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Austroalpine Liassic Ammonites from the Adnet Formation (Northern Calcareous Alps)

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With 14 Text-Figures and 9 Plates

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Oberostalpine Liasammoniten aus der Adnetformation (Nördlichen Kalkalpen)

Zusammenfassung

Das Oberostalpin spielt eine Schlüsselrolle für das Verständnis der Verteilungsmuster der jurassischen Ammonitenfaunen und für die Fixierung genauer biostratigraphischer Korrelationen zwischen Tethyaler und Euroborealer Faunenprovinz.

Eine mittelliassische Ammonitenfauna (mehr als 500 Exemplare), die wir an vier Lokalitäten der Nördlichen Kalkalpen (Salzburg und südliches Dachsteingebiet) aus Adneter Schichten aufsammelten, erlaubt es uns, 21 Horizonte oder biostratigraphische Faunen-Horizonte aufzustellen. Diese fügen sich zum Teil in die nordwesteuropäische Standardzonierung, zum Teil in die der Tethysregionen. Die Semicostatum-, Obtusum- und Raricostatum-Zone des Sinemur und die Jamesoni-, Ibex-, Davoei- und Margaritatus-Zone des Pliensbach sind durch die Ammonitenfaunen belegt.

Die Faunenzusammensetzung läßt deutlich den Tethys-Charakter des Oberostalpins erkennen. Daneben sind aber in fast allen Horizonten euroboreale Einflüsse erkennbar, besonders durch das Auftreten von Asteroceras aff. confusum und aff. stellare, Tragophylloceras, Platypleuroceras, Uptonia, Acanthopleuroceras, Liparoceratidae, Prodactylioceras davoei, Amaltheidae, P. (Matteiceras) und P. (Fieldingiceras).

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Abstract

The Upper Austroalpine occupies a key position for the understanding of the patterns of Liassic ammonite distribution and for making precise correlation between the Tethyan and Euroboreal realms.

The collection of a Middle Liassic ammonite fauna (more than 500 specimens) from four localities in the Northern Calcareous Alps (Salzburg area and southern Dachstein) allows us to establish a set of 21 horizons or biostratigraphical levels for the Adnet Formation. These units are readily correlated with parts of the NW European standard zonation and parts of the zonation used for the Tethyan realm. The Semicostatum, Obtusum and Raricostatum zones for the Sinemurian stage and the Jamesoni, Ibex, Davoei and Margaritatus zones for the Pliensbachian stage are identified in the formation with ammonites.

The faunal composition clearly indicates the Tethyan affinities of the Upper Austroalpine; but this alpine unit is constantly subject to Euroboreal influences, marked especially by the presence of Asteroceras aff. confusum and aff. stellare, Tragophylloceras, Platypleuroceras, Uptonia, Acanthopleuroceras, Liparoceratidae, Prodactylioceras davoei, Amaltheidae, P. (Matteiceras), P. (Fieldingiceras).

Les ammonites austroalpines de la Formation d'Adnet au Lias (Alpes calcaires septentrionales)

Résumé

L'Austroalpin supérieur occupe une position clef pour la compréhension des "modes" de distributions des ammonites et pour l'établissement de corrélations précises entre les domaines téthysien et euroboreal. La récolte d'une faune d'ammonites du Lias moyen (plus de 500 exemplaires) dans 4 localités des Alpes Calcaires du Nord (région de Salzburg et partie méridionale des Dachstein) nous a permis de mettre en évidence une série de 21 horizons ou niveaux pour la formation d'Adnet. Ces unités biostratigraphiques s'intègrent en partie dans la zonation standard du nord-ouest de l'Europe et en partie dans la zonation utilisée pour le domaine Téthysien. Ainsi les zones à Semicostatum, Obtusum et Raricostatum pour le Sinémurien et les zones à Jamesoni, Ibex, Davoei et Margaritatus pour le Pliensbachien sont attestées par la présence d'ammonites.

Les compositions fauniques montrent clairement les affinités téthysiennes de l'Austroalpin supérieur. Toutefois cette unité alpine reste constamment soumise aux influences euroboréales avec en particulier Asteroceras aff. confusum et aff. stellare, Tragophylloceras, Platypleuroceras, Uptonia, Acanthopleuroceras, Liparoceratidae, Prodactylioceras davoei, Amaltheidae, P. (Matteiceras) et P. (Fieldingiceras).

1. Introduction

The Liassic of the Upper Austroalpine unit of Austria was the subject of numerous palaeontological studies mainly during the second half of the 19th and the beginning of the 20th century. Most of the famous outcrops for Liassic ammonites are situated in the Salzburg area (Salzkammergut, Tennengau) at the Adnet quarries, and the Schafberg north of Lake Wolfgang (HAUER, 1853, 1854 a,b, 1856; SUESS & MOJSISOVICS, 1868; WÄHNER, 1882–1898, 1886, 1903; GEYER, 1893; ROSENBERG, 1909; PIA, 1914; BLIND, 1963; SIEBER, 1961, 1975; WENDT, 1971; SCHÄFFER & STEIGER, 1986). The southern Dachstein area with another less famous but very prolific site for ammonites, was the subject of the works of TRAUTH (1925), TOLL-MANN (1960) and HIRSCHBERG & JACOBSHAGEN (1965).

Although the Lias of Austria is very fossiliferous, surprisingly the biostratigraphy in this "key" region has never been accurately studied to understand the patterns of ammonite distribution and to make precise correlations between the Tethyan and Euroboreal realms sensu DOM-MERGUES & MEISTER (1991, p. 267). This is partly explained by the often condensed levels and the scarcity of continous sections. In our work on Sinemurian and Pliensbachian ammonites we seek to give a detailed stratigraphical description of four sections from different tectonic units of the Northern Calcareous Alps in order to improve the biostratigraphical framework of this period of time. From our data it is also possible to make some remarks on the palaeo- and biogeographical situation of the Upper Austroalpine unit.

2. Geographical and Geological Framework

The four sections studied are situated in the middle part of the Northern Calcareous Alps, which are the sedimentary permo-mesozoic cover of the Upper Austroalpine palaeozoic basement. Today the Northern Calcareous Alps are in an allochtonous position, sheared off from their former basement and transported to the north by the Cretaceous orogeny. Internally the Northern Calcareous Alps themselves are a pile of allochthonous nappes.

Two of our sections (Schmiedwirt and Breitenberg) lie within the Osterhornscholle, which is part of the Tirolic nappes. The third (Rotkogel) belongs to the Höllengebirgsdecke, another part of this nappe complex. The sediments of Tirolic nappes were situated on the middle part of the Northern Calcareous Alps before their tectonic displacement. The fourth section (Rötelstein) is part of the southern Juvavic nappes (Hallstätter Schollen). The Juvavic nappes are supposed to have formed the southern rim of the carbonate platform of the Northern Calcareous Alps during the Upper Triassic (LIEN, 1987). There may have been an ocean or at least an area of thinned crust further south of this zone (Text-Figs. 1 and 14).

During the Liassic period the distance between the Tirolic and Juvavic realms may have been about 100 km (SPENGLER, 1956), while the distance today is only about 30 km north-south. Little is known about the area between the Northern Calcareous Alps and the European continent during the Liassic because most of the rocks of this region are metamorphosed or overthrust by the Austroalpine nappes. Most probably there was no oceanic crust there at that time but a rather shallow (up to a few hundred meters) sea and possibly some land.

The Adnet Formation, the source of most of our samples, is characterized by red, micritic, partly nodular limestones. It is of Liassic age and is partly comparable to the Ammonitico Rosso Inferiore of the Southern Alps. At the Rötelstein, we also found some ammonites in the grey Fleckenmergel. In this study we concentrate on the Upper Sinemurian and Pliensbachian parts of the sections, excluding the earlier Liassic and Toarcian, which may be the subject of future work.



Text-Fig. 1. The middle part of the Northern Calcareous Alps (upper) with the locations of the sections studied (above).

Tectonic overview of the Eastern Alps (below). The sections belong to three different tectonic units. Schmiedwirt, Breitenberg and Rotkogel lie within different parts of the Tirolic nappes, Rötelstein belongs to the Juvavic Hallstatt Nappe (after TOLLMANN, 1976a; GWINNER, 1978).

3. Lithological Description and Qualitative/Quantitative Ammonite Distributions

3.1. Schmiedwirt Quarry

The Schmiedwirt quarry lies near the old Wiestal Road, 5 km NW of Hallein, SE of Salzburg, between the Schmiedwirt and the Bischoff inn (Text-Fig. 2). The site is part of the famous quarries of Adnet, the type section of the Adnet Formation. The quarry is still occasionally used. Quarrying is a very old tradition in the Wiestal. It can be traced back at least to the 15th century (KIESLINGER, 1964).



Little detailed geological or palaeontological work had been done in this quarry before. HAUER (1856) in his work on Liassic cephalopods described some samples from the Schmiedwirt quarry. SIEBER (1961) also mentioned some ammonites from this site in a short note. There are also geological maps by SCHLAGER & SCHLAGER (1960, 1 : 10.000) and PLÖCHINGER (1987, 1 : 50.000).

The thickness of the outcropping section is about 20 m. It comprises most of the Early Jurassic. Below the quarry floor there are a few meters of bedded, grey, cherty limestones, which crop out along the way to the quarry. They are probably of Hettangian age. They are capped by a layer of reddish crinoidal limestone, a yellow-red hard ground and a grey breccia with clasts of grey limestones containing yellow chert nodules (base of section in Text-Fig. 3).

Above the breccia, reddish-grey, thin-bedded limestone without chert (layer 2 in Text-Fig. 3) passes into red limestone of the Adnet Formation with thin marly layers. In contrast to the Adnet Formation at its type section in a quarry at Adnet (3 km to the southeast) there are few beds with nodular fabric. The Adnet Formation at the Schmiedwirt quarry is a biodetrital wackestone with crinoidal debris (enriched in some layers), ostracods and foraminifera.

Within the uppermost five meters of the section the rock becomes more marly and nodular (layers 8–10, 12 and 13 in Text-Fig. 3) with lenses of fine-grained breccia. The top bed is a breccia up to 1.5 m thick (layer 14 in Text-Fig. 3), which lies unconformably on the underlying strata. Above are a few centimeters of red marl and about half a meter of manganiferous red limestone, badly exposed, which may be referred to the Upper Liassic or possibly Middle Jurassic. The radiolarite, which is attributed to the Oxfordian in this region, is only found in boulders just above the manganiferous limestone.

All of the sediments forming this section were deposited on a slightly inclined slope at a water depth of a few hundred meters, below storm wave base and the photic zone.

3.2. Breitenberg Quarry

The outcrop at the Breitenberg, as at Schmiedwirt, is in an old quarry, but this one is abandoned. The quarry lies

Text-Fig. 2. Location map of the Schmiedwirt quarry near Adnet.

about 500 m southeast of the summit of the Breitenberg at approximately 1150 m (Text-Fig. 4). The Breitenberg occurence belongs to the same tectonic unit as that in the Schmiedwirt guarry. Both belong to the Osterhornscholle, which is part of the Tirolic nappe complex. As at Schmiedwirt the beds are flat lying, and there is only minor tectonic disturbance. There are two publications on the quarry: one by SUESS & MOJSISOVICS (1868), who gave a detailed description of the stratigraphic sequence, but concentrated on the Upper Triassic strata. The other was by BLIND (1963) who worked on the Lower Liassic ammonites. There are two geological maps by PLÖCHINGER (1973, 1982) covering this area. The lithology and succession (Text-Fig. 5) of the section are very similar to those of Schmiedwirt quarry. Again most of the rocks are red micritic limestones of the Adnet Formation. They are less nodular but more marly than at Schmiedwirt. For our study only the upper part of the section is of interest. It starts with two thick beds of crinoidal micrite. There follows a succession up to 20 cm thick of slightly nodular, thin-bedded limestones with marl interbeds. On top there is a packet of slightly brecciated, nodular, platy limestone, poor in microfossils and free of ammonites. It is capped by a pebbly marl with a mixed fauna of Carixian to Domerian ammonites (laver 18). The section ends with a massive nodular breccia bed half a meter thick. There are no exposures above it, so it is not clear how much is missing between the breccia and the radiolarite of probable Upper Jurassic age, which is exposed at the top of the Breitenberg quarry.

3.3. Rotkogel Outcrop

The Rotkogel outcroup east of Bad Ischl (Text-Fig. 4) exposes on its eastern side a section of Middle Liassic red Adnet Formation. It rests on a thick series of grey marly limestones of Sinemurian age (Fleckenmergel, [SCHÄFFER & STEIGER, 1986]). There is a geological map (SCHÄFFER, 1982), but apart from brief account of SCHÄFFER & STEIGER (1986) not much has been written about this locality and its stratigraphy.

The tectonic situation in this area is much more complex than in the Osterhornscholle. The Rotkogel block rests on the Tirolic Höllengebirgsdecke, which is the eastern equivalent of the Osterhornscholle. It is not quite certain that this block is really a part of that nappe. If so, then its palaeogeographic position was probably similar to that of the Osterhornscholle during the Liassic.

The section starts with reddish marly bedded limestones (Text-Fig. 6). The marl content is even higher than at the Breitenberg. In the upper part of the section three breccia beds occur, separated by deep red marls and marly limestones, which became of to their high content of fine crinoidal debris have a "sandy" appearance. This is a very typical facies for the middle and higher Liassic of the Tirolic nappes. It has been also found in the Osterhornscholle, where it has been called "Adneter Mergel" (Adnet Marls) by TOLLMANN (1976 b) and thoroughly described by PLÖCHINGER (1975), who called it "Saubachschichten".

HMIEDWIRT	ax var rariplicatum s var cenotrtum bildes usum usum eigeni osum ustulus tus um gr. inflatum gr. inflatum			Text-Fig. 3. Schmiedwirt quarry. Lithological profile and am monite ranges.
Ē	Amloceras sp. Amloceras gr. mendd P. (Calaiceras) calais P. (Zetoceras) catas Anloceras gr. cerati Asterocoras gr. cerati Asterocoras gr. frond Lytoceras sp. Epidechicceras gr. frond P. (Zetoceras gr. frond D. (Topidoceras sp. Juraphyllites gr. diop Uptonia gr. contusa Uptonia gr. contusa Uptonia pr. contusa Uptonia pr. contusa Uptonia pr. contusa Uptonia pr. contusa Uptonia pr. contusa Uptonia pr. dimbriat Lytoceras frandrif Lytoceras gr. filmbriat Lytoceras gr. filmbriat	Horizons	Stage & substage	
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		' 	HEMURIAN	
		1	SI	
	2	?		Figure captions 3, 5, 6, 8 •••• Breccia Limestone rich in crinoidal debris Nodular limestone Micritic limestone
	Angulaticeras sp. (1), Apoderoceras (Miltoceras) juv. (1), Juraphyliites nardii (1), Juraphyliites libertus lumensis (1), P. (Zetoceras) gr. zetes (2), Partschiceras striatocostatum (5), Tropidoceras aff. gr. zitteli (2), Metaderoceras aff. gr. muticum (1) in the screes.			Calcareous mari



Text-Fig. 4.

Location map for the Breitenberg (upper part left) and the Rotkogel (upper right).

The lower part shows an overview of the area.

3.4. Rötelstein Outcrop

Unlike the other three sections the Rötelstein (otherwise "Rettenstein") is part of the so-called Hallstätter Schollen or Southern Juvavic Nappes (Text-Fig. 1). These formed the southernmost part of the Northern Calcareous Alps during the Triassic and probably Liassic. So the Rötelstein was in a different palaeogeographical position as compared to the other localities (TOLLMANN, 1981). There may have been some emerged ridges between the Juvavic (this site) and the Tirolic (first three sites) depositional areas during the Liassic, but this is not very probable. The whole area was probably a deep neritic or shallow bathyal sea at this time.

Even though the tectonics are severe in this region, the outcrops show a rather undisturbed section of Liassic

strata. It is one of the best sections for Fleckenmergel of the whole eastern Calcareous Alps. Only the base and top of the section are cut out by thrusts, and there are some minor displacements by blockfaulting.

The outcrops are situated at the upper end of the Weitenhausgraben between steep cliffs of Triassic dolomites below and Upper Jurassic limestone above. They can be reached from the west by following small paths through a large thicket of dwarf pines (Text-Fig. 7).

Previous publications include a geological map (GANSS, KÜMEL & SPENGLER, 1954) with a detailed description of the section, and the papers of TOLLMANN (1960) and of HIRSCHBERG & JACOBSHAGEN (1965), discussing the stratigraphy and listing numerous ammonites from the section. HIRSCHBERG & JACOBSHAGEN suggested a mixing of Ca-

BREITENBERG	is dosum titoides fusum dragonatum juv. ssum volubile-pantanelli sp. rosticillatum ssum	
E	Arnioceras sp. Asteroceras sp. Angulaticeras sp. P. (Calaiceras) cala Phylloceras gr. frond Juraphyllites nardli P. (Zetoceras gr. ceral Asteroceras gr. ceral Asteroceras gr. ceral Asteroceras gr. ceral Microderoceras sp. P. (Zetoceras gr. au Microderoceras sp. Juraphyllites sp. Lytoceras sp. Derolytoceras sp. Arieticeras gr. algov Horizons Horizons	Stage & substages
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	≺ 4 Microderoceras aff. gigas (1) and
I	Galaticeras sp. (1) in the screes

Lithological profile and ammonite ranges.

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rixian and Domerian ammonites in the upper part of the section, which according to our results is not the case.

The sequence starts with a thick succession of grey marls (Fleckenmergel) of Lower to Middle Liassic age (Text-Fig. 8). At the top they become slightly more calcareous and then pass abruptly into about 10 m of red, slightly nodular marls and marly limestones, containing a very rich ammonite fauna. There is no obvious difference in microfacies between the grey and the red marls. The red marly limestone ends with a yellow-stained hardground. Above there are about two meters of red marls with layers rich in shells of the small bivalve Bositra. They are capped by radiolarite, locally developed as a breccia with metersized blocks of grey shallow-water limestone. The breccia may be of tectonic origin. The Upper Jurassic Plassenkalk forms the cliffs above the section separated from by a fault.

4. Systematic Palaeontology

In this paper we will not repeat descriptions and discussions that are thoroughly detailed in previous works. For the well-known taxa we refer the reader to these studies: DOMMERGUES et al., 1985, 1990; MEISTER, 1986, 1989;

DOMMERGUES & MEISTER, 1987 a/b, 1989 a/b, 1990 a/b; MEISTER & LOUP, 1989; BLAU & MEISTER, 1991. For certain taxa we only give brief remarks and in most cases the taxonomy is consistent with all these published studies.

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SINEMURIAN





Text-Fig. 8. Rötelstein.

Lithological profile and ammonite ranges.

Moreover because of our often badly preserved and fragmentary material, it is unfortunately impossible to obtain good and acute measurements for the ammonites.

Phylloceratina ARKELL 1950
Phyllocerataceae ZITTEL 1884
Phylloceratidae ZITTEL 1884
Phylloceratinae ZITTEL 1884
Phylloceras SUESS 1865

Type species: Ammonites heterophyllus SowERBY 1820.

Remark: The proliferation of taxa of the long-ranging Phylloceratidae provides a problem for each stage or substage (Upper Sinemurian, Carixian and Domerian). Indeed many forms with the same morphology have different taxonomic names only because of their different ages. This results in a stress of biostratigraphical considerations rather than on morphological criteria for this long-ranging family.

Often the morphological variability that can be observed over a long time range does not exceed the intraspecific variability that we can find in the Ammonitina. So for us Zetoceras, Calliphylloceras and Calaiceras are considered at best as sub-genera of *Phylloceras* and each of them probably is characterized by few species. Indeed the main morphological differences are for Calliphylloceras the presence or persistence of constrictions, for Zetoceras the compressed whorl section and for Calaiceras the broad whorl section. Moreover they are often in association in the same beds.

In other terms, the genera or subgenera of the Phylloceratidae would probably better be considered as species, and the numerous "species" names of Phylloceras, Zetoceras, Calliphylloceras, Calaiceras show only the morphological intraspecific variability.

Phylloceras gr. frondosum (REYNES 1868) Plate 2, Figs. 1, 2

- *1868 Ammonites frondosus REYNES, PI. 5, Fig. 1. Ammonites Hebertinus REYNES, PI. 2, Fig. 3.
- 1884 Phylloceras Meneahinii GEMMELLARO, PI. 2, Fig. 13-17. 1986 Phylloceras frondosum (REYNES). – GAKOVIC, PI. 1, Fig. 1. Phylloceras hebertinum (REYNES). – GAKOVIC, PI. 1, Fig. 2.
- 1989 Phylloceras frondosum (REYNES). MEISTER, Pl. 2, Fig. 1, 2 with
- synonymy. Phylloceras hebertinum (REYNES). - MEISTER, PI. 2, Fig. 5, 7
 - with synonymy.

We regroup, into this species, quite "globose" and more compressed morphologies of typical Phylloceras (Text-Fig. 9 C, D), often in association in the same beds (MEI-STER, 1989). This may be the expression of a sexual dimorphism, indeed during the Pliensbachian, very often we have the association of both morphologies.

Local range: Obtusum zone (confusum horizon) - Gibbosus subzone (ragazzoni horizon).

Subgenus: Calliphylloceras SPATH 1927

Type species: *Phylloceras disputabile* ZITTEL 1869.

P. (Calliphylloceras) bicicolae (MENEGHINI 1874) Plate 1, Figs. 2, 5

- *1874 Phylloceras Bicicolae MENEGHINI, p. 106.
- 1989 Calliphylloceras bicicolae (MENEGHINI). MEISTER, Pl. 2, Fig. 3, 4 with synonymy.
- 1991 Phylloceras (Calliphylloceras) bicicolae (MENEGHINI). BLAU & MEISTER, Pl. 1, Fig. 6-9; Pl. 2, Fig. 1.

This regularly strongly constricted ammonite is rather common in our outcrops. Again the proliferation of taxa does not give a good image of the "reality". In our opinion P. (C.) bicicolae includes nearly all of the "species" as described by BRAGA & RIVAS (1987). Only perhaps P. (C.) dubium (FUCINI), a more constricted form or P. (C.) stoppani (MENEG-HINI), a more compressed one, could be a different species.

Local range: Luridum subzone (Reynesocoeloceras horizon) - Gibbosus subzone (algovianum horizon).

Subgenus: Zetoceras Kovács 1939

Type species: Ammonites zetes d'ORBIGNY 1850.



Text-Fig. 9.

Whorl sections (×33). A = P. (Zetoceras) gr. zetes (d'ORBI-GNY), B = Galaticeras sp. indet., CD = Phylloceras gr. frondosum (REY-NES), E,F = P. (Calaiceras) calais (MENEGHINI), G = "Metaderoceras" venustulus (DUMORTIER), H = Protogrammoceràs gr. dilectum (FUCINI), ,J = Protogrammoceras gr. volubile (FUCINI) - pantanelli (FUCINI), K = "Protogrammoceras" gr. costicillatum (FUCINI), L = Asteroceras gr. stellare (SOWERBY), M,N,O = Asteroceras aff. confusum SPATH, P = Asteroceras gr. quadragonatum (HYATT).

P. (Zetoceras) gr. zetes (d'ORBIGNY 1850) Plate 1, Figs. 3, 4

- Ammonites heterophyllus amalthei QUENSTEDT, PI. 6, Fig. 1. 1845
- *1850 Ammonites zetes d'ORBIGNY, p. 247.
- 1908a Phylloceras pseudo-zetes FUCINI p. 12.
- Zetoceras zetes (d'ORBIGNY). WIEDENMAYER, Pl. 5, Fig. 5-8. 1977 Zetoceras pseudozetes (FUCINI). - WIEDENMAYER, PI. 5, Fig. 9-10 with synonymy.
- 1982 Phylloceras (Zetoceras) zetes (d'ORBIGNY). - ALKAYA, PI. 1, Fig. 5 a-c.

Phylloceras (Zetoceras) pseudozetes (FUCINI). - ALKAYA, PI. 2, Fig. 1 a -c.

In the P. (Z.) zetes (d'ORBIGNY) we group all Phylloceras with a very compressed whorl-section (Text-Fig. 9 A).

Thus P. (Z.) oenotrium (FUCINI) (essentially Early Carixian), P. (Z.) zetes (d'ORBIGNY) (Pliensbachian), P. (Z.) bonarelli (BET-TONI) and P. (Z.) lavizzarii (HAUER) (Domerian forms) belong probably to a single species and P. (Z.) oenotrium and P. (Z.) bonarelli are only morphological varieties (see also BRAGA & RIVAS, 1987).

The variety *cenotrium* (FUCINI), already known in the Sinemurian, has a more rounded elliptical whorl section than Z. zetes (d'ORBIGNY) which shows a more compressed triangular one with flat flanks. The type of P. (Z.) bonarelli (BETTONI) seems to have a more rounded ventral area but the difference contained with P. (Z.) zetes is very small.

Local range: Obtusum zone (stellare horizon) - Gibbosus subzone (algovianum horizon).

P. (Zetoceras) zetes var. oenotrium (Fucini 1901) Plate 2, Fig. 3

- 1901 Phylloceras oenotrium FUCINI, Pl. 5, Fig. 8, 9; Pl. 6, Fig. 1.
- 1977 Zetoceras oenotrium (FUCINI). WIEDENMAYER, Pl. 6, Fig. 1 with
- synonymy. 1982 Phylloceras (Zetoceras) oenotrium (FUCINI). - ALKAYA, PI. 2, Fig. 4–6.

This form, characterized by a weak convexity of the whorl section near the lower third of the flanks, fits WIEDENMAYER's description (1977, p. 21). For FUCINI this form characterized the Early Lias (Sinemurian).

Local range: Semicostatum zone (mendax horizon) 🖛 Obtusum zone (confusum horizon).

Subgenus: Calaiceras Kovács 1939 (Syn. Hantkeniceras Kovács 1939)

Type species: Phylloceras calais MENEGHINI 1874 (see BRAGA & RIVAS, 1987).

P. (Calaiceras) calais (MENEGHINI 1874) Plate 1, Fig. 1

* 1874 Phylloceras Calais MENEGHINI, p. 106.

- 1977 Calaiceras calais (MENEGHINI). WIEDENMAYER, Pl. 1, Fig. 1, 8; Pl. 8, Fig. 2, 3 with synonymy.
- ?1981 Hantkeniceras cf. hantkeni (SCHLOENBACH). WANG & HE, PI. 1, Fig. 13-15.
- 1987 Calaiceras calais (MENEGHINI). BRAGA & RIVAS, PI. 2, Fig. 1.
- ?1987 Calaiceras cf. hantkeni (SCHLOENBACH). BRAGA & RIVAS, Fig. 4f, 5g.
- 1991 Phylloceras (Calaiceras) calais (MENEGHINI). BLAU & MEISTER, PI. 1, Fig. 1, 2.

Our sample corresponds well with WIEDENMAYER's description (1977). P. (C.) calais (MENEGHINI) from the Rötelstein is a constricted phragmocone with a typically broad and subsquare whorl section (Text-Fig. 9 E,F).

This very uncommon group is composed of two main species P. (C.) calais (MENEGHINI) and P. (C.) hantkeni (SCHLOENBACH) according to the literature. The essential difference, as in the other Phylloceratidae, is the whorl section more compressed in the former group and more square and broad in the latter. And again this is probably a case of intraspecific variation, but our material does not allow us to solve this issue.

Local range: Semicostatum zone (mendax horizon) -Luridum subzone (Reynesocoeloceras horizon).

Genus: Partschiceras FUCINI 1923

Type species: Ammonites Partschi STUR 1851.

Partschiceras striatocostatum (MENEGHINI 1853) Plate 2, Fig. 4

- 1851 Ammonites Partschi STUR, p. 26 (nom. nudum).
- *1853 Ammonites striatocostatus MENEGHINI, p. 28.
- 1868 Ammonites Sturi REYNES, PI. 3, Fig. 1.
- 1913 Phylloceras anonymum HAAS, Pl. 1, Fig. 5.
- 1977 Partschiceras sturi (REYNES). WIEDENMAYER, PI. 2, Fig. 6, 7; Pl. 5, Fig. 1-4 with synonymy.
- Partschiceras striatocostatum (MENEGHINI). WIEDENMAYER, PI. 4, Fig. 5–8 with synonymy. 1986 Partschiceras anonymum (HAAS). – GAKOVIC, PI. 1, Fig. 3.
- 1987 Partschiceras striatocostatum (MENEGHINI). BRAGA & RIVAS, Pl. 1, Fig. 5-8.
- 1989 Partschiceras striatocostatum (MENEGHINI). MEISTER, PI. 2, Fig. 6.
- 1991 Partschiceras striatocostatum (MENEGHINI). BLAU & MEISTER, Pl. 2, Fig. 2, 3.

In agreement with BRAGA & RIVAS (1987), we consider MENEGHINI's species and *P. sturi* (REYNES) as synonyms. Again the genus *Partschiceras* is said to be represented by numerous "species" but we believe that there are probably one or two species only. P. proclive (ROSENBERG, 1909) is different with its rursiradiate external ribbing.

In the Schmiedwirt faunas we only found fragments exhibiting the characteristic ribbing: well preserved primary ribs associated with fine secondary ribs.

Local range: Valdani subzone (gemmellaroi horizon).

Family: Juraphyllitidae ARKELL 1950 Genus: Juraphyllites MÜLLER 1939

Type species: Phylloceras diopsis GEMMELLARO 1884.

Remarks: Generally the Juraphyllitidae are predominant among the Phylloceratina fauna during the whole Pliensbachian, but the Phylloceratidae appear to be more diversified during this period.

A small specimen shows an adult morphology with the aperture characterized by a rostrum and a little crenulated keel: probably a microconch form.

As for the Phylloceratidae, the described Juraphyllitidae are characterized by a prolific taxonomy, but the morphological differences between the main "species" are minor.

In the Salzburg area it is possible to distinguish among the Juraphyllitidae three kinds of morphologies succeeding each other stratigraphically: in the Late Sinemurian we have the *J. nardii* morphology with typical lateral ribs. For the Early Carixian, the *Juraphyllites* (from the lower part of Schmiedwirt profile (bed 10) possess fine, close, prorsiradiate ribs (except for the last whorl which has quite sharp and rather coarse ribbing) and are weakly constricted, have no constriction in the adult stage and belong to *J. diopsis* (GEMMELLARO). Overlying beds (beds 11, 12, 13 in Schmiedwirt) contain coarser and less prorsiradiate forms with a long constricted stage before the adult body chamber. They belong to the *J. libertus* (GEMMELLARO). In the Middle and Late Carixian as well as in the Domerian (Rötelstein) *J. libertus* (GEM-MELLARO) is only sporadically present.

Juraphyllites nardii (MENEGHINI 1853)

Plate 2, Fig. 8

- *1853 Ammonites Nardii MENEGHINI, p. 27.
- 1856 Ammonites transylvanicus HAUER, p. 192.
- 1901 Rhacophyllites nardii (MENEGHINI). FUCINI, PI. 7, Fig. 1-7.
 - Rhacophyllites nardii var. dorsocurvata FUCINI, Pl. 8, Fig. 7.
- ? 1901 Rhacophyllites transylvanicus var. dorsoplanata FUCINI, PI. 8, Fig. 1–6.
- non 1927 Rhacophyllites cf. nardii (MENEGHINI). SCHRÖDER, PI. 8, Fig. 4.
 - 1955 Juraphyllites aff. nardii (MENEGHINI). DONOVAN, for PI. 39, Fig. 12–16 in REYNES.
 - ? 1956 Juraphyllites cf. nardii (MENEGHINI). ERBEN, PI. 27, Fig. 6.
 - 1959 Juraphyllites transylvanicus (HAUER). VIALLI, PI. 13, Fig. 3. ? 1965 Juraphyllites transylvanicum (HAUER). MOUTERDE, PI. 2,
 - Fig. 4.
 - 1978 Juraphyllites gr. nardii (Мемеднімі). Venturi, Pl. 1, Fig. 5.

In *J. nardii* (MENEGHINI) the ribbing is well developed on the whole flank in the adult ontogenetic stage. It characterizes the Late Sinemurian. *J. transylvanicus* belongs to this species by taxonomic priority.

Local range: Obtusum zone (*confusum* horizon).

Juraphyllites gr. diopsis (GEMMELLARO 1884) Plate 2, Fig. 10

- * 1884 Phylloceras diopsis GEMMELLARO, PI. 2, Fig. 6-8; PI. 6, Fig. 1, 2.
- ?1909 Rhacophyllites limatus ROSENBERG, Pl. 11, Fig. 10, 11.
- 1977 Juraphyllites diopsis (GEMMELLARO). WIEDENMAYER, PI. 8, Fig. 4–7 with synonymy.
- 21977 Juraphyllites limatus limatus (ROSENBERG). WIEDENMAYER, Pl. 3, Fig. 4; Pl. 8, Fig. 8, 12 with synonymy.
- 1987 Juraphyllites cf. diopsis (GEMMELLARO). HILLEBRANDT, PI. 1, Fig. 9 with synonymy.

Local range: Jamesoni zone (Platypleuroceras horizon).

Juraphyllites gr. libertus (GEMMELLARO 1884)

Plate 2, Figs. 5, 9; Plate 3, Fig. 5

- 1884 Phylloceras libertum GEMMELLARO, Pl. 2, Fig. 1-5.
- 1977 Juraphyllites libertus (GEMMELLARO). WIEDENMAYER, PI. 1, Fig. 4; PI. 3, Fig. 1, 2, 5.
- 1986 Juraphyllites libertus (GEMMELLARO). MEISTER, PI. 2, Fig. 8.
- 1986 Juraphyllites libertus (GEMMELLARO). GAKOVIC, PI. 2, Fig. 1.
- 1989 Juraphyllites libertus (GEMMELLARO). MEISTER, PI. 2, Fig. 9.
- 1990 Juraphyllites gr. libertus (GEMMELLARO). DOMMERGUES & MEISTER, Fig. 3 (15).
- Local range: Jamesoni subzone 🖛 Gibbosus subzone.

Juraphyllites libertus lumensis (DI STEFANI 1886) Plate 3, Fig. 4

- * 1886 Phylloceras lumense DI STEFANI, Pl. 3, Fig. 1, 2.
- ?1888 Phylloceras lumense (DI STEFANI). CANAVARI, Pl. 2, Fig. 14.
 ?1901 Rhacophyllites lumensis (DI STEFANI). FUCINI, Pl. 11, Fig. 1–4.

Rhacophyllites lumensis var. incerta FUCINI, Pl. 11, Fig. 6. Rhacophyllites lumensis var. longispirata FUCINI, Pl. 11, Fig. 5. Rhacophyllites lumensis var. plicata FUCINI, Pl. 10, Fig. 5–6. 1959 Juraphyllites lumensis (DI STEFANI). – VIALLI, Pl. 13, Fig. 2.

Only one specimen shows great affinites with DI STEFA-NI's type and with FUCINI's variety *plicata*. It bears numerous broad constrictions. This "species" probably belongs to the group of *J. libertus* (GEMMELLARO).

Local range: ?Jamesoni - ?Ibex zones.

Genus: Tragophylloceras HYATT 1900

Type species: Ammonites heterophyllus numismalis QUEN-STEDT 1845.

Tragophylloceras loscombi (Sowerby 1814)

- *1814 Ammonites loscombi Sowerby, p. 185, Pl. 183.
- 1986 Tragophylloceras loscombi (SOWERBY). MEISTER, PI. 2, Fig. 11 with synonymy.
- 1989 Tragophylloceras loscombi (SOWERBY). MEISTER, PI. 2, Fig. 8.
- 1990 Tragophylloceras cf. loscombi (SOWERBY). DOMMERGUES, MEI-STER & METTRAUX, PI. 6, Fig. 10–12.

With its more compressed whorl section, more acute venter and broad umbilicus, this smooth Phylloceratina belongs to *Tragophylloceras*, especially to *T. loscombi* (So-WERBY). Contemporaneous specimens of *P. (Zetoceras)*, at the same size, have a more quadrangular whorl section and the venter is more flat.

Local range: Luridum subzone (crassum horizon) - Maculatum subzone (lataecosta horizon).

Genus: Galaticeras SPATH 1938

Type species: *Amphiceras harpoceratoides* **GEMMELLARO** 1884.

The systematic position of this genus is still enigmatic, but we doubtfully accept the position of the Treatise (AR-KELL et al., 1957) which attributes this taxon to the Jura-phyllitidae.

Galaticeras sp. indet

Plate 2, Fig. 6

With its typical whorl section (Text-Fig. 9 B) and its very characteristic suture line, some phragmocones of our material belong to the genus *Galaticeras*. This form seems to be smooth and perhaps agrees with *G. propinquum* (GEM-MELLARO).

Local range: Obtusum zone - Jamesoni or Masseanum subzones.

Suborder:	Lytoceratina HYATT 1889
Superfamily:	Lytocerataceae NEUMAYR 1875
Family:	Lytoceratinae NEUMAYR 1875
Genus:	Lytoceras SUESS 1865

Type species: Ammonites fimbriatus SOWERBY 1817.

Lytoceras gr. fimbriatum (SowERBY 1817) Plate 4, Figs. 1, 2

*1817 Ammonites fimbriatus SOWERBY, PI. 164.

- 1986 Lyloceras fimbriatum (SOWERBY). MEISTER, PI. 1, Fig. 1, 2 with synonymy.
- 1987 Lytoceras limbriatum (SOWERBY). BRAGA, JIMENEZ & RIVAS, Pl. 1, Fig. 1, 2.
- 1990 Lytoceras gr. fimbriatum (SOWERBY). DOMMERGUES & MEI-STER, Fig. 5 (22).

Our specimen are specially finely ribbed (Schmiedwirt) and in nearly all samples, the ribbing is no longer conspicuous due to poor preservation. So in Rötelstein it is impossible to distinguish *L. fimbriatum* (SOWERBY) from *L. villae* (MENEGHINI) in the Late Domerian.

Local range: Jamesoni zone (*Platypleuroceras* horizon) **+** Maculatum subzone (*lataecosta* horizon).

Genus: Derolytoceras ROSENBERG 1909

Type species: Ammonites lineatus tortus QUENSTEDT 1885.

Derolytoceras tortum (QUENSTEDT 1885)

Plate 3, Fig. 1

- *1885 Ammonites lineatus tortus QUENSTEDT, Pl. 39, Fig. 12, 13.
- 1989 Derolytoceras tortum (QUENSTEDT). MEISTER & LOUP, PI. 6, Fig. 7.
- 1990 Derolytoceras tortum (QUENSTEDT). DOMMERGUES, MEISTER & METTRAUX, Pl. 6, Fig. 8, 9 with synonymy.
- 1990 Derolytoceras tortum (QUENSTEDT). DOMMÉRGUES & MEISTER, Fig. 3 (13, 14); Fig. 5 (23).

A typical fragment of a body chamber with coarse annular ribbing.

Local range: Jamesoni subzone (jamesoni horizon).

Suborder:Ammonitina HYATT 1889Superfamily:Psilocerataceae HYATT 1867Family:Schlotheimiidae SPATH 1923Genus:Angulaticeras QUENSTEDT 1883

Type species: Ammonites lacunatus BUCKMAN 1844.

Angulaticeras sp. indet.

cf. 1990 Angulaticeras (Boucaulticeras) sp. DOMMERGUES, MEISTER & METTRAUX, PI. 2, Fig. 1.

Three fragments of *Angulaticeras* have been found at the locality Breitenberg. The lower one (bed 13, lower part) is coarser ribbed and reminds one rather of *A. boucaultiana* (d'ORBIGNY). The two other specimens coming from level 13 (upper part) are more closely and finely ribbed. It is rather like *A. lacunata* (BUCKMAN) or better *A. coquandi* (DI STEFA-NI) – *angustisulcatum* (GEYER).

Local range: Obtusum zone (confusum horizon).

Family:Arietitidae HYATT 1875Subfamily:Arietitinae HYATT 1875Genus:Arnioceras HYATT 1867

Type species: Arnioceras cuneiforme HYATT, 1867.

Arnioceras gr. mendax var. rariplicatum Fucini 1902

Plate 4, Fig. 4

- *1902 Arnioceras mendax n. sp. var. rariplicala FUCINI, PI. 17, Fig. 7; PI. 18, Fig. 3, 6, 8, 9.
- 1990 Arnioceras cf. mendax var. rariplicatum FUCINI. DOMMERGUES, MEISTER & METTRAUX, Pl. 1, Fig. 6–9 with synonymy.

1.7 m below bed 5 of the Schmiedwirt quarry, the *Arnioceras* forms are distinguishable from the overlying *A. ceratitoides* (QUENSTEDT) by a larger adult size, more projected ribs on the external part and wider spaced ribs. These features recall the *A.* gr. *mendax* var. *rariplicatum* FUCINI that we have described from the "Préalpes médianes romandes" (DOMMERGUES et al., 1990).

Local range: Semicostatum zone (mendax horizon).

Arnioceras gr. ceratitoides (QUENSTEDT 1849) Plate 4, Figs. 3, 5, 6, 10

- * 1849 Ammonites ceratitoides QUENSTEDT, Pl. 19, Fig. 13.
 1882–85 Ammonites ceratitoides QUENSTEDT, Pl. 13, Fig. 8–11, 23.
 1886 Arietites ceratitoides (QUENSTEDT). DI STEFANI, Pl. 4,
- Fig. 6, 7.
 Arielites ceratitoides (QUENSTEDT). PARONA, PI. 13, Fig. 1;
- PI. 14, Fig. 4.
 Annoceras cerationdes (QUENSTEDT). PARONA, FI. 13, Fig. 1,
 PR. 14, Fig. 4.
- 1899 Arnioceras ceratitoides (QUENSTEDT). BONARELLI, PI. 8, Fig. 4, 5, ? 6.
- 1902 Arnioceras ceratitoides (QUENSTEDT). FUCINI, PI. 14, Fig. 13; PI. 15, Fig. 1–15 with all varieties. Arnioceras rejectum FUCINI, PI. 16, Fig. 1–6.
 - Arnioceras abjectum FUCINI, PI. 26, Fig. 1–3.
- 1917 Arietites (Arnioceras) ceratitoides (QUENSTEDT). TILMAN, PI. 21, Fig. 3.
- 1942 Arnioceras cf. ceratitoides (QUENSTEDT). KOVÁCS, PI. 4, Fig. 5.
- ?1956 Arnioceras ceratitoides mexicanum ERBEN, PI. 29, Fig. 3–7; no PI. 30, Fig. 1, 2.
- 1959 Arnioceras cf. ceratitoides (QUENSTEDT). VIALLI, Pl. 14, Fig. 9, 10.
- 1965 Arnioceras cf. ceratitoides (QUENSTEDT). MOUTERDE, PI. 1, Fig. 4.
- ?1969 Arñioceras ceratitoides mexicanum ERBEN. TOPCHISVILI, Pl. 4, Fig. 2.
- 1975 Arniocera's ceratitoides paucicosta FUCINI. FERRETTI, PI. 22, Fig. 1–3.
- 1976 Arnioceras ceratitoides (QUENSTEDT). SCHLEGELMILCH, PI. 20, Fig. 6.
 1982 Arnioceras cf. ceratitoides (QUENSTEDT). – HILLEBRANDT.
- 982 Arnioceras cf. ceratitoides (QUENSTEDT). HILLEBRANDT, Pl. 1, Fig. 3.
- 1985 Arniocera's ceratitoides (QUENSTEDT). PRINZ, PI. 3, Fig. 3, 4.
- 1985 Arnioceras ceratitoides (QUENSTEDT). BRAGA, MARTIN-AL-GARA & RIVAS, PI. 1, Fig. 6.
- 1986 Arnioceras ceratitoides (QUENSTEDT). WANG & SMITH, PI. 4, Fig. 1–3.

This ubiquitous species is characterized by a very reduced smooth ontogenetic stage, no more than 1 cm in diameter.

Following BLIND (1963) we attribute the *Arnioceras* fauna from Breitenberg to *A. ceratitoides* (QUENSTEDT). This species shows a particular thickening of the rib near the venter (see QUENSTEDT, 1849, Pl. 19, Fig. 13 and ibidem 1882–85, Pl. 13, Fig. 8). This particular feature is not really the same in *A.* gr. *mendax* FUCINI, a very closely-related group, perhaps older (BRAGA at al., 1985 and DOMMER-GUES et al., 1990).

Among the two other species described by BLIND from the Breitenberg area, *A. falcaries* (QUENSTEDT) possesses a longer juvenile smooth stage and more curved ribs with a weaker rib density. This last feature is also true for *A. kri*- dioides (HYATT). A. pluriplicatum FUCINI, a very similar species, also has a longer juvenile smooth stage.

The Schmiedwirt Arnioceras from bed 5 are the same as the Breitenberg Arnioceras from bed 13; they also co-occur with Asteroceras aff. confusum SPATH.

Local range: Obtusum zone (confusum horizon).

Subfamily: Asteroceratinae SPATH 1946 Genus: Asteroceras HYATT 1867

Type species: Ammonites stellaris SOWERBY, 1815.

Asteroceras aff. confusum SPATH, 1925

Plate 4, Figs. 7, 9, 11

- 1880-81 Arietites obtusus WRIGHT, PI. 21, Fig. 3, 4.
- *1925 Asteroceras confusum Spath, p. 300.
- 1961 Asteroceras confusum SPATH. - SACCHI-VIALLI & CAN-TALUPPI, PI. 4, Fig. 5.
- 1954 Asteroceras confusum SPATH. - DONOVAN, p. 32.
- 1966 Asteroceras confusum SPATH. - GUERIN-FRANIATTE, PI. 172-174.
- 1976 Asteroceras confusum SPATH. - SCHLEGELMILCH, PI. 19, Fig. 2.

All the Breitenberg Asteroceras from bed 13 have great affinities with A. confusum SPATH. They are characterized by coarse and straight widely spaced ribbing, still well developed near the sulci, by a broad whorl section (Text-Fig. 9 M-O) and guite evolute conch. A. confusum SPATH is close to the morphology of A. obtusum (SOWERBY), but the SOWERBY's species is characterized by a particular acute and curved outline of the ribs, by a more rounded whorl section and by a broad blunted keel. True A. obtusum are rare outside the Southern England.

Local range: Obtusum subzone (confusum horizon).

Asteroceras gr. quadragonatum (HYATT 1889)

- 1843 Ammonites obtusus SOWERBY. d'ORBIGNY, Pl. 44.
- 1889 Asteroceras obtusum var. quadragonatum HYATT, Fig. 34, 35.
- Asteroceras aff. quadragonatum (HYATT). GUERIN-FRANIATTE, 1966 Pl. 175, Fig. 1, 2; Pl. 176-178 with synonymy.

This variety repesents only the broadest morphology of the Asteroceras group (Text-Fig. 9 P).

Local range: Obtusum subzone (confusum horizon).

Asteroceras aff. stellare (SOWERBY 1815)

- * 1815 Ammonites stellaris SOWERBY, PI. 93.
- ?1960 Arietites (Asteroceras) aff. stellare (SOWERBY). PREDA & RAI-LEANU, PI. 9, Fig. 3.
- 1961 Asteroceras stellare (SOWERBY). DEAN, DONOVAN & HOWARTH, Pl. 67, Fig. 2.
- 1961 Asteroceras stellare (SOWERBY). SACCHI-VIALLI & CANTALUPPI, Pl. 5, Fig. 1-5.
- Asteroceras sp. SACCHI-VIALLI & CANTALUPPI, PI. 3, Fig. 6.
- 1965 Asteroceras stellare (SOWERBY). ANDRUSOV, Fig. 49-1. 1966 Asteroceras stellare (SOWERBY). - GUERIN-FRANIATTE, PI.
- 153–155 with synonymy.
- 1968 Asteroceras stellare (SOWERBY). TAN, Pl. 1, Fig. 1-5. 1976 Asteroceras (Asteroceras) stellare (SOWERBY). - SCHLEGELMILCH,
- Pl. 18, Fig. 3.
- 1977 Asteroceras stellare (SOWERBY). URLICHS, PI. 4, Fig. 2.
- 1987 Asteroceras cf. stellare (SOWERBY). QUINZIO SINN, PI. 4, Fig. 1.

Overlying the Obtusum beds (bed 15 in Breitenberg), we can observe Asteroceras with a more involute conch and more compressed whorl section. Some larger specimens (up to 35-40 cm) are characterized by a tendency for disappearance of the ornamentation on the body chamber and by a more acute whorl section. We put all these forms in the A. stellare group although some specimens are reminiscent of A. suevicum (QUENSTEDT) or A. varians (FUCINI). Local range: Stellare subzone (stellare horizon).

Family: Oxynoticeratidae HYATT 1875 Genus: Radstockiceras BUCKMAN 1918

Type species: R. complicatum BUCKMAN 1918.

Radstockiceras gemmellaroi (POMPECKJ 1906)

1884 Amaltheus n. sp. indet. GEMMELLARO, Pl. 1, Fig. 18, 19.

- *1906 Oxynoticeras Gemmellaroi POMPECKJ, p. 283.
- 1986 Radstockiceras gemmellaroi (POMPECKJ). MEISTER, Pl. 2, Fig. 7; Pl. 3, Fig. 1.

Radstockiceras gemmellaroi (POMPECKJ) characterizes the Middle Carixian and seems to be closely related to the Late Carixian Radstockiceras: R. willshirei (WRIGHT), R. pseudosaemanni RIVAS and R. oscensis RIVAS described by RIVAS (1977) in the Cordilleras Beticas.

Local range: Luridum subzone (Reynesocoeloceras horizon).

Family: Echioceratidae BUCKMAN 1913 Genus: Paltechioceras BUCKMAN 1924

Type species: Paltechioceras elicitum BUCKMAN 1924.

Paltechioceras gr. insigne (TRUEMAN & WILLIAM) 1925 Plate 5, Fig. 2

- *1925 Euechioceras insigne TRUEMAN & WILLIAM, PI. 3, Fig. 3. 1989a Paltechioceras aff. insigne (TRUEMAN & WILLIAM). - DOM-MERGUES & MEISTER, PI. 3, Fig. 1.
- 1990 Paltechioceras cf. insigne (TRUEMAN & WILLIAM). - DOMMER-GUES, MEISTER & METTRAUX, Pl. 3, Fig. 1.
- 1990 Paltechioceras cf. tardecrescens (HAUER) - insigne (TRUEMAN & WILLIAM). - DOMMERGUES & MEISTER, PI. 1, Fig. 8-10; Pl. 2, Fig. 1-4.

These taxa are tricarinate Paltechioceras with a broad whorl section and weakly curved outline of the rib.

Local range: Raricostatum zone.

Genus: Leptechioceras BUCKMAN 1923

Type species: Ammonites macdonnelli PORTLOCK 1843.

Leptechioceras gr. meigeni (Hug 1899) Plate 4, Fig. 13

- *1899 Arietites meigeni Hug, Pl. 11, Fig. 2, 3.
- 1989a Leptechioceras meigeni (Hug). DOMMERGUES & MEISTER, PI. 3, Fig. 3, 4.

1990 Leptechioceras meigeni (Hug). – DOMMERGUES & MEISTER, PI. 1, Fig. 4–6 with synonymy.

Local range: Raricostatum zone (meigeni horizon).

Superfamily:Eoderocerataceae SPATH 1929Family:Phricodoceratidae SPATH 1938Genus:Epideroceras SPATH 1923

Type species: Ammonites roberti HAUER 1854.

Epideroceras gr. lorioli (Hug 1899) Plate 5, Fig. 1

- *1899 Aegoceras lorioli Hug, Pl. 8, Fig. 1; Pl. 9, Fig. 3.
- 1983 Epideroceras Iorioli (Hug). BLAU, PI. 6, Fig. 1, 2.
- 1987a Epideroceras gr. lorioli (Hug). Dommergues & Meister, Pl. 5, Fig. 9 with synonymy.
- 1989 Epideroceras (Epideroceras) Iorioli (Hug). DOMMERGUES & GECZY, PI. 2, Fig. 1–4.
 1989a Epideroceras Iorioli (Hug). – DOMMERGUES & MEISTER, PI. 4,
- 1989а *Epideroceras Iorioli* (HuG). DOMMERGUES & MEISTER, Pl. 4, Fig. 2, 4; Pl. 5, Fig. 1, 2; Pl. 6, Fig. 1, 3.
- 1990 Epideroceras Iorioli (Hug). DOMMERGUES, MEISTER & MET-TRAUX, Pl. 5, Fig. 2.
- 1990 Epideroceras aff. Iorioli (HuG). DOMMERGUES & MEISTER, Pl. 2, Fig. 2, 6, 7.

Intermediate whorls of *Epideroceras* which are quite evolute with rather coarse ribbing are attributed to *E. lorioli*, a species with a great morphological variability.

Local range: Macdonnelli subzone (*meigeni* horizon).

Genus: Apoderoceras BUCKMAN 1921 Subgenus: Miltoceras WIEDENMAYER 1980

Type species: Aegoceras sellae GEMMELLARO 1884.

A. (Miltoceras) juv. Plate 4, Fig. 12

cf. 1884 Aegoceras sellae GEMMELLARO, Pl. 3, Fig. 1-5.

This ammonite resembles with Apoderoceras and especially Milloceras inner whorls. However the distinction between the inner whorls of Apoderoceras sensu stricto like A. hamiltoni (SIMPSON) or A. triornatum BUCKMAN (1928, PI. DCCLXXXIII) or still A. nodogigas BUCKMAN (1928, PI. DXXX) and the inner whorls of A. (M.) gr. sellae (GEMMELLARO) remains very weak.

Local range: Late Raricostatum zone to Early Jamesoni zone.

Family: Eoderoceratidae SPATH 1929 Genus: *Microderoceras* HYATT 1871

Type species: Ammonites birchi SowERBY 1820.

Microderoceras aff. gigas (QUENSTEDT, 1883) Plate 3, Fig. 3

*1882/85 Ammonites birchii gigas QUENSTEDT, Pl. 18, Fig. 13. 1928 Microderoceras gigas (QUENSTEDT). – BUCKMAN, Pl. DCCLXII. Unfortunately the only identifiable *Microderoceras* have been found in scree coming from the beds 10 to 18 of the Breitenberg section.

The widely spaced ribs show some affinities with the large *M. gigas* (QUENSTEDT) group. As recorded by CORNA (1985), *M.* aff. *gigas* (QUENSTEDT) can co-occur with *Asteroceras* (in the Obtusum zone). It is probably the same at Breitenberg because we have collected juvenile *Microderoceras* sp. with *A.* aff. *confusum* SPATH. As DONOVAN (1990) we consider that *M. birchi* (SOWERBY) (in DONOVAN & FORSEY, 1973) is rare outside the southern England – Basin of Paris and is often wrongly identified specially in the alpine and italian areas.

Our example has also great affinities with large adult *M. inexpectans* SPATH from the Dorset Coast.

Genus: Metaderoceras SPATH 1925

Type species: Ammonites muticus d'ORBIGNY 1844.

Metaderoceras aff. gr. muticum (d'ORBIGNY 1844) Plate 5, Fig. 3

- * 1844 Ammonites muticus d'ORBIGNY, PI. 80.
- 1976 Metaderoceras muticum (d'ORBIGNY). GECZY, Pl. 11, Fig. 3, 4.
- 1979 Metaderoceras muticum (d'Orbigny). Dommergues, Pl. 4, Fig. 1.
- ? 1981 Crucilobiceras cf. C. mulicum (d'ORBIGNY). IMLAY, PI. 7, Fig. 6-10, 12-15.
- aff. 1984 Metaderoceras mulicum (d'ORBIGNY). CUBAYNES, BOUTET, DELFAUD & FAURE, PI. 1, Fig. 4, 5.
 - 1987 Metaderoceras mulicum (d'OrBIGNY). DOMMERGUES, Pl. 1, Fig. 3–6.
- non1988 Metaderoceras aff. muticum (d'ORBIGNY). SMITH, TIPPER, TAYLOR & GUEX, PI. 2, Fig. 7–9.

This ammonite fragment has a subradiate, irregular and lateral subdivided ribbing and a coarse marginal tubercle and probably belongs to the *M. muticum* (d'ORBIGNY) group.

Local range: Jamesoni zone (Brevispina-Polymorphus subzones).

"Metaderoceras" venustulus (DUMORTIER 1869) Plate 5, Fig. 6

*1869 Ammonites venustula DUMORTIER, PI. 17, Fig. 4–6. 1986 Metaderoceras venustulum (DUMORTIER). – MEISTER, PI. 3, Fig. 5.

This evolute form, which is characterized by radiate, quite rigid, close and regular ribbing, and a compressed subquadratic whorl section (Text-Fig. 9 G) with flattened venter and marginal tubercle belongs to the species "*M*." *venustulus* (DUMORTIER). DUMORTIER's type has a higher rib density mainly in the adult stage. The generic attribution to either *Platypleuroceras* or *Metaderoceras* is still a problem. The poor preservation of our specimen does not allow us to solve this problem.

Local range: Jamesoni zone (Brevispina-Polymorphus subzones).

Metaderoceras gr. gemmellaroi (LEVI 1896) Plate 7, Fig. 1

- *1896 Aegoceras gemmellaroi Levi, Pl. 8, Fig. 3, 6.
- 1921 Deroceras evolutum FUCINI, Pl. 1, Fig. 14 ab.
- 1983 Metaderoceras gemmellaroi (Levi). Rivas, Pl. 2, Fig. 4–10 with synonymy.
 - Metaderoceras evolutum (FUCINI). RIVAS, PI. 1, Fig. 1-8 with synonymy.
- 1985 Metaderoceras evolutum (FUCINI). COMAS RENGIFO, PI. 3, Fig. 2, 4.
- 1988 Metaderoceras evolutum (FUCINI). SMITH, TIPPER, TAYLOR & GUEX, PI. 1, Fig. 11.

Like the contemporaneous NW European *Metaderoceras* venarense (OPPEL) (DOMMERGUES & MOUTERDE, 1978; DOM-MERGUES, 1979, 1987; MEISTER, 1986), the Middle Carixian *Metaderoceras* from Austria are characterized by two kinds of morphology associated in the same level. The first one concerns less spineous forms with more regular and quite close ribs. Generally they have a smaller adult stage than the second ones wich possess coarser ribs and larger marginal spines. The first group belongs to *M. gemmellaroi* (LEVI) and the second to *M. evolutum* (FUCINI). As suggested by RIVAS (1983, p. 394), this perhaps reflects a (sexual) dimorphism as in *M. venarense* (MEISTER, 1986, p. 127). So we assume that *M. gemmellaroi* (LEVI) and *M. evolutum* (FUCINI) belong to the same species.

Between these two supposed dimorphic groups, *M. venarense* (OPPEL) and *M.* gr. *gemmellaroi* (LEVI), the morphological differtiation is very weak and their ontogenetic development (MEISTER, 1986) is the same. One significant difference may be the closer ribbing of *M. gemmellaroi* (LEVI) as we can usually observe when we compare Tethyan and Euroboreal ammonites. But sometimes it is impossible to find a difference betwen *M. venarense* (OPPEL) and coarse ribbed *M. gr. gemmellaroi* (LEVI). Perhaps, as in the case of *Arieticeras* we have only one species (MEISTER in DOM-MERGUES et al., 1989) with a morphological intra-specific drift.

Local range: Valdani subzone (gemmellaroi horizon).

Family: Polymorphitidae HAUG 1887 Genus: *Platypleuroceras* HYATT 1867

Type species: Ammonites brevispina SowERBY 1827.

Platypleuroceras sp. indet.

This very evolute member of the Polymorphitidae underlies the *Uptonia* beds and belongs without doubt to *Platy-pleuroceras*. Unfortunately the poor preservation does not allow us to go further.

Local range: Brevispina-Polymorphus subzone (*Platy-pleuroceras* horizon).

Genus: Uptonia BUCKMAN 1887

Type species: Ammonites Jamesoni Sowerby 1827.

Uptonia gr. confusa (QUENSTEDT 1856) Plate 6, Fig. 6

- *1856 Ammonites confusus QUENSTEDT, Pl. 15, Fig. 8-10.
- 1980 Uptonia confusa (QUENSTEDT). SCHLATTER, PI. 13, Fig. 2, 3 with synonymy.
- 1986 Uptonia confusa (QUENSTEDT). MEISTER, PI. 5, Fig. 2, 4.

Only one sample with coarse ribs, well developed external tubercules, and flattened ventral area, has good affinities with QUENSTEDT's species. The whorl section is subquadrate and not oval as in *U. jamesoni* (SOWERBY). This form is very close to *U. confusa* in MEISTER (1986, Pl. 5, Fig. 4).

Local range: Jamesoni subzone (jamesoni horizon).

Uptonia gr. jamesoni (SOWERBY 1827)

Plate 5, Figs. 4, 5; Plate 6, Fig. 1

- *1827 Ammonites Jamesoni SOWERBY PI. 555, Fig. 1.
- 1934 Uptonia jamesoni (SOWERBY). ROSENKRANTZ, PI. 5, Fig. 1.
- 1986 Uptonia jamesoni (SOWERBY). MEISTER, PI. 4, Fig. 8; PI. 6, Fig. 1, 5 with synonymy
- 1987 Uptonia lata sensu SCHLATTER DOMMERGUES, Pl. 10, Fig. 1–6.
- 1990 *Uptonia* cf. *jamesoni* sensu DONOVAN & FORSEY DOMMER-GUES, MEISTER & METTRAUX, p. 320.

This form is characterized by a wide variability of rib density. While the *jamesoni* morphology, with compressed whorl section, fine prorsiradiate ribs and chevrons is well represented, some specimens are more involute and finely ribbed with broader whorl sections close to *U. involuta* MEISTER (1986, Pl. 3, Fig. 3).

Therefore several Schmiedwirt *Uptonia* adults keep the outer tubercules until the end of the phragmocone. They still recall the ancestral morphology of *Platypleuroceras*, especially the *P. tenuilobus-amplinatrix* morphology. But these *Uptonia* differ from the earlier *Platypleuroceras* by a slightly more involute conch, with a higher and oval worhl section, by prorsiradiate ribs and by small prorsiradiate chevrons on the venter. In heterochronic terms, the *Platypleuroceras*-*Uptonia* evolution is characterized by a peramorphosis by acceleration (GOULD, 1977; ALBERCH et al., 1979; MCNA-MARA, 1982; DOMMERGUES et al., 1986).

Local range: Jamesoni subzone (jamesoni horizon).

Uptonia bronni (ROEMER 1836) Plate 6, Fig. 2

- *1836 Ammonites Bronnii ROEMER, Pl. 12, Fig. 8.
- 1984 Polymorphites gr. bronni (ROEMER). ČUBAYNES, BOUTET, DEL-FAUD & FAURE, PI. 2, Fig. 5, 6, 8, 9.
- 1986 Polymorphites bronni (ROEMER). MEISTER, PI. 4, Fig. 1, 5, 6 with synonymy.
- 1987 Uptonia gr. bronni (ROEMER). DOMMERGUES, Pl. 10, Fig. 6, 7.
- 1990 Uptonia bronni (ROEMER). DOMMERGUES & MEISTER, Fig. 5 (3).

This little ammonite is a microconch and U.jamesoni (SOWERBY) represents the macroconch form (MEISTER, 1986, p. 126; DOMMERGUES, 1987). Full descriptions are given by these authors.

Local range: Jamesoni subzone (jamesoni horizon).

Family: Acanthopleuroceratidae ARKELL 1950 Genus: *Tropidoceras* HYATT 1867

Type species: Ammonites Masseanum d'ORBIGNY 1844. There are two *Tropidoceras* morphologies in the Schmiedwirt outcrop. The first one is characterized by involute, compressed forms with flattened sides and two rows of tubercules: *T. flandrini* (DUMORTIER). The second one includes also bituberculate specimens but they are more evolute and characterized by broader whorl sections and coarser ribbing: *T.* aff. gr. *zitteli* (FUCINI).

Tropidoceras flandrini (DUMORTIER 1869) Plate 6, Fig. 11

- *1869 Ammonites Flandrini DUMORTIER, PI. 14, Fig. 1, 2.
- 1893 Cycloceras Flandrini var. densicosta Futterer, Pl. 12, Fig. 6, 7. 1985 Tropidoceras flandrini (DUMORTIER). – BRAGA & RIVAS, Pl. 1,
- Fig. 3, Pl. 2, Fig.1 with synonymy. 1986 Tropidoceras Ilandrini (DUMORTIER). – MEISTER, Pl. 8, Fig. 7
 - with synonymy. Tropidoceras flandrini densicosta (FUTTERER). – MEISTER, PI. 6, Fig. 7 with synonymy.
- 1987 Tropidoceras llandrini var. cf. obtusa (FUTTERER). HILLEBRANDT, Pl. 3, Fig. 4, 5.
- 1988 Tropidoceras Ilandrini (DUMORTIER). SMITH, TIPPER, TAYLOR & GUEX, PI. 2, Fig. 6.

This bituberculate group loses its ornamention in the adult stage, especially on the body chamber. If the inner whorls are evolute, the shell becomes rather quickly involute during ontogeny.

The outer tubercules, situated on the bifurcation point of the ribbing, may be well developed or absent. There is a notable variation in this character.

BRAGA & RIVAS (1985), MEISTER (1986) and DOMMERGUES (1987) give a more complete description.

Local range: Jamesoni subzone (*jamesoni* horizon) - ? Masseanum subzone (*Tropidoceras* horizon).

Tropidoceras aff. gr. zitteli FUCINI 1899 Plate 6, Figs. 5, 7, 8, 10

*1899 Tropidoceras Zitteli FUCINI, PI. 22, Fig. 3.

1985 Tropidoceras zitteli (FUCINI). – BRAGA & RIVAS, PI. 3, Fig. 5–7; PI. 4, Fig. 1–5 with synonymy.

This group presents affinities with the species *T. zitteli* FUCINI, with a large umbilicus, and coarse bituberculate ribs (BRAGA & RIVAS, 1985, PI. 4, Fig. 3, 4) especially in the inner whorls. But it also has affinities with *T. stahli* (OPPEL) (WIEDENMAYER, 1977). Actually it seems that *T. zitteli* FUCINI and *T. stahli* (OPPEL) are evolved from *T. flandrini* (BRAGA & RIVAS, 1985; DOMMERGUES, 1987). The first one is a typical Tethyan form. The second occurs more in NW Europe. Again the relationships between these two species are very close and we may really have only one species. Our material does not allow us to develop this idea. For the moment the well-developed keel and the slightly more compressed whorl section remind us of the *zitteli* morphology rather than of the *stahli* group which is characterized by a smooth keel.

A *Tropidoceras* from the Rötelstein with quite coarse and widely spaced ribbing, a small marginal tubercle, and a prominent keel, is also doubtfully attributed to this species. It is perhaps a microconch (see BRAGA & RIVAS, 1985, pl. 4, Fig. 2).

Local range: Probably Masseanum subzone to Valdani subzone (*gemmellaroi* horizon); see BRAGA & RIVAS (1985, p. 570).

Genus: Acanthopleuroceras HYATT 1900

Type species: Ammonites valdani d'ORBIGNY 1844.

Acanthopleuroceras gr. inflatum (QUENSTEDT 1885) Plate 6, Fig. 9

- *1885 Ammonites Maugenestii inflatus QUENSTEDT, PI. 35, Fig. 17.
- 1986 Acanthopleuroceras aff. inflatum (QUENSTEDT). MEISTER, PI. 9, Fig. 8 with synonymy.
- 1991 Acanthopleuroceras gr. inflatum (QUENSTEDT). BLAU & MEISTER, Pl. 5, Fig. 1, 2.

These two evolute ammonite fragments are characterized by widely spaced, coarse and bituberculate ribs. The inner tubercules are less developed than the outer ones. The venter is typically fastigate and quite flattened like Quenstedt's species. Our specimens are also close to intermediate morphologies between true *A. maugenesti* (d'ORBIGNY) and true *A. valdani* (d'ORBIGNY).

Local range: Valdani subzone (inflatum horizon).

Family: Liparoceratidae HYATT 1867 Genus: *Liparoceras* HYATT 1867

Type species: *Liparoceras bronni* SPATH 1938 (ICZN opinion 308)

Liparoceras sp. juv.

Only one globular, involute ammonite fragment with finely ventral ribs and coarser, more spaced bituberculate lateral ribs has been found. Without doubt it belongs to *Liparoceras*.

Local range: Luridum subzone (crassum horizon) - Maculatum subzone (sparsicosta horizon).

Genus: Androgynoceras HYATT 1867

Type species: Ammonites hybrida d'ORBIGNY 1844.

Remark: This genus comprises ammonites characterized by a "capricorn" and "liparoceratid" ontogeny. This androgyne morphology is interpreted either in terms of sexual dimorphism (MEISTER, 1986) or in terms of *Aegoceras* variability where they represent the peramorphic pole (DOMMERGUES, 1987; DOMMERGUES, et al., 1986). These two approaches are not incompatible.

Androgynoceras sparsicosta (TRUEMAN 1919)

- *1919 Liparoceras sparsicosta TRUEMAN, Pl. 21, Fig. 2, 3.
- 1985 Androgynoceras (Aegoceras) sparsicosta (TRUEMAN). PHELPS, Pl. 1, Fig. 1.
- 1986 Androgynoceras aff. sparsicosta (TRUEMAN). MEISTER, PI. 16, Fig. 1 with synonymy.
- Local range: Maculatum subzone (sparsicosta horizon).

Genus: Aegoceras WAAGEN 1869

Type species: Ammonites capricornus SCHLOTHEIM 1820.

Remark: The systematic and biostratigraphy of this genus is well known (DOMMERGUES, 1979, 1987; PHELPS, 1985; MEISTER, 1986).

Subgenus: Beaniceras BUCKMAN 1913

Type species: Ammonites luridus SIMPSON, 1855.

A. (Beaniceras) gr. crassum BUCKMAN 1919 Plate 7, Fig. 5

- *1919 Beaniceras crassum BUCKMAN, PI. CXLVII.
- 1938 Beaniceras crassum BUCKMAN. SPATH, Pl. 10, Fig. 2 with synonymy.
- 1990 Beaniceras crassum BUCKMAN. DOMMERGUES, MEISTER & METTRAUX, Pl. 5, Fig. 4–11 with synonymy.
- 1990 Beaniceras cf. crassum BUCKMAN. DOMMERGUES & MEISTER, Fig. 5 (4, 5).

Our specimens are characterized by an irregular and "geminate" ribbing. These features distinguish the species from *A. (B.) luridum* (SIMPSON).

A small *A. (Beaniceras)* below (?) the *A. (B.)* gr. *crassum* is characterized by quite close, regular ribbing and by protuberant ventral "chevrons". It resembles *A. (B.) larzacensis* MEISTER (1986) from the Causses Basin.

Local range: Luridum subzone (crassum horizon).

A. (Aegoceras) lataecosta (SOWERBY 1827) Plate 7, Figs. 2, 6

- *1827 Ammonites lataecosta SOWERBY, Pl. 556, Fig. 3, 4.
- 1986 A. (Aegoceras) lataecosta (SOWERBY). MEISTER, PI. 15, Fig. 6, 7; PI. 17, Fig. 1 with synonymy.
- 1990 Aegoceras cf. lataecosta (SOWERBY). DOMMERGUES & MEISTER, Fig. 3 (1).

The quite coarse and widely spaced ribbing of the juvenile stage is characteristic of *A. (A.) lataecosta* (SOWERBY) in the lineage of *Aegoceras (maculatum – lataecosta – capricornus)* (DOMMERGUES, 1979, 1987; MEISTER, 1986). The rib density is: N/2 = 9 for a diameter of 19 mm and 10 for 26 mm.

Local range: Maculatum subzone (lataecosta horizon).

A. (Aegoceras) capricomus (SCHLOTHEIM 1820)

- *1820 Ammonites capricornus SCHLOTHEIM, p. 71.
- 1985 Aegoceras (Aegoceras) capricornus (SCHLOTHEIM). COMAS RENGIFO, PI. 8, Fig. 7–10.
- 1985 A. (Aegoceras) capricornus (SCHLOTHEIM). PHELPS, PI. 2, Fig. 6, 7.
- 1986 A. (Aegoceras) capricornus (SCHLOTHEIM). MEISTER, PI. 15, Fig. 8 with synonymy.
- 1990 Aegoceras capricornus (SCHLOTHEIM). DOMMERGUES & MEI-STER, Fig. 5 (7, 8).

We attribute these nuclei of *Aegoceras* (*Aegoceras*) to *A. (A.)* capricornus because of the high rib density which is N/2 = 12 for 10 mm diameter (DOMMERGUES, 1987, p. 191).

Local range: Capricornus subzone (*capricornus* horizon).

Family: Amaltheidae HYATT 1867Genus: Amaltheus DE MONTFORT 1808

Type species: Amaltheus margaritatus DE MONTFORT 1808.

Amaltheus margaritatus forme gibbosus (SCHLOTHEIM 1820)

- *1820 Ammonites Amaltheus gibbosus SCHLOTHEIM, p. 66.
- 1958 Amaltheus gibbosus (SCHLOTHEIM). HOWARTH, PI. 3, Fig. 7–10; Text-Fig. 10 with synonymy.
- 1960 Amaltheus (Amaltheus) gibbosus (SCHLOTHEIM). JORDAN, Pl. 2, Fig. 5–8; Pl. 8, Fig. 7.

- 1961 Amaltheus (Amaltheus) gibbosus (SCHLOTHEIM). TINTANT, GAU-THIER & LACROIX PI. 1, Fig. 4.
- 1973 Amaltheus gibbosus (SCHLOTHEIM). HOWARTH, Fig. A, B.
- 1976 Amaltheus (Amaltheus) gibbosus (SCHLOTHEIM). SCHLEGEL-MILCH, PI. 35, Fig. 4, 5.
- 1977 Amaltheus gibbosus (SCHLOTHEIM). URLICHS, Pl. 1, Fig. 6.
- 1985 Amaltheus "de type" gibbosus (Schlotнеім). Маттеі, РІ. 11, Fig. 1, 2, 4–6, 10.
- 1988 Amaltheus margarilatus forme gibbosus (SCHLOTHEIM). MEI-STER, PI. 3, Fig. 1, 2, 6-8.

This species, extensively described especially by HO-WARTH (1958), JORDAN (1960), MATTEI (1985) and MEISTER (1988), characterizes the Middle Domerian.

Local range: Gibbosus subzone.

Family:Dactylioceratidae HYATT 1867
sensu DOMMERGUES 1986Subfamily:Reynesocoeloceratinae
DOMMERGUES 1986Genus:Reynesocoeloceras GECZY 1976

Type species: Coeloceras crassum var. indunensis MENEGHI-NI 1881.

Reynesocoeloceras sp. indet. Plate 7, Figs. 3, 7

Level 15 at Rötelstein contains several fragments of Dactylioceratidae, essentially body chambers. With their prominent, rather coarsely spaced lateral ribs, these forms belong to the genus *Reynesocoeloceras*. The ribbing is continuous across the venter and only a few ribs are subdivided. This character recalls the *R. indunense* (MENEGHINI) – *fallax* (FUCINI) group. Marginal tubercules are very attenuated or absent.

Local range: Luridum subzone (*Reynesocoeloceras* horizon).

Genus Prodactylioceras SPATH 1923

Type species: Ammonites Davoei SOWERBY 1822.

Prodactylioceras aff. gr. italicum (FUCINI 1900) Plate 7, Fig. 4

- * 1900 Coeloceras italicum MENEGHINI in FUCINI, PI. 13, Fig. 4.
 1976 Prodactylioceras (Aveyroniceras) italicum (FUCINI). GECZY, PI. 25, Fig. 8, 9; PI. 26, Fig. 1–4 with synonymy.
- non ? 1981 Prodactylioceras cf. italicum (FUCINI). IMLAY, PI. 10, Fig. 4, 5.
- non ? 1981 Prodactylioceras cf. italicum italicum (FUCINI). IMLAY, Pl. 10, Fig. 3.
 - 1983 Reynesoceras italicum (FUCINI). BRAGA, PI. 16, Fig. 3 with synonymy.
 - 1983 Prodaclylioceras italicum (FUCINI). DOMMERGUES, FER-RETTI, GECZY, MOUTERDE, PI. 6, Fig. 7–12.
 - 1985 Aveyroniceras cf. italicum (FUCINI). COMAS RENGIFO, PI. 12, Fig. 2.

Our *Prodactylioceras* from level 17c (Rötelstein) presents an intermediate morphology between *P.* gr. *italicum* (FUCINI) and *P. davoei* (SOWERBY). Our specimen has in common with FUCINI's species a fine, regular, very close prorsiradiate ribbing. Like the SOWERBY's species it possesses lengthened, irregular tubercules and a tendency for the ribbing to become more coarse and widely spaced at the end of the body chamber. The juvenile whorl section is cadicone and becomes subrounded in the adult stage. In our view P. italicum is the Tethyan ancestor of P. davoei and it is not a surprise that we have intermediate morphologies. P. rectiradiatum (WINGRAVE) only known in the "Anglo-Lusitanian" countries, is closely connected with P. italicum and it is perhaps the Euroboreal equivalent. It is characterized by very fine tubercules with a quite low position on the whorl sides.

Local range: Maculatum subzone (lataecosta horizon).

Prodactylioceras gr. davoei (SOWERBY 1822) Plate 7, Figs. 8, 10

- *1822 Ammonites Davoei SOWERBY, p. 71, PI. 350.
- 1986 Prodactylioceras davoei (SOWERBY). MEISTER, PI. 18, Fig. 8; Pl. 19, Fig. 3, 7 with synonymy.

Prodactylioceras davoei enode (QUENSTEDT). - MEISTER, PI. 19, Fig. 4 with synonymy.

Prodactylioceras davoei nodosissimus (QUENSTEDT). - MEISTER, PI. 19, Fig. 1; PI. 23, Fig. 5 with synonymy. 1988 *Prodactylioceras* aff. *davoei* (SOWERBY). – SMITH, TIPPER, TAY-

- LOR & GUEX PI. 3, Fig. 4.
- 1989 Prodactylioceras gr. davoei (SOWERBY). MEISTER & LOUP, PI. 6, Fig. 5.
- 1990 Prodactylioceras davoei (Sowerby). Dommergues & Meister, Fig. 3 (8), Fig. 5 (9).

These Prodactylioceras correspond well to the description by DOMMERGUES (1980, 1987) and MEISTER (1986). If generally the ribs are guite fine and close, the presence of irregular, coarse tubercules and the degeneration of the ribbing near the aperture are characteristic of SOWERBY's species. Our samples are closely related to the Bakony forms (DOMMERGUES et al., 1983).

Local range: Capricornus subzone (capricornus horizon).

Subfamily: Dactylioceratinae HYATT in SMITH 1913 Genus: Reynesoceras SPATH 1936

Type species: Ammonites ragazzoni HAUER 1861.

Reynesoceras gr. ragazzoni (HAUER 1861)

Plate 7, Figs. 9, 11

- *1861 Ammonites ragazzoni HAUER, Pl. 1, Fig. 16, 17.
- 1868 Ammonites acanthoides REYNES, Pl. 1, Fig. 3. 1988 Reynesoceras ragazzoni (HAUER). - SMITH, TIPPER, TAYLOR &
- GUEX, PI. 4, Fig. 12. 1989 Reynesoceras acanthoides (REYNES). - MEISTER, PI. 5, Fig. 1,
 - 3-5, 8-10 with synonymy. Reynesoceras ragazzoni (HAUER). - MEISTER, PI. 5, Fig. 2, 6, 7

with synonymy.

The dimorphic pair: microconch (ragazzoni) and macroconch (acanthoides) is now well established (FANTINI-SESTI-NI, 1975; MEISTER, 1989). Among the Ammonitina fauna from Rötelstein we have only found four macroconch specimens.

Local range: Gibbosus subzone (ragazzoni horizon).

Superfamily: Hildocerataceae HYATT 1867 Family: Hildoceratidae HYATT 1867 Subfamily: Harpoceratinae NEUMAYR 1875 Genus: Protogrammoceras SPATH 1913

Type species: Grammoceras bassanii FUCINI 1900.

Remark: We use Protogrammoceras in a wide sense. The ambiguous forms with typically sigmoidal rursiradiate ribs (angulirursiradiate sensu SPATH) and a tricarinate flat venter are called "Protogrammoceras" previously named Fuciniceras.

Protogrammoceras gr. dilectum (FUCINI 1900) Plate 8, Figs. 1, 2

- * 1900 Grammoceras dilectum FUCINI, PI. 11, Fig. 2, 3.
- 1904 Harpoceras (?) dilectum FUCINI, PI. 18, Fig. 11, 12.
- 1972 Protogrammoceras dilectum (FUCINI). FERRETTI, Pl. 13, Fig. 2. P1977 Protogrammoceras cf. dilectum (FUCINI). WIEDENMAYER,
- ?1977 Pl. 19, Fig. 11.
- 1980 Protogrammoceras dilectum (FUCINI). BRAGA & RIVAS, PI. 1, Fig. 12, 13.
- 1983 Protogrammoceras dilectum (FUCINI). DOMMERGUES, FERRETTI, GECZY & MOUTERDE, PI. 3, Fig. 1, 2.

In Rötelstein the species P. gr. dilectum is present below and above the acme of Metaderoceras gr. gemmellaroi (LEVI). The underlying one is in the Fleckenmergel facies and displays a more primitive appearance. It has rather close, sigmoidal (slightly falciform) ribbing and differs from the other "primitive" Protogrammoceras (P. carixiense CANTALUPPI, P. mellahense DUBAR) by more widely spaced ribbing and probably a larger size. From the overlying P. gr. dilectum (FUCINI) it is distinguished by more projected ribs on the external part and a smaller umbilicus, but it could be a crushed exemplar. This specimen also has affinities with P. hungaricum GECZY, a similar form which has a small umbilicus and more irregular, fasciculate with more projected ribs on the venter.

With absence of sulci on the venter, a sharp keel (Text-Fig. 9 H) and sometimes fasciculate and guite close ribbing, the overlying Protogrammoceras belong without doubt to FUCINI's species P. dilectum. The species P. pseudodilectum DOMMERGUES, MEISTER & FAURE has a larger umbilicus, coarser and spaced ribs and is present only in the Upper Carixian (Davoei zone).

Local range: Valdani subzone (gemmellaroi horizon) 🖛 Luridum subzone (Reynesocoeloceras horizon).

Protogrammoceras gr. volubile (FUCINI 1900) pantanelli (FUCINI 1900) Plate 8, Figs. 3, 4

- 1900 Harpoceras? volubile FUCINI, PI. 7, Fig. 3. Grammoceras varicostatum FUCINI, Pl. 8, Fig. 6. Harpoceras? pantanelli Fucini, Pl. 7, Fig. 7
- ?1905 Hildoceras bastianii. FUCINI, PI. 44, Fig. 14.
- ?1905 Hildoceras bastianii var. perplicata FUCINI, Pl. 43, Fig. 1; Pl. 44, Fig. 1.
- 1976 Fuciniceras pantanelli serratum (FUCINI). GECZY, PI. 35, Fig. 6-7; Pl. 36, Fig. 1-5.
- Protogrammoceras ? volubile (FUCINI). WIEDENMAYER, PI. 19, 1977 Fig. 16.
- 1983 Protogrammoceras gr. volubile (FUCINI). pantanelli (FUCINI). -DOMMERGUES, FERRETTI, GECZY & MOUTERDE, Pl. 5, Fig. 1 to 17.
- 1991 Protogrammoceras gr. volubile (FUCINI). BLAU & MEISTER, Pl. 6, Fig. 1, 2.

This species is used sensu DOMMERGUES et al. (1983) and DOMMERGUES (1987). It includes several taxa, especially *varicostatum* (FUCINI). It is distinguished on one hand from the underlying *P. dilectum* by the presence of two flats on both sides of the keel (Text-Fig. 9 I, J) which cut the ribbing and on the other hand from the overlying *P. costicillatum* (FUCINI) by more sigmoidal ribbing; but the transition between these two species is rather gradual and sometimes the distinction is difficult.

Local range: Luridum subzone (crassum horizon).

"Protogrammoceras" gr. costicillatum (FUCINI 1900) Plate 8, Figs. 5, 6, 9

- *1900 Grammoceras Normanianum (d'Orbigny) var. costicillata Fucini, Pl. 7, Fig. 10; Pl. 8, Fig. 1.
- 1986 Fuciniceras gr. costicillatum (FUCINI). MEISTER, PI. 21, Fig. 2 with synonymy.

Our specimens are characterized by rursiradiate and less sinuous ribs and a quite large and flat venter with sulci (Text-Fig. 9 K). This group is quite difficult to distinguish from the underlying *P*. gr. *volubile* (FUCINI) but it is the first Harpoceratinae which looks like *Fuciniceras* although the body chamber still shows sinuous ribs.

Local range: Maculatum subzone (*sparsicosta* horizon) - Capricornus subzone (*capricornus* horizon).

Protogrammoceras aff. gr. pseudodilectum DOMMERGUES, MEISTER & FAURE 1985 Plate 8, Fig. 7

- 1983 Protogrammoceras nov. sp. 1 DOMMERGUES, FERRETTI, GECZY & MOUTERDE, PI. 3, Fig. 3–5, 8.
- *1985 Protogrammoceras pseudodilectum DOMMERGUES, MEISTER & FAURE, PI. 1, Fig. 1 with synonymy.
- 1986 Protogrammoceras pseudodilectum DOMMERGUES, MEISTER & FAURE. MEISTER, PI. 21, Fig. 1.

This crushed *Protogrammoceras* stands apart from the associated *P. costicillatum* (FUCINI) by its sinuous ribs. It recalls the *P. dilectum* (FUCINI) group by its rib shape but the ribbing is more widely spaced, rather like *P. pseudodilectum* DOM-MERGUES, MEISTER & FAURE. So we attribute it, with doubt, to the last species.

Local range: Capricornus subzone (*capricornus* horizon).

"Protogrammoceras" gr. lavinianum (FUCINI 1900) Plate 8, Figs. 8, 10, 12

- *1900 Hildoceras Lavinianum MENEGHINI FUCINI, Pl. 11, Fig. 6, 7. Grammoceras portisi FUCINI, Pl. 9, Fig. 1–3.
- 1900 Hildoceras Lavinianum var. brevispirata FUCINI, Pl. 8, Fig. 6.
- 1983 Fuciniceras lavinianum (FUCINI). BRAGA, PI. 1, Fig. 6–8; PI. 2, Fig. 1–3 with synonymy.
- 1983 Fuciniceras brevispiratum (FUCINI). BRAGA, Pl. 2, Fig. 4–9 with partim synonymy; no P. pantanelli (FUCINI).
- 1983 Fuciniceras portisi (FUCINI). lavinianum (FUCINI). DOMMER-GUES, FERRETTI, GECZY & MOUTERDE, PI. 6, Fig. 9–10.
- 1991 Protogrammoceras aff. gr. lavinianum (FUCINI). BLAU & MEISTER, PI. 5, Fig. 23; PI. 6, Fig. 5–11.

"P." lavinianum (FUCINI) and "P." portisi (FUCINI) sensu DOM-MERGUES et al. (1983) probably constitute only one species, but BRAGA (1983) observe a morphological and a stratigraphical difference with "P." lavinianum (FUCINI) overlying the "P." portisi (FUCINI) group.

At Rötelstein we have only one morphology, that of "P." *lavinianum* (FUCINI) characterized by more coarse, rursiradiate and perhaps less sinuous ribbing than "P." portisi (FU-CINI), but the distinction between these two groups remains very weak (if such distinction must be made).

Local range: Stokesi subzone (lavinianum horizon).

At Rötelstein, level 18c is the first level which contains abundant Harpoceratinae. Low *Protogrammoceras* occurs very sporadically. This level characterizes the Early Domerian.

Protogrammoceras cf. isseli (FUCINI 1900) Plate 8, Figs. 11, 14

- *1900 Grammoceras isseli Fucini, Pl. 9, Fig. 6–8.
- 1983 Fuciniceras isseli (FUCINI). BRAGĀ, PI. 2, Fig. 10; PI. 3, Fig. 1–5.
- 1983 Protogrammoceras isseli (FUCINI). DOMMERGUES, FERRETTI, GECZY & MOUTERDE, PI. 4, Fig. 1–12.
- 1991 Protogrammoceras gr. isseli (FUCINI). BLAU & MEISTER, PI. 5, Fig. 15-22.

The typical "*Fuciniceras* morphology" is less developed in *P. isseli*. The ribs are more sigmoidal (sinuous) and tend to project forward near the venter. On the whole, the rib density increases and the adult whorl sections become more rounded on the venter.

Local range: Stokesi subzone (isseli horizon).

Protogrammoceras marianii (FUCINI 1904)

Plate 8, Figs. 13, 15–17; Plate 9, Figs. 2–4

- *1904 Harpoceras marianii FUCINI, Pl. 41, Fig. 1–3.
- 1972 Prologrammoceras marianii (FUCINI). FERRETTI, Pl. 13, Fig. 6.
- 1977 Protogrammoceras marianii (FUCINI). WIEDENMAYER, PI. 19, Fig. 7, 8 with synonymy.
- 1989 P. (Protogrammoceras) aff. gr. marianii (FUCINI). MEISTER, PI. 3, Fig. 11.
- 1991 Protogrammoceras aff. gr. mariani (FUCINI). BLAU & MEISTER, Pl. 5, Fig. 26, 27.

P. marianii (FUCINI) shows a rib morphology intermediate between *P.* gr. *isseli* (FUCINI) and *P. celebratum* (FUCINI). Indeed, the ribs are more sinuous than in *P. isseli* (FUCINI), becoming quite falcate, and they are less projected forward on the venter than in *P. celebratum* (FUCINI). During this evolutionary trend shown by three species, the whorl section becomes more and more ogival. Moreover the ribbing is generally coarser in *P. marianii* (FUCINI).

Local range: Stokesi subzone (marianii horizon).

Text-Figure 10 shows the peramorphic tendency by acceleration (GOULD, 1977; ALBERCH et al., 1979; MCNAMARA, 1982; DOMMERGUES et al., 1986) to acquire an ogival whorl section and falciform ribbing for three species of *Protogrammoceras* immediately succeeding each other in the Stokesi subzone (see BLAU & MEISTER, 1991). These morphological features are first manifested in the adult stages and reach more and more juvenile ontogenetic stages until *P. celebratum*, which foreshadows *P. (Paltarpites)*. We assume that the inner whorls of the three species have the same morphology. For MCNAMARA (1990) this tendency is an anagenetic peramorphocline.



Subgenus: Matteiceras WIEDENMAYER 1980

Type species: Ammonites nitescens Young & BIRD 1913.

P. (Matteiceras) monestieri (FISCHER 1975) Plate 9, Fig. 1

- 1934 Harpoceras falciplicatum (FUCINI). MONESTIER, PI. 1, Fig. 3, 13, 32, 33, 36, 37; no PI. 10, Fig. 40, 41.
- *1975 Protogrammoceras monestieri FISCHER, Pl. 1, Fig. 13–17; App. 10, 14, Fig. 4–7; App. 15, Fig. 5.
- 1986 *P. (Matteiceras) monestieri* (FISCHER). MEISTER, PI. 21, Fig. 3, 4, 8, 9.
- 1989 P. (Matteiceras) monestieri (FISCHER). MEISTER, p. 38 with synonymy.
- 1990 P. (Matteiceras) monestieri (FISCHER). DOMMERGUES & MEI-STER, Fig. 5 (20).
- 1991 Protogrammoceras (Matteiceras) gr. monestieri (FISCHER). BLAU & MEISTER, PI. 6, Fig. 3, 4.

This typical coarse Euroboreal form (DOMMERGUES & MEISTER, 1989b) co-occurs with the Tethyan *P. gr. isseli* (FUCINI) and so allows us to make a good correlation between these two realms.

Local range: Stokesi subzone (isseli horizon).

P. (Matteiceras) nitescens (YOUNG & BIRD 1828)

- *1828 Ammonites nilescens YOUNG & BIRD, p. 257.
- 1985 Protogrammoceras nitescens (YOUNG & BIRD). COMAS RENGIFO, Pl. 14, Fig. 5–6 with synonymy.
- 1989 P. (Matteiceras) nitescens (YOUNG & BIRD). MEISTER, PI. 3, Fig. 10, 12.
- 1990 P. (Matteiceras) nitescens (YOUNG & BIRD). DOMMERGUES & MEISTER, Fig. 3 (11, 12); Fig. 5 (21).

Coarser but poorly preserved *P. (Matteiceras)* associated with *P.* gr. marianii (FUCINI) are stratigraphically higher than *P.* (*M.*) monestieri (FISCHER). They belong to the *P. (M.) nitescens* (YOUNG & BIRD) group which is the descendant of *P. (M.)* monestieri (FISCHER) (DOMMERGUES & MEISTER, 1989b, Fig. 3).

Local range: Stokesi subzone (marianii horizon).

Subgenus: Fieldingiceras WIEDENMAYER 1980

Type species: Ammonites Fieldingi Reynes 1868.

P. (Fieldingiceras) depressum (QUENSTEDT 1883) Plate 9, Fig. 6

- 1883 Ammonites radians depressum QUENSTEDT, Pl. 42, Fig. 42 no 40, 41.
- 1989 *P. (Protogrammoceras) depressum* (QUENSTEDT). MEISTER, PI. 4, Fig. 4, 6–10 with synonymy.
- 1990 *P. (Fieldingiceras) depressum* (QUENSTEDT). DOMMERGUES, MEI-STER & METTRAUX, p. 322.

This *P.* (*Fieldingiceras*) is a particulary evolute *Protogrammoceras* characterized by very irregular ribbing, especially in the inner whorls. Near the adult aperture the ribbing mostly tends to disappear.

Our specimen is in association with a quite involute rather badly preserved *Protogrammoceras* sp. indet. which possesses ribs hardly projected towards the keel. It would recall (?) *P. celebratum* (FUCINI).

Local range: Subnodosus subzone (*depressum* horizon).

Subgenus: Paltarpites BUCKMAN 1922

Type species: Paltarpites paltus BUCKMAN 1922.

P. (Paltarpites) aff. aequiondulatum (BETTONI 1900)

Plate 9, Fig. 11 1900 Harpoceras (?) aequiondulatum BETTONI, Pl. 6, Fig. 11.

1983 Protogrammoceras aequiondulatum (BETTONI). – BRAGA, PI. 5, Fig. 3–5 with synonymy.

The systematics of *Paltarpites* (= *Argutapites*) is too prolific. In a strictly typological view, our specimen has great affinities with BETTONI's form, but the relations between *P.* (*P.*) *aequiondulatum* and especially *P.* (*P.*) *kurrianus* (OPPEL) are still not well understood.

Text-Fig. 10. Whorl-section and falciform ribbing of *Protogrammoceras isseli* (FUCINI), *P. marianii* (FUCINI) and *P. celebratum* (FUCINI). *P.* (*P.*) menghini (BONARELLI) is closer ribbed and *P.* (*P.*) ilurcense BRAGA has coarser and more widely spaced ribs. Local range: Gibbosus subzone (algovianum horizon).

Subfamily: Arieticeratinae HOWARTH 1955 Genus: Arieticeras SEGUENZA 1885

Type species: Ammonites algovianus OPPEL, 1862.

Arieticeras gr. algovianum (OPPEL 1862)

Plate 9, Figs. 5, 7-10

- 1862 Ammonites Algovianum OPPEL, p. 137.
- 1991 Arieticeras ruthenense (REYNES). ANTONIADIS, PI. 1, Fig. 4.
- 1987 Arieticeras cf. algovianum (OPPEL). SMITH, TIPPER, TAYLOR & GUEX, Pl. 4, Fig. 10, 11.
- 1989 Arieticeras gr. algovianum (OPPEL). MEISTER, PI. 7, Fig. 10–12 with synonymy.
- 1991 Arieticeras gr. algovianum (OPPEL). BLAU & MEISTER, PI. 6, Fig. 23; PI. 7, Fig. 1–18.

This species of *Arieticeras* differs from *A. bertrandi* (KILIAN) by having ribs which are more sinuous and more projected forward on the external part of the whorl. Their adult size also is larger (D = 75 mm); for *A. bertrandi* the adult maximum diameter is 50–60 mm. At Rötelstein, the *Arieticeras* population appears to be more homogeneous in rib density than in the Causses Basin (MEISTER, 1989, Fig. 40). At Breitenberg the *Arieticeras* fauna shows broader whorl sections and is near *A. algovianum* "forme" *almoetianum* (FUCINI) (ibidem 1989, p. 48).

Local range: Gibbosus subzone (algovianum horizon).

Family: Hildoceratidae HYATT 1867 Genus: *Hildoceras* HYATT 1867

Type species: Ammonites bifrons BRUGUIERE, 1789.

Hildoceras sp. indet.

Only one poorly preserved *Hildoceras*, which characterizes the upper part of the Early Toarcian, has been found in Rötelstein (see DEAN et al., 1961, GUEX 1972). Local range: Bifrons zone.

5. Biostratigraphical framework

Our study allows us to establish a set of 21 horizons (Text-Fig. 11) which are well integrated in part to the standard zonation of NW Europe (DEAN et al., 1961; DOM-MERGUES & MEISTER, 1987b) and in part to the zonation of the Tethyan realm (FERRETTI, 1990).

5.1. Sinemurian

5.1.1. Early Sinemurian

Semicostatum zone

The study of the Early Sinemurian was not the purpose of this work. Nevertheless the *Arnioceras* sp. found in Breitenberg (bed 10) and in Schmiedwirt may be attributed to this period.

Sauzeanum subzone *Mendax* horizon (I)

Arnioceras gr. mendax var. rariplicatum also belongs to the Semicostatum zone and probably to the Sauzeanum subzone as in the Swiss Prealps (DOMMERGUES et al., 1990). It co-occurs with Phylloceratina: *Phylloceras (Calaiceras) calais* and *Partschiceras (Zetoceras) zetes* var. *oenotrium*.

5.1.2. Late Sinemurian

Obtusum Zone

As recorded by CORNA (1985) for the Jura Mountains, *Microderoceras gigas* also may occur in the Obtusum zone and probably the *Microderoceras* aff. *gigas* from the screes at Breitenberg, belongs to this zone.

Obtusum subzone

Confusum horizon (II)

This local stratigraphical unit is characterized by Asteroceras aff. confusum associated with several Phylloceratina: Phylloceras frondosum, Phylloceras (Zetoceras) zetes var. oenotrium, Phylloceras (Calaiceras) calais, Juraphyllites sp.; Arnioceras also is common with A. gr. ceratitoides; Angulaticeras sp. and Microderoceras sp. juv. are less abundant.

Stellare subzone

Stellare horizon (III)

This horizon is quite rich in *Phylloceras (Zetoceras)* gr. *zetes* co-occuring with the index species. *Arnioceras* sp. is very rare.

Raricostatum Zone

Only a few ammonites of this period have been found. These ammonites belong to *Leptechioceras* gr. *insigne*, *Palte-chioceras* gr. *meigeni*, *Epideroceras* gr. *lorioli* and *Apoderoceras* (*Miltoceras*) sp. In regard to the biozonation of North-West Europe, there is in Schmiedwirt at least one potential horizon: the *meigeni* horizon (IV) (DOMMERGUES & MEISTER, 1989a).

Some *Lytoceras* occur sporadically during this period. The gap in the data is probably an artefact due to the high and inaccessible wall of the quarry.

5.2. Pliensbachian

5.2.1. Early Pliensbachian (Carixian)

Jamesoni Zone

Brevispina (-Polymorphus) subzone (see DOMMERGUES & MEISTER, 1987b)

Platypleuroceras Horizon (V)

Platypleuroceras sp. and different Polymorphitinae juv. are associated with Phylloceras gr. frondosum, Phylloceras (Zetoceras) gr. zetes, Phylloceras (Calaiceras) calais, Juraphyllites gr. diopsis and Lytoceras sp. In the scree, we have found Metaderoceras venustulum and Metaderoceras aff. gr. mulicum; by comparison with the Causses Basin and Burgundy, these taxa probably belong to this biostratigraphical unit.

Jamesoni horizon (VI)

The lower part of this horizon is characterized by Uptonia gr. confusa, Phylloceras sp. and Juraphyllites sp. only. Uptonia jamesoni, Uptonia bronni and Tropidoceras flandrini characterize its upper part; they always occur with Phylloceras gr. frondosum, P. (Zetoceras) gr. zetes, Juraphyllites gr. libertus, Lytoceras gr. fimbriatum and Derolytoceras tortum.

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		Mendex (1)			Confusum (II)	Similare (11)			-					Molgeni (IV)	7		/// animal medition /		(N) trosemul	Tropidocenas (VII)	inflatum (VIII)	Gemmellarol (IX)			Craseum (XI)	Sparalcosts (XXI)	Latascosta (XIII)	Capricomus (XIV)			Lavinianum (XV)	Issedii (XVI)	Martanii (XVII)	Depreseum (XVIII)	Regezzoni (XIX)	Algovianum (XX)								? Hildocerae (XXI)	-,	Hortzona
																																														Phyloceras gr. frondosum Phyloceras gr. P. (Zatsoorras) zetes var. cenothum P. (2.) gr. zetes P. (Calisiceras) catels P. (Calishyliceras) bicicotae Partschioeras stratocostatum P. sp. Auraphylitee nardi J. gr. dopets J. ibertus tunensis J. gr. bartus J. gr. bartus J. gr. bartus J. gr. bartus J. gr. bartus J. gr. partus J. gr. partus Arricoeras gr. forlosum A. gr. quartagonatum A. gr. partus Metodercoeras gr. Iorioli Apoderoceras gr. Iorioli Apoderoceras gr. Iorioli Apoderoceras sp. Metoderoceras sp. J. yorni T. gr. gr. titali ? (microconch) Acarthopieuroceras gr. inflatum Radsbockiceras ger. meligeni Liparoceras sp. Androgynoceras gr. agazzoni Protogrammoceras gr. diloctum P. gr. outobe-partantili P. gr. j. seeli P. matantil P. (Faltingloeras) depressum P. (Faltingloeras) depressum P. (Pattarphice) aff. aequiondutatum Aretoeras gr. sigovianum
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Text-Fig. 11. Biostratigraphical framework of the sections studied.

lbex zone

Masseanum subzone

In regard to our collection, the Masseanum subzone is poorly documented. Only the *Tropidoceras* sp. juv., *Lytoceras* gr. *fimbriatum* and *Juraphyllites* gr. *libertus* association seems to attest its presence (*Tropidoceras* horizon VII)

Valdani subzone

As in the Masseanum subzone, ammonites are rare in the lower part of this subzone. It is indicated by fragments of *Acanthopleuroceras* gr. *inflatum* associated with *Tropidoceras* sp. and *Juraphyllites* gr. *libertus* (*inflatum* horizon VIII).

Tropidoceras aff. gr. *zitteli* from scree belongs either to this horizon or the *Tropidoceras* horizon.

The upper part of the Valdani subzone is more clearly documented in the Rötelstein outcrops by the presence of a rich level with *Metaderoceras* gr. *gemmellaroi*, *Partschiceras striatocostatum* (*gemmellaroi* horizon IX). The first *Protogrammoceras*, belonging to the gr. *dilectum*, appears in this horizon associated with *Juraphyllites* and *Phylloceras*.

Tropidoceras aff. gr. *zitteli* (microconch) probably occurs in the upper part of this subzone.

Luridum subzone

We attribute two horizons to this biochronological subdivision.

- The first one with P. (Calliphylloceras) calais, Radstockiceras gemmellaroi, the first P. (Calliphylloceras) bicicolae, Juraphyllites gr. libertus, Lytoceras gr. fimbriatum, Reynesocoeloceras sp. and doubtful Protogrammoceras gr. dilectum from bed 11 (Rötelstein) (Reynesocoeloceras horizon X). This association is not very characteristic and could still belong to the uppermost Valdani subzone.
- The second one, crassum horizon (XI) with A. (Beaniceras) crassum, Protogrammoceras gr. volubile pantanelli truely characterizes the Luridum subzone. One also finds Phylloceras gr. frondosum. P. (Zetoceras) gr. zetes, P. (Calliphylloceras) bicicolae, Juraphyllites gr. libertus, Lytoceras gr. fimbriatum and some typical euroboreal ammonites like Tragophylloceras loscombi and Liparoceras sp.

Davoei zone

Maculatum subzone

The biochronological unit is subdivided into two local horizons.

- The index species, "Protogrammoceras" costicillatum, A. (Aegoceras) sp., Liparoceras sp. P. (Zetoceras) gr. zetes and P. (Calliphylloceras) bicicolae constitute the sparsicosta horizon (XII).
- The lataecosta horizon (XIII) is well represented and characterized by A. (Aegoceras) lataecosta, "Protogrammoceras" gr. costicillatum, Protogrammoceras aff. gr. pseudodilectum, Lytoceras gr. fimbriatum, Phylloceratina and among them Tragophylloceras loscombi. In the upper part Prodactylioceras gr. italicum is also present.

Capricornus subzone

Capricornus horizon (XIV)

A level with only *Prodactylioceras* gr. *davoei* characterizes the base of this horizon. Overlying this level, we find A. (Aegoceras) capricornus, *Prodactylioceras* gr. *davoei* again, "*Protogrammoceras*" gr. *costicillatum*, *Protogrammoceras* aff. *pseudodilectum* and *Phylloceras*. The index species only occurs in the lower and middle part. Perhaps the upper part of the unit belongs to the Figulinum subzone, the last Carixian biochronological subdivision which is not identified by a characteristic ammonite in the outcrops studied.

5.2.2. Late Pliensbachian (Domerian)

Margaritatus zone

Stokesi subzone

Lavinianum horizon (XV)

Besides the index species we only find *Juraphyllites* gr. *libertus* and *Phylloceras* gr. *frondosum*.

Isseli horizon (XVI)

Protogrammoceras isseli, P. (Mateiceras) monestieri, Phylloceras and Lytoceras characterize this biostratigraphical unit.

Marianii horizon (XVII)

In this horizon, *Protogrammoceras marianii* takes the place of *Protogrammoceras isseli* and *P. (Matteiceras) nitescens* takes the place of *P. (Matteiceras) monestieri*. That is of great interest for the comparison between the Tethyan and Euroboreal realms sensu DOMMERGUES & MEISTER (1991, p. 267). *Phylloceras* and *Lytoceras* are also present.

Subnodosus subzone

This subdivision is represented by one horizon (*depressum* horizon XVIII) characterized by *P. (Fieldingiceras) depressum*, *Phylloceras* gr. *frondosum*, *Juraphyllites* sp. and *Lytoceras* sp.

Gibbosus subzone

This biochronological unit is represented by two horizons. Besides the index species, we have some *Phylloceras* gr. *frondosum* in the first one (*ragazzoni* horizon XIX). The second one is characterized by *Arieticeras algovianum*, *P. (Paltarpites)* aff. *aequiondulatum* and *Phylloceras* and *Juraphyllites* (*algovianum* horizon XX).

Coming from scree, *Amaltheus margaritatus* "forme" *gibbosus* also characterizes this subzone (HOWARTH, 1958; JORDAN, 1960; MATTEI, 1985; MEISTER, 1988).

All of the Late Domerian (Spinatum zone) is apparently lacking in the outcrops studied or more probably not represented by ammonites.

5.3. Toarcian

Bifrons Zone

In the Rötelstein area, the beds with *Hildoceras* sp. (*Hil-doceras* horizon XXI) immediately overly the levels of the Margaritatus zone. This discontinuity is characterized by a hard ground the age of which lies between the Spinatum zone (Late Domerian) and the Falcifer zone (Early Toarcian).

Thus our biostratigraphical framework is based on both Euroboreal and Tethyan faunas.

* * *

The Sinemurian faunas, except for *Arnioceras* gr. *mendax* which shows rather ubiquitous affinities, present great affinities with the Euroboreal realms with the beds with *Asteroceras* (*A.* aff. *confusum* and *A.* aff. *stellare*) and Echioceratidae (*L. meigeni*). But this period still needs further study.

For the Pliensbachian our taxa associations well underline (Text-Fig. 12) the intermediate palaeogeographical position of the Upper Austroalpine between the Tethyan and the Euroboreal realms sensu DOMMERGUES & MEISTER (1991, p. 267). This Alpine unit thanks to its mixed ammonite faunas (Liparoceratidae/Harpoceratinae for the Carixian and Harpoceratinae (*Matteiceras*)/Harpoceratinae for the Domerian) provides the key for the understanding of biochronological correlation.

	·					···		
Stage	Zones	Subzones	NW European horizons	Upper Austroalpine horizons	Apennines biostratigraphical framework (Ferretti 1990)	Eustatic curve (Haq et al. 1988) + -		
_	1	Hawekereese			EMACIATICERAS	/		
	l₹l		yı, LV110		LIOCERATOIDES			
i 1	4		SOLARE	1	(SOLARE)			
	ا مَعْ	Apyrenum	TRANSIENS	1	ļ			
1	لـــّـــا		SALEBROSUM	1 i	l i	/		
;			RUTHENENSE		l i	\		
				ALGOVIANUM	η			
			BERTRANDI		ARIETICERAS & A.			
l		Gibbosus	KURRIANUS	I I	UGDULENAI			
	13	· · ·	UGDULENAI	Į.				
	M	1	MACRUM	l				
	GARI			RAGAZZONI				
1	AR	!	FONTANEILLESI	1	? PECTINATUM	/		
I	2	Subnodosus	BOSCENSE	1	? PERSPIRATUM	/		
l		1	DEPRESSUM	DEPRESSUM]	/		
]		[]	CELEBRATUM		CELEBRATUM] //		
	1	ا _	NITESCENS	MARIANII	MARIANII] [(
1		Stokesi	MONESTIERI	ISSELI	ISSELI			
l		1	OCCIDENTALE	LAVINIANUM	PORTISI = LAVINIANUM	$1 \rightarrow $		
-			FIGULINUM		Ν	1 /		
M		rigulinum	ANGULATUM	1				
E		Carrie	CRESCENS/SAMONTAENSIS]]	/		
¥	ا ق	Capricornus	CAPRICORNUS	CAPRICORNUS		/		
<u>S</u>			LATAECOSTA	LATAECOSTA		(\		
Ē		Maculatum	MACULATUM		11			
		ļi	SPARSICOSTA	SPARSICOSTA	IJ	$ \rangle$		
<u>َ</u> ا		· ·	LURIDUM		К	$\left\{ \right\}$		
1		Luridum	CRASSUM	CRASSUM	11	1/ \		
1		·····	ROTUNDUM	REYNESOCOELOCERAS				
			ALISIENSE			1 \		
		l .	CENTAURUS		V	11		
	۲ ۲	Į,	VENARENSE		GEMMELLARO	11 1		
1	<u>∞</u>		ACTAEON			/		
1		Valdani	VALDANI					
1		1	MAUGENESTI		4			
1			ARIETIFORME		4	11/		
		Masseanum	MASSEANUM	TROPIDOCERAS	4	1 //		
		Jamesoni	PETTOS			$ \rangle \rangle$		
1		}	JAMESONI s. l.	JAMESONI	4	$ \rangle \rangle$		
	Z	_	TENUILOBUS/SUBMUTICUM		POLYMORPHITES	$ \rangle \rangle$		
ł	ĒS	Brevispina /	BREVISPINA/BREVISPINOIDES	PLATYPLEUROCERAS	4	$ \setminus \setminus$		
	AM	- olymorphus	POLYMORPHUS s. I.	4		$ \rangle \rangle$		
	[]		BIRUGA	4	1	$ \langle \rangle$		
		Taylori	TAYLORI	4		$ \rangle \rangle$		
		1	NODOGIGAS/QUADRARMATUM	<u> </u>		$ \rangle \rangle$		

Text-Fig. 12.

Correlation attempt between NW European, Austroalpine and Apennines biostratigraphical frameworks and comparison with the eustatic curve of HAO et al. (1988).

It is possible to build a quite detailed biostratigraphical framework based on Euroboreal ammonites for the Carixian (except for the *gemmellaroi* and *Reynesocoeloceras* horizons which relate to the Tethyan realm). On the contrary the biostratigraphical scale for the Domerian is wholly based on Tethyan ammonites (except for the *depressum* horizon). The *gemmellaroi* horizon is quite difficult to correlate and is considered here as an equivalent of the *venarense* horizon. The biostratigraphical scale proposed here for the Upper Austroalpine is still incomplete and needs further study.

While the correlation is very good with the well known Subboreal areas (Causses, Burgundy...), the comparison with the Apennines of the Marches (Tethyan realm) is more problematic, mainly for the Carixian (Text-Fig. 12). Indeed the ranges of Carixian Protogrammoceras species ranges are not well known especially for P. volubile and "P." costicillatum. The last one is only known in the Bakony Mountains (DOM-MERGUES et al., 1983; DOMMERGUES, 1987) and seems to indicate the upper Davoei zone. For these authors (ibidem) P. volubile characterizes the lower part of the Davoei zone (and the upper Ibex zone). The same we can observe in the Upper Austroalpine. For FERRETTI (1990) P. volubile characterized the whole Late Carixian but this is probably only a question of taxonomic interpretation. For the Domerian

Period	Stage: subst	s å ages	Zones	Horizons	Ammonite faunas compositions	Paleogeographical affinities
	z		BIFRONS	Hildoceras (XXI)	no avaliable data	no available data
	ARCIA	EARLY	FALCIFER			
	2		TENUICOSTATUM			
			SPINATUM			
				Algovianum (XX)	22 ел.	
				Ragazzoni (XIX)	7 ex.	
			MARGARITATUS	Depressum (XVIII)	8 ex.	
		MERIAN		Marlanii (XVII)	74 ex.	
		8		isseli (XVI)	31 ex.	
	ACHIAN			Lavinianum (XV)	18 ex.	
	ENSB			Capricomus (XIV)	17 ez.	
	2		DAVOEI	Lataecosta (XIII)	28 ех.	
				Sparsicosta (XII)	9 ez.	
LIAS				Crassum (XI)	37 ех.	
		NVIXE		Reyneso coeloceras (X)	11 ex.	
		ß	IBEX	Gemmellaroi (IX)	8 ex.	
				Inflatum (VIII)	Ser.	
				Tropicioceras (VII)	12 ex.	
				Jamesoni (VI)	53 ex.	
			JAMESONI	Platypieuroceras (V)	10 ex.	
			RARICOSTATUM	Melgeni (IV)	no available data	no available data
		٣	OXYNOTUM			
	IRIAN	3		Stellare (III)	12 ex.	
	SINEMI		OBTOSOM	Confusum (II)	85 ex.	
		~	TURNERI			
		EARL	SEMICOSTATUM	Mondax (1)	19 ex.	
$\left[\right]$			Federacentidas			
		7	Oxynoticeratidae	Amath	eidae	Ubiquitous ammonites
	Ē		Asteroceratinae		peratidae Lytoceratina	Euroboreal ammonites
	E	⊞	Arietitinae	Acanth	opleuroceratidae	Tethuan ammonian
	Z	Ζ	Schlotheimiidae	Polyma	orphitidae 🔀 Harpoceratinae	
						· · · · · · · · · · · · · · · · · · ·

Text-Fig. 13. Faunal composition and paleogeographical affinities of the sections studied.

the correlations are good but the comparison with the Causses or the Apennines shows several faunal gaps for the Upper Austroalpine in the outcrops considered.

6. Faunal Composition and Palaeogeographical Remarks

The interpretation of the faunal ratio in Text-Figure 13 must be taken prudently for some horizons because of the small numbers of specimens. Nevertheless, general tendencies can be described. We consider the taxa of higher order (subfamilies, families and suborder). The quite strong presence of Phylloceratina (Juraphyllitidae + Phylloceratidae) during all of the period in question must be emphasized. The presence of Lytoceratina is more episodic and their relative abundance in the Upper Ibex zone and in the middle part of the Subnodosus subzone (depressum horizon) coincides exactly with the same phenomenon in NW Europe and in the Betics (FERRETTI & MEISTER, in press). In NW Europe the Lytoceratina occur in the Upper Ibex zone just after the hegemony of Acanthopleuroceratidae and just before the explosion of the Liparoceratidae. In the Upper Subnodosus subzone Lytoceratina occur between the main acmes of the Harpoceratinae and the Arieticeratinae also indicating probably strong inter-taxa competition. So the Lytoceratina seem to exploit periods of instability of Ammonitina (the periods of faunal replacements ?).

During the Carixian and also during the Obtusum zone (Sinemurian) the faunal ratio among Ammonitina is rather heterogeneous. None of the Ammonitina taxa dominates (except in the *Tropidoceras, inflatum* ? and *gemmellaroi* horizons). This phenomenon perhaps can be interpreted as reflecting strong inter-taxa competition between different groups of Ammonitina. On the contrary during the Early and Middle Domerian, the different horizons are dominated by one taxon. So the faunal composition ratio seems to express an imbalance connected perhaps on a larger scale (Euroboreal and Tethyan realms) to a more stressed faunal provincialism.

The *Phylloceratina*, with the Phylloceratidae and the Juraphyllitidae, are well represented in the Adnet Formation, even so they do not really dominate the Ammonitina. Their relative abundance seems to be closely connected with the "Ammonitico Rosso" s. I. facies as in the Bakony, in the Southern Calcareous Alps and even in part in the Apennines. This is rather a question of ecological constraints.

When we compare the palaeogeographical affinities of our ammonite faunas – Tethyan affinity of Juraphyllites, Phylloceratidae, Arnioceras, Microderoceras, Tropidoceras gr. zitteli, Harpoceratinae (except P. (Matteiceras) and P. (F.) depressum), Reynesocoeloceras, P. italicum, Reynesoceras, Arieticeratinae; Euroboreal affinity of Asteroceras aff. confusum and aff. stellare, Tragophylloceras, Platypleuroceras, Uptonia, Acanthopleuroceras, Liparoceratidae, P. davoei, Amaltheidae, P. (Matteiceras), P. (F.) depressum; ubiquitous or apparently



Palinspastic reconstructions of the Alpine Ranges (after TRUMPY, 1990).

u b i quitous for Lytoceras gr. fimbriatum-villae, Radstockiceras, Metaderoceras gr. gemmellaroi, Angulaticeras, Tropidoceras flandrini – the upper Austroalpine clearly belongs to the Tethyan realm but it is constantly subject to Euroboreal influences, even if they remain quite weak. Generally for the Early and Middle Carixian the faunal exchanges are due to the ubiquitous ammonites and partly to the euroboreal ammonites. Then in the Late Carixian and in the Domerian the faunal exchange is only due to the Euroboreal ammonites. This feature appears more conspicuous when we make a comparison at the larger scale of the western Tethys (see FERRETTI & MEISTER, in press).

7. Conclusion

For the first time a detailed biostratigraphical framework is given for the Upper Austroalpine Pliensbachian in the Northern Calcareous Alps. The Austroalpine unit represents without doubt a Tethyan region, but it reveals an intermediate character both for its palaeogeographical position (Text-Fig. 14), classically situated on the South Tethyan margin and its faunal composition.

Plate 1

The comparison between the ammonite record and global eustatic changes (HAQ et al., 1988) shows no significant correspondence (Text-Fig. 12, 13). Indeed in the Adnet Formation, the ammonite record appears not to be influenced by periods of general transgression or regression; except perhaps by the well-known period of emhasized regression at the Carixian-Domerian and Domerian-Toarcian boundaries which seem to express themselves by the absence of the Figulinum and the Hawskerense subzones at the Rötelstein. But we emphasize that the palaeontological studies must be continued in the Northern Calcareous Alps to become more definitive and to distinguish between the local (tectonic...) and the global constraints.

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 Fig. 1: *P. (Calaiceras) calais* (MENEGHINI). Coll. MEISTER, no. 55401, Breitenberg, bed 13, Semicostatum zone.
 Figs. 2,5: *P. (Calliphylloceras) bicicolae* (MENEGHINI) Coll. MEISTER, no. 55402–03, Rötelstein, bed 15, Luridum subzone.

Figs. 3,4: *P. (Zetoceras)* gr. *zetes* (d'ORBIGNY). Fig. 3: Coll. MEISTER, no. 55404, Rotkogel, bed 14, Jamesoni subzone. Fig. 4: Coll. MEISTER, no. 55405, Breitenberg, bed 15, Stellare subzone.

All the ammonites are in natural size.



Figs.	1,2:	Phylloceras gr. frondosum (REYNES). Fig. 1: Coll. MEISTER, no. 55406, Rötelstein, bed 17b, Maculatum subzone. Fig. 2: Coll. MEISTER, no. 55407, Schmiedwirt, bed 9, Jamesoni zone ?					
Fig.	3:	<i>P. (Zetoceras) zetes var. oenotrium</i> (Fucini). Coll. MEISTER, no. 55408, Schmiedwirt, bed 4, Semicostatum zone.					
Fig.	4:	<i>Partschiceras striatocostatum</i> (Меледнілі). Coll. Meister, no. 55409, Rötelstein, 6–7 m < bed 10, Valdani subzone.					
Figs.	5,9:	<i>Juraphyllites</i> gr. <i>libertus</i> (GEMMELLARO). Fig. 5: Coll. MEISTER, no. 55410, Rötelstein, bed 16, Luridum subzone. Fig. 9: Coll. MEISTER, no. 55411, Schmiedwirt, bed 12, Masseanum subzone.					
Fig.	6:	<i>Galaticeras</i> sp. indet. Coll. MEISTER, no. 55412, Rotkogel, bed 16, Jamesoni or Masseanum subzones.					
Fig.	7:	<i>Juraphyllites</i> juv. sp. indet. Coll. MEISTER, no. 55413, Breitenberg, bed 18, Carixian to Domerian.					
Fig.	8:	Juraphyllites nardii (MENEGHINI). Coll. MEISTER, no. 55414, Schmiedwirt, from the screes.					
Fig.	10:	<i>Juraphyllites</i> gr. <i>diapsis</i> (GEMMELLARO). Coll. MEISTER, no. 55415, Schmiedwirt, from the screes.					
All th	All the ammonites are in natural size.						

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Fig. 1: Derolytoceras tortum (QUENSTEDT). Coll. MEISTER, no. 55416, Schmiedwirt, from the screes. Fig. 2: Microderoceras sp. juv. Coll. MEISTER, no. 55417, Breitenberg, bed 13, Obtusum zone. Fig. 3: Microderoceras aff. gigas QUENSTEDT. Coll. MEISTER, no. 55418, Breitenberg, from the screes probably Turneri - Obtusum zones.

Fig. 4: Juraphyllites libertus lumensis (DI STEFANI). Coll. MEISTER, no. 55419, Schmiedwirt, from the screes.

Fig. 5: Juraphyllites gr. libertus (GEMMELLARO). Coll. MEISTER, no. 55420, Schmiedwirt, bed 12, Masseanum subzone.

All the ammonites are in natural size.

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Figs. 1,2:	<i>Lytoceras</i> gr. <i>fimbriatum</i> (Sowerby). Coll. Meister, no. 55421, Schmiedwirt, bed 10, Jamesoni subzone.
Figs. 3,5,6,10	Arnioceras gr. ceratitoides (QUENSTEDT). Coll. MEISTER, no. 55422–25, Breitenberg, bed 13, Obtusum subzone.
Fig. 4:	Arnioceras gr. mendax var. rariplicatum Fucini. Coll. Meister, no. 55426, Schmiedwirt, bed 4, Semicostatum zone.
Figs. 7,9,11:	<i>Asteroceras</i> aff. <i>confusum</i> Spath. Coll. Meister, no. 55427–29, Breitenberg, bed 13, Obtusum subzone.
Fig. 8:	Asteroceras sp. Coll. MEISTER, no. 55430, Breitenberg, bed 12, Obtusum subzone ?
Fig. 12:	A. (Miltoceras) juv. Coll. MEISTER, no. 55431, Schmiedwirt from the screes; probably Late Raricostatum zone to Early Jamesoni zone.
Fig. 13:	<i>Leptechioceras</i> gr. <i>meigeni</i> (Hug). Coll. MEISTER, no. 55432, Schmiedwirt bed 7 or 8, Raricostatum zone.

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All the ammonites are in natural size.



- Fig. 1: *Epideroceras* gr. *lorioli* (Hug). Coll. MEISTER, no. 55433, Schmiedwirt, bed 6, Macdonnelli subzone.
- Fig. 2: *Paltechioceras* gr. *insigne* (TRUEMAN & WILLIAM). Coll. MEISTER, no. 55434, Schmiedwirt, bed 7 or 8, Raricostatum zone.
- Fig. 3: *Metaderoceras* aff. gr. *mulicum* (d'ORBIGNY). Coll. MEISTER, no. 5535, Schmiedwirt, from the screes, Jamesoni zone.
- Figs. 4,5: *Uptonia* gr. *jamesoni* (SowerBY). Fig. 4: Coll. MEISTER, no. 55436, Rötelstein, 10–12 m < bed 10, Jamesoni subzone. Fig. 5: Coll. MEISTER, no. 55437, Schmiedwirt, bed 10, Jamesoni subzone.
- Fig. 6: *"Metaderoceras" venustulus* (DUMORTIER). Coll. MEISTER, no. 55438, Schmiedwirt, from the screes, Middle Jamesoni zone.

All the ammonites are in natural size.



Fig.	1:	Uptonia gr. jamesoni (Sowerby). Coll. MEISTER, no. 55439, Schmiedwirt, bed 10, Jamesoni subzone.
Fig.	2:	<i>Uptonia bronni</i> (Remer). Coll. MEISTER, no. 55440, Schmiedwirt, bed 10, Jamesoni subzone.
Figs.	3,4:	Tropidoceras juv. Coll. MEISTER, no. 55441–42, Schmiedwirt, bed 13, Masseanum subzone.
Figs.	5,7,8:	<i>Tropidoceras</i> aff. gr. <i>zitteli</i> FUCINI. Coll. MEISTER, no. 55443–45, Schmiedwirt, from the screes, probably Masseanum subzone.
Fig.	6:	Uplonia gr. confusa (QUENSTEDT). Coll. MEISTER, no. 55446, Schmiedwirt, from the screes, Jamesoni subzone.
Fig.	9:	Acanthopleuroceras gr. inflatum (QUENSTEDT). Coll. MEISTER, no. 55447, Schmiedwirt, bed 13, Valdani subzone.
Fig.	10:	Tropidoceras aff. gr. zitteli FUCINI form (?) microconch. Coll. MEISTER, no. 55448, Rötelstein, 5–7 m < bed 10, Ibex zone.
Fig.	11:	<i>Tropidoceras flandrini</i> (Dumortier). Coll. MEISTER, no. 55449, Schmiedwirt, bed 10, Jamesoni subzone.
All th	e ammo	onites are in natural size.

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Fig. 1:	<i>Metaderoceras</i> gr. <i>gemmellaroi</i> (Levi). Coll. MEISTER, no. 55450, Rötelstein, 6-7 m < bed 10, Valdani subzone.		
Figs. 2,6:	<i>A. (Aegoceras) lataecosta</i> (Sowerby). Coll. MEISTER, no. 55451–52, Rötelstein, bed 17bc, Maculatum subzone.		
Figs. 3,7:	<i>Reynesocoeloceras</i> sp. indet. Coll. MEISTER, no. 55453–54, Rötelstein, bed 15 (upper part). Luridum subzone.		
Fig. 4:	<i>Prodactylioceras</i> aff. gr. <i>italicum</i> (Fucını). Coll. MEISTER, no. 55455, Rötelstein, bed 17c, Maculatum subzone.		
Fig. 5:	<i>A. (Beaniceras)</i> gr. <i>crassum</i> Вискман. Coll. MEISTER, no. 55456, Rötelstein, bed 16 (lower part), Luridum subzone.		
Figs. 8,10:	 Prodactylioceras gr. davoei (SowERBY). Fig. 8: Coll. MEISTER, no. 55457, Rötelstein, bed 18a, Capricornus subzone. Fig. 10: Coll. MEISTER, no. 55458, Rötelstein, bed 17 (uppermost part), Capricornus subzone. 		
Figs. 9,11:	<i>Reynesoceras</i> gr. <i>ragazzoni</i> (HAUER). Coll. MEISTER, no. 55459–60, Rötelstein, bed 21, Gibbosus subzone.		
All the ammonites are in natural size.			



Figs.	1,2:	Protogrammoceras gr. dilectum (FUCINI). Fig. 1: Coll. MEISTER, no. 55461, Rötelstein, 8 m < bed 10, Ibex zone. Fig. 2: Coll. MEISTER, no. 55462, Rötelstein, bed 11, probably Ibex zone.
Figs.	3,4:	Protogrammoceras gr. volubile (Fucini) – pantanelli (Fucini). Fig. 3: Coll. MEISTER, no. 55463, Rötelstein, bed 16, Ibex zone. Fig. 4: Coll. MEISTER, no. 55464, Breitenberg, bed 18, probably Ibex zone.
Figs.	5,6,9:	"Protogrammoceras" gr. costicillatum (FUCINI). Fig. 5: Coll. MEISTER, no. 55465, Breitenberg, bed 18, probably Davoei zone. Fig. 6, 9: Coll. MEISTER, no. 55466–67, Rötelstein, bed 18a, Davoei zone.
Fig.	7:	<i>Protogrammoceras</i> aff. gr. <i>pseudodilectum</i> Dommergues, Meister & Faure. Coll. Meister, no. 55468, Rötelstein, bed 18b, Capricornus subzone.
Figs.	8,10,12:	" <i>Protogrammoceras"</i> gr. <i>lavinianum</i> (Fucini). Coll. MEISTER, no. 55469–71, Rötelstein, bed 18c, Stokesi subzone.
Figs.	11,14:	<i>Protogrammoceras</i> gr. <i>isseli</i> (Fucını). Coll. MEISTER, no. 55472–73, Rötelstein, bed 19, Stokesi subzone.
Figs.	13,15–17:	Protogrammoceras marianii (Fucini). Coll. MEISTER, no. 55474–77, Rotkogel, bed 22, Stokesi subzone.

All the ammonites are in natural size.



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Plate 9

Fig.	1:	P. (Matteiceras) monestieri (FISCHER). Coll. MEISTER, no. 55478, Rötelstein, bed 19, Stokesi subzone.
Figs.	2–4:	Protogrammoceras marianii (Fucini). Coll. MEISTER, no. 55479–81, Rotkogel, bed 22, Stokesi subzone.
Figs.	5,7–10:	Arieticeras gr. algovianum (OPPEL). Fig. 5: Coll. MEISTER, no. 55482, Breitenberg, bed 18, probably Gibbosus subzone. Fig. 7–10: Coll. MEISTER, no. 55483–86, Rötelstein, bed 22, Gibbosus subzone.
Fig.	6:	P. (Fieldingiceras) depressum (QUENSTEDT). Coll. MEISTER, no. 55487, Rötelstein, bed 20, Subnodosus subzone.
Fig.	11:	<i>P. (Paltarpites)</i> aff. aequiondulatum (Веттом). Coll. MEISTER, no. 55488, Rötelstein, bed 22, Gibbosus subzone.

All the ammonites are in natural size.



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