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New Results on Microfacies, Biostratigraphy and Sedimentology of Late Jurassic – Early Cretaceous platform carbonates of the Northern Calcareous Alps

Part I: Tressenstein Limestone, Plassen Formation

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With 4 Text-Figures, 8 Tables and 12 Plates

Steirisches Salzkammergut
Nördliche Kalkalpen
Tressensteinkalk
Plassenkalk
Barmsteinkalk
Oberalmer Schichten
Oberjura
Unterkreide
Mikrofazies
Sedimentologie
Stratigraphie

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Content

Neue Ergebnisse zur Mikrofazies, Biostratigraphie und Sedimentologie oberjurassischer – unterkretazischer Plattformkarbonate der Nördlichen Kalkalpen Teil I: Tressensteinkalk, Plassen Formation

Zusammenfassung

In der vorliegenden Arbeit werden neue Ergebnisse zur Mikrofazies, Mikropaläontologie, Biostratigraphie und Sedimentologie spätjurassischer-frühkretazischer Plattformkarbonate der Trisselwand und des Tressenstein/Steirisches Salzkammergut vorgestellt. Die untersuchten

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Kalke der Trisselwand umfassen – von stratigraphisch älteren hin zu jüngeren Schichten – die innere Lagunenfazies ("mikritischer Plassenkalk"), die externe Plattform ("sparitischer Plassenkalk"), den proximalen und distalen Talus sowie die hemipelagischen Oberalmer Schichten in Übergangsfazies. Insgesamt repräsentiert die untersuchte Abfolge somit einen transgressiven, retrogradierenden Sedimentationszyklus, der den nachgewiesenen Zeitbereich vom Tithon bis ins frühe Valangin umfaßt. Da die basalen Abschnitte im untersuchten Profil nicht mit erfaßt sind, ist davon auszugehen, daß die mikritischen Plassenkalke bis in das obere Kimmeridge hinunterreichen. Die Jura-Kreide-Grenze liegt in den sparitischen Plassenkalken etwa am Übergang zum Talus. Der Talus wird in der vorliegenden Arbeit als Teil der Karbonatplattform in die **Plassen Formation** integriert. Mit seinem (par)autochthonen Mikrobenthos unterscheidet er sich deutlich vom brekziösen Tressensteinkalk sensu stricto der Typlokalität, der in die Oberalmer Schichten eingeschaltet ist und sich durch ein Klastengestütztes Gefüge auszeichnet. Der geringe Matrixanteil zwischen den Klasten besteht hier aus einem Calpionellen-führenden wackestone. Als Komponenten finden sich in untergeordneten Mengen eindeutiger Flachwasserdetritus des Plattformrandes insbesonders aber verschiedene Mikrofaziestypen des Talus und auch der Oberalmer Schichten in Übergangsfazies. Besonders hervorzuheben ist das Auftreten der mit Kieselschwämmen assoziierten *"Tubiphytes"–Terebella* Assoziation (SCHMID, 1996), welche anstehend auch im Profil der Trisselwand im Bereich des mittleren Talusabschnittes anzutreffen ist. Das Vorkommen verdeutlicht, daß derartige Bildungen nicht ausschließlich auf die oberjurassischen Rampen des nordtethyalen Schelfes beschränkt waren, sondern sich auch im Bereich der auf konvergente Tektonik zurückzuführenden alpinen Gleitschollen ausbilden konnte. Die Megabrekzie des Tressensteinkalk s. str. kann nicht mehr wie bisher als Vorriffbrekzie interpretiert werden, sondern ist wie der turbiditische Barmsteinkalk ein Sediment, das als Ergebnis von gravitativ induzierten Schüttungen in größeren Wassertiefen, wahrscheinlich als debris flow abgelagert wurde. Hiermit erklärt sich auch zwanglos die in der Literatur oftmals angemerkte enge räumliche Assoziierung beider Schichtglieder. Initiiert durch synsedimentäre Bewegungen (? Reliefversteilung), kam es offensichtlich zu einem partiellen Kollaps von Teilen des Talus, was schließlich zur Ablagerung des Tressensteinkalkes führte. Das gemeinsame Auftreten von *Meandrospira favrei* (CHAROLLAIS, BRÖNNIMANN & ZANINETTI) und *Neotrocholina valdensis* REICHEL in Resedimentlagen der Oberalmer Schichten in Übergangsfazies deutet auf (unteres?) Valangin hin. Hiermit ist stratigraphisch eine Verbindung zum Beginn des siliziklastisch-flyschoiden Zyklus der Rossfeld-Schichten hergestellt, der im Ober-Valangin einsetzt (WEIDICH, 1990). Das Ende des karbonatischen Plattformzyklus erfolgte durch "drowning" und fand zu einer Zeit statt (Berrias), in dem eine globale Regression stattfand (HAQ et al., 1988). Dieser Umstand und der lückenlose Nachweise einer Becken-Talus-Plattform-Abfolge verdeutlicht, daß synsedimentäre Gleittektonik der steuernde Mechanismus der Plattformentwicklung war, welcher zu einem finalen Eingleiten der Hallstätter Massive in tiefere Beckenbereiche der tirolischen Schrambach Formation führte. Die Annahme von Kippschollen mit einem nördlichen, steilen "by-pass margin" sowie einem südlichen flacher einfallenden "depositional margin" (? Rampe) könnte sowohl das Fehlen von siliziklastischem/ultrabasischem Detritus in der Plassen Formation und auch die unterschiedliche sedimentologische Ausbildung sowie das gegensätzliche Klastenspektrum von Barmsteinkalk und Tressensteinkalk erklären.

Abstract

This paper evaluates new results on microfacies, micropaleontology, biostratigraphy and sedimentology of Late Jurassic-Early Cretaceous platform carbonates of the Trisselwand and Tressenstein/Styrian Salzkammergut. The investigated limestones of the Trisselwand comprise, from stratigraphic older to younger strata, the internal lagoonal facies ("micritic Plassen Limestone"), the external platform ("sparitic Plassen Limestone"), the proximal – distal talus, and the Oberalm transitional facies. As a whole, the studied section represents a transgressive, retrograde sedimentary cycle, which comprises the Tithonian to Early Valanginian. Since the basal parts of the micritic Plassen Limestone are not present in the studied profile, it can be concluded, that these reach the Upper Kimmeridgian. The Jurassic/Cretaceous-boundary can be placed within the sparitic Plassen Limestone, approximately at the transition to the talus. The talus being part of the former carbonate platform is assigned to the **Plassen Formation**. Mainly due to its (par)autochthonous microbenthos the talus facies differs essentially from the brecciated Tressenstein Limestone sensu stricto, of the type-locality that occurs intercalated within the Oberalm Formation and is characterized by a grain-supported fabric. The sparse matrix between the clasts is a calpionellid-bearing wackestone. Typical shallow water clasts derived from the platform margin occur in minor abundance; most prominent are different microfacies types of the talus and also the Oberalm transitional facies. Most noteworthy is the occurrence of the *"Tubiphytes"–Terebella* facies (SCHMID, 1996), associated with siliceous sponges, which is autochthonous also in the middle part of the talus of the Trisselwand section. This occurrence documents, that these sediments were not only restricted to the Upper Jurassic ramps of the northern Tethyan margin, but that they also developed on the Alpine sliding blocks that evolved in a convergent regime. Thus, the megabreccia of the Tressenstein Limestone s. str. can no longer be interpreted as a fore-reef breccia. Like the turbiditic Barmstein Limestone, the Tressenstein megabreccia resulted from gravity induced sediment flows that were deposited in the deeper water environment, which explains their close association, often cited in the literature. Initiated by synsedimentary movements in combination with relief steepening, a collapse of parts of the talus led to the deposition of the Tressenstein Limestone. The finding of *Meandrospira favrei* (CHAROLLAIS, BRÖNNIMANN & ZANINETTI) together with *Neotrocholina valdensis* REICHEL in the Oberalm transitional facies indicates a (Lower?) Valanginian age, and shows that there was a stratigraphic and tectonosedimentary connection with the beginning of the siliciclastic-flyschoid cycle of the Rossfeld Formation, dated as Upper Valanginian (WEIDICH, 1990). The end of the carbonate platform cycle was caused by drowning during a time (Berriasian) when a global lowering of the sea-level occurred (HAQ et al., 1988), documenting that synsedimentary sliding tectonics was the main driving force of platform evolution, culminating with the final sliding of the Hallstatt blocks into the deeper parts of the basin of the Tyrolian Schrambach Formation. The assumption of tilted blocks with a northern steep by-pass margin and a southern more gentle dipping depositional margin (? carbonate ramp) can explain the different sedimentological features and the differences in the clast spectrum of the Barmstein Limestone and Tressenstein Limestone.

1. Introduction

In the Northern Calcareous Alps "Upper Jurassic" carbonate platform sedimentation developed on top of tectonically uplifted blocks in the Juvavicum (Hallstatt and Dachstein nappe system) that were mobilized when the southern passive continental margin of the Upper Austroalpine transformed into a convergent one (TOLLMANN, 1987; GAWLICK, 1996). The platform carbonates containing abundant reef-building organism and their debris are termed Plassen Limestone (e. g. TOLLMANN, 1976), well-known from the Austrian Salzkammergut. Generally the lower part is said to be more micritic, whereas the upper part is predominantly sparitic. The Tressenstein limestone, with the type-locality at Mount Tressenstein near Bad Aussee, is characterized by a brecciated habitus and has been interpreted as deposits of the "peri-platform talus" or a "fore-reef breccia" (FLÜGEL & FENNINGER, 1966; TOLLMANN, 1976; SCHÄFFER & STEIGER, 1986; HERRMANN, 1990). Platform derived allodapic limestones that have been transported downslope into the basin of the Oberalm Formation are represented by the Barmstein Limestones (STEIGER, 1981).

In the literature, these autochthonous and resedimented Alpine platform carbonates are generally considered as Oxfordian to Tithonian (FENNINGER & HOLZER, 1970; HOLZER, 1978; STEIGER, 1981). As regards the biostratigraphic and paleogeographic framework as well as the depositional environment, only little has been added since then (e. g. DYA, 1992) and still today there is a lack of reliable stratigraphic data. Furthermore, current knowledge on the Alpine "Upper Jurassic" carbonate platform sediments is still largely based on the above cited studies. One major objective of our studies is, therefore, to investigate the stratigraphy of the classical localities Trisselwand and Tressenstein near Altaussee/Styrian Salzkammergut. For the present study, the samples taken from the Tressenstein Limestone, near the type-locality, bring further information on the depositional setting and help define and evaluate distinguishing criteria for the Barmstein Limestone. The faunal and floral inventory treated in the systematic part, are supplemented with those of samples from the Krahstein, Styrian Salzkammergut. This locality has been investigated in detail by STEIGER & WURM (1980). The initial investigations (part I) are followed by a description of the "Lärchberg Formation" (Lerchkogel Limestone, Lofer Beds) in part II.

2. Geological setting

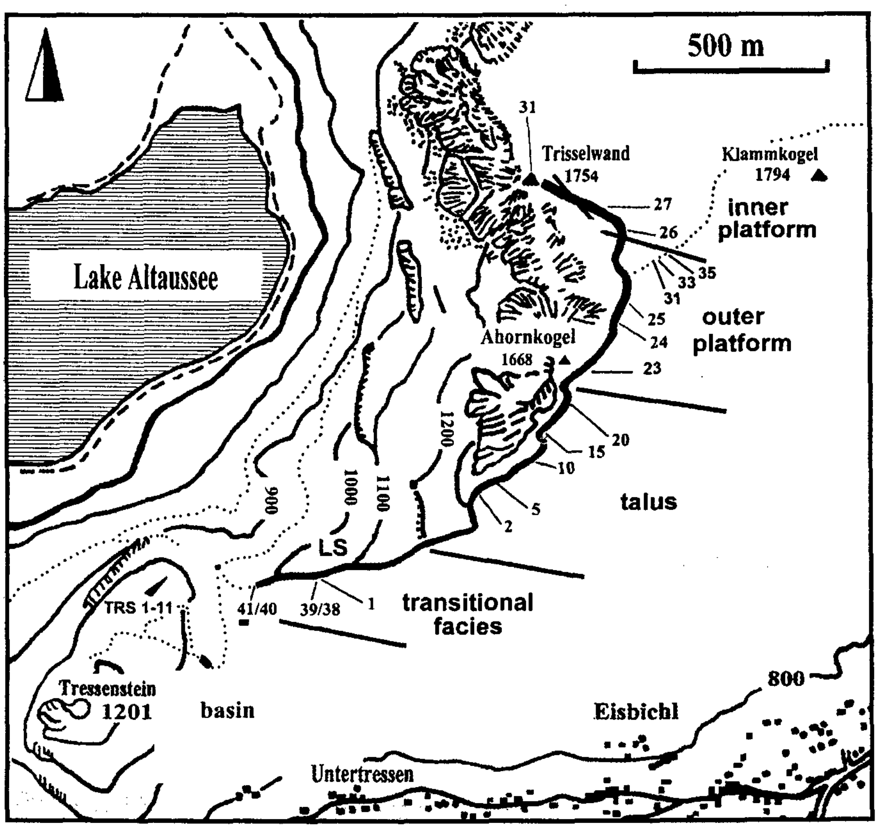
The Trisselwand (altitude 1754 m above s. l.) is part of the large karst plateau of the Tote Gebirge, situated near the Altaussee in the Styrian Salzkammergut. Tectonically, this area belongs to the Lower Juvavic Hallstatt Nappe. The Trisselwand massif is mainly build up of Late Jurassic carbonate platform deposits of the Plassen Limestone (GEYER, 1884). As far back as 1884, GEYER assigned a Tithonian age to the Plassen Limestone of the Trisselwand, based on macrofossils. He also reported *Rhynchonella alata* LAM., *Rhynchonella compressa* SOW. and *Inoceramus* sp., concluding that parts of the Plassen Limestone may belong to the Neocomian. HÖTZL (1966) distinguished a (stratigraphic) lower micritic part and an upper sparitic complex of Plassen Limestone. The micritic complex of the Trisselwand has been supposed to correspond to the interval of Kimmeridgian – Lower Tithonian (FENNINGER & HOLZER, 1972; FENNINGER, 1978). From the sparitic Plassen Limestone of the Trisselwand, FENNINGER (1978) described *Montenegrella florifera* BERNIER (Tithonian of France) and affirmed the still open question concerning the stratigraphic age of the top exposures of the carbonate succession.

The sampled and investigated limestones crop out along the footpath that starts behind the inn at Tressenstein Pass (altitude about 970 m a. s.-l.) and leads to the Ahornkogel (1686 m a. s.-l.) and further to the top of the Trisselwand (1754 m a. s.-l.). The first sample (TW 41) is from about 980 meters altitude, to be found on the topographic map of Austria, No. 96 Bad Ischl (Text-Fig. 1). According to the Geological map of Austria 1 : 50 000 sheet Bad Ischl, the Tressenstein Pass and the forested area that forms the eastern slope of Mount Tressenstein are composed of the Oberalm Formation (GEYER, 1884; HÖTZL, 1966; see text-fig. 2). Samples from the brecciated Tressenstein Limestone s. str. have been taken for thin-section preparations from an outcrop on the eastern side of the Mount Tressenstein at 1080 m above sea level (Text-Fig. 1) and from the footpath that reaches the summit.

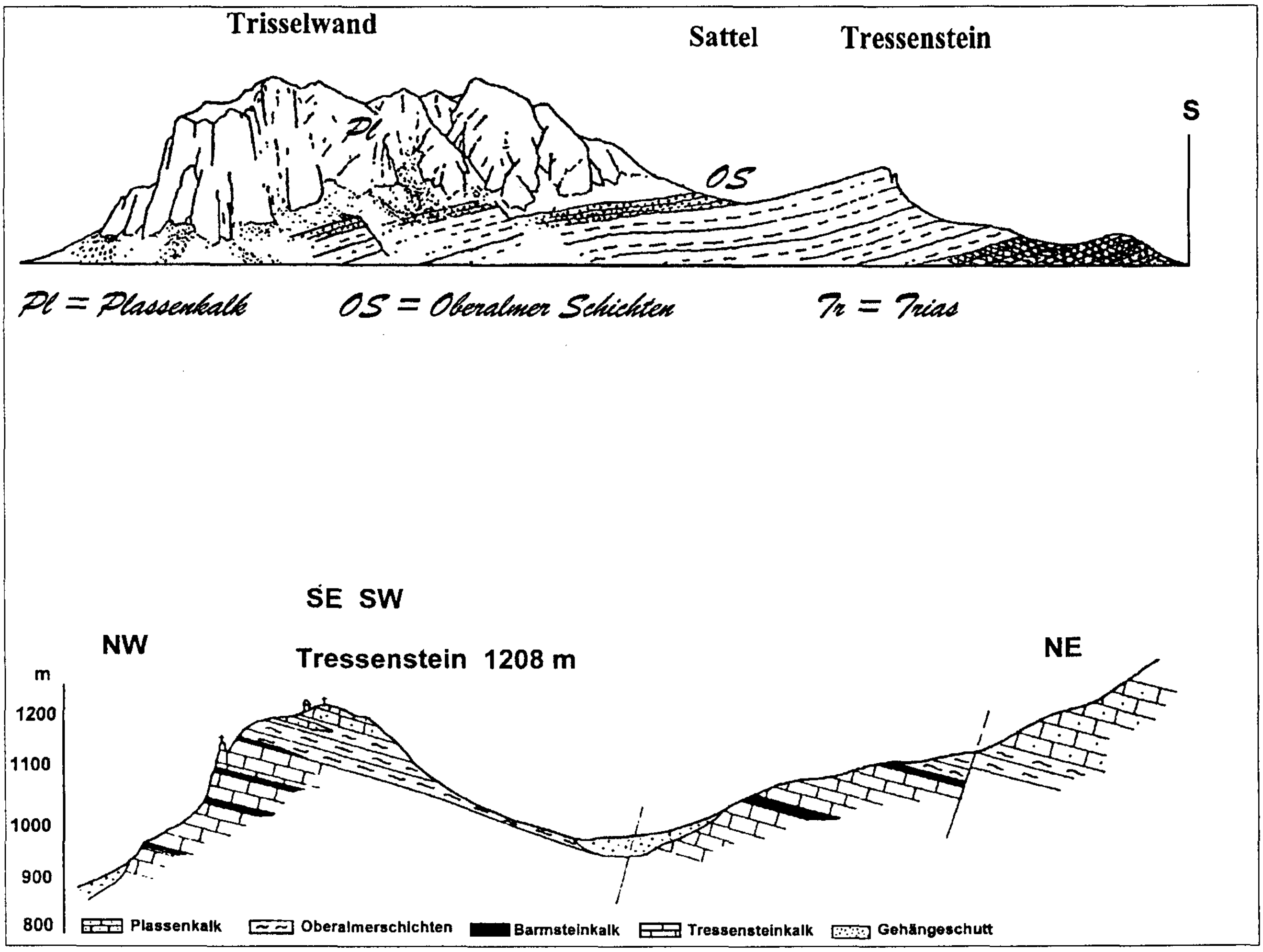
The structural sketches of GEYER (1884) and HÖTZL (1966) that show uniform NE dipping of the strata in the Tressenstein-Trisselwand area must be revised, because we discovered small scale syncline-anticline structures. Up to an altitude of about 1100 m the limestone beds strike NW–SE and dip with approximately 30° to NE. Further on dipping is flatter (about 5°SE). From 1255 m onwards, this simple layering is replaced by folds, of which the axes first strike W–E and higher than 1275 m mainly strike NNE–SSW. The limbs of these folds are steep to very steep (rarely 30°, more often 40–88°). Some 100 m west of the summit a small syncline is exposed at 1710 m. The faults indicated by Hötzl (1966) are assumed erroneous due to an incorrect approach and correlation of lithologies.

3. Microfacies and sedimentology

As will be discussed later, the microfacies and stratigraphic analysis of the section shows, that from Tressen Pass to the Trisselwand the strata get successively older: the Oberalm



Text–Fig. 1.
Location map of the studied section and samples with the distribution of the major facies zones. Note that the separation of the Oberalm Formation transitional facies and the distal talus has been tentatively drawn, since no samples were taken between TW 1 and TW 2. Also the different facies zones are unequally represented by numbers of samples, which have been taken to get a first overview. The middle/upper talus, for example, is much better represented than the outer platform and respectively the platform margin and the distal talus. LS = Loitzlschlucht.



Text–Fig. 2.
Geological and tectonical situation of the Trisselwand after Geyer (1884) (above) and Hötzl (1966) (below).

transitional facies are followed by the platform talus deposits, the external and finally internal platform. Thus, lagoonal wackestones are overlain by outer platform limestones, which in turn are superimposed by proximal and finally distal slope deposits, documenting a retrograde (transgressive) carbonate platform cycle. The micropaleontological characterization of the different facies zones of the Trisselwand section and the biostratigraphic framework are summarized in table 1. The description of the facies follows the sample-order, from the Tressenstein limestone, of the type-locality, and further to the Trisselwand. The Oberalm Formation has not been investigated and is therefore not treated.

3.1 Tressenstein Limestone sensu stricto

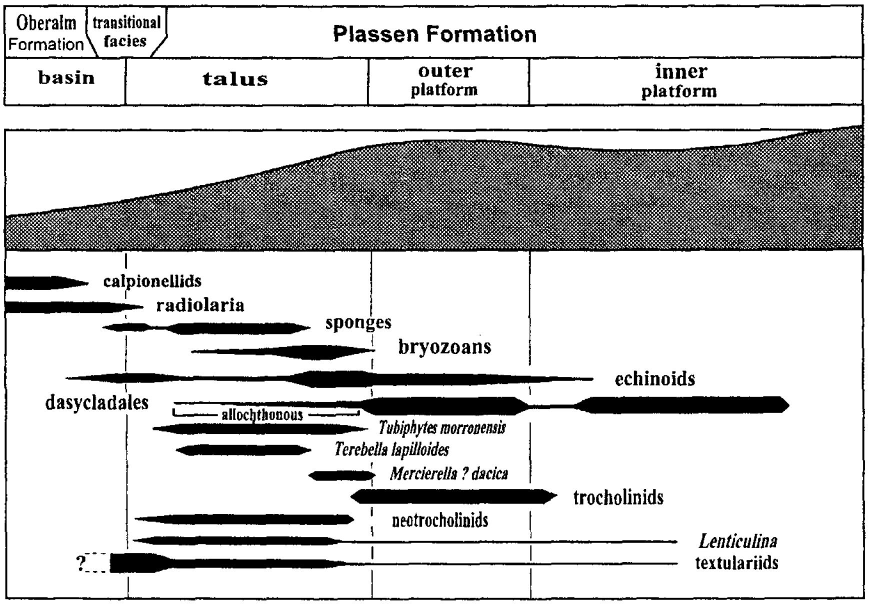
(Pl. 1, Figs. 1–2, 4–5)

Our samples typically contain macroscopic corals/hydrozoans and lithoclasts, typical of the proximal-distal talus and the platform margin. Hötzl (1966: p. 306) mentioned lithoclasts of pelmicrites, occurring as components within the Tressenstein limestone. We believe that these pelmicrites originated from the transitional facies of the Oberalm Formation or more likely from the distal talus of the Trisselwand section (e.g. pl. 2, fig. 1). It is important to stress that we did not find micritic Plassen Limestone of the internal lagoon. The clasts usually exhibit a fitted fabric and therefore the matrix is very reduced (Pl. 1, fig. 1). The matrix surrounding the above mentioned clasts is biomicrite (wackestone) with calpionellids, as pelagic elements, and some remains of echinoids. Most of the corals and hydrozoans occur as individual components embedded within the micritic matrix. The calpionellids can be observed within the interstitial space (Pl. 1, fig. 2, 4). The occurrence of *Crassicolaria* cf. *intermedia* (Duran Delga) together with findings of Perisphinctidae (det. Dr. Schairer, Munich) accounts for a Tithonian age of our samples TRS 1-11 (Text-Fig. 1). Quite surprising is the total absence, **within the sparse matrix**, of shallow water foraminifers like *Mohlerina,* protopeneroplids, trocholinids and dasycladales like *Salpingoporella pygmaea* (Guembel). Due to their abundance in the peri-reefal sparitic Plassen Limestone, these could be expected in fore-reef breccias. Calcareous algae and shallow water benthic foraminiferids have been observed only rarely **within the clasts**. The most remarkable clasts are composed of the remains of siliceous sponges, *Tubiphytes morronensis* Crescenti and the agglutinated polychaete *Terebella lapilloides* Münster, occurring in a tuberolithic, peloidal packstone facies (Pl. 1, fig. 5). As will be discussed in chapter 3.3, these clasts were derived from the middle part of the talus. The clast spectrum also yields packstones with silicified matrix and abundant echinoid debris. These can be assigned to the Oberalm transitional facies (see chapter 3.2).

The original definition of the terminus Tressenstein Limestone introduced by Mojsisovics (1905) encompassed

Table 1.
Micropaleontological characterization and the biostratigraphic framework of the Trisselwand section. Note that the continuous stratigraphic sequence ranges from samples TW 41 to TW 27 (see also text-fig. 1).

Stratigraphy	Tithonian											Berriasian																					Va.					
inner platform		o	o	o	o	o																																Facies zone
outer platform	o						o	o	o	o	o																											
proximal to middle talus												o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o										
distal talus																													o	o	o	o						
transitional facies																																	o	o	o	o	o	
Acicularia sp.							o	o	o											o		o	o													o		Calcareous Algae
Halimedoidea indet.									o	o																												
Clypeina jurassica					o	o				o																												
Clypeina parasolkani							o				o																											
Clypeina sp. A PECORINI					o																																	
Cylindroporella arabica						o																																
Dissocladella cf. *intercedens*										o																												
Epimastoporella jurassica	o			o						o	o									o	o	o																
Linoporella gigantea	o												o																									
Linoporella ? sp.						o													o																	o		
Linoporella cf. *kapelensis*											o																											
Neoteutloporella socialis											o																											
Petrascula bursiformis										o																												
Rivulariaceae	o			o	o		o			o	o																				o							
Salpingoporella sellii					o																																	
Salpingoporella pygmaea	o			o			o			o	o		o		o			o	o	o	o	o	o		o				o							o		
Thaumatoporella parvovesic.	o			o	o		o			o			o						o	o	o				o	o		o	o	o		o	o			o	o	
Anchispirocyclina lusitanica		o	o					o		o																												Foraminifera
Charentia cuvillieri							o	o					o															o	o				o					
Coscinophragma cribrosum																			o									o	o			o				o		
Hedbergella ? sp.																			o																	o		
Lenticulina sp.			o					o												o		o	o			o					o	o		o	o			
Meandrospira favrei																																	o	o		o	o	
Mohlerina basiliensis	o	o	o	o				o	o	o	o		o	o									o		o			o			o	o	o			o		
Neotrocholina valdensis																																	o					
Neotrocholina infragranulata												o	o			o	o		o		o											o		o	o			
Ophthalmidium sp.																										o												
Protopeneroplis aff. banatica																																o				o	o	
Protopeneroplis striata					o																																	
Protopeneroplis ultragranulata				o			o	o				o				o	o	o	o	o			o	o	o							o	o			o		
Pseudocyclammina lituus					o																																	
Trocholina alpina	o			o			o		o	o	o								o																			
Trocholina odukpaniensis	o															o			o				o										o					
Troglotella incrustans	o						o												o	o	o			o	o			o	o			o				o		
Spirillina sp.					o								o			o		o		o				o									o					
Didemnoides moreti				o								o	o	o		o	o	o	o	o				o	o	o		o	o		o	o	o			o		Microproblematica
Koskinobullina socialis															o				o	o	o											o		o				
Crust problematicum										o		o				o		o	o																	o		
Lithocodium / Bacinella	o	o		o			o		o	o									o			o			o			o	o	o	o	o				o		
Radiomura cautica														o																								
Mercierella? dacica													o	o	o		o	o		o	o											o						
Terebella lapilloides													o	o	o	o	o	o	o	o	o	o		o									o					
Tubiphytes morronensis													o	o	o	o	o	o	o	o	o	o	o	o				o	o		o	o	o	o		o		
bryozoa											o	o	o	o	o	o	o		o	o	o	o	o	o							o	o		o	o			Others
calcisphaerulidae				o							o	o			o	o	o	o	o	o		o		o	o	o		o	o	o	o	o	o	o	o	o		
echinoids (> 5 %)	o	o	o					o				o	o			o	o		o	o	o	o	o	o				o		o	o		o	o	o	o	o	
gastropods										o	o					o	o		o																			
corals / hydrozoa	o						o	o	o	o		o		o	o			o	o		o		o	o		o		o			o	o				o		
Neuropora lusitanica												o		o							o	o								o								
radiolaria																																o		o	o		o	
sponges													o	o	o	o	o	o		o		o		o					o			o					o	
Sample	31	30	29	28	27	26	35	33	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	38	39	40	41	



Text–Fig. 3.
Carbonate platform facies distribution of major biogenic groups and selected microfossils.

both, the locality of Mount Tressenstein, where they were said to be typically developed (p. 43: "...auf dem Tressenstein südlich vom Alt-Ausee'r See typisch entwickelt") and the limestones underlying the Plassen Limestone of the Trisselwand. But, as will be shown, both are totally different as regards lithology, sedimentology, microfacies and depositional setting. As concerns the genetic origin, the brecciated Tressenstein Limestone s. str. was first considered as a near-shore deposit, with the clast debris believed to have resulted from emerged areas (HÖTZL, 1966). By means of grain-size analysis and reference to the well-known diagram of HJULSTRÖM, a well-agitated environment was concluded by the latter author. As will be discussed later the paleo-relief in connection with probable synsedimentary tectonism was the driving force for transportation and not the water energy index. The interpretation of the genesis of the Tressenstein Limestone changed in the seventies to a shallow water setting on the adjacent flanks of reefs (fore reef breccia) (e. g. TOLLMANN, 1976: p. 361), which is still generally accepted. The circumstance that fore-reef breccias of the Tressenstein Limestone s. str. are said to directly follow allodapic Barmstein Limestones, which were deposited in the basin, and vice versa (HÖTZL, 1966) has never been satisfactorily been explained in the literature. Additionally, as already stated above, the rich microfauna (e. g. trocholinids) and microflora (e. g. salpingoporellids) of the sparitic peri-reefal Plassen Limestone contrasts strikingly to the impoverished microbenthos and the lack of shallow water elements in the matrix of the Tressenstein Limestone s. str., contradicting a fore-reef position of the latter. Quite the contrary, especially the clasts derived from middle to deeper parts of the autochthonous talus, notably, for example, the *Tubiphytes-Terebella* facies that originated from the middle part of the talus (see chapter 3), demonstrate that the depositional setting of the Tressenstein Limestone s.str. must have been in a much deeper position than the depth of normal fore-reef deposits. The main argument for a deeper water setting is, however, the calpionellid-bearing matrix. The results of the microfacies analysis show that the brecciated Tressenstein Limestone does not correspond to infralittoral fore-reef breccias, but was deposited in the deeper water environment of the Oberalm Formation. With respect to the type-locality, the lateral association of the Tressenstein Limestone to the Oberalm Formation has already been recognized by MOISISOVICS (1905: p. 43 "...stellen eine durch mannigfache Übergänge vorhandene Fazies der Oberalmer Schichten dar".) In as much as the Tressenstein Limestone at its type-locality represents resediments that have been deposited in the basin, then the limestones that have been described in different parts of the Salzkammergut, which are laterally associated with the Plassen Limestone, belong to the talus facies as described in the present paper (see chapter 3.3). According to HÖTZL (1966) and also to the Geological map of Austria, the top of the Mount Tressenstein is supposed to be build up of micritic Plassen Limestone, reported as micrites to pelmicrites (without reference to faunal or flora content) which should occur together with intercalations of Barmstein Limestone. Pelmicrites, however, are a characteristic facies of the distal talus (see chapter 3.3).

Plate 1

Microfacies of the Tressenstein Limestone and the Oberalm transitional facies

Fig. 1.
Polished slab of the brecciated Tressenstein Limestone (type-locality). Sample TRS 1 (x 1).

Fig. 2.
Resedimented hydrozoan skeleton within the Tressenstein Limestone. Sample TRS 11 (x 19).

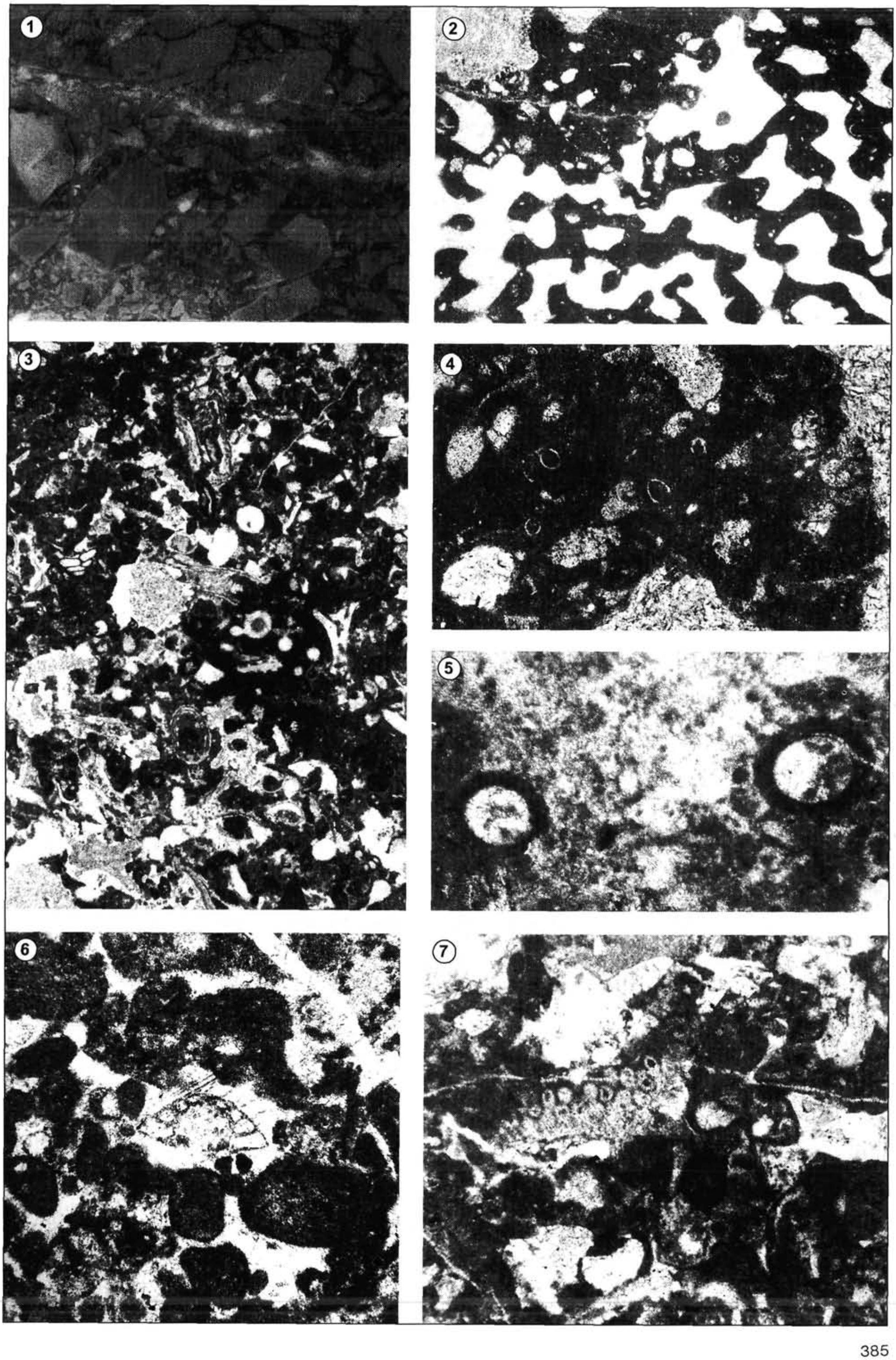
Fig. 3.
Packstone with debris of echinoids, sponge spicules, radiolaria, calcisphaerulidae and textulariid foraminifera; Oberalm transitional facies. Sample TW 38 (x 28).

Fig. 4.
Detail of fig. 2 showing the calpionellid-bearing matrix between interseptal space of hydrozoan, Tressenstein Limestone. Sample TRS 11 a (x 74).

Fig. 5.
Peloidal packstone/wackestone with transverse sections of ***Terebella lapilloides*** MÜNSTER; Tressenstein Limestone. Sample TRS 4 b (x 72).

Fig. 6.
Packstone with ***Neotrocholina valdensis*** REICHEL. Note the syntaxial overgrowth of the test; Oberalm transitional facies, resediment layer. Sample TW 2 (x 54).

Fig. 7.
Packstone with fragment of ***Thaumatoporella parvovesiculifera*** (RAINERI); Oberalm transitional facies. Sample TW 41 (x 80).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Thus, we doubt the existence of Plassen Formation at the type-locality of the Tressenstein Limestone, especially because fine brecciated limestones have been found by us at the top of Mount Tressenstein.

According to FENNINGER & HOLZER (1970: p. 65), the distinction of Tressenstein Limestone and Barmstein Limestone is neither microfacially nor stratigraphically justified. Thus, with respect to the type-locality of the Barmstein Limestone, FENNINGER & HOLZER (1970: p. 65) spoke of "Tressen Limestones of the Barmstein". Two years later FENNINGER (1972) stated that, from a megascopic point of view, except for the intercalation in pelagic sediments and the internal grading of the Barmstein Limestone, both cannot be distinguished. However, in thin-sections the Tressenstein Limestone is said to represent a coarse-grained monomict breccia, whereas the Barmstein Limestones are polymict containing components of different sedimentary environments of the Oberalm Formation, such as radiolarite, biomicrites and saccocoma limestones. Clasts of basement origin also occur, for example, Jurassic filament limestones derived from the Klaus Formation and even Triassic lithologies like Dachstein Limestone (op. cit. p. 21; STEIGER, 1981). Other authors also reported clasts from the Triassic basement, such as, sandstones (Werfen Formation), black limestones (Gutenstein Limestone) and clay pebbles (? Haselgebirge) in the Tressenstein Limestone (MANDL, 1982: p. 71). The most outstanding and typical clasts were derived from the inner platform facies, such as, wackestones with *Anchispirocyclina lusitanica* (EGGER) and dasycladales in the Barmstein Limestone (STEIGER, 1981). A new clast variety of the Tressenstein Limestone, so far not described from the Barmstein Limestone, is of the *Tubiphytes-Terebella* facies. An important sedimentological feature of the Barmstein Limestone is furthermore the occurrence of disperse silification (STEIGER, 1981; MIŠÍK & SÝKORA, 1982), a phenomenon not reported from the Tressenstein Limestone.

The features of both, the Barmstein Limestone and Tressenstein Limestone s. str., indicate that they resulted from gravity-induced processes (gravity flow deposits sensu MIDDLETON & HAMPTON, 1976). For the Barmstein Limestone a turbidity current model, namely of allodapic limestones, has been worked out in detail by STEIGER (1981). Following the model of submarine gravity flow deposits, the genesis of the Tressenstein Limestone s.str. can be attributed to a debris flow mechanism (e. g. MIDDLETON & HAMILTON, 1976) initiated by synsedimentary tectonics and/or an oversteepening of the platform slope transition. A causal link with salt diapirism ("Haselgebirge") beneath the platforms has been discussed by STEIGER (1981) for the formation of the Barmstein Limestone. In the Salt Mines of Bad Ischl, "Tressenstein Limestone" has been found in direct contact with the "Haselgebirge" (G. SCHÄFFER pers. comm. in MANDL, 1982: p. 71). Both, Tressenstein Limestone and Barmstein Limestone apparently document the break-up and drowning of the platform as has been well reconstructed in the scheme of HERRMANN (1990).

In summary, the original definition of the Tressenstein Limestone is inadequate because it encompasses two different lithologies of two distinct depositional settings (polymict breccia at the type-locality versus platform talus limestones "below" the Plassen Limestone Formation of the Trisselwand). It is important to stress, that the latter does contain individual resediment layers but no polymict breccias. These differences have not been recognized previously. A reinvestigation of the brecciated successions of Mount Tressenstein is strongly needed, with special attention on stratigraphic considerations, vertical changes in the clast spectrum and size. A coarsening upward trend could reflect a shifting towards a more proximal position whereas a fining upward sequence might be interpreted by a removal of the topography. These investigations are being presently undertaken by the authors.

3.2 Oberalm transitional facies

(Pl. 1, Fig. 3, 6–7)

The "Oberalm Formation of transitional facies" (FENNINGER & HOLZER, 1970: Oberalmer Schichten in Übergangsfazies) or "varied coloured Oberalm Formation" (PLÖCHINGER, 1964: wechselfarbige Oberalmer Schichten) marks the transition from the distal talus of the Plassen Formation to the basinal facies of the Oberalm Formation. They have been sampled upwards from the Inn to the Tressen Pass at an altitude of about 980 m. Note that the separation of the Oberalm transitional facies and the distal talus in text-figure 1 has been tentatively drawn, since no samples were taken between samples TW 1 and TW 2. According to FENNINGER & HOLZER (1972: p. 79) the transitional facies occur in areas where the Oberalm Formation is overlain by Plassen Limestone or "Tressenstein Limestone" marking the transition to the shallow water limestones. In this connection it is also important to remark on a profile mentioned by HÖTZL (1966: p. 283/284) showing an alternation of "Barmstein Limestone" and "Tressenstein Limestone". This 60 m profile starts at about 1077 meters in the socalled "Loitzlschlucht" (see Fig. 1). A study of thin-section material, kindly lent by Dr. BOOROVA (Bratislava), shows that the succession belongs to the Oberalm transitional facies and the differences in grain-size are solely due to individual resediment layers containing shallow water elements of the outer platform realm that were either finer or coarser grained. The resediments of the Oberalm transitional facies are clearly recognized by their faunal and flora contents (see table 1).

Our samples of the Oberalm transitional facies are characterized by packstones, rarely wackestones, with echinoderm remains, sponge spicules, radiolaria and occasionally debris of *Thaumatoporella parvovesiculifera* (RAINERI) (Pl. 1, Fig. 3, 7). Benthic foraminifera encountered are textulariids, some miliolids, *Lenticulina* sp., and occasionally *Meandrospira favrei* (CHAROLLAIS, BRÖNNIMANN & ZANINETTI) (Pl. 4, Fig. 8) and *Neotrocholina valdensis* REICHEL (Pl. 1, Fig. 6). As can be seen in table 1, there are intercalations of resedimented components (e. g. sample TW 40) containing shallow water elements such as the dasyclad *Salpingoporella pygmaea* (GUEMBEL). Partial silification can often be observed, apparently resulting from the diagenesis of siliceous sponges and/or radiolaria. The uppermost units of the Barmstein Limestones and the Oberalm transitional facies can hardly be distinguished from in thin-sections since these formations both can display silification phenomena. Distinguishing criteria can be the field situation, namely clasts of inner platform facies, graded bedding, and other sedimentological features (STEIGER, 1981). The abundance of sponge spicules and echinoid remains in the Oberalm transitional facies is interpreted to reflect the accumulation of these components as a result of size-sorting related to the decreasing slope energy in the talus basin transition.

3.3 Plassen Formation

Samples taken between the elevations of approximately 1200 m to about 1500 m belong to the autochthonous platform talus, comprising the depositional area that extends upwards from the hemipelagic facies of the Oberalm transitional facies to the platform margin, grading into the "sparitic Plassen Limestone". The microfacies of the talus facies is totally different from the resedimented brecciated Tressenstein Limestone of the type-locality. It should be stressed here, that the talus facies should neither be included under the name "Tressenstein Limestone" nor "Plassen Limestone". Until now, these limestones respectively only referred to the micritic lagoonal facies and the predominantly biosparitic outer platform with patch-reefs (TOLLMANN, 1976: p. 363 ff.). In the models of Lower Cretaceous "Urgonien" carbonate platforms of S-France (e. g. ARNAUD-VANNEAU, 1980), the outer platform and the talus are defined as the external facies of the platform. In analogy, it is reasonable to include the autochthonous talus facies, being part of the former carbonate platform, in a "Plassen Formation" comprising:

- basal transgressive clastics (breccias, conglomerates)
- internal platform (= micritic Plassen Limestone or "Plassenkalke der Schlamm-Fazies" sensu FENNINGER & HOLZER, 1970)
- external platform (= sparitic Plassen Limestone or "Plassenkalk-Riff-Fazies" sensu FENNINGER, 1966 and FENNINGER & HOLZER, 1970)
- platform talus

In a former, preliminary report (SCHLAGINTWEIT & EBLI, 1998), we introduced the name Plassen Limestone Formation. This lithologic restriction, however, is now eliminated since basal clastics (conglomerates, breccias) should also be included. It should be mentioned, that TOLLMANN (1987: p. 115) distinguished a Plassen formation (reef limestone) and a Tressenstein formation (reef-talus material). The total stratigraphic range of the Plassen Formation investigated so far is Upper Kimmeridgian – Berriasian (see chapter 5).

Platform talus

(Pl. 2, Figs. 1–7)

The **distal talus** is represented by the samples TW 2-5 (table 1), showing peloidal wackestones/packstones as prevailing microfacies (Pl. 2, Fig. 1). Within the muddy background sedimentation with cadosinids, corroded tests of *Protopeneroplis* aff. *banatica* BUCUR and fine debris of *Thaumatoporella parvovesiculifera* RAINERI can be found (Pl. 2, Fig. 1–2). This microfacies also contains *Neotrocholina infragranulata* (NOTH) (Pl. 2, Fig. 3). In contrast to the Oberalm transitional facies our samples from the distal talus are devoid of sponge spicules and debris of echinodermata. The **middle part of the talus** is characterized by the already mentioned siliceous sponge facies of peloidal microstructure with *Tubiphytes morronensis* CRESCENTI and *Terebella lapilloides* MÜNSTER, often displaying larger solution cavities filled with sparite (Pl. 2, Fig. 4, 6). Besides sporadic small benthic foraminifera and rare sclerites of holothurids, no other microbiota have been observed in this microfacies. The *Terebella-"Tubiphytes"* association thrived in a deeper, low-energy environment and could also tolerate dysaerobic conditions (LEINFELDER et al., 1993; SCHMID, 1996). This characteristic facies, until now not reported from the Alpine Upper Jurassic/Lower Cretaceous, is known from the siliceous sponge facies that is widely reported from the northern shelf of the Western Tethys. It extends from Romania through Southern Germany and southeastern Spain to Portugal (BRACHERT, 1986; NOSE, 1995; LEINFELDER et al., 1993; SCHMID, 1996). In contrast to the occurrences in Portugal and Southern Germany, the Alpine siliceous sponge facies developed in a convergent regime and is of Berriasian age (Tab. 1). According to LEINFELDER et al. (1993: p. 240), the "siliceous sponge facies commonly occurs in beds deposited during periods of regionally lowered sedimentation rates ... which can be interpreted as condensed levels or transgressive system tracts in a sequence stratigraphic context". As will be discussed later, the Plassen Formation represents a retrograde, transgressive carbonate sedimentary cycle. One should note, however, that verified sponge-build-ups such as those recorded from the Franconian Alb of Bavaria (e. g. BRACHERT, 1986) have not been observed, but there are equivalent types of microfacies and microbiota. There is also a microfacies type that is dominated solely by *Tubiphytes morronensis* CRESCENTI, which can be assigned to the middle/upper talus (Pl. 2, Fig. 5). A typical microfacies of the **proximal** talus are grainstones with a bryozoan-echinoid (? crinoid)-*Tubiphytes* association, abundant resedimented bioclasts of dasycladales (e. g. *Salpingoporella pygmaea*), foraminifera (e. g. *Trocholina alpina*), and corals/hydrozoans from the outer platform (Pl. 2, Fig. 7). Here, *Terebella lapilloides* MÜNSTER is rare. Typical benthic foraminifera of the proximal talus include small miliolids, *Protopeneroplis ultragranulata* (GORBATCHIK), *Mohlerina basiliensis* (MOHLER), *Charentia cuvillieri* NEUMANN, and trocholinids, assumed to be parautochthonous. The autochthonous microbenthos consists of *Spirillina* sp., *Ammodiscus* sp., *Rheophax* sp., and small ophthalmiids, and further downslope of *Lenticulina* sp., textulariids, and neotrocholinids. Note that the mentioned microfauna is comparable to that of the talus facies ("étage circalittoral") reported by ARNAUD-VANNEAU (1980) from the Urgonien of southern France. Calcisphaerulidae indet. are also typical microfossils, but they are more abundant in the middle and lower talus. Characteristic microproblematica are: serpulid *Mercierella? dacica* DRAGASTAN and colonies of *Koskinobullina socialis* CHERCHI & SCHROEDER; the latter encrusted fragments of reef-builders. In summary, the platform talus contains a typical mixed faunal-floral association especially in the proximal parts of the talus. Bathymetrically downwards, resedimented shallow water elements become successively reduced and are most often restricted to individual resedimented beds. Unlike the platform talus facies, many of the above mentioned taxa have been recorded also from the Barmstein Limestone which, however, are found here within transported clasts and not within the normal sediment.

Some indications of water depth can be estimated with the occurrence of *Tubiphytes morronensis* CRESCENTI, that in the literature has typically been reported from the reef and fore-reef area of the platform margin down to depths of 100 m (LEINFELDER et al., 1993; SCHMID, 1995). With respect to the thalli of dasycladales in the talus facies, we assume that these are allochthonous. The dasycladales are generally restricted to infralittoral environments, that are considered to range down to a depth of 20 m, the boundary of the infralittoral-circalittoral (MASSE, 1988). According to the latter author, the transition from the neritic to the bathyal domain begins at a depth of about 120 m to 300 m. We believe that this "boundary" is marked approximately by the Oberalm transitional facies. In this connection, the occurrence of *Terebella lapilloides* in the middle part of the talus seems to fit well to the depth interval of 100 to 200 m, where the related recent genus *Terebellides* thrives in the Black Sea (BACESCO, 1963).

Let us point out that Mount Tressenstein is separated from the Trisselwand massif by the Oberalm Formation, which underlies the forested area of the eastern slope and the depression of the Tressen Pass. This morphological situation has not been interpreted sedimentologically, but tectonically by HÖTZL, (1967; Fig. 1), which in our opinion was due to his incorrect approach of the facies zones. In the section drawn by GEYER (1884: page 352), undisturbed bedding of the Oberalm Formation ("Hornsteinkalke des Loser") is shown, and he concludes that the top parts of the Tressenstein Limestone may be laterally associated with the Oberalm Formation (GEYER, 1884: p. 353, "heteropisch vertreten"). Thus, if we exclude larger vertical tectonics between the Tressenstein and the Trisselwand massif and assume more or less undisturbed layering, the difference in present-day altitude between the platform margin (about 1670 m) and the Tressenstein (about 1200 m) is about 470 meters and could correspond to the original depositional depth of the Tressenstein Limestone. For the Barmstein Limestones in the Berchtesgaden area, BRAUN (1993) concludes a depositional depth of about 2000 m. This assumption is based on an approximation of about 2000 m for the thickness of the sliding blocks and the fact that shallow water limestones on the blocks (e. g. Mount Untersberg) as well as adjacent basin deposits are preserved.

Outer platform

(Pl. 3, Figs. 1–4)

The outer platform facies is represented in our material by biointrasparites (grainstones/rudstones) that display a huge interparticle porosity. The micritized skeletal grains usually consist of small gastropod (e. g. nerineids) and corals (Pl. 3, Fig. 2). The non-skeletal particles are intraclasts. Algae are represented by the large dasyclads *Dissocladella* cf. *intercedens* BAKALOVA (e. g. Pl. 9, Fig. 5), *Linoporella gigantea* (CAROZZI) FARINACCI & RADOICIC (Pl. 9, Fig. 9), *Neoteutloporella socialis* (PRATURLON) (e. g. Pl. 10, Fig. 5), the most typical *Salpingoporella pygmaea* (GUEMBEL) (e. g. Pl. 8, Fig. 5), and other salpingoporellas. The latter are generally found within facies near coral constructions (BERNIER, 1984), which is in good accordance to our observations. Typical foraminiferids comprise *Mohlerina basiliensis* (MOHLER), trocholinids, with the most typical being *Trocholina alpina* (LEUPOLD), *Coscinophragma cribrosum* (REUSS), and larger lituolids. From external facies of the Krahstein we also observed the dasyclads *Epimastoporella jurassica* (ENDO) (Pl. 3, Fig. 3), *Epimastoporella* sp. (Pl. 11, Fig. 7), *Petrascula bursiformis* ETTALON (Pl. 9, Fig. 1), *Salpingoporella* ex. gr. *enayi – tosaensis* (Pl. 8, Fig. 1), *Linoporella* ? sp., and the much more abundant *Thaumatoporella parvovesiculifera* RAINERI, and *Pseudolithocodium carpathicum* MIŠÍK (Pl. 10, Fig. 3). A typical reef facies with corals is well developed at the Krahstein (Pl. 3, Fig. 1), but has not been observed so far in our samples from the Trisselwand sequence. Floatstones are assumed to have been deposited in sheltered areas between patch reefs (Pl. 3, Fig. 3).

Internal platform

(Pl. 3, Figs. 5–6)

The inner platform corresponds to an exterior open lagoon and inner quiet water lagoon. Micritic lagoonal facies is widely distributed within the central parts of the Tote Gebirge (FENNINGER & HOLZER 1970: p. 95, pl. 15, fig. 4) and is represented in our samples by wackestones with *Anchispirocyclina lusitanica* (EGGER). The dasyclad assemblage is clearly dominated by *Clypeina jurassica* FAVRE. Further important taxa are *Cylindroporella* cf. *arabica* ELLIOTT (Pl. 11, Fig. 1) and *Clypeina* sp. A PECORINI (Pl. 11, Fig. 5). These wackestones typically lack encrusting taxa. The occasionally observed small fragments of Thaumatoporellaceans are assumed to be allochthonous, having been swept into the lagoon from the outer platform. *Clypeina* wackestones have been depicted by FENNINGER & HOLZER (1970: Pl. 15, Fig. 4), from the Plassen Formation of the Totes Gebirge. The exterior parts of the open lagoon are marked by oolitic-peloidal grainstones with a typical bimodal grain-size distribution, containing some rounded tests of *Anchispirocyclina lusitanica* (EGGER) (Pl. 3, Fig. 5). Following our scheme of facies successions, the older parts of the inner platform can be expected along the path to the Klammkogel (Fig. 1), a subject of future investigations. Samples that have been taken about 200 m after the crossing of the path to the Klammkogel show the transition from the inner to the outer platform. They disclose a mixture of external elements, such as *Protopeneroplis ultragranulata* (GORBATCHIK) and internal taxa such as *Anchispirocyclina lusitanica* (EGGER). From a stratigraphic point of view it can thus be followed, that the inner platform facies may reach into the Middle (? Upper) Tithonian (see text-fig. 4).

Plate 2

Microfacies of the Plassen Formation, distal and middle talus

Fig. 1.
Peloidal wackestone with calcisphaerulidae, debris of ***Thaumatoporella parvovesiculifera*** RAINERI (a) and a test of ***Protopeneroplis*** aff. ***banatica*** BUCUR (b), distal talus facies. Sample TW 2/2 (x 50).

Fig. 2.
Protopeneroplis aff. ***banatica*** BUCUR; distal talus facies. Sample TW 41 (x 61).

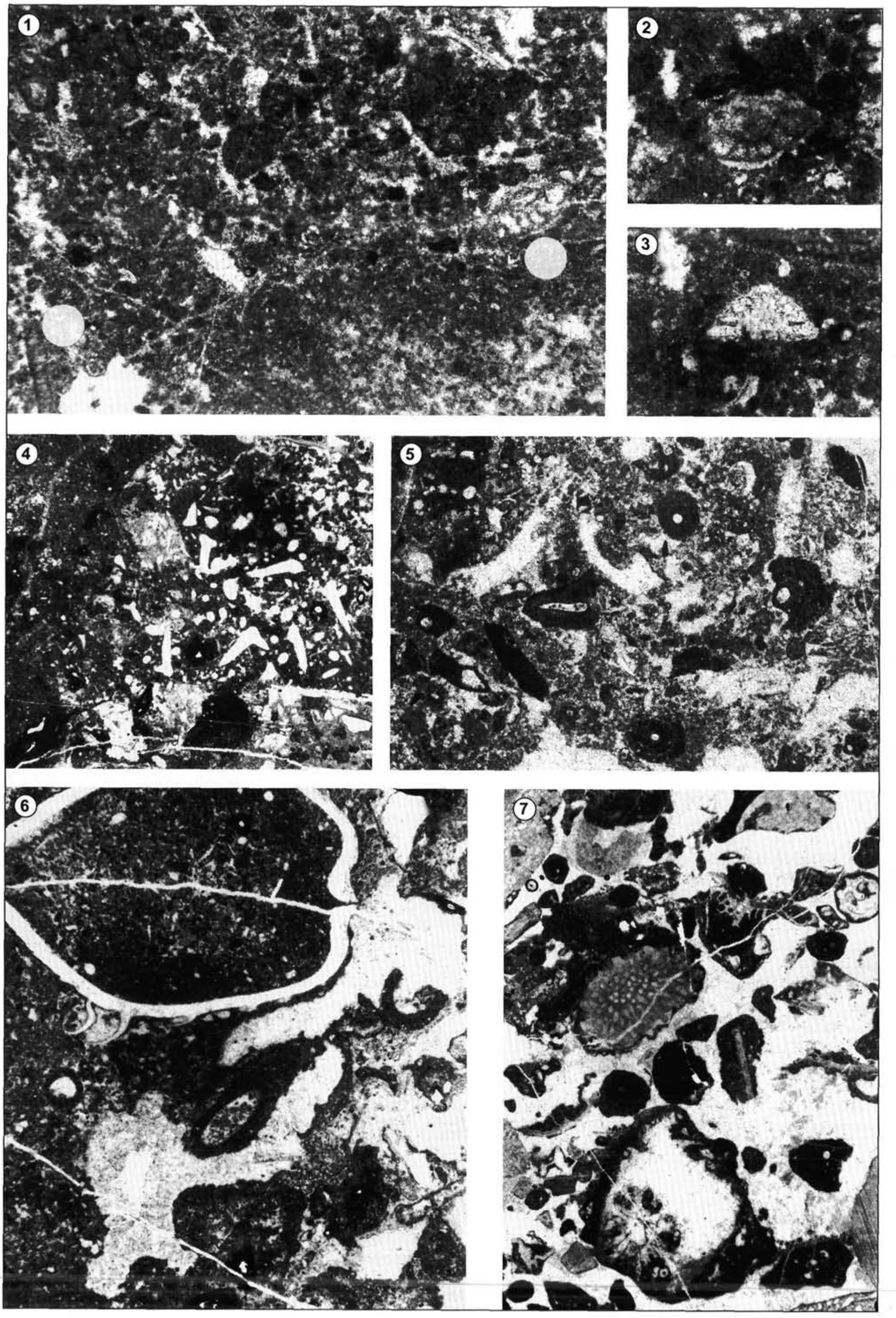
Fig. 3.
Neotrocholina infragranulata (NOTH); distal talus facies. Sample TW 2/2 (x 66).

Fig. 4.
Siliceous sponge facies with ***Tubiphytes morronensis*** CRESCENTI, middle talus facies. Sample Kra 109 (x 12).

Fig. 5.
Talus facies with abundant ***T. morronensis*** CRESCENTI, middle talus facies. Sample Kra 119 b (x 20).

Fig. 6.
Tubiphytes-Terebella facies with pelecypod shell in the upper part. Note the large porosity. Middle talus facies. Sample TW 26 (x 12).

Fig. 7.
Upper talus facies with bryozoa, *Tubiphytes,* echinoids and coral debris. Sample TW 13 (x 11).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4. Micropaleontology

Regardless of their supra-generic classification, calcareous algae, benthic foraminifera, microproblematica and other groups are treated in alphabetic order. In order to present the overall microspectrum we have also included samples from the Plassen Formation of the Krahstein/Salzkammergut (STEIGER & WURM, 1980). They belong to the outer platform facies and contain some taxa that we either have not observed in our samples or ones not so well preserved in small debris. Some of them are included in the flora list of FENNINGER (1978).

4.1 Calcareous algae

Genus ***Acicularia*** ARCHIAC, 1843

Acicularia sp.

(Pl. 11, Figs. 3–4, 6)

Remarks: Elongated spicules (ratio width/length: 0.18–0.22) with up to 22–24 sporangial capsules, measuring about 0.06 mm in diameter. Length (complete specimens): 0.64–0.78 mm, width: about 0.14 mm. Our sections are identical to the specimen figured as *Acicularia elongata* CAROZZI by SOTÁK & MIŠÍK (1993: Pl. 2, Fig. 10) from the Tithonian/Berriasian of the Western Carpathians. *A. elongata,* however, shows bent spicules with an irregular periphery ("periphérie creusée") in longitudinal sections, and is therefore different from our specimens. Moreover, the spicules of *A. elongata* have much larger dimensions (length: up to 2.18 mm, width: 0.14–0.35 mm acc. to CAROZZI (1955). *Acicularia* sp. has been identified in outer platform debris facies (biointrasparites).

Genus ***Clypeina*** (MICHELIN, 1845) BASSOULLET et. al., 1978

Clypeina jurassica FAVRE, 1927

(Pl. 11, Fig. 2)

1967 *Clypeina jurassica* FAVRE – FENNINGER & HÖTZL: 9, pl. 3, fig. 1, 4, Mount Plassen and Mount Tressenstein.
1970 *Clypeina jurassica* FAVRE – FENNINGER & HOLZER: Pl. 15, fig. 4, micritic Plassen Formation of the Tote Gebirge.
1980 *Clypeina jurassica* FAVRE & RICHARD – STEIGER & Wurm: 264, pl. 26, fig. 4, Plassen Formation of the Rötelstein.
1991 *Clypeina jurassica* FAVRE – DARGA & SCHLAGINTWEIT: 211, pl. 2, fig. 1, pl. 3, fig. 6, Lerchkogel Limestone of Dietrichshorn.
1992 *Clypeina jurassica* FAVRE & RICHARD – DYA: 71, Pl. 7, fig. 9, 11, Lärchberg Formation of the Salzburg Calcareous Alps.
1997 *Clypeina jurassica* FAVRE – SCHÜTZ & HÜSSNER: Pl. 20, fig. 3-4, Barmstein Limestone of the Osterhorn Mountains.

Remarks: Well known and widespread alga of the alpine Plassen Formation and Lerchkogel Limestone (see synonymy). According to BERNIER (1984: p. 487) the facies rich in *Clypeina jurassica* typically occurs in biomicrites corresponding with shallow protected areas of the platform. The usually large amount of verticil debris found accounts for the assumption of a remarkable articulation of the original skeleton (DE CASTRO, 1997).

Clypeina cf. ***parasolkani*** FARINACCI & RADOICIC, 1991

(Pl. 11, Fig. 11)

1980 *Salpingoporella annulata* CAROZZI – STEIGER & WURM: Pl. 26, fig. 2, Tithonian ? Plassen Formation of Rötelstein /Krahstein.
*1991 *Clypeina parasolkani* n. sp. – FARINACCI & RADOICIC: 137, pl. 2, figs. 1–18, Berriasian of the Western Pontides, Turkey.
1995 *Clypeina parasolkani* FARINACCI & RADOICIC – BUCUR et al.: Pl. 8, fig. 2–4, Valanginian of Serbia.

Remarks: Although the Turkian specimens were found in a grainstone facies, FARINACCI & RADOICIC (1991: p. 137) conclude the life environment "was localized in a closed lagoon, since the verticils are enveloped by mud and penecontemporaneously resedimented". Since the stratigraphic range is indicated as Upper Tithonian-Valanginian (BUCUR et al., 1995) we did not recognize the species in our samples from the inner platform due to stratigraphic reasons (see text-fig. 4). Our rare specimens come from the external platform facies near the transition to the inner platform. Age is Upper Tithonian.

Plate 3 ►

Microfacies of the Plassen Formation, outer and inner platform

Fig. 1.
Coral framestone. Sample Kra 118 (x 7).

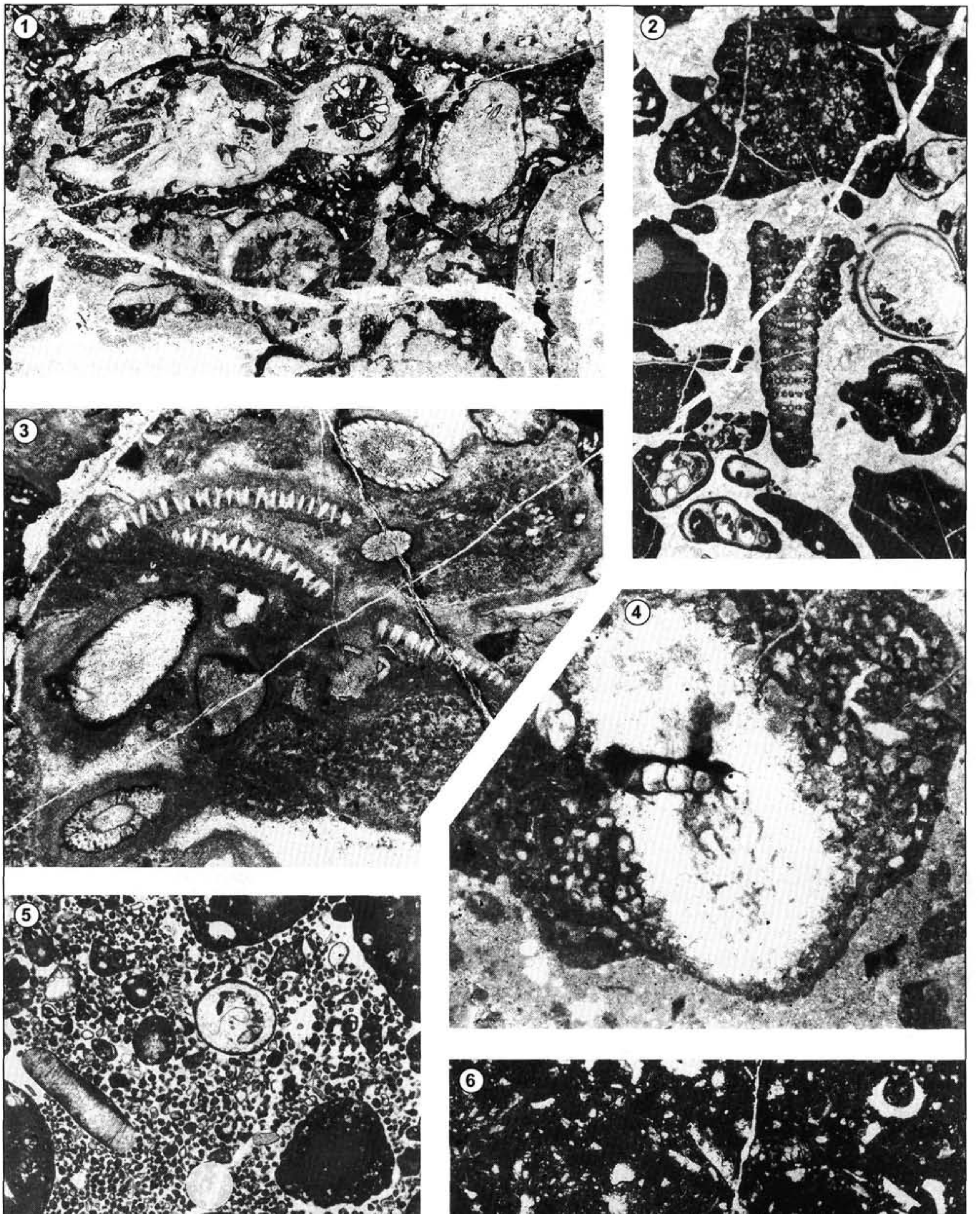
Fig. 2.
Outer platform rudstone with gastropods and ***Dissocladella*** cf. ***intercedens*** BAKALOVA. Sample TW 24 (x 7).

Fig. 3.
Floatstone with coral debris, intraclasts, echinoids and the dasycladales ***Epimastoporella jurassica*** ENDO and ***Salpingoporella*** gr. ***enayitosaensis***. Sample Kra 105 (x 10).

Fig. 4.
Coral fragment with biogenic crust and endolithic borer ***Troglotella incrustans*** WERNLI & FOOKES. Sample Kra 130 (x 33).

Fig. 5.
Open lagoonal facies of the inner to outer platform transition containing gastropods and ***Anchispirocyclina lusitanica*** (EGGER) (A). Sample TW 33 a (x 10).

Fig. 6.
Inner platform wackestone with debris of ***Clypeina jurassica*** FAVRE and ***Salpingoporella*** sp. Sample TW 26 (x 12).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Clypeina sp. A PECORINI, 1972

(Pl. 12, Fig. 5)

1972 *Clypeina* sp. A – PECORINI: 378, fig. 3, a-h, ? Valanginian of Sardegna.
1992 *Actinoporella podolica* ALTH – DYA: 68, pl. 7, fig. 6-7, Lärchberg Formation of Dietrichshorn and Hochkranz.
1998 *Clypeina* sp. A PECORINI – EBLI & SCHLAGINTWEIT: Pl. 2, fig. 3–4, subsurface Upper Tithonian-Berriasian of S-Germany.

Remarks: *Clypeina* sp. A, from the Purbeckian of Sardinia/ Italy, has already been recognized as a new species by PECORINI (1972): "I rari esemplari non monstrano identica di caratteri con alcuna delle specie di Clypeina finora note". The new species of *Clypeina* is going to be described in a separate forthcoming paper together with I. DIENI (Padova) and R.RADOICIC (Beograde). *Clypeina* n. sp., typically preserved as isolated verticils, is restricted to a wackestone facies of the inner platform. It is one of the most conspicuous flora elements of the Lofer member in the area of Lofer, where it has been discovered in Tithonian to (Middle) Berriasian strata (SCHLAGINTWEIT & EBLI in prep.).

Genus *Cylindroporella* JOHNSON, 1954

Cylindroporella cf. *arabica* ELLIOTT, 1957

(Pl. 11, Fig. 1)

1976 not indicated – TOLLMANN: Fig. 207, Plassen Formation of the type locality Mount Plassen.
1992 *Cylindroporella arabica* ELLIOTT – DYA: 74, Pl. 7, fig. 1, 3, Lärchberg Formation of Lofer.

Remarks: One poorly preserved oblique transverse section has been detected in inner platform wackestones (sample TW 26). A nice section has been figured by TOLLMANN (1976: Fig. 207) from the Plassen Formation of Mount Plassen. The species is also present in the Lerchkogel Limestone in the vicinity of Lofer (DYA, 1992).

Genus *Dissocladella* Pia, 1936

Dissocladella cf. *intercedens* BAKALOVA, 1978

(Pl. 9, Figs. 5–6, 8, 10)

1978 *Dissocladella intercedens* n. sp. – BAKALOVA: 14, pl. 1, fig. 4, Upper Tithonian-Lower Berriasian of Bulgaria.
1978 *Montenegrella florifera* BERNIER – FENNINGER: 116, pl. 1, fig. 1–4, Plassen Formation (Tithonian) of the Trisselwand.
1987 *Dissocladella intercedens* BAKALOVA – BARATTOLO & PUGLIESE: Pl. 10, fig. 2–4, pl. 11, 1–3, Berriasian of Capri Island/Italy.
1994 *Dissocladella* aff. *D. intercedens* BAKALOVA – SCHINDLER & CONRAD: Pl. 3, fig. 4–6, U. Valanginian-L. Hauterivian of Friuli/Italy.

Remarks: In its original description, the species has been inadequately illustrated by only one tangential section. Similarities and possible synonymies among *D. intercedens* BAKALOVA, *Montenegrella tubifera* BERNIER and *Linoporella svilajaensis* SOKAC & VELIC are discussed by DRAGASTAN (1989) and FARINACCI & RADOICIC (1991). Our material does not allow further contributions. Nonetheless, we attribute our specimens to the genus *Dissocladella* due to the globulous primaries, occurring on a short handle arranged perpendicular to the main axis, and phloiophorous secondaries.

Genus *Epimastoporella* ROUX, 1979

Epimastoporella jurassica (ENDO, 1961) SENOWBARI-DARYAN et al., 1994

(Pl. 3, Fig. 1, Pl. 10, Fig. 2)

1967 *Pseudoepimastopora jurassica* ENDO – FENNINGER & HÖTZL: 11, pl. 3, fig. 3, pl. 5, fig. 2, Mount Plassen and Mount Tressenstein.

Remarks: *E. jurassica* occurs in peri-reefal limestones of the Krahstein and amongst the debris in the outer platform and talus facies of the Trisselwand. According to GRANIER & DELOFFRE (1993) it represents a nomen nudem.

Epimastoporella sp.

(Pl. 11, Fig. 7)

Remarks: Dasycladale with large main axis (d/D = 71 %), very thin walls and simple branches. D = 0.95 mm, d = 0.68 mm, p max = 0.07 mm. It has been detected in peri-reefal limestones of the Krahstein.

Genus *Gyroporella* GÜMBEL, 1872

emend. BENECKE, 1878

Gyroporella ? sp.

(Pl. 11, Fig. 8–9, 12)

Remarks: This relatively large dasycladale with a wide axial cavity and numerous, presumably aspondylous simple

Tab. 2.
Dimensions of *Dissocladella* cf. *intercedens* BAKALOVA from the Plassen Formation of the Trisselwand (TW 24a-b, and FENNINGER, 1978) in comparison to the dimensional parameters indicated in the original description (Bakalova, 1978).

	Sample TW 24a	Sample TW 24b	BAKALOVA 1978	FENNINGER 1978
D	2.28	1.86	2.015	1.7–2.3
D	1.11	0.65	0.84	0.7–1.2
d/D	48 %	35 %	41 %	41–52 %
P	0.17–0.18	0.16–0.2	0.158	0.2–0.35
W	–	–	–	25
P'	0.05–0.065 prox.	0.05–0.065 prox.	0.0530 prox. 0.123 distal	–
W'	5	5?	4?, 5?	4?
l'	–	0.29	0.265	0.25–0.35
H	–	0.36–0.39	0.42	0.4
L	7.28	5.9	3.52	–

Table 3.
Dimensions (in mm) of *Linoporella gigantea* from the Plassen Formation of the Trisselwand (slide TW 21) and the Lerchkogel limestone of the Litzelkogel (slide LK 27) in comparison with the original description of CAROZZI (1956), and *Linoporella capriotica* (OPPENHEIM) from the BERRIASIAN of Capri/Italy (BARATTOLO, 1991). Number of branches (w) has been calculated geometrically after DE CASTRO (1997: Fig. 36).

	Linoporella gigantea (CAROZZI)			*Linoporella capriotica* (OPPENHEIM)
	TW 21	LK 27	CAROZZI, 1956	BARATTOLO, 1991
D	1.6–2.86	2.67	1.2–1.75	1.0–3.1 (2.26)
d	0.75–1.46	1.17	0.8–1.2	0.34–1.6 (0.96)
d/D	47–51 %	44 %	–	–
p	0.08 prox. 0.07 distal	0.04–0.05 prox. 0.1–0.12 distal	–	0.03–0.07 (0.05)
p'	–	0.1–0.19	0.09–0.2 (0.15)	0.03–0.05 (0.04)
l	0.3–0.4	0.52	–	0.08–0.23 (0.13)
w	–	32	–	17–44 (11)
l'	0.12–0.16	0.4	–	0.3–0.57 (0.44)
w'	–	4	–	2–5
p"	–	about 0.06	–	0.04–0.07 (0.04)
l"	–	0.13–0.21	–	0.09–0.2 (0.13)
h	–	0.11–0.14	about 0.17	0.06–0.1
w"	–	–	–	2–3
L	2.48–5.6	4.0	–	–

branches, occurs in peri-reefal limestones of the Krahstein. It cannot be determined to generic level due to the strong recrystallization, especially of the inner part of skeleton. The morphology of the branches could not be directly observed, but, due to the proximal bubbly branch widening, it may originally be of the vesiculiferous type, such as in the genus *Gyroporella* GÜMBEL: D = up to 1.4 mm, d = 0.9 mm, d/D = 59 %, e = about 0.32 mm, pmax. = 0.14 mm. Although being a little bit smaller in dimensions, there are some resemblances to *Gyroporella lukicae* SOKAC & NIKLER, 1982 from the Aptian of Bosnia.

Halimedoidea indet

(Pl. 10, Fig. 6)

Remarks: Some rare and not well preserved specimens have been observed in outer platform grainstones. The affinity to the Halimedoidea becomes evident when the thallus structure, having a medullar zone composed of subparallel filaments and bifurcating cortical filaments, is taken in consideration. Apart from the curious microgranular calcification, the genus *Halimeda* LAMOUROUX seems closely related. Our material, however, does not allow a detailed morphological study. Our specimens are identical to *Carpathocodium* cf. *anae* (DRAGASTAN), described by SENOWBARI-DARYAN et al. (1994) from the Tithonian of Sicily. In our opinion, however, the Italian specimens and *C. anae* from the Tithonian of the East Carpathians are different and represent two separate taxa.

Genus ***Linoporella*** STEINMANN, 1899, emend. BASSOULLET et al., 1978, emend. DIENI, MASSARI & RADOICIC, 1985

Linoporella gigantea (CAROZZI, 1955)

(Pl. 9, Fig. 7, 9)

*1955 *Macroporella gigantea* n. sp. – CAROZZI: 43, text-fig. 7, pl. 6, fig. 4, Upper Jurassic of Switzerland.
1970 *"Macroporella" gigantea* CAROZZI – FENNINGER & HOLZER: pl. 17, fig. 6, Plassen Formation of Scheffelblick-Falkenstein.
1991 *Linoporella* cf. *gigantea* (CAROZZI) emend. – FARINACCI & RAROICIC: 138, Pl. 9, fig. 5, text-fig. 1, Berriasian of Turkey.
1995 *Linoporella* cf. *gigantea* (CAROZZI) – BUCUR, CONRAD & RADOICIC: Pl. 10, fig. 7, Valanginian of Serbia.

Remarks: Large dasycladale with slender primaries inclined towards the main axis, bearing tufts of four secondaries (Pl. 9, Fig. 7). Tertiary branches are barley detectable due to the outer erosion of the recrystallized thalli. According to FARINACCI & RADOICIC (1991) *L. gigantea* differs from *L. capriotica* (OPPENHEIM) by "its smaller number of branches per verticil, and by its greater inclination". As can be seen from table 3, *L. giantea* furthermore displays a larger verticil spacing (h). No data on facies has been provided by CAROZZI 1955. However, from the mentioned common cooccurrence with *Salpingoporella pygmaea* (GUEMBEL) and the illustrated sparitic microfacies of the holotype, it can be concluded that *L. gigantea* (CAROZZI) and also *Dissocladella* cf. *intercedens* BAKALOVA flourished in well-agitated external habitats such as some other larger dasycladales of the Lower Cretaceous (CONRAD, 1970). *Linoporella gigantea* (CAROZZI) has also been detected in the Lerchkogel Limestone of the Gerhardstein, near Lofer, in comparable facies. In our material of the sparitic Plassen Formation, both *Dissocladella* cf. *intercedens* BAKALOVA and *Linoporella gigantea* (CAROZZI) are much less frequent than *Salpingoporella pygmaea* (PIA). *Linoporella* aff. *gigantea* recovered from the same sample as *L. gigantea* has a wider verticil spacing, whereas other dimensions correspond to data given by CAROZZI (1956).

Linoporella cf. ***kapelensis*** SOKAC & NIKLER, 1973

(Pl. 8, Fig. 4)

*1973 *Linoporella kapelensis* n. sp. – SOKAC & NIKLER: 65, pl. I-III, Tithonian of Croatia.

Remarks: *L. kapelensis* is a species that, according to our knowledge, is known so far only from its type-locality. Besides others, the wider verticil spacing allows a clear differentiation to both, *L. gigantea* and *L. capriotica* (see table 3). The differences of some biometric parameters of our specimen compared to those given in the original description, accounts for the cf. designation (table 4). At Mt. Velica Kapela, the species occurs in "reef sediments" (biosparrudites). In the Trisselwand section, *L.* cf. *kapelensis* occurs in (Upper Tithonian) biosparites of the external platform (sample TW 21). The stratigraphy has been assigned to the Tithonian (SOKAC & NIKLER 1973; GRANIER & DELOFFRE, 1993). In samples TW 15 and TW 40 we observed *Linoporella* sp., which we cannot exclude possibly belong to *L. kapelensis,* so that ist stratigraphic range may also extend into the Berriasian (?Early Valanginian).

Linoporella ? sp.

(Pl. 9, Figs. 3–4)

Table 4.
Dimensions (in mm) of *Linoporella* cf. *kapelensis* SOKAC & NIKLER from the Trisselwand section in comparison to the type-specimens from Croatia.

	Linoporella* cf. *kapelensis	***Linoporella kapelensis* SOKAC & NIKLER, 1973**
	Upper Tithonian of Mt. Trisselwand	Tithonian of Mt. Velika Kapela
D	1.6	2.22–2.59
d	0.75	1.0–1.4
d/D	47 %	–
p	0.07 proximal 0.08 distal	0.07–0.1
h	0.36–0.4	0.45–0.55
l	0.3–0.4	0.4–0.6
l'	0.12–0.14	0.28–0.45
L	2.48	14

Remarks: One tangential section has been observed in sample Kra 128 from the Plassen Formation of the Krahstein. The existence of primaries and secondaries is evident. Although we could not detect third order branches in our section, the close set verticils and the thinness of the conspicuously only slightly widening of the elongated secondaries are reminiscent of the genus *Linoporella* STEINMANN. Note that all linoporellas detected in our material are from well agitated outer platform deposits. Dimensions: D = 0.72 mm, L = 4.1 mm, h = about 0.12 mm, p = 0.048 mm, p' = 0.024 mm.

Genus *Neoteutloporella* BASSOULLET et al., 1978

Neoteutloporella socialis (PRATURLON)

(Pl. 10, Figs. 5, 7)

1987 *Neoteutloporella socialis* (PRATURLON) – DRAGASTAN: 147, pl. 1, fig. 1–4, Tithonian of Romania.
1994 *Neoteutloporella socialis* (PRATURLON) emend. – DE CASTRO: 174, pl. 18–20, text-fig. 12.

Remarks: An excellent and very exhaustive description of the species has recently been provided by DE CASTRO (1994). The dimensions are (sample TW 23): D = 1.70 mm, d = 0.41 mm, h = 0.12 mm. According to DRAGASTAN (1987: p. 143), in good accordance to our observation, *"N. socialis* may be found either *in situ*, in the outer platform, or transported, in the basin area (slope)". Stratigraphy: Oxfordian-Tithonian (GRANIER & DELOFFRE, 1993).

Genus *Petrascula* GÜMBEL, 1873

Petrascula bursiformis (ETTALON, 1858) Pia, 1920

(Pl. 9, Figs. 1–2)

1964 *Petrascula bursiformis* (ETTALON) – FLÜGEL: 223, pl. 13, fig. 10, Upper Jurassic Plassen Formation of the Krahstein.
1967 *Petrascula bursiforms* (ETTALON) – FENNINGER & HÖTZL: 12 (not figured), Tressenstein.
1970 *Petrascula bursiformis* (ETTALON) – FENNINGER & HOLZER: pl. 17, fig. 4, Plassen Formation, Mount Rettenstein.

Remarks: Large fragments of the thallus-handle have been observed in outer platform debris limestones (grainstones) at the Krahstein (sample Kra 103). Dimensions: D = 4.3 mm, h = 0.46 mm, p = 0.34–0.4 mm, p' = 0.08–0.16 mm. According to GRANIER & DELOFFRE (1994) the stratigraphic range of *P. bursiformis* is Kimmeridgian – Tithonian.

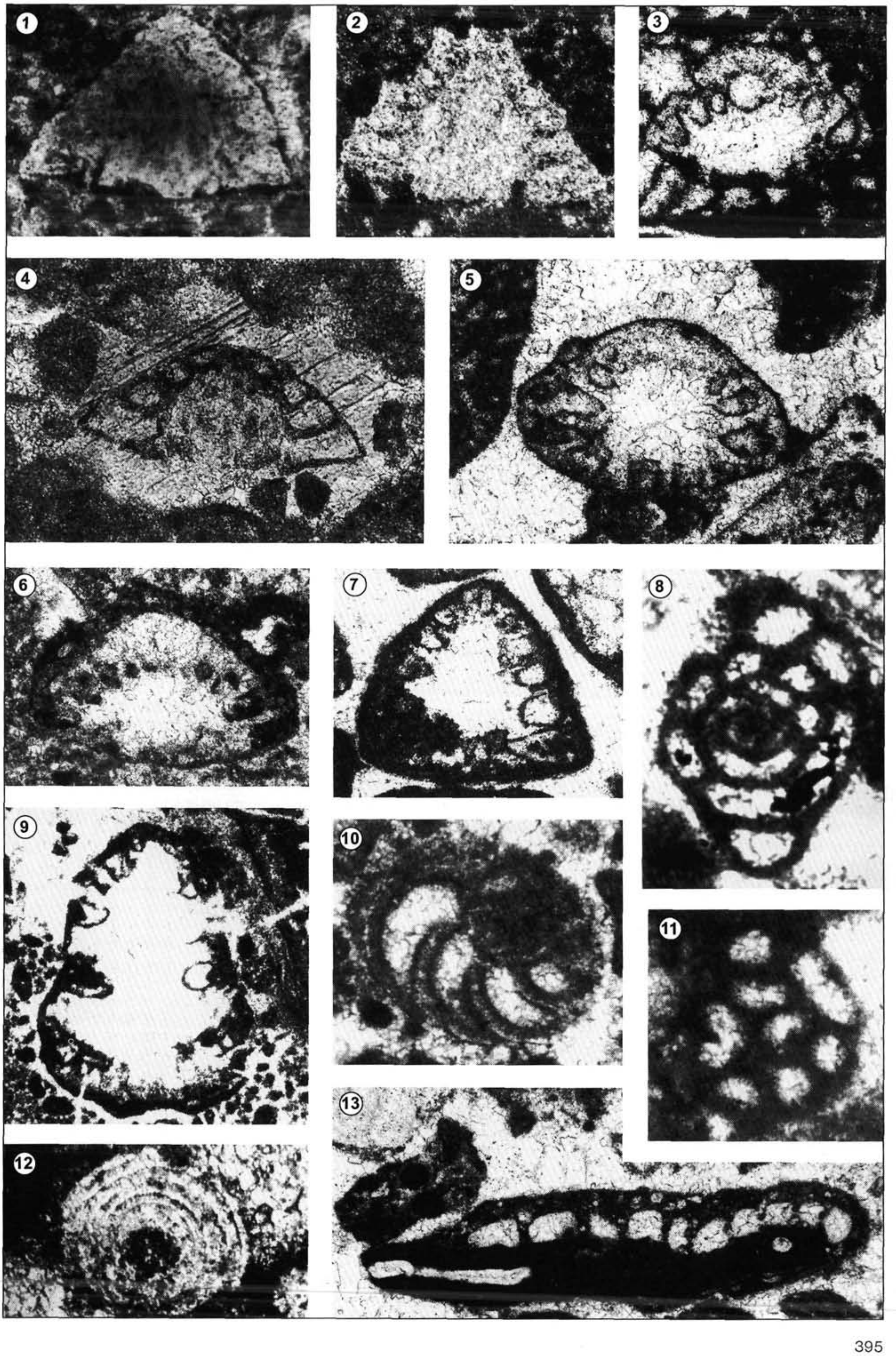
Genus *Salpingoporella* (PIA, 1918) CONRAD, 1969

Salpingoporella gr. *pygmaea* (GUEMBEL, 1891)

(Pl. 8, Figs. 5, 8, 10–11)

Remarks: The problem of differentiating various Upper Jurassic representatives of the genus *Salpingoporella* originated from the initial description of *Salpingoporella pygmaea* (GUEMBEL), that did not specify the range of biometric parameters, as one usually does today. This resulted in the establishment of various similar species said to differ from each others according to the dimensions of their cylindrical thallus (d, D, d/D-D ratio as introduced by BERNIER, 1984) and the numbers of branches (w) they have. One ▶

Plate 4
Foraminifera
Fig. 1–2.
Neotrocholina infragranulata (NOTH). Fig. 1: Sample TW 17 (x 127); Fig. 2: Sample TW 2/2 (x 127).
Fig. 3, 5–6.
Trocholina odukpaniensis DESSAUVAGIE. Fig. 3: Sample TW 32 (x 66); Fig. 5: Sample TW 11 (x 66); Fig. 6: Sample TW 15-1 (x 66).
Fig. 4.
Neotrocholina valdensis REICHEL. Sample TW 1 (x 117).
Fig. 7.
Trocholina alpina (LEUPOLD). Sample TW 23 (x 54).
Fig. 9.
Trocholina cf. ***delphinensis*** ARNAUD-VANNEAU, BOISSEAU & DARSAC. Sample TW 31 (x 37).
Fig. 10.
Equatorial section of ? ***Mohlerina basiliensis*** (MOHLER). Sample Kra 113 (x 130).
Fig. 8, 11.
Meandrospira favrei (CHAROLLAIS, BRÖNNIMANN & ZANINETTI). Fig. 8: Sample TW 40 (x 243); Fig. 11: Sample TW 41 (x 243).
Fig. 12.
Spirillina sp. Sample Kra 128 (x 144).
Fig. 13.
Acruliammina cf. ***neocomiana*** (BARTENSTEIN) encrusting ***Tubiphytes morronensis*** CRESCENTI. Sample TW 21a (x 13).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should note, however, that in cylindrical dasycladales, exactly centered sections are needed for the correct measurement of the mentioned parameters, as outlined by DE CASTRO (1997). Several authors have already contributed in solving this problem with different results (e. g. BERNIER, 1984; DRAGASTAN, 1989; SENOWBARI-DARYAN et al., 1994).

Salpingoporella gr. ***enayi*** BERNIER, 1984 – ***tosaensis***

(YABE & TOYAMA, 1949) BASSOULLET et al., 1978

(Pl. 8, Figs. 1–3)

Remarks: This taxon occurs relatively frequent in the perireefal limestones of the Krahstein. Its dimensions (e. g. D and w) allows the distinction of the specimens we assign to *S.* gr. *pygmaea* (GUEMBEL). It should be mentioned, that the branches of our specimens only gradually widen during the first 2/3 of their length, becoming markedly broader in the distal parts. Dimensions: D = 0.5–0.92 mm (mean: 0.76 mm), d = 0.18–0.32 mm (mean: 0.27 mm), d/D = 32–40 % (mean: 35 %), p = 0.12 mm, l = 0.26–0.3 mm, w = 25–28.

Salpingoporella ettaloni BERNIER, 1984

(Pl. 8, Fig. 12)

Remarks: Like *S. johnsoni, S. ettaloni* is a small *salpingoporella,* exhibiting close set verticils. Dimensions: D = 0.4 mm, d = 0.12 mm, d/D = 30 %, p = 0.048 mm, l = 0.14 mm, h = 0.04 mm. Rare specimens have been detected in near-reefal limestone of the Krahstein.

Salpingoporella gr. ***johnsoni*** DRAGASTAN, 1969

(Pl. 8, Fig. 9)

Remarks: *S. johnsoni* is particularly distinct, in comparison to other related species, by its small cylindrical thallus. The dimensions we found, fit well with those given by Bernier (1984), DRAGASTAN (1989) and SENOWBARI-DARYAN et al. (1994). Dimensions: D = 0.22–0.24 mm, d = 0.08 mm, d/D = 36 %, p = 0.06 mm, h = 0.064 mm. Occurrence: Same as for *S. ettaloni.*

4.2 Foraminifera

Genus ***Acruliammina*** LOEBLICH & TAPPAN, 1946

Acruliammina cf. ***neocomiana*** BARTENSTEIN, 1962

(Pl. 4, Fig. 13)

1980 *Acruliammina neocomiana* BARTENSTEIN – ARNAUD-VANNEAU: 331, pl. 42, fig. 1, pl. 66, fig. 1–2, text-fig. 111, Lower Cretaceous of S-France.

Remarks: The encrusting species occurs in the Plassen Formation of the Trisselwand and the Krahstein (e. g. sample Kra 122-4), in near and peri-reefal facies. According to ARNAUD-VANNEAU et al. (1978), *A. neocomiana* has a stratigraphic range of Lower Berriasian – Aptian.

Genus ***Ammobaculites*** CUSHMAN, 1910

Ammobaculites sp. aff. ***celatus*** ARNAUD-VANNEAU, 1980

(Pl. 5, Fig. 5)

Remarks: The reduced and thus hardly detectable initial spire, the chamber shape in longitudinal section, and the dimensions are in good accordance to *A. celatus* ARNAUD-VANNEAU from the Lower Cretaceous of S-France. Our specimen, however, lacks a slightly eccentric aperture that alternates remarkably in position between successive chambers, a diagnostic feature of *A. celatus.* Note that an identical form has been described as Lituolidae by BARATTOLO & PUGLIESE (1987: Pl. 51) from Aptian shallow water limestones of Capri/Italy. Another species with a well developed initial coiling stage made up of six chambers followed by an enrolled stage composed of 3 chambers has been detected in the outer platform facies (grainstone to rudstone) of the Litzelkogel (Lärchberg Formation, pl. 5, fig. 4).

▶

Plate 5

Foraminifera

Fig. 1–3.
Charentia cuvillieri NEUMANN. Fig. 1: Sample TW 21a (x 105); Fig. 2: Sample TW 6 (x 83); Fig. 3: Sample TW 6 (x 83).

Fig. 4.
Ammobaculites sp. Sample LK 18 (x 73).

Fig. 5.
Ammobaculites sp. aff. ***celatus*** ARNAUD-VANNEAU. Sample TW 6 (x 73).

Fig. 6.
Coscinophragma cribrosum (REUSS). Sample TW 16 (x 25).

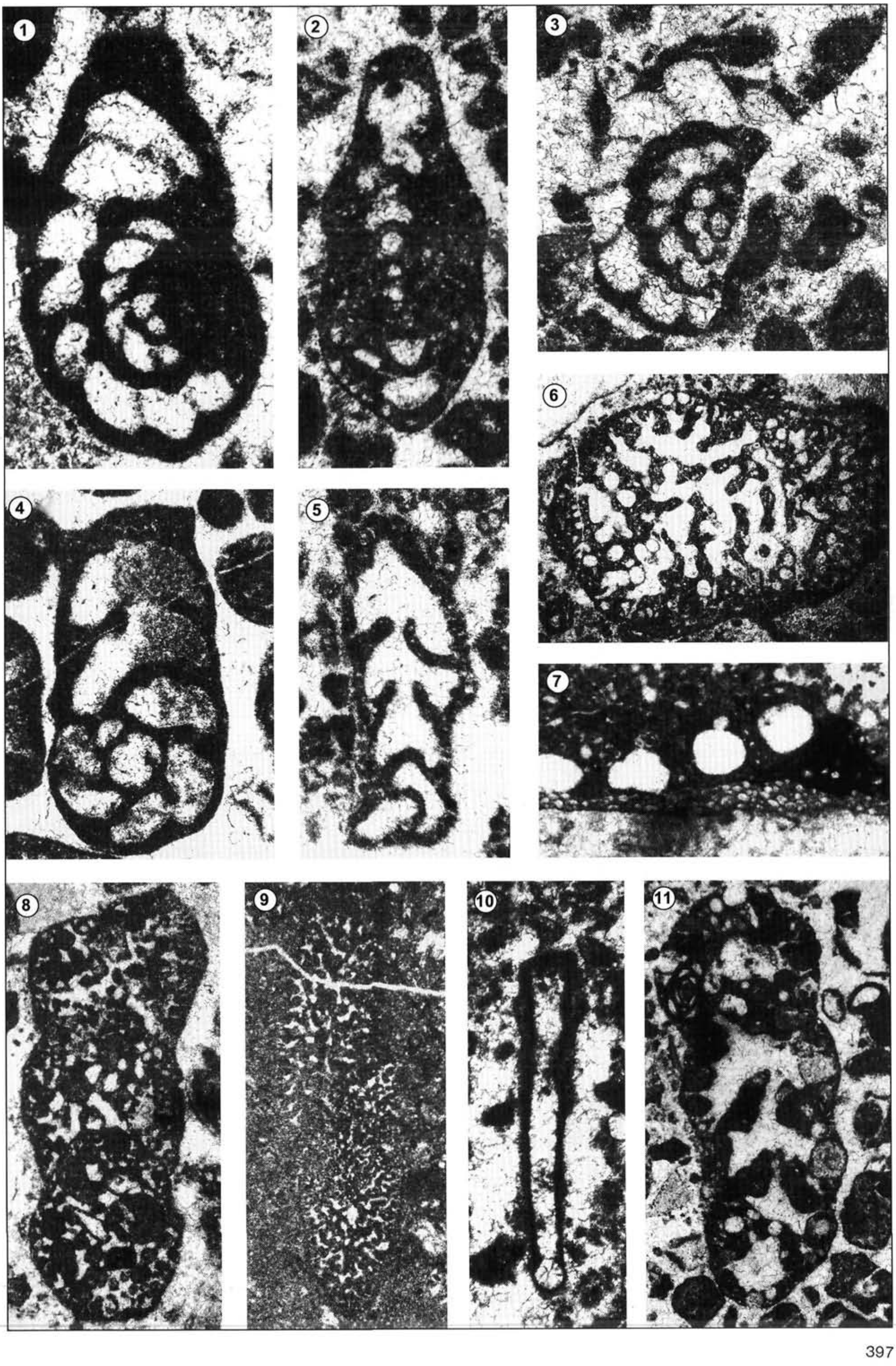
Fig. 7.
Unidentified foraminifera in encrusting association with ***Koskinobullina socialis*** CHERCHI & SCHROEDER. Sample Kra 116 (x 30).

Fig. 8.
Lituolidae gen. et sp. indet. Sample TW 21 a (x 31).

Fig. 9.
Anchispirocyclina lusitanica (EGGER). Sample TW 30 (x 26).

Fig. 10.
Earlandia **?** sp. Sample Kra 122–3 (x 87).

Fig. 11.
Rheophax sp. Sample TW 21 a (x 25).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Genus ***Anchispirocyclina*** JORDAN & APPLIN, 1952

Anchispirocyclina lusitanica (EGGER)

(Pl. 5, Fig. 9)

1981 *Anchispirocyclina lusitanica* (EGGER) – STEIGER: Barmstein Limestones of the Salzburg Calcareous Alps, not figured.
1982 Alveosepta sp. – MIŠÍK & SÝKORA: Pl. 3, fig. 3–4, Barmstein Limestone of the Western Carpathians.
1986 *Anchispirocyclina lusitanica* (EGGER) – DARGA & WEIDICH: Pl. 1, fig. 11, Lackbach Formation.
1991 *Anchispirocyclina lusitanica* (EGGER) – DARGA & SCHLAGINTWEIT: 213, pl. 2, fig. 2, pl. 4, fig. 2–3, Lerchkogel Limestone of the Dietrichshorn.
1992 *Anchispirocyclina lusitanica* (EGGER) – DYA: 53, Pl. 12, fig. 5, 7–8, Lerchkogel Limestone of the Dietrichshorn and Lärchberghörndl.

Remarks: *Anchispirocyclina lusitanica* (EGGER), being the most typical foraminifera of the Lerchkogel Limestone in the vicinity of Lofer (DARGA & SCHLAGINTWEIT, 1991; DYA, 1992), has not been reported so far from the Plassen Formation. It has been mentioned by STEIGER (1981) from the Barmstein Limestones of the Salzburg Calcareous Alps. *A. lusitanica* occurs in inner platform wackestones and in the inner to outer platform transitional zone. Its stratigraphic range within the Lerchkogel Limestone is Tithonian to Lower Berriasian.

Genus ***Charentia*** NEUMANN, 1965

Charentia cuvillieri NEUMANN, 1965

(Pl. 5, Figs. 1–3)

1985 *Nummoloculina?* sp. – WEIDICH: Pl. 3, fig. 8, Branderfleck Formation (Lower Cenomanian) of the Allgäu Alps.
1991 *Charentia cuvillieri* NEUMANN – SCHLAGINTWEIT: 34, Pl. 9, fig. 6–9, Urgonian limestones (Aptian) of the Northern Calcareous Alps.
1992 *Charentia cf. cuvillieri* NEUMANN – DYA: 42, Pl. 11, fig. 7, Plassen Formation of Hirschangerkopf/Untersberg and Lerchkogel limestone of the Dietrichshorn, Gerhardstein and Hochkranz.
1994 *Charentia* sp. – LOBITZER et al.: Pl. 12, fig. 9, Barmstein Limestone of the Salzburg Calcareous Alps.

Remarks: In the Northern Calcareous Alps, *Ch. cuvillieri* was so far reported from Aptian Urgonian Limestones and Lower Cenomanian orbitolinid sandstones of the Branderfleck Formation (see synonymy). Its stratigraphic range is designated as Berriasian to Cenomanian (BUCUR, CONRAD & RADOICIC, 1995), but from our material it is most likely that *C. cuvillieri* was already present in the Late Tithonian (table 1).

Genus ***Hedbergella*** BRÖNNIMANN & BROWN, 1958

Hedbergella ? sp.

(Pl. 6, Fig. 12)

Remarks: A low trochospiral planctonic foraminifera with globular chambers, smooth surface and rounded periphery has been discovered in samples TW 15 (Berriasian) and TW 40 (? Early Valanginian). The thin-section appearance resembles the genus *Hedbergella*, that, however, has been reported to appear later in the Barremian (e. g. WEIDICH, 1990). Dimensions: test diameter = 0.42 mm, test height = 0.22 mm.

Lituolidae gen. et. sp. indet

(Pl. 5, fig. 8, pl. 7, figs. 2–3, 7)

Remarks: We designate as "Lituolidae gen. et sp. indet" a group of benthic foraminifera that have not been determined down to the generic level. They surely belong to different genera, but incomplete specimens or agglutinated material, masking internal features, such as aperture etc. do not allow an exact determination. Important is, that this "group" typically occurs in biosparites of the external platform.

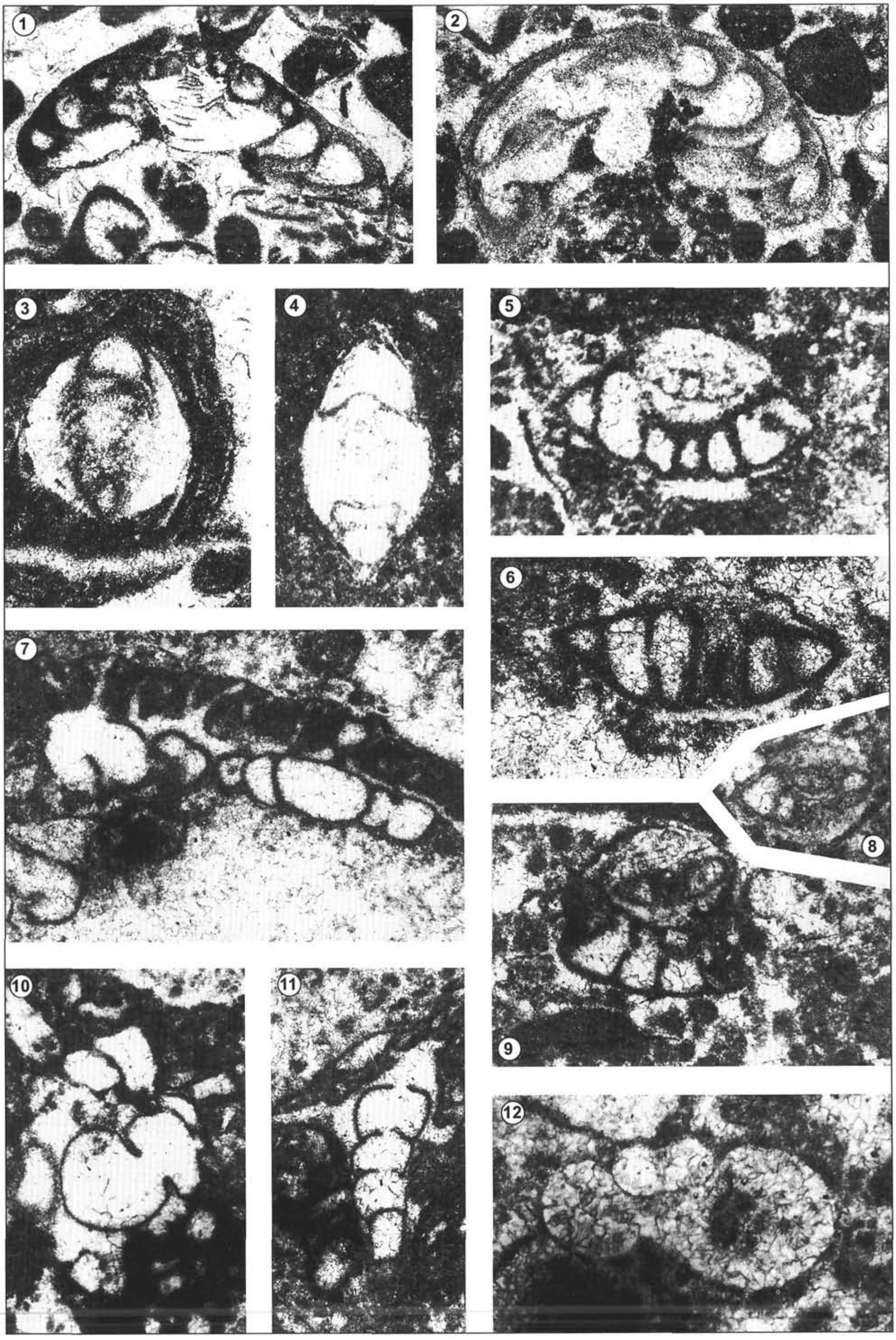
Genus ***Meandrospira*** LOEBLICH & TAPPAN, 1946

Meandrospira favrei (CHAROLLAIS, BRÖNNIMANN & ZANINETTI, 1966)

(Pl. 4, Figs. 8, 11)

* 1966 *Citaella? favrei* n. sp. – CHAROLLAIS, BRÖNNIMANN & ZANINETTI: 37, pl. 2, fig. 3–4, pl. 3, fig. 1–5, pl. 5, fig.1–2, text-fig. 4–6, Upper Valanginian-Upper Hauterivian of Switzerland.
1970 *Meandrospira bancilai* n. sp. – NEAGU: 412, pl. 1, figs. 1–16 (Upper Barremian-Lower Aptian of Romania).

Plate 6.
Foraminifera
Fig. 1–2.
Mohlerina basiliensis (MOHLER). Fig. 1: axial section, sample TW 31 (x 53); Fig. 2: Oblique section, sample TW 31 (x 53).
Fig. 3–4.
Protopeneroplis striata WEYNSCHENK. Fig. 3: Sample TW 36 (x 111). Fig. 4: Sample TW 27 (x 111).
Fig. 5–6, 9.
Protopeneroplis ultragranulata (GORBATCHIK). Fig. 5: Sample TW 36 (x 100); Fig. 6: Sample TW 37 b (x 100); Fig. 8: Sample TW 35 (x 90).
Fig. 8.
Protopeneroplis aff. ***banatica*** BUCUR. Sample TW 40 (x 87).
Fig. 7, 10–11.
Troglotella incrustans WERNLI & FOOKES. Fig. 7 and 9: Sample TW 15-1 (x 69); Fig. 10: Sample Kra 118 (x 70).
Fig. 12.
Low trochospiral planctonic foraminifera ***Hedbergella*** ? sp. Sample TW 15-1 (x 130).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1975 *Meandrospira bancilai* NEAGU – NEAGU: 47, pl. 33, fig. 14–25, Upper Hauterivian, Barremian of Romania.
1991 *Meandrospira bancilai* NEAGU – SCHLAGINTWEIT: 41, pl. 15, fig. 6–7, Lower Cretaceous Urgonian Limestones, Northern Calcareous Alps.
1991 *Meandrospira favrei* (CHAROLLAIS, BRÖNNIMANN & ZANINETTI) – ALTINER: Pl. 13, fig. 1–5, Upper Valanginian-Hauterivian of Turkey.
1993 *Meandrospira favrei* (CHAROLLAIS, BRÖNNIMANN & ZANINETTI) – BUCUR: Hauterivian of Romania, not figured.
1993 *Meandrospira favrei* (CHAROLLAIS, BRÖNNIMANN & ZANINETTI) – MASSE, ARIAS & VILA: Pl. 1, fig. 8–9, Lower Hauterivian of Murcia region/Spain.
1994 *Meandrospira favrei* (CHAROLLAIS, BRÖNNIMANN & ZANINETTI) – SCHINDLER & CONRAD, not figured, Upper Valanginian of Friuli/Italy.
1995 *Meandrospira favrei* (CHAROLLAIS, BRÖNNIMANN & ZANINETTI) – BUCUR, CONRAD & RADOICIC: Pl. 5, fig. 13–15, Valanginian of Serbia.

Remarks: *M. favrei* typically occurs in the talus facies (étage circalittoral in French literature), and has been used by ALTINER (1991: p. 180) "as the zonal marker to establish the link between benthonic and planktonic zonal schemes". The oldest known record of *M. favrei* is from the well studied Lower Cretaceous succession of the Neufchatel area, where it appears in the uppermost Berriasian (ARNAUD-VANNEAU et al., 1987).

Genus ***Mohlerina*** BUCUR, SENOWBARI -DARYAN & ABATE, 1996

Mohlerina basiliensis (MOHLER, 1938)

(Pl. 6, figs. 1–2, ? pl. 4, fig. 10)

1992 *Conicospirillina basiliensis* MOHLER – DYA: 63, Pl. 11, fig. 9–10, Plassen Formation of Mount Untersberg, Lerchkogel Limestone of Lofer.
1996 *Mohlerina basiliensis* (MOHLER) nov. comb. – BUCUR et al.: 70, pl. 3, figs. 3–6, pl. 4, figs. 2–3, 5–9, Tithonian of Sicily/Italy.

Remarks: *M. basiliensis* is one of the most frequent benthic foraminifera in the studied samples. The species ranges from the internal platform to the talus facies with preference in the high energy outer platform biosparites where it is typically associated with trocholinids.

Genus ***Neotrocholina*** REICHEL, 1955

Neotrocholina valdensis REICHEL, 1955

(Pl. 4, Fig. 4)

*1955 *Neotrocholina valdensis* n. gen., n. sp. – REICHEL: 26, pl. 16, fig. 1–5, 7, Text-Fig. 5, Valanginian of Suisse.
1963 *Neotrocholina valdensis* REICHEL – DESSAUVAGIE: Text-Fig. 2–6, pl. 1, fig. A-d (Upper Tithonian?) Valanginian of Turkey.
1971 *Trocholina valdensis* (REICHEL) – RIVA-PALACIO: 103, pl. 1, fig. 1–6, ? Upper Berriasian-Valanginian of Mexico.
1991 *Neotrocholina valdensis* REICHEL – ALTINER: Pl. 9, fig. 27–29, (? Upper) Berriasian-Valanginian of Turkey.
? 1994 *Trocholina valdensis* (REICHEL) – LOBITZER et al.: Pl. 11, fig. 8, Barmstein Limestone of Salzburg Calcareous Alps.
1995 *Neotrocholina valdensis* REICHEL – BUCUR, CONRAD & RADOICIC: Pl. 2, fig. 9, Valanginian of Serbia.

Remarks: According to REICHEL (1955) there can be distinguished a low and high conical variety. Our specimens with test diameters (D) = 0.38–0.46 mm, height (H) = 0.168–0.22 mm, ratio D/H = 2.1–2.26, apical angle about 95° belong to the latter variety. The specimens show chambers that in the last tour are markedly broader than high, being characteristic for *N. valdensis* (REICHEL, 1955: p. 27). The stratigraphic range of *N. valdensis* is Upper Berriasian – Valanginian (ARNAUD-VANNEAU et al., 1991).

Neotrocholina infragranulata (NOTH, 1951)

(Pl. 2, Fig. 3, Pl. 4, Figs. 1–2)

*1951 *Trocholina infragranulata* n. sp. – NOTH: 69, pl. 1, fig. 32 a–c, Valanginian of Austria.
1972 *Neotrocholina infragranulata* (NOTH) – NEAGU: 117, pl. XCVI, fig. 1–12, 25–26, 29–30, Barremian of Romania.
1979 Trocholina infragranulata NOTH – KRISTAN – TOLLMANN (in FAUPL & TOLLMANN): Pl. 2, fig. 8, redrawing of the holotype.
1990 *Trocholina infragranulata* NOTH – WEIDICH: 146, pl. 29, fig. 32, 34, Berriasian-Lower Aptian of Northern Calcareous Alps.

Remarks: Small, hemispherical ("Kugelkalotte") to conical ▶

Plate 7
Foraminifera, microproblematica, sclerosponges
Fig. 1.
Upper talus grainstone with abundant ophthalmiids. Sample TW 8 (x 59).
Fig. 2–3.
Lituolidae gen. et. sp. indet. Fig. 2: Sample TW 35 (x 73); Fig. 3: Sample TW 35 (x 95).
Fig. 4–6.
Ophthalmidium sp.. Fig. 4: Equatorial section, fig. 5-6: Axial sections. Sample TW 8 (x 190).
Fig. 7.
Lituolidae gen. et sp. indet. Sample TW 24 (x 17).
Fig. 8, 9.
Microproblematicum ***Radiomura cautica*** SENOWBARI-DARYAN & SCHÄFER. Fig. 8: Sample Kra 106 (x 25); Fig. 9: Sample LK 24 (locality Litzelkogel) (x 41).
Fig. 10–11.
Sclerosponge ***Neuropora lusitanica*** TERMIER. Fig. 10: Sample TW 20 (x 14); Fig. 11: Detail of fig. 10, sample TW 20 (x 50).

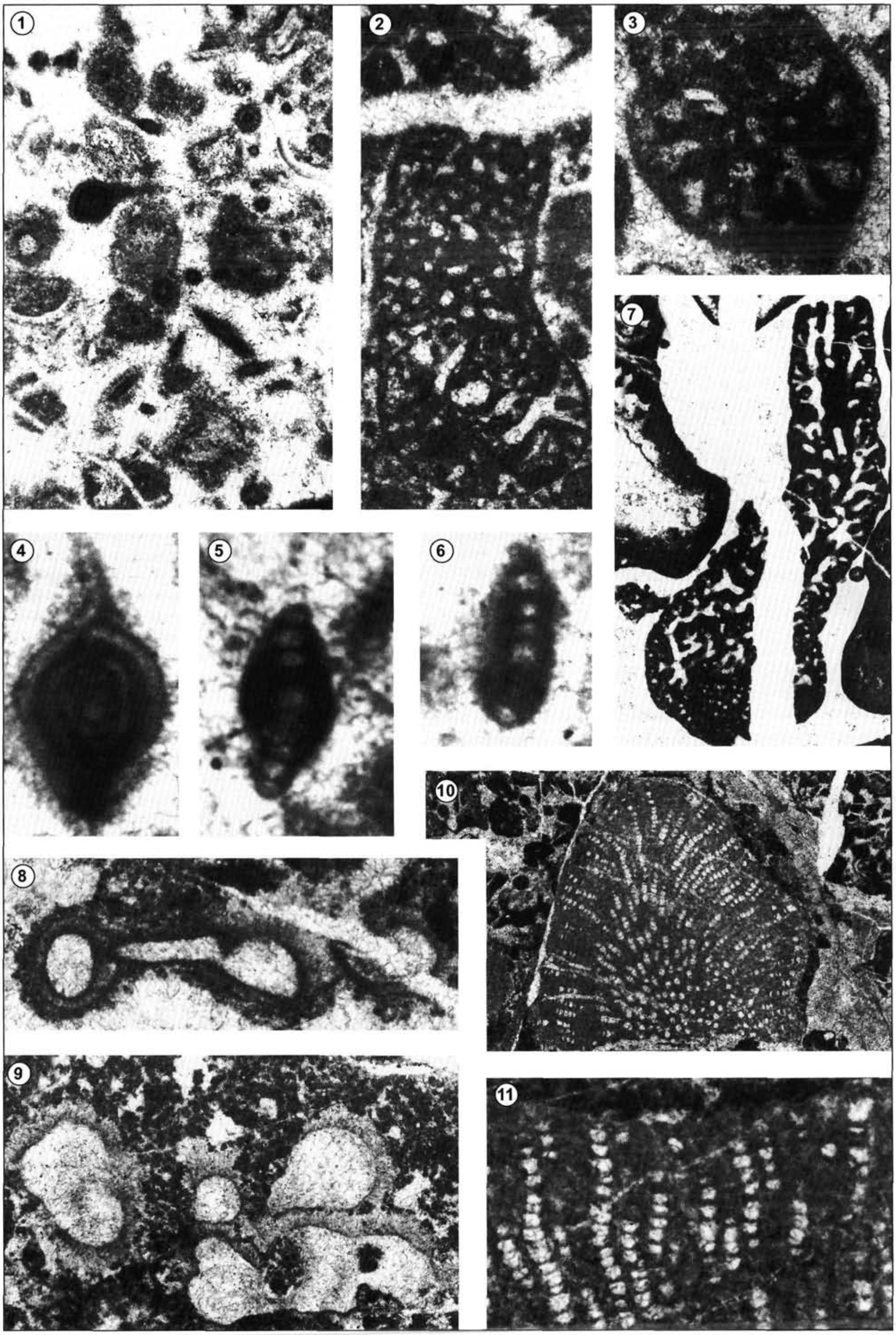
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Table 5.
Comparative table of the dimensions of *Neotrocholina infragranulata* (NOTH) and *Neotrocholina valdensis* Reichel from the Plassen Formation/Oberalm transitional facies of the Trisselwand. D and H in mm.

D	H	D/H	Number of whorls	species	sample
0.46	0.385	1.19	6	*N. infragranulata*	TW 13
0.54	0.34	1.59	?	*N. infragranulata*	TW 22
0.28	0.2	1.4	6	*N. infragranulata*	TW 15
0.4	0.28	1.43	?	*N. infragranulata*	TW 2
0.46	0.22	2.1	?	*N. valdensis*	TW 1
0.38	0.168	2.26	4	*N. valdensis*	TW 1

test with about 6 whovls. As already noted by REICHEL (1955), some specimens of *Neotrocholina valdensis* maybe confused with *N. infragranulata* NOTH. The central pillars of the latter seem to reach only the niveaux of the last chamber whorl, whereas in *N. valdensis* the pillars protrude further in the direction towards the apex. As regards the morphology, the test of *N. valdensis* is low conical having a ratio diameter/height (D/H) of 2.2 to 2.6 (REICHEL, 1955). In addition, it seems that the test wall in *N. infragranulata* is thinner. The stratigraphic range of *N. infragranulata* is Upper Tithonian/ Berriasian – Lower Aptian (ARNAUD-VANNEAU et al., 1991; own observations).

Genus ***Ophthalmidium*** KÜBLER & ZWINGLI, 1866

Ophthalmidium sp.

(Pl. 7, Figs. 1, 4–6)

Remarks: This small milolid with an equatorial diameter of 0.2–0.29 mm, an axial diameter of 0.048–0.06 mm and up to 4 whorls occurs in the upper talus facies. *Ophthalmidium* sp. belongs to the typical autochthonous microbenthos of the (upper) talus of the Urgonian limestones of S-France (ARNAUD-VANNEAU, 1980).

Genus ***Protopeneroplis*** WEYNSCHENK, 1950

Protopeneroplis aff. ***banatica*** BUCUR, 1993

(Pl. 2, Figs. 1, 2)

*1993 *Protopeneroplis banatica* n. sp. – BUCUR: 218, pl. 1, pl. 2, fig. 3–4, 6–7, 9–10, 13, Late Valanginian – Early Hauterivian of Romania.

Remarks: *P.* aff. *banatica* commonly occurs in the distal talus and rarely in the Oberalm transitional facies. There is some uncertainty in our determination due to the bad state of conservation of the specimens and the test diameter (D = 0.29–0.38 mm) that lies partly above the range indicated by BUCUR (1993), but overlaps partly with that of *P. ultragranulata*. These assumed autochthonous specimens of the distal talus appear to substantiate the adaptation of these species to this environment (BUCUR, 1993: p. 222, .."adaptée au milieu circalittoral".). The stratigraphic range of *P. banatica* is terminal Berriasian-Early Hauterivian (BUCUR, 1993; BLANC et al., 1992).

Protopeneroplis striata WEYNSCHENK, 1950

(Pl. 6, Figs. 3–4)

1967 *Protopeneroplis striata* WEYNSCHENK – FENNINGER & HÖTZL: 4, Plassen Formation of the Mount Plassen (not figured).
1970 *Protopeneroplis striata* WEYNSCHENK – FENNINGER & HOLZER: Pl. 17, fig. 1–3, Plassen Formation of the Mount Falkenstein.
1980 *Protopeneroplis striata* WEYNSCHENK – STEIGER & WURM: 262, pl. 26, fig. 1, Plassen Formation of the Krahstein and Rötelstein.
1992 *Protopeneroplis striata* WEYNSCHENK – DYA: 61, Pl. 11, fig. 5–6, Plassen Limestone Formation of Mount Untersberg, Lärchberg Formation of Gerhardstein.

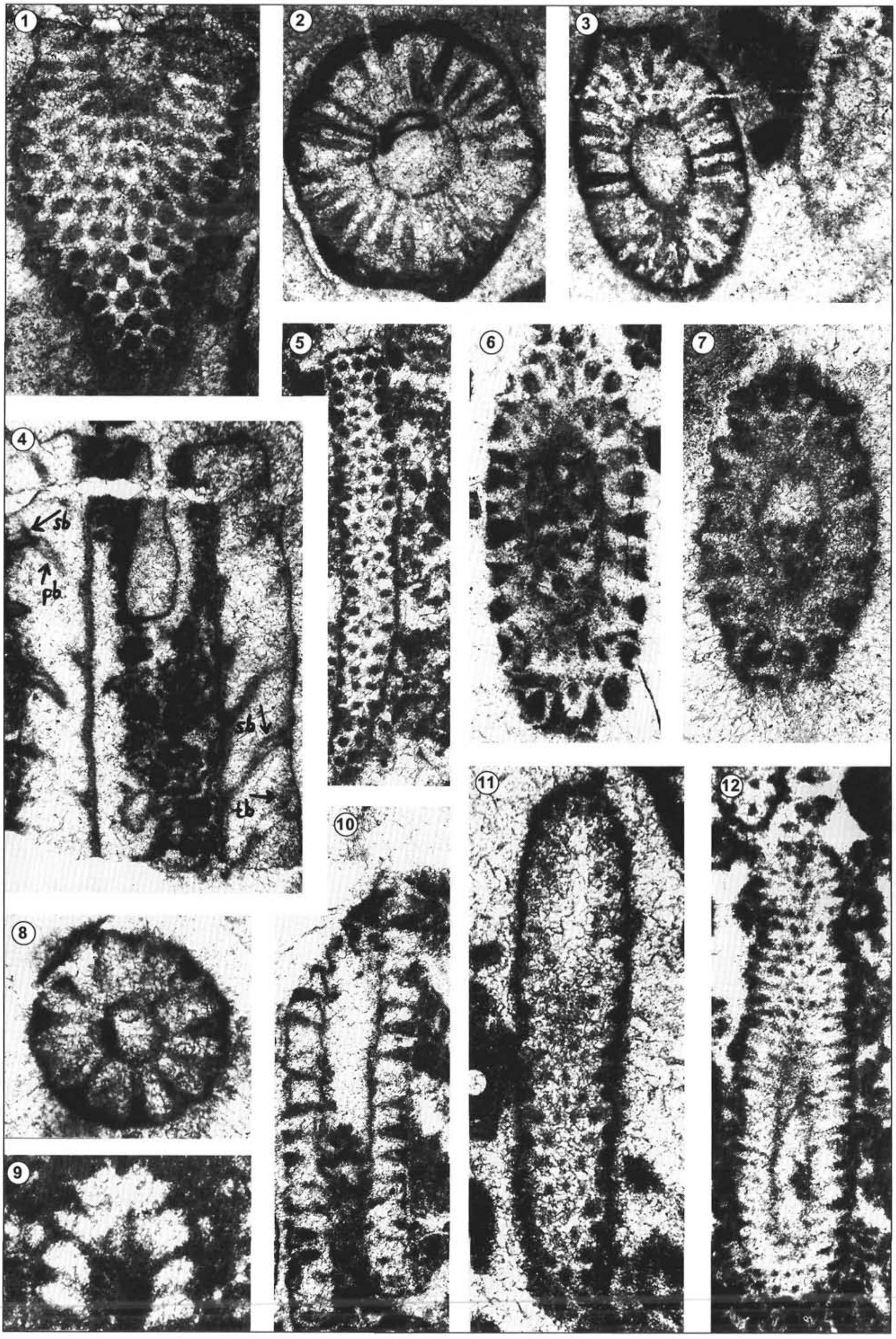
Remarks: Due to stratigraphy and facies, *P. striata* is much less frequent in the material we investigated than *P. ultragranulata*. *P. striata* has been used by previous workers for biozonation of the Alpine Plassen Formation (see discussion in chapter 5).

Protopeneroplis ultragranulata (GORBATCHIK, 1971)

(Pl. 6, Figs. 5–6, 9)

1992 *P. trochangulata* SEPTFONTAINE – DYA: 62, Lerchkogel limestone of Gerhardstein and Hochkranz (not figured).

Plate 8 ▶
Calcareous Algae (Dasycladales)
Fig. 1–3.
Salpingoporella gr. ***enayi*** BERNIER – tosaensis (YABE & TOYAMA). Fig. 1: Sample Kra 105 (x 50), fig. 2: Sample Kra 105 (x 60); Fig. 3: Sample Kra 105 (x 60).
Fig. 4.
Linoporella cf. ***kapelensis*** SOKAC & NIKLER, longitudinal section. Pb = primary branch, sb = secondary branch, tb = tertiary branch. Sample TW 21 (x 31).
Fig. 5, 8–9, 11.
Salpingoporella gr. ***pygmaea*** (GUEMBEL). Fig. 4: Longitudinal oblique section, sample TW 32 (x 52); Fig. 5: Tangential section, sample Kra 122-3 (x 44); Fig. 8: Sample Kra 103 (x 77).
Fig. 6–7.
Salpingoporella ? sp.. Fig. 6: Sample Kra 121 (x 55); Fig. 7: Sample Kra 126 (x 55).
Fig. 9.
Salpingoporella gr. ***johnsoni*** (DRAGASTAN), sample Kra 122-3 (x 125).
Fig. 12.
Salpingoporella ettaloni BERNIER. Sample Kra 122-1 (x 58).


sb
pb
sb
tb

1994 *P. trochangulata* SEPTFONTAINE – LOBITZER et al.: Pl. 12, fig. 1, 3, Barmstein Limestone of Salzburg Calcareous Alps.

Remarks: *P. ultragranulata* (GORBATCHIK) differs from *P. striata* WEYNSCHENK by its trochospiral test with angular periphery, larger dimensions and a pustulated ornamentation on the spire face. Dimensions: Diameter of test (D) = 0.34–0.53 mm, height of test (H) = 0.24–0.32 mm, ratio H/D = 0.58–0.63. The stratigraphic range is indicated as Middle Tithonian to Lower Barremian (HEINZ & ISENSCHMIDT, 1988; BUCUR, 1993). Most references in literature are from Berriasian strata.

Genus *Trocholina* PAALZOW, 1922

Trocholina alpina (LEUPOLD, 1935)

(Pl. 4, Fig. 7)

1988 *Trocholina alpina* (LEUPOLD) – ARNAUD-VANNEAU et al.: 359, fig. 3, pl. 4, fig. 1–12, Berriasian of France.

Remarks: *T. alpina* is typically found in biosparitic limestones of the outer platform (see tab. 1). A detailed description of *T. alpina* has been provided by ARNAUD-VANNEAU et al. (1988). The stratigraphic range is indicated as Upper Kimmeridgian to Upper Valanginian (BUCUR et al., 1995).

Trocholina cf. *delphinensis* ARNAUD-VANNEAU, BOISSEAU & DARSAC, 1988

(Pl. 4, fig. 9)

*1988 *Trocholina delphinensis* n. sp. – ARNAUD-VANNEAU et al.: 358, pl. 1, fig. 1, pl. 3, fig. 1–8.

Remarks: *T. delphinensis* is a high conical representative of *trocholina* with chamber lumina that in the adult stage are slightly inclined at their inner endings toward the apex. The latter feature, however, cannot be indicated with certainty in our single specimen. Test diameter: 1.17 mm, test height: 1.43 mm. Stratigraphy: Late Tithonian-Berriasian (Valanginian) (ARNAUD-VANNEAU et al., 1988).

Trocholina odukpaniensis DESSAUVAGIE, 1968

(Pl. 4, Fig. 3, 5–6)

1988 *Trocholina odukpaniensis* DESSAUVAGIE – ARNAUD-VANNEAU et al.: 361, pl. 5, fig. 7–22.

Remarks: *T. odukpaniensis* is characterized by thick calcareous walls delimiting the chamber lumina from the outer surface, which is best visible at the apex of the test. According to ARNAUD-VANNEAU et al. (1988) it has a stratigraphic range from the Berriasian to earliest Cenomanian. The clear identification of *T. odukpaniensis* in the sample TW 23, supports the probability that the species already appears in the uppermost Tithonian, as already suggested by ALTINER (1991: Fig. 3) in his stratigraphic table of Jurassic-Lower Cretaceous carbonate successions in North-western Anatolia/Turkey.

Genus *Troglotella* WERNLI & FOOKES, 1992

Troglotella incrustans WERNLI & FOOKES, 1992

(Pl. 3, Fig. 4, Pl. 6, Figs. 7, 9–10)

1980 *Lithocodium morikawi* ENDO – STEIGER: Pl. 29, fig. 1, Plassen Formation of the Krahstein (= *T. incrustans* and *L. aggregatum* ELLIOTT).

1991 boring foraminifera gen. et sp. indet – SCHLAGINTWEIT: 44, Pl. 10, fig. 13–14, Upper Aptian Urgonian limestones of Oberwössen/Chiemgau Alps.

1991 unnamed structure within *Lithocodium* crust – DARGA & SCHLAGINTWEIT: Pl. 2, fig. 6, Lerchkogel Limestone of Dietrichshorn/Salzburg Calcareous Alps.

Remarks: Nothing new can be added to the exhaustive descriptions and discussions by SCHMID & LEINFELDER (1996) and KOLODZIEJ (1997). *T. incrustans* may occur alone (endolithic stage, pl. 3, fig. 4) or with the typical association of *Lithocodium aggregatum* ELLIOTT (e. g. pl. 6, fig. 7).

4.3 Calcisphaerulidae

(Pl. 12, Figs. 9–10, 13–15)

Remarks: Late Jurassic to Early Cretaceous calcisphaerulidae are usually refered to the genera *Stomiosphaera,*

Plate 9

Calcareous Algae (Dasycladales)

Fig. 1–2.

Petrascula bursiformis ETTALON. Fig. 1: Fragment of the skeleton hamp, longitudinal section. The existence of tertiary branches is marked by the arrows. Sample Kra 103 (x 11); Fig. 2: Detail of Fig. 1 (zone indicated by black lines) showing bulbous primaries and higher order branches, sample Kra 103 (x 34).

Fig. 3–4.

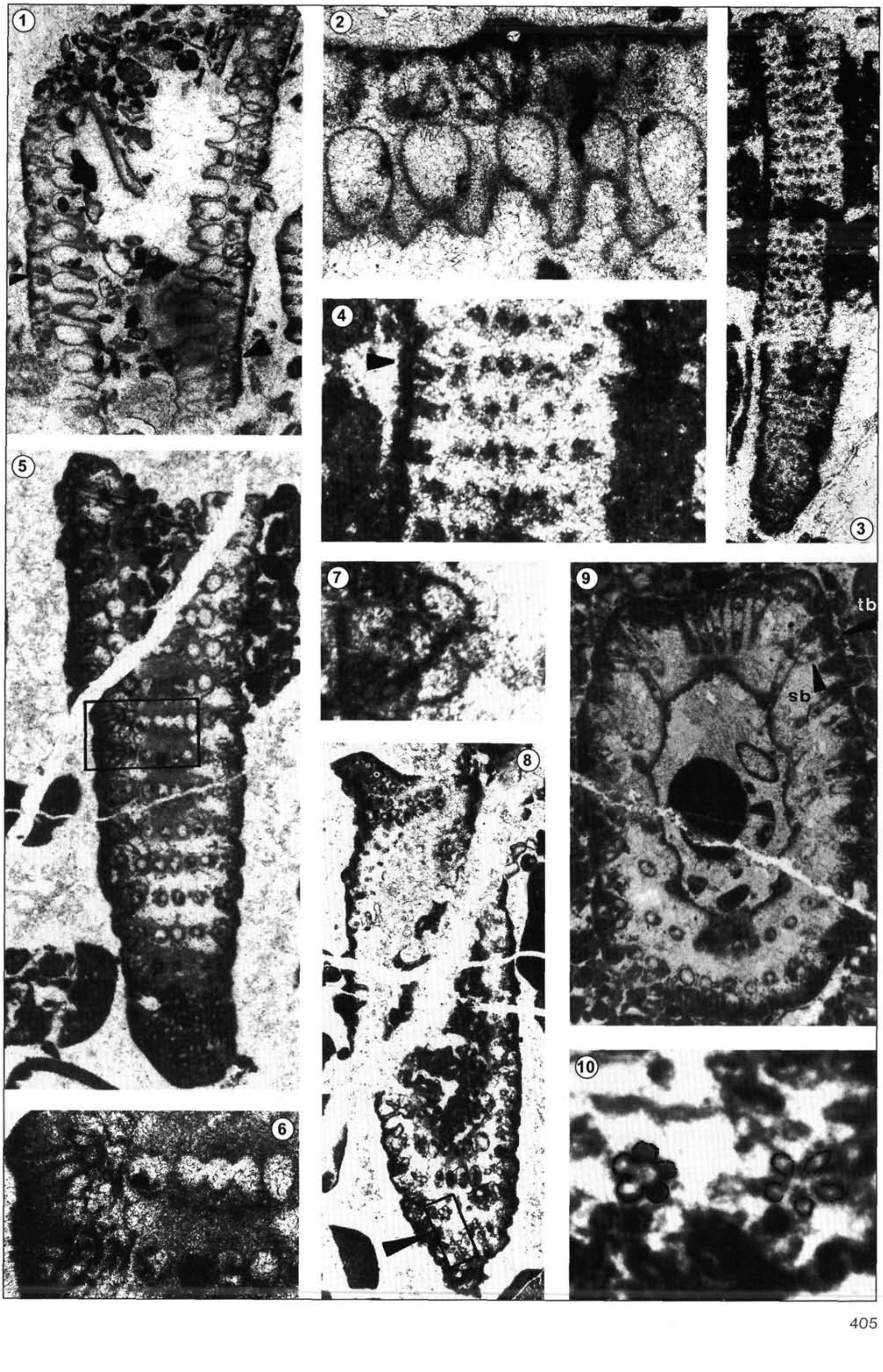
Linoporella? sp.. Fig. 3: Longitudinal-tangential section (black lines mark the detail of fig. 4). Sample Kra 128 (x 21); Fig. 4: Detail of Fig. 3 showing the secondary branches (? 3 to 4), sample Kra 128 (x 69).

Fig. 5–6, 8, 10.

Dissocladella cf. ***intercedens*** BAKALOVA. Fig. 5: Tangential section, sample TW 24 (x 21); Fig. 6: detail of figure 5 showing the two order of branches, sample TW 24 (x 58); Fig. 8: Oblique section, note the secondaries cut in the upper and lower portion, sample TW 24 (x 14); Fig. 10: Detail of figure 8 showing tufts of five secondaries, sample TW 24 (x 68).

Fig. 7, 9.

Linoporella gigantea (CAROZZI) FARINACCI & RADOICIC. Fig. 9: Oblique section. Sb = secondary branches, tb = tertiary branches, sample TW 21 (x 23); Fig. 7: Detail of figure 9 showing a bunch of four secondaries, sample TW 21 (x 91).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Cadosina and others. Determination criteria are besides others the wall thickness. The latter feature, however, might be obliterated by diagenetic alteration. Thus, we believe that the literature about this group of microfossils mainly provided by Czechoslovakian workers strongly needs a systematic taxonomic revision. We therefore desisted from a detailed determination to both, generic and specific level.

4.4 Sclerosponges

Genus ***Neuropora*** BRONN, 1825

Neuropora lusitanica TERMIER, 1985

(Pl. 7, Figs. 10–11)

*1985 *Neuropora lusitanica* n. sp. – TERMIER (in TERMIER & TERMIER): 207, pl. 5, fig. 1–2, text-fig. 4–5, Upper Oxfordian of the Lusitanian Basin/Portugal.
1986 Bryozoan type 1 – BRACHERT: 245, pl. 43, fig. 5, Lower Kimmeridgian of S-Germany.
1995 *Neuropora lusitanica* TERMIER – NOSE: Fig. 99, Upper Kimmeridgian of the Algarve Basin/Portugal.

Remarks: *Neuropora lusitanica* TERMIER (type-locality: Upper Jurassic of Portugal) is reported here for the first time from the Northern Calcareous Alps. It has been found in microfacies belonging to the outer platform (rare) and the upper to middle talus (more common). Because *N. lusitanica* occasionally occurs together with bryozoans displaying a similar light honey-coloured appearance, it can at first sight be mistaken for them (see synonymy).The skeleton is characterized by (sub) parallel septated tubes in encrusting morpho-types ("formes encroutantes") and parallel axial tubes ("tubes axiaux ou verticaux") with diverging lateral tubes ("tubes lateraux") in more nodular morpho-types ("formes rameuseses"). The paleoenvironment of *N. lusitanica* ranges from "deeper marine siliceous sponge-microbial encrusted reefs to shallow water, coral dominated reefs" (NOSE, 1995: P. 126). Dimensions: Diameter = 3–4 mm (NOSE, 1995: max. 3–4 mm), distance between tubes = 0.4–0.8 mm, inner tube diameter = about 0.8 mm.

4.5 Annelidae

Genus ***Terebella*** LINNE

Terebella lapilloides MÜNSTER, 1833

(Pl. 1, Fig. 5, Pl. 2, Fig. 6, Pl. 12, Fig. 6, 11)

1985 *Terebella lapilloides* MÜNSTER – KLIEBER: 125, pl. 4, fig. 1–2, pl. 5, fig. 1–2, Oxfordian of Franconian Alb/S-Germany.
1986 *Terebella lapilloides* MÜNSTER – BRACHERT: 244, pl. 42, fig. 6, pl. 44, fig. 3, Malm gamma of Franconian Alb/S-Germany.
1993 *Terebella lapilloides* MÜNSTER – LEINFELDER et al.: Pl. 41, fig. 3, Kimmeridgian of Algarve/Portugal.
1995 *Terebella lapilloides* MÜNSTER – NOSE: text-fig. 70, Upper Jurassic of Algarve basin/Portugal and Celtiberic zone of eastern Spain.
1996 *Terebella lapilloides* MÜNSTER – SCHMID: 204, Fig. 74, Oxfordian of Algarve/Portugal (with synonymy).

Remarks: In our material, it is possible to distinguish two varieties that mainly differ in the dimensions of their outer and inner tube diameters (see Tab. 6). Note, that the references listed above are from Upper Jurassic strata, our specimens, from the Trisselwand section, can be assigned to the Berriasian (see Tab. 1).

4.6 Microproblematica

Crust Problematicum SCHMID, 1996

(Pl. 12, Fig. 1)

1996 "Crust Problematicum" – SCHMID: 205, fig. 125–126, Kimmeridgian of the Lusitanian Basin/Portugal.

Remarks: The "Crust Problematicum" SCHMID, 1996 with very tiny superimposed cells occurs either encrusting (thickness of crusts usually 0.2–0.4 mm) large bioclasts such as corals (crustose morphotype) or forms nodular masses ("solenoporoid" morphotype, pl. 12, fig. 1). The association with *Koskinobullina socialis* CHERCHI & SCHROEDER mentioned by SCHMID (1996) may also be present in our material. The stratigraphic range of "Crust problematicum" extends from the Kimmeridgian into the Berriasian. Occurrences: Outer platform and talus facies, Trisselwand and Krahstein.

Genus ***Didemnoides*** BONET & BENVENISTE-VELASQUEZ, 1971

Didemnoides moreti (DURAND DELGA, 1957)

(Pl. 12, Figs. 7–8, 12)

1978 *Didemnoides moreti* (DURAND DELGA) – MIŠÍK & BORZA:

Plate 10

Calcareous Algae, Microproblematica

Fig. 1.
"Crust problematicum" SCHMID (1996), nodular morphotype ("solenoporoid"). Sample Kra 118 (x 12).
Fig. 2.
Epimastoporella jurassica (ENDO) SENOWBARI-DARYAN et al. Sample Kra 105 (x 32).
Fig. 3–4.
Pseudolithocodium carpathicum MIŠÍK. Fig. 3: in association with ***Thaumatoporella parvovesiculifera*** RAINERI, Sample Kra 123 (x 43); Fig. 4: Sample Kra 118 (x 53).
Fig. 5, 7.
Neoteutloporella socialis PRATURLON. Fig. 5: Sample TW 25 (x 17); Fig. 7: TW 25 (x 56).
Fig. 6.
Halimedoidea indet. Sample TW 25 (x 61).

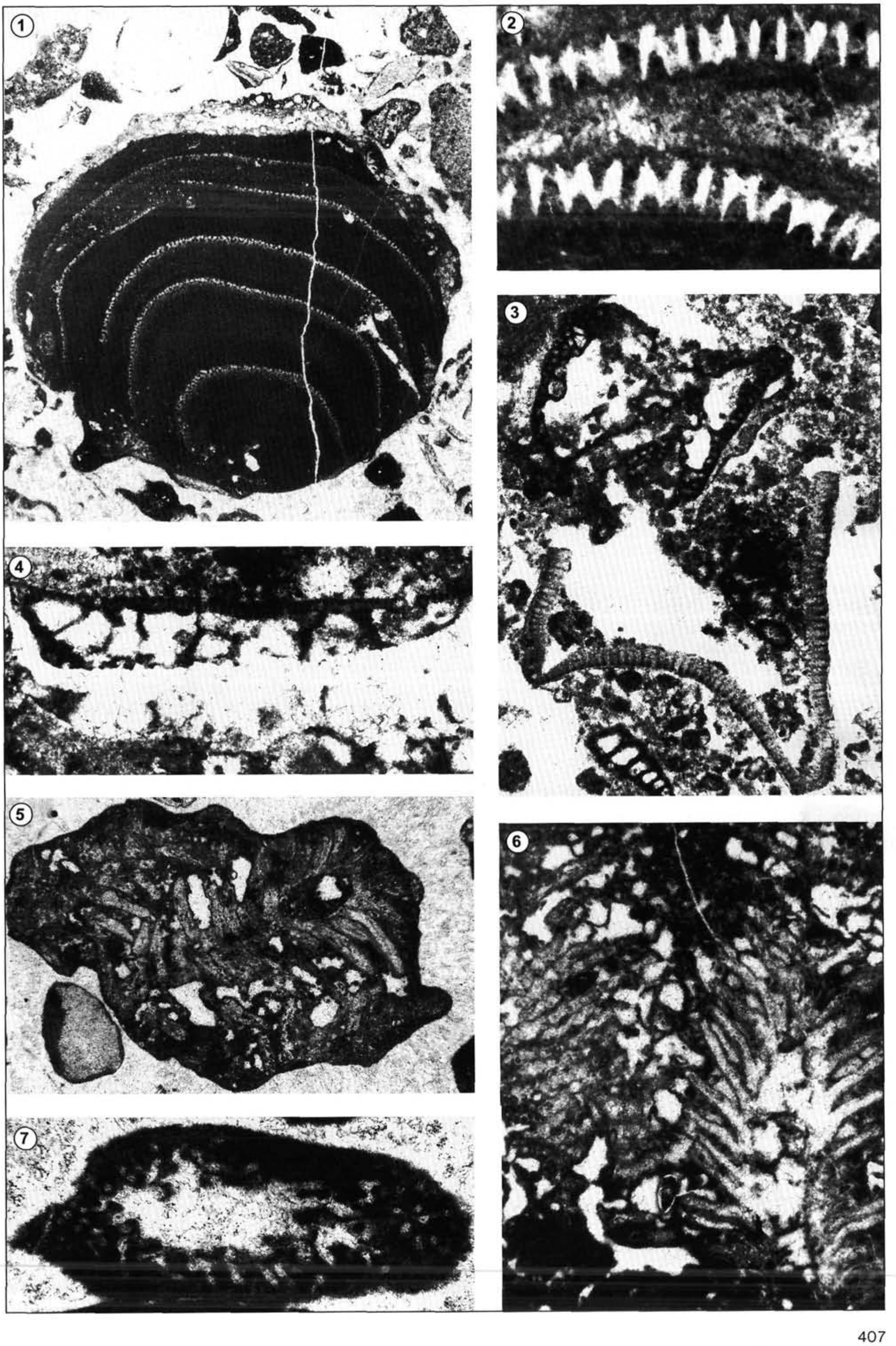
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Table 6.
Dimensions of *Terebella lapilloides* MÜNSTER from the Tressenstein Limestone. D = outer tube diameter, d = inner tube diameter, L max. = maximum observed length (in mm).

	Morphotype 1	Morphotype 2
D	0.21–0.28	0.6–0.76 mm
d	0.18–0.2	0.35–0.46 mm
Ratio d/D	0.69–0.84	0.55–0.61
L max.	0.96 mm	1.1 mm

312, pl. 2, fig. 1–19, pl. 3, fig. 1–9, Carnian to Lower Albian of Western Carpathians.

? 1981 *Enigma parvissima* (DRAGASTAN) – ELIASOVA: 30, pl. 3, fig. 1a-b, pl. 4, fig. 1, Tithonian of Czechoslovakia.

1994 *Didemnoides moreti* (DURAND DELGA) – BODROGI et al.: Pl. 1, fig. 1, pl. 2, fig. 1, pl. 4, fig. 1–4, Upper Santonian (? Lower Campanian) Gosau Group of Kainach/ Austria.

Remarks: The small, more or less spherical bodies are made up of radially arranged calcite crystals. Sometimes, a central hollow can be observed, that, according to BORZA & MIŠÍK (1978), is not primary in origin, but caused by dissolution. As revised by BONET & BENVENISTE-VELASQUEZ (1971), these spheroids belong to spiculae of Aszidae, similar to the modern genus *Didemnum.* The occurrences of *D. moreti* have been summarized by MIŠÍK & BORZA (1978), showing that it occurs from central reef areas to the basin facies, especially in (hemi-) pelagic settings, where it is associated with calcisphaerulids. In our material we observed *D. moreti* in the Plassen Formation with rare occurrences in the inner platform and common distribution within the whole talus facies. To the proposed synonymy of *Clypeina parvissima* DRAGASTAN with *D. moreti* by MIŠÍK & BORZA (1978), the genus *Enigma* ELIASOVA, 1981 (type-species *C. parvissimia*) must also be included. The total stratigraphic range of *D. moreti* is Carnian to Upper Santonian – ? Lower Campanian (MIŠÍK & BORZA 1978; BODROGI et al., 1994).

Genus **Koskinobullina** CHERCHI & SCHROEDER, 1979

Koskinobullina socialis CHERCHI & SCHROEDER, 1979

(Pl. 11, Fig. 10)

? 1972 Problematicum section multicellulair – FENNINGER & HOLZER: p. 116, Plassen Formation of Jainzen/Bad Ischl (not figured).

1982 *Koskinobullina socialis* CHERCHI & SCHROEDER – MIŠÍK & SYKORA: Pl. 5, fig. 2, Barmstein Limestone of Western Carpathians.

1991 *Koskinobullina socialis* CHERCHI & SCHROEDER – SCHLAGINTWEIT: 30, Pl. 8, fig. 17, Urgonian limestones of the Northern Calcareous Alps.

1991 *Koskinobullina socialis* CHERCHI & SCHROEDER – DARGA & SCHLAGINTWEIT: pl. 3, fig. 1, Lerchkogel Limestone of Dietrichshorn.

Remarks: It has been found in the talus facies, encrusting fragments of corals and hydrozoans (see table 2) that are assumed to be resedimented. From the Upper Jurassic of Portugal, the *"Tubiphytes"-Koskinobullina* association has been assigned to a middle ramp environment (SCHMID, 1995: p. 213 ff.).

Genus ***Mercierella*** FAUVEL, 1923

Mercierella? dacica DRAGASTAN, 1966

(Pl. 12, Figs. 1–3)

* 1966 *Mercierella? dacica* n. sp. – DRAGASTAN: 14, fig. 1–3, Tithonian-Berriasian of Apuseni Mountains/Romania.

1982 *Mercierella? dacica* DRAGASTAN – MIŠÍK & SYKORA: Pl. 3, fig. 7, Barmstein Limestones of Western Carpathians.

1987 *"Mercierella" dacica* DRAGASTAN – SOTAK: Pl. 11, fig. 4–5, Upper Tithonian-Lower Berriasian of the Outer Western Carpathians.

1987 *Mercierella? dacica* DRAGASTAN – BARATTLO & PUGLIESE: Pl. 12, fig. 1-11, Berriasian of Capri Island/ Italy.

1989 *Mercierella? dacica* DRAGASTAN – DRAGASTAN: 44, pl. 18, fig. 4–5, Tithonian of Eastern Carpathians/ Romania.

1995 *Mercierella? dacica* DRAGASTAN – CARRAS: Pl. 27, fig. 1–4, pl. 28, fig. 1–4, Kimmeridgian-Tithonian of Greece.

Remarks: Thin-walled tubes with two to three collars have a spinose appearance in longitudinal sections.

Plate 11

Calcareous Algae, microproblematica

Fig. 1.
Cylindroporella cf. ***arabica*** ELLIOTT. Sample TW 26 (x 128).

Fig. 2.
Clypeina jurassica FAVRE. Sample TW 26 (x 31).

Fig. 3–4, 6.
Acicularia sp. Fig. 3-4: Sample TW 35 (x 90); Fig. 6: Sample TW 35 (x 100).

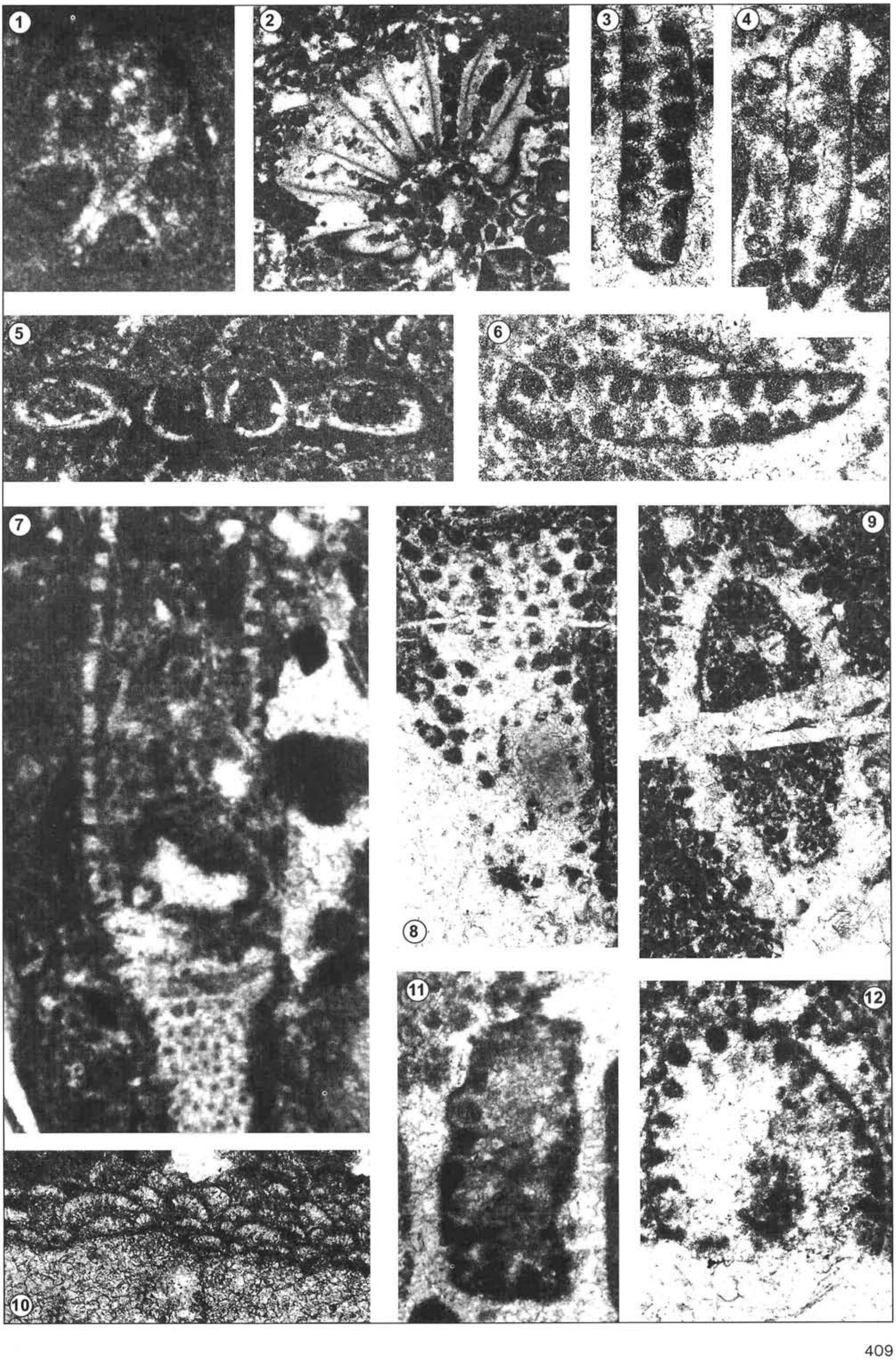
Fig. 5.
Clypeina sp. **A** PECORINI. Tangential section of a whorl Sample TW 27 (x 59).

Fig. 7.
Epimastoporella sp. Longitudinal section. Sample Kra 106 (x 39).

Fig. 8–9, 12.
Gyroporella ? sp. Fig. 8: Sample Kra 122-9 (x 35); Fig. 9: Sample Kra 122-9 (x 28), Fig. 12: Sample Kra 127-5b (x 62).

Fig. 10.
Microproblematicum ***Koskinobullina socialis*** CHERCHI & SCHROEDER. Sample TW 15 (x 70).

Fig. 11.
Clypeina cf. ***parasolkani*** FARINACCI & RADOICIC. Sample TW 35 (x 119).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Dimensions: outer diameter of tubes = 0.056–0.09 mm, inner diameter of tubes = 0.04–0.064 mm, wall thickness = 0.008–0.012 mm. The function of the collars may have been the better fixation to the mobile bottom substrate. The wall is typically bilamellar (see pl. 11, fig. 3). *Mercierella? dacica* DRAGASTAN represents an excellent facies microfossil that occurs predominantly in micropelloidal packstones and is said to be typical of the platform margin and upper talus facies (e. g. BARATTOLO & PUGLIESE, 1987: "deposits di margine"; CARRAS, 1995: "facies di margine e di piattaforma esterna"; SOTAK, 1987: "reef edge bindstones-framestones"). Cryptic habitats are possible. It occurs resedimented within clasts in the middle talus facies of the Trisselwand section. From the Calcari di Distomon of Greece, CARRAS (1995) mentions comparable biota accompanying *Mercierella? dacica* DRAGASTAN with *Tubiphytes*, Protopeneroplids, Mohlerina basiliensis (MOHLER), *Trocholina spp.* and *Salpingoporella* gr. *pygmaea* (GUEMBEL). The total stratigraphic range of *M.? dacica* is given as Kimmeridgian to Berriasian (DRAGASTAN, 1989). In our material it has been found in the (upper) talus facies and resedimented within clasts in the middle talus (Pl. 11, fig. 2). It is noteworthy that we also observed *M. ? dacica* within a comparable facies in the Plassen Formation of the Krahstein/Salzkammergut and the Lerchkogel Limestone of the Litzelkogel.

Genus *Pseudolithocodium* MIŠÍK, 1979

Pseudolithocodium carpathicum MIŠÍK, 1979

(Pl. 10, Figs. 3–4)

* 1979 *Pseudolithocodium carpathicum* nov. gen., nov. sp. – MIŠÍK: 7, pl. 2, fig. 2–8.

Remarks: *P. carpathicum* MIŠÍK occurs very frequently in the peri-reefal limestones of the Krahstein, and is associated with *Thaumatoporella parvovesiculifera* RAINERI. It has been regarded synonymous to *Lithocodium aggregatum* ELIOTT by BANNER et al. (1990) and SCHMID & LEINFELDER (1996). The first authors consider *L. aggregatum* to be a codiacean alga, whereas SCHMID & LEINFELDER regard *L. aggregatum* and consequently also *P. carpathicum* a loftusiid foraminifer. SENOWBARI-DARYAN et al. (1994) remark a possible difference at the specific level. In our opinion, *P. carpathicum* and *L. aggregatum* are two different taxa (see table below), so that the first should rather be considered another species of the genus *Lithocodium* ELLIOTT because in the original generic definition of ELLIOTT (1956: p. 331) nothing has been said about the degree of calcification: "Encrusting or nodose Codiaceae with a subdermal structure similar to that of the segmented *Boueina*". Thus, it is questionable whether the characteristic of *Pseudolithocodium* that "the tubes of cortical layer are densely packed, not submerged in micrite" (MIŠÍK, 1979: p. 709) justifies the creation of a new genus.

Genus *Radiomura* SENOWBARI-DARYAN & SCHÄFER, 1979

Radiomura cautica SENOWBARI-DARYAN & SCHÄFER, 1979

(Pl. 7, Figs. 8–9)

1980 *Radiomura cautica* SENOWBARI-DARYAN & SCHÄFER – SENOWBARI-DARYAN: 86, pl. 20, fig. 1-8, Upper Triassic of Northern Calcareous Alps.

1992 *Radiomura cautica* SENOWBARI-DARYAN & SCHÄFER – DYA: 91, pl. 5, fig. 4, 10, Berriasian of the Northern Calcareous Alps (Lerchkogel Limestone).

Remarks: *R. cautica* has originally been described from Upper Rhaetian reef limestones of the Northern Calcareous Alps. DYA (1992) described *R. cautica* from a Berriasian fore-reef breccia (Lerchkogel Limestone) of the Hochkranz/Salzburg Calcareous Alps. The stratigraphic range of *R. cautica* is Middle Triassic – Cretaceous (SENOWBARI-DARYAN pers. comm.). In our material, it occurs in reefal limestones of the Krahstein, where *R. cauti-*

Plate 12

Microproblematica, Calcisphaerulidae

Fig. 1–3.
Mercierella*? *dacica DRAGASTAN. Fig. 1: Sample Kra 125 (x 200), fig. 2: Sample TW 14 (x 78), fig. 3: TW 21 b (x 146).

Fig. 4–5.
Tubiphytes morronensis CRESCENTI. Fig. 4: "***Tubiphytes*** chimney" sensu SCHMID (1995). Sample TW 17 (x 29); Fig. 5: Longitudinal section showing pyriform chambers. Note agglutinated material in the micritic envelope and ***Salpingoporella*** sp. on the right. Sample TW 11 (x 35).

Fig. 6, 11.
Agglutinated polychaete ***Terebella lapilloides*** MÜNSTER. Fig. 6: Longitudinal section, sample TW 15-1 (x 25); Fig. 11: Cross section, slightly oblique, sample TW 18 (x 30).

Fig. 7–8, 12.
Didemnoides moreti DURAND DELGA. Fig. 7: Sample TW 14 (x 122), Fig. 8: Sample TW 27 (x 161); Fig. 12: Sample TW 27 (x 183).

Fig. 9.
Calcisphaerulidae indet. Sample TW 5 (x 280).

Fig. 10.
Calcisphaerulidae indet. Sample TW 19-1 (x 253).

Fig. 13.
Calcisphaerulidae indet. Sample TW 15-2 (x 253).

Fig. 14.
Calcisphaerulidae indet. Sample Kra 122-1 (x 263).

Fig. 15.
Calcisphaerulidae indet. Sample TW 10 (x 242).

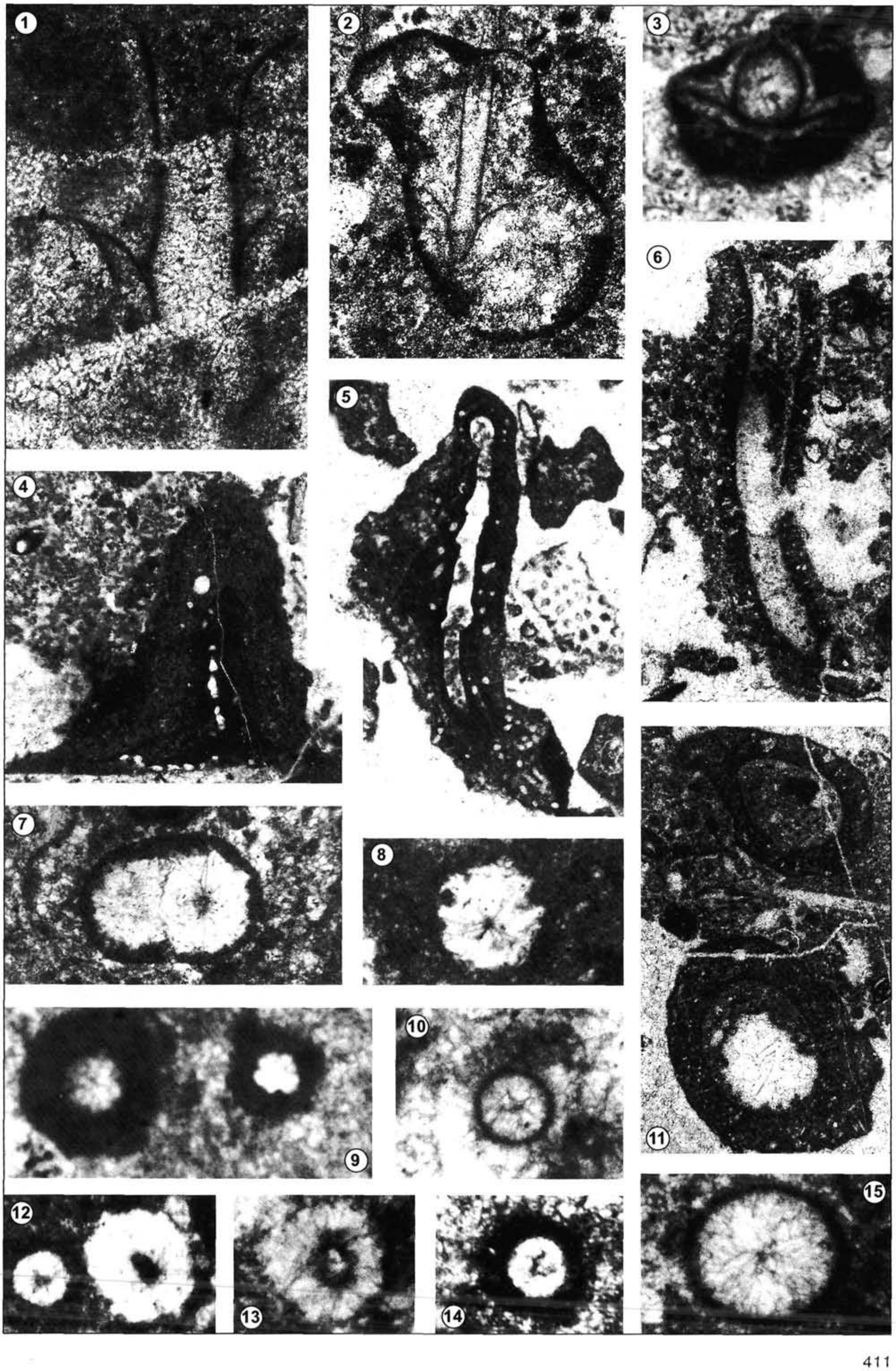
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Table 7.
Main differences between *L. aggregatum* ELLIOTT and *P. carpathicum* MIŠÍK. Dimensions of pore diameter after SENOWBARI-DARYAN (1980) and MIŠÍK (1979).

	Lithocodium aggregatum	*Pseudolithocodium carpathicum*
Stratigraphy	Anisian-Upper Cretaceous (acc. to SCHMID & LEINFELDER, 1996)	? Upper Jurassic (Tithonian)
Lithocodium-Troglotella consortium	known from Kimmeridgian to Lower Cretaceous	*Troglotella incrustans* not reported within the tissue
Bacinella stage	May be present	Missing
Outer pores (or cortical filaments)	diameter 0.05–0.1 mm, mostly bifurcating, often diverging	diameter 0.01–0.015 mm, rarely bifurcating, close set, and more or less parallel to each other
Facies	Quiet water depoits (inner platform) and external habitats of moderately to well agitated water	Open marine, external habitats of moderately to well agitated water

ca is fixed to corals, and peri-reefal limestones of the Lärchberg Formation of the Litzelkogel, near Lofer. In the Upper Triassic, *R. cautica* is also restricted to the central reef region (SENOWBARI-DARYAN, 1980).

Genus *Thaumatoporella* RAINERI, 1922

Thaumatoporella parvovesiculifera (RAINERI, 1922)

(Pl. 10, Fig. 3)

1967 *Thaumatoporella parvovesiculifera* (RAINERI) – FENNINGER & HÖTZL: 18, pl. 1, fig. 5, pl. 3, fig. 5, Plassen Formation of the type-locality Mount Plassen.
1972 *Thaumatoporella parvovesiculifera* (RAINERI) – FENNINGER: Pl. 3, fig. 1–3, Barmstein Limestones near Trattberg/Salzburg.
1992 *Thaumatoporella parvovesiculifera* (RAINERI) – DYA: 92, pl. 5, fig. 1–2, Plassen Formation of Mount Untersberg, Lärchberg Formation of the Lofer area.

Remarks: At Mount Krahstein abundant (par-) autochthonous thalli, typically associated with *P. carpathicum* MIŠÍK, occur in near reef limestone (Pl. 10, fig. 3). Fragments of *T. parvovesiculifera* occur resedimented within the talus sediments of the Trisselwand section and even the Oberalm transitional facies, showing that they could withstand transport well.

Genus *Tubiphytes* MASLOV, 1956

Tubiphytes morronensis CRESCENTI, 1969

(Pl. 2, Fig. 5, Pl. 4, Fig. 13, Pl. 12, Figs. 4–5)

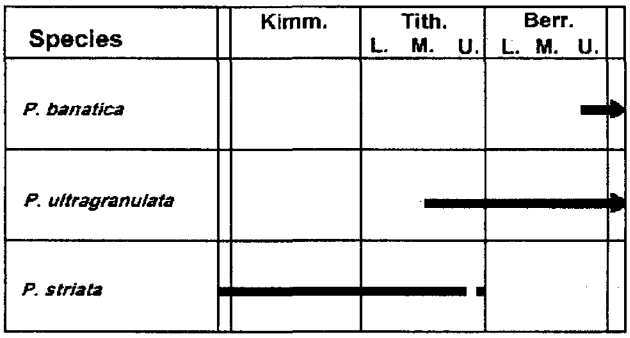
1970 *Tubiphytes morronensis* CRESCENTI – FENNINGER & HOLZER: Pl. 17, fig. 5, Plassen Formation of Stubwieswipfel.
1986 *Labes atramentosa* nov. gen., n. sp. – ELIASOVA: 109, pl. 1-2, text-fig. 1, Tithonian of the Outer Flysch Carpathians.
1994 *Tubiphytes morronensis* CRESCENTI – LOBITZER et al: pl. 12, fig. 4, Barmstein Limestones of Northern Calcareous Alps.

Remarks: *T. morronensis* is abundant in the proximal talus environment, occurring together with echinoids and bryozoan. In a more downslope position it typically is associated with the *"Tubiphytes"-Terebella* facies. It has rarely been observed within the sparitic Plassen Formation of the outer platform. In our material we observed both free and fixed specimens; fixed types forming "*Tubiphytes* chimneys" and massive growth forms (SCHMID, 1996). The latter have also been termed "complex *Tubiphytes* nodules" by LEINFELDER et al. (1993).These show a striking resemblance to the incertae sedis *Labes atramentosa* ELIASOVA (1986) from the Tithonian of the Outer Flysch Carpathians of Czechoslovakia, which, in our opinion, must be regarded equivalent to *T. morronensis* CRESCENTI. In our samples, it is most typical for the upper and middle talus facies.

5. Biostratigraphy

A chronostratigraphic subdivision of the Plassen Formation is not possible yet, because ammonites are almost completely missing. Biozonation, of Alpine Upper Jurassic – p. p. Lower Cretaceous platform carbonates, based on dasycladales and benthic foraminifera is especially difficult because longer profiles that would allow detailed continuous sampling are rare, due to large and small scale faulting and folding and the karstification of the steep flanked outcrops. Moreover, there are no stratigraphic boundaries defined on the basis of lithologic units. Therefore, the biostratigraphy must be constructed by using well-known range charts of dasycladales and benthic foraminifera that have been established elsewhere in other parts of the Tethys (e. g. ARNAUD-VANNEAU et al., 1991). In our opinion, the maximum time range of each taxon has to be considered since the coenozone concept, including mass occurrences and typical for-algal associations, that has been worked out for the Apennine Mountains, cannot be applied to the Upper Jurassic of the Northern Calcareous Alps, as proposed by FENNINGER & HÖTZL (1967) and STEIGER & WURM (1980). These are, however, essentially Italian "stages" and thus of limited value for detailed stratigraphy. For example, CHIOCCHINI et al. (1994) use a biozone with *P. striata* for the interval Early Bajocian – Oxfordian of the Central-Southern Apennines. STEIGER & WURM (1980) indicate an (Upper) Oxfordian age for the lower part of the Plassen Formation, deduced on the abundant occurrences of *Protopeneroplis striata* WEYNSCHENK. The species may, however, also be very frequent in higher stratigraphic positions, e. g. the Tithonian of Sicily/Italy (BUCUR et al., 1996). In the Trisselwand section, for example, *P. striata* occurs in the Middle/Late Tithonian (table 1), as is also the case for *Protopeneroplis ultragranulata* (GORBATCHIK), that flourished in well-agitated water and therefore is abundant in tidal oolites as well as in the reef flat, showing that its occurrence is facies-controlled. It is important to note that *Protopeneroplis ultragranulata* (GORBATCHIK, 1971), established in the Russian literature, was overlooked

Tab. 8.
Stratigraphy of representatives of the genus *Protopeneroplis* WEYNSCHENK after BLANC et al. (1992), BUCUR (1993) and SEPTFONTAINE (1974).



for a long time (SEPTFONTAINE et al., 1991). *P. trochangulata* SEPTFONTAINE, a junior synonym of the former, was introduced in 1974, and therefore the older determination of *Protopeneroplis striata* WEYNSCHENK in the Alpine literature of the sixties and seventies, along with stratigraphic conclusions have to be treated with caution (see tab. 8). It can be speculated that determinations of *Protopeneroplis* sp. (e. g. FENNINGER & HOLZER, 1970) could actually be *P. ultragranulata*. In fact, in reviewing the literature, there is no data supporting an Oxfordian age for any part of the Plassen Formation.

The dasycladale *Clypeina jurassica* FAVRE, often reported from the Alpine Plassen Formation, is known to occur from the Upper Kimmeridgian (*eudoxus*-zone) to the base of the Upper Berriasian (*paramimounum*-zone) (DE CASTRO, 1994). Consequently, the occurrence of *Clypeina jurassica* FAVRE in the basal parts of the Alpine Plassen Formation can be taken as a useful marker, indicating astratigraphic age not older than the Upper Kimmeridgian. On the other hand, the absence of *C. jurassica* FAVRE in the reef-facies of the Krahstein (STEIGER, 1980: p. 224) does not have stratigraphic implications because *C. jurassica* is a typical lagoonal flora element, and it does usually not occur in the "sparitic Plassen Formation" of the outer platform. The absence of *C. jurassica* in various localities of the Plassen Formation should therefore be taken to be facies controlled and not to be indicative for stratigraphic differences as assumed also by FENNINGER & HÖTZL (1967: p. 28). At Untersberg, near Salzburg, the basal breccia of the Plassen Formation containing *Clypeina jurassica* FAVRE is followed by wackestones with the benthic foraminifera *Kurnubia palastiniensis* HENSON, *Labyrinthina mirabilis* WEYNSCHENK, and *Neokilianina rahonensis* (FOURY & VINCENT) (DYA, 1992; own observations). This beginning of the shallow water platform sedimentation can be assigned to the Upper Kimmeridgian. Consequently, the *"Alveosepta jaccardi & Clypeina jurassica"* zone established by DYA (1992) and a given range from the uppermost Lower Kimmeridgian to the Middle Kimmeridgian must be revised. Following BERNIER (1984: fig. 164), *A. jaccardi* ranges from the Upper Oxfordian to the end of the Upper Kimmeridgian. *A. jaccardi* can therefore have been coeval with *C. jurassica* during the Upper Kimmeridgian interval. In the area of Bad Ischl/Salzkammergut, the sedimentary model of HERRMANN (1991: Fig. 2), that he established with biostratigraphic data, also shows the beginning of carbonate platform sedimentation to be the Upper Kimmeridgian. The Lower Kimmeridgian, on the other side, is represented by pelagic swell sediments of the Agatha limestone.

The following taxa, most of them illustrated for the first time from the Alpine Plassen Formation and the Oberalm transitional facies, are noteworthy because of their stratigraphic importance:

Calcareous algae

Dissocladella intercedens BAKALOVA: Upper Tithonian – Berriasian (? Valanginian) (GRANIER & DELOFFRE, 1993; SCHINDLER & CONRAD, 1994)

Linoporella gigantea (CAROZZI) FARINACCI & RADOICIC: Kimmeridgian – Valanginian (BUCUR, CONRAD & RADOICIC, 1995)

Linoporella kapelensis SOKAC & NIKLER: Tithonian (GRANIER & DELOFFRE, 1993), ? Berriasian (own obs.)

Petrascula bursiformis (ETTALON): Kimmeridgian-Tithonian (GRANIER & DELOFFRE, 1993)

Benthic foraminifera

Anchispirocyclina lusitanica (EGGER): Tithonian – Lower Berriasian (own observations for the Northern Calcareous Alps)

Charentia cuvillieri NEUMANN: Late Tithonian – Cenomanian (BUCUR, CONRAD & RADOICIC, 1995; own observations)

Meandrospira favrei (CHAROLLAIS et al.): Late Berriasian – Aptian (ARNAUD-VANNEAU et al., 1987; own observations)

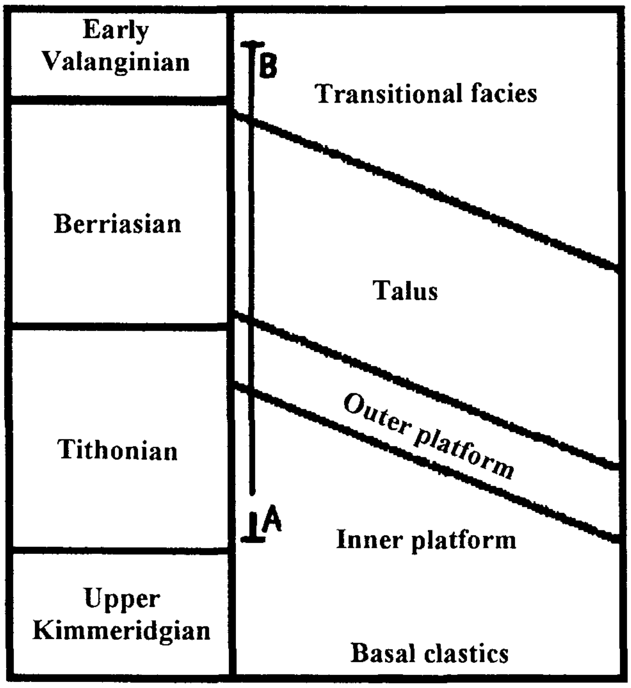
Protopeneroplis ultragranulata (GORBATCHIK): Middle Tithonian – Lower Barremian (HEINZ & ISENSCHMID, 1987, BUCUR, 1993)

Trocholina delphinensis ARNAUD-VANNEAU et al. – (Lower) Upper Berriasian – Valanginian (ARNAUD-VANNEAU et al., 1988)

Trocholina odukpaniensis DESSAUVAGIE: Late Tithonian – Albian (BUCUR, CONRAD & RADOICIC, 1995; own observations)

Neotrocholina valdensis (REICHEL): Upper Berriasian – Valanginian (ARNAUD-VANNEAU et al., 1991; ALTINER, 1991; BUCUR, CONRAD & RADOICIC, 1995)

Although the above mentioned species have been found in different samples and not in one association, they clearly show that the Berriasian stage is well documented in our investigated material of the talus facies (Table 1). A Berriasian age for parts of the Lerchkogel limestone in the area of Lofer, but in an inner platform setting, has already been described by DARGA & SCHLAGINTWEIT (1991) and DYA (1992). Additionally, FENNINGER & HOLZER (1970: Pl. 17, fig. 4) figured *Triploporella neocomiensis* RADOICIC (= *Diplopora johnsoni* PRATURLON) from the Plassen Formation of Sandling, a species that according to ARNAUD-VANNEAU et al. (1991) is restricted to Berriasian – Valanginian strata. From the top parts of the Krahstein *Clypeina parasolkani* FARINACCI & RADOICIC has been illustrated by STEIGER & WURM (1981: pl. 26, fig. 2 *"Salpingoporella annulata* CAROZZI"), indicating a (Upper Tithonian) Berriasian – Valanginian age (BUCUR, CONRAD & RADOICIC, 1995). A lower/middle Berriasian age for some Barmstein Limestones of the Salzburg Calcareous Alps has been reported by LOBITZER et al. (1994), based on the co-occurrence of *Protopeneroplis ultragranulata* (GORBATCHIK) with *Clypeina jurassica* FAVRE. The former, however, may be also present in the Middle and Upper Tithonian. For the sample TW 2, containing *Meandrospira favrei* (CHAROLLAIS, BRÖNNIMANN & ZANINETTI) and *Neotrocholina valdensis* REICHEL, we assume an Early Valanginian age on the basis of the location within the investigated stratigraphic column and the range charts of the two species. One sample (leg. D. BOOROWA) of the Oberalm transitional facies, exposed in the so-called "Loitzl-Schlucht" located at the path to the Trisselwand, contained fragments of *C. jurassica* FAVRE indicating an age older than the Upper Berriasian. This documents a diachronism of the boundaries of the facies zones and that our stratigraphic succession only applies to the limestones exposed along the forested way from Tressenstein Pass to the Trisselwand (Text-Fig. 4). Another example is the occurrence of clasts of the *Tubiphytes-Terebella* facies in the Upper Tithonian samples



Text–Fig. 4.
Diachronous facies zones of the Plassen Formation of the Trisselwand. The line A-B marks the studied section.

of the Tressenstein Limestone, showing that this characteristic facies of the middle talus already existed during the Upper Tithonian, whereas in the Trisselwand succession it is Berriasian in age.

On the basis of the microfauna and flora, and hydrozoans, the age of the Tressenstein Limestone at the type-locality has been assigned to the Kimmeridgian (HÖTZL, 1967, FENNINGER & HÖTZL, 1967), and the same stratigraphy has been assigned to the Tressenstein Limestone of Sandling, located about 3 kilometers north-west of Trisselwand. The stratigraphic range of the entire Tressenstein Limestone has been considered to be Kimmeridgian – Tithonian by HOLZER (1978). We suggest that a critical reconsideration of the Kimmeridgian age, previously assigned to parts of the Tressenstein Limestone, is necessary, because our samples TRS 1-11 indicate (upper) Tithonian age on the basis of the calpionellids with Perisphinctidae.

Exposures of the paleo-slope facies, followed by the high-energy sparitic outer platform deposits, and finally the micritic inner platform facies of the Plassen Formation may be observed along the path leading from the Tressenstein Pass upwards to the Ahornkogel and further to the summit of Trisselwand. The following carbonate facies can be differentiated in the Trisselwand succession:

- Oberalm transitional facies: Early Valanginian
- talus facies: (Early Valanginian?) Berriasian
- outer platform: (p. p. Berriasian) – Upper Tithonian
- inner platform: Lower/middle Tithonian

In summary, the stratigraphic range of the Plassen Formation is Upper Kimmeridgian – Berriasian (Early Valanginian?). The same stratigraphy has also been ascertained for the Lärchberg Formation (FERNECK, 1962) of the Lower Juvavic Lofer-Hallstatt nappe (SCHLAGINTWEIT & EBLI in prep.). In our opinion this common stratigraphy is not just an accidental coincidence, but rather an indication of a common genetically linked tectonosedimentary history. Based on the faunal and flora elements occurring in our samples, we conclude that the Jurassic/Cretaceous-boundary should be placed within the sparitic facies of the Plassen Formation, approximately in the transition of the platform margin to the talus (Tab. 1). However, we have not found an exact biostratigraphic marker for this boundary. Revising the literature data, *P. striata* is not recorded to persist into the Berriasian, whereas it seems to be present still in the Upper Tithonian. In sample TW 35, taken about 200 m beyond the path-crossing leading to Zinkenkogel, we found *P. ultragranulata* (GORBATCHIK) together with *A. lusitanica* (EGGER) in a wackestone/packstone, showing a mixing of the faunal and flora elements of the inner and outer platform facies. This documents, that the inner platform facies reaches at least the Middle Tithonian.

Generalizations of our stratigraphic data obtained from the different facies zones of the Trisselwand section should not be indiscriminately transferred to other occurrences of the Plassen Formation without further stratigraphic analysis. However, initial investigations of other outcrops of the Plassen Formation, have shown that our stratigraphic succession of facies zones can also be applied there.

6. Paleogeographic implications

According to modern paleogeographic concepts, the Northern Calcareous Alps and the Southern Alps constituted the opposite sides of an oceanic realm that was part of the Tethys which terminated in the Austroalpine region. This former oceanic realm has received various names: Austroalpine aulacogen (LEIN, 1987), Neotethyan bay (FRANK, 1987), gulf of the old Triassic Tethys ocean (DECKER, FAUPL & MÜLLER, 1987) and Hallstatt/Meliata ocean (e. g. SCHWEIGL & NEUBAUER, 1997). In the context of plate tectonics, the southern rim of the Northern Calcareous Alps was involved in the compressional tectonics of the closure of the Hallstatt-Meliata ocean that started in the Dogger and resulted in accretion, block faulting and uplift (GAWLICK, 1996). This first affected the Juvavicum as the structurally highest part of the Alpine Limestone Nappes. It should also be mentioned that in the Western Carpathians a comparable situation has been reconstructed for the Silica gravity nappe system overlying the Meliata Unit, which is supposed to be equivalent to the Hallstatt nappe ascribed to Late Jurassic ("Neo-Cimmerian") tectonic movements (MICHALIK, 1994; RAKUS, 1996). Recently SCHWEIGL & NEUBAUER (1997a, b) proposed a model that exactly follows the paleogeographic scheme presented by RAKUS (1996) by postulating the separation of the Tyrolian and Juvavic realm by a branch of the Vardar ocean. However, in our opinion, this model can not explain the occurrence of synsedimentary Tithonian Barmstein Limestones within the Oberalm Formation of the Tyrolian Unit if the platforms of the Plassen Formation were separated from their depositional area by means of an accretionary wedge during late Jurassic times. It is noteworthy that the Barmstein Limestones of the type-locality represent deposition in **proximal areas** with transportation directions from south, west and south-west (STEIGER, 1981). This constellation requires a closer position of the source areas, which excludes the transportation of the Juvavic nappes over the Tyrolian unit during mid-Cretaceous times as concluded by SCHWEIGL & NEUBAUER (1997a, b). GAWLICK et al. (1994) carried out very detailed examinations of Conodonts from Triassic lithologies of the Juvavic domain. By applying the Conodont Alteration Index (CAI) they state that metamorphosis in the southern parts of the NCA reached temperatures up to 450 °C. They found a very complicated distribution-pattern of different domains with equivalent temperatures. By means of detailed mapping of the Juvavic Zone they recognized a melange-like structure of this tectonic unit with olistolithic mega-blocks of up to nappe-size. The best explanation for the strongly differing metamorphosis of the Juvavicum would be a stacking of the "olistoliths" with strongly varying burial depths in an accretionary wedge. This metamorphosis was related to the final closure of the Meliata-Hallstatt branch of the Vardar ocean. Both, this closure and the initial emplacement of the Juvavicum by gravity tectonics occured in Late Jurassic times. Therefore the metamorphism should predate the Hallstatt gravity tectonics. This assumption is in accordance with the data of KRALIK et al. (1987): metamorphosis about 135–150 Mio. y.). Further evidences for Late Jurassic sliding tectonics is provided by the Trisselwand section that shows a complete basin-talus-platform succession. As discussed by TOLLMANN (1987: p. 118), "the best indication for "sedimentary tectonics" is a sedimentary contact between the sliding block or nappe and the surrounding younger sediments of the basin".

The final drowning of the platforms, during the Berriasian, is related to accelerated tectonic subsidence, and the sliding of the Juvavic blocks into deeper parts of the Oberalm-Schrambach basin. The Early? Valanginian age of parts of the Oberalm transitional facies of the Trisselwand nearly closes the stratigraphic gap that existed between the end of the carbonate platform evolution and the starting of the siliciclastic-flyschoid Rossfeld-Formation (FAUPL & TOLLMANN, 1978) in the Upper Valanginian (WEIDICH, 1990). Siliciclastic detritus and heavy minerals such as chrome spinels, occurring in the Rossfeld Formation, have so far not been mentioned in the Plassen Formation. The absence of ultrabasic detritus in the Plassen Formation can be explained by the geometry of the sliding blocks: In a model, assuming southward dipping, as is indicated for the Lerchkogel Limestone of the Hallstatt-Lofer Nappe (SCHLAGINTWEIT & EBLI in prep.), the blocks would have functioned as a barrier, so that siliciclastic/ultrabasic detritus could not reach the platform itself or the Tyrolian realm. With regard to the facies map of the Plassen Formation of Rötelstein (STEIGER & WURM, 1980), it is striking that the reef, e. g. *Ellipsactinia* limestones, and reef-debris facies are restricted to the southern part of the plateau, showing a SW–NE orientation. This supports a model, assuming block geometry with a more gentle dipping southern ramp-like talus and a steep northern flank, explaining some of the main sedimentological clast spectrum differences between the mass flow deposits of the Tressenstein Limestone of the southern flanks and the Barmstein Limestone (type-locality!) of the northern flanks. The steep morphology towards the north would have produced high energy turbidites, eroding down into the Triassic basement of the platform, producing the observed extraclasts. Moreover, a northern "by-pass margin" could explain the missing of clasts of the talus facies in the Barmstein Limestones (type-locality!).The corresponding southern talus of the Plassen Formation was a depositional type of margin presumably of a ramp-like morphology.

7. Conclusions

New stratigraphic results are presented, showing that the Plassen Formation of the Trisselwand succession was deposited on a carbonate platform that did not have any siliciclastic influx during the Upper Kimmeridgian to Berriasian. The latter stage is well documented in the platform talus facies. The profile, consisting of lagoonal wackestones overlain by outer platform limestones, which in turn are covered by slope deposits, indicates a retrograde (transgressive) cycle of carbonate platform evolution. The characteristic succession of facies zones and the biostratigraphic analysis shows that the sedimentary environment continuously deepened (drowning) without yielding evidence for the Berriasian global regression (HAQ et al., 1988). Signs of emersion or shallowing tendencies (regression or uplift), assumed by STEIGER & WURM (1980) for the Tithonian Plassen Formation of Krahstein/Rötelstein, have not been observed in the Trisselwand succession.

Sedimentation of the Plassen Formation took place on blocks of Triassic limestones and dolomites that were uplifted as a result of the closure of the Hallstatt-Meliata ocean, and the collision and obduction of its former opposite margins. Uplift must have been short termed, followed by continuous subsidence from the Kimmeridgian until the Late Berriasian/Early Valanginian. The diachronous facies zones can be best explained by sedimentation on tilted blocks with steep northern flanks and a less inclined, ramp-like southern flanks. This constellation can explain the differences in the clast content of the Barmstein Limestone (type-locality!) and Tressenstein Limestone. Therefore, the controlling factor of the Alpine platform sedimentation and the associated gravity-flow deposits was synsedimentary tectonics as proposed by HERRMANN (1991). An eustatic control of the Barmstein Limestone sedimentation as assumed by BRAUN (1991), followed by SCHÜTZ & HÜSSNER (1997), is not apparent. The latter authors explain the high content of biota as having been a result of sedimentation during relative sea-level highstands. In this connection, it should be diagnostically important to check whether the occurring components display the same age as the embedding normal sediment of the Oberalm Formation or whether they comprise clasts of different stratigraphic levels.

It can be stated that the locality of the Trisselwand can be taken as an Alpine reference or key-section of the Plassen Formation (hypostratotype sensu HEDBERG, 1972), exposing the complete carbonate platform to basin succession. Moreover, this section allows detailed micropaleontological investigations of the Jurassic-Cretaceous boundary in a neritic regime. Future sample investigations will attempt to gain greater detail on the margin-talus transition, the proximal talus, and the passage of distal talus to the Oberalm transitional facies. Initial investigations of other occurrences of the Plassen Formation indicate that they also exhibit the characteristic talus facies described in the present paper. For example, we have recognized the *Tubiphytes-Terebella* facies with siliceous sponges and other microfacies types of the platform talus at the locality of Krahstein (e. g. Pl. 2, fig. 4), which was not mentioned *expressis verbis* by STEIGER & WURM (1991). Whether our facies model represents an encompassing stratigraphic scheme can only be answered in future investigations.

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References

ALTINER, D.: Microfossil biostratigraphy (Mainly Foraminifers) of the Jurassic-Lower Cretaceous carbonate successions in North-

Western Anatolia (Turkey). – Geol. Romana, **27**, 167–213, Rome 1991.

ARNAUD-VANNEAU, A.: L'Urgonien du Vercors septentrional et de la Chartreuse. Géol. Alpine, Mém., **11**, 1–874, Grenoble 1980.

ARNAUD-VANNEAU, A., ARNAUD, H., ADATTE, T., ARGOT, M., RUMLEY, G. & THIEULOY, J.P.: The lower Cretaceous from the Jura Platform to the Vocontian Basin (Swiss Jura, France). – Field trip guide book, Excursion D, 3rd. Int. Cret. Symp. 26.8.–8.9.87, 1–128, Tübingen 1987.

ARNAUD-VANNEAU, A., BOISSEAU, T. & DARSAC, C.: Le genre *Trocholina* et ses principales espèces au Crétacé. – Rev. Paleobiol., Vol. spéc., **2**, 353–377, Geneva 1988.

ARNAUD-VANNEAU, A., CONRAD, M.A., LUPERTO SINNI, E., MASSE, J.P., PEYBERNES, B., RADOICIC, R., SOKAC, B. & VELIC, I.: Distribution of Lower Cretaceous Foraminifera and Dasyclad algae of the Adriatic plate. – In: VELIC, I. & VLAHOVIC, L. (Eds.), Abstracts 2nd Int. Symp. on the Adriatic carbonate platform, Zadar, 12.–18.05.91, 22–26.

BAKALOVA, D.: Algues calcaires de la Formation de Brestnica (Tithonique Superieur-Barremien Superieur). – Rev. Bulg. Geol. Soc., **39**/1, 3–16, Sofia 1978.

BANNER, F.T., FINCH, E.M. & SIMMONS, M.D.: On *Lithocodium* ELLIOTT (Calcareous algae); its paleobiogeographical and stratigraphical significance. – J. Micropalaeontol., **9**/1, 21–36, London 1990.

BARATTOLO, F. & PUGLIESE, A.: Il Mesozoico dell'Isola di Capri. – Quad. Accad. Pont., **8**, 1–172, Naples 1987.

BERNIER, P: Les formations carbonatées du Kimmeridgien et du Portlandien dans le Jura méridional. Stratigraphie, micropaleontologie, sédimentologie. – Doc. Lab. Geol., **92**/1, 1–803, Lyon 1984.

BLANC, E., ARNAUD-VANNEAU, A., ARNAUD, H., BULOT, L., GIDON, M., THIEULOY, J.P. & REMANE, J.: Les couches du passage du Berriasien au Valanginien dans le secteur du Fontanil (Isère, France). – Géol. Alpine, **68**, 3–12, Grenoble 1992.

BODROGI, I., EBNER, F., LOBITZER, H., PASAVA, J. & SACHSENHOFER, R.F.: Die Bitumenmergel der Kainacher Gosau (Steiermark, Österreich). – Jubiläumsschr. 20 Jahre Geol. Zusammenarbeit Österr. – Ungarn, Teil **2**, 127–144, Wien 1994.

BRACHERT, T.C.: Kontinuierliche und diskontinuierliche Sedimentation im süddeutschen Oberjura (unteres Kimmeridge; Ludwag/Oberfranken, Nördliche Frankenalb). – Facies, **15**, 233–284, Erlangen 1986.

BRAUN, R.: Die Barmsteinkalke (Kimmeridge-Berrias) der Berchtesgadener und Salzburger Kalkalpen – posttektonische, eustatisch gesteuerte Kalkturbiditsequenzen. – Geol. et Palaeont., **27**, 18–19, Marburg 1993.

BUCUR, I.I.: Les représentants du genre *Protopeneroplis* WEYNSCHENK dans les dépots du Crétacé inférieur de la zone de Resita-Moldova Noua (Carpathes mériodionales, Roumanie). – Rev. Micropaläont., **36**/3, 213–223, Paris 1993.

BUCUR, I.I., CONRAD, M.A. & RADOICIC, R.: Foraminifers and Calcareous Algae from Valanginian limestones in the Jerma River Canyon, Eastern Serbia, – Rev. Paléobiol., **14**/2, 349–377, Geneva 1995.

CARRAS, N.: La piattaforma carbonatica del Parnasso durante il Giurassico superiore-Cretaceo inferiore. – Ph. D. thesis, 1–232, Athens 1995 (in Greece with Italian abstract).

CAROZZI, A.: Dasycladacées du Jurassique supérieur du bassin de Genève. – Eclogae geol. Helv., **48**/1, 31–67, Basel 1955.

CHAROLLAIS, J., BRÖNNIMANN, P. & ZANINETTI, L.: Troisième note sur les Foraminifères du Crétacé inférieur de la région Genevoise. Remarques stratigraphiques et description de *Pseudotextulariella salevensis,* n. sp.; *Haplophragmoides joukowskyi,* n. sp.; *Citaella?* favrei, n. sp. – Arch. Sci., **19**, 23–48, Geneva 1966.

CHIOCCHINI, M., FARINACCI, A., MANCINELLI, A., MOLINARI, V. & POTETTI, M.: Biostratigrafia a foraminiferi, dasicladali e calpionelle delle successioni carbonatiche Mesozoiche dell' Appennino Centrale (Italia). – Studi Geol. Camerti, vol. spec., 9–129, Camerino 1994.

DARGA, R. & SCHLAGINTWEIT, F.: Mikrofazies, Paläontologie und Stratigraphie der Lerchkogelkalke (Tithon-Berrias) des Dietrichshorns (Salzburger Land, Nördliche Kalkalpen). – Jb. Geol. B.-A., **134**/2, 205–226, Wien 1991.

DARGA, R. & WEIDICH, K.F.: Die Lackbach-Schichten, eine klastische Unterkreide-Serie in der Unkener Mulde (Nördliche Kalkalpen, Tirolikum). – Mitt. Bayer. Staatsslg. Paläont. Hist. Geol., **26**, 93–112, Munich 1986.

DE CASTRO, P.: Observations on *Campbelliella* RADOICIC, 1959 and *Neoteutloporella* BASSOULLET et al., 1978 (green algae, Dasycladales). – Boll. Soc. Paleont. Ital., Spec. Vol. 1, 121–184, Modena 1993.

DE CASTRO, P.: Introduzione allo studio in sezione sottile delle Dasicladali fossili. – Quad. Accad. Pontaniana, **22**, 1–131, Naples 1997.

DESSAUVAGIE, T.F.J.: On the occurrence of *Neotrocholina* in Turkey. – Bull. Min. Res. Explor. Inst., **60**, 71–75, Ankara 1963.

DRAGASTAN, O.: A new Serpulid species in the Upper Jurassic of Romania. – Paläont. Z., **40**/1–2, 147–150, Stuttgart 1966.

DRAGASTAN, O.: *Neoteutloporella socialis* (PRATURLON), algue "recifale" du domaine Tethysien. – Rev. Paléobiol., **6/1**, 143–149, Geneva 1987.

DRAGASTAN, O.: Calcareous algae (new and revised), microproblematicae and Foraminiferida of Jurassic – Lower Cretaceous deposits from the Carpathian area. – Rev. Esp. Micropaleont., **XXI**/1, 5–65, Madrid 1989.

DYA, M.: Mikropaläontologische und fazielle Untersuchungen im Oberjura zwischen Salzburg und Lofer. – Diss. TU Berlin,1–137, Berlin 1992.

EBLI, O. & SCHLAGINTWEIT, F.: On some biostratigraphic important microfossils (Benthic foraminifera, dasycladales) from the subsurface Late Jurassic-Early Cretaceous of Baviera. – Mitt. Bayer. Staatsslg. Paläont. hist. Geologie, **38**, 9–23, München 1998.

ELIASOVA, H.: Some binding microorganisms of the Stramberk reef limestones (Tithonian, Czechoslovakia). – Vestnik Ustr. Ust. Geol., **56**/1, 27–31, Prag 1981.

ELIASOVA, H.: A new binding microorganism of shallow-water limestones. – Vestnik Ustr. Ust. Geol., **61**/2,109–111, Prag 1986.

FAUPL, P. & TOLLMANN, A.: Die Roßfeld-Schichten: Ein Beispiel für Sedimentation im Bereich einer tektonisch aktiven Tiefseerinne aus der kalkalpinen Unterkreide. – Geol. Rdsch., **68**/1, 93–120, Stuttgart 1978.

FENNINGER, A.: Riffentwicklung im oberostalpinen Malm. – Geol. Rdsch., **56**, 171–185, Stuttgart 1966.

FENNINGER, A. : Die Fauna und Flora der Barmsteinkalk-Bank B2 im Raume des Trattberges (Osterhorngruppe, Salzburg). – Ber. Haus Nat. Salzburg, **3**, 10–23, Salzburg 1972.

FENNINGER, A.: Neue Faunen- und Florenelemente aus den Plassenkalken der Trisselwand (Totes Gebirge, Steiermark). – Mitt. Naturwiss. Ver. Steiermark, **108**, 115–119, Graz 1978.

FENNINGER, A. & HOLZER, H.L.: Fazies und Paläogeographie des oberostalpinen Malm. – Mitt. Geol. Gesell., 63, 52–141, Wien 1970.

FENNINGER, A. & HÖTZL, H.: Die Mikrofauna und -flora des Plassen- und Tressensteinkalkes der Typlokalität (Nördliche Kalkalpen). – N. Jb. Geol. Paläont. Abh., **128**/1, 1–37, Stuttgart 1967.

FLÜGEL, E.: Ein neues Vorkommen von Plassenkalk (Ober-Jura) im Steirischen Salzkammergut, Österreich. – N. Jb. Geol. Paläont. Abh., **120**/2, 213–232, Stuttgart 1964.

FLÜGEL, E. & FENNINGER, A.: Die Lithogenese der Oberalmer Schichten und der mikritischen Plassenkalke (Tithonium, Nördliche Kalkalpen). – N. Jb. Geol. Paläont. Abh., **123**/3, 249–280, Stuttgart 1966.

GAWLICK, H.J.: Die früh-oberjurassischen Brekzien der Strubbergschichten im Lammertal – Analyse und tektonische Bedeutung (Nördliche Kalkalpen, Österreich). – Mitt. Ges. Geol. Bergbaustud. Österr., **39**/40, 119–186, Wien 1996.

GAWLICK, H.J., KRYSTIN, L. & LEIN, R.: Condont colour alteration indices: Palaeotemperatures and metamorphism in the Northern Calcareous Alps – a general view. – Geol. Rdsch, **83**, 660–664, Berlin 1994.

GEYER, G.: Ueber jurassische Ablagerungen auf dem Hochplateau des Todten Gebirges in Steiermark. – Jb. k. k. geol. B.-A., **34**/2, 335–366, Wien 1884.

GRANIER, B. & DELOFFRE, R.: Inventaire critique des Algues dasycladales fossiles. II° Partie – Les Algues Dasycladales du Jurassique et du Crétacé. – Rev. Paläobiol., **12**/1, 19–65, Geneva 1993.

HAQ, B.U., HARDENBOL, J. & VAIL, P.R.: Mesozoic and Cenozoic chronostratigraphy and cycles of sea-level change. – SEPM, Spec. Pub., **42**, 71–108, Tulsa 1988.

HEDBERG, H.D. (Ed.): Summary of an international guide to stratigraphic classification, terminology, and usage. – Lethaia, **5**, 297–323, Oslo 1972.

HEINZ, R.A. & ISENSCHMID, C.: Mikrofazielle Untersuchungen im Massivkalk (Malm) der Préalpes médianes. – Eclogae geol. Helv., **81**/1, 1–62, Basel 1988.

HERRMANN, J.: Zur Unterscheidung von Barmsteinkalk und Tressensteinkalk (Oberjura, Nördliche Kalkalpen). – Zbl. Geol. Paläont., Teil 1, **9**/10 (1989), 1349–1357, Stuttgart 1990.

HOLZER, H.L.: Eine stratigraphische Tabelle der Malmvorkommen Österreichs (mit erläuternden Bemerkungen und einem Schichtenverzeichnis). – Schriftenreihe Erdwiss. Komm. Österr. Akad. Wiss., **4**, 219–242, Wien 1978.

HÖTZL, H.: Zur Kenntnis der Tressenstein-Kalke (Ober-Jura, Nördliche Kalkalpen). – N. Jb. Geol. Paläont. Abh., **123**/3, 281–310, Stuttgart 1966.

KLIEBER, D.: Über einen Fund von *"Terebella" lapilloides* MÜNSTER (1833) aus dem Mitteloxford der Mittleren Frankenalb. – Geol. Bl. NO-Bayern, **34/35**, 125–136, Erlangen 1985.

KOLODZIEJ, B.: Boring foraminifera from exotics of the Stramberk-type limestones (Tithonian-Lower Berriasian, Polish Carpathians). – Ann. Soc. Geol. Pol., **67**, 249–256, Warschau 1997.

KRALIK, M., KRUMM, H. & SCHRAMM, J.M.: Low grade and very low grade metamorphism in the Northern Calcareous Alps and in the Greywacke Zone: Illite-crystallinity data and isotopic ages. – In: FLÜGEL, H.W. & FAUPL, P. (Eds.): Geodynamics of the Eastern Alps, 164–178, Wien 1987.

LEINFELDER, R.R., KRAUTTER, M., NOSE, M., RAMALHO, M.M. & WERNER, W.: Siliceous sponge facies from the Upper Jurassic of Portugal. – N. Jb. Geol. Paläont. Abh., **189**/1–3, 199–254, Stuttgart 1993.

LEINFELDER, R.R., NOSE, M., SCHMID, D.U. & WERNER, W.: Microbial crusts of the late Jurassic: Composition, palaeoecological significance and importance in reef construction. – Facies, **29**, 195–230, Erlangen 1993.

LOBITZER, H., BODROGI, I. & FILACZ, E.: Lebensspuren der Oberalmer *Schichten, Schrambach- und Rossfeld-Formation* (Oberjura/Unterkreide) der Salzburger Kalkalpen. – Jubiläumsschrift 20 Jahre Geol. Zusammenarbeit Österr. – Ungarn, Teil **2**, 285–322, Wien 1994.

MANDL, G.W.: Jurassische Gleittektonik im Bereich der Hallstätter Zone zwischen Bad Ischl und Bad Aussee (Salzkammergut, Österreich). – Mitt. Ges. Geol. Bergbaustud. Österr., **28**, 55–76, Wien 1982.

MASSE, J.P.: L'étagement bionomique des milieux benthiques néritiques actuels: signification bathymétrique et implications paléobathymétriques. – Géol. Méd., **15**/1, 91–102, Marseille 1988.

MASSE, J.P., ARIAS, C. & VILAS, L.: Caracterizacion litoestratigrafica y bioestratigrafica del Valanginiense superior-Hauteriviense inferior en el Prebetico de la Zona Septentrional de Murcia. – Rev. Esp. Micropaleont., **XXV**/3, 123–136, Madrid 1993.

MIDDLETON, G.V. & HAMPTON, M.A.: Subaqueous sediment transport and deposition by sediment gravity flows. – In: STANLEY, D.J. & SWIFT, D.J.P. (Eds.), Marine sediment transport and environmental management, 197–218, New York 1976 (J. WILEY & SONS).

MIŠÍK, M.: Jurassic and Cretaceous algae (Dasycladales excepted) from the West Carpathians. – Bull. Cent. Rech. Explor.-Prod. Elf-Aquitaine, **3**/2, 705–712, Pau.

MIŠÍK, M. & BORZA, K.: *Gemeridella, Didemnoides, Didemnum* und Körperchen ähnlicher Gestalt aus dem Mesozoikum der Westkarpaten. – Geol. Zbor. Geol. carpath., **29**/2, 307–326, Bratislava 1978.

MIŠÍK, M. & SYKORA, M.: Allodapische Barmsteinkalke im Malm des Gebirges Cachticke Karpaty. – Geol. Zbor. Geol. carpath., **33**/1, 51–78, Bratislava 1982.

MOJSISOVICS, E. von: Erläuterungen zur Geologischen Karte der im Reichsrate vertretenen Königreiche und Länder der Österr.-ungar. Monarchie. SW-Gruppe Nr. 19, Ischl und Hallstatt. Wien 1905 (Verlag der k. k. geol R.-A.).

NEAGU, T.: The genus *Meandrospira* (Foram.) from Lower Cretaceous strata in Roumania. – Senckenberg. Lethaea, **51**, 5/6, 411–415, Frankfurt 1970.

NEAGU, T.: Monographic de la Faune des Foraminifères éocrétacés du couloir de Dimbovicioara, de Codlea et des Monts Persani (Couches de Carhaga). – Mém. Inst. Geol. Géophys., **25**, 1–141, Bukarest 1975.

NOSE, M.: Vergleichende Faziesanalyse und Paläkologie korallenreicher Verflachungsabfolgen des iberischen Oberjura. – Profil, **8**, 1–237, Stuttgart 1995.

NOTH, R.: Foraminiferen aus Unter- und Oberkreide des Österreichischen Anteils an Flysch, Helvetikum und Vorlandvorkommn. – Jb. Geol. B.-A., Sonderband **3**, 1–91, Wien 1951.

PECORINI, G.: Microflora "Purbeckiana" della Nurra (Sardegna). – Boll. Soc. Geol. It., 91, 373–385, Milano 1972.

PLÖCHINGER, B.: Die tektonischen Fenster von St. Gilgen und Strobl am Wolfgangsee (Salzburg, Österreich). – Jb. Geol. B.-A., **107**, 11–69, Wien 1964.

POBER & FAUPL, P.: The chemistry of detrital chromian spinels and its implications for the geodynamic evolution of the Eastern Alps. – *Geol. Rdsch., 77/3, 641–670, Stuttgart 1988.*

RAKUS, M.: Jurassic of the innermost Western Carpathian zones – its importance and influence on the geodynamic evolution of the area. – Slovak Geol. Mag., **3–4**, 311–317, Bratislava 1996.

REICHEL, M.: Sur une Trocholine du Valanginian d'Arzier. – Ecl. Geol. Helv., **48**/2, 396–408, Basel 1955.

RIVA-PALACIO, E.: *Trocholina valdensis* (REICHEL) 1955, dans le *Crétacé basal de l'Est du Mexique.* – Rev. Micropaléont., **14**/2, 102–105, Paris 1971.

SCHÄFFER, G. & STEIGER, T.: Der Jura zwischen Salzburg und Bad Aussee – Stratigraphie und Gleitmassen in Tiefwassersedimenten der Nördlichen Kalkalpen. – Exkursionsführer Jahrestag. Subkomm. Jurastratigraphie, 12.–15.09.86, 1–67, Munich, Salzburg, Bad Aussee 1986.

SCHINDLER, U. & CONRAD, M.A.: The Lower Cretaceous dasycladales from the northwestern Friuli platform and their distribution in chronostratigraphic and cyclostratigraphic units. – Rev. Paléobiol., **13**/1, 59–96, Geneva 1994.

SCHLAGINTWEIT, F.: Allochthone Urgonkalke im Mittleren Abschnitt der Nördlichen Kalkalpen: Fazies, Paläontologie und Paläogeographie. – Münchner Geowiss. Abh., (A), **20**, 1–120, Munich 1991.

SCHLAGINTWEIT, F. & EBLI, O.: New results on stratigraphy, facies and sedimentology of Late Jurassic to Early Cretaceous platform carbonates of the Austrian Salzkammergut (Plassen Limestone Formation, Tressenstein Limestone). – Carpathian-Balkan Geol. Ass. XVI *Congress, Abstract, p. 536, Wien 1998.*

SCHMID, D.U.: *"Tubiphytes" morronensis* – eine fakultativ inkrustierende Foraminifere mit endosymbiontischen Algen. – Profil, **8**, 305–317, Stuttgart 1995.

SCHMID, D.U.: Marine Mikrobolithe und Mikroinkrustierer aus dem Oberjura. – Profil, **9**, 101–251, Stuttgart 1996.

SCHMID, D.U. & LEINFELDER, R.R.: The Jurassic *Lithocodium aggregatum-Troglotella incrustans* foraminiferal consortium. – Paleont., **39**/1, 21–52, London 1996.

SCHÜTZ, S. & HÜSSNER, H.: Sedimentäre Rhythmen im Oberjura der Nördlichen Kalkalpen. – Geol. Bl. NO-Bayern, **47**/1–4, 273–288, Erlangen 1997.

SCHWEIGL, J. & NEUBAUER, F.: New structural, sedimentological and geochemical data on the Cretaceous geodynamics of the central Northern Calcareous Alps (Eastern Alps). – Zbl. Geol. Paläont. Teil I, **3/4**, 329–343, Stuttgart 1997a.

SCHWEIGL, J. & NEUBAUER, F.: Structural evolution of the central Northern Calcareous Alps: Significance for the Jurassic to Tertiary geodynamics in the Alps. – Eclogae geol. Helv., **90**, 303–323, Basel 1997b.

SENOWBARI-DARYAN, B.: Fazielle und paläontologische Untersuchungen in oberrhätischen Riffen (Feichtenstein- und Gruberriff bei Hintersee, Salzburg, Nördliche Kalkalpen). – Facies, **3**, 1–237, Erlangen 1980.

SENOWBARI-DARYAN, B., BUCUR, I.I. & ABATE, B.: Upper Jurassic calcareous algae from the Madonie Mountains, Sicily. – Beitr. Paläont., **19**, 227–259, Wien 1994.

SEPTFONTAINE, M.: Présence de *Protopeneroplis trochangulata* sp. nov. (Foraminifère) dans le Crétacé inférieur du Jura méridional et révision de *Protopeneroplis* WEYNSCHENK, 1950. – Eclogae geol. Helv., **67**/3, 605–628, Basel 1974.

SEPTFONTAINE, M., ARNAUD-VANNEAU, A., BASSOULLET, J.P., GUSIC, I., RAMALHO, M. & VELIC, I.: Les Foraminifères imperforés des milieux de plate-formes carbonatées jurassiques: état des connaissances et perspectives d'avenir. – Bul. Soc. Vaud. Sci. Nat., **80**/3, 255–277, Lausanne 1991.

SOKAC, B. & NIKLER, L.: *Linoporella kapelensis* n. sp. (Dasycladaceae) from the Tithonian of Mt. Velika Kapela. – Geol. Vjesnik, **25**, 65–71, Zagreb 1973.

SOKAC, B. & VELIC, I.: *Gyroporella lukicae* n. sp. (Dasycladaceae) from the Lower Aptian of the surroundings of Jajce. – Geol. Vjesnik, **35**, 37–41, Zagreb 1982.

SOTAK, J.: Protopeneroplide foraminifers from lowermost Cretaceous of the Stramberk Carbonate platform (outer Western Carpathians). – Geol. Zbor. Geol. carpath., **38**/6, 651–667, Bratislava 1987.

STEIGER, T.: Geologische Aufnahme des Zauchenbachtales und des Krahstein-Massivs am Südrand des Toten Gebirges N' Bad Mitterndorf (Nördliche Kalkalpen, Steirisches Salzkammergut, Österreich). – Mitt. Gesell. Geol. Bergbaustud. Österr., **26**, 213–245, Wien 1980.

STEIGER, T.: Kalkturbidite im Oberjura der Nördlichen Kalkalpen (Barmstein Kalke, Salzburg, Österreich). – Facies, **4**: 215–348, Erlangen 1981.

STEIGER, T. & WURM, D.: Faziesmuster oberjurassischer Plattform-Karbonate (Plassenkalke, Nördliche Kalkalpen, Steirisches Salzkammergut, Österreich). – Facies, **2**: 241–284, Erlangen 1980.

TOLLMANN, A.: Analyse des klassischen Nordalpinen Mesozoikums. – 1–579, Wien 1976 (Deuticke).

TOLLMANN, A.: Late Jurassic/Neocomian gravitational tectonics in the Northern Calcareous Alps in Austria. – In: FLÜGEL, H.W. & FAUPL, P. (Eds.): Geodynamics of the Eastern Alps, 112–125, Wien 1987 (Deuticke).

WEIDICH, K.F.: Stratigraphie der Branderfleck-Schichten (Untercenoman-Untercampan) in den Bayerischen Kalkalpen. – Schriftenr. Erdwiss. Komm., Österr. Akad. Wiss., **7**, 221–261, Wien 1985.

WEIDICH, K.F.: Die kalkalpine Unterkreide und ihre Foraminiferenfauna. – Zitteliana, **17**, 1–312, Munich 1990.