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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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Oberösterreich
Nördliche Kalkalpen
Lias
Ammoniten
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Palaeogeographie

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Contents

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), TOLLMANN (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 DOMMERGUES & 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.

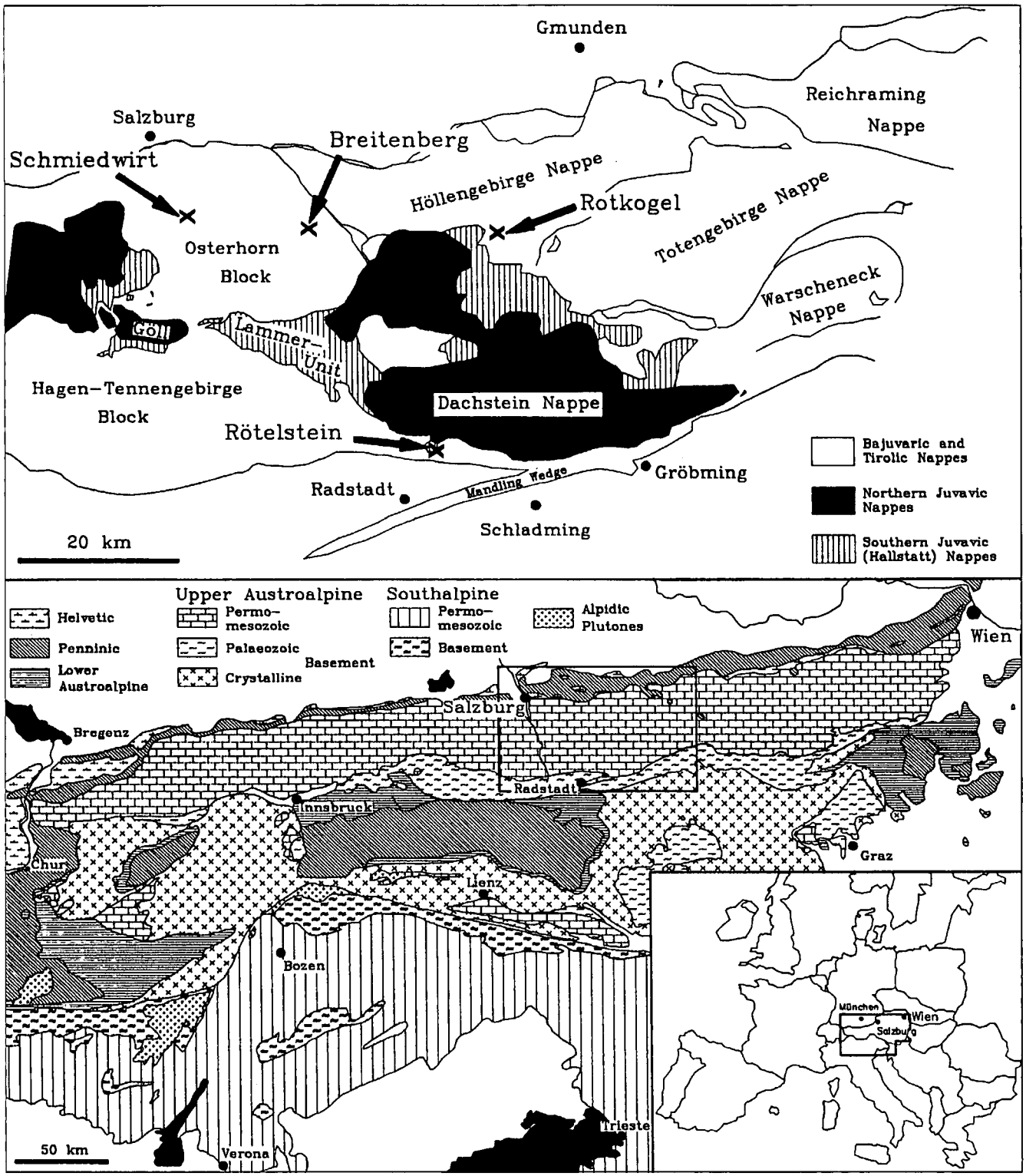
2. Geographical and Geological Framework

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.

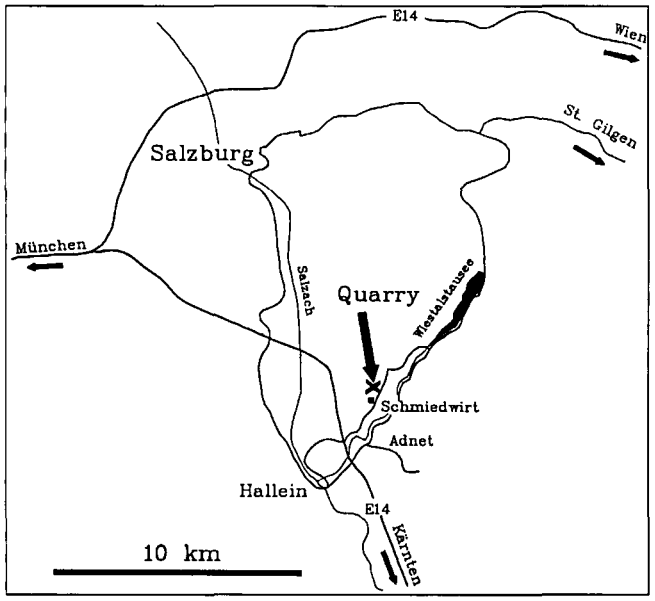


Text-Fig. 1.
The middle part of the Northern Calcareous Alps (upper) with the locations of the sections studied (above).
Tectonic overview of the Eastern Alps (below).
The sections belong to three different tectonic units. Schmiedwirt, Breitenberg and Rotkogel lie within different parts of the Tirolic 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).



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

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

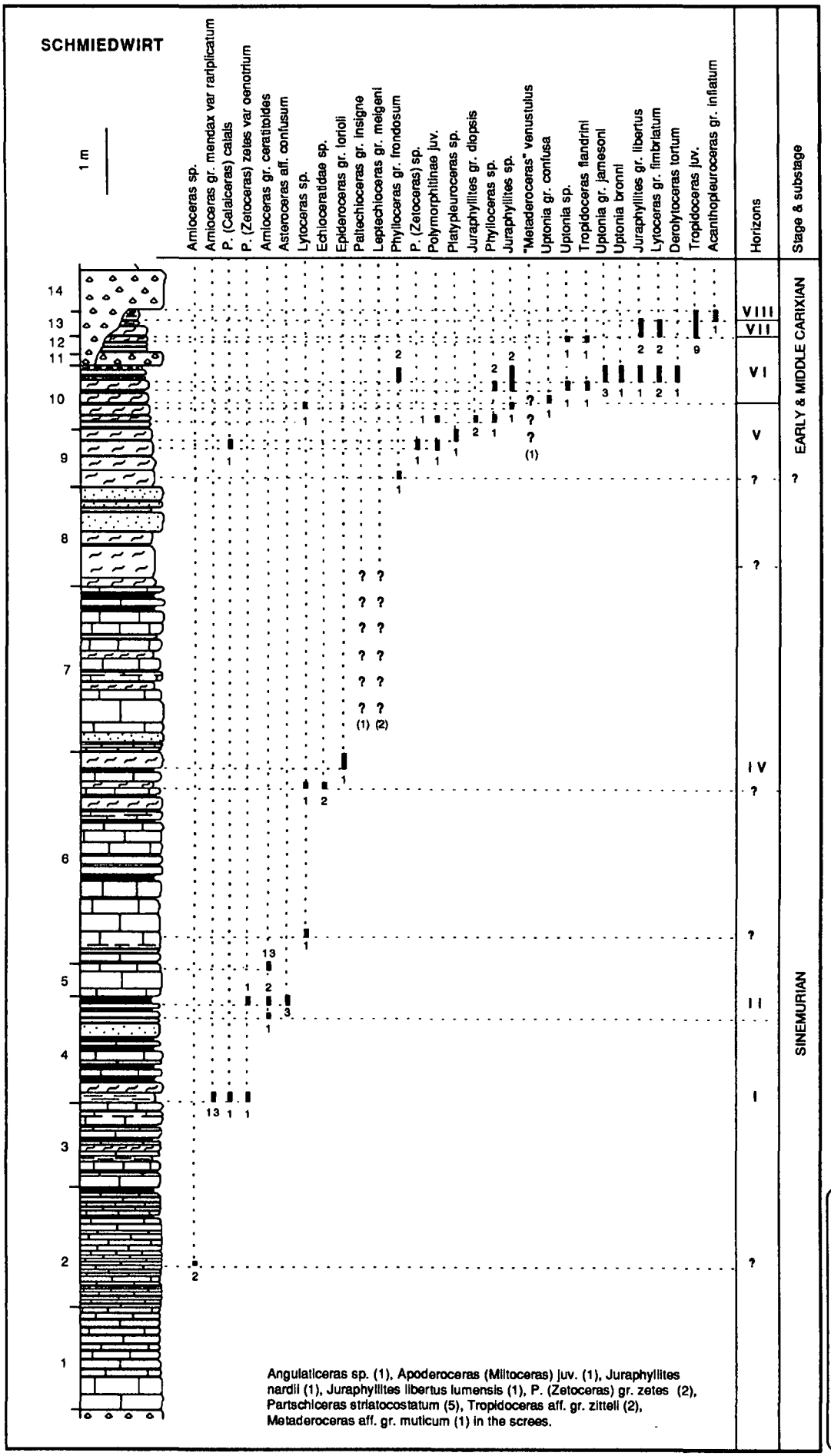
The outcrop at the Breitenberg, as at Schmiedwirt, is in an old quarry, but this one is abandoned. The quarry lies about 500 m southeast of the summit of the Breitenberg at approximately 1150 m (Text-Fig. 4). The Breitenberg occurence belongs to the same tectonic unit as that in the Schmiedwirt quarry. 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 (layer 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.

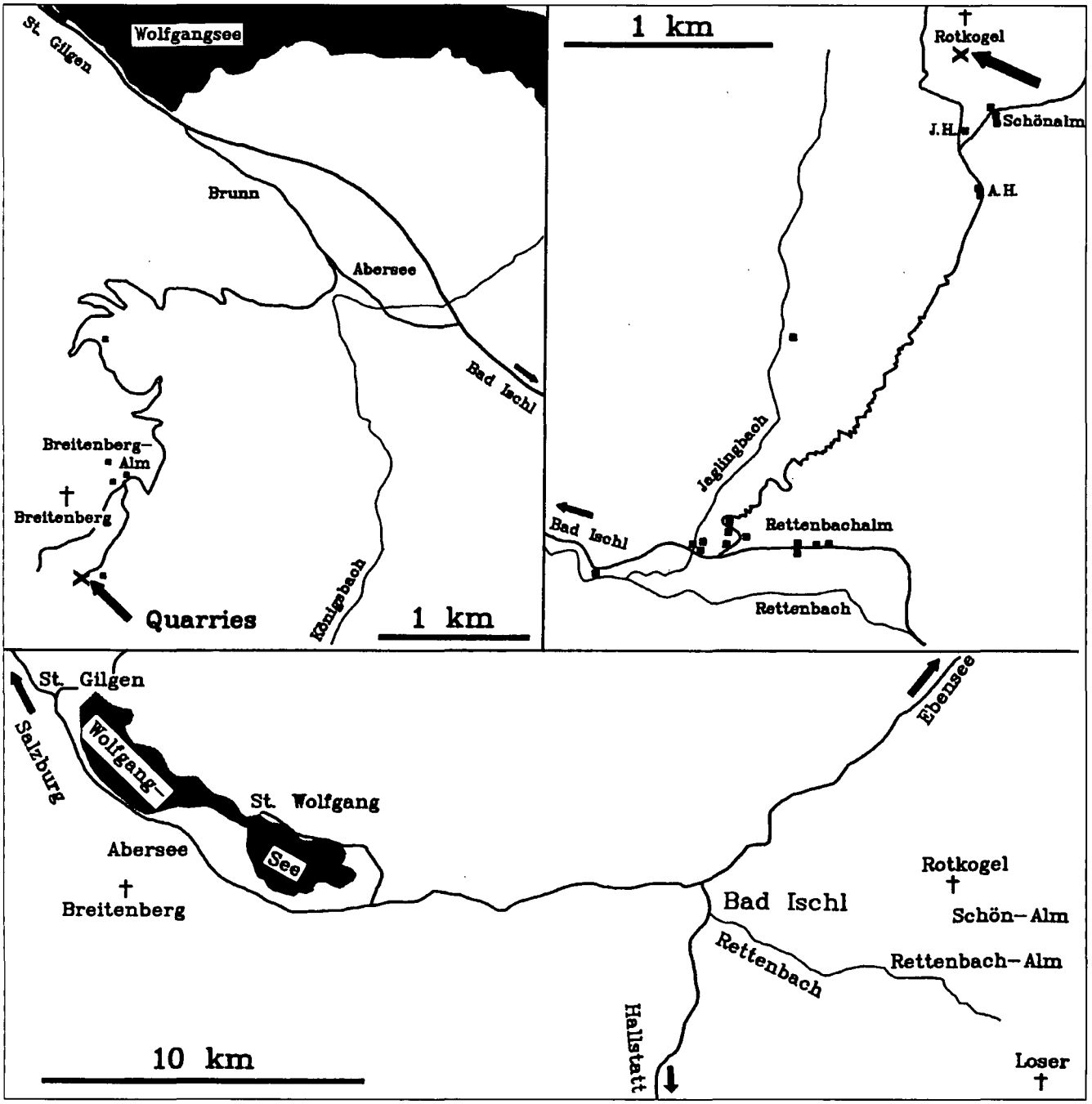
The section starts with reddish marly bedded limestones (Text-Fig. 6). The marl content is even higher than at the Breitenberg. In the upper part of the section three breccia beds occur, separated by deep red marls and marly limestones, which became of to their high content of fine crinoidal debris have 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".



Text-Fig. 3.
Schmiedwirt quarry.
Lithological profile and ammonite ranges.

Figure captions 3, 5, 6, 8

- Breccia
- Limestone rich in crinoidal debris
- Nodular limestone
- Micritic limestone
- Marly limestone
- Calcareous marl
- Layers of marl



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.

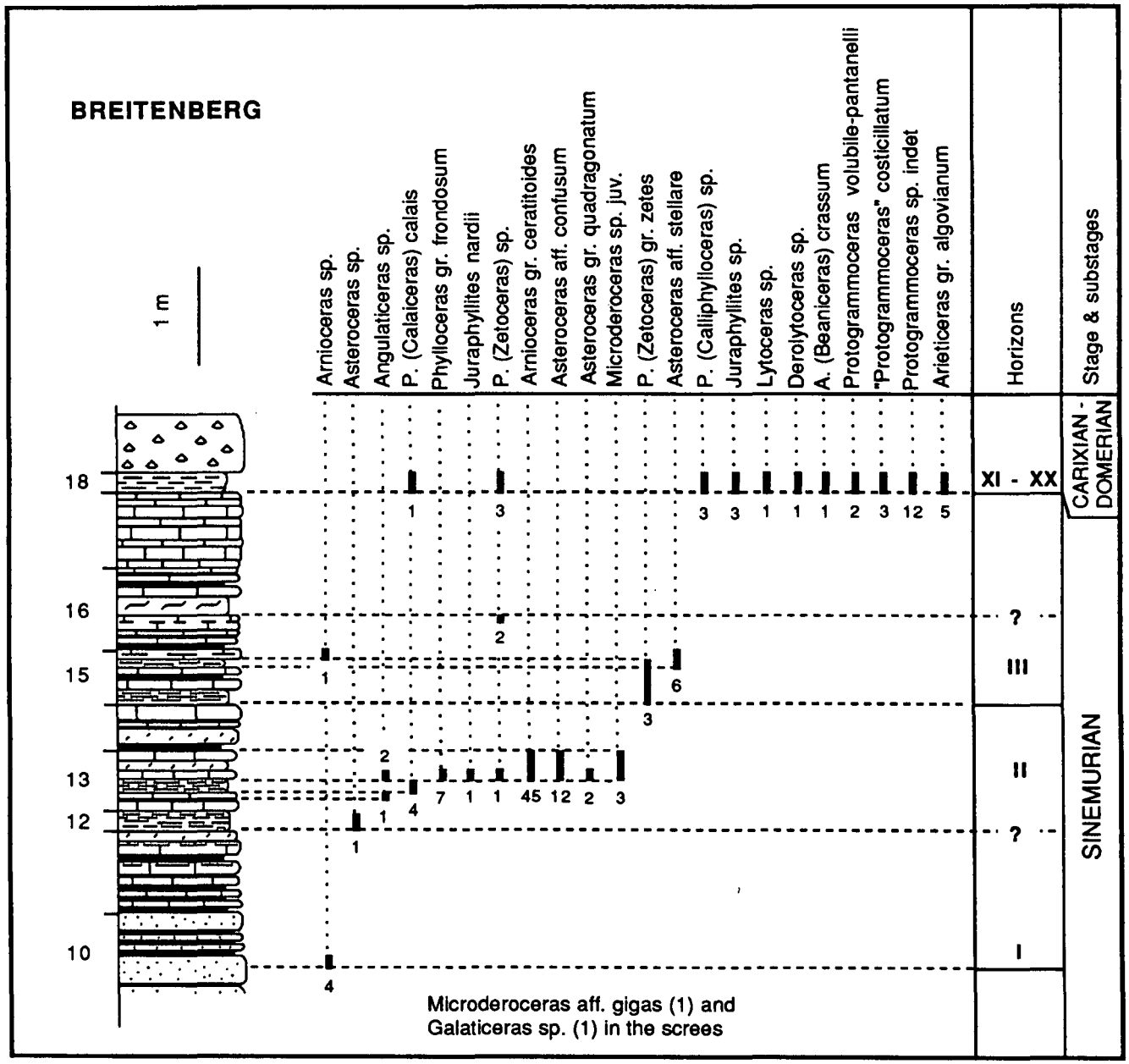
3.4. Rötelstein Outcrop

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-



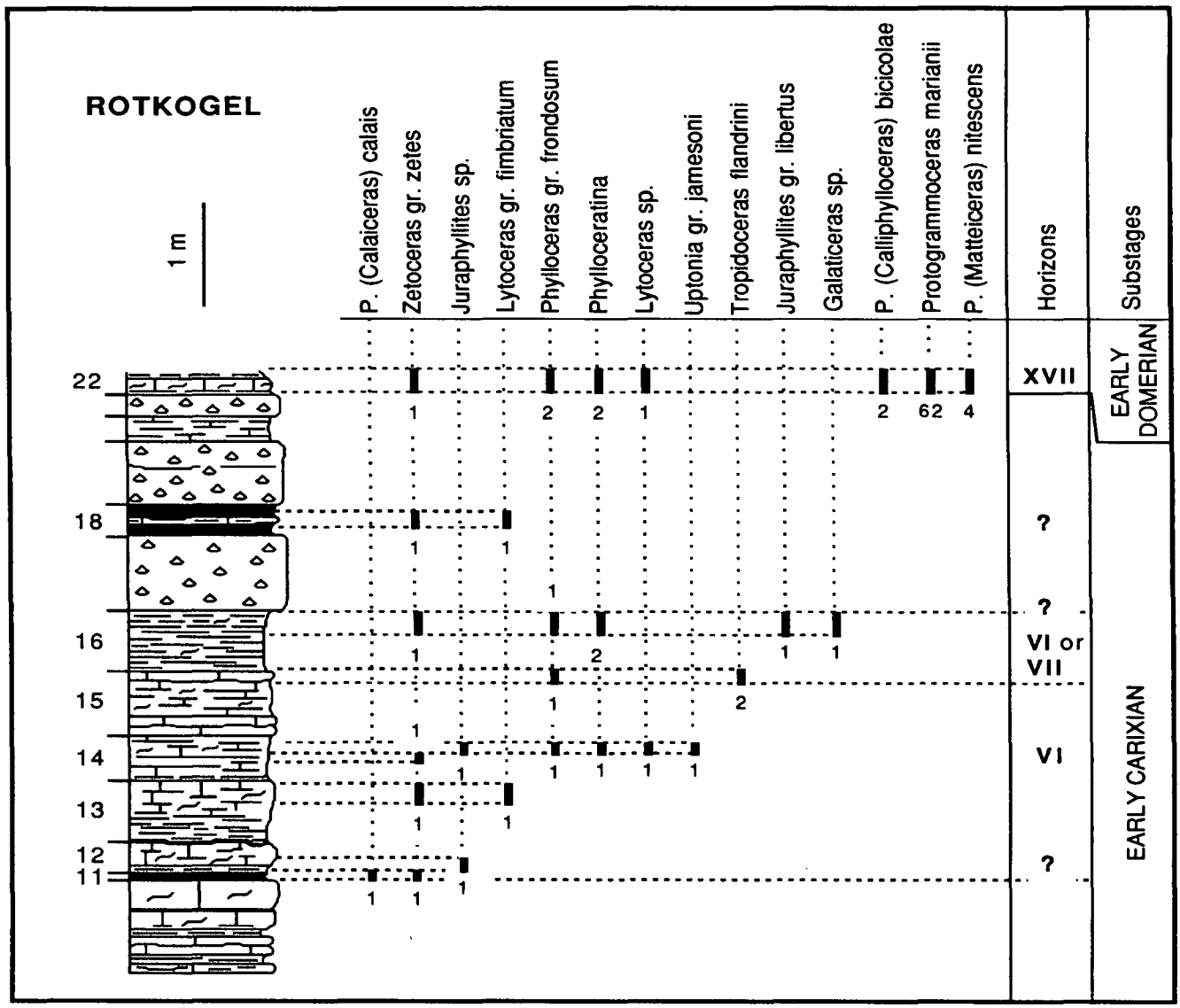
Text-Fig. 5.
Breitenberg quarry.
Lithological profile and ammonite ranges.

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

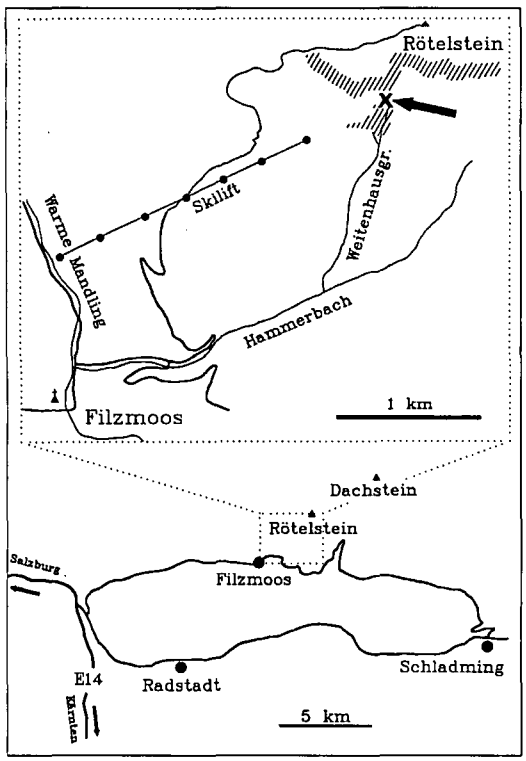
The sequence starts with a thick succession of grey marls (Fleckenmergel) of Lower to Middle Liassic age (Text-Fig. 8). At the top they become slightly more calcareous and then pass abruptly into about 10 m of red, slightly nodular marls and marly limestones, containing a very rich ammonite fauna. There 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 meter-sized 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

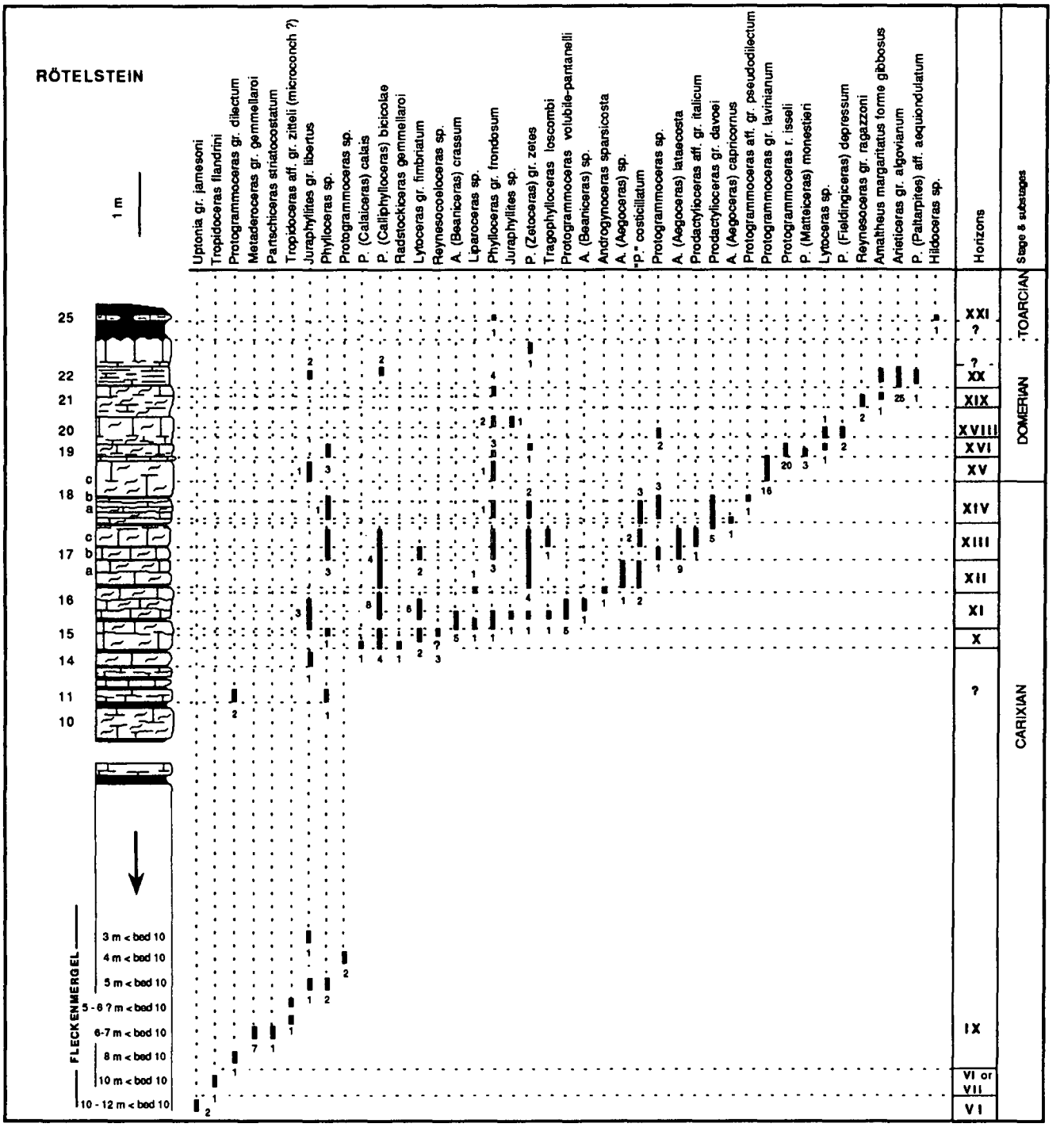
In this paper we will not repeat descriptions and discussions that are thoroughly detailed in previous works. For the well-known taxa we refer the reader to these studies: DOMMERGUES et al., 1985, 1990; MEISTER, 1986, 1989; DOMMERGUES & MEISTER, 1987 a/b, 1989 a/b, 1990 a/b; MEISTER & LOUP, 1989; BLAU & MEISTER, 1991. For certain taxa we only give brief remarks and in most cases the taxonomy is consistent with all these published studies.



Text-Fig. 6.
Rotkogel lithological profile and ammonite ranges. ▲



Text-Fig. 7.
Location map for the Rötelstein.
The dashed areas below and above the outcrops are cliffs. ◀



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.

Suborder: Phylloceratina ARKELL 1950
Superfamily: Phylloceratacea ZITTEL 1884
Family: Phylloceratidae ZITTEL 1884
Subfamily: Phylloceratinae ZITTEL 1884
Genus: *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 Ammoni-

tina. 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, Pl. 5, Fig. 1.
Ammonites Hebertinus REYNES, Pl. 2, Fig. 3.
1884 *Phylloceras Meneghinii* GEMMELLARO, Pl. 2, Fig. 13–17.
1986 *Phylloceras frondosum* (REYNES). – GAKOVIC, Pl. 1, Fig. 1.
Phylloceras hebertinum (REYNES). – GAKOVIC, Pl. 1, Fig. 2.
1989 *Phylloceras frondosum* (REYNES). – MEISTER, Pl. 2, Fig. 1, 2 with synonymy.
Phylloceras hebertinum (REYNES). – MEISTER, Pl. 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 (MEISTER, 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

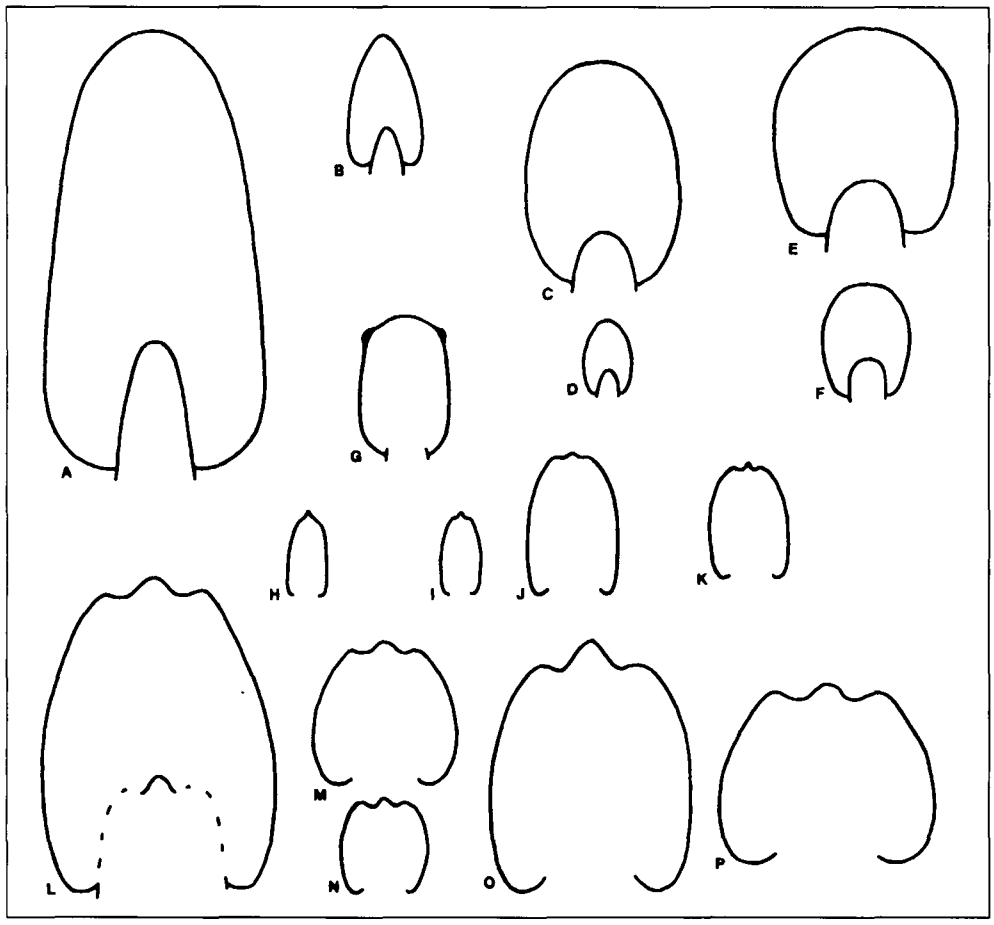
*1874 *Phylloceras Bicicolae* MENEGHINI, p. 106.
1989 *Calliphylloceras bicicolae* (MENEGHINI). – MEISTER, Pl. 2, Fig. 3, 4 with synonymy.
1991 *Phylloceras (Calliphylloceras) bicicolae* (MENEGHINI). – BLAU & MEISTER, Pl. 1, Fig. 6–9; Pl. 2, Fig. 1.

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* (MENEGHINI), 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'ORBIGNY), B = *Galaticeras* sp. indet., CD = *Phylloceras* gr. *frondosum* (REYNES), E,F = *P. (Calaiceras) calais* (MENEGHINI), G = *"Metaderoceras" venustulus* (DUMORTIER), H = *Protogrammoceras* gr. *dilectum* (FUCINI), I,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

1845 *Ammonites heterophyllus amalthei* QUENSTEDT, Pl. 6, Fig. 1.
*1850 *Ammonites zetes* d'ORBIGNY, p. 247.
1908a *Phylloceras pseudo-zetes* FUCINI p. 12.
1977 *Zetoceras zetes* (d'ORBIGNY). – WIEDENMAYER, Pl. 5, Fig. 5–8.
Zetoceras pseudozetes (FUCINI). – WIEDENMAYER, Pl. 5, Fig. 9–10 with synonymy.
1982 *Phylloceras (Zetoceras) zetes* (d'ORBIGNY). – ALKAYA, Pl. 1, Fig. 5 a-c.
Phylloceras (Zetoceras) pseudozetes (FUCINI). – ALKAYA, Pl. 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* (BETTONI) 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 *oenotrium* (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, Pl. 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, Pl. 1, Fig. 13–15.
1987 *Calaiceras calais* (MENEGHINI). – BRAGA & RIVAS, Pl. 2, Fig. 1.
?1987 *Calaiceras* cf. *hantkeni* (SCHLOENBACH). – BRAGA & RIVAS, Fig. 4f, 5g.
1991 *Phylloceras (Calaiceras) calais* (MENEGHINI). – BLAU & MEISTER, Pl. 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, Pl. 3, Fig. 1.
1913 *Phylloceras anonymum* HAAS, Pl. 1, Fig. 5.
1977 *Partschiceras sturi* (REYNES). – WIEDENMAYER, Pl. 2, Fig. 6, 7; Pl. 5, Fig. 1–4 with synonymy.
Partschiceras striatocostatum (MENEGHINI). – WIEDENMAYER, Pl. 4, Fig. 5–8 with synonymy.
1986 *Partschiceras anonymum* (HAAS). – GAKOVIC, Pl. 1, Fig. 3.
1987 *Partschiceras striatocostatum* (MENEGHINI). – BRAGA & RIVAS, Pl. 1, Fig. 5–8.
1989 *Partschiceras striatocostatum* (MENEGHINI). – MEISTER, Pl. 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 suc-

ceeding 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* (GEMMELLARO) 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, Pl. 7, Fig. 1–7.
Rhacophyllites nardii var. *dorsocurvata* FUCINI, Pl. 8, Fig. 7.
? 1901 *Rhacophyllites transylvanicus* var. *dorsoplanata* FUCINI, Pl. 8, Fig. 1–6.
non 1927 *Rhacophyllites* cf. *nardii* (MENEGHINI). – SCHRÖDER, Pl. 8, Fig. 4.
1955 *Juraphyllites* aff. *nardii* (MENEGHINI). – DONOVAN, for Pl. 39, Fig. 12–16 in REYNES.
? 1956 *Juraphyllites* cf. *nardii* (MENEGHINI). – ERBEN, Pl. 27, Fig. 6.
1959 *Juraphyllites transylvanicus* (HAUER). – VIALLI, Pl. 13, Fig. 3.
? 1965 *Juraphyllites transylvanicum* (HAUER). – MOUTERDE, Pl. 2, Fig. 4.
1978 *Juraphyllites* gr. *nardii* (MENEGHINI). – 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, Pl. 2, Fig. 6–8; Pl. 6, Fig. 1, 2.
?1909 *Rhacophyllites limatus* ROSENBERG, Pl. 11, Fig. 10, 11.
1977 *Juraphyllites diopsis* (GEMMELLARO). – WIEDENMAYER, Pl. 8, Fig. 4–7 with synonymy.
?1977 *Juraphyllites limatus limatus* (ROSENBERG). – WIEDENMAYER, Pl. 3, Fig. 4; Pl. 8, Fig. 8, 12 with synonymy.
1987 *Juraphyllites* cf. *diopsis* (GEMMELLARO). – HILLEBRANDT, Pl. 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, Pl. 1, Fig. 4; Pl. 3, Fig. 1, 2, 5.
1986 *Juraphyllites libertus* (GEMMELLARO). – MEISTER, Pl. 2, Fig. 8.
1986 *Juraphyllites libertus* (GEMMELLARO). – GAKOVIC, Pl. 2, Fig. 1.
1989 *Juraphyllites libertus* (GEMMELLARO). – MEISTER, Pl. 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 STEFANI'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* QUENSTEDT 1845.

Tragophylloceras loscombi (SOWERBY 1814)

*1814 *Ammonites loscombi* SOWERBY, p. 185, Pl. 183.
1986 *Tragophylloceras loscombi* (SOWERBY). – MEISTER, Pl. 2, Fig. 11 with synonymy.
1989 *Tragophylloceras loscombi* (SOWERBY). – MEISTER, Pl. 2, Fig. 8.
1990 *Tragophylloceras* cf. *loscombi* (SOWERBY). – DOMMERGUES, MEISTER & METTRAUX, Pl. 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* (SOWERBY). 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 (ARKELL et al., 1957) which attributes this taxon to the Juraphyllitidae.

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* (GEMMELLARO).

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, Pl. 164.
1986 *Lytoceras fimbriatum* (SOWERBY). – MEISTER, Pl. 1, Fig. 1, 2 with synonymy.
1987 *Lytoceras fimbriatum* (SOWERBY). – BRAGA, JIMENEZ & RIVAS, Pl. 1, Fig. 1, 2.
1990 *Lytoceras* gr. *fimbriatum* (SOWERBY). – DOMMERGUES & MEISTER, 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, Pl. 6, Fig. 7.
1990 *Derolytoceras tortum* (QUENSTEDT). – DOMMERGUES, MEISTER & METTRAUX, Pl. 6, Fig. 8, 9 with synonymy.
1990 *Derolytoceras tortum* (QUENSTEDT). – DOMMERGUES & 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 1889
Superfamily: Psiloceratacea HYATT 1867
Family: Schlotheimiidae SPATH 1923
Genus: *Angulaticeras* QUENSTEDT 1883

Type species: *Ammonites lacunatus* BUCKMAN 1844.

Angulaticeras sp. indet.

cf. 1990 *Angulaticeras (Boucaulticeras)* sp. DOMMERGUES, MEISTER & METTRAUX, Pl. 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 STEFANI) – *angustisulcatum* (GEYER).

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

Family: Arietitidae HYATT 1875
Subfamily: Arietitinae HYATT 1875
Genus: *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. *rariplicata* FUCINI, Pl. 17, Fig. 7; Pl. 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.
1898 *Arietites ceratitoides* (QUENSTEDT). – PARONA, Pl. 13, Fig. 1; ? Pl. 14, Fig. 4.
1899 *Arnioceras ceratitoides* (QUENSTEDT). – BONARELLI, Pl. 8, Fig. 4, 5, ? 6.
1902 *Arnioceras ceratitoides* (QUENSTEDT). – FUCINI, Pl. 14, Fig. 13; Pl. 15, Fig. 1–15 with all varieties.
Arnioceras rejectum FUCINI, Pl. 16, Fig. 1–6.
Arnioceras abjectum FUCINI, Pl. 26, Fig. 1–3.
1917 *Arietites (Arnioceras) ceratitoides* (QUENSTEDT). – TILMAN, Pl. 21, Fig. 3.
1942 *Arnioceras* cf. *ceratitoides* (QUENSTEDT). – KOVÁCS, Pl. 4, Fig. 5.
?1956 *Arnioceras ceratitoides mexicanum* ERBEN, Pl. 29, Fig. 3–7; no Pl. 30, Fig. 1, 2.
1959 *Arnioceras* cf. *ceratitoides* (QUENSTEDT). – VIALLI, Pl. 14, Fig. 9, 10.
1965 *Arnioceras* cf. *ceratitoides* (QUENSTEDT). – MOUTERDE, Pl. 1, Fig. 4.
?1969 *Arnioceras ceratitoides mexicanum* ERBEN. – TOPCHISVILI, Pl. 4, Fig. 2.
1975 *Arnioceras ceratitoides paucicosta* FUCINI. – FERRETTI, Pl. 22, Fig. 1–3.
1976 *Arnioceras ceratitoides* (QUENSTEDT). – SCHLEGELMILCH, Pl. 20, Fig. 6.
1982 *Arnioceras* cf. *ceratitoides* (QUENSTEDT). – HILLEBRANDT, Pl. 1, Fig. 3.
1985 *Arnioceras ceratitoides* (QUENSTEDT). – PRINZ, Pl. 3, Fig. 3, 4.
1985 *Arnioceras ceratitoides* (QUENSTEDT). – BRAGA, MARTIN-ALGARA & RIVAS, Pl. 1, Fig. 6.
1986 *Arnioceras ceratitoides* (QUENSTEDT). – WANG & SMITH, Pl. 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 DOMMERGUES 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, Pl. 21, Fig. 3, 4.
*1925 *Asteroceras confusum* SPATH, p. 300.
1961 *Asteroceras confusum* SPATH. – SACCHI-VIALLI & CANTALUPPI, Pl. 4, Fig. 5.
1954 *Asteroceras confusum* SPATH. – DONOVAN, p. 32.
1966 *Asteroceras confusum* SPATH. – GUERIN-FRANIATTE, Pl. 172–174.
1976 *Asteroceras confusum* SPATH. – SCHLEGELMILCH, Pl. 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 quite 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.
1966 *Asteroceras* aff. *quadragonatum* (HYATT). – GUERIN-FRANIATTE, 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, Pl. 93.
?1960 *Arietites (Asteroceras)* aff. *stellare* (SOWERBY). – PREDA & RAILEANU, Pl. 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, Pl. 3, Fig. 6.
1965 *Asteroceras stellare* (SOWERBY). – ANDRUSOV, Fig. 49–1.
1966 *Asteroceras stellare* (SOWERBY). – GUERIN-FRANIATTE, Pl. 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, Pl. 4, Fig. 2.
1987 *Asteroceras* cf. *stellare* (SOWERBY). – QUINZIO SINN, Pl. 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. wiltshirei* (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, Pl. 3, Fig. 3.
1989a *Paltechioceras* aff. *insigne* (TRUEMAN & WILLIAM). – DOMMERGUES & MEISTER, Pl. 3, Fig. 1.
1990 *Paltechioceras* cf. *insigne* (TRUEMAN & WILLIAM). – DOMMERGUES, MEISTER & METTRAUX, Pl. 3, Fig. 1.
1990 *Paltechioceras* cf. *tardecrescens* (HAUER) – *insigne* (TRUEMAN & WILLIAM). – DOMMERGUES & MEISTER, Pl. 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, Pl. 3, Fig. 3, 4.

1990 *Leptechioceras meigeni* (HUG). – DOMMERGUES & MEISTER, Pl. 1, Fig. 4–6 with synonymy.

Local range: Raricostatum zone (*meigeni* horizon).

Superfamily: Eoderocerataceae SPATH 1929
Family: Phricodoceratidae SPATH 1938
Genus: *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 lorioli* (HUG). – BLAU, Pl. 6, Fig. 1, 2.
1987a *Epideroceras* gr. *lorioli* (HUG). – DOMMERGUES & MEISTER, Pl. 5, Fig. 9 with synonymy.
1989 *Epideroceras (Epideroceras) lorioli* (HUG). – DOMMERGUES & GECZY, Pl. 2, Fig. 1–4.
1989a *Epideroceras lorioli* (HUG). – DOMMERGUES & MEISTER, Pl. 4, Fig. 2, 4; Pl. 5, Fig. 1, 2; Pl. 6, Fig. 1, 3.
1990 *Epideroceras lorioli* (HUG). – DOMMERGUES, MEISTER & METTRAUX, Pl. 5, Fig. 2.
1990 *Epideroceras* aff. *lorioli* (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 *Miltoceras* inner whorls. However the distinction between the inner whorls of *Apoderoceras* sensu stricto like *A. hamiltoni* (SIMPSON) or *A. triornatum* BUCKMAN (1928, Pl. DCCLXXXIII) or still *A. nodogigas* BUCKMAN (1928, Pl. 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, Pl. 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. muticum* (d'ORBIGNY). – IMLAY, Pl. 7, Fig. 6–10, 12–15.
aff. 1984 *Metaderoceras muticum* (d'ORBIGNY). – CUBAYNES, BOUTET, DELFAUD & FAURE, Pl. 1, Fig. 4, 5.
1987 *Metaderoceras muticum* (d'ORBIGNY). – DOMMERGUES, Pl. 1, Fig. 3–6.
non 1988 *Metaderoceras* aff. *muticum* (d'ORBIGNY). – SMITH, TIPPER, TAYLOR & GUEX, Pl. 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, Pl. 17, Fig. 4–6.
1986 *Metaderoceras venustulum* (DUMORTIER). – MEISTER, Pl. 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, Pl. 1, Fig. 1–8 with synonymy.
1985 *Metaderoceras evolutum* (FUCINI). – COMAS RENGIFO, Pl. 3, Fig. 2, 4.
1988 *Metaderoceras evolutum* (FUCINI). – SMITH, TIPPER, TAYLOR & GUEX, Pl. 1, Fig. 11.

Like the contemporaneous NW European *Metaderoceras venarense* (OPPEL) (DOMMERGUES & MOUTERDE, 1978; DOMMERGUES, 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 diffentiation 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 DOMMERGUES 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 *Platypleuroceras*. Unfortunately the poor preservation does not allow us to go further.

Local range: Brevispina-Polymorphus subzone (*Platypleuroceras* 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, Pl. 13, Fig. 2, 3 with synonymy.
1986 *Uptonia confusa* (QUENSTEDT). – MEISTER, Pl. 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 Pl. 555, Fig. 1.
1934 *Uptonia jamesoni* (SOWERBY). – ROSENKRANTZ, Pl. 5, Fig. 1.
1986 *Uptonia jamesoni* (SOWERBY). – MEISTER, Pl. 4, Fig. 8; Pl. 6, Fig. 1, 5 with synonymy
1987 *Uptonia lata* sensu SCHLATTER – DOMMERGUES, Pl. 10, Fig. 1–6.
1990 *Uptonia* cf. *jamesoni* sensu DONOVAN & FORSEY – DOMMERGUES, 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; MCNAMARA, 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). – CUBAYNES, BOUTET, DELFAUD & FAURE, Pl. 2, Fig. 5, 6, 8, 9.
1986 *Polymorphites bronni* (ROEMER). – MEISTER, Pl. 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, Pl. 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 flandrini* (DUMORTIER). – MEISTER, Pl. 8, Fig. 7 with synonymy.
Tropidoceras flandrini densicosta (FUTTERER). – MEISTER, Pl. 6, Fig. 7 with synonymy.
1987 *Tropidoceras flandrini* var. cf. *obtusa* (FUTTERER). – HILLEBRANDT, Pl. 3, Fig. 4, 5.
1988 *Tropidoceras flandrini* (DUMORTIER). – SMITH, TIPPER, TAYLOR & GUEX, Pl. 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, Pl. 22, Fig. 3.
1985 *Tropidoceras zitteli* (FUCINI). – BRAGA & RIVAS, Pl. 3, Fig. 5–7; Pl. 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, Pl. 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, Pl. 35, Fig. 17.
1986 *Acanthopleuroceras* aff. *inflatum* (QUENSTEDT). – MEISTER, Pl. 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, Pl. 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, Pl. 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, Pl. 15, Fig. 6, 7; Pl. 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, Pl. 8, Fig. 7–10.
1985 *A. (Aegoceras) capricornus* (SCHLOTHEIM). – PHELPS, Pl. 2, Fig. 6, 7.
1986 *A. (Aegoceras) capricornus* (SCHLOTHEIM). – MEISTER, Pl. 15, Fig. 8 with synonymy.
1990 *Aegoceras capricornus* (SCHLOTHEIM). – DOMMERGUES & MEISTER, 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 1867
Genus: *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, Pl. 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, GAUTHIER & LACROIX Pl. 1, Fig. 4.
1973 *Amaltheus gibbosus* (SCHLOTHEIM). – HOWARTH, Fig. A, B.
1976 *Amaltheus (Amaltheus) gibbosus* (SCHLOTHEIM). – SCHLEGELMILCH, Pl. 35, Fig. 4, 5.
1977 *Amaltheus gibbosus* (SCHLOTHEIM). – URLICHS, Pl. 1, Fig. 6.
1985 *Amaltheus* "de type" *gibbosus* (SCHLOTHEIM). – MATTEI, Pl. 11, Fig. 1, 2, 4–6, 10.
1988 *Amaltheus margaritatus* forme *gibbosus* (SCHLOTHEIM). – MEISTER, Pl. 3, Fig. 1, 2, 6–8.

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

Local range: Gibbosus subzone.

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

Type species: *Coeloceras crassum* var. *indunensis* MENEGHINI 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, Pl. 13, Fig. 4.
1976 *Prodactylioceras (Aveyroniceras) italicum* (FUCINI). – GECZY, Pl. 25, Fig. 8, 9; Pl. 26, Fig. 1–4 with synonymy.
non ? 1981 *Prodactylioceras* cf. *italicum* (FUCINI). – IMLAY, Pl. 10, Fig. 4, 5.
non ? 1981 *Prodactylioceras* cf. *italicum italicum* (FUCINI). – IMLAY, Pl. 10, Fig. 3.
1983 *Reynesoceras italicum* (FUCINI). – BRAGA, Pl. 16, Fig. 3 with synonymy.
1983 *Prodactylioceras italicum* (FUCINI). – DOMMERGUES, FERRETTI, GECZY, MOUTERDE, Pl. 6, Fig. 7–12.
1985 *Aveyroniceras* cf. *italicum* (FUCINI). – COMAS RENGIFO, Pl. 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, Pl. 350.
1986 *Prodactylioceras davoei* (SOWERBY). – MEISTER, Pl. 18, Fig. 8; Pl. 19, Fig. 3, 7 with synonymy.
Prodactylioceras davoei enode (QUENSTEDT). – MEISTER, Pl. 19, Fig. 4 with synonymy.
Prodactylioceras davoei nodosissimus (QUENSTEDT). – MEISTER, Pl. 19, Fig. 1; Pl. 23, Fig. 5 with synonymy.
1988 *Prodactylioceras* aff. *davoei* (SOWERBY). – SMITH, TIPPER, TAYLOR & GUEX Pl. 3, Fig. 4.
1989 *Prodactylioceras* gr. *davoei* (SOWERBY). – MEISTER & LOUP, Pl. 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 quite 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, Pl. 4, Fig. 12.
1989 *Reynesoceras acanthoides* (REYNES). – MEISTER, Pl. 5, Fig. 1, 3–5, 8–10 with synonymy.
Reynesoceras ragazzoni (HAUER). – MEISTER, Pl. 5, Fig. 2, 6, 7 with synonymy.

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

Local range: Gibbosus subzone (*ragazzoni* horizon).

Superfamily: Hildoceratacea 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, Pl. 11, Fig. 2, 3.
1904 *Harpoceras* (?) *dilectum* FUCINI, Pl. 18, Fig. 11, 12.
1972 *Protogrammoceras dilectum* (FUCINI). – FERRETTI, Pl. 13, Fig. 2.
?1977 *Protogrammoceras* cf. *dilectum* (FUCINI). – WIEDENMAYER, Pl. 19, Fig. 11.
1980 *Protogrammoceras dilectum* (FUCINI). – BRAGA & RIVAS, Pl. 1, Fig. 12, 13.
1983 *Protogrammoceras dilectum* (FUCINI). – DOMMERGUES, FERRETTI, GECZY & MOUTERDE, Pl. 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 quite 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, Pl. 7, Fig. 3.
Grammoceras varicostatum FUCINI, Pl. 8, Fig. 6.
Harpoceras ? *pantanelli* FUCINI, Pl. 7, Fig. 7.
?1905 *Hildoceras bastianii*. – FUCINI, Pl. 44, Fig. 14.
?1905 *Hildoceras bastianii* var. *perplicata* FUCINI, Pl. 43, Fig. 1; Pl. 44, Fig. 1.
1976 *Fuciniceras pantanelli serratum* (FUCINI). – GECZY, Pl. 35, Fig. 6–7; Pl. 36, Fig. 1–5.
1977 *Protogrammoceras* ? *volubile* (FUCINI). – WIEDENMAYER, Pl. 19, 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, Pl. 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, Pl. 3, Fig. 3–5, 8.
*1985 *Protogrammoceras pseudodilectum* DOMMERGUES, MEISTER & FAURE, Pl. 1, Fig. 1 with synonymy.
1986 *Protogrammoceras pseudodilectum* DOMMERGUES, MEISTER & FAURE. – MEISTER, Pl. 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* DOMMERGUES, 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, Pl. 1, Fig. 6–8; Pl. 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). – DOMMERGUES, FERRETTI, GECZY & MOUTERDE, Pl. 6, Fig. 9–10.
1991 *Protogrammoceras* aff. gr. *lavinianum* (FUCINI). – BLAU & MEISTER, Pl. 5, Fig. 23; Pl. 6, Fig. 5–11.

"P." lavinianum (FUCINI) and *"P." portisi* (FUCINI) sensu DOMMERGUES 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* (FUCINI), 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). – BRAGA, Pl. 2, Fig. 10; Pl. 3, Fig. 1–5.
1983 *Protogrammoceras isseli* (FUCINI). – DOMMERGUES, FERRETTI, GECZY & MOUTERDE, Pl. 4, Fig. 1–12.
1991 *Protogrammoceras* gr. *isseli* (FUCINI). – BLAU & MEISTER, Pl. 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)

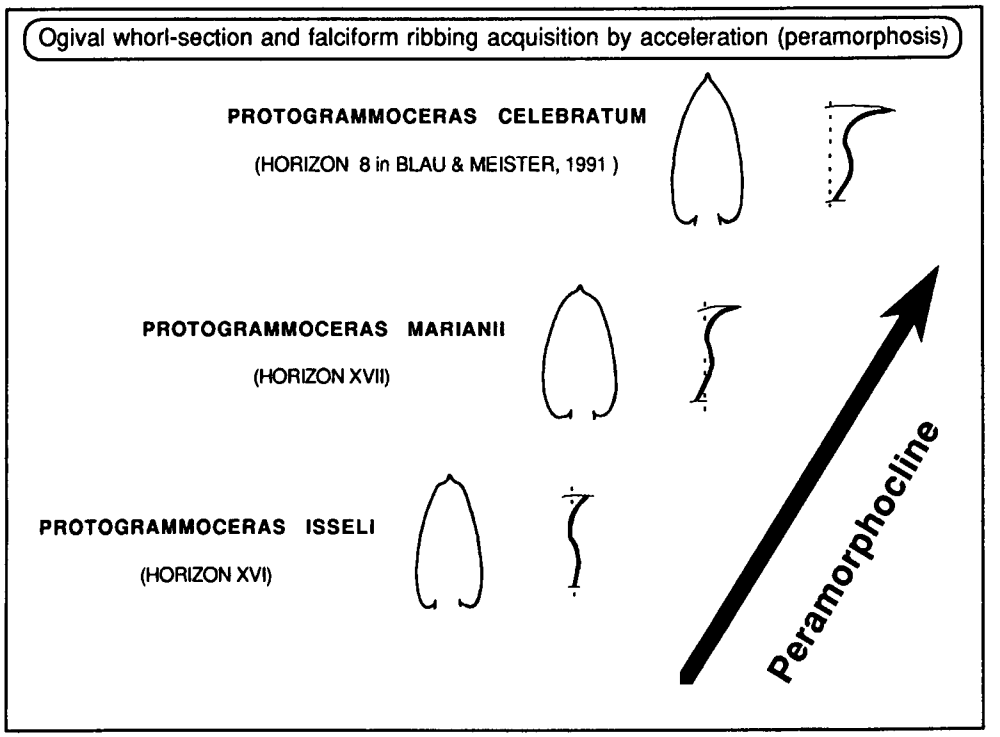
Plate 8, Figs. 13, 15–17; Plate 9, Figs. 2–4

*1904 *Harpoceras marianii* FUCINI, Pl. 41, Fig. 1–3.
1972 *Protogrammoceras marianii* (FUCINI). – FERRETTI, Pl. 13, Fig. 6.
1977 *Protogrammoceras marianii* (FUCINI). – WIEDENMAYER, Pl. 19, Fig. 7, 8 with synonymy.
1989 *P. (Protogrammoceras)* aff. gr. *marianii* (FUCINI). – MEISTER, Pl. 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.



Text-Fig. 10.
Whorl-section and falciform ribbing of *Protogrammoceras isseli* (FUCINI), *P. marianii* (FUCINI) and *P. celebratum* (FUCINI).

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, Pl. 1, Fig. 3, 13, 32, 33, 36, 37; no Pl. 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, Pl. 21, Fig. 3, 4, 8, 9.
1989 *P. (Matteiceras) monestieri* (FISCHER). – MEISTER, p. 38 with synonymy.
1990 *P. (Matteiceras) monestieri* (FISCHER). – DOMMERGUES & MEISTER, Fig. 5 (20).
1991 *Protogrammoceras (Matteiceras)* gr. *monestieri* (FISCHER). – BLAU & MEISTER, Pl. 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 nitescens* 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, Pl. 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, Pl. 4, Fig. 4, 6–10 with synonymy.
1990 *P. (Fieldingiceras) depressum* (QUENSTEDT). – DOMMERGUES, MEISTER & 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, Pl. 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.

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, Pl. 1, Fig. 4.
1987 *Arieticeras* cf. *algovianum* (OPPEL). – SMITH, TIPPER, TAYLOR & GUEX, Pl. 4, Fig. 10, 11.
1989 *Arieticeras* gr. *algovianum* (OPPEL). – MEISTER, Pl. 7, Fig. 10–12 with synonymy.
1991 *Arieticeras* gr. *algovianum* (OPPEL). – BLAU & MEISTER, Pl. 6, Fig. 23; Pl. 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; DOMMERGUES & 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*, *Paltechioceras* 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

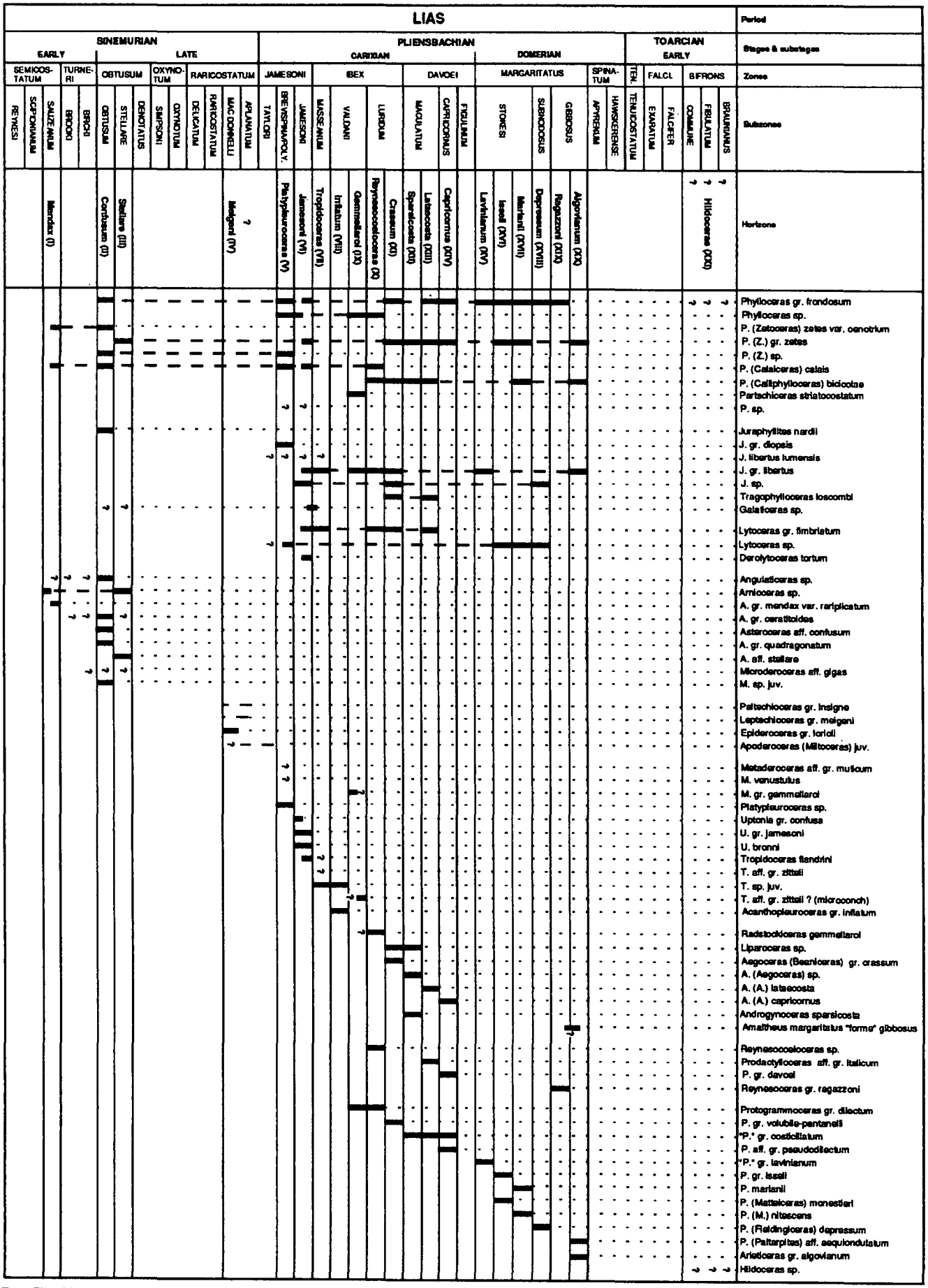
Brevispina (-Polymorphus) subzone
(see DOMMERGUES & MEISTER, 1987b)

***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. *muticum*; 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*.



Text-Fig. 11.
Biostratigraphical framework of the sections studied.

Ibex 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

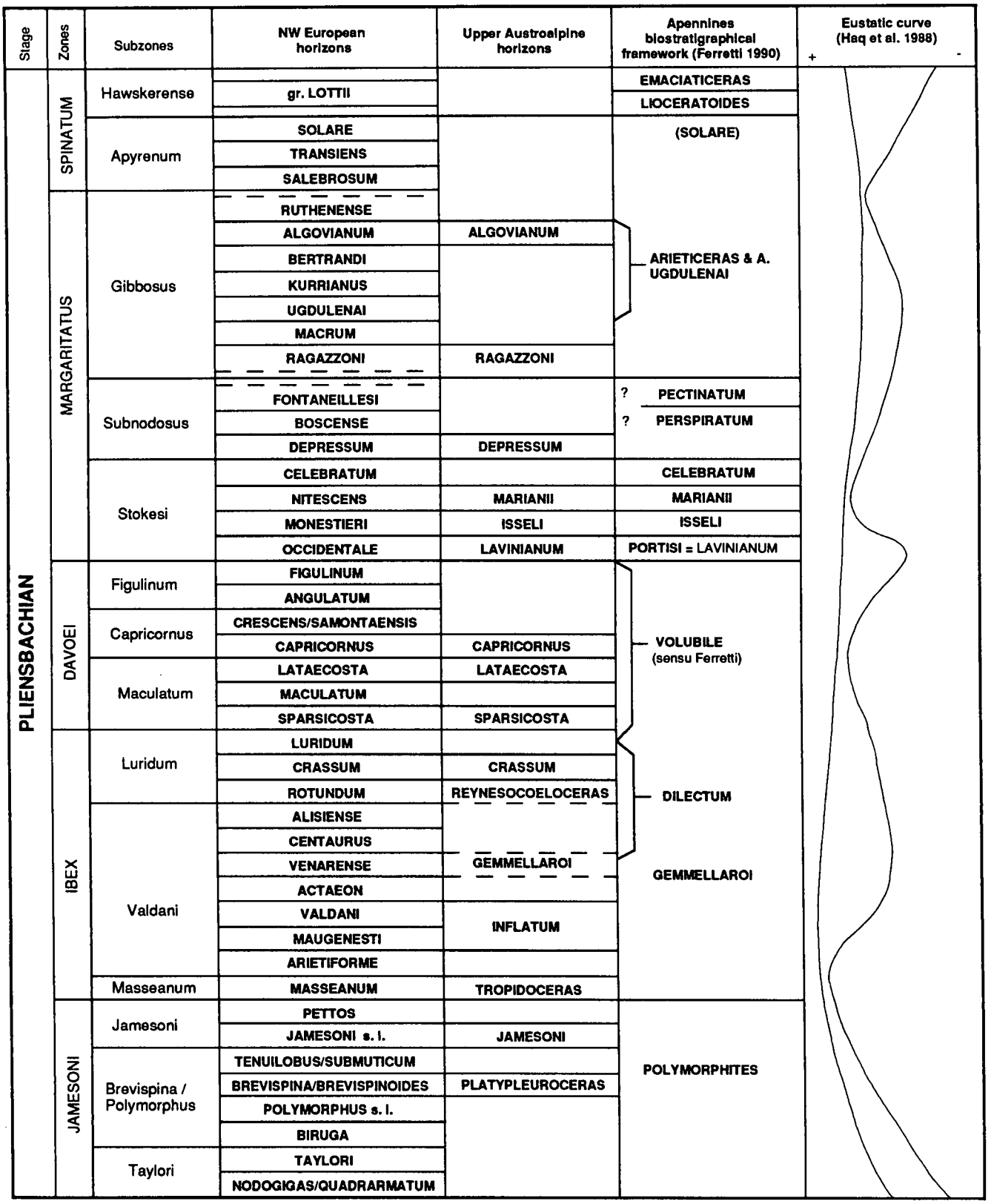
In the Rötelstein area, the beds with *Hildoceras* sp. (*Hildoceras* horizon XXI) immediately overly the levels of the Margaritatus zone. This discontinuity is characterized by a hard ground the age of which lies between the Spinatum zone (Late Domerian) and the Falcifer zone (Early Toarcian).

* * *

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.



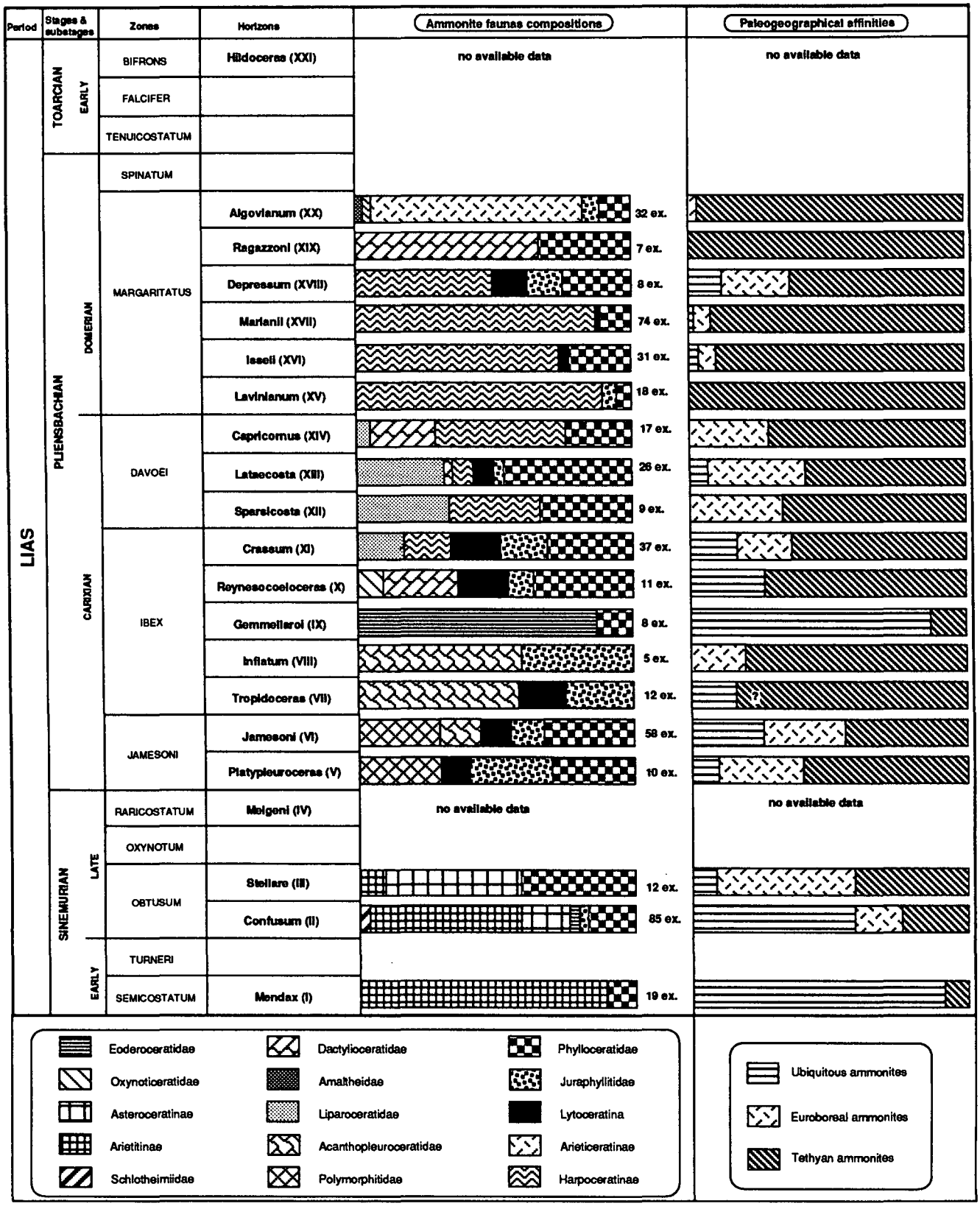
Text-Fig. 12.
Correlation attempt between NW European, Austroalpine and Apennines biostratigraphical frameworks and comparison with the eustatic curve of HAQ et al. (1988).

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 (DOMMERGUES 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



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.

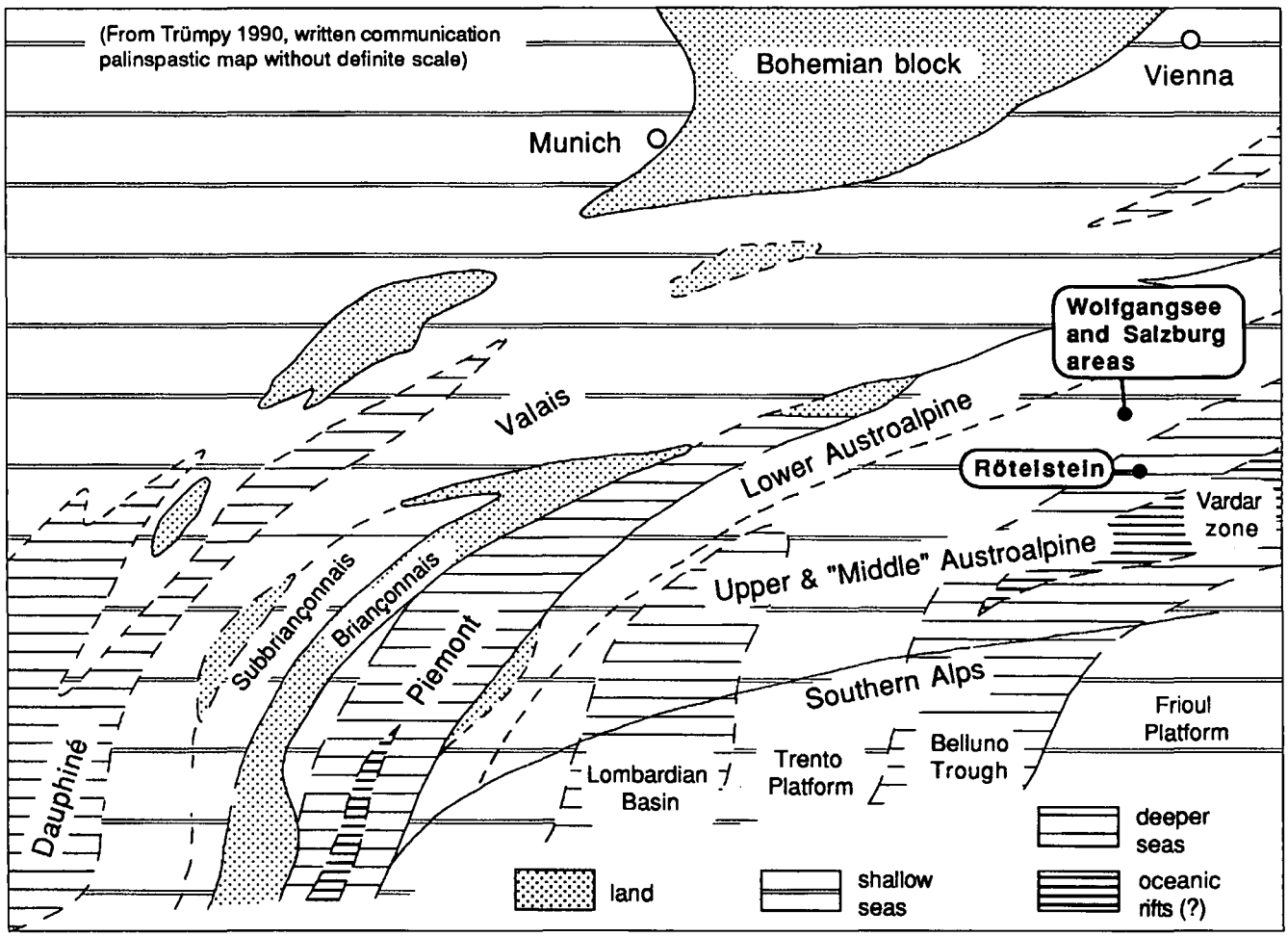
6. Faunal Composition and Palaeogeographical Remarks

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. l. 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



Text-Fig. 14.
Palinspastic reconstructions of the Alpine Ranges (after TRÜMPY, 1990).

ubiquitous 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.

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.

Acknowledgements

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Plate 1

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.

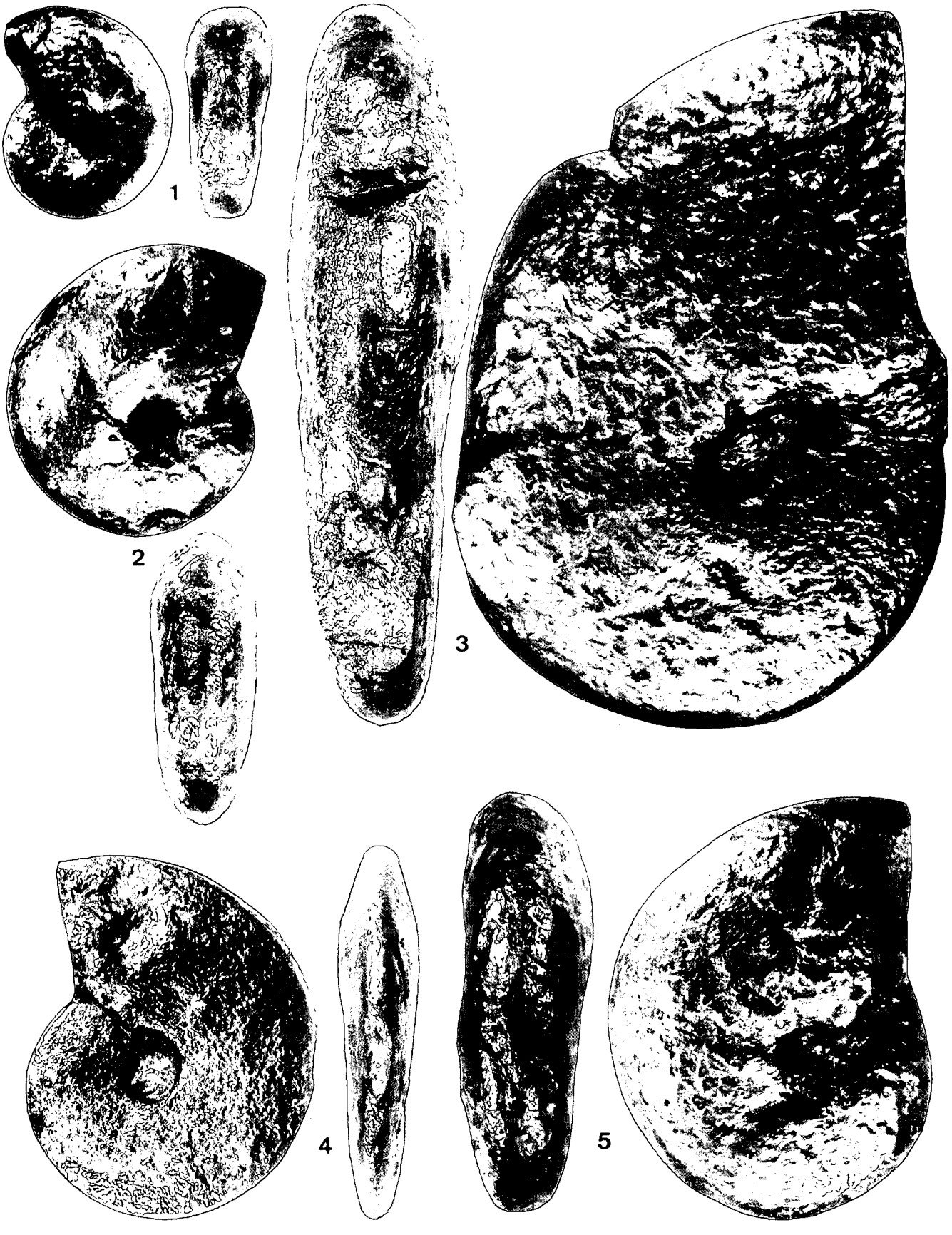


Plate 2

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: ***P. (Zetoceras) zetes* var. *oenotrium* (FUCINI).**
Coll. MEISTER, no. 55408, Schmiedwirt, bed 4, Semicostatum zone.

Fig. 4: ***Partschiceras striatocostatum* (MENEGHINI).**
Coll. MEISTER, no. 55409, Rötelstein, 6–7 m < bed 10, Valdani subzone.

Figs. 5,9: ***Juraphyllites* gr. *libertus* (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: ***Galaticeras* sp. indet.**
Coll. MEISTER, no. 55412, Rotkogel, bed 16, Jamesoni or Masseanum subzones.

Fig. 7: ***Juraphyllites* 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: ***Juraphyllites* gr. *diopsis* (GEMMELLARO).**
Coll. MEISTER, no. 55415, Schmiedwirt, from the screes.

All the ammonites are in natural size.

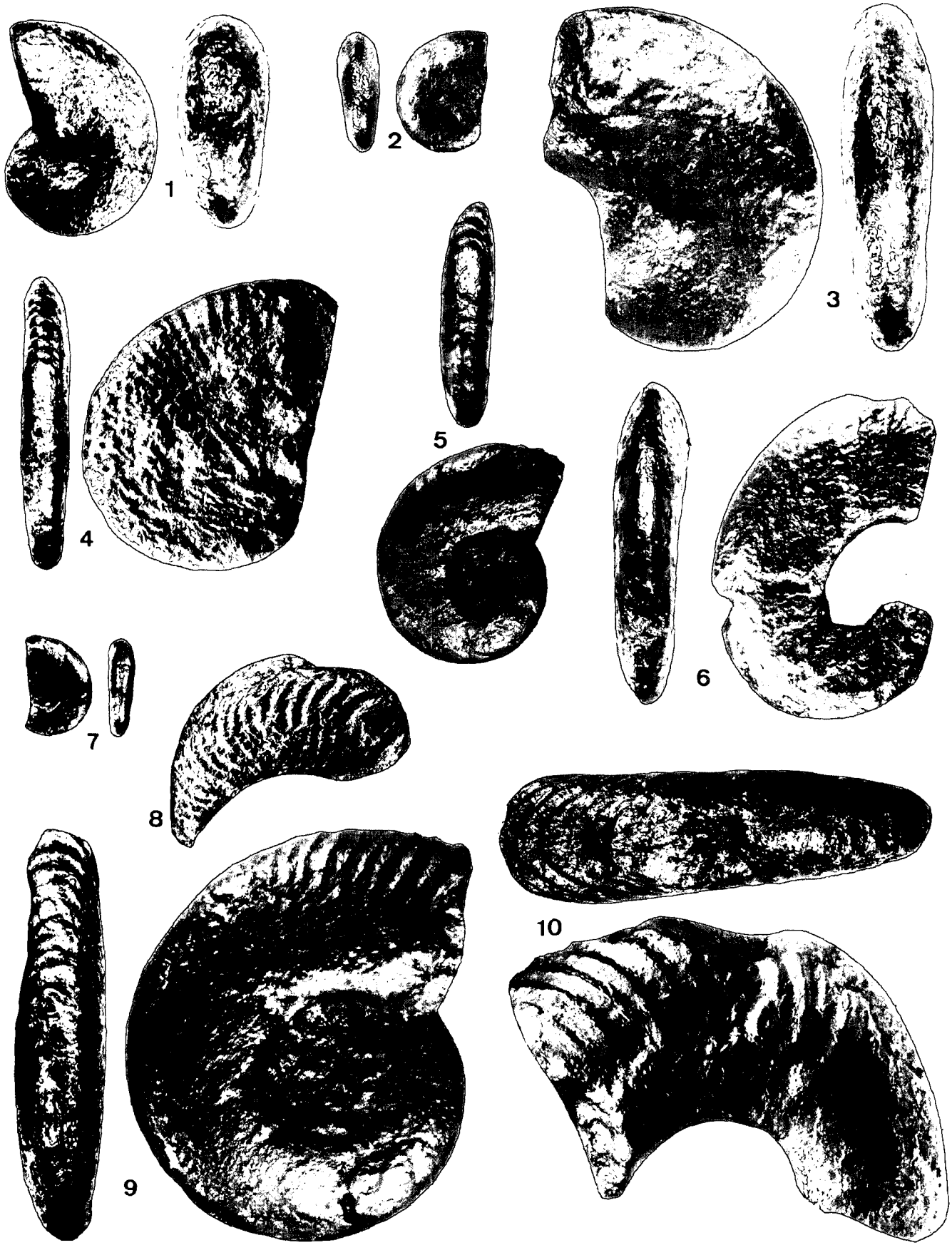


Plate 3

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.

Plate 4

Figs. 1,2: ***Lytoceras* gr. *fimbriatum* (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: ***Asteroceras* aff. *confusum* 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: ***Leptechioceras* gr. *meigeni* (HUG).**
Coll. MEISTER, no. 55432, Schmiedwirt bed 7 or 8, Raricostatum zone.

All the ammonites are in natural size.

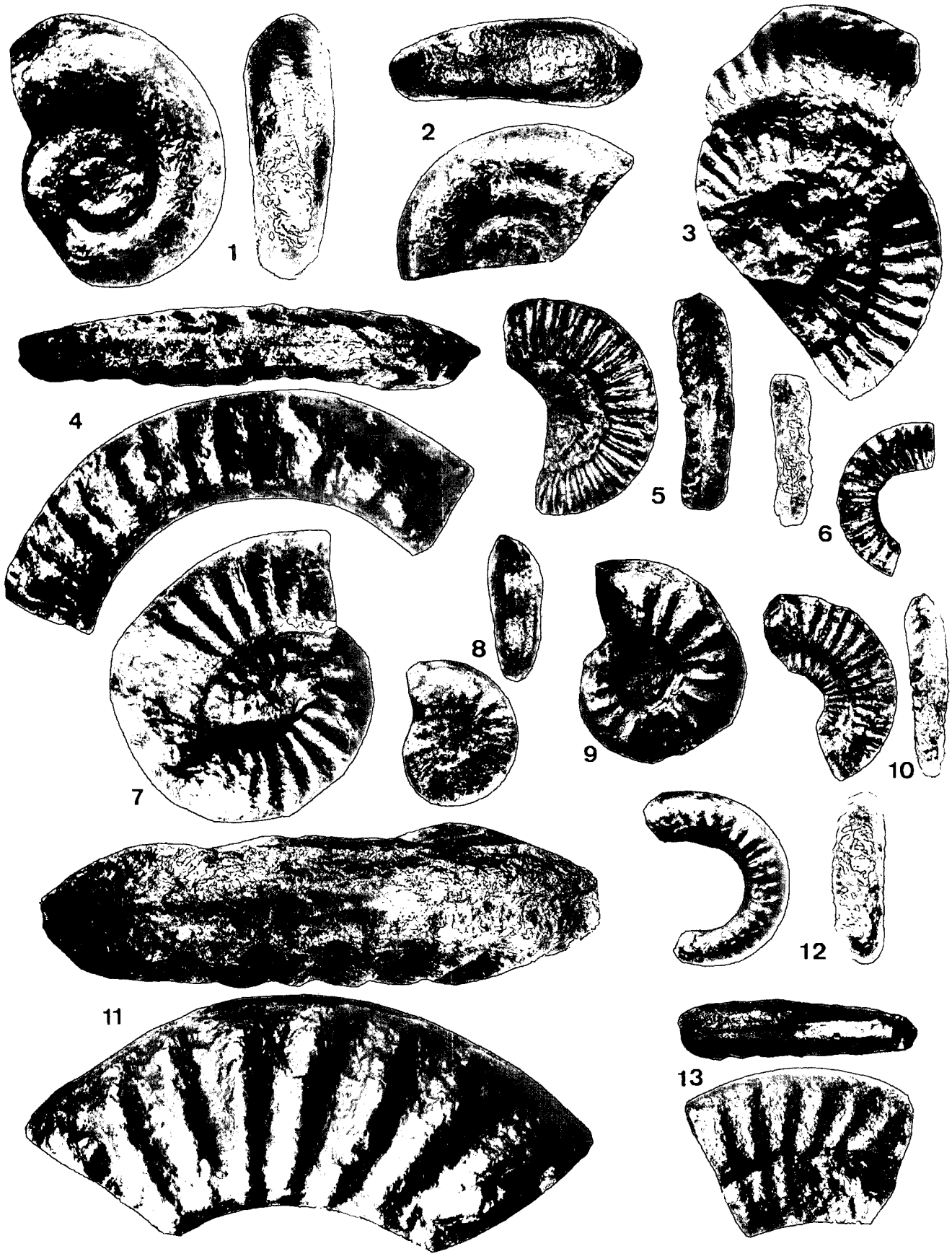


Plate 5

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. *muticum* (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.

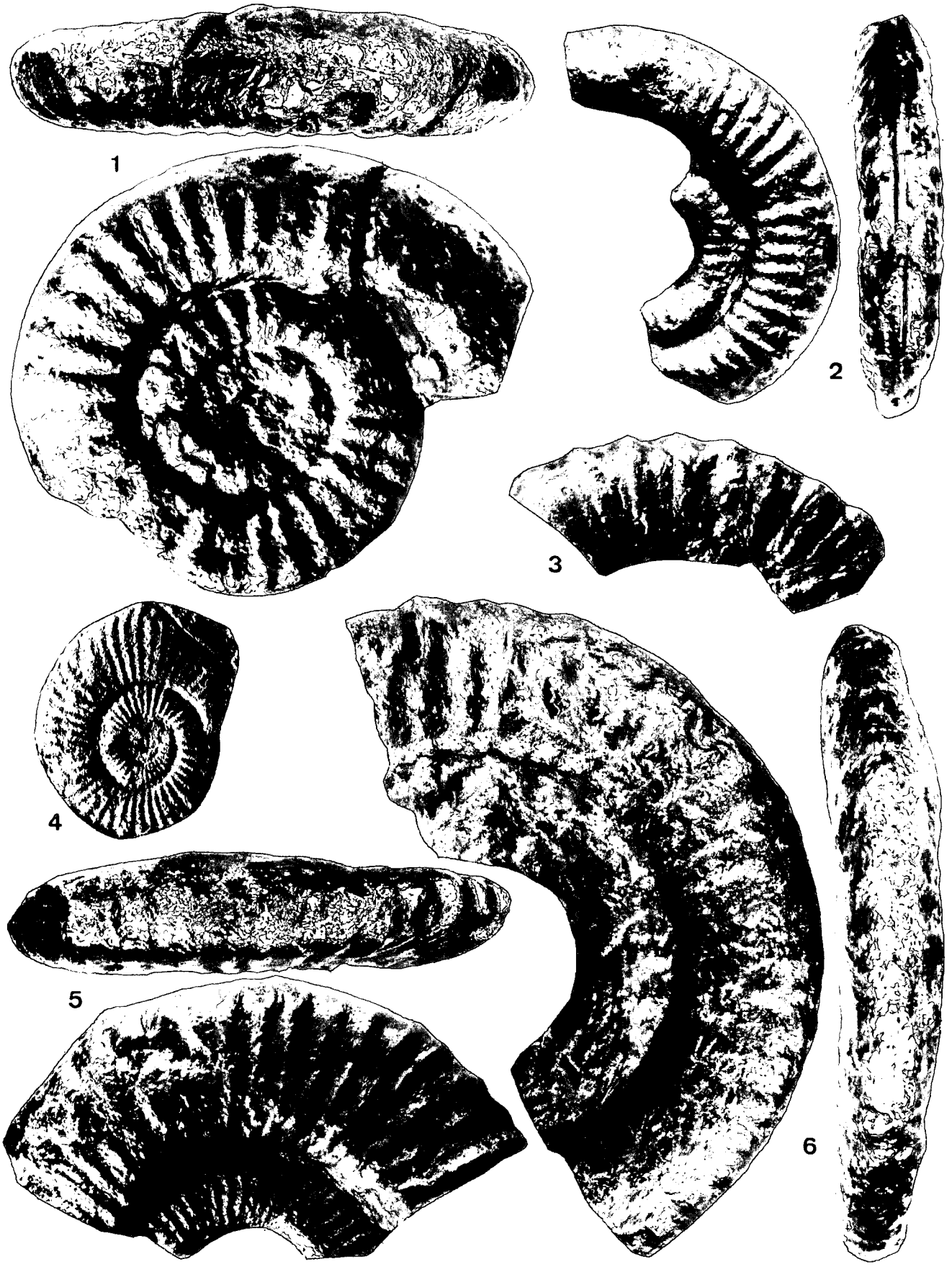


Plate 6

Fig. 1: ***Uptonia* gr. *jamesoni* (SOWERBY).**
Coll. MEISTER, no. 55439, Schmiedwirt, bed 10, Jamesoni subzone.

Fig. 2: ***Uptonia bronni* (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: ***Tropidoceras* aff. gr. *zitteli* FUCINI.**
Coll. MEISTER, no. 55443–45, Schmiedwirt, from the screes, probably Masseanum subzone.

Fig. 6: ***Uptonia* 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: ***Tropidoceras flandrini* (DUMORTIER).**
Coll. MEISTER, no. 55449, Schmiedwirt, bed 10, Jamesoni subzone.

All the ammonites are in natural size.

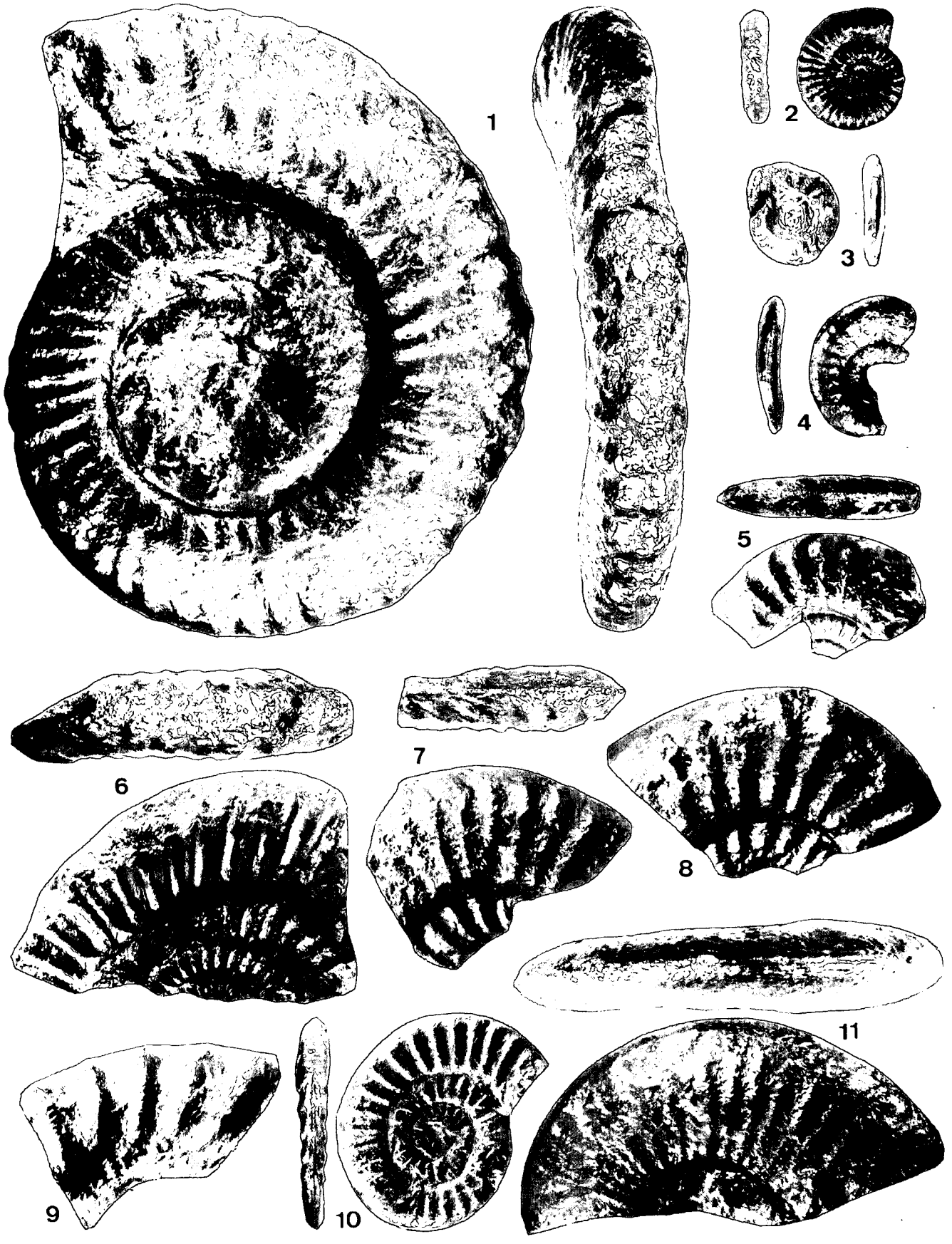


Plate 7

Fig. 1: ***Metaderoceras* gr. *gemmellaroi* (LEVI).**
Coll. MEISTER, no. 55450, Rötelstein, 6–7 m < bed 10, Valdani subzone.

Figs. 2,6: ***A. (Aegoceras) lataecosta* (SOWERBY).**
Coll. MEISTER, no. 55451–52, Rötelstein, bed 17bc, Maculatum subzone.

Figs. 3,7: ***Reynesocoeloceras* sp. indet.**
Coll. MEISTER, no. 55453–54, Rötelstein, bed 15 (upper part). Luridum subzone.

Fig. 4: ***Prodactylioceras* aff. gr. *italicum* (FUCINI).**
Coll. MEISTER, no. 55455, Rötelstein, bed 17c, Maculatum subzone.

Fig. 5: ***A. (Beaniceras)* gr. *crassum* BUCKMAN.**
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: ***Reynesoceras* gr. *ragazzoni* (HAUER).**
Coll. MEISTER, no. 55459–60, Rötelstein, bed 21, Gibbosus subzone.

All the ammonites are in natural size.

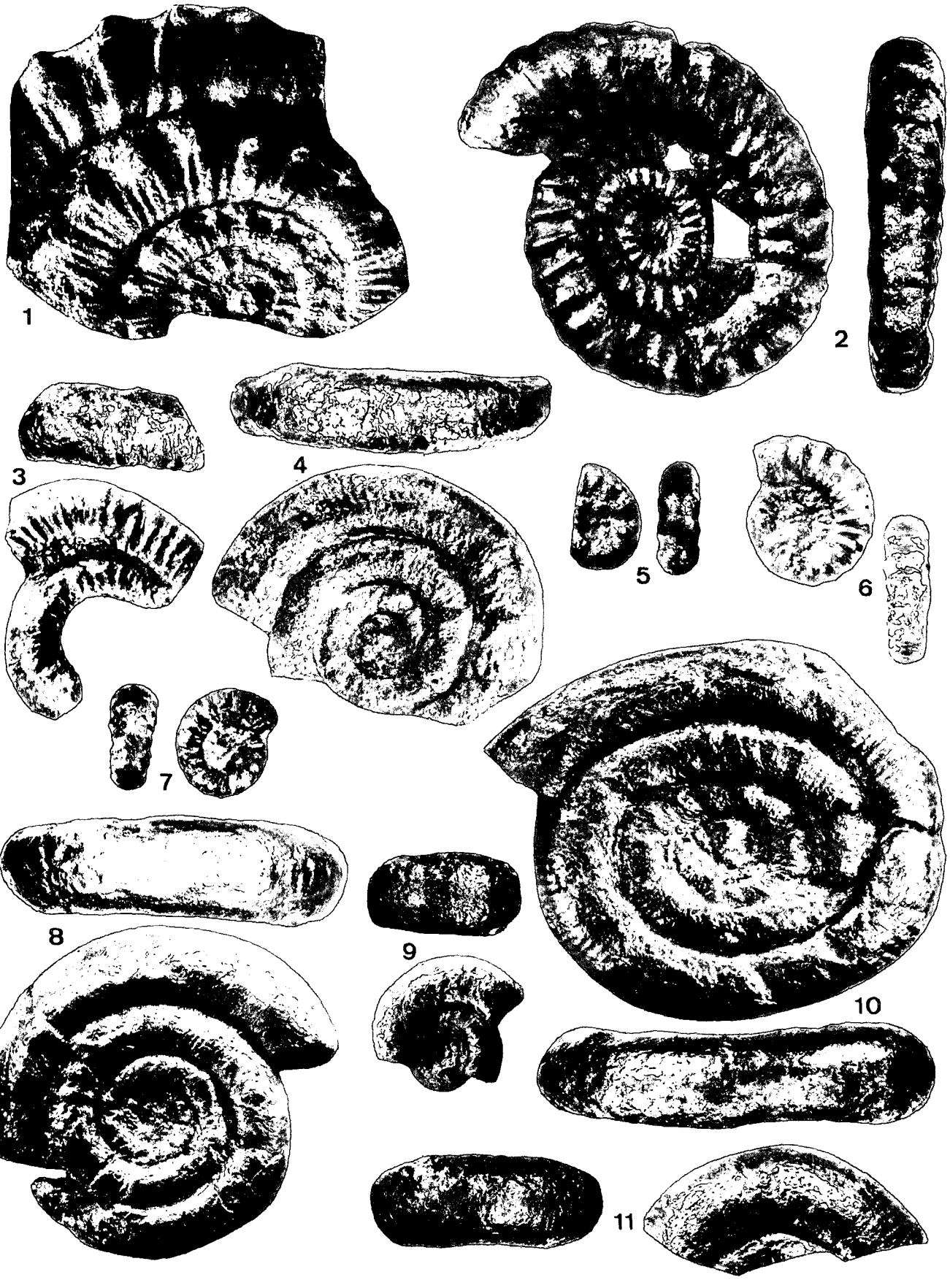


Plate 8

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: ***Protogrammoceras* aff. gr. *pseudodilectum* DOMMERGUES, MEISTER & FAURE.**
Coll. MEISTER, no. 55468, Rötelstein, bed 18b, Capricornus subzone.

Figs. 8,10,12: ***"Protogrammoceras" gr. *lavinianum* (FUCINI).**
Coll. MEISTER, no. 55469–71, Rötelstein, bed 18c, Stokesi subzone.

Figs. 11,14: ***Protogrammoceras* gr. *isseli* (FUCINI).**
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.

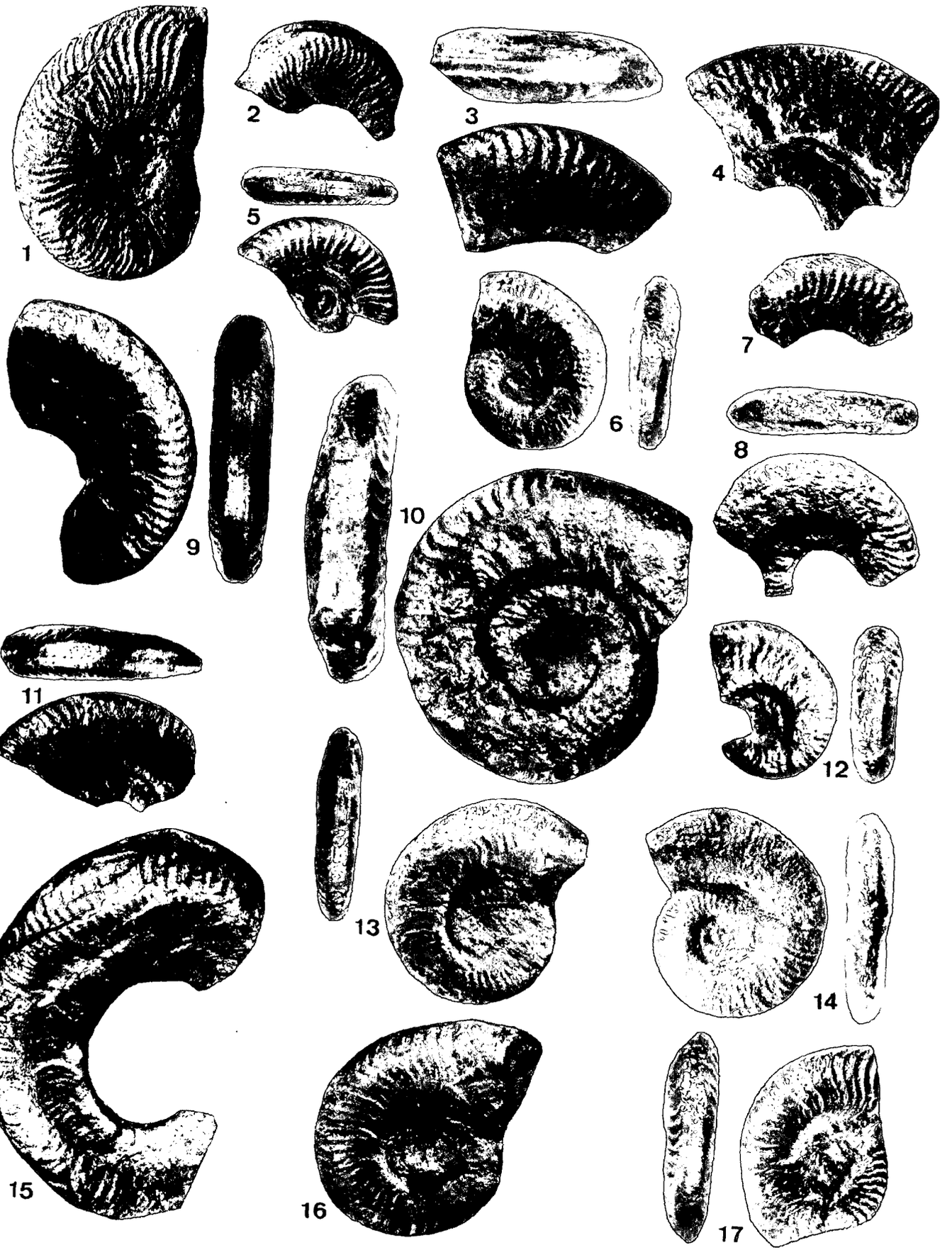


Plate 9

Fig. 1: ***P. (Matteiceras) monestieri*** **(FISCHER).**
Coll. MEISTER, no. 55478, Rötelstein, bed 19, Stokesi subzone.

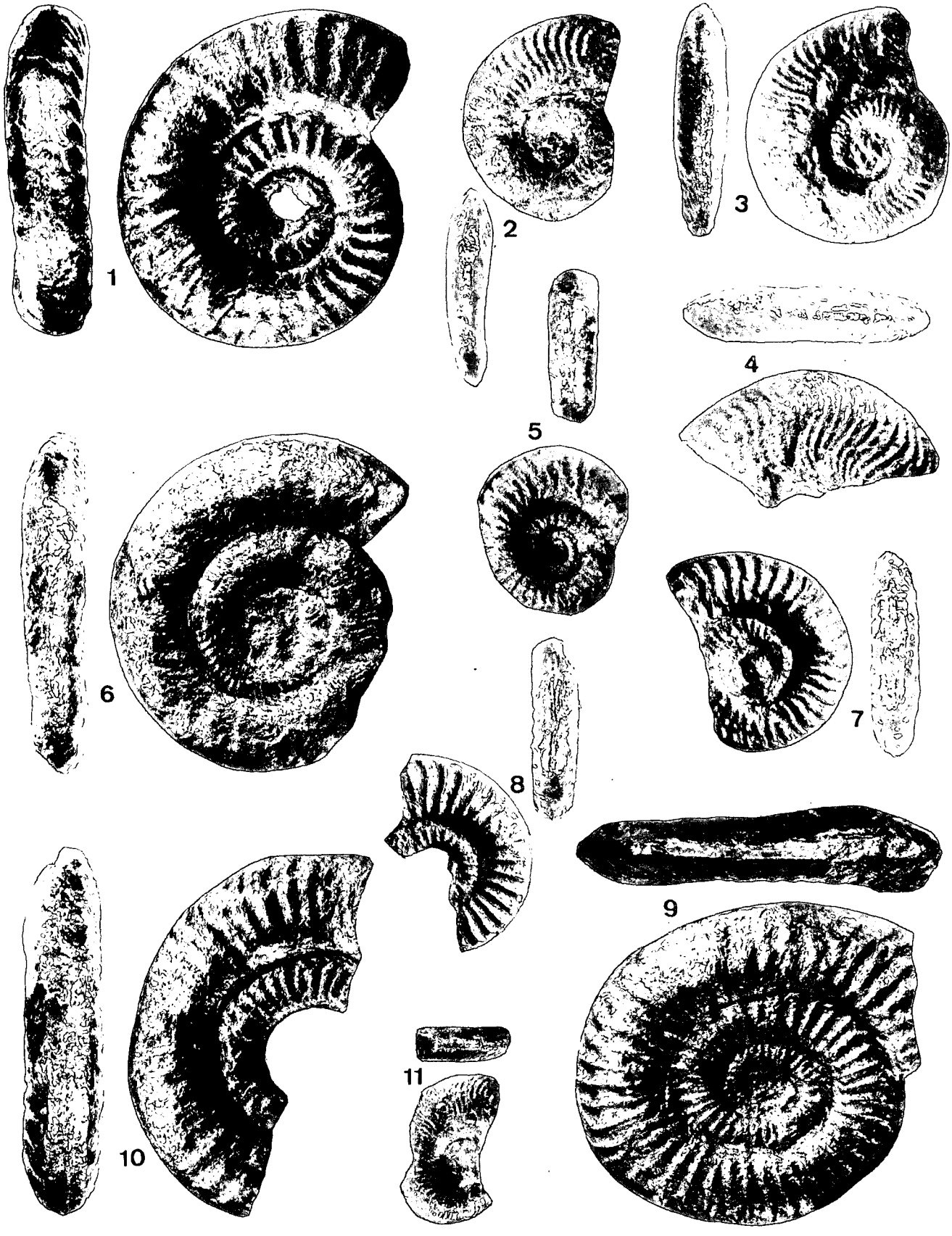
Figs. 2–4: ***Protogrammoceras marianii*** **(FUCINI).**
Coll. MEISTER, no. 55479–81, Rotkogel, bed 22, Stokesi subzone.

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: ***P. (Paltarpites)*** **aff.** ***aequiondulatum*** **(BETTONI).**
Coll. MEISTER, no. 55488, Rötelstein, bed 22, Gibbosus subzone.

All the ammonites are in natural size.



References

ALBERCH, P., GOULD, S.J., OSTER, G.F. & WAKE, D.B.: Size and shape in ontogeny and phylogeny. – Paleobiology, **5**/3, 296–317, Menlo Park (Cal.) 1979.

ALKAYA, F.: Kuzey Anadolu Alt Jura (Lyias) Phylloceratidlerinintaksonomik revizyonu (I. bölüm). – Bull. Geol. Soc. Turkey, **25**, 31–40, Ankara 1982.

ANDRUSOV, D.: Geologie der tschechoslowakischen Karpaten, II. – Berlin (Akademie-Verlag) 1965.

ANTONIADIS, P.A.: Ein Beitrag zur Biostratigraphie des Lias im Nördlichen Oberostalpin (zwischen Tiroler Ache und Weisser Traun). – Doc. naturae, **20**, 1–21, München 1984.

ARKELL, W.J., KUMMEL, B. & WRIGHT, C.W.: Mesozoic Ammonoidea. – In: MOORE, R.C. (ed.) Treatise on Invertebrate paleontology, (L) Mollusca **4**, 80–490, Geol. Soc. Am. & Kansas Press, Lawrence 1957.

BETTONI, A.: Fossili Domeriani della Provincia di Brescia. – Mém. Soc. Suis. Paléont., **28**, 1–88, Bâle 1900.

BLAU, J.: Stratigraphische Untersuchungen im Lias der westlichen Lienzer Dolomiten (Osttirol/Österreich) unter besonderer Berücksichtigung von zwei neugefundenen Ammonitenfaunen. – Dipl. Thesis, 135 p., Giessen 1983.

BLAU, J. & MEISTER, C.: Liassic (Pliensbachian) Ammonites from the Upper Austroalpine (Lienz Dolomites, East Tyrol, Austria). – Jb. Geol. B.-A., **134**/2, 171–204, Wien 1991.

BLIND, W.: Die Ammoniten des Lias Alpha aus Schwaben, vom Fonsjoch und Breitenberg (Alpen) und ihre Entwicklung. – Palaeontographica, A, **121**, 38–131, Stuttgart 1963.

BONARELLI, G.: Le ammoniti del "Rosse Amonitico". – Bull. soc. Malacol., **20**, 198–219, Pisa 1899.

BRAGA, J.C.: Ammonites del Domerense de la Zona Subbetica (Cordilleras Beticas, sur de Espana). – Tesis Doctoral, 410 p., Granada 1983.

BRAGA, J.C., JIMENEZ, A.P. & RIVAS, P.: Lytoceratidae (Ammonoidea) del Lias Medio de la Zona Subbética. – Bol. R. Soc. Espanola Hist. Nat. (Geol.), **82**, 5–23, Madrid 1987.

BRAGA, J.C., MARTIN-ALGARA, A. & RIVAS, P.: Ammonites du Lias inférieur (Sinémurien – Lotharingien) de Sierra Harana (Cordillères bétiques, Espagne). – In "1er Coll. du Centre International d'Etude du Lias", Cahier Inst. Cath., **14**, 85–100, Lyon 1985.

BRAGA, J.C. & RIVAS, P.: *Protogrammoceras* y *Fuciniceras* (Ammonoidea, Hildoceratacea) del Carixiense Superior en las Cordilleras Beticas (Andalucia, Espana). – Estud. geol., **36**, 169–176, Madrid 1980.

BRAGA, J.C. & RIVAS, P.: The mediterranean Tropidoceras (Ammonitina) in the Betic Cordilleras. – Eclogae geol. Helv., **78**/3, 567–605, Bâle 1985.

BRAGA, J.C. & RIVAS, P.: Phylloceratidae del Lias Medio de la Zona Subbética. – Bol. R. Soc. Espanola Hist. Nat. (Geol.), **82**, 65–86, Madrid 1987.

BUCKMAN, S.S.: Yorkshire Type Ammonites. – Vol. 1–7 (for the dates of delivery see DEAN et al., 1961), 709 pl., London (Weldon & Wesley) 1909–1930.

CANAVARI, M.: Contribuzione alla fauna de Lias inferiore di Spezia. – Mem. Regio. Com. Geol. Italia, **3**, 57–227, Firenze 1888.

COMAS RENGIFO, M.J.: El Pliensbachiense de la Cordillera Ibérica. – Tesis Doctoral, 591 p., Madrid 1985.

CORNA, M.: Le Lias du Jura méridional, paléontologie biostratigraphique du Sinémurien, approche paléoécologique. – Thèse Univ. (inédit): 1– 246, Lyon 1985.

CUBAYNES, R., BOUTET, C., DELFAUD, J. & FAURE, P.: La mégaséquence d'ouverture du Lias quercynois (bordure sud-ouest du Massif Central français). – Soc. Nat. Elf-Aquitaine, **8**/2, 334–370, Pau 1984.

DEAN, W.T., DONOVAN, D.T. & HOWARTH, M.K.: The liassic ammonites zones and subzones of the North-West European Province. – Bull. British Museum (Nat. Hist.) Geol., **4**/10, 437–505, London 1961.

DOMMERGUES, J.-L.: Le Carixien bourguignon, biostratigraphie, paléogéographie, approches paléontologique et sédimentologique. – Thèse doctorat 3ème Cycle, 195 p., Dijon 1979.

DOMMERGUES, J.-L.: *Prodactylioceras davoei* (Sow.) (Ammonitina), en Bourgogne; paléontologie et dynamique du peuplement. – Bull. Scient. Bourgogne, **33**, 33–55, Dijon 1980.

DOMMERGUES, J.-L.: L'évolution des Ammonitina au Lias moyen (Carixien, Domérien basal) en Europe occidentale. – Doc. Lab. Géol., **98**, 298 p., Lyon 1987.

DOMMERGUES, J.-L., CARIOU, E., CONTINI, D., HANTZPERGUE, P., MARCHAND, D., MEISTER, C. & THIERRY, J.: Homéomorphies et canalisations évolutives: le rôle de l'ontogenèse. Quelques exemples pris chez les ammonites du Jurassique. – Geobios, **22**/1, 5–48, Lyon 1989.

DOMMERGUES, J.-L., DAVID, B. & MARCHAND, D.: Les relations ontogenèse – phylogenèse: applications paléontologiques. – Geobios, **19**/3, 335–356, Lyon 1986.

DOMMERGUES, J.-L., FERRETTI, A., GECZY, B. & MOUTERDE, R.: Eléments de corrélation entre faunes d'ammonites mésogéennes (Hongrie, Italie) et subboréales (France, Portugal) au Carixien et au Domérien inférieur. – Geobios, **16**/4, 471–499, Lyon 1983.

DOMMERGUES, J.-L. & GECZY, B.: Les faunes d'ammonites du Carixien basal de Villany (Hongrie); un témoin paléobiogéographique des peuplements de la Marge méridionale du continent Euro-Asiatique. – Rev. Paléobio., **8**, 21–37, Genève 1989.

DOMMERGUES, J.-L. & MEISTER, C.: Succession des faunes d'ammonites au Langenegggrat (Préalpes médianes, région de Thoune, Suisse): une série de référence dans le Sinémurien supérieur. – Geobios, **20**, 313–335, Lyon 1987a.

DOMMERGUES, J.-L. & MEISTER, C.: La biostratigraphie des ammonites du Carixien (Jurassique inférieur) d'Europe occidentale: un test de la méthode des associations unitaires. – Eclogae geol. Helv., **80**/3, 919–938, Bâle 1987b.

DOMMERGUES, J.-L. & MEISTER, C.: Succession des faunes d'ammonites du Sinémurien supérieur dans le Chablais méridional et les Klippes de Savoie (Préalpes médianes, Haute-Savoie France). – Geobios, **4**, 455–483, Lyon 1989a.

DOMMERGUES, J.-L. & MEISTER, C.: Trajectoires ontogénétiques et hétérochronies complexes chez des ammonites (Harpoceratinae) du Jurassique inférieur (Domérien). – Geobios, Mém. spécial, **12**, 157–166, Lyon 1989b.

DOMMERGUES, J.-L. & MEISTER, C.: De la Grosse Pierre des Encombres aux Klippes de Suisse centrale: un test d'homogénéité des paléoenvironnements subbriançonnais et des contraintes paléobiogéographiques alpines par les ammonites du Lias moyen (Jurassique inférieur). – Bull. Soc. géol. France, **8**/4, 635–646, Paris 1990a.

DOMMERGUES, J.-L. & MEISTER, C.: Les faunes d'ammonites liasiques de l'Austroalpin moyen dans les Alpes Rhétiques italiennes (Region de Livigno); Biostratigraphie et implications paléogeographiques. – Rev. Paléobio., **9**/2, 291–307, Genève 1990b.

DOMMERGUES, J.-L. & MEISTER, C.: Area of mixed marine faunas between two major paleogeographical realms, exemplified by the Early Jurassic (Late Sinemurian and Pliensbachian) ammonites in the Alps. – Palaeogeo. Palaeoclim. Palaeoecol., **86**, 265–282, Amsterdam 1991.

DOMMERGUES, J.-L., MEISTER, C. & FAURE, P.: Trois espèces nouvelles d'Harpoceratinae du Carixien supérieur et du Domérien basal du nord-ouest de L'Europe. – In "1er Coll. Centre Int. Etude du Lias 1984". – Cahiers Inst. Cath., 153–173, Lyon 1985.

DOMMERGUES, J.-L., MEISTER, C. & METTRAUX, M.: Succession des faunes d'ammonites du Sinémurien et du Pliensbachien dans les Préalpes médianes de Suisse romande (Vaud et Fribourg): implications biochronologiques et paléobiogéographiques. – Geobios, **23**/3: 307–341, Lyon 1990.

DOMMERGUES, J.-L. & MOUTERDE, R.: Les faunes d'ammonites du Carixien inférieur et moyen du gisement des Cottard (Cher). – Geobios, **11**, 345–365, Lyon 1978.

DONOVAN, D.T.: Synoptic supplement to T. WRIGHT's "Monograph on the Lias Ammonites of the British Islands" (1878–86). – Palaeontogr. Soc., 54 p., London 1954.

DONOVAN, D.T.: Revision des espèces décrites dans la "Monographie des Ammonites" (Lias inférieur) de P. Reynès. – Mém. Soc. géol. France, **34**, 1–73, Paris 1955.

DONOVAN, D.T.: Sinemurian and Pliensbachian ammonites faunas of Central Italy. – Atti Conv. Int. F. E. A., **2**, 253–262, Pergola 1990.

DONOVAN, D.T. & FORSEY, G.F.: Systematics of Lower Liassic Ammonitina. – Paleont. Contr. Univ. Kansas, **64**, 1–18, Kansas City 1973.

DUMORTIER, E.: Etudes paléontologiques sur les dépôts jurassiques du bassin du Rhône, 3ème et 4ème parties, Lias moyen et supérieur. – 299 p., Paris (Savy) 1869–1874.

ERBEN, H.K.: El Jurassico inferior de Mexico y sus Ammonitas. – In "20ème Congr. Geol. Int. Mexico", 1–393, Mexico 1956.

FANTINI SESTINI, N.: Dactylioceratidae (Ammonoidea) del Domeriano. – Riv. Ital. Paleont., **81**/4, 437–476, Milano 1975.

FERRETTI, A.: Ricerche biostratigrafiche sul Domeriano nel gruppo montuoso del Nerone (Appennino Marchigiano). – Riv. Ital. Paleont., **78**/1, 93–130, Milano 1972.

FERRETTI, A.: Ricerche biostratigrafiche sul Sinemuriano – Pliensbachiano nella gola del F. Bosso (Appennino marchigiano). – Riv.Ital. Paleont., **81**/2, 161–194, Milano 1975.

FERRETTI, A.: Biostratigrafia del Domeriano nell'Appennino Marchigiano. – Cahiers Univ. Catho. Lyon, **4**, 53–56, Lyon 1990.

FERRETTI, A. & MEISTER, C.: Composition des faunes d'ammonites dans les Apennins des Marches et comparaison avec les principales régions téthysiennes et subboréales. – In "3ème Convegno int. Fossili, Evoluzione, Ambiente" Pergola 1989 (in press).

FISCHER, R.: Die deutschen Mittellias-Falciferen (Ammonoidea, *Protogrammoceras, Fuciniceras, Arieticeras*). – Palaeontographica A, **151**, 47–101, Stuttgart 1975.

FUCINI, A.: Cefalopodi Liassici del Monte Cetona. – Parte 1, Paleont. Ital., **7** (1901), 1–89; parte 3, ibid., **9** (1903), 125–185; parte **4**, ibid., **10** (1904), 275–298; parte 5, ibid., **11** (1905), 93–146; Pisa 1901–1905.

FUCINI, A.: Ammoniti del Lias Medio dell'Appennino Centrale existense nel museo di Pisa. – Paleont. Ital., **5**/6, 145–185, Pisa 1899–1900.

FUCINI, A.: Synopsis delle Ammoniti del Medolo. – Ann. Univ. Toscana, **28**, 1–107, Pisa 1908a.

FUCINI, A.: Ammoniti medoliane dell'Appennine. – Atti Soc. Nat. Tosc. Mem., **24**, 18 p., Pisa 1908b.

FUCINI, A.: Fossili domeriani dei dintorni di Taormina. – Parte 1, Paleont. Ital., **26**/1920 (1923), 75–116; parte 2, ibid., **27**/1921 (1924), 1–21; parte 3, ibid., **29–30**/1923–1928 (1929), 41–77: parte 4, ibid., **31**/1929–1930 (1931), 93–149; parte 5, ibid., **35**/1934–1935 (1935), 85–100; Pisa 1920–1935.

FUTTERER, K.: Die Ammoniten des mittleren Lias von Östringen. – Mitt. bad. geol. Landesanst., **2**, 277–343, Heidelberg 1893.

GAKOVIC, M.B.: Stratigraphy of the liassic of the Zalomka and Gacko in Herzegovina as a base of biostratigraphic division of the Lower Jurassic in the Dinarides. – Geol. Glas. Pos. Izd., **21**, 1–143, Sarajevo 1986.

GANSS, O., KÜMEL, F. & SPENGLER, E.: Erläuterungen zur geologischen Karte der Dachsteingruppe. – Wiss. Alpenvereinsh., **15**, 1–82, Innsbruck 1954.

GECZY, B.: Les ammonites du Carixien de la montagne du Bakony. – Akadémiai Kiado, 220 p., Budapest 1976.

GEYER, G.: Die mittel-liasische Cephalopoden-Fauna des Hinter-Schafberges in Oberösterreich. – Abh. k. k. geol. R.-A., **15**, 1–76, Wien 1893.

GEMMELLARO, G.G.: Sui fossili degli strati a Terebratura aspasia della contrada Rocche Rosse presso Galati (provincia di Messina). – Giorn. Sc. Nat. Econ., **16**, 1–48, Palermo 1884.

GOULD, S.J.: Ontogeny and phylogeny. – Harvard Univ. press, 501 p., Cambridge (Mass.) 1977.

GUERIN-FRANIATTE, S.: Ammonites du Lias inférieur de France, Psiloceratacеae: Arietitidae. – Edit. CNRS, 1–2, 455 p., Paris 1966.

GUEX, J.: Répartition biostratigraphique des ammonites du Torcien moyen de la bordure sud des Causses (France) et révision des ammonites décrites et figurées par Monestier (1931). – Eclogae Geol. Helv., **65**/3: 611–645, Bâle 1972.

GWINNER, M.P.: Geologie der Alpen. – 480 p., Stuttgart (Schweizerbart) 1978.

HAAS, O.: Die Fauna des mittleren Lias von Ballino in Südtirol. – Beitr. Paleont. Geol. Österr. – Ungarn Orient, **26**, 1–161, Wien 1913.

HAQ, B.U., HARDENBOL, J. & VAI, P.R.: Mesozoic and Cenozoic chronostratigraphy and cycles of sea-level change. – SEPM special publication, Soc. Ec. Paleont. Mineral., **42**, 71–108, Tulsa 1988.

HAUER, F.: Über die Gliederung der Trias-Lias und Juragebilde in den nordöstlichen Alpen. – Jb. k. k. geol. R.-A., **4**, 715 p., 1853.

HAUER, F.: Beiträge zur Kenntnis der Heterophyllen der Österreichischen Alpen. – Sitzber. Akad. Wiss. Wien, math.-natw., Cl. **12**/5, 861–910, Wien 1854a.

HAUER, F.: Beiträge zur Kenntnis der Capricornier der Österreichischen Alpen. – Sitzber. Akad. Wiss. Wien, math.-natw. Cl. **13**, 94–121, Wien 1854b.

HAUER, F.: Über die Cephalopoden aus dem Lias der nord-östlichen Alpen. – Denkschr. k.k. Akad. Wiss. Wien, math.-natw. Cl., **1**, 1–86, Wien 1856.

HAUER, F.: Ueber die Ammoniten aus dem sogenannten Medolo der Berge Domaro und Guglielmo im Val Trompia. – Sitzber. K. Akad. Wiss. Wien, math.-natw. Cl., **44**, 403–422, Wien 1861.

HAUG, E.: Beiträge zur einer Monographie der Ammonitengattung Harpoceras. – N. Jb. Mineral. Geol. Paleont., **3**, 586–722, Stuttgart 1885.

HILLEBRANDT, (VON) A.: Faunas de Amonites del Liasico inferior y medio (Hettangiano hasta Pliensbachiano) de America del sur (excluyendo Argentina). – Cuncas Sed. Jurasico y Cretacico Am. Sur, **2**, 499–538, Buenos Aires 1982.

HILLEBRANDT, (VON) A.: Liassic ammonite zones of South America and correlations with other provinces. – Bioestr. Sistemas Reg. del Jurassico y Cretacico Am. Sur Contr. IGCP **171**, 111–157, Mendoza 1987.

HIRSCHBERG, K. & JACOBSHAGEN, V.: Stratigraphische Kondensation in Adneter Kalken am Rötelstein bei Filzmoos (Salzburger Kalkalpen). – Verh. Geol. B.-A., **1965**, 33–42, Wien 1965.

HOWARTH, M.K.: The ammonites of the Liassic family Amaltheidae in Britain. – Paleont. Soc. London, **111–112**, 90 p., London 1958.

HOWARTH, M.K.: The stratigraphy and ammonite fauna of the Upper Liassic Grey Shales of the Yorkshire Coast. – Bull. Brit. Mus. (Nat. Hist.) Geol., **24**/4, 237–277, London 1973.

HUG, O.: Beiträge zur Kenntnis der Lias- und Dogger Ammoniten aus der Zone der Friburger Alpen. II, die Unter- und Mittellias Ammoniten-Fauna von Blumenstein Allmend und Langeneckgrat am Stockhorn. – Abh. schweiz. paläont. Ges., **26**, 1–39, Zürich 1899.

HYATT, A.: Genesis of the Arietidae. – Smiths. Contrb. Knowl., **673**, xi + 238 p., Washington 1889.

IMLAY, R.W.: Early Jurassic Ammonites from Alaska. – U. S. Geol. Surv. Prof. Pap., **1148**, 1–49, Washington 1981.

JORDAN, R.: Paläontologische und stratigraphische Untersuchungen im Lias delta (Domerium) Nordwestdeutschlands. – Thesis, 178 p., Tübingen 1960.

KIESLINGER, A.: Die nutzbaren Gesteine Salzburgs. – 436 p., Salzburg (Berglandbuch) 1964.

KOVÁCS, L.: Monographie der liassischen Ammoniten des nördlichen Bakony. – Geologica Hung., ser. paleont., **17**, 220 p., Budapest 1942.

LEIN, R.: Evolution of the Northern Calcareous Alps during Triassic Times. – In FLÜGEL, H.W. & FAUPL, P., Geodynamics of the Eastern Alps, 85–102, Wien 1987.

LEVI, G.: Sui Fossili degli strati a Terebratula aspasia di M. Calvi presso Campiglia. – Boll. Soc. geol. Ital., **15**, 262–276, Roma 1896.

MATTEI, J.: Application de méthodes d'analyse globale à l'étude des Amaltheidae du bassin sédimentaire des Causses (Carixien supérieur et Domérien). – Cahiers Paléont., 146 p., Paris (CNRS) 1985.

MCNAMARA, K.J.: Heterochrony and phylogenetic trends. – Paleobiology, **8**/2, 130–142, Menlo Park (Cal.) 1982.

MCNAMARA, K.J.: The role of heterochrony in evolutionary trends. – In MCNAMARA "Evolutionary trends", 59–73, London (Belhaven press) 1990.

MENEGHINI, J.: Nuovi fossili toscani illustrati dal Prof. G. Meneghini. In appendice alle considerazioni sulla geologia statigrafica toscana dei Professori Cavaliere P. Savi e G. Meneghini. – Ann. Univ. Tosc., **3**, Pisa 1853.

MENEGHINI, J.: Monographie des fossiles du calcaire rouge ammonitique (Lias supérieur) de Lombardie et de l'Appennin Central. – In STOPPANI, Paleont. Lombarde, **4**, 112 p., Milano 1867–1881.

MEISTER, C.: Les ammonites du Carixien des Causses – France. – Mém. Suiss. Paléont., **109**, 209 p., Bâle 1986.

MEISTER, C.: Ontogenèse et évolution des Amaltheidae (Ammonoidea). – Eclogae geol. Helv., **81**/3, 763–841, Bâle 1988.

MEISTER, C.: Les ammonites du Domérien des Causses (France). Analyses paléontologiques et stratigraphiques. – Cahiers Pal., 98 p., Paris (CNRS) 1989.

MEISTER, C. & LOUP, B.: Les gisements d'ammonites liasiques (Hettangien à Pliensbachien) du Ferdenrothorn (Valais, Suisse): analyses paléontologiques, biostratigraphiques et aspects lithostratigraphiques. – Eclogae geol. Helv., **82**/3, 1003–1041, Bâle 1989.

MONESTIER, J.: Ammonites du Domérien de la région du sud-est de l'Aveyron et de quelques régions de la Lozère à l'exclusion des Amalthéidés. – Mém. Soc. Géol. France, N.S., **23**, 1–102, Paris 1934.

MOUTERDE, R.: Sur quelques ammonites du Lias du Rif remarques paléontologiques. – Notes & Mém. Serv. Géol. Maroc, **184**, 227–243, Rabat 1965.

OPPEL, A.: Über jurassische Cephalopoden. Paleontologische Mittheilungen aus dem Museum des Königl.-Bayer. Staates., **1**/1–3, 266 p., München 1862–1863.

ORBIGNY, (D') A.: Paléontologie française. Terrains jurassiques – I Cephalopodes. – 642 p., Paris (Masson) 1842–1851.

PARONA, C. F.: Contribuzione alla conoscenza della Ammoniti Liasiche di Lombardia I & II. – Mém. Soc. paléont. Suisse, **24**, 1–19, Bâle 1896–1898.

PHELPS, M.C.: A refined ammonite biostratigraphy for the Middle and Upper Carixian (Ibex and Davoei Zones, Lower Jurassic) in North-West Europe and stratigraphical details of the Carixian-Domerian boundary. – Geobios, **18**/3, 321–362, Lyon 1985.

PIA, J.: Untersuchungen über die Gattung *Oxynoticeras* und einige damit zusammenhängende allgemeine Fragen. – Abh. k. k. Geol. R.-A., **23**/1, 1–179, Wien 1914.

PLÖCHINGER, B.: Erläuterungen zur geologischen Karte des Wolfgangseegebietes (Salzburg, Oberösterreich 1 : 25.000. – Geol. B.-A., **92** p., Wien 1973.

PLÖCHINGER, B.: Das Juraprofil an der Zwölferhorn-Westflanke (Nördliche Osterhorngruppe, Salzburg). – Verh. Geol. B.-A., 27–33, Wien 1975.

PLÖCHINGER, B.: Erläuterungen zu Blatt 95 Sankt Wolfgang im Salzkammergut, 1 : 50.000. – Geol B.-A., 1–74, Wien 1982.

PLÖCHINGER, B.: Geologische Karte der Republik Österreich 1:50000, Blatt 94 Hallein. – Geol. B.-A., Wien 1987.

POMPECKJ, J.F.: Notes sur les *Oxynoticeras* du Sinémurien supérieur du Portugal et remarques sur le genre *Oxynoticeras*. – Com. Serv. Geol. Portugal, **6**, 214–338, Lisboa 1906–1907.

PREDA, D.M. & RAILEANU, G.: Contributions à la connaissance du Lias des Monts Persani. – Ann. Com. Géol. **26–28**, 53–68, Bucarest 1960.

PRINZ, P.: Stratigraphie und Ammonitenfauna der Pucara-Gruppe (Obertrias-Unterjura) von Nord-Peru. – Palaeontographica, A, **188**, 153–197, Stuttgart 1985.

QUENSTEDT, F.A.: Petrefactenkunde Deutschlands. I Cephalopoden. – 580 p., Tübingen (Schweitzerbart) 1845–1849.

QUENSTEDT, F.A.: Der Jura. – Vi + 842 p., Tübingen (Laupp.) 1856–1857.

QUENSTEDT, F.A.: Die Ammoniten des Schwäbischen Jura. I Der Schwarze Jura. – 440 p., Tübingen (Schweitzerbart) 1882–1885.

QUINZIO SINN, L.A.: Stratigraphische Untersuchungen im Unterjura des Südteils der Provinz Antofagasta in Nord-Chile. – Berlin. Geowiss. Abh., A **87**, 105 p., Berlin 1987.

REPIN, J. S.: The Jurassic ammonites zones of the Soviet Union. – Spec. Pap., **223**, 6–13, Boulder (Colorado) 1988.

REYNES, P.: Essai de géologie et de paléontologie aveyronnaises. – 110 p., Paris (Baillière & fils) 1868.

REYNES, P.: Monographie des Ammonites. – 58 pl., Paris et Marseilles (Baillière & fils) 1879.

RIVAS, P.: Los Oxynoticeratidae del Carixiense superior (*Radstockiceras*) en el sector central de las Cordilleras Beticas (Prov. Granada). – Cuadernos Geol., **8**, 159–165, Granada 1977.

RIVAS, P.: El genero *Metaderoceras* (Eoderoceratacea, Ammonitina) en las Cordilleras Beticas. – Estud. geol., **39**, 387–403, Madrid 1983.

ROEMER, F.A.: Die Versteinerungen des Norddeutschen Oolithen-Gebirges. – 225 p., Hannover (Hahn'sche Hofbuchhandlung) 1835–1836.

ROSENBERG, P.: Die liasische Cephalopodenfauna der Kratzalpe im Hagengebirge. – Beitr. Paleont. Geol. Oesterr. Ungarns Orient, **22**, 193–345, Wien 1909.

ROSENKRANTZ, A.: The Lower Jurassic rocks of East Greenland. – Medd. om Groenland, **110**, 1–121, Copenhague 1934.

SACCHI-VIALLI, G. & CANTALUPPI, G.: Revisione della fauna di Saltrio. – Atti Ist. Geol. Univ. Pavia, **12**, 5–49, Pavia 1961.

SCHÄFFER, G.: Geologische Karte von Österreich 1 : 50.000 Blatt 96 Bad Ischl. – Geol B.-A., Wien 1982.

SCHÄFFER, G. & STEIGER, T.: Der Jura zwischen Salzburg und Bad Aussee. – Exkursionsführer zur Jahrestagung der Subkommission für Jura-Stratigraphie: 68 p., München 1986.

SCHLAGER, M. & SCHLAGER, W.: Geologische Karte von Adnet und Umgebung 1 : 10.000. – Geol. B.-A., Wien 1960.

SCHLATTER, R.: Biostratigraphie und Ammonitenfauna des Unter-Pliensbachium im Typusgebiet (Pliensbach, Holzmaden und Nürtingen; Württemberg, SW-Deutschland). – Stuttgarter Beitr. Naturk., B, **65**, 1–261, Stuttgart 1980.

SCHLEGELMILCH, R.: Die Ammoniten des süddeutschen Lias. – 212 p., Stuttgart (Gustav Fischer Verlag) 1976.

SCHLOTHEIM, E.F.: Die Petrefactenkunde auf dem jetzigen Standpunkte durch die Beschreibung seiner Sammlung versteinerter und fossiler Überreste des Thier- und Pflanzenreichs der Vorwelt erläutert. – LXII + 437 p., Gotha (Becker) 1820.

SCHRÖDER, J.: Die Ammoniten der jurassischen Fleckenmergel in den Bayrischen Alpen. – Palaeontographica, **68**, 111–232, Stuttgart 1927.

SIEBER, R.: Bericht 1960 über paleontologisch-stratigraphische Untersuchungen im Mesozoikum der westlichen Kalkalpen Österreichs. – Verh. Geol. B.-A., **1961**, A107–A110, Wien 1961.

SIEBER, R.: Bericht 1974 über geologische Aufnahmen auf Blatt 96 Bad Ischl, Paleontologie. – Verh. Geol. B.-A., A72–A73, Wien 1975.

SMITH, P.L., TIPPER, H.W., TAYLOR, D.G. & GUEX, J.: An ammonite zonation for the Lower Jurassic of Canada and the United States: the Pliensbachian. – Can. J. Earth Sci., **25**, 1503–1523, Ottawa 1988.

SOWERBY, J.: Mineral Conchology of Great Britain. – **1–6**, 648 pl., London (Meredith) 1812–1846.

SPATH, L.F.: Notes on Yorkshire Ammonites. – Naturalist, **6**, 107–364, London 1925.

SPATH, L.F.: The ammonites of the Liassic family Liparoceratidae. – Brit. Mus. Nat. Hist., 191 p., London 1938.

SPENGLER, E.: Versuch einer Rekonstruktion des Ablagerungsraumes der Decken der Nördlichen Kalkalpen. Teil II: Der Mittelabschnitt der Kalkalpen. – Jb. Geol. B.-A., **99**, 1–74, Wien 1956.

STEFANI, C. (DI): Lias inferiore ad Arieti dell'Appennino settentrionale. – Atti Soc. tosc. Sci. nat., **8** (1887), 9–76, Pisa 1886.

STUR, D.: Die Liassischen Kalksteingebilde von Hirtenberg und Enzesfeld. – Jb. k.k. geol. R.-A., **2**, 3, 5, 19–27, Wien 1851.

SUESS, E. & MOJSISOVICS, E.: Studien über die Gliederung der Trias und Jurabildungen in den östlichen Kalkalpen. Nr. II. Die Gebirgsgruppe des Osterhornes. – Jb. k.k. geol. R.-A., **18**, 167–200, Wien 1868.

TAN, TA-TRAN: Ammonites sinémuriennes à Chan-Toi (Province de Bien-Hoa). – Arch. géol. Viet-Nam, 103–112, Hanoi 1968.

TINTANT, H., GAUTHIER, J. & LACROIX, L.: Les Amalthéidés de Côte d'Or et leur répartition stratigraphique. – Bull. Sci. Bourgogne **20**, 137–161, Dijon 1961.

TILMANN, N.: Die Fauna des unteren und mittleren Lias in Nord- und Mittelperu. – N. Jb. Miner., **41**, 628–712, Stuttgart 1917.

TOLLMANN, A.: Die Hallstätter Zone des östlichen Salzkammergutes und ihr Rahmen. – Jb. Geol. B.-A., **103**, 37–131, Wien 1960.

TOLLMANN, A.: Der Bau der Nördlichen Kalkalpen. Orogene Kalkalpen und regionale Tektonik. – 449 p., Wien (Deuticke) 1976a.

TOLLMANN, A.: Analyse des klassischen Mesozoikums (Stratigraphie, Fauna und Fazies) der Nördlichen Kalkalpen. – 2: XVI–580, Wien (Deuticke) 1976B.

TOLLMANN, A.: Oberjurassische Gleittektonik als Haupformungsprozess der Halstätter Region und neue Daten zur Gesamttektonik der Nördlichen Kalkalpen in den Ostalpen. – Mitt. österr. geol. Ges., **74–75**, 167–195, Wien 1981.

TOPCHISHVILI, M.V.: Faune du Jurassique inférieur de la région de Tbilissi, Grand-Caucase. – Trud. Geol. Inst. Akad. Nauk. Gruz. SSR, 21, 115 p., Tbilisi 1969.

TRAUTH, F.: Geologie der nördlichen Radstädter Tauern und ihres Vorlandes I. – Denkschr. Akad. Wiss. Wien, math.-natw. Kl, **100**, 101–212, Wien 1925.

TRUEMAN, A.E.: The evolution of the Liparoceratidae. – Quart. Jour. Geol. Soc., **74**/4, 247–298, London 1919.

TRUEMAN, A.E. & WILLIAMS, D.: Studies in the Ammonites of the family Echioceratidae. – Trans. Roy. Soc. Edin., **53**/3, 699–739, Edinbourgh 1925.

TUTCHER, J.W. & TRUEMAN, A.E.: The Liassic rocks of the Radstock district, Somerset. – Quart. J. geol. Soc., **81**, 595–666, London 1925.

URLICHS, M.: Stratigraphy, Ammonite Fauna and some Ostracods of the Upper Pliensbachian at the Type Locality (Lias, SW-Germany). – Stuttg. Beitr. Naturk. Serie B, **28**, 13 p., Stuttgart 1977.

VENTURI, F.: Ammoniti della "Corniola" del Monte Catria (Appennino Marchigiano). Un orrizonte fossilifero, attribuibile all'intervallo Lotharingiano sup. – Carixiano inf. – Boll. Soc. Pal. Italiana, **17**, 98–117, Modena 1978.

VIALLI, V.: Ammoniti Sinemuriane del Monte Albenza (Bergamo). – Mem. Soc. Ital. Sci. Nat. Mus. Civ. Storia nat., **12**/3, 141–188, Milano 1959.

WÄHNER, F.: Beiträge zur Kenntniss der tieferen Zonen des unteren Lias in den nordöstlichen Alpen. – Beitr. Paleont. Österr.-Ung. u. Orients., **2–6**, **8**, **9**, **11**, 1–226, Wien 1882–1898.

WÄHNER, F.: Zur heteropischen Differensierung des alpinen Lias. – Verh. geol. R.-A.: 168–206, Wien 1886.

WÄHNER, F.: Exkursion nach Adnet und auf den Schafberg. – Führer Geol. R.-A., Exk. 9 Internat. Geol.-Kongr., **4**, 1–20, Wien 1903.

WANG, Y.-G. & HE, G.: Some Early Jurassic Ammonoids from Eastern Himalayas. – Palaeont. Xizang, **3**, 314–334, Peking 1981.

WANG, Y.-G. & SMITH P. L.: Sinemurian (Early Jurassic) ammonite fauna from Guangdong region of Southern China. – J. Paleont., **60**, 1075–1085, Chicago 1986.

WENDT, J.: Die Typlokalität der Adneter Schichten (Lias, Österreich). – Ann. Inst. Geol. Publ. Hung., **54**, 105–116, Budapest 1971.

WIEDENMAYER, F.: Die Ammoniten des Besazio-Kalks (Pliensbachian, Südtessin). – Mém. Suis. Paléont., **98**, 1–131, Bâle 1977.

WIEDENMAYER, F.: Die Ammoniten der mediterranen Provinz im Pliensbachian und unteren Toarcian aufgrund neuer Untersuchungen im Generoso-Becken (Lombardische Alpen). – Mém. Soc. Hélv. Sc. Nat., **93**, 197 p., Bâle 1980.

WRIGTH, T.: A monograph on the Lias ammonites of the British Islands. – Palaeontogr. Soc., **2–5**, 7, 49–480, London 1879–1884.

YOUNG, G.M. & BIRD, J.: A geological survey of the Yorkshire Coast: describing the strata and fossils occurring between the Humber and the Tees, from the German Ocean to the Plain of York. – 368 p., Whitby 1828.

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