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The Valanginian Stage

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Abstract

The Working Group provisionally recommends that the base of the Valanginian is placed at the base of Calpionellid Zone E, which corresponds almost exactly to the base of the ammonite zone of ''*Thurmanniceras*'' *pertransiens*. The base of the Upper Valanginian as agreed at Copenhagen (1983) is widely used and lies at the base of the ammonite zone of *Saynoceras verrucosum*. No feasible alternative has been proposed but the Working Group still has to document evidence from other fossil groups.
Sections in SE France and the Betic Cordillera (Spain) are under consideration as boundary stratotype sections.

Key-words: Valanginian, Lower Cretaceous, stratotypes, biostratigraphy, ammonites, calpionellids, nannofossils.

Résumé

Le Groupe de Travail recommande provisoirement que la base du Valanginien soit placée à la base de la Zone E à Calpionellides, qui correspond presque exactement à la base de la Zone à ammonites ''*Thurmanniceras*'' *pertransiens*. La base du Valanginien supérieur telle qu'elle a été convenue à Copenhague (1983), est largement utilisée et se situe à la base de la zone à ammonites *Saynoceras verrucosum*. Aucune alternative valable n'a été proposée, mais le Groupe de Travail doit encore s'informer des données sur d'autres groupes fossiles.
Des coupes dans la SE de la France et dans la cordillère bétique (Espagne) sont envisagées comme stratotypes de la limite.

Mots-clefs: Valanginien, Crétacé inférieur, stratotypes, biostratigraphie, ammonites, calpionellides, nannofossiles.

Валанжинский ярус.

Резюме.

Рабочая группа временно рекомендует определять основание Валанжина в основании кальпионельской Зоны E, почти точно совпадающей с основанием аммонитовой Зоны *Thurmanniceras pertransiens*. Основание Верхнего Валанжина, определённое ещё в течение копенгагского Симпозиума 1983 года, широко используется и располагается в основании аммонитовой Зоны *Saynoceras verrucosum*. На данный момент, не существует приемлемой альтернативы для этого основания; тем не менее Рабочая Группа должна еще обработать данные, касающиеся других групп ископаемых.
Разрезы на юго-востоке Франции и в бетической кордильере Испании рассматриваются в качестве прототипа границы.

Ключевые слова: Валанжинский ярус, нижний мел, стратотипы, биостратиграфия, аммониты, Calpionellida, нанофоссилии.

Editors' note: The Working Group chairman, Luc Bulot, had to withdraw from the Brussels meeting at the last minute, but faxed a preliminary report for discussion there. As Luc has not been able to produce an updated version subsequently, the paper published here has been modified from the preliminary report by one of the editors (PFR). It incorporates the provisional recommendations made at Brussels, but because of time constraints it has not been circulated to members of the Valanginian Working Group. Hence the paper must be regarded simply as a working document that illustrates the progress made and indicates what further research the Working Group will be undertaking.

In addition to the contributors listed above, we are grateful to other Working Group Members who have supplied information cited in the text.

Introduction

The historical type area of the Valanginian Stage is the Seyon Gorge, near Valangin in the Swiss Jura (see BARBIER & THIEULOY, 1965; RAWSON, 1983). Recognition of the inadequacy of this section for correlation purposes led to the proposal for two ''hypostratotype'' sections at Angles (Alpes-de-Haute-Provence) and Barret-le-Bas (Hautes-Alpes) in the south-east of France (BUSNARDO *et al.*, 1979). The ranges of ammonites, belemnites, ostracods, foraminifera, calpionellids and nannofossils were documented for the two sections. The base of the Valanginian was placed at the base of the ''*Thurmanniceras*'' *otopeta* Zone and the Lower/Upper Valanginian boundary at the base of the *Saynoceras verrucosum* Zone. Subsequently, the Copenhagen Symposium **provisionally** recommended that the base of the Valanginian be placed at the base of the *otopeta* Zone (BIRKELUND *et al.*, 1984, p. 6). It suggested that candidate boundary stratotypes ''should be investigated in southeast Spain, southeast France, the Crimea and Caucasus.''

The Lower/Upper Valanginian boundary was not considered at Copenhagen.

The base of the Valanginian Stage

AMMONITE SCALES

Since BUSNARDO *et al.*'s (1979) work was published there has been much discussion of the Berriasian-Valanginian boundary among ammonite workers. The biostratigraphy at this level is affected by four main problems that limit its resolution and are at the base of the disputes mentioned below:

- Subdivisions of the various zonal schemes were defined after different biostratigraphic concepts and therefore correlations between the different types of biozones are sometimes difficult to achieve

- Collection failure restricts the biostratigraphic value of some reference sections

- Lack of suitable monographs misleads biostratigraphers in the taxonomic interpretation of most key species

- Important provincialism (Tethyan and Boreal) reduces the significance of the regional zonal scheme

The debate has centred on evidence from the French (Subalpine Range) and Spanish (Betic Cordillera) successions (e.g. HOEDEMAEKER, 1982; RAWSON, 1983; COMPANY, 1987; BULOT, BLANC, *et al.*, 1993; BULOT *et al.*, 1994; BULOT, 1995; HOEDEMAEKER & LEEREVELD, 1995). These sequences have provided a biostratigraphic framework for the whole Valanginian Stage that the successive Cephalopod working groups of IGCP projects 262 and 362 have applied to the rest of the Mediterranean Province (HOEDEMAEKER & BULOT, 1990; HOEDEMAEKER, COMPANY *et al.,* 1993). For the sake of stability, the working groups retained the base of the *otopeta* Zone as the Berriasian/Valanginian boundary for the standard Mediterranean succession. However, **this proposition was considered as a workable consensus and not as a definitive solution.** It is one of four candidate boundaries that have been put forward so far:

- the base of the *pertransiens* Subzone *sensu* LE HÉGARAT (1971);

- the base of the *otopeta* Zone *sensu* BUSNARDO & THIEULOY (1979), a solution provisionally recommended by the Cretaceous Subcommission at Copenhagen (BIRKELUND *et al.,* 1984);

- the base of the *alpillensis* Subzone *sensu* HOEDEMAEKER (1982), a solution so far rejected by many Cretaceous stratigraphers;

- the base of the *pertransiens* Zone *sensu* BULOT (1995).

Three important points should be mentioned:

1. Correlation between the *alpillensis* Zone *sensu* HOEDEMAEKER, *alpillensis* Zone *sensu* BULOT and *callisto* Zone *sensu* LE HÉGARAT is still problematic.

2. Since reinvestigation of the Los Miravetes section (Caravaca, Spain) by AGUADO, COMPANY, TAVERA and SANDOVAL (1995, poster in Brussels) it is now clear that the differences between the ammonite distributions documented by HOEDEMAKER (1982) on the one side and THIEULOY (1979), COMPANY (1987), BULOT *et al.* (1993) and BULOT (1995) are essentially linked to different taxonomic interpretations. According to all the authors except HOEDEMAKER, the *alpillensis* assemblage is almost equivalent to the *callisto* assemblage.

3. In addition, *''Thurmanniceras'' pertransiens sensu* THIEULOY, COMPANY and BULOT is interpreted in a much more restricted sense than *''T.'' pertransiens sensu* HOEDEMAEKER. According to the French and Spanish workers, the *pertransiens*-like forms associated with *''T.'' otopeta* are *Tirnovella* n. sp. close to the *alpillensis* group. This taxon ranges high in the *otopeta* Subzone but disappears below the first occurrence of the calpionellid *Calpionellites darderi.* According to BULOT (1995), the *''Thurmanniceras'' pertransiens* figured by LE HÉGARAT & REMANE (1968) from Ginestou is a *Tirnovella* nov. sp.

In BULOT's (1995) opinion, as the *alpillensis* Subzone *sensu* HOEDEMAEKER roughly corresponds to the interval between the FO (first occurrence) of *Lorenziella hungarica* and the LO (last occurrence) of *''T.'' otopeta* (see HOEDEMAEKER & LEEREVELD, 1995), the *alpillensis* Subzone and the *callisto* Subzone correspond to the approximately same time interval.

CALPIONELLIDS

Since the early work by REMANE (1963), an almost complete agreement has been reached for the Late Berriasian and Early Valanginian calpionellid zonation. Four different events are considered as biostratigraphic markers:

- base of D Zone and of D1 Subzone, marked by the first occurrence of *Calpionellopsis simplex* (ALLEMANN & REMANE, 1979; REMANE, 1985; POP, 1994; BLANC, 1995).

- base of D2 Subzone, characterised by the progressive domination of *C. oblongata* over *C. simplex* (ALLEMANN & REMANE, 1979; REMANE, 1985)

- base of D3 Subzone, defined by the first occurrence of *Lorenziella hungarica* (ALLEMANN & REMANE, 1979; REMANE, 1985; POP, 1994; BLANC, 1995).

- base of E Zone, marked by the first occurrence of

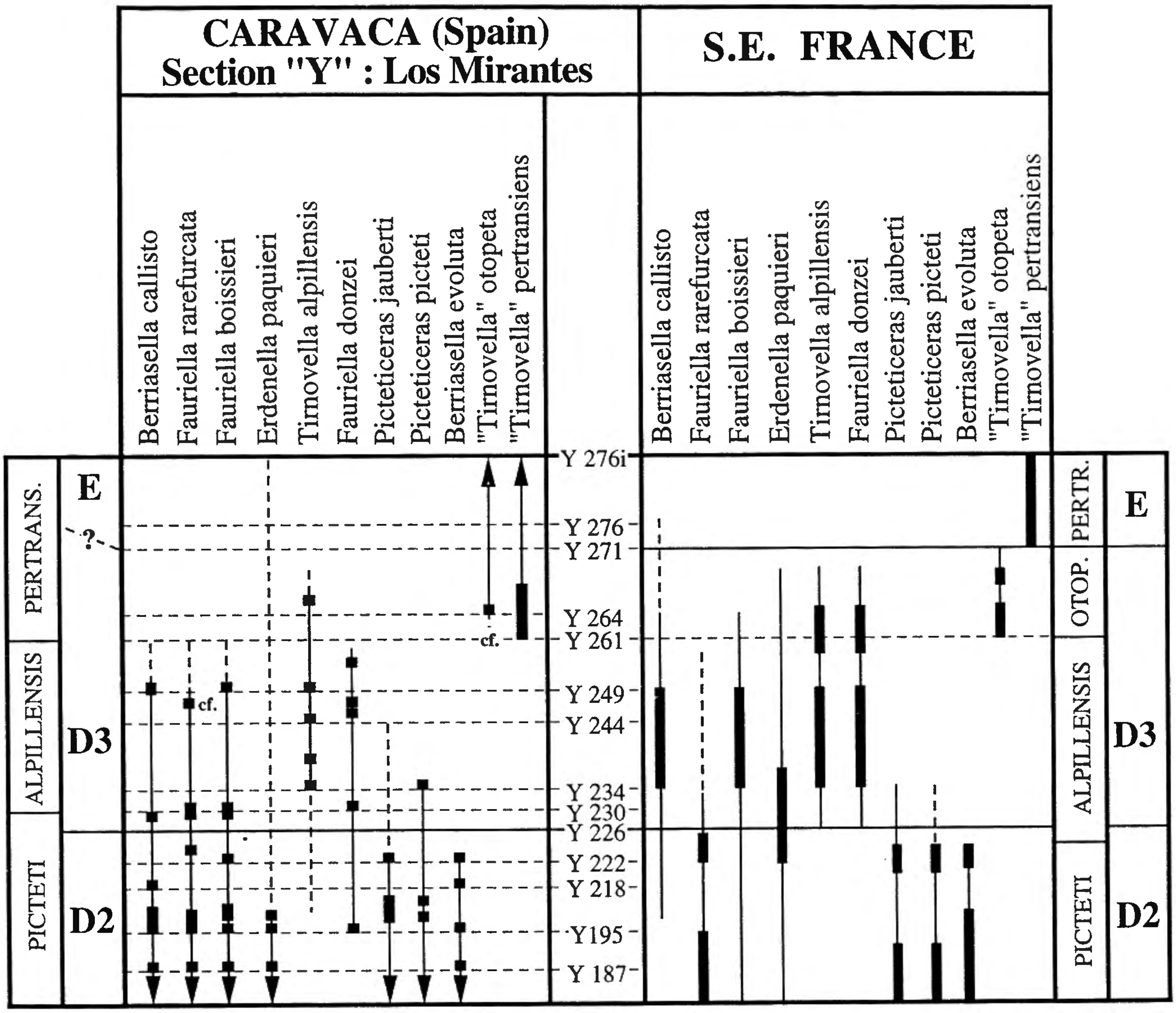

Fig. 1 — Biostratigraphy (calpionellids and ammonites) of the top Berriasian and basal Valanginian, and comparison of ammonite distributions in SE France and Los Miravetes, SE Spain (modified from Bulot, 1995, fig. 9).
For "Section Y: Los Mirantes" read "Section Y: Los Miravetes".

Calpionellites darderi (Allemann & Remane, 1979; Remane, 1985; Pop, 1994; Blanc, 1995).

More recently, Pop (1994) and Blanc (1995) have shown that the first occurrence of *Praecalpionellites murgeanui* is a significant event in Rumania, Cuba and SE France. Nevertheless, it must be stressed that there is no major turnover in the evolution of calpionellids around the Berriasian-Valanginian transition beds:

- all species of the D2 Zone cross the D2/D3 boundary and *L. hungarica*, whose first appearance defines the base of D3, always remains rare. The same is true for *Calpionellites darderi* (base of Zone E).

- the only spectacular event is the sudden disappearance of *Calpionellopsis oblonga* in the upper D3 Zone in SE France. However, elsewhere this species or at least very similar forms continue upwards well into the E Zone.

The calibration between the calpionellid and ammonite zones is synthesised in Figure 1, based on bed by bed sampling in SE France (Le Hégarat & Remane, 1968; Allemann & Remane, 1979; synthesis in Blanc, 1995). Furthermore, the typical uppermost D3 calpionellid assemblage (*murgeanui* Subzone *sensu* Pop, 1994) can be correlated with the upper *otopeta* Subzone (*thieuloyi* Biohorizon) (Bulot, 1995; Blanc, 1995).

Even if the ammonite zonal scheme based on the French Valanginian standard sections indicates the high correlation value of the *otopeta* Subzone, Allemann & Remane (1979) have shown that no important changes are observed in calpionellid populations at that level.

Therefore calpionellids can hardly be used to characterise a Berriasian-Valanginian boundary drawn at the base of the *otopeta* Subzone. So far, this boundary has been estimated by placing it between the FOs of *L. hungarica* and *C. darderi*. Over most of the Vocontian Basin, a level where *C. oblonga* reaches up to 30% of the calpionellid association has been recognised in the lower part of the *otopeta* Subzone. Above, *C. oblonga* seems to disappear. Unfortunately, this observation does not apply to the rest of Tethys (the Balearics and Mexico, for example) because there *C. oblonga* or very similar forms coexist with *Calpionellites* species.

Recently, BLANC *et al.* (1994), BULOT (1995) and BLANC (1995) have recorded *C.* aff. *oblongata* associated with *C. darderi*. Therefore, ALLEMANN & REMANE's ((1979) proposal to define the Berriasian-Valanginian boundary by using the last appearance of *C. oblonga* does not seem to be workable. It is easier to recognise BULOT, BLANC, *et al.*'s (1993) suggested boundary (base of the *pertransiens* Zone) using calpionellids because the FO of *"T." pertransiens* and *C. darderi* are almost synchronous (BLANC, POP and REMANE, *personal communications*).

CALCAREOUS NANNOFOSSILS

In this section, special emphasis is given to SE France, because this region (together with SE Spain: AGUADO, 1994) is the only one where nannofossil events have been calibrated directly with ammonite successions.

Calcareous nannofossil studies of the Vocontian Basin originate in works by THIERSTEIN (1971, 1973, 1976) and MANIVIT (1979). More recent investigations by BRALOWER *et al.* (1989), GARDIN & MANIVIT (1993), BERGEN (1994) and BULOT & GARDIN (*in prep.*) have allowed a refined understanding of the calcareous nannofossil biostratigraphy for the Berriasian-Valanginian time interval owing to the exceptional preservation and recovery of the nannofloras.

Four sections [Angles (Alpes-de-Haute Provence), Barret-le-Bas (Hautes-Alpes), Majastres (Alpes-de-Haute-Provence) and Montbrun-les-Bains (Drôme)] have been sampled bed by bed by BULOT & GARDIN (*in prep.*). Preparation of slides was made using the standard technique of MONECHI & THIERSTEIN (1985). No centrifuging was made to eliminate "spottiness" because the intermittent occurrence of taxa are here considered and interpreted as the expression of significant changing factors. At least 500 fields of view per slide were analysed for biostratigraphic purposes. Samples from Barret, Angles and Montbrun yield abundant, diverse and well preserved nannofloras, while at Majastres the assemblages are less diverse and preservation is poorer.

Main nannofossil events

Tubodiscus verenae has been considered as a Lower Valanginian marker by ROTH (1978), BRALOWER (1987), ERBA & QUADRIO (1987), APPLEGATE & BERGEN (1988), BRALOWER *et al.* (1989) and BERGEN (1994). According to our data, its FO is at the base of the *otopeta* Subzone (bed 175 at Angles; bed 71b at Montbrun-les-Bains). Similar results were published by MANIVIT (1979). BERGEN (1994) recorded an earlier occurrence of this taxon at Angles in the transitional beds between the *picteti* and *alpillensis* subzones. In SE France, the occurrence of *T. verenae* is not continuous and shows a "false" extinction at the top of the *O. nicklesi* biohorizon (*trinodosum* Zone). In fact, it then reappears sporadically from the uppermost Valanginian (*callidiscus* Zone) throughout the Hauterivian. It should be noted that at ODP Site 638B, *T. verenae* shows a continuous distribution throughout the whole upper Valanginian (APPLEGATE & BERGEN, 1988 and GARDIN, unpublished data). This pattern invalidates the LO of *T. verenae* as a reliable marker.

In addition, BERGEN (1994) and BULOT & GARDIN (*in prep.*), outlined some other events. The LO of *Rhagodiscus nebulosus* was near the top of the *alpillensis* Subzone (*otopeta* biohorizon) at Majastres (bed PG 166). According to BERGEN (1994), this event occurs a little lower in the *alpillensis* Subzone. Overlap between *R. nebulosus, T. verenae* and *N. silvaradion* at Angles will be discussed below. Preliminary results at Angles (bed 200) and Montbrun-les-Bains (bed 208b) suggest that *Cyclagelosphera* sp. 4 disappears in the uppermost part of the *otopeta* Subzone. More detailed work is needed to determine the value of this taxon as a biostratigraphic marker.

A significant change in the nannofossil assemblage occurs in the *pertransiens* Zone. In all sections, the first biostratigraphic event recorded in this zone is the FO of *Calcicalathina oblongata*. A precursor form, here referred to as *C.* aff. *oblongata (= Calcicalathina* sp. A *in* BERGEN, 1994) has been recorded in all the studied sections. In agreement with BERGEN's observations, this form seems transitional between the genus *Rhagodiscus* and the genus *Calcicalathina*. The bed-by-bed sampling at Montbrun-les-Bains allows us to draw an evolutionary lineage. *C.* aff. *oblongata* ranges through the entire *pertransiens* Zone and its FO has been observed within the *alpillensis* Subzone at both Angles and Montbrun.

A new genus, *Bulotinus*, appears in the lower part of the *pertransiens* Zone at Angles (bed 236), Majastres (bed PRY 150) and Barret-le-Bas (bed 47). BERGEN (1994) records the stratigraphic range of *Pickelhaube umbellatus (Bulotinus umbellatus* in BULOT and GARDIN, *in prep.*) as restricted to the lowermost *pertransiens* Zone to the base of the *inostranzewi* Zone (bed 300).

One of the most significant records within the upper part of the *pertransiens* Zone is the occurrence of *Micrantholithus speetonensis*, a taxon supposedly restricted to the Boreal Realm (TAYLOR, 1978; PERCH-NIELSEN, 1979; CRUX, 1989; MUTTERLOSE, 1991). *M. speetonensis* is very rare in the studied sections but seems to always occur at the same stratigraphic level at Angles, Majastres and Barret-le-Bas. The presence of this boreal species in a North Western Tethyan basin is a useful datum for inter-regional correlations and could be a further witness of the pertinence of the Vocontian basin as an intermediate area between the Boreal and Tethyan Realms (see discussion below).

The FO of *Rhagodiscus dekaeneli* and *Eiffellithus windii* are also recorded within the upper *pertransiens* Zone at Angles (bed 255), Barret-le-Bas (bed 42) and Majastres (bed PRY 153b). These findings are consistent with those of BERGEN (1994).

Problems

A recent report by ERBA *et al.*, (1995) has proposed an integrated stratigraphic framework for the Lower Cretaceous using ammonites, nannofossils, calpionellids, magnetostratigraphy and carbon stable isotopes. Raw data were mainly obtained from the Italian Maiolica succession and the Rio Argos section in SE Spain.

Comparison between the chart proposed by ERBA *et al.* (1995) and data provided in this report suggests that either the nannofossil workers have not reached full agreement on the taxonomy of such key species as *T. verenae* or *C. oblongata* or that preservation problems and/or hiatuses have been overlooked in the study of the nannofossils.

As an example, according to ERBA *et al.* (1995), the range of *T. verenae* is restricted to the Upper Valanginian, while all the data collected separately in SE France by MANIVIT, BERGEN and GARDIN shows that this species first appears in the *otopeta* Subzone and disappears high in the Hauterivian.

OTHER FOSSIL GROUPS

Recent work on dinoflagellates, ostracods and foraminifera does not appear to have reached the same degree of resolution as the fossil groups discussed so far. However, points to consider include:

ostracods: BULOT (1995) presented a table of the ostracod markers of the French Berriasian and Valanginian, showing that several taxa first appear in the *otopeta* Subzone or the *pertransiens* Zone.

dinoflagellates: after comparison between the ranges proposed by MONTEIL (1992) and LEEREVELD *in* HOEDEMAEKER & LEEREVELD (1995), it is difficult to see how far the dinoflagellates can help in defining the Berriasian-Valanginian boundary.

foraminifera: MOULLADE (1979) and MAGNIEZ-JANNIN (*personal communication*) show that in our present state of knowledge the small benthic foraminifera are of little help in characterising the boundary.

NON-BIOLOGICAL EVENTS

magnetostratigraphy: because of the problems discussed in the nannofossil section, it should be stressed that the calibration of magnetostratigraphic reversals against biostratigraphic scales needs much improvement. Unfortunately, the sampling at Montbrun-les-Bains has not allowed a direct calibration for the Berriasian-Valanginian boundary beds. So far, for the Berriasian-Valanginian boundary, the only section where a direct correlation between ammonite zonation and magnetostratigraphy has succeeded is at Cehegin in SE Spain (OGG *et al.*, 1988).

sea level changes: these have been investigated at length in recent years, but for the Valanginian there is still no general agreement on their significance and correlation potential at a very large scale (except perhaps for the ''Mid Valanginian'' event). Additionally, sequence stratigraphy analysis *sensu* Vail is a method not a finality of itself.

TETHYAN-BOREAL CORRELATIONS

While Aptian and Albian ammonites show only limited geographical differentiation, during Berriasian to Barremian times the Boreal and Tethyan Realms were characterised by two distinct faunas. This pattern of ammonite distribution necessitates the construction of two different ammonite scales (RAWSON, 1981, 1995). Generally, discussion on patterns of migration of boreal faunas to NW Tethys has been based on data from SE France even though Boreal occurrences are recorded from the Helvetic domain, the Carpathian belt and the Swiss Jura.

The first detailed account of the biostratigraphic distribution of boreal ammonites in SE France was by THIEULOY (1973, 1977), while KEMPER *et al.* (1981), THIEULOY *et al.* (1990) and BULOT, THIEULOY, *et al.* (1993) have provided further information. The occurrence of boreal species in SE France is sporadic and all specimens recorded belong to the fauna described from the West European Province of RAWSON (1981). For the interval considered herein, two successive periods can be distinguished:

- **Late Berriasian**: no boreal species have ever been recorded from SE France.

- Early Valanginian: boreal species occur scarcely in SE France. The West European genus *Platylenticeras* provides a good link with the Boreal Realm even though this taxon is rare outside North Germany (RAWSON, 1993).

It should be noted that the origin of *Platylenticeras* is still under discussion. KEMPER *et al.* (1981) and RAWSON (1993) favour a Tethyan ancestry but BULOT (1990) considers *Platylenticeras* as a Northern European offshoot of the boreal Craspèditinae. In SE France, *Platylenticeras* is rare at the base of the *pertransiens* Zone but evolved to produce two successive populations that include endemic species. Even where *Platylenticeras* reached its maximum abundance (base of the *stephanophorus* Zone), the genus represents less than 1% of the assemblage in SE France.

In addition, two dubious *Paratollia* and a single *Polyptychites* were recorded from the Lower Valanginian by THIEULOY (1977). The biostratigraphic position of this record has been revised since. The ''*Paratollia*'' come from the lower part of the *pertransiens* Zone while the *Polyptychites* was found in the middle part of the *stephanophorus* Zone (probably from the upper part of the *subcampylotoxus* biohorizon).

In contrast to the difference in the ammonite faunas, calcareous nannofloras had a much more cosmopolitan distribution during Early Cretaceous times. For the north European Boreal area, nannofossil events were calibrated against the ammonite succession at the Speeton section (Yorkshire, UK). There the Late Berriasian and Early Valanginian D beds represent the *albidum, Paratollia* and *Polyptychites* zones that correlate roughly with the upper part of the *boissieri* Zone to the top of the *stephanophorus* Zone. Comparison of the assemblages described by PERCH-NIELSEN (1979), TAYLOR (1982) and CRUX (1989) with data from SE France shows that most of the species are common to the two provinces. The following species, usually considered as ''boreal'', are recorded for the first time in SE France:

S. silvaradion - lowest occurrence at Angles is at bed 172 (uppermost part of the *alpillensis* Subzone)

S. horticus and *C. salebrosum* - known from the base of the *pertransiens* Zone (Angles and Majastres)

M. speetonensis - a ''spot'' species that occurs in the upper part of the *pertransiens* Zone.

According to CRUX (1989), *C. salebrosum* and *S. horticus* appear in bed D7B (lower part of the *albidum* Zone), while *S. silvaradion* appears a little higher, in bed D7A. The lowest occurrence of *M. speetonensis* is in bed D4B (*Paratollia* Zone). According to the known correlations, this distribution implies that the FO of *S. silvaradion* and *M. speetonensis* is at the same level at Speeton and SE France, while *C. salebrosum* and *S. horticus* appear earlier in NW Europe than in SE France.

If the LO of *S. silvaradion* is synchronous in the two realms the base of the *albidum* Zone should be correlated with the transitional beds between the *alpillensis* and *otopeta* subzones. This is an improvement for inter-realm correlations that were speculative at this level.

C. salebrosum is rare in SE France and very common in offshore Norway and at Speeton (CRUX, 1989). This suggests that this species is a true boreal taxon that appeared first in NW Europe and reached NW Tethys by the beginning of the Valanginian just like the first occurrence of *Platylenticeras*. This would confirm that a migration event occurred at the base of the *pertransiens* Zone. A similar pattern of distribution is shown by *S. horticus* but this species is rare in both provinces.

M. speetonensis suggests a very different problem. In SE France, a taxon that shows affinities with *M. speetonensis (M.* sp. in GARDIN & MANIVIT, 1993) is known from the Late Berriasian (*picteti* Subzone) and ranges up into the *inostranzewi* Zone. This form does not show as regular a shape as *M. hoschulzi* nor does it bear the distinct ''spines'' as *M. speetonensis*. It is considered as a possible ancestor of *M. speetonensis*. In SE France, *M. speetonensis* is very rare (1 specimen in 500 fields of view!) and its distribution is limited to some beds in the upper part of the *pertransiens* Zone. In the West European Province, its range is longer but the form is rare there as well. Such a pattern suggests two possible hypotheses:

- *M. speetonensis* is of Tethyan ancestry but became established as a permanent ''population'' in the southern part of the Boreal Realm due to better conditions.

- there is no phyletic link between *M.* aff *speetonensis* and *M. speetonensis*, in which case the ''spotty'' occurrence of the latter in SE France is indicative of a brief connection between the two realms.

POSSIBLE BOUNDARY STRATOTYPES

Since Copenhagen, sections have been investigated in detail at several localities in SE France and the Betic Cordillera of SE Spain. Provisionally, Montbrun-les-Bains (SE France) appears to be the most promising section.

PROVISIONAL RECOMMENDATION

A majority of participants at Brussels voted to place the boundary at the base of Calpionellid Zone E, which corresponds almost exactly to the base of the ammonite zone of *Thurmanniceras pertransiens*. A minority voted for the latter. The calpionellid index was preferred because it can be recognised over a broader geographic area, as far west as Mexico. This provisional decision awaits ratification after the whole Working Group has been consulted.

The Lower/Upper Valanginian boundary

This boundary is much less contentious. Over the last 25 years it has been widely accepted to lie at the base of the *Saynoceras verrucosum* ammonite Zone *sensu* THIEULOY, 1979. Since then, ammonite sequences have been logged in numerous sections in SE France (BULOT, THIEULOY, *et al.*, 1993; BULOT & THIEULOY, 1993; BULOT,

1995) and the Betic Cordillera (Company, 1987). These have shown that the major faunal turnover occurs a little lower in the stratigraphic column (base of the *inostranzewi* Zone *sensu* Bulot, 1995 = uppermost part of the *campylotoxus* zone *sensu* Thieuloy, 1979). However, the base of the *verrucosum* Zone is distinctive and can be recognised also in the West European Province of the Boreal Realm.

Other faunal/floral markers still await documentation by the Working Group, and only then will a stratotype section be recommended. Sections in both SE France and the Betic Cordillera are under consideration.

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