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Ammonite biostratigraphy of the Pliensbachian stage in the Upper Austroalpine Jurassic

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Key words: Ammonites, biostratigraphy, Lias , Alps, Austroalpine, Austria

ABSTRACT

A set of 20 biostratigraphic horizons or levels based on ammonites is given for the Pliensbachian of the Upper Austroalpine nappes. This biostratigraphical framework is compared and correlated with those of NW Europe (Euroboreal Realm) and Central Apennines (Tethyan Realm). The "key" position of the Upper Austroalpine is underlined by these correlations. In the lower, Carixian Substage, many of the horizons correspond to those of the NW European zonation, while others, mainly in the upper, Domerian Substage, are well correlated with the Tethyan zonation.

ZUSAMMENFASSUNG

Aufbauend auf Ammonitenaufsammlungen in den Nördlichen Kalkalpen und im Drauzug wird eine biostratigraphische Gliederung des oberostalpinen Pliensbachium mit 20 Horizonten präsentiert. Dieses biostratigraphische Gerüst wird mit den Gliederungen NW-Europas (Euroboreal) und des Zentral-Apennin (Tethys) verglichen. Die Schlüsselstellung des Oberostalpins in der Korrelation der beiden Faunenprovinzen wird anhand der Ammoniten-Horizonte aufgezeigt. Während sich ein Teil der Horizonte (vor allem während des Carixium) sehr gut in die NW-europäische Zonengliederung fügt, findet man vor allem im Domerium gute Übereinstimmungen mit dem Tethysbereich.

RESUME

Nous présentons ici une série de 20 unités biostratigraphiques (horizons ou niveaux) basés sur les ammonites du Pliensbachien de l'Austroalpin supérieur. Ce cadre biostratigraphique est comparé et corrélé avec ceux établis pour le nord-ouest de l'Europe (domaine euroboréal) et l'Apennin Central (domaine téthysien). La succession des horizons établie ici met en évidence la position «clef» qu'occupe l'Austroalpin supérieur pour la compréhension des corrélations entre les deux domaines. En effet une partie des horizons s'intègrent bien dans la zonation du nord-ouest de l'Europe, principalement pour le Carixien alors que l'autre partie peut être facilement corrélée avec la zonation proposée pour l'Apennin Central, essentiellement pour le Domérien.

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1. Introduction

Although the Liassic of the Upper Austroalpine of Austria supplied abundant ammonite faunas for early fundamental paleontological studies in the second half of the 19th and beginning of the 20th century, modern biostratigraphers have given it only little attention. Numerous famous outcrops of ammonite-rich Liassic limestones and marls, situated in the Salzkammergut, near the city of Salzburg (Hauer 1853, 1854a, b, 1856; Suess & Mojsisovics 1868; Wähner 1882–1898; Geyer 1903, 1893; Rosenberg 1909; Pia 1914), still exist today. But their biostratigraphy has been studied only incidentally after the early days of alpine paleontology (Blind 1963, Sieber 1961, 1975; Wendt 1971; Schäffer & Steiger 1986). The same holds true for the Liassic sequences of the southern Dachstein area (Trauth 1925; Tollmann 1960; Hirschberg & Jacobshagen 1965) and in the Lienzer Dolomiten (Emmrich 1855; Stur 1856; Hauer 1856; Benecke 1868; Geyer 1903; Mariotti 1972; Blau 1983).

Such lack of modern studies is surprising, as the Austroalpine tectonic unit is a key region for close biostratigraphical correlations between the Tethyan and the Euroboreal Realms. It may be due in part to the often strong condensation of the faunas and to the scarcity of continous sections. In this paper, based on two recent studies (Fig. 1) in the Salzburg area, southern Dachstein and Lienz areas (Blau & Meister 1991; Meister & Böhm 1993), we present the results of a first but by no mean exhaustive attempt to construct a biostratigraphical framework for the Upper Austroalpine unit during the Pliensbachian.

The sections studied in the Salzburg area are situated in the middle part of the Northern Calcareous Alps, which represent the northern part of the Upper Austroalpine tec-

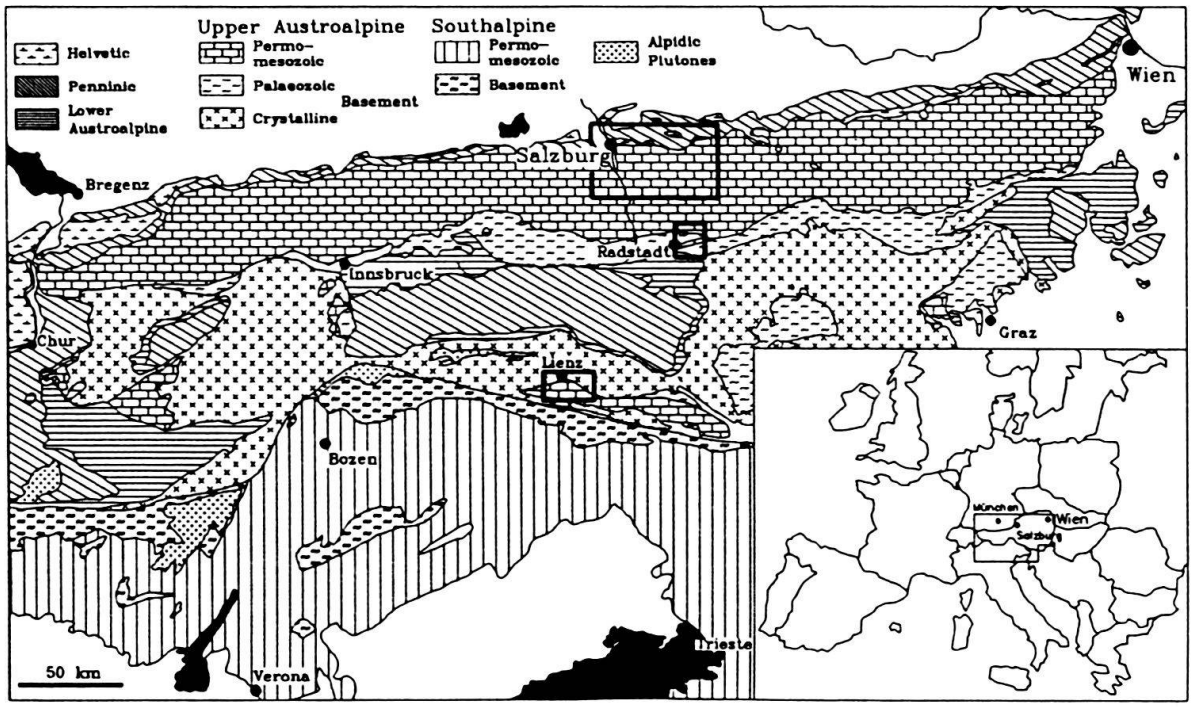


Fig. 1. Tectonic overview of the Eastern Alps with the locations of studied areas (after Tollmann 1976, Gwinner, 1978).

tonic unit. Two of our sections (Schmiedwirt and Breitenberg) lie within the Osterhornscholle, which is part of the Tirolic nappes (Fig. 2). The third (Rotkogel) belongs to the Höllengebirgsdecke (Fig. 3), another part of the Tirolic nappe system. The fourth section (Rötelstein, Fig. 4) is in part of the southern Juvavic nappes (Hallstätter Schollen) (Meister & Böhm 1993, Fig. 1). The Lienzer Dolomiten, where three outcrops have been studied (Lavant, Blasbründel and Stadtweg), represent the western part of the Drauzug (Fig. 5). Tectonostratigraphically, the Drauzug represents the southern and western part (Licicum, Tollmann 1976) of the Upper Austroalpine tectonic unit (Blau & Meister 1991, Fig. 1).

Taxonomy and detailed descriptions of the sections are given in Blau & Meister (1991) and Meister & Böhm (1993).

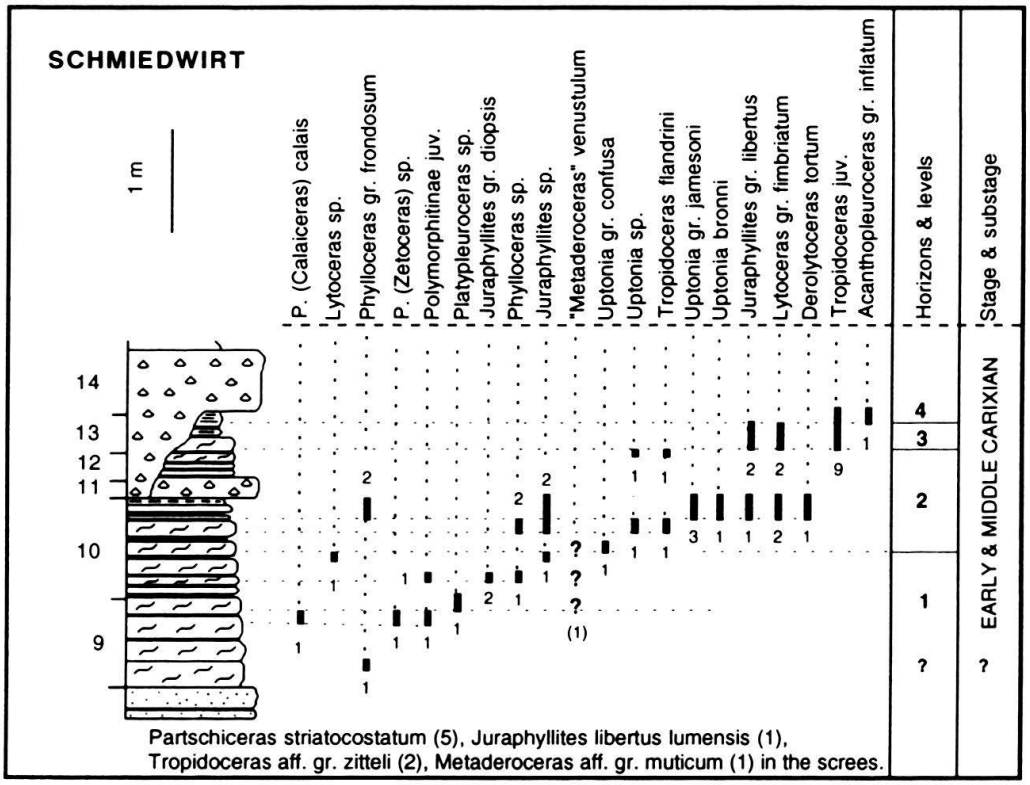


Fig. 2. Reminder of ammonite ranges in Schmiedwirt profile; (detailed location in Meister & Böhm 1993).

2. Biostratigraphical framework and comparisons

Our studies of the Pliensbachian ammonites allow us to identify a set of 20 biostratigraphic, ammonite faunal horizons (Fig. 6 and 7) for the Upper Austroalpine that are in part well integrated with the standard zonation of NW Europe (Dean, Donovan & Howarth 1961, Dommergues & Meister 1987) on the one hand and in part with the zonation of the Tethyan realm (Ferretti 1990) (Fig. 8) on the other. The term "horizon" is used here for one or a number of beds containing a characteristic ammonite assemblage and which cannot be stratigraphically further subdivided. We then use "level" or "levels" for

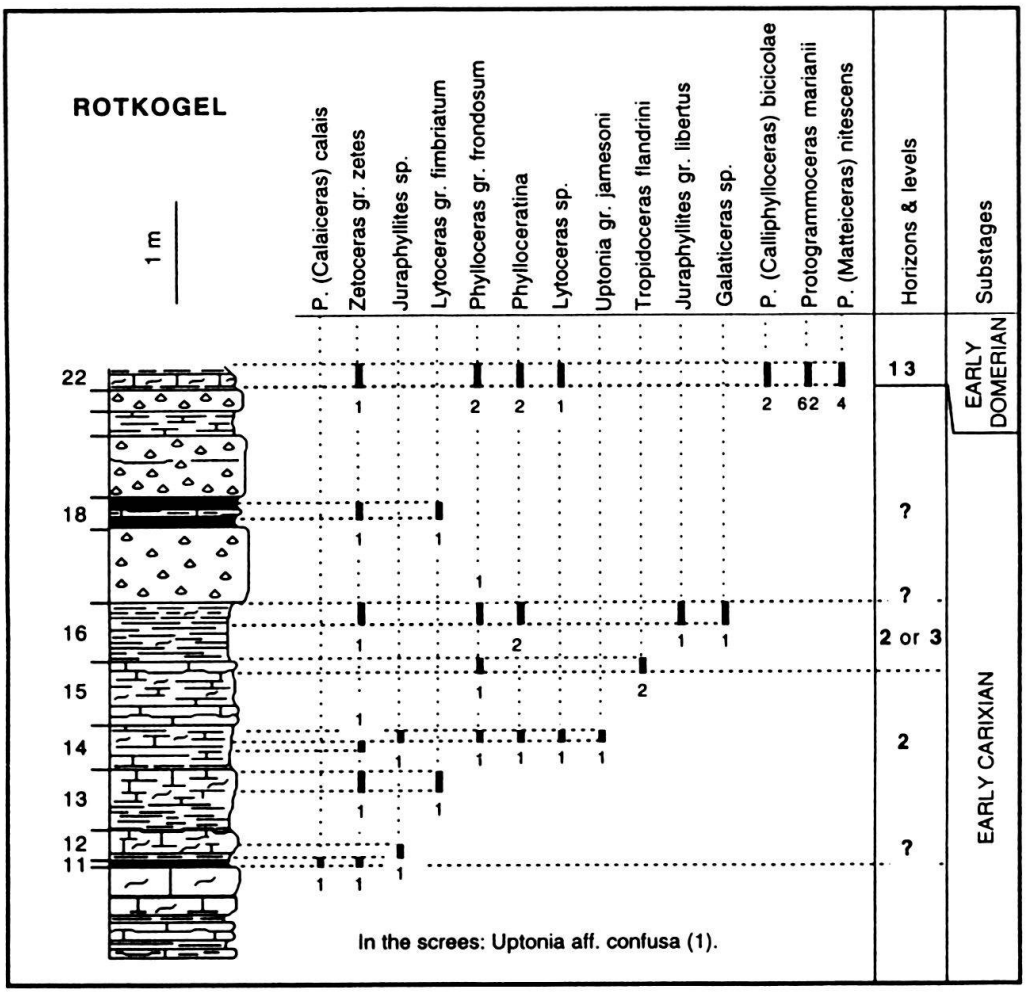


Fig. 3. Reminder of ammonite ranges in Rotkogel profile; (detailed location in Meister & Böhm 1993).

condensed beds, or beds with a poor or no characteristic fauna respectively, that are potentially open to regrouping or subdivision on the strenght of new data. For the labelling of standard Stages, Zones, Subzones and faunal horizons we follow Callomon (1985).

Pliensbachian Stage
Carixian Substage
Jamesoni Zone

The lower part of the Jamesoni Zone is probably present in the Salzkammergut, but cannot be clearly demonstrated. In a private collection at Hallein (samples from Hagengebirge, Tannhausberg, Golling) we have seen *Phricodoceras taylori* (SOWERBY), but this species is now known to have a long range (Raricostatum to Jamesoni Zone according to Dommergues & Meister 1990; see also Schlatter 1990). The data for this biochronological subdivision come from the Salzburg area.

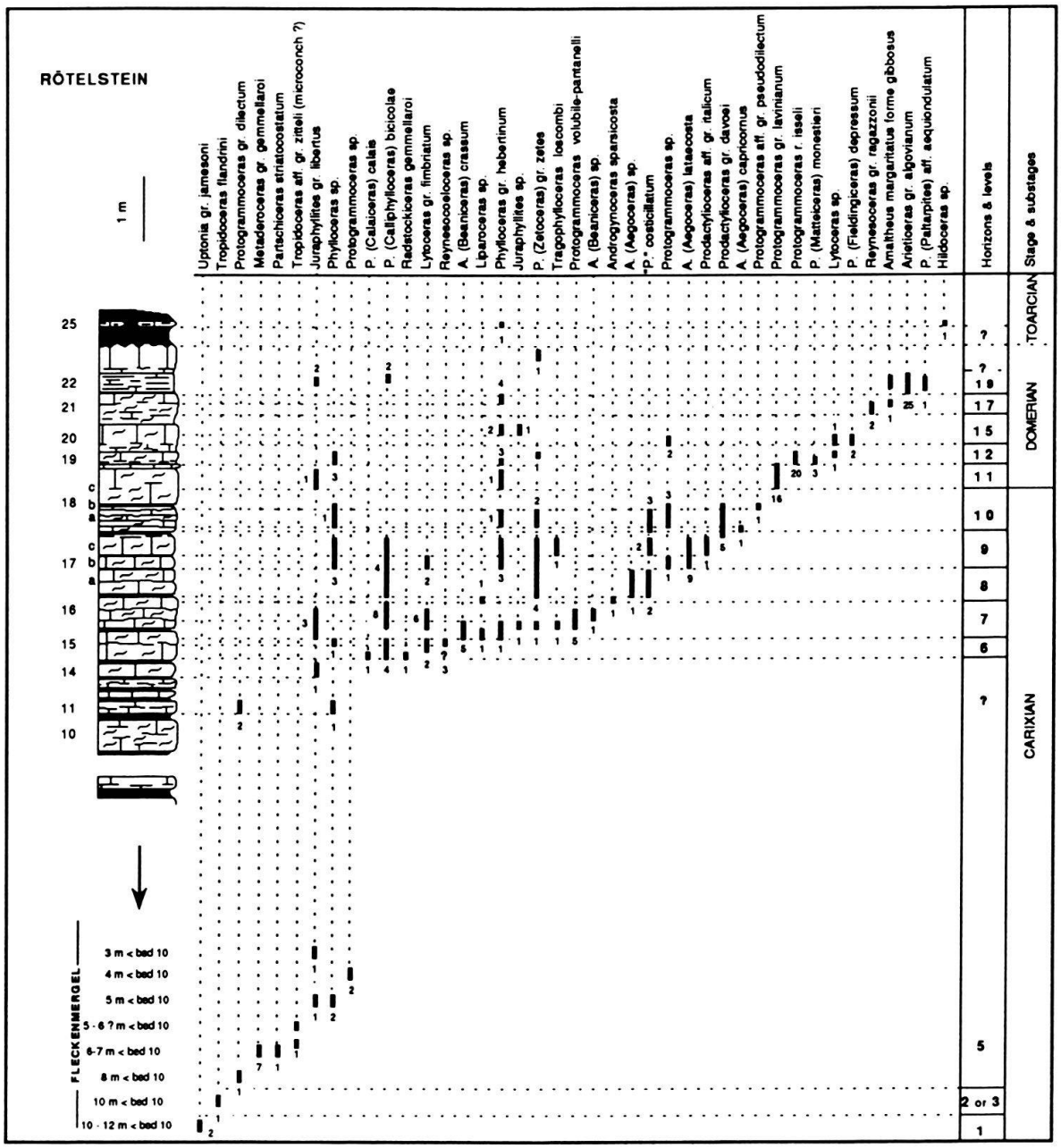


Fig. 4. Reminder of ammonite ranges in Rötelstein profile; (detailed location in Meister & Böhm 1993).

Brevispina (-Polymorphus) Subzone (see Dommergues & Meister 1987)

– 1 *Platypleuroceras* horizon
Platypleuroceras sp. and different Polymorphitinae juv. are associated with *Phylloceras* gr. *frondosum* (REYNES), *Ph. (Zetoceras)* sp., *Ph. (Calaiceras) calais* (MENEGHINI), *Juraphyllites* gr. *diopsis* (GEMMELLARO) and *Lytoceras* sp. (Fig. 2).

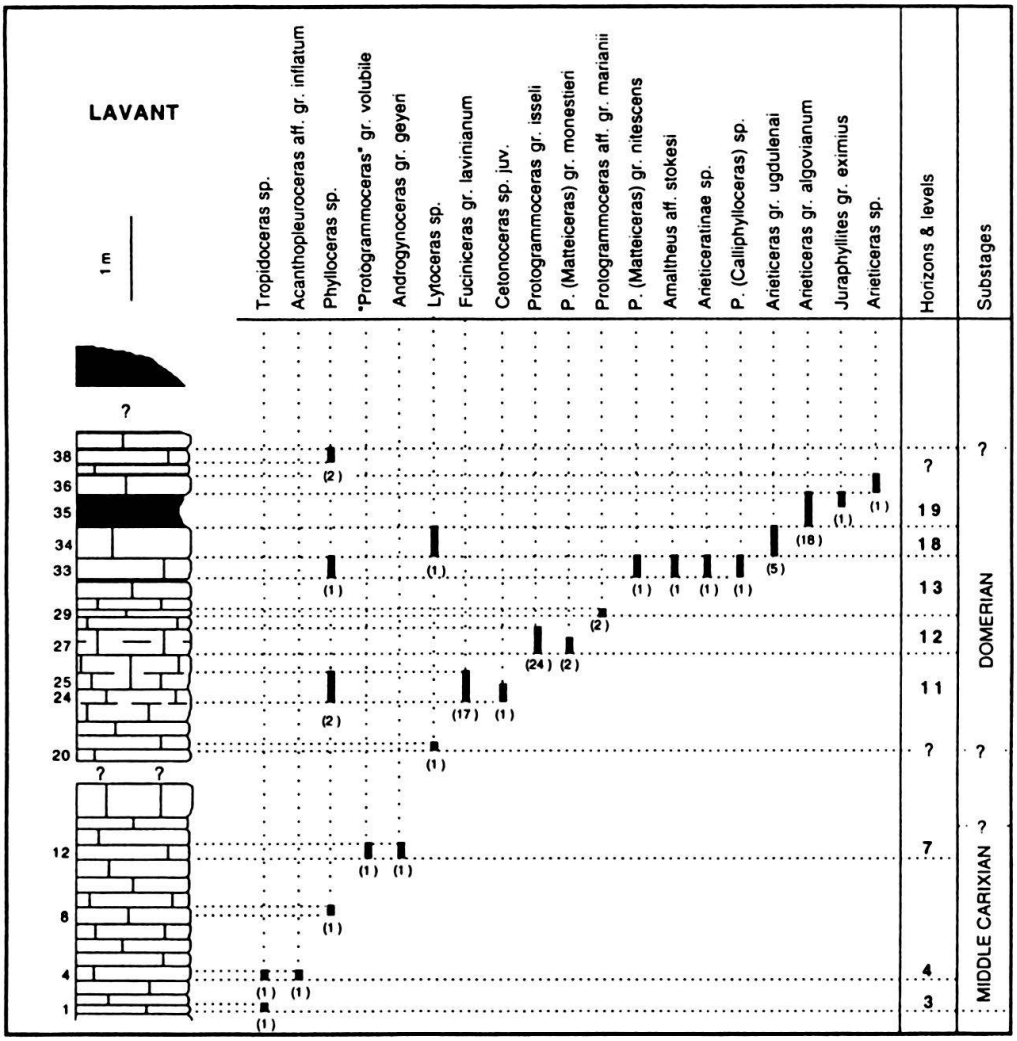


Fig. 5. Reminder of ammonite ranges in Lavant profile; (detailed location in Blau & Meister 1991).

In scree (Schmiedwirt), we have found *Metaderoceras venustulum* (DUMORTIER) and *M.* aff. gr. *muticum* (d'ORBIGNY); on the basis of observations in the Causses Basin and Burgundy, these two taxa probably belong to here.

Jamesoni Subzone

– 2 *Uptonia jamesoni* horizon

This horizon is represented by several beds at the investigated localities (Schmiedwirt, Rotkogel, Rötelstein) and is characterized by *Uptonia.* In the lower beds *U.* gr. *confusa* (QUENSTEDT), *Phylloceras* sp., and *Juraphyllites* sp. are present. In the upper beds *Uptonia jamesoni* (SOWERBY), *U. bronni* (ROEMER) and *Tropidoceras flandrini* (DUMORTIER) occur always with *Phylloceras* gr. *frondosum* (REYNES), *Ph. (Calaiceras) calais* (MENEGHINI), *Ph. (Zetoceras)* gr. *zetes*

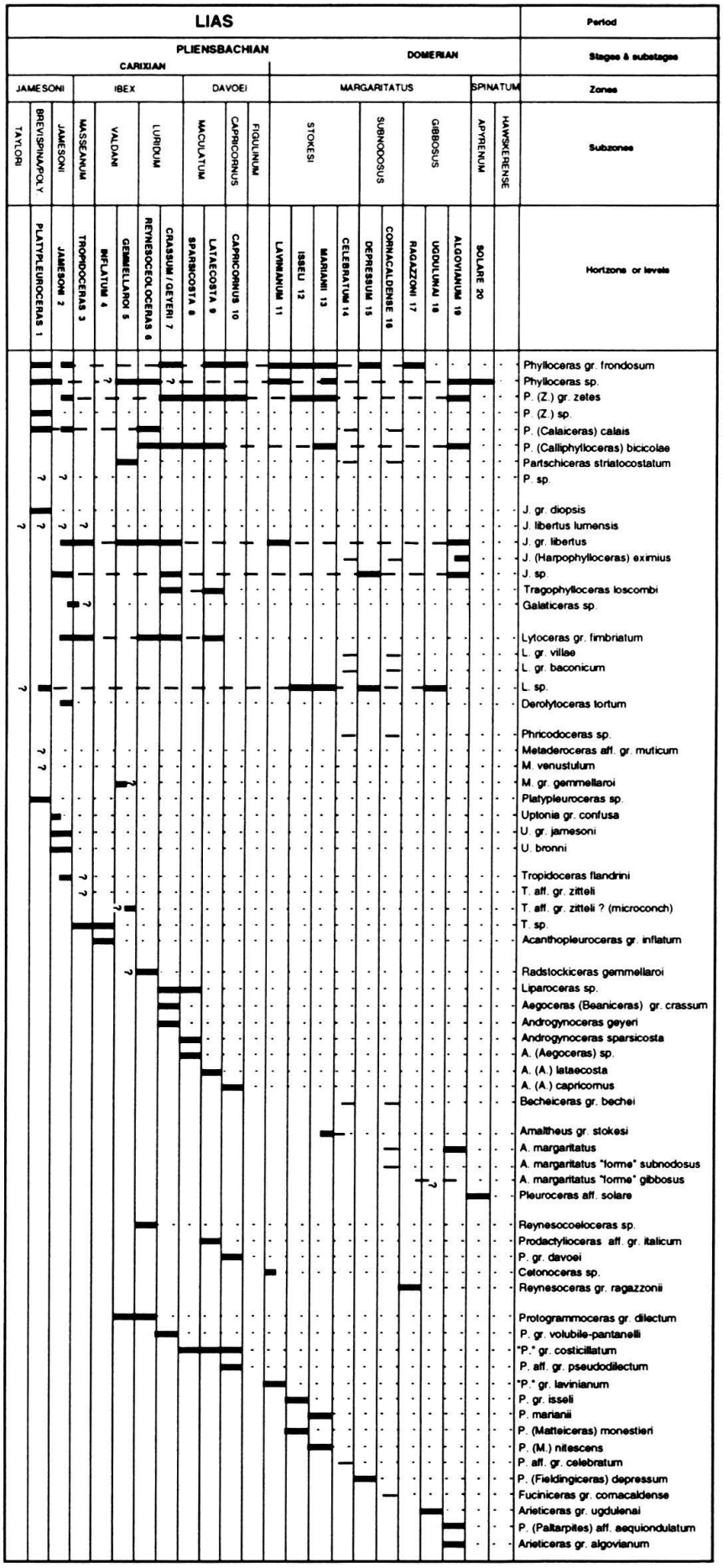
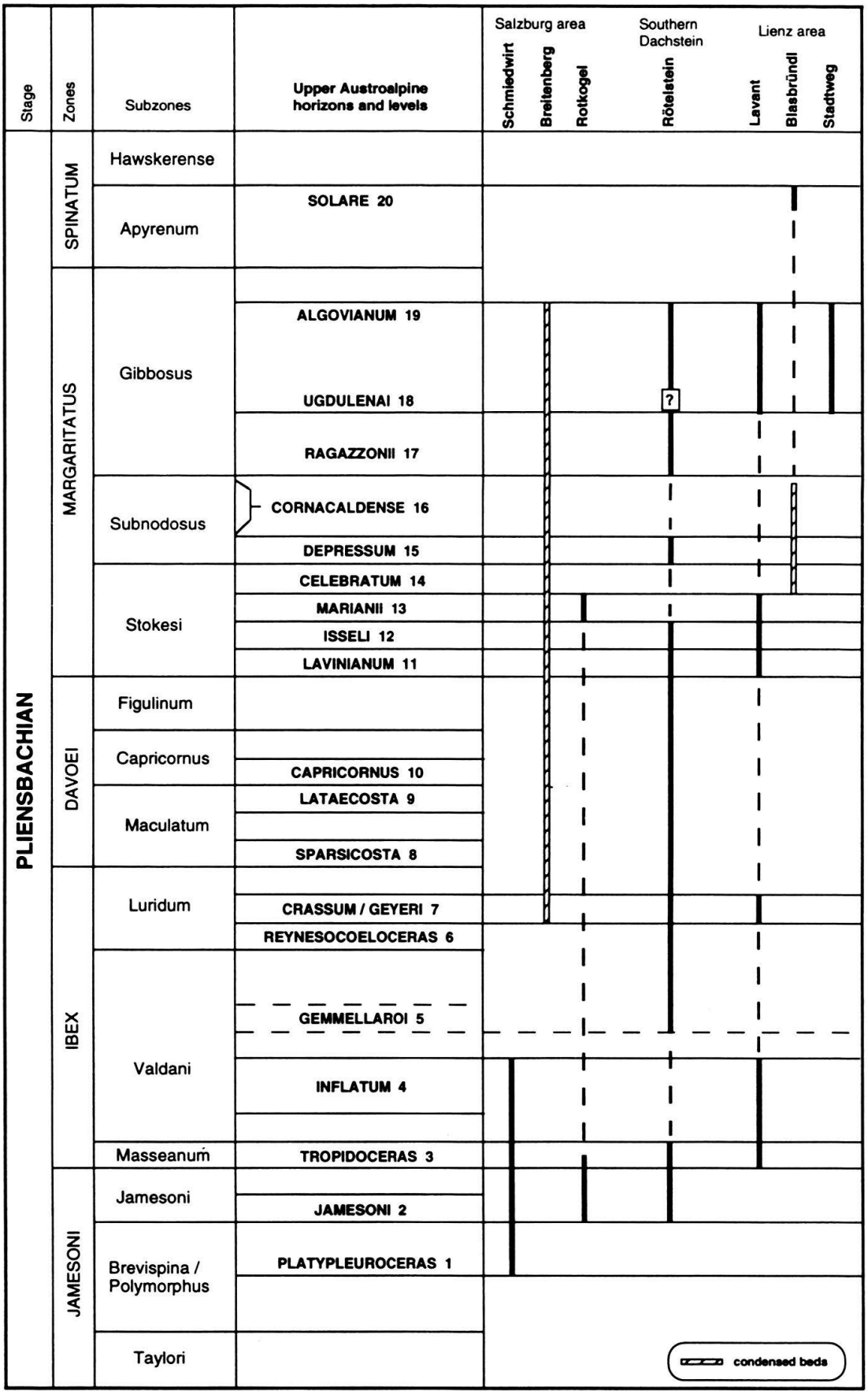


Fig. 6. Upper Austroalpine Pliensbachian ammonite range chart.


Stage
Zones
Subzones
Upper Austroalpine horizons and levels
Salzburg area
Schmiedwirt
Breitenberg
Rotkogel
Southern Dachstein
Rötelstein
Lienz area
Lavant
Blasbründl
Stadtweg
PLIENSBACHIAN
SPINATUM
Hawskerense
Apyrenum
SOLARE 20
MARGARITATUS
Gibbosus
ALGOVIANUM 19
UGDULENAI 18
?
RAGAZZONII 17
Subnodosus
CORNACALDENSE 16
DEPRESSUM 15
Stokesi
CELEBRATUM 14
MARIANII 13
ISSELI 12
LAVINIANUM 11
DAVOEI
Figulinum
Capricornus
CAPRICORNUS 10
Maculatum
LATAECOSTA 9
SPARSICOSTA 8
IBEX
Luridum
CRASSUM / GEYERI 7
REYNESOCOELOCERAS 6
Valdani
GEMMELLAROI 5
INFLATUM 4
Masseanum
TROPIDOCERAS 3
JAMESONI
Jamesoni
JAMESONI 2
Brevispina / Polymorphus
PLATYPLEUROCERAS 1
Taylori
condensed beds

(d'ORBIGNY), *Juraphyllites* gr. *libertus* (GEMMELLARO), *Lytoceras* gr. *fimbriatum* (SOWERBY), *Derolytoceras tortum* (QUENSTEDT) and *Galaticeras* sp. On the basis of data from north-west Germany (Hoffmann 1982) and from the Causses Basin (Meister 1986), *Uptonia confusa* (QUENSTEDT) and *U. jamesoni* (SOWERBY) co-occour; therefore we consider our beds to represent only one horizon. Moreover, we probably have not enough data in the lower beds, with *U.* gr. *confusa* (QUENSTEDT), to test whether these could be faunally separable.

Ibex Zone
Masseanum Subzone

– 3 *Tropidoceras* horizon
In our collection, the Masseanum Subzone is poorly documented in both the Salzburg and Lienz areas. In the Lienz area it is indicated only by *Tropidoceras* sp. Only the association of *Tropidoceras* sp. juv., *Lytoceras* gr. *fimbriatum* (SOWERBY) and *Juraphyllites* gr. *libertus* (GEMMELLARO) seems to attest its presence, even if *Tropidoceras* is a long ranging genus. However the genus *Tropidoceras* as a whole is more abundant in the previous horizon, with *T. flandrini* (DUMORTIER).

Valdani Subzone

– 4 *Acanthopleuroceras inflatum* horizon
As in the Masseanum Subzone, ammonites are rare in the lower part of this Subzone. It is indicated by an association of *Acanthopleuroceras* gr. *inflatum* (QUENSTEDT) and *Tropidoceras* sp.

– 5 *Metaderoceras gemmellaroi* horizon
In the Salzburg area (Rötelstein) the upper part of the Valdani Subzone is more clearly documented by the presence of a level rich in *Metaderoceras* gr. *gemmellaroi* (LEVI) and *Partschiceras striatocostatum* (MENEGHINI). The first *Protogrammoceras*, belonging to the gr. *dilectum* (FUCINI), appear in this horizon, associated with *Juraphyllites* and *Phylloceras*.

Compared with the north-west European sequence (Fig. 8), the upper part of the Valdani Subzone seems not to be represented. Perhaps *Tropidoceras* aff. gr. *zitteli* FUCINI (microconch) represents that part of the Subzone (see Braga & Rivas 1985). But we need more data.

Fig. 7. Biostratigraphical framework of the studied sections.

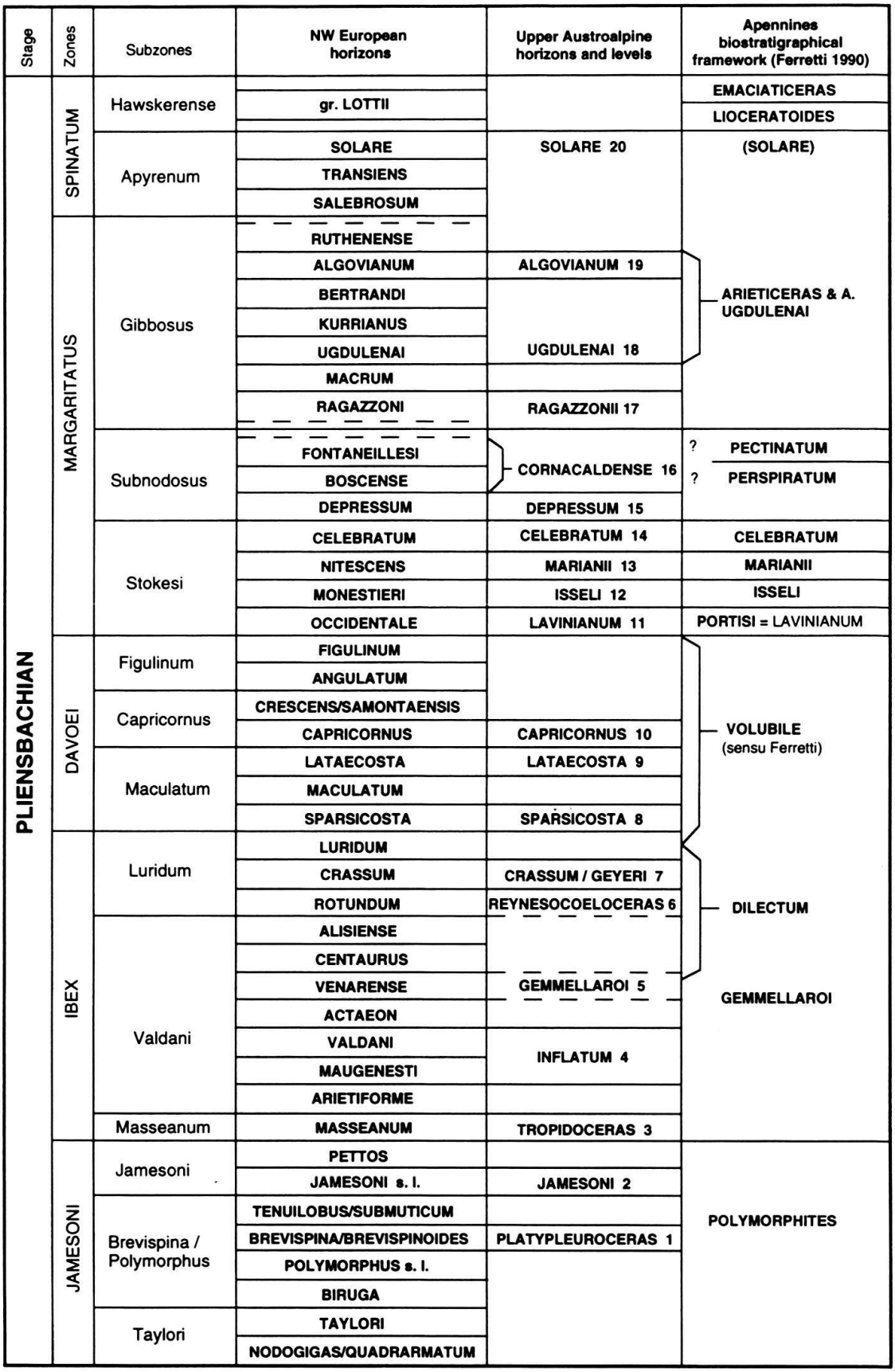


Fig. 8. Attempted correlation between NW European, Austroalpine and Central Appennine regions.

Luridum Subzone

We assign two biostratigraphical units to this standard chronostratigraphical unit.

- 6 *Reynesocoeloceras* level
  The first level is known only in the Salzburg area (Rötelstein). It is characterized by *Phylloceras (Calaiceras) calais* (MENEGHINI), *Radstockiceras gemmellaroi* (POMPECKJ), the first *Ph. (Calliphylloceras) bicicolae* (MENEGHINI), *Juraphyllites* gr. *libertus* (GEMMELLARO), *Lytoceras* gr. *fimbriatum* (SOWERBY), *Reynesocoeloceras* sp. and, with doubt, *Protogrammoceras* gr. *dilectum* (FUCINI) (Rötelstein, Meister & Böhm 1993). This association is not very time-characteristic and could still belong to the uppermost Valdani Subzone.

- 7 *Aegoceras (Beaniceras) crassum / Androgynoceras geyeri* horizon
  The second horizon, with *Aegoceras (Beaniceras) crassum* BUCKMAN, *Protogrammoceras* gr. *volubile* (FUCINI) – *pantanelli* (FUCINI), truly characterises the Luridum Subzone. Associated are *Phylloceras* gr. *frondosum* (REYNES), *Ph. (Zetoceras)* gr. *zetes* (d'ORBIGNY), *Ph. (Calliphylloceras) bicicolae* (MENEGHINI), *Juraphyllites* gr. *libertus* (GEMMELLARO), *Lytoceras* gr. *fimbriatum* (SOWERBY) and some typical euroboreal ammonites such as *Tragophylloceras loscombi* (SOWERBY) and *Liparoceras* sp. In the Lienz area (Lavant), *Androgynoceras geyeri* (SPATH) co-occurs with *Programmoceras* gr. *volubile* (FUCINI). As *Aegoceras (Beaniceras) crassum* (BUCKMAN) and *Androgynoceras geyeri* (SPATH) are commonly in association in the same beds in NW Europe, we take this to be only one horizon.

Davoei Zone
Maculatum Subzone

The biochronological unit is represented by two faunal horizons.

- 8 *Androgynoceras sparsicosta* horizon
  The index species, *"Protogrammoceras" costicillatum* (FUCINI), *Aegoceras (Aegoceras)* sp., *Liparoceras* sp., *Phylloceras (Zetoceras)* gr. *zetes* (d'ORBIGNY) and *Ph. (Calliphylloceras) bicicolae* (MENEGHINI) characterize the fauna of this unit.

- 9 *Aegoceras lataecosta* horizon
  - This horizon is well represented in Rötelstein and characterized by *Aegoceras (Aegoceras) lataecosta* (SOWERBY), *"Programmoceras"* gr. *costicillatum* (FUCINI), *Lytoceras* gr. *fimbriatum* (SOWERBY), Phylloceratina and among these *Tragophylloceras loscombi* (SOWERBY). *Prodactylioceras* gr. *italicum* (FUCINI) is also present.

Capricornus Subzone

- 10 *Aegoceras capricornus* levels
  These levels include a sequence of several beds in which only *Prodactylioceras* gr. *davoei* (SOWERBY) occurs at the base. Overlying this bed, we find in Rötelstein *Aegoceras (Aegoceras) capricornus* (SCHLOTHEIM), *P.* gr. *davoei* (SOWERBY) again, *"Protogrammoceras"* gr. *costicillatum* (FUCINI), *Protogrammoceras* aff. *pseudodilectum* DOMMERGUES, MEISTER & FAURE and *Phylloceras.* The index species only occurs in the middle part of the bed sequence and perhaps the upper *capricornus* levels already belong to the Figulinum subzone; but this, the topmost Carixian subzone, is not firmly documented by any characteristic ammonite in the studied outcrops. Probably with more informations, these levels can be resolved into separate horizons.

We were not able to prove the existence of the Davoei Zone in the Lienz Dolomites. Nevertheless Geyer (1903) reported *Aegoceras capricornus* (SCHLOTHEIM) from the Amlacher Wiesen Syncline. Perhaps this horizon is missing in the investigated profiles.

Domerian Substage

The family Amaltheidae is rather well represented in the faunas of the Lienz Dolomites and is quite diversified, with *Amaltheus stokesi* (SOWERBY), *A. margaritatus* de MONTFORT, *A. margaritatus* "form" *subnodosus* (YOUNG & BIRD) and *Pleuroceras.* Although Amaltheidae are also well represented in northern part of the Upper Austroalpine unit (Schafberg area, Geyer 1893), they are very rare in the Rötelstein section.

Margaritatus Zone
Stokesi Subzone

The correlations between the Euroboreal and Tethyan realms appear to be good now for this period, especially between the Apennines and the Causses basin.

- 11 *"Protogrammoceras" lavinianum* horizon
  The *lavinianum* horizon classically characterizes the base of the Domerian in the Tethyan Realm (Dommergues et al. 1983; Braga 1983). In the Upper Austroalpine nappes (Rötelstein, Lavant) *"Protogrammoceras"* gr. *lavinianum* (FUCINI), *Cetonoceras* sp., *Phylloceras* gr. *frondosum* (REYNES) and *Juraphyllites* gr. *libertus* (GEMMELLARO) occur in this unit.

- 12 *Protogrammoceras isseli* horizon
  Beside *Protogrammoceras isseli* and *Phylloceras, Lytoceras,* we find in the *isseli* horizon a Euroboreal group: *Programmoceras (Matteiceras) monestieri* (FISCHER). This species allows us a good correlation especially with the Causses basin (Meister 1986) and Burgundy (Dommergues 1987). Thus the *monestieri* horizon from the southern part of the Euroboreal realm appears to be at least roughly equivalent to the "Tethyan" *isseli* horizon.

- 13 *Protogrammoceras marianii* horizon
  In this horizon, *Protogrammoceras marianii* (FUCINI) takes the place of *P. isseli* (FUCINI) and *Protogrammoceras (Matteiceras) nitescens* (YOUNG & BIRD) takes the place of *P. (M.) monestieri* (FISCHER). This is of great interest for the comparison of the Tethyan and Euroboreal Realms; the *marianii* horizon appears to be equivalent to the Euroboreal *nitescens* horizon. *Amalteus* aff. *stokesi* (SOWERBY), *Phylloceras* and *Lytoceras* also are present.

- 14 *Protogrammoceras celebratum level*
  The celebratum level is present as a condensed bed in the Lienz area (Blasbründl, Blau & Meister 1991), when compared with a more continuous biostratigraphical sequence, such as is found in the Causses Basin (Meister 1989). It marks the top of the Stokesi subzone in the NW European Realm. *Protogrammoceras* aff. gr. *celebratum* (FUCINI) and *Amaltheus stokesi* (SOWERBY) without doubt belong to the *celebratum* level. However it is impossible to assign with precision the longer ranging taxa of the condensed bed of Blasbründl [Phylloceratina, Lytoceratina, *Phricodoceras* sp., *Becheiceras* gr. *bechei* (SOWERBY)], which can occur in the inverval between the top of the Stokesi Subzone and the upper part of the Subnodosus Subzone.

Subnodosus Subzone

This subdivision is represented by the *depressum* horizon and the *cornacaldense* level.

- 15 *Protogrammoceras depressum* horizon
  This horizon is characterized by *Protogrammoceras (Fieldingiceras) depressum* (QUENSTEDT), *Phylloceras* gr. *frondosum* (REYNES), *Juraphyllites* sp. and *Lytoceras* sp. (Fig. 4).

- 16 *Fuciniceras cornacaldense* level
  A second stratigraphic unit can be recognized in the Subnodosus Subzone. Like the *celebratum* level, it lies in the condensed bed in the Lienz area (Blasbründl, Blau & Meister 1991), and only *Fuciniceras* gr. *cornacaldense* (TAUSCH) and *Amaltheus margaritatus* de MONTFORT [with *A. margaritatus* "form" *subnodosus* (YOUNG & BIRD)] doubtlessly belong to it.

Gibbosus Subzone

- 17 *Reynesoceras ragazzonii* horizon
  In the *ragazzonii* horizon (Rötelstein), besides *Reynesoceras ragazzonii* (HAUER) we also have *Phylloceras* gr. *frondosum* (REYNES).

- 18 *Arieticeras ugdulenai* horizon
  The *ugdulenai* horizon (Lavant) is characterized by *Arieticeras ugdulenai* (GEMMELLARO) and some *Lytoceras* sp.

- 19 *Arieticeras algovianum* horizon
  As the Apennines or in the Causses Basin , we find an *algovianum* horizon immediately overlying the *ugdulenai* horizon. *Arieticeras* gr. *algovianum* (OPPEL) is associated with *Amaltheus margaritatus* de MONTFORT, *Protogrammoceras (Paltarpites)* aff. *aequiodulatum* (BETTONI), Juraphyllitidae and Phylloceratidae. In the scree was found *Amaltheus margaritatus* "form" *gibbosus* (SCHLOTHEIM), which also characterizes this Subzone (Howarth 1958; Jordan 1960; Mattei 1985; Meister 1988).

Spinatum Zone
Apyrenum Subzone

- 20 *Pleuroceras solare* horizon
  This horizon, with *Pleuroceras* aff. *solare* (PHILLIPS) and *Phylloceras,* is well known throughout the Euroboreal and the western Tethyan Realms [Southern Alps (Wiedenmayer 1980), Beticas (Braga 1983) and Central Apennine (first record in Ferretti & Meister, in press)]. So far, neither *Lioceratoides* nor *Emaciatericeras,* classical forms of the Tethyan Upper Domerian, are known from the studied outcrops.

3. Concluions

For the first time, a detailed biostratigraphic framework based on ammonites is given for the Upper Austroalpine Pliensbachian of the Northern Calcareous Alps. The bioprovincial affinities of this alpine unit are without doubt with the "Tethyan" region, but its ammonite faunal compositions reveal a character intermediate towards those of the Euroboreal Realm (Meister & Böhm 1993, fig. 13). This is in accordance with current paleogeographic concepts (Trümpy in Blau & Meister 1991, fig. 17).

Leaving aside the strong presence of pelagic Phylloceratina and the lesser presence of Lytoceratina, the fauna of Ammonitina is increasingly made up of Tethyan forms, from the Early Carixian to the Domerian. Though its mixed ammonite faunas, consisting in the Carixian of Acanthopleuroceratidae *(Acanthopleuroceras,* some *Tropidoceras),* Liparoceratidae *(Aegoceras),* Dactylioceratidae *(Prodactylioceras davoei* (SOWERBY)), *Reynesocoeloceras, Prodactylioceras* gr. *italicum* (FUCINI), some Harpoceratinae, and in the Domerian of Amaltheidae, Harpoceratinae *Protogrammoceras (Matteiceras), Protogrammoceras (Fieldingiceras) depressum* (QUENSTEDT), and other *Protogrammoceras* and *Fuciniceras),* this Alpine unit provides a key for the correlation between the two realms, especially in the Domerian.

For the Carixian it is possible to build a quite detailed biostratigraphical framework based on Euroboreal ammonites, except for the *gemmellaroi* horizon and the *Reynesocoeloceras* level, which are of Tethyan affinities. The biostratigraphical scale for the Domerian is, however, mainly based on Tethyan ammonites, except for the *depressum* and *solare* horizons. The Austroalpine *gemmellaroi* horizon is quite difficult to place and is considered here to be an equivalent fo the NW European *venarense* horizon. Our correlations agree with the well known Euroboreal areas (Causses, Burgundy ...). The com-

parison with the Apennine of the Marche (Tethyan realm) is more problematic, especially in the Carixian. The ranges of Carixian species of *Protogrammoceras* are not well known for *P. volubile* (FUCINI) and *"P." costicillatum* (FUCINI). The latter is known only in the Bakony mountains (Dommergues et al. 1983; Dommergues 1987) and seems to indicate the upper Davoei Zone. According to these authors, *P. volubile* (FUCINI) characterizes the lower part of the Davoei Zone (and the upper Ibex Zone). This is also what we observe in the Upper Austroalpine. But according to Ferretti (1990), *P. volubile* (FUCINI) characterises the entire Late Carixian. For the Domerian the correlations are good, but comparison with the Causses Basin or the Apennines shows several faunal gaps in the Upper Austroalpine succession, mainly in the Figulinum and Hawskerense Subzones.

Although the faunal compositions clearly show Tethyan affinities at all levels in the Upper Austroalpine Pliensbachian, a nearly continuous Euroboreal influence is also apparent. It is more accentuated in the Carixian and becoms slightly more episodic during the Domerian. The biostratigraphic scale proposed here for the Upper Austroalpine tectonic unit is a first attempt, and only detailed study of new outcrops will provide precisions.

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