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On some biostratigraphically important microfossils (benthic foraminifera, dasycladales) from subsurface Late Jurassic-Early Cretaceous shallow water limestones of S-Germany

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With 2 figures, 5 tables and 3 plates

Kurzfassung

Aus Flachwasserkalken des Obertithon-Berrias der in den 60er Jahren abgeteuften Molassebohrungen Utting und Endorf/Oberbayern werden einige biostratigraphisch bedeutsame Mikrofossilien (benthonische Foraminiferen, Dasycladaceen) beschrieben. Paläogeographische und lithofazielle Beziehungen zu den schweizerisch-französischen subalpinen Ketten werden diskutiert.

Abstract

Some biostratigraphically important microfossils (benthic foraminifera, dasycladales) are described from Upper Tithonian-Berriasian neritic limestones from the Upper Bavarian drillings of the sixties from Utting and Endorf. Paleogeographic and lithofacies relationships with the French-Swisse subalpine chains are discussed.

Content

Introduction

The Franconian Alb (plateau) of Southern Germany represents the eastern end of an extensive SW-NE running Jurassic mountain chain. The youngest Jurassic outcrops belong to the Neuburg Formation of Upper Tithonian age (Barthel 1969). These shallow water

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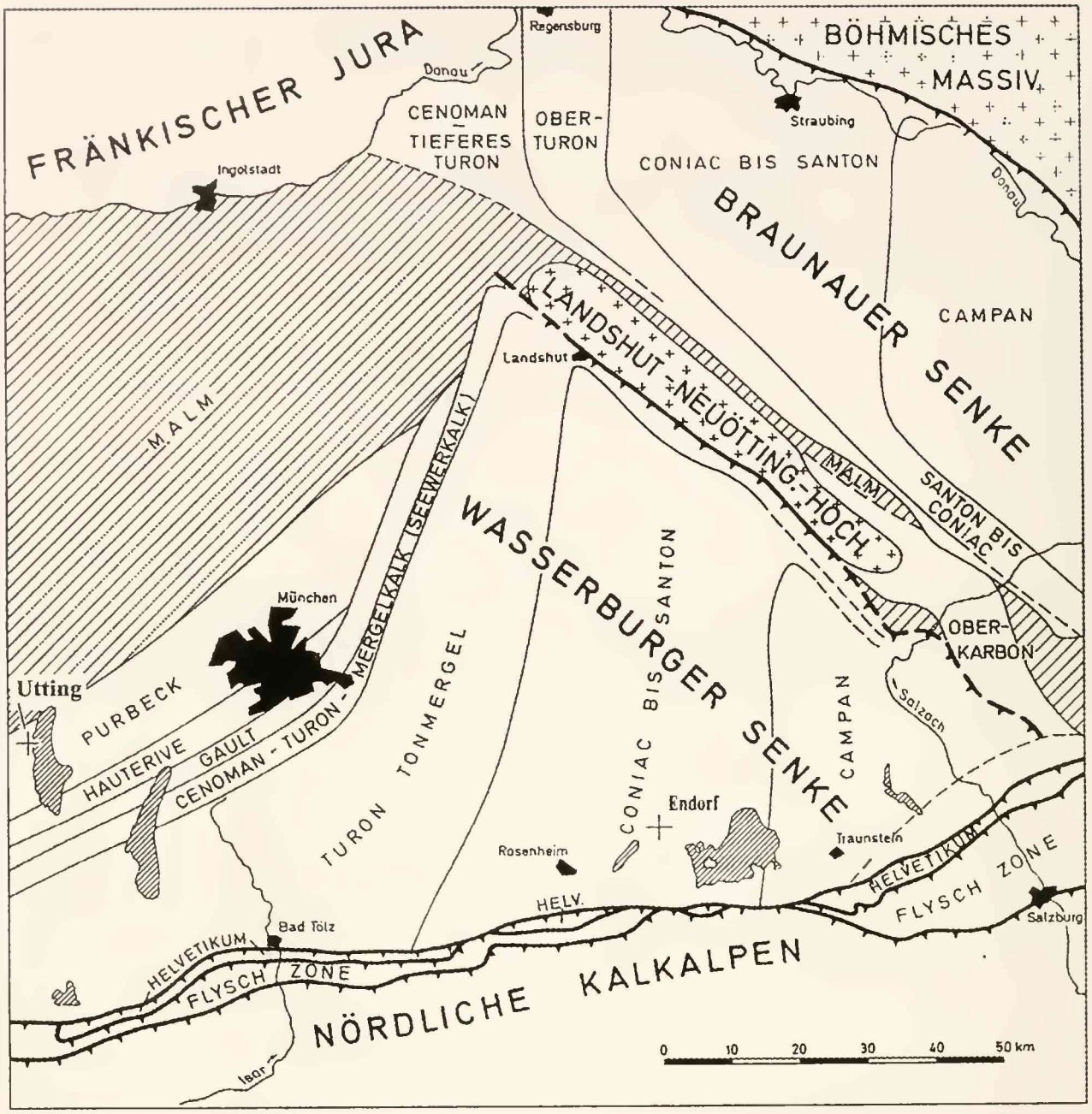


Text-Fig. 1: Distribution of Late Jurassic to Cretaceous sediments below the Subalpine Molasse after LANGE (1981) and location of the drillings of Utting and Endorf.

limestones only occur in the region of Neuburg, along the Danube river, because, due to the Tithonian regression, the sea retreated southwards in the direction of the Helvetic zone. The western part of the forealpine realm, from Eastern Switzerland to the river Lech, was not covered by the sea. To the north-east, the shallow epicontinental sea was bordered by the NW-SE running Landshut-Neuötting structural high, that during the (Upper) Cretaceous period, separated two troughs, the north-eastern „Braunauer Senke" and the south-western "Wasserburger Senke" (e.g. LEMCKE 1981; HERM 1978). Due to this constellation, the knowledge of Cretaceous paleogeography south of the Danube river, below the forealpine Molasse clastic blanket only stems from boreholes that have been drilled for hydrocarbon prospecting. Amongst them, the borehole of Miesbach was the deepest, reaching down to 5748 m. In the period 1953 to 1979 a number of 37 oil and gas fields were prospected (LEMCKE 1981: p. 15).

The information obtained from the numerous wells showed that the sediments just below the Molasse get younger from the west (area of Munich) to the east, from the Purbeckian till the

Campanian (LANGE 1981; Fig. 1). The lower/middle Berriasian, dated by means of ostracods, is known from wells beneath the Molasse zone, reported as „Purbeckian", consisting of brackish-saline facies (e.g. BARTHEL 1969: p. 151, well Ampfing 1). From the well Moosburg 4 a, Purbeckian facies, with a thickness of 134 m, have been reported by MEYER (1994), which consist of characean limestones, laminates and oolithic limestones with authigenic dolomite and crustacean coprolites (*Favreina salevensis*) are known. During the late Jurassic the so-called „Munich Bay", as a part of the „Wasserburger Trog" (trough), evolved just prior to the deposition of the Purbeckian. This is documented by a large thickness of the Upper Jurassic, attaining up to more than 600 m in the well of Utting I (PORTH 1965: p. 348). Within the „Wasserburger Trog", initially evaporitic and later brackish Purbeckian facies were deposited (LEMCKE 1981). During the Lower Cretaceous the former land surface began to tilt towards the south indicating the beginning of the formation of the Molasse foredeep. This resulted in the erosion of the Upper Jurassic limestones, whereby stratigraphically older deposits were affected from south to north. Consequently, the thickness and completeness of the Lower Cretaceous sediments increases towards the south (BARTHEL 1965: p. 772).

The present paper provides new results concerning biostratigraphically important microfossils from boreholes of the forealpine Molasse basin. These microfossils characterise Late Jurassic-Early Cretaceous neritic limestones and are typical „Tethyan" forms that are partly known from the region of the Northern Calcareous Alps, but poorly to unknown from the Mesoeuropean shelf deposits of S-Germany. To our knowledge, there are no publications that deal with biostratigraphic data of this period from boreholes of S-Germany.

The work presented here is dedicated to our former teacher Prof. emer. Dr. D. HERM (Munich).

2. Material

The original material of BARTHEL (1969) about the Neuburg Formation of the southern Franconian Alb has been kindly made available to the authors of the present paper by Dr. SCHAIRER from the „Bayerische Staatssammlung für Paläontologie und historische Geologie" of Munich. Some first new results of this investigation have already been published (SCHLAGINTWEIT & EBLI 1997). The material contains about 40 thin-sections from the wells of Kaufbeuren 1, Eigelwald, Gablingen 1a, Endorf 2 and Utting 1. From a micropaleontological point of view, the thin-sections from Utting 1 and Endorf 2 are the most interesting because they contain stratigraphically important benthic foraminifera and dasycladales of the Late Jurassic-Early Cretaceous neritic regime.

The drilling well of Utting 1, at the western side of the Ammersee, reached a depth of 3402 m and contains over 600 m of the Upper Jurassic (PORTH 1965: p. 348). The limestone samples of Utting 1 are represented by 17 thin-sections (2,5 x 7,5 cm and 6 x 4 cm) and were derived from depths of 2689,0 to 2707,3 m. They all display a wackestone texture and can be referred to a quiet water environment („lagoon") of an inner platform realm. The distribution of benthic foraminifera and dasycladales are shown in table 2. Taking into account the known stratigraphic ranges of the microfossils encountered, the samples can be placed in the Upper Tithonian.

The well of Endorf 2, northwest of the Chiemsee, was drilled into the Infravalanginian (Berriasian) and Purbeckian (HARK 1963: p. 894; PORTH 1965: p. 349). The material investigated is represented by 4 thin-sections:

- BAB 20 (6 x 4 cm): depth 4847,0 - 4848,8 m, „0,3 m über Krone"
- BAB 21 (6 x 4 cm): depth 4847,0 - 4848,8 m, „Krone"
- BAB 22 (6 x 4 cm): depth 4823,5 - 4841,1 m, „Kiste 9 unten"
- BAB 23 (7,5 x 2,5 cm): depth 4823,5 - 4841,1 m, „Kiste 9 unten"

The microfacies of the samples BAB 20 and 21 are grainstones with extraclasts (e.g. Charalimestones) and abundant benthic foraminifera, namely miliolids and trocholinids. The samples BAB 22 and 23 are packstones with scattered ooids. The benthic foraminifera are accompanied by remains of crinoids (Pl. 1, fig. 1). The occurrence of *Pseudotextulariella courtionensis* BRÖNNIMANN in all 4 samples together with the other microfauna shows that they are of Upper Berriasian age (Tab. 1). The samples BAB 22 and 23 are from a more shallow position within the borehole and therefore a little bit younger in age. This difference, however, can not be further differentiated by means of microfossils. The occurring clasts of charalimestones can be deduced to have been derived from the underlying Purbeckian that had been reworked during the transgression. According to HARK (1964), the drilling of Endorf 2 documents a northward marine transgression that took place during the Berriasian and Valanginian.

3. Paleontological part

3.1 Benthic foraminifera

Genus *Anchispirocyclina* JORDAN & APPLIN, 1952

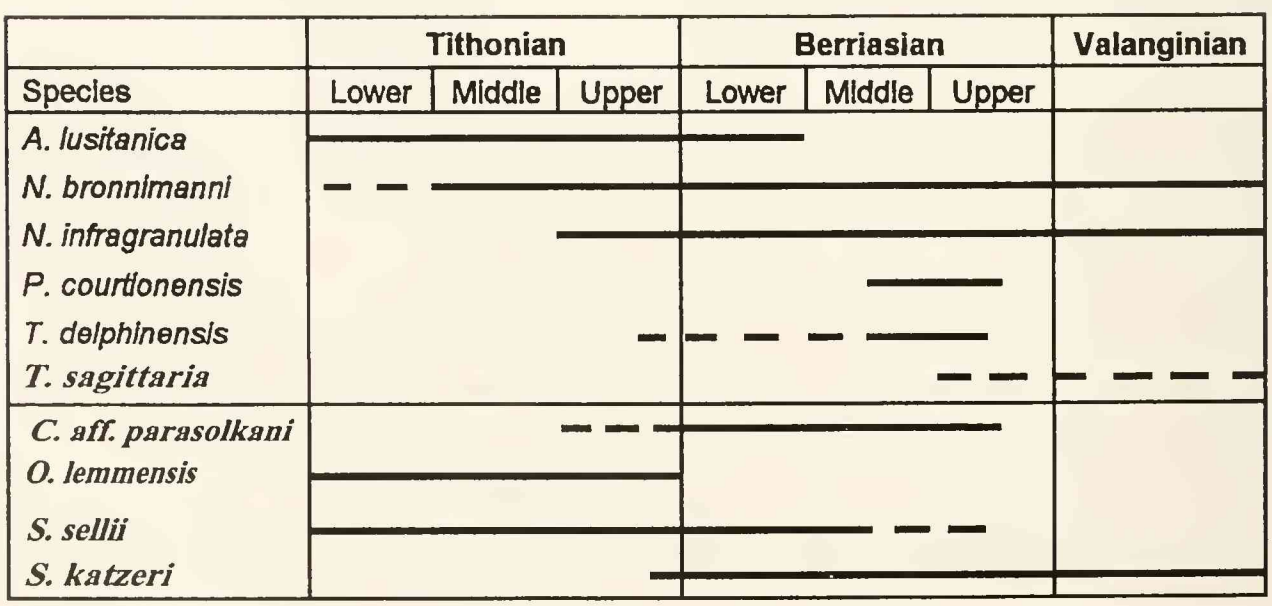
Anchispirocyclina lusitanica (EGGER)

(Pl. 1, fig. 6)

1969 *Anchispirocyclina lusitanica* (EGGER) - BARTHEL: 17, pl. 5, fig. 1-6, Upper Tithonian of Franconian Alb/S-Germany (with synonymy).

Remarks: *A. lusitanica* has been reported within dark and grey micrites from the borehole of Kaufbeuren (depth 3276,1 - 3286,0 m) by BARTHEL (1969: p. 153). The occurrence in the well of Utting together with the accompanying biota is shown in table 2. According to BARTHEL(1969) *A. lusitanica* is typical for very shallow, near-coastal habitats of changing salinities.

Tab. 1: Stratigraphic distribution of benthic foraminifera and dasycladales after ARNAUD-VANNEAU et al. (1987, 1988, 1991), BUCUR, CONRAD & RADOICIC (1995) and own observations.



Tab. 2: Distribution of benthic foraminifera and calcareous algae within the samples of the well Utting (Upper Tithonian).

Algae							Foraminifera										
Clypeina aff. *parasolkani*	*Clypeina* sp. A PECORINI	*Lithocodium / Bacinella*	*Otternstella lemmensis*	*Rajkaella bartheli*	*Salpingoporella annulata*	*Thaumatoporella parvovesic.*	*Anchispirocyclina lusitanica*	*Everticyclammina virguliana*	*Mohlerina basiliensis*	*Nautiloculina oolithica*	*Neotrocholina infragranulata*	*Pseudocyclammina lituus*	*Trocholina alpina*	*Trocholina elongata*	*Valvulina lugeoni*	Sample	m under head
0	:	:	0	:	0	:	:	:	:	:	0	:	0	:	:	BAB 19	1,95 (Kern 3)
0	:	0	0	:	0	:	:	:	0	0	:	0	0	:	0	BAB 18	0,35 (Kern 3)
:	0	0	:	:	:	:	:	:	0	0	:	:	:	:	0	BAB 17	0,2 (Kern 3)
0	0	:	:	:	0	0	:	:	:	0	0	:	0	:	:	BAB 16	0,25 (Kern 3)
:	:	:	:	:	:	0	:	:	0	0	0	:	0	:	:	BAB 15	4,3
:	:	:	:	:	:	:	:	:	0	0	:	:	0	:	:	BAB 11 a	1,3 (?)
0	:	0	:	:	0	0	0	:	0	0	0	:	:	0	:	BAB 10	2,55
0	:	0	:	:	0	:	0	:	0	0	:	:	:	:	0	BAB 9	2,4
:	:	:	:	0	0	:	:	:	:	:	0	:	0	:	0	BAB 8	2,35
0	:	:	0	:	0	:	0	:	0	0	0	:	0	:	:	BAB 7	2,3
0	:	:	:	:	:	0	:	:	:	0	:	0	0	:	:	BAB 6	2,15
0	:	:	:	:	0	0	:	:	:	0	0	:	0	:	:	BAB 5	1,9
0	:	:	:	:	0	:	:	:	:	0	0	:	0	:	:	BAB 4	1,65
0	:	0	:	:	0	:	:	0	:	0	0	:	0	:	:	BAB 3	1,6
0	0	:	:	:	0	:	0	:	0	0	:	:	:	:	0	BAB 2 a	1,45
0	:	:	:	:	:	:	0	:	0	:	:	:	0	:	:	BAB 2	1,45

Genus *Nautiloculina* MOHLER, 1938

Nautiloculina bronnimanni ARNAUD-VANNEAU & PEYBERNES, 1978

(Pl. 2, fig. 5-6)

* 1978 *Nautiloculina bronnimanni* n. sp. - ARNAUD-VANNEAU & PEYBERNES: 70, fig. 2, pl. 1, fig. 6-8, pl. 2, fig. 4-11.

1986 *Nautiloculina bronnimanni* ARNAUD-VANNEAU & PEYBERNES: WYSSLING: Pl.5, fig. 4, Berriasian of Vorarlberg/Helvetic Zone.

1991 *Nautiloculina oolithica* MOHLER – HAGN, SCHLAGINTWEIT & STEIGER: Pl. 4, fig. 1-2.

R e m a r k s : The size of the tests with quadrangular chambers that in the last whorl display a characteristic shape (ARNAUD-VANNEAU & PEYBERNES 1978: forme en „champignon") account for *N. bronnimanni*. According to ARNAUD-VANNEAU & PEYBERNES (1978) the Lower Cretaceous nautiloculinas are indicative for a shallow infralittoral platform environment displaying good oxygenation and normal salinity.

Genus *Pseudotextulariella* BARNARD, 1953, emend. CHAROLLAIS, BRÖNNIMANN & ZANINETTI, 1966

Pseudotextulariella courtionensis BRÖNNIMANN, 1966

(Pl. 1, fig. 1-5, pl. 2, fig. 1)

* 1966 *Pseudotextulariella courtionensis* n. sp. - BRÖNNIMANN: 267, text-fig. 8, pl. 1, fig. 1-5, pl. 2, fig. 1-2, pl. 3, fig. 3, „Valanginian" of Switzerland.

1984 *Pseudotextulariella courtionensis* BRÖNNIMANN - SALVANI-BONNARD, ZANINETTI & CHAROLLAIS: Pl. 2, fig. 1, Upper Berriasian of Haute-Savoie, France.

R e m a r k s : *P. courtionensis* has been established from the drilling of Courtion 1, Canton of Fribourg, Switzerland, encountered in thin sections of core no. 4, 1402,70-1407,70 m (BRÖNNIMANN 1966: p. 265). The samples have been attributed to the Valanginian by FISCHER & LUTERBACHER (1963) on the basis of their lithology. The latter are described as oolithic limestones with benthic foraminifera amongst miliolids and trocholinids, from which, an equivalent microfacies to the samples with *P. courtionensis* from the drilling of Endorf can be concluded.

Tab. 3: Dimensions of *Pseudotextulariella courtionensis* BRÖNNIMANN (in mm) from the well Endorf 2, 4823,5-4841,1 m. D = test diameter, H = height of the test.

D	H	D/H
0,37	0,31	1,2
0,44	0,5	0,88
0,55	0,46	1,2
0,66	0,88	0,75
0,44	0,42	1,0
0,47	0,5	0,94

Genus *Trocholina* PAALZOW, 1922

Trocholina sagittaria ARNAUD-VANNEAU, BOISSEAU & DARSAC; 1988

(Pl. 2, fig. 7-8)

* 1988 *Trocholina sagittaria* n. sp. - ARNAUD-VANNEAU, BOISSEAU & DARSAC: 361, pl. 1, fig. 5, pl. 6, fig. 1-10, Upper Berriasian? - Barremian of Switzerland and Italy.

R e m a r k s : Small and high conical test with a relatively large number of whorls (n = 11, ? 12). Chamber lumen typically rectangular in axial sections.

Tab. 4: Dimensions of *Trocholina sagittaria* ARNAUD-VANNEAU et al. (in mm) from the well Endorf 2. D = test diameter, H = height of the test, n = number of whorls.

D	0,22	0,29	0,26
H	0,42	0,62	0,74
D/H	0,52	0,47	0,35
n	9 (10?)	?	?

Trocholina delphinensis ARNAUD-VANNEAU, BOISSEAU & DARSAC, 1988
(Pl. 2, fig. 1-2, 9)

*1988 *Trocholina delphinensis* n. sp. - ARNAUD-VANNEAU, BOISSEAU & DARSAC: 358, fig. 2, pl. 1, fig. 1, pl. 3, fig. 1-8, Berriasian of France.

R e m a r k s : *T. delphinensis* belongs to the group with tests „formes coniques elevees" displaying a tendency within the last 2 to 3 whorls to become cylindro-conical. The inner chamber-ending is most often slightly bended upward toward the apex. From a stratigraphic point of view *T. delphinensis* is a species „essentiellement berriasienne" that becomes more frequent with the beginning of the Upper Berriasian and disappears progressively during the Valanginian (ARNAUD-VANNEAU et al. 1978: p. 358).

Tab. 5: Dimensions of *Trocholina delphinensis* ARNAUD-VANNEAU et al. (in mm) from the well Endorf 2. D = test diameter, H = height of the test, n = number of whorls.

D	0,6	0,62	0,43	0,62	0,74
H	0,88	1,1	0,72	0,94	1,22
D/H	0,68	0,56	0,59	0,66	0,6
n	?	11	?	9	8

Trocholina molesta GORBATCHIK, 1959
(Pl. 2, fig. 3)

1988 *Trocholina molesta* GORBATCHIK - ARNAUD-VANNEAU, BOISSEAU & DARSAC: 359, pl. 6, fig. 11-21.

R e m a r k s : Small *Trocholina* with low conical test. According to ARNAUD-VANNEAU et al. (1988) *T. molesta* has a stratigraphic extension from the top of the Purbeckian to the Barremian. In our material *T. molesta* is the less frequent *Trocholina* encountered.

D i m e n s i o n s : D = 0,36 mm, H = 0,26 mm, D/H = 0,73, number of whorls = 6.

3.2 D a s y c l a d a l e s

Genus Clypeina MICHELIN, 1845, emend. REZAK, 1957
Clypeina sp. A, PECORINI, 1972
(Pl. 3, fig. 1, 7, 9)

1972 *Clypeina* sp. A - PECORINI: 378, fig. 3 a-h, Purbeckian of Sardinia/Italy.

R e m a r k s : Some rare transverse sections of *Clypeina* sp. A, PECORINI have been discovered within the Upper Tithonian of the Utting drilling (samples BAB 2 and 2a). The species, identified as a new species in the original description, has been described from the Purbeckian facies of Sardinia/Italy. PECORINI (1972) assumed a Valanginian age for his samples („molto probabilmente valanginiana"). According to own observations, *Clypeina* sp. A is a common dasycladale of the Alpine Lerchkogel Limestone (Lofer Member) and Plassen Limestone (Tithonian-Berriasian).

D i m e n s i o n s : D = 0,56-0,72 mm (0,3-0,6 mm), d = 0,15-0,21 mm (0,1-0,25 mm), ratio d/D = 0,25 - 0,36, p = 0,14-0,15 mm, w = 11-12. The dimensionsal data obtained from PECORINI (1972) are given between brackets.

Clypeina aff. *parasolkani* FARINACCI & RADOICIC, 1991
(Pl. 3, fig. 6, 11-12)

1996 *Clypeina* aff. *parasolkani* FARINACCI & RADOICIC - ERCEGOVAC et al.: pl. 2, fig 1-9, Upper Jurassic of Montenegro.

Remarks: A small representative of *Clypeina* with short, rounded branches (8-12) displays a thin calcareous envelope. One specimen of small dimensions and 6 laterals might belong to the apical part of the thallus (Pl. 3, fig. 11). The species is a frequent element from the Upper Tithonian limestones of the drilling of Utting but also occurs in the samples from Endorf. *Clypeina parasolkani* FARINACCI & RADOICIC, 1991 from the Berriasian of Turkey is the species being nearest to our specimens.

Dimensions: D = 0,22-0,42 mm, d = 0,07-0,152 mm, ratio d/D = 0,25-0,4, p = 0,07-0,09 mm, w = 6, 8-12?.

Genus *Otternstella* GRANIER, 1994

Otternstella lemmensis (BERNIER 1971) GRANIER, 1994
(Pl. 3, fig. 4, 8)

*1971 *Heteroporella lemmensis* n. sp. – BERNIER: 177, pl. A.
1986 *Heteroporella lemmensis* (BERNIER) - WYSSLING: Pl. 2, fig. 4, Helvetic Zone of Vorarlberg.
1994 *Otternstella lemmensis* (BERNIER) nov. gen., nov. comb. – GRANIER in GRANIER et al.: 134, pl. 2, fig. 4-5.

Remarks: The species originally described as belonging to the genus *Heteroporella* has been revised and transferred to the new genus *Otternstella* by GRANIER (in GRANIER et al. 1994). *O. lemmensis* has been discovered in three thin-sections of Utting (BAB 7, 18, 19; see also table 2).

Dimensions: D = 0,4-0,46 mm (0,33-0,68 mm), d = 0,04 mm (0,05-0,1 mm), d/D = 0,1, w = 7, h about 0,09 mm, p = 0,12 mm (0,075-0,12 mm). The dimensions given by BERNIER (1971) are shown in brackets.

Genus *Salpingoporella* PIA, 1918

Salpingoporella katzeri CONRAD & RADOICIC, 1978
(Pl. 3, fig. 3)

* 1978 *Salpingoporella katzeri* n.sp. - CONRAD & RADOICIC: 69, text-fig. 1, pl. 1-2, Berriasian-Valanginian of Hercegovina.

Remarks: One single longitudinal section has been discovered in sample BAB 20 showing primaries that widen rapidly towards their distal endings („trumpet-shaped"). *Salpingoporella katzeri* CONRAD & RADOICIC has been established originally from the Berriasian and Valanginian of Jugoslavia, Switzerland and Spain.

Dimensions: D = 0,36 mm (0,26-0,8 mm), d = 0,12 mm (0,1-0,4 mm), d/D = 0,33, h = 0,12-0,136 mm (0,08-0,16 mm); data from CONRAD & RADOICIC (1978) within brackets.

Salpingoporella sellii (CRESCENTI, 1959) BASSOULLET et al. 1978
(Pl. 3, fig. 2)

* 1959 *Macroporella sellii* n. sp. - CRESCENTI: 195, pl. 1, fig. 1-9, Upper Jurassic of Italy.

Remarks: *S. sellii* is commonly reported from Upper Jurassic strata. In the Dinarides for example, the *Salpingoporella sellii* Zone corresponds to the Oxfordian–lowermost Kimmeridgian (TIŠLJAR & VELIC 1993). In the Lerchkogel Limestone of the Northern Calcareous Alps *S. sellii*

has been found in the (Lower?) Berriasian (DARGA & SCHLAGINTWEIT 1991). In the samples from the drilling of Endorf *S. sellii* is associated with *P. courtionensis*, *N. bronnimanni*, *T. sagittaria* and *T. delphinensis* documenting that the stratigraphic range must be extended into the Upper Berriasian (see Table 1).

D i m e n s i o n s : D = 0,24 mm (0,24-0,44), d = 0,11 mm (0,06-0,16), d/D = 0,47, p about 0,017 mm (0,016-0,02). Data from CRESCENTI (1959) is shown between brackets.

4. Conclusions

The obtained results demonstrate that Late Jurassic - Early Cretaceous neritic limestones from the subsurface of S-Germany can be dated by means of larger benthic foraminifera and dasycladales (see table 1). All literature data on the published range charts are in good accordance to our findings. The stratigraphic range of *Salpingoporella sellii* (CRESCENTI) must be expanded to include the Upper Berriasian.

For correlation purposes it is necessary to refer to the surface „Neocomian" in the stratotype area near Neuchâtel, Switzerland and the subalpine chains of France. There, the Purbeckian is time-equivalent to South-Germany and also the facies with evaporites, breccias and black pebbles („cailloux noirs") is directly comparable. The end of the Purbeckian facies is marked by the discontinuity DiO, which occurs in the Middle Berriasian and corresponds to the formation of open marine conditions („Berriasian-Hauterivian platform") which resulted from rising sea-level (ARNAUD-VANNEAU et al. 1987). A late Berriasian sea-level rise is also documented within the Hohenems Nappe of the Helvetic Zone of Vorarlberg (WYSSLING 1986). This paleogeographic change led to the marine transgression over Purbeckian which has been reported also from the drilling of Endorf (BARTHEL 1969: Fig. 39, and this work) and from the drilling of Kastl 2 and 2a of the Eastern Molasse Basin (BARTHEL 1965: p. 773). From a microfacies point of view, the resulting mixture of external and internal faunal elements corresponds to „Faciès de Transgression" (ARNAUD-VANNEAU 1980; ARNAUD-VANNEAU et al. 1987). The Lower Cretaceous transgressive series corresponds to a "deepening event" that led to a microfaunistic renewal, that is to say the disappearance and appearance of different species of benthic foraminifera (ARNAUD-VANNEAU et al. 1987). It is important to mention, that in Switzerland, the post-Purbeckian Middle/Upper Berriasian strata have individual terms, e.g. „Unité Inférieure Oolitique", „Marbre Batard" or „Formation de Pierre Chatel" (ARNAUD-VANNEAU et al. 1987), wheras the Lower Cretacous beneath the Molasse foredeep in Bavaria is not grouped into units, memers or formations. Here, the Berriasian-Valanginian (and younger strata) is simply reported lithologically as „limestone, marl, sandstone" (e.g. LANGE 1981). The Hohenems Nappe of the Helvetic Zone of Vorarlberg (WYSSLING 1986) can be regarded as a connecting link between the Late Jurassic-Early Cretaceous of the French-Suisse subalpine chains and the material described in the present paper. It is also interesting to note, that from the Eocene of the Helvetic Zone near Salzburg HAGN, SCHLAGINTWEIT & STEIGER (1991) described Late Jurassic? (most probably early Cretaceous) pebbles of shallow water limestones with nautiloculinas and pfenderinids. These were assumed to have originated from the Previndelicic Islands that bordered the southern Mesoeuropean continental margin.

For the moment, it is likely that, from the perspectives of paleogeography, lithostratigraphy and facies, correlations of the Portandian, Purbeckian and „post-Purbeckian", from Molasse boreholes, with the French-Swiss Subalpine Chains are possible, as has been discussed earlier by BARTHEL (1969: p. 154). For detailed lithologic and stratigraphic correlations, however, investigations of thin-section material from different boreholes of Southern Germany are needed.

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Plate 1 Benthic Foraminifera

Fig. 1: Grainstone with crinoids, trocholinids and *Pseudotextulariella courtionensis* BRÖNNIMANN (X 27), slide BAB 20.

Fig. 2-5: Different sections of *Pseudotextulariella courtionensis* BRÖNNIMANN (X 59). Fig. 2, 4: Slide BAB 20; Fig. 3: Slide BAB 23; Fig. 5: Slide BAB 22.

Fig. 6: *Anchispirocyclina lusitanica* (EGGER) (X45), slide BAB 10.

Fig. 7: *Mohlerina basiliensis* (MOHLER) (X 74), slide BAB 2.

Fig. 8: *Pseudocyclammina* sp. (X 34), slide BAB 6.

Age and location:

Fig. 1-5: Upper Berriasian, well Endorf.
Fig. 6-8: Upper Tithonian, well Utting.

Plate 2 Benthic Foraminifera

Fig. 1: Grainstone with *Trocholina delphinensis* Arnaud-Vanneau et al. and cross-section of *Pseudotextulariella courtionensis* Brönnimann (X 27), slide BAB 27.

Fig. 2, 9: *Trocholina delphinensis* Arnaud-Vanneau et al. (X 58), slide BAB 20.

Fig. 3: *Trocholina molesta* Gorbatchik (X 73), slide BAB 23

Fig. 4: *Trocholina* sp. (X 73), slide BAB 23.

Fig. 5-6: *Nautiloculina bronnimanni* Arnaud-Vanneau & Peybernes (X 38), slide BAB 20.

Fig. 7-8: *Trocholina sagittaria* Arnaud-Vanneau et al. (X 58), slide BAB 10.

Fig. 10-11: *Neotrocholina infragranulata* (Noth). Fig. 10: X 103, slide BAB 10; Fig. 11: X 155, slide BAB 4.

Age and location:

Fig. 1-9: Upper Berriasian, well Endorf.
Fig. 10-11: Upper Tithonian, well Utting.

Plate 3 Calcareous Algae

Fig. 1, 7-9: *Clypeina* sp. A, Pecorini. Fig. 1 (X 64), slide BAB 2. Fig. 7 (X 66), slide BAB 2. Fig. 9 (X 45), slide BAB 2a.

Fig. 2: *Salpingoporella sellii* (Crescenti) (X 81), slide BAB 22.

Fig. 3: *Salpingoporella katzeri* Conrad & Radoicic (X 67), slide BAB 20.

Fig. 4, 8: *Otternstella lemmensis* (Bernier) Granier (X 57), slide BAB 7 (fig. 4) and BAB 19 (fig. 8) (both X 57).

Fig. 5: *Salpingoporella annulata* (Carozzi) (X 52), slide BAB 16.

Fig. 6, 10-12: *Clypeina* aff. *parasolkani* Farinacci & Radoicic. Fig. 6: x 54, slide BAB 2; Fig. 10: X 94, slide BAB 16, Fig. 12: X 115, slide BAB 6.

Fig. 10: Characean gyrogonite (X 59), slide BAB 21.

Age and location:

Fig. 1, 4-9, 11-12: Upper Tithonian, well Utting.
Fig. 2-3, 10: Upper Berriasian, well Endorf.