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Stratigraphic implications of late Carboniferous and early Permian megafloras in Lérida, south-central Pyrenees; Comparison with the Cantabrian Mountains

Implicaciones estratigráficas de las megafloras del Carbonífero superior y Pérmico inferior de Lérida, Pirineo central; Comparación con la Cordillera Cantábrica

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ABSTRACT

Comparison is made between the stratigraphic development of Carboniferous and Permian strata in the Cantabrian Mountains and the central Pyrenees, the latter being markedly less complete. Both belong to the same general palaeogeographical area. Elements of the upper Carboniferous and lower Permian succession in the Pyrenees are dated by means of plant megafossil assemblages which are listed and discussed with regard to stratigraphic age. Records in the literature are complemented by hitherto unpublished assemblages brought together by the first author. It is concluded that the central Pyrenees of Lérida contain a small remnant of unconformable upper Westphalian D (or basal Cantabrian?) strata (at Aguiró), which are followed, also unconformably, by an upper Stephanian C-lower Autunian succession (Malpás Formation). Further Autunian strata occur in an either conformable or slightly unconformable succession. The very substantial stratigraphic gaps in the Carboniferous of the central Pyrenees are apparent in Fig. 2.

RESUMEN

La representación muy completa del Carbonífero y Pérmico de la Cordillera Cantábrica ha servido para atribuir los fragmentos de serie existentes en el Pirineo central, al tratarse del mismo área paleogeográfica general. Mediante los registros de

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megaflora, tanto los publicados como los correspondientes a recogidas propias, se han podido datar tres intervalos continentales posteriores al Namuriense (¿y Westfaliense inferior?). El primero corresponde a las capas de Aguiró, de edad westfaliense D superior o cantabriense inferior; el segundo al Estefaniense C superior y/o Autuniense inferior; el tercero a un Autuniense más alto. Hay discordancias aparentes por debajo del Westfaliense D superior (Aguiró) y del Estefaniense C superior (Malpás).

La práctica totalidad del Westfaliense parece faltar en el Pirineo central; lo mismo ocurre con el Estefaniense del que únicamente las partes basal(?) y más alta parecen estar representadas (Fig. 2).

Key words: Megafloras, Westphalian D, Stephanian C, Autunian, Lérida, Pyrenees.

Palabras clave: Megafloras, Westfaliense D, Estefaniense C, Autuniense, Lérida, Pirineos.

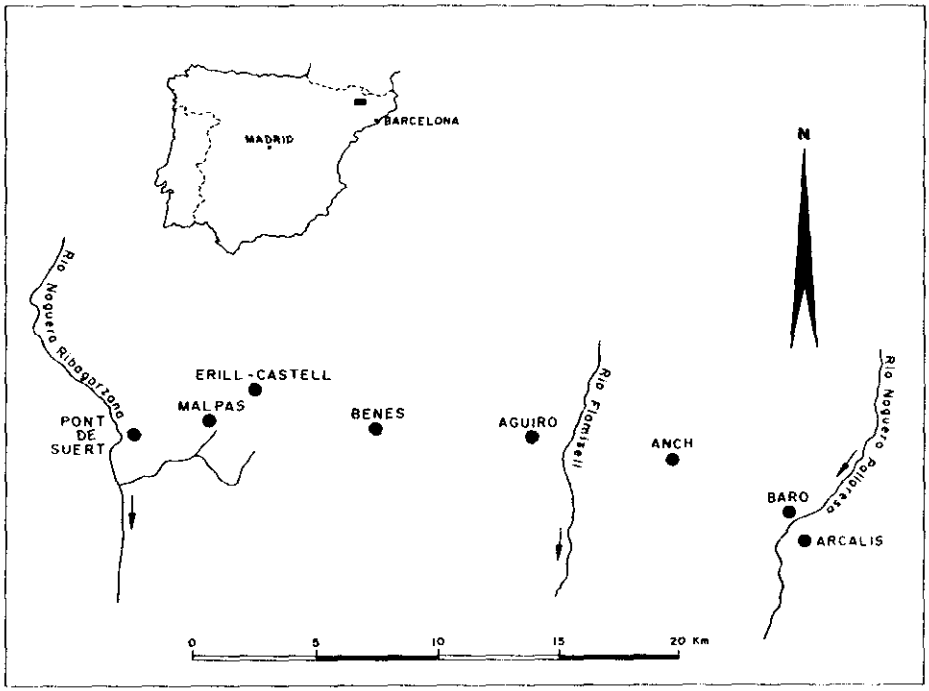

Figure 1.—Map showing the position of localities mentioned.
Figura 1.—Mapa con la situación de las localidades mencionadas

PREAMBLE

The authors are pleased to dedicate this paper to Emeritus Professor B. Meléndez, and thus record their indebtedness to the person who promoted their investigations on the Carboniferous of Spain, from the 1950's onwards. Professor Meléndez was largely instrumental in reactivating palaeobotanical studies in Spain. This was done first of all through the active involvement of the late Professor W.J. Jongmans, whose summary paper «Las floras carboníferas de España» (JONGMANS, 1951) constitutes the starting point of modern stratigraphic palaeobotanical work on the Carboniferous of Spain. Professor Jongmans visited the Pyrenees in 1956, being accompanied in the field by J. Talens, who subsequently (1957) initiated work on the Carboniferous stratigraphy and palaeobotany of the central Pyrenees of Lérida for a doctoral thesis at the Universidad Complutense of Madrid (TALENS, 1973). Supervision was provided by Professor Meléndez.

The plant fossils collected for this thesis have been reexamined conjointly by the present writers, who have also been able to revise a collection studied previously by MENÉNDEZ AMOR (1952). The results of these revisions are combined with an analysis of published information for an appraisal of the stratigraphic ages of terrestrial Carboniferous and Permian strata in the south-central Pyrenees. More extensive, illustrated accounts of the different floras are being prepared for publication elsewhere, the present paper being restricted to a summary of stratigraphic results based on the revision of floras which are only listed for the time being.

INTRODUCTION

An analysis of the plant megafossil assemblages present in the axial zone of the Pyrenees does not merely allow dating more exactly the higher Carboniferous and Permian strata present in this area, but it also permits a comparison with certain parts of the more completely developed Carboniferous and Permian in the Cantabrian Mountains, Northwest Spain. Both the Cantabrian Mountains and the Pyrenees seem to have formed part of the same general palaeogeographical area in Palaeozoic times and this makes the comparison particularly valuable. The most obvious resemblances are with the Palentine region in the southeastern part of the Palaeozoic outcrops in the Cantabrian Mountains, *i.e.* northern Palencia, Liébana (part of Cantabria), and northeastern León, south of the Picos de Europa. A brief summary is presented for comparative purposes.

A SUMMARY ACCOUNT OF CARBONIFEROUS AND LOWER PERMIAN SUCCESSIONS IN THE CANTABRIAN MOUNTAINS (SOUTHEASTERN PART IN PARTICULAR)

In this region a highly condensed succession of strata containing limestones, cherts and black shales of Famennian, Tournaisian and Viséan ages is followed by shallow water limestones of the Namurian and lower Westphalian, in conjunction with lower Westphalian siliciclastics. This succession, less than 2,000 m thick and containing a number of stratigraphic breaks due to repeated uplift of local importance, was tectonically deformed in late Langsettian times. This deformation, which is sharply delimited in time, produced important shortening as a result of large-scale thrusting. This includes nappe structures.

Several thousand metres of predominantly marine strata were laid down subsequently in a totally unconformable succession of latest Langsettian, Duckmantian, Bolsovian and early Westphalian D ages. In part of the area this succession was eliminated by uplift in mid-Westphalian D times. The steeply angled (normal?) faults had a throw commensurate with the elimination of at least 3,000 m of strata. In other parts of the area, only minor tilting and weak folding took place. This produced paraconformable contacts between lower Westphalian D and higher strata, which belong to the upper Westphalian D in some places, and lower Cantabrian in others.

A total succession of up to 5,500 m of upper Westphalian D, Cantabrian and lower Barruelian (ex Stephanian A) deposits constitute the subsequent basin fill. These are largely marine in the eastern part of the basin and predominantly terrestrial, non-marine in the western part.

The two successions, with a total (combined) maximum thickness of 8,500 m of strata, ranging in age from latest Langsettian to early Barruelian, were folded and thrust together in mid-Barruelian times. These were the much-quoted Asturian movements of the Cantabrian Mountains. Unconformable upper Barruelian, Stephanian B and lower Stephanian C deposits accumulated subsequently in a basin (or basins?) showing onlap westwards and eastwards from an initial depression at Sabero in northeastern León.

All the different successions mentioned above, laid down in successive basins occupying only partly coincident areas, were folded and thrust in conformity with the arcuate fold belt which characterises the tectonic structure of the Palaeozoic strata in the Cantabrian Mountains, up to and including lower Stephanian C.

This arcuate fold belt is overlain, with angular unconformity, by Permian and Mesozoic strata which show a different structural pattern. In central Asturias,

strata of late Stephanian C age, the San Tirso beds, occur below the Permian succession. These beds are overlain by volcanic deposits. Volcanic beds are also known from lower Permian strata in the southeastern part of the Cantabrian Mountains. Triassic deposits overlie the Permian rocks with low-angle unconformity.

This very brief summary of the geological history of a relatively large, complex area with partly contradictory published information, corresponds, in the main, to the experience accumulated by the second author (R.H. Wagner) over a period of about forty years. Any attempt to quote relevant literature would lengthen the account out of all proportion to its aim which is to provide the elements for a comparison with the fragmentary successions present in the Pyrenees (to be discussed in the following chapters).

AXIAL ZONE OF THE PYRENEES

Tournaisian-Namurian succession

The uppermost Devonian and lower Carboniferous succession in the Pyrenees is of condensed facies and very similar to that developed in the southeastern corner of the Cantabrian Mountains. It is followed by siliciclastic deposits of Namurian and, possibly, also early Westphalian ages. Megafloras reputed to be of Westphalian A (=Langsettian) age have been recorded from Huesca by SCHMIDT (1931) and WENSINK (1962), but essentially the same assemblages have been figured and described more recently by LAVEINE (*in* DELVOLVÉ & LAVEINE, 1985) from the Béarnais, on the French side of the axial zone of the Pyrenees. These plant assemblages occur in a stratigraphic succession which also contains middle Namurian goniatite faunas (DELVOLVÉ & LAVEINE, 1985). It is therefore possible that the succession in Huesca also belongs to the Namurian and that it does not reach into the lower Westphalian. More complete data must be awaited before a proper comparison can be made with the better known succession in the Cantabrian Mountains.

Uppermost Westphalian D or basal Cantabrian of Aguiró

DALLONI (1930, p.95) listed three successive assemblages of plant megafossils from a section of strata near the village of Aguiró (Fig. 1). These

were identified by P. Bertrand and attributed to middle and upper Westphalian. WATERLOT (1969, p. 114) translated this into Westphalian B, C and D, but it is most unlikely that the succession sampled by Dalloni would represent such a substantial time interval. Indeed, a later record by Stockmans (*in* NAGTEGAAL, 1969, p.146) refers merely to Westphalian D. A completely different opinion is expressed by BROUTIN & GISBERT (1985), who referred the flora of Aguiró to the middle Stephanian (read: Stephanian B).

One of the present writers (J. Talens) also collected from the plant-bearing section near Aguiró. A revision of the total assemblage encountered shows the following taxa to occur in the c. 20 m sampled:

Neuropteris ovata HOFFMANN
Cyclopteris sp. (laciniate and probably attributable to *Odontopteris)*
Macroneuropteris scheuchzeri (HOFFMANN) CLEAL, SHUTE & ZODROW
Linopteris palentina WAGNER
Alethopteris lesquereuxii WAGNER
cf. *A. grandinioides* var. *subzeilleri* WAGNER
Callipteridium (Praecallipteridium) jongmansii (BERTRAND) WAGNER
Pseudomariopteris cordato-ovata (WEISS) GILLESPIE & PFEFFERKORN
cf. *Ps. corsinii* (TEIXEIRA) WAGNER
Eusphenopteris cf. *neuropteroides* (BOULAY) NOVIK
Pecopteris unita BRONGNIART
P. cf. *nyranensis* NĚMEJC
Lobatopteris vestita (LESQUEREUX) WAGNER
Sphenophyllum emarginatum (BRONGNIART) BRONGNIART
Annularia sphenophylloides (ZENKER) VON GUTBIER
An. stellata (VON SCHLOTHEIM) WOOD
Lepidodendron worthenii LESQUEREUX
Lepidostrobophyllum hastatum (LESQUEREUX) CHALONER

This assemblage clearly corresponds to either upper Westphalian D or basal Cantabrian, and is strikingly similar to that found in upper Westphalian D and lower Cantabrian strata of the post-Leonian succession in Palencia and northeastern León, Cantabrian Mountains (compare WAGNER, 1983). The present writers thus confirm in essence the age attribution made by Stockmans, and reject the suggestion of a mid-Stephanian age made by BROUTIN & GISBERT (1985).

The stratigraphic succession at Aguiró commences with alluvial fan deposits (NAGTEGAAL, 1969) which represent the basal part of an unconformable succession. The map published by ROBERTI (1970) shows a highly angular unconformity between the Aguiró beds and underlying, previously folded

Devonian limestones and siliciclastics. There is a marked structural difference between these Devonian rocks and the overlying Aguiró beds.

Summarising, there appear to be no reliable records in the axial zone of the Pyrenees to prove the presence of Westphalian strata, with the exception of the possible uppermost Westphalian D found at Aguiró, (which cannot be distinguished from basal Cantabrian on the floral records available at present.)

It is likely that the equivalent of the uppermost Langsettian, Duckmantian, Bolsovian and lower Westphalian D strata deposited after the main tectonic event (Palentian Phase) in the southeastern part of the Cantabrian Mountains, is not represented in the Pyrenees. This amounts to a very substantial time gap in the Pyrenean record, the magnitude of which is not generally acknowledged in the literature. The Aguiró beds coincide in age with the equally unconformable, post-Leonian deposits in the Cantabrian Mountains.

Upper Stephanian C - lower Autunian Malpás Formation

The plant-bearing strata of late Westphalian D or earliest Cantabrian age at Aguiró, are overlain unconformably by a succession of volcanic rocks which are identified as those of Erill-Castell, of andesitic composition. On the map published by ROBERTI (1970), this unconformity is clearly visible, although unacknowledged. DALLONI (1930, p.36) mentions a Stephanian flora, comparable to that of Malpás, from a fourth plant-bearing horizon at Aguiró. Although the shales which are supposed to contain Dalloni's fourth plant-bearing horizon, are seen in the field to underlie the Erill-Castell volcanics, it is unclear whether they are in sequence with the volcanic interval and unconformable with the Aguiró beds, or are to be attributed to the latter. Unfortunately, the present writers have not seen a flora of general Stephanian aspect as recorded by Dalloni, in the Aguiró area. No definite conclusions may therefore be drawn as yet.

The volcanics are unconformably overlain by presumed Triassic rocks in the Aguiró region, but c. 12 km westwards, near the abandoned village of Erill-Castell (Fig. 1), the volcanic rocks are followed in conformable succession by the coal-bearing strata of the Malpás Formation of MEY *et al.* (1968) and NAGTEGAAL (1969).

Although the Erill-Castell volcanics are mentioned as being in gradual transition with the overlying coal-bearing strata (with intercalated volcanics), MEY *et al.* (1968) and NAGTEGAAL (1969) distinguished the two as different mappable units, viz. the Erill-Castell Formation and the Malpás Formation. GISBERT (1981) incorporated these two formations in a single unit, his «unidad gris», and BESLY &

COLLINSON (1991) emphasised the stratigraphic continuity and genetic relationship between both by recognising the Erill-Castell volcanic unit as the lower member of an expanded Malpás Formation. On the other hand, GISBERT (1981) separated off the conglomeratic uppermost part of NAGTEGAAL's Malpás Formation as his «unidad de tránsito» which he described as unconformable with the underlying coal-bearing succession. BESLY & COLLINSON (1991) accepted that the «unidad de tránsito» should be regarded as a separate interval.

The coal-bearing strata of the Malpás Formation have yielded floral remains of apparent Stephanian B-C age to DALLONI (1930, p.94) and NAGTEGAAL (1969, p. 148). The latter mentioned the possibility that the Malpás Formation might reach into the lower Permian.

One of the present writers (J.Talens) has collected the following floral elements at the tip of the Malpás Mine, south of Erill-Castell:

Neurocallipteris neuropteroides (GÖPPERT) CLEAL, SHUTE & ZODROW
Odontopteris brardii BRONGNIART
Reticulopteris germari (GIEBEL) GOTHAN
Callipteridium gigas (VON GUTBIER) WEISS
C. cf. *zeilleri* WAGNER
«Callipteris» bilharzii (FRENTZEN) WAGNER (figured and described by WAGNER, 1958; the generic attribution has later been questioned by KERP & HAUBOLD, 1988, p. 140)
Alethopteris bohemica FRANKE
Dicksonites leptophylla DOUBINGER
Lobatopteris corsinii WAGNER
Polymorphopteris polymorpha (BRONGNIART) WAGNER
P. villablinensis WAGNER
Pecopteris unita BRONGNIART
P. densifolia (GÖPPERT) WEISS
P. robustissima WAGNER
P. cf. *arborescens* (VON SCHLOTHEIM) BRONGNIART
Sphenophyllum oblongifolium (GERMAR & KAULFUSS) UNGER
Annularia stellata (VON SCHLOTHEIM) WOOD
Asterophyllites sp.
Calamites sp.
Cordaites palmaeformis (GÖPPERT) WEISS

This assemblage is clearly of late Stephanian age, and most likely late Stephanian C. (if the restricted range of N. *neuropteroides* is taken into consideration.)

The Malpás Formation crops out in a narrow strip of tilted strata forming a monocline in the area which extends from a little west of Erill-Castell to beyond the Flamisell River (Fig. 1). Further eastwards the exposures become less continuous. Plant megafossils occur in various different localities (Fig. 1). The most significant assemblage has been encountered near Benés, at c. 5.5 km east of Erill-Castell:

Odontopteris brardii BRONGNIART
Callipteridium cf. *zeilleri* WAGNER
Dicksonites sp.
cf. *Pseudomariopteris paleaui* (ZEILLER) DANZÉ-CORSIN
Asterotheca truncata GERMAR
Pecopteris permica NĚMEJC
P. cf. *cyathea* (VON SCHLOTHEIM) BRONGNIART
P. cf. *robustissima* WAGNER
Sphenophyllum oblongifolium (GERMAR & KAULFUSS) UNGER
Annularia stellata (VON SCHLOTHEIM) WOOD
Cordaites sp.
Sigillaria brardii BRONGNIART forma *ichthyolepis* STERNBERG
Walchia hypnoides BRONGNIART

This assemblage belongs to either upper Stephanian C or lower Autunian.

A locality at c. 500 m east of Anch (Fig. 1), a hamlet 4.5 km east of the Flamisell River, has yielded a small floral assemblage as follows:

Sphenopteris cf. *castelii* ZEILLER
Renaultia sp.
cf. *Pseudomariopteris cordato-ovata* (WEISS) GILLESPIE & PFEFFERKORN
Sphenophyllum verticillatum (VON SCHLOTHEIM) ZEILLER
Asterophyllites sp. indet.

Although this locality appears as Aguiró Formation on the map published by ROBERTI (1970, *in* ZWART, 1979), the floral assemblage suggests Malpás Formation.

The floral assemblages obtained from Malpás and Benés indicate quite clearly that the Malpás Formation is comparable in age to the San Tirso beds in central Asturias (Cantabrian Mountains) (WAGNER & MARTÍNEZ-GARCÍA, 1982).

There is an important time gap between the upper Westphalian D or basal Cantabrian Aguiró beds and the upper Stephanian C Malpás Formation, a gap which corresponds to most of the post-Leonian succession (Cantabrian and lower Barruelian of the lower Stephanian) and the entire post-Asturian succession

(upper Barruelian, Stephanian B, and lower Stephanian C) in the Cantabrian Mountains.

Autunian floras

The strip containing the discontinuous outcrops of the Malpás Formation continues eastwards beyond the Noguera-Pallaresa River. Just beyond this river and corresponding to a position south of the strip of Malpás Formation (Fig. 1), Permian floras have been recorded from red beds with an intercalation of dark grey, slaty mudstones, reputedly with a high pyrites content. From this slaty interval DALLONI (1930, p. 114) reported a megafloral assemblage which P. Bertrand identified as being of early Permian age. Similarly, MENÉNDEZ AMOR (1952) recorded a lower Permian flora from Baró (Fig. 1), east of the Noguera-Pallaresa River. The present writers have been able to reexamine the collection described by Menéndez Amor. Although some of the material seems to have been lost, the majority of her specimens are still available in the Museo Geológico, Madrid. A revision of this material has yielded the following list of species.

cf. *Neurocallipteris neuropteroides* (GÖPPERT) CLEAL, SHUTE & ZODROW
cf. *Reticulopteris germari* (GIEBEL) GOTHAN
Callipteridium rochei ZEILLER
Rachiphyllum schenkii (HEYER) KERP
cf. *Dichophyllum flabelliferum* (WEISS) KERP & HAUBOLD
cf. *Gracilopteris raymondii* (ZEILLER) KERP & HAUBOLD
Taeniopteris multinervia WEISS
Walchia hypnoides BRONGNIART
Annularia spicata (VON GUTBIER) SCHIMPER

These identifications are only partly identical to those provided by MENÉNDEZ AMOR (1952). A full discussion of the identifications is postponed until the Baró flora can be illustrated.

ALVAREZ RAMIS (1985) also figured and described megafloral remains from Baró. She did not refer to Menéndez Amor's work, and her determinations are only partly coincident with those of the earlier author and those given in the present paper. Alvarez Ramis assigned an Autunian age to this flora.

Apparently the same dark grey mudstones crop out near Arcalís (Fig. 1), at about 1.5 km east of Baró. A broad anticline repeats the succession in these two localities. Arcalís is mentioned by SCHMIDT (1931, p. 173), who collected an Autunian flora which was identified by W. Gothan. One of the present writers

(J. Talens) also collected near Arcalís, and this provided a floral assemblage similar to but not identical with that at the locality near Baró:

Rachiphyllum schenkii (HEYER) KERP
Taeniopteris cf. *multinervia* WEISS
Pecopteris cf. *densifolia* (GÖPPERT) WEISS
Culmitzschia cf. *parvifolia* (FLORIN) KERP & CLEMENT-WESTERHOF.

Similar assemblages have been recorded from several localities further east, in the province of Gerona (DOUBINGER *et al.*, 1978; BROUTIN & GISBERT, 1985). Megafloral remains were illustrated from two localities (Coll de Jou and Coll de la Caritat) by BROUTIN & GISBERT (1985), and these have both been attributed to Gisbert's «unidad de tránsito». Their ages were given as Autunian and latest Stephanian, respectively. The presence of several conifer species at the Coll de la Caritat locality is most noteworthy. The variable composition of the floral assemblages in the «unidad de tránsito» has been attributed to different biofacies linked to sedimentary and edaphic conditions (*op. cit.*). It has been suggested by Broutin & Gisbert that these different compositions would influence the age attributions and that floras of apparent Stephanian B-C and Stephanian C aspect might be contemporaneous with those clearly attributable to the Autunian. The classical paper by GOTHAN & GIMM (1930) is the first to have drawn attention to this problem which has been debated extensively in the Central European literature and, more recently, by French workers. Gothan and Gimm distinguished between a peat-forming assemblage of pecopterids and calamiteans, and a non-peat-forming assemblage of callipterids and walchian conifers. The latter assemblage would now be called «extrabasinal», a term coined by HAVLENA (1970).

The «unidad de tránsito» has been described as lying unconformably on the (modified) Malpás Formation (GISBERT, 1981). Although this relationship is accepted by BESLY & COLLINSON (1991), these authors doubt that the unconformity is due to a major erosive event. It is true enough that the Autunian (Rotliegend) type floras from the «unidad de tránsito» do not seem much different in age to the more generally peat-forming assemblages of late Stephanian (probably late Stephanian C) age which are found in the coal-bearing succession of the Malpás Formation. Although the two different lithostratigraphic units can be distinguished, both on lithofacies and biofacies, the age difference seems to be minor.

The «unidad de tránsito» may be compared, both with regard to its stratigraphic position and its lithofacies, with the Sotres and Cabranes Formations of northern Asturias (MARTÍNEZ GARCÍA, 1991). A small lower Permian (Autunian) flora has been recorded from the Cabranes Formation by WAGNER &

MARTÍNEZ GARCÍA (1982) and this is also comparable to the megafloral assemblages found in the «unidad de tránsito». The Sotres and Cabranes Formations are generally grey in colour and are apparently overlapped by the Caravia red beds. A regional, low-angle unconformity is generally present. Other lower Permian strata with a volcanic component are known from Peña Labra in northern Palencia (MAAS, 1974). The reader is referred to MARTÍNEZ GARCÍA (1991) for a summary of the Permian deposits in the Cantabrian Mountains.

The Peranera Formation of MEY *et al.* (1968) and NAGTEGAAL (1969) is a red-bed unit (unidad roja inferior of GISBERT, 1981) which overlies and overlaps the «unidad de tránsito» and which has yielded Autunian floras to BROUTIN & GISBERT (1985). The present writers have no information to contribute with regard to the Peranera Formation as known from the Erill-Castell/Malpás area.

CONCLUSIONS

1. The Aguiró beds as reported by DALLONI (1930) and NAGTEGAAL (1969) have yielded megafloral remains of either late Westphalian D or earliest Cantabrian age. The suggestion made by BROUTIN & GISBERT (1985), that these beds would represent middle Stephanian (read: Stephanian B), cannot be accepted. Comparison is made with the basal deposits of the post-Leonian succession of the Cantabrian Mountains.

2. The Malpás Formation of MEY *et al.* (1968) and NAGTEGAAL (1969), as modified by GISBERT (1981) and BESLY & COLLINSON (1991), is apparently of late Stephanian C age. It compares in age and stratigraphic position with the San Tirso beds in central Asturias, Cantabrian Mountains. The post-Asturian Stephanian (upper Barruelian to lower Stephanian C), which is widely developed in the Cantabrian Mountains, is apparently absent in the Pyrenees.

3. Autunian floras have been recorded from a black shale intercalation in the red-beds of the «unidad de tránsito» of GISBERT (1981). It is unclear whether these red-beds are in continuous succession with the Malpás Formation or not.

4. The substantial gaps in the higher Carboniferous succession of the south-central Pyrenees possibly comprise almost the entire Westphalian (upper Westphalian D excepted) and most of the Stephanian (upper Stephanian C excepted) (see Fig. 2).

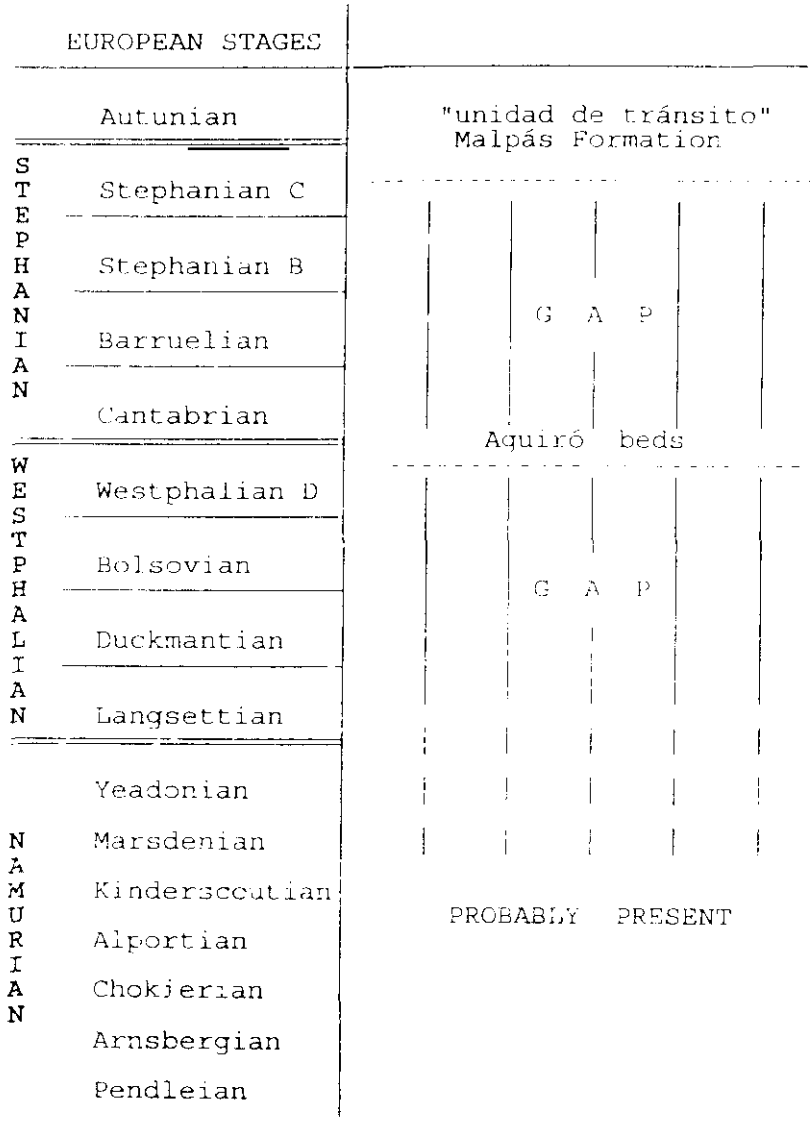

Figure 2.—Table showing the position of the stratigraphic units with megafloras as discussed in the present paper. Note the very substantial gaps in the Carboniferous succession of the south-central Pyrenees in Lérida.

Figura 2.—Tabla con la posición de las unidades estratigráficas con megafloras analizadas en el presente trabajo. Nótese las lagunas sustanciales en la sucesión del Carbonífero del Pirineo central de Lérida.

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