. balderum*: *Streblites, Glochiceras, Creniceras, Crussoliceras, Garnierisphinctes, Aspidoceras.*

In Franconia, especially in the Central and S Alb, where the majority of bedsets consists of densely packed limestones, the BB and BTB is not easy to detect. Furthermore the index fossil is rare. This lack of *I. balderum* finds made not only the correlation with the adjacent Swabian Alb difficult, but also within the Franconian Alb itself.

Yet, another index fossil was frequently found in these beds in question in Franconia: *Aspidoceras (Pseudhimalayites) uhlandi.* In Swabia it is the contrary, this species was not found too often in the Central Swabian Alb, where most of the research has been done. *A. uhlandi* finds were reported from below and within the Balderum-Bank, but never above (Oppel 1863, p. 225; Haizmann 1902, p. 513; Veit, 1936, p. 91; Aldinger 1945, p. 131; Zeiss 1964, p. 112). This "fact" has led in Franconia to the misleading conclusion that the LAD of *Idoceras balderum* and *Aspidoceras uhlandi* are coincidental. This idea was published by Streim (1961, p. 11) who had not succeeded in finding *I. balderum* in his Arzberg section. The relative frequency of *A. uhlandi* in Franconia and the lack of *I. balderum* finds there had made *A. uhlandi* to be employed as a stratigraphical "substitute" of *I. balderum*.

To prove his statement, Streim (1961, p. 11) employed the bed-by-bed correlation. He was convinced that his bed "371" could be correlated to the E Ries area, in the S Franconian Alb, some 70 kilometres to the West. There, in the presumed equal bed, had Weber (1941) encountered *I. balderum*. First doubts of this correlation practice was uttered by Hertle (1979) who had encountered several *I. balderum* beds, and the appropriate index fossil to it, in the N Franconian Alb (Thurnau), Central Franconian Alb

(Gräfenberg, Pegnitz) and S Franconian Alb (Treuchtlingen). Hertle stated, that the vertical distribution of *I. balderum* does not exceed 0.6 m in Franconia, bringing former presumptions of several metres to an end.

Some new finds of *Aspidoceras* (*Pseudhimalayites*) *uhlandi* by myself above the "Balderum-Bank", in outcrops of the W and Central Swabian Alb, made the former correlation attempt by Streim (1961) obsolete. This deduction is not only based on the *A. uhlandi* finds in Swabia but also on more finds of *Idoceras balderum* in Franconian quarries, including the Arzberg quarry, the stratotype locality of the Arzberg Formation. For the distribution of these index fossils see Fig. 3.

The present knowledge about the distribution of these two important species *Aspidoceras uhlandi* and *Idoceras balderum* within the *Divisum* Zone in S Germany enables long-distance correlation to southern Spain. There, Olóriz (1978) has described the same situation concerning the vertical distribution of *A. uhlandi* and *I. balderum*: Olóriz has distinguished a *Uhlandi* Subzone within the *Divisum* Zone and in the middle of this subzone the *Balderum* horizon is placed. The stratigraphical distribution of *A. uhlandi* in this region is also reported by Checa (1985), Olóriz & Rodriguez-Tovar (1993), Caracuel et al. (1998) and others.

To some extent the enlarged occurrence of *A. uhlandi* in Swabia makes now the zonal chart of Switzerland by Gigy & Persoz (1986, tab. 2) better understood: therein the *Uhlandi* subchron is positioned above the *Balderum* subchron, which means no *uhlandi* finds were made there below the *balderum* horizon until now.

Conclusions

The influence of the Mediterranen Domain is clearly notable in SW Germany. The distributions of major index fossils are alike. Hence the concept of the Mediterranean zonal chart of the *Divisum* Zone of Olóriz (1978) can be applied also for the Swabian and Franconian Alb, since the chart of Atrops (1982) embraces ± *Platynota* and *Hypselocyclum* Zone, and not the deposits in between *Perayensis* horizon and *Idoceras balderum* bed and the layers above.

The detailed zonal chart of the *Platynota* Zone and *Hypselocyclum* Zone of Atrops (1982) can also be employed in SW Germany, but further research is necessary, for example, above the *Uhlandi* subzone a diverse *Progeronia* and *Discosphinctoides* fauna is encountered. The exact occurrence of the *Nebrodites* and *Mesosimosceras* fauna in the SW should also be studied.

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