

*Upper Namurian/lower Westphalian of La Camocha,  
Asturias: Review of floral and faunal data*

El Namuriense superior y Westfaliense inferior de La  
Camocha, Asturias, Revisión de los datos florísticos y  
faunísticos

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**ABSTRACT**

A review is presented of palaeontological data regarding the age of coal-bearing strata in the La Camocha Mine near Gijón, Asturias. Megafloral remains collected from the upper Namurian and lower Westphalian strata in this coal mine are listed, and a few selected taxa are briefly discussed. Comparable floras from other parts of the Iberian Peninsula are briefly mentioned and commented upon with regard to stratigraphic age.

**RESUMEN**

Se citan y comentan la totalidad de los datos paleontológicos publicados sobre la sucesión hullera de La Camocha, cerca de Gijón (Asturias). Se revisa el material existente de megaflores, y se discuten algunas de las especies presentes. La edad obtenida es Namuriense superior (Yeadoniense) y Westfaliense inferior (Langsettiense). Se comparan estos datos con los correspondientes a las mismas edades en otras partes de la Península Ibérica.

**Key words:** megaflores, microflora, invertebrates, Yeadonian, Langsettian.

**Palabras clave:** megaflores, microflora, invertebrados, Yeadoniense, Langsettiense.

**PREAMBLE**

Professor B. Meléndez was largely instrumental in re-establishing the links with the palaeontological fraternity abroad after Spain became politically isolated

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after the Civil War and World War II. Among the various investigations he promoted were those of Professor W.J. Jongmans, an outstanding palaeobotanist from The Netherlands, whose expertise in the stratigraphic use of Carboniferous plant fossils was extremely useful for dating the coal deposits in various parts of Spain. In the present paper the writers pay homage to the late Professor Jongmans, who initiated modern stratigraphic work on the Carboniferous floras of Spain, and are pleased to dedicate this paper to Professor B. Meléndez who organised most of the work done by Jongmans and his pupils.

## INTRODUCTION

The coal-bearing strata of La Camocha were found under a Permo-Triassic cover by boreholes put down by the Felgueroso brothers at the turn of the century. Much later, in 1930, the first shaft was sunk for the exploitation of the coal seams encountered in this area at a few kilometres southwest of the coastal city, Gijón (Fig. 1). The age of these coal-measures was the subject of a controversy between ADARO (1914) and PATAc (1920, 1933), who opted for Westphalian and Stephanian, respectively (in present-day terminology). Adaro based his opinion mainly on the geological relationships, whilst Patac identified plant megafossils from the La Camocha Mine.

In 1947, Professor W.J. Jongmans was invited to visit the La Camocha Mine and other Carboniferous localities in the Asturias in order to collect plant fossils for the stratigraphic dating of coal deposits. He was accompanied by the mining engineer I. Patac, who had organised the visit, and who was particularly keen to obtain a professional opinion on the plant fossils of the La Camocha Mine. Both gentlemen being somewhat advanced in years, they limited their excursion to the La Camocha Mine to collecting at the coal tip. JONGMANS (1951) published the results as being indicative of Westphalian A, thus supporting the point of view expressed by Adaro. This implied grave doubts as to the correctness of the identifications of plant fossils as given by PATAc (1933). There is no evidence that the latter accepted Jongmans's verdict and since the sample collected in 1947 was rather small, it seemed important to return to La Camocha for a more exhaustive study.

The opportunity for such a study arose in 1952, when the Consejo Superior de Investigaciones Científicas subsidised fieldwork in the Asturias through the good offices of Professor B. Meléndez. The Jefatura de Minas de Asturias, headed by the mining engineer T. Hevia, provided the letters of introduction which were instrumental in gaining access to coal mines.

At this time, one of the present authors (RHW) was taken along as assistant

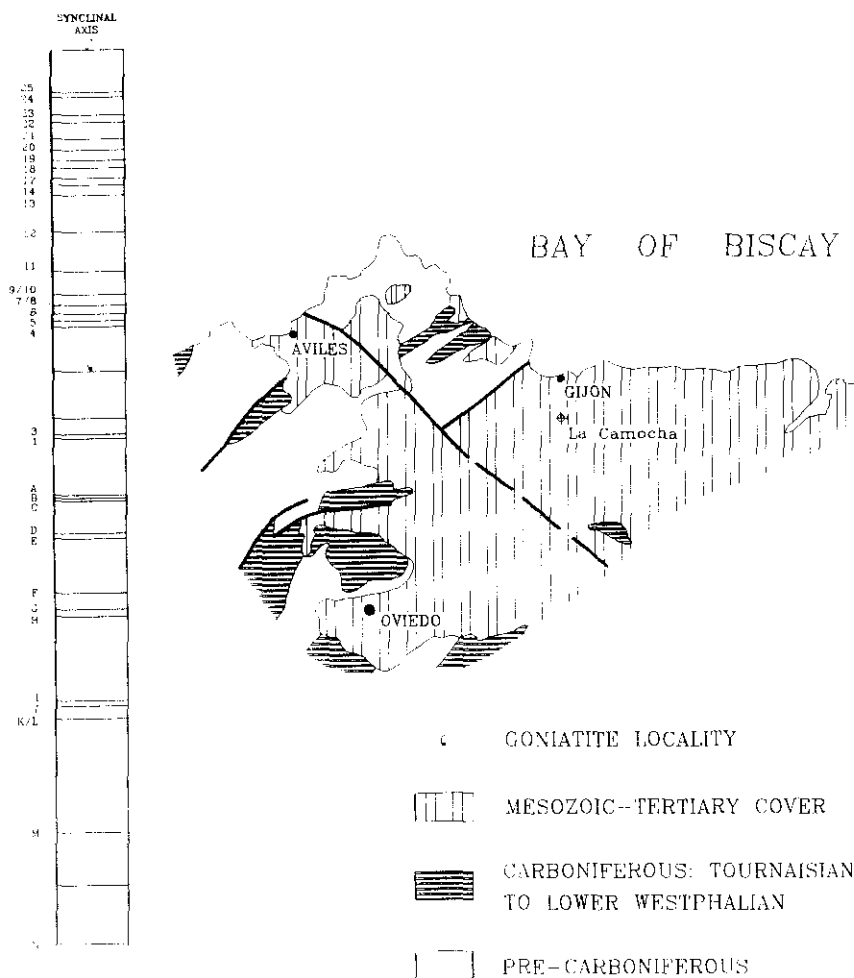


Figure 1 - Location of La Camocha in relation to lower Westphalian outcrops in the general area (after TRUYOLS SANTONJA & SÁNCHEZ DE POSADA, 1983, modified). Generalised column shows the distribution of coal seams as well as the position of the marine locality studied by SCHMIDT (1955) and others.

Figura 1.- Situación de La Camocha en relación a los afloramientos del Westfaliense inferior en el área (según TRUYOLS SANTONJA & SÁNCHEZ DE POSADA, 1983, modificado). La columna general muestra la distribución de las capas de carbón así como la posición de la localidad con fauna marina estudiada por SCHMIDT (1955) y otros.

to Professor Jongmans. Three weeks were spent at La Camocha which allowed the assistant to obtain a detailed lithological section from cross-cuts in the coal mine, and to collect bulk samples of fossiliferous strata. These samples were sent up by the tubload for hammering by Professor Jongmans and Mrs Wagner at the pithead. A fair-sized collection of plant megafossils, non-marine bivalves and marine faunal remains was thus obtained and shipped to the Geologisch Bureau at Heerlen, The Netherlands, for study. Coal samples collected along the section were studied by BONET & DIJKSTRA (1956) and NEVES (1964), and marine fossils were sent to H. SCHMIDT (1955).

Professor Jongmans prepared the preliminary draft of a paper meant to provide a fully illustrated account of this flora. The stratigraphy of La Camocha and the evidence for its synclinal structure would have been published at the same time. However, Professor Jongmans died in 1957 when the palaeobotanical manuscript was still in draft stage.

This manuscript and photographs of the floral remains were handed to his prospective co-author on the stratigraphic side, who published the identifications of plant fossils in Jongmans's name in a general paper on the stratigraphic implications of Carboniferous floras in Northwest Spain and North Portugal (WAGNER, 1959). Unfortunately, it was not realised at the time that Jongmans's study was still in a preliminary stage, and that his fossil identifications and stratigraphic conclusions needed further work. This became most apparent after the photographs were mounted on plates and an effort was made to edit Jongmans's manuscript notes for a posthumous paper. Several of the identifications proved to be questionable, and it must be regretted that WAGNER (1959) published the list of plant fossils as it appeared in Jongmans's manuscript notes. It became clear that the description of this flora could not be published without a major revision.

One new species intended by Jongmans, *Neuropteris asturiana*, was introduced with a brief diagnosis in a general paper by WAGNER (1962), who also named and diagnosed *Rhodeopteridium jongmansii* WAGNER and illustrated two other named taxa. However, a proper revision was not undertaken until 1993, when the opportunity arose to compare and contrast the La Camocha flora with a lower Westphalian flora from the Peñarroya-Belmez-Espiel Coalfield (Córdoba) studied in detail by one of the present authors (CAV).

## HISTORY OF INVESTIGATIONS

The La Camocha Mine, at less than 7 km southeast of Gijón, on the Asturian coast, represents the only case in the Asturias of a wholly concealed coalfield which

has been discovered by means of boreholes. In all other cases where Carboniferous coal-measures were worked from beneath a Permian and/or Mesozoic unconformable cover, there were at least some exposures. The story of the successive drilling operations, spread out over a period of about thirty years, has been told by FELGUEROSO (1932), PATAC (1933) and P. H. SAMPELAYO (1944, pp.57-66). A summary of data regarding the different boreholes, including simplified logs, has been given by ALMELA & RÍOS (1962). An even more up-to-date account of boreholes in the general area has been published by NAVARRO *et al.* (1988). Only the earlier ones will concern us here.

The first borehole was sunk in 1901 by two brothers of the Felgueroso family, near the village of Vega. It reached Carboniferous strata after cutting through some 160 m of presumed Triassic limestones, marls and conglomerates (ADARO, 1914, p. 56), and showed the presence of two coal seams which later received the letters B and C in the coalfield succession. Shortly after, in 1902, it was attempted to sink a mine shaft on this site which was known as La Camocha after a former occupant, a one-horned cow (la vaca mocha) which used to graze there (*vide* SAMPELAYO, 1944, p. 59). The attempt was unsuccessful because of the difficulty in passing through an aquifer, for which technical knowledge was insufficient at the time. Indeed, it was many years later, in 1931, when a shaft reached the Carboniferous.

Meanwhile, additional boreholes were made. In 1914, the next hole was drilled near the village of Caldones where Carboniferous strata were reached under a presumed Triassic cover of 330 m. This is a celebrated borehole because the drilling operations were interrupted by an explosion of natural gas which blew up the drillrig. RUIZ FALCÓ (1916) presented a detailed account of this borehole which led to further exploration to determine the size of the natural gas deposit. These further investigations were unfortunately unsuccessful. RUIZ FALCÓ (1916, pp. 14, 15) mentioned marine faunal remains (brachiopods, bivalves and a trilobite) as well as plant fossils from the Carboniferous interval between 358.20 and 529.90 m depth. The latter were identified as *Neuropteris gigantea* (STERNBERG) STERNBERG, *cf. Neuropteris villiersii* BRONGNIART, *Sphenopteris trifoliolata* BRONGNIART, *Sphenopteris artemisiaefolia* STERNBERG and *Stigmaria ficoidea* (STERNBERG) BRONGNIART. He also mentioned specifically, from a depth of 527.60 m, a plant fossil combining a nervation of *Neuropteris* type with a general habit suggestive of *Alethopteris*. Unfortunately, none of these remains were figured but the list suggests lower Westphalian.

Presumably the same plant remains were later examined by A. de Alvarado (as quoted by SAMPELAYO, 1944, p. 93), who identified *Diplothmema* (*Sphenopteris*)

*furcata* and *Senftenbergia crenata* or *Pecopteris dentata*. Although Alvarado seemed to favour a Stephanian age (Hullero superior in the then current terminology), Ruiz Falcó opted for middle Westphalian (*loc. cit.*).

The fossils found in the Caldones borehole came from a 210 m thick interval of mudstones with thin limestone intercalations. The lithological characteristics reminded RUIZ FALCÓ (1916, p. 19) of the «Subhullero» interval of the Asturian coal-measures in Adaro's stratigraphic classification. However, he regarded the floral remains are indicative of Adaro's «Hullero intermedio». Since it is presently known that limestone bands in terrigenous units characterise different parts of the Carboniferous depending on which area of Asturias is being dealt with, the lithological data can only be used in the local palaeogeographical context.

The next two boreholes sunk in the area (n<sup>os</sup>. 3 and 4) looked for natural gas and did not attain the Carboniferous (*vide* SAMPELAYO, 1944, p. 62). A fifth borehole, near the village of Aroles, undertaken by the Felgueroso brothers in 1929, reached the Carboniferous at 145 m below presumed Triassic rocks. RUIZ FALCÓ (*in* SAMPELAYO, 1944, p. 92) identified *Spirifer mosquensis* from these strata. This would suggest the Moscovian which is generally the same age as the Westphalian (although the boundaries of these chronostratigraphic units do not coincide.) The sixth borehole, also put down in 1929, this time near Leorio, reached Carboniferous after cutting through 126 m of presumed Triassic strata. Three coal seams were encountered by this boring. A seventh hole, near Pinzales, did not reach the Carboniferous.

The stratigraphic age of the Carboniferous in the La Camocha area has been disputed ever since the first results of the exploratory boreholes became available. ADARO (1914, pp. 56-59) was in favour of a Westphalian age and assigned the coal-bearing strata of La Camocha to his «inferior» and «medio» units. He argued that the steep dip of these strata (about 80° SE) indicated intense folding which he believed to be in keeping with a Westphalian age rather than Stephanian. This opinion was reflected on his general map and corresponding cross sections (ADARO, 1914, lám. 1 and lám. 2, fig. D) which showed an isoclinal syncline on the site of the Vega borehole.

A completely opposed viewpoint was expressed by PATAC (1920, 1933), who stated quite categorically that the coal-bearing strata of La Camocha would belong to the Stephanian which he believed to have been folded into an anticline. He supported these conclusions by a long list of plant fossils obtained from exploratory workings at La Camocha and neighbouring Leorio (PATAC, 1933, pp. 76, 77): (Present-day taxonomic nomenclature and generally accepted

synonyms are placed between brackets, and spelling mistakes have been corrected as well as the names of the authors where the wrong ones appeared in the list.)

- Neuropteris stipulata* ZEILLER (= *Neuropteris ovata* HOFFMANN)  
*Mixoneura neuropteroides* (GÖPPERT) ZEILLER (= *Neurocallipteris neuropteroides* (GÖPPERT) CLEAL, SHUTE & ZODROW)  
*Sphenopteris notha* EICHWALD  
*Sph. castelii* ZEILLER  
*Sph. mathetii* ZEILLER  
*Pecopteris (Dactylothea) gruneri* ZEILLER (= *Senftenbergia gruneri* (ZEILLER) *comb. nov.*)  
*Dactylothea plumosa* (ARTIS) BRONGNIART (= *Senftenbergia plumosa* (ARTIS) STUR)  
*Pecopteris biotii* BRONGNIART (= *Senftenbergia biotii* (BRONGNIART) STUR)  
*Annularia stellata* (VON SCHLOTHEIM) WOOD  
*Asterophyllites longifolius* STERNBERG  
*Calamites suckowii* BRONGNIART  
*C. cistii* BRONGNIART  
*Arthropitys approximata* (VON SCHLOTHEIM) RENAULT (= *Calamites approximatus* (VON SCHLOTHEIM) ARTIS, a species not figured by von Schlotheim and which must be considered invalid).  
*A. bistrinata* (COTTA) GÖPPERT (= *Calamites bistrinatus* COTTA)  
*A. gigas* (BRONGNIART) RENAULT (= *Calamites gigas* BRONGNIART)  
*A. elongata* RENAULT (= *Calamites elongatus* (RENAULT) JONGMANS)  
*A. stephanense* RENAULT (= *Calamites undulatus* STERNBERG)  
*Calamodendron inaequale* RENAULT (= *Calamites infractus* VON GUTBIER)  
*Calamocladus lignosus* RENAULT (= *Asterophyllites lignosus* (RENAULT) JONGMANS)  
*Cordaites lingulatus* GRAND'EURY  
*Dorycordaites affinis* (GRAND'EURY) RENAULT  
*Poacordaites linearis* GRAND'EURY  
*Artisia ortonis* GEINITZ  
*Dicranophyllum longifolium* RENAULT  
*Titanophyllum* sp.  
*Sigillaria brardii* BRONGNIART  
*S. deutschii* BRONGNIART  
*Stigmaria ficoides* (STERNBERG) BRONGNIART

On the face of it, this list may be construed as evidence of a Stephanian age. However, the proportion of the different groups represented in this list, is not that

usually found in Stephanian floras which tend to show a predominance of pectopterid ferns. It is also apparent that the few pectopterids listed all belong to the fructification genus *Senftenbergia* which is common in Westphalian strata and only a minority element among Stephanian pectopterids. In the absence of illustrations, Patac's list will always remain the subject of doubt, but it is difficult to avoid the suspicion that the identifications were made on the *a priori* conviction that a Stephanian flora would be present.

More palaeontological data became available through the work of SAMPELAYO (1944, pp. 82-93, láms VIII-XI), who studied the marine faunal remains obtained from the La Camocha mine workings. A stratigraphically significant fauna came from c. 114 m below Seam 4. The following elements were recorded (*op. cit.*, p. 83):

- Temnocheilus coronatus* McCoy
- Gastrioceras* cf. *subcrenatum* VON SCHLOTHEIM
- Reticuloceras* sp. ?
- Goniatites spiralis* PHILLIPS
- Homoceras* sp.
- Homoceratoides* sp.
- Paradomatoceras* sp.?
- Pleuronautilus cornatum* Girty
- P. perelegans* Girty
- Coelonautilus* sp. (*Vestinautilus* sp.)
- Serpula nautiloides* McCoy
- Bellerophon urii* FLEMING

Despite certain contradictions in this list, which presents a mixture of upper Viséan, Namurian and lowermost Westphalian elements, SAMPELAYO (1944, p. 90) concluded on an early Westphalian age.

This conclusion found support in Jongmans's opinion on the basis of plant fossils collected from the general tip of the La Camocha mine in 1947 (JONGMANS 1951, p. 287; 1952, p. 14, lám. XXIV):

- Neuropteris* cf. *schuetzei* POTONIÉ (later identified as *Neuropteris asturiana* JONGMANS in WAGNER, 1962, pl. 26, figs 3, 3a)
- Alloiopteris* (*Corynepteris*) *coralloides* (VON GUTBIER) POTONIÉ
- Renaultia* sp.
- Asterophyllites grandis* (STERNBERG) GEINITZ
- Calamites undulatus* STERNBERG
- C. suckowii* BRONGNIART
- Sigillaria elegans* BRONGNIART *non* STERNBERG



*S. cf. scutellata* BRONGNIART

*Sigillariostrobus cf. goldenbergii* FEISTMANTEL

The presence of *Sigillaria elegans* provided a clear indication of either a late Namurian or an early Westphalian age. This is probably the same species as that identified by PATAK (1933) as *S. brardii*, the ultimate branches of which have often been confused with *S. elegans* (quite apart from the nomenclatorial difficulties surrounding this taxon).

The presence of a lower Westphalian flora at La Camocha motivated the collecting trip and stratigraphic investigation carried out in 1952 by Professor W.J. Jongmans and one of the present authors (RHW). Apart from obtaining a 1:100 scale stratigraphic section, the latter found evidence of an isoclinal synclinal core in the mine workings. Plant megafossils and coal samples for palynology were collected, as well as both marine and non-marine invertebrates. An important locality (n° 121) for marine fossils was found at the roof of a thin coal situated at some 120 m below the workable Seam 4. This is probably the same horizon from which SAMPELAYO (1944) obtained the faunal remains mentioned earlier. Cephalopod remains found at loc. 121 (marked as goniatite locality in Fig. 1) were identified by SCHMIDT (1955), who figured and described the most important elements:

*Paralegoceras percostatum* SCHMIDT (tentatively referred to *Axinolobus* by MCCALED, 1968)

cf. *Gastrioceras cancellatum* BISAT

*Homoceras* sp.

*Anthracoceras* sp.

*Metacoceras* sp.

*Coelonautilus stygialis* DE KONINCK

*Thoracoceras vestitum* FISCHER DE WALDHEIM

He also mentioned some brachiopods occurring with the cephalopods: *Martinia* sp., *Schuchtertella* sp., *Chonetinella* sp. SCHMIDT (1955) concluded that a fauna of late Namurian age was represented, a conclusion based primarily on the more fragmentary remains present. The new species, *Axinolobus percostatus*, was compared with Atokan forms from North America and Westphalian elements from North Africa.

The coal samples collected from the productive measures of La Camocha were analysed for megaspores by BONET & DIJKSTRA (1956), who recorded the following taxa (names adjusted to present-day nomenclature):

*Laevigatisporites glabratus* (ZERNDT) POTONIE & KREMP

*Setosisporites hirsutus* (LOOSE) IBRAHIM  
*Setosisporites praetextus* (ZERNDT) POTONIÉ & KREMP  
*Valvisporites auritus* (ZERNDT) POTONIÉ & KREMP  
*Tuberculatisporites mamillarius* (BARTLETT) POTONIÉ & KREMP  
*Zonalesporites brassertii* (STACH & ZERNDT) POTONIÉ & KREMP  
*Lagenosporites rugosus* (LOOSE) POTONIÉ & KREMP  
*Lagenicula horrida* ZERNDT  
*Cystosporites giganteus* (ZERNDT) SCHOPF  
*C. varius* (WICHER) DIJKSTRA  
*C. verrucosus* DIJKSTRA  
*Triangulatisporites triangulatus* (ZERNDT) POTONIÉ & KREMP.

They also recorded the following large microspores and prepollen (names also adjusted to present-day nomenclature):

*Schopfipollenites* sp.  
*Calamospora* sp.  
*Spencerisporites karczewskii* (ZERNDT) CHALONER.

They concluded on a Westphalian A age (BONET & DIJKSTRA, 1956, p. 262).

After a brief report given by MELÉNDEZ (1952), in which Professor Jongmans was quoted as having identified both Westphalian A and Namurian C in the 1,300 m thick succession worked by the coal mine, a full list of megafloreal taxa described by W.J. Jongmans in an unpublished manuscript was reproduced by WAGNER (1959, pp. 398, 399). This list, published posthumously, was mistakenly regarded as the result of finished work. In fact, Jongmans's manuscript was probably only a preliminary draft. It contains several errors as well as a number of manuscript names which are *nomina nuda* in the list published by WAGNER (1959). No useful purpose is served by repeating this list here, since the present authors have been able to revise the identifications on the basis of the actual specimens studied by Jongmans. Some additional material obtained later has been included in the revision (Fig. 2). JONGMANS (*in* WAGNER, 1959), on the basis of his preliminary determinations, concluded on Namurian B-C and early Westphalian A ages.

JONGMANS (1957) commenced the description of the megaflorea collected in the La Camocha mine with the introduction of a new species, *Calamites circularis* JONGMANS. Additional taxa were introduced by WAGNER (1962, pl. 29): *Neuropteris asturiana* JONGMANS MS (transferred to *Paripteris* by LORENZO, 1977), and *Rhodeopteridium jongmansii* WAGNER. There is a suspicion that the latter represents the rooting system of a fern. *Rhodeopteridium* is therefore eliminated from the list of taxa from La Camocha. WAGNER (1962) also figured *Alethopteris edwardsii* STOCKMANS & WILLIÈRE and *Sigillaria elegans* BRONGNIART

|   | loc |     | seam number |     |    |   |    |   |    |     |   |
|---|-----|-----|-------------|-----|----|---|----|---|----|-----|---|
|   | 116 | 115 | 22          | 21  | 16 | 9 | 8  | 7 | 3  | 2   | 1 |
| <i>Neuropteris obliqua</i>                    |     |     |             |     |    | + |    |   | +  | +   |   |
| <i>Paripteris gigantea</i>                    |     |     |             |     |    | + | cf |   |    | +   |   |
| <i>Paripteris asturiana</i>                   | +   |     | +           | +   |    |   | +  |   | +  | +   | + |
| <i>Linopteris</i> cf. <i>neuropteroides</i>   |     |     |             |     |    | + |    |   | +  | +   |   |
| <i>Potoniaea</i> sp.                          |     |     |             |     |    | + |    |   |    |     |   |
| <i>Alethopteris</i> cf. <i>edwardsii</i>      |     |     |             |     |    |   |    |   |    | +   |   |
| <i>Karinopteris acuta</i>                     |     |     |             |     |    |   |    |   | +  | +   |   |
| <i>Eusphenopteris neuropteroides</i>          |     |     |             |     |    | + |    |   | +  |     |   |
| <i>Renaultia crepinii</i>                     | cf. |     |             |     |    |   | +  |   | +  |     |   |
| <i>Renaultia footneri</i>                     |     |     |             |     |    |   | +  |   |    |     |   |
| <i>Renaultia rotundifolia</i>                 |     |     |             |     |    |   | +  |   |    |     |   |
| <i>Renaultia schatzlaensis</i>                | +   |     |             |     |    |   |    |   |    |     |   |
| <i>Sphyropteris obliqua</i>                   |     |     |             |     |    |   | +  |   |    |     |   |
| <i>Zeilleria avoldensis</i>                   | +   |     |             |     |    |   |    |   |    |     |   |
| <i>Corynepteris coralloides</i>               |     |     |             |     |    | + |    |   |    |     |   |
| <i>Corynepteris essinghii</i> *               |     |     |             |     |    |   |    |   |    |     |   |
| <i>Senftenbergia plumosa</i>                  |     |     |             |     |    |   |    |   |    | +   |   |
| <i>Sphenophyllum cuneifolium</i>              | +   |     |             | +   |    | + | +  |   | +  |     |   |
| <i>Sphenophyllum</i> cf. <i>kidstonii</i>     |     |     |             | cf. |    |   |    |   |    |     |   |
| <i>Sphenophyllum</i> cf. <i>wingfieldense</i> |     |     |             |     |    |   |    |   |    | cf. |   |
| <i>Sphenophyllostachys</i> sp.                |     |     |             |     |    |   | +  |   |    |     |   |
| <i>Annularia ramosa</i>                       |     |     |             |     |    |   | +  |   | cf | +   |   |
| <i>Asterophyllites grandis</i>                |     |     |             |     |    |   | +  | + |    |     |   |
| <i>Asterophyllites longifolius</i>            | +   |     |             |     |    |   |    |   |    |     |   |
| <i>Asterophyllites charaeformis</i>           |     |     |             | +   |    |   |    | + |    |     | + |
| <i>Calamostachys charaeformis</i>             |     |     | +           | +   |    |   |    |   |    |     |   |
| <i>Calamites carinatus</i>                    |     |     |             |     |    |   | +  |   |    |     |   |
| <i>Calamites circularis</i>                   |     |     |             |     |    |   |    |   | +  |     |   |
| <i>Calamites cistii</i>                       |     |     |             |     |    |   |    |   | +  |     |   |
| <i>Calamites suckowii</i>                     |     |     | +           |     |    |   | +  | + | +  | +   | + |
| <i>Lepidodendron aculeatum</i>                |     |     |             |     |    |   |    | + |    |     |   |
| <i>Lepidodendron acutum</i>                   |     |     | +           |     |    |   |    |   |    |     |   |
| <i>Lepidophloios laricinus</i>                |     |     |             | +   |    | + |    | + | +  |     |   |
| <i>Bothrodendron minutifolium</i>             |     |     |             |     |    |   | +  | + |    |     |   |
| <i>Lepidostrobus ornatus</i>                  |     |     |             | +   |    |   |    |   |    |     |   |
| <i>Lepidostrobophyllum lanceolatum</i>        | +   | +   |             | +   |    | + |    | + | +  |     | + |
| <i>Lepidostrobophyllum majus</i>              |     |     |             |     |    |   |    | + |    | cf  |   |
| <i>Lepidostrobophyllum morrisianum</i>        |     |     |             |     |    |   |    | + |    |     |   |
| <i>Cantheliophorus waldenburgense</i>         |     |     |             | +   |    |   |    | + | +  |     | + |
| <i>Sigillaria elegans</i>                     |     |     |             |     | +  |   |    |   |    |     |   |
| <i>Sigillaria</i> cf. <i>schlotheimiana</i> * |     |     |             |     |    |   |    |   |    |     |   |
| <i>Cyperites bicarinatus</i>                  |     |     |             |     |    |   |    | + |    |     |   |

Figure 2 - Distribution of plant megafloal taxa in the succession worked for coal in the La Camocha Mine (i.e., the upper part of total succession as depicted in Fig. 1). Taxa marked with an asterisk have been obtained from unstated levels in the coal-bearing succession as worked in the mine.

Figura 2.- Distribución de los taxones de megafloora en la parte superior de la sucesión reconocida en la Mina La Camocha ( Fig. 1). Los taxones marcados con un asterisco se han obtenido a partir de niveles no situados con precisión en la sucesión.

non STERNBERG. He listed a selection of species based, in the main, on Jongmans's manuscript notes as quoted in WAGNER, 1959.

The coal samples investigated by BONET & DIJKSTRA (1956) were analysed for their miospore contents by NEVES (1964), who also studied the coals found in an exploratory cross-cut which opened up an additional 1,000 m of strata in the lower part of the succession. The same cross-cut yielded megafloral remains in the vicinity of Seam J (see page 169-170 of the present paper). NEVES recorded a substantial number of taxa, 31 of which were figured on his pls I-III. He regarded the following miospores as being of stratigraphic significance (NEVES 1964, Table 1):

- Schulzospora campyloptera* (WALTZ) POTONIÉ & KREMP
- S. rara* KOSANKE
- Remysporites magnificus* BUTTERWORTH & WILLIAMS
- Camptotriletes superbus* NEVES
- Crassispora kosankei* (POTONIÉ & KREMP) BHARADWAJ
- Dictyotriletes bireticulatus* (IBRAHIM) POTONIÉ & KREMP
- Reinschospora speciosa* (LOOSE) SCHOPF, WILSON & BENTALL
- R. triangularis* KOSANKE
- Florinites antiquus* SCHOPF
- Alatisporites pustulatus* IBRAHIM
- A. inflatus* KOSANKE
- Cirratriradites ornatus* NEVES
- C. saturni* (IBRAHIM) SCHOPF, WILSON & BENTALL
- Armatisporites castanaeformis* DYBOVA & JACHOWICZ
- Mooreisporites fustis* NEVES
- Endosporites ornatus* WILSON & COE
- E. globiformis* (IBRAHIM) SCHOPF, WILSON & BENTALL
- Vestispora pseudoreticulata* SPODE
- V. tortuosa* (BALME) BHARADWAJ
- Laevigatosporites desmoinensis* (WILSON & COE) SCHOPF, WILSON & BENTALL
- Densosporites striatus* (KNOX) POTONIÉ & KREMP
- Lycospora* spp.
- Kosankeisporites* sp.
- Microsporites radiatus* (IBRAHIM) DIJKSTRA (= *Spencerisporites karczewskii* (ZERNDT) CHALONER)

NEVES (1964) distinguished five miospore zones, viz. the *Remysporites magnificus*, *Dictyotriletes bireticulatus*, *Vestispora tortuosa*, *Vestispora pseudoreticulata* and *Endosporites globiformis* zones (in upward succession). The total range of ages represented was given as late Namurian A to earliest

Westphalian B. This range was shortened subsequently by HORVATH (1985) (see page ---).

The brachiopod faunas from the marine intervals in the La Camocha succession were partially incorporated in a systematic treatment of productid and chonetid faunas from the Cantabrian Mountains by WINKLER PRINS (1968), who mentioned: *Productus carbonarius* DE KONINCK, *Antiquatonia hindi* (MUIR-WOOD), *Cancrinella retiformis* (MUIR-WOOD), *Tornquistia diminuta* (DEMANET) and *Rugosochonetes acutus* (DEMANET). He regarded these elements as lower Moscovian. A more complete record of brachiopod faunas from La Camocha was provided later by MARTÍNEZ CHACÓN (1977, 1979).

A single ostracode species was described from the lower part of the La Camocha succession by BLESS (1969): *Hollinella? cf. avonensis* (LATHAM). More complete faunas were described later by SÁNCHEZ DE POSADA (1977).

Non-marine bivalves from La Camocha were mentioned briefly by EAGAR & WEIR (1971). Two taxa were stated to be present, viz. *Curvirimula* spp. of the *C. belgica* (HIND) group and *Naiadites* sp.

A few megafossil remains from La Camocha were recorded by ÁLVAREZ RAMIS (1974a, b, 1977, 1985), without locality details. The same photographs were used in the three different papers with illustrations. She identified the following taxa: *Sturia amoena* (STUR) NĚMEJC, *Renaultia footneri* (MARRAT) KIDSTON, *Discopteris bertrandii* DANZÉ and *Sphenopteris cf. sewardii* KIDSTON. The enlargements used in the 1977 paper (lám. V) permit the following observations: The specimen identified as *S. amoena* is apparently not this species but resembles *R. footneri*. The specimen figured under the name of *R. footneri*, although poorly preserved, probably belongs to this species. The present writers also agree with the likelihood that a *Discopteris* has been found, but prefer to determine the figured specimen (ÁLVAREZ RAMIS, 1977, lám. V, figs 3, 3a) as *cf. Discopteris karwinensis* Stur. The fourth species recorded can only be identified as *Sphenopteris* sp. In her 1974a paper, ÁLVAREZ RAMIS ventured to comment on the specimens figured by JONGMANS (1952), attributing *Sigillaria elegans* to *S. mammillaris* BRONGNIART and the *Neuropteris cf. schuetzei* POTONIÉ (= *Paripteris asturiana* (JONGMANS) LORENZO) to *Linopteris neuropteroides* (VON GUTBIER) POTONIÉ. These reidentifications are without foundation, and it is clear that she overlooked the *Paripteris asturiana* as figured by WAGNER (1962). Indeed, she failed to refer to either WAGNER, 1959, or WAGNER, 1962, in which the megafloora of La Camocha was mentioned and at least partly illustrated.

ÁLVAREZ RAMIS (1974a, p. 51) concluded that the coal-bearing strata of La Camocha should be attributed to the Upper Westphalian B or, more likely,

Westphalian C. There are no reasonable grounds for this conclusion which runs counter to the results of palynological studies by BONET & DIJKSTRA (1956) and NEVES (1964), which she does not mention and may have been unaware of.

LACHKAR (1976) made a new investigation of the megaspores from La Camocha. He recorded essentially the same assemblage as BONET & DIJKSTRA (1956), but added *Lagenosporites nudus* (NOVAK & ZERNDT) POTONIÉ & KREMP, *Pseudovalvisisporites nigrozonalis* (STACH & ZERNDT) LACHKAR, and *Bentzisporites tricollinus* var. *parviverrucosus* (BHARDWAJ) LACHKAR, and recorded *S. karczewskii* as *Microsporites radiatus* (IBRAHIM) POTONIÉ & KREMP. He noted that his *P. nigrozonalis* is the same spore as that recorded as *Triletes auritus* by BONET & DIJKSTRA. LACHKAR (1976) confirmed the Westphalian A age of the coal seams worked in the La Camocha Mine.

An exhaustive study of mainly marine but partly freshwater to brackish ostracode faunas from La Camocha was published by SÁNCHEZ DE POSADA (1976, 1977). The more complete 1977 paper also contains three lists of microfloral elements identified by M.J.M. Bless from the upper part of the succession repeated in the normal flank of the synclinal structure. These were attributed to the upper Westphalian A. The following ostracodes were recorded by SÁNCHEZ DE POSADA (1977):

- Hollinella* cf. *H. (Keslingella) radiata* (JONES & KIRKBY)
- H. sp. aff. H. (Praehollinella) camoni* BLESS
- Jordanites camochensis* SÁNCHEZ DE POSADA
- Kirkbya waltheri* OMARA & GRAMANN
- Kirkbya?* sp.
- Amphissites (Amphissites) centronotus* (ULRICH & BASSLER)
- Amphissites (Ectodemites)? pataci* SÁNCHEZ DE POSADA
- Kirkbyella (Bernadella)* sp.
- Roundyella simplicissima* (KNIGHT)
- Hypotetragona* sp.
- Sansabella aff. reversa* COPELAND
- Bairdia (Bairdia)* spp.
- Bairdia (Rectobairdia)* sp.
- Bairdia (Orthobairdia) cf. cestriensis* ULRICH
- Bairdia (Cryptobairdia) cf. coryelli* ROTH & SKINNER
- Bairdiacypris* sp.
- Fabalicypis* sp.
- Carbonita cf. pungens* (JONES & KIRKBY)
- Monoceratina* sp.

*Healdia* spp.  
*Asturiella limburgensis* BLESS  
*A.* sp. cf. *calveri* BLESS  
*Asturiella* spp.  
*Cavellina* sp. cf. *cuningsi* PAYNE  
*Pseudobythocypris pediformis* (KNIGHT)

All specimens were obtained from the upper part of the succession (from Seam D upwards). No comments were made as to the stratigraphic age of these ostracode faunas.

A fairly exhaustive record of brachiopod faunas from La Camocha was published on three occasions by MARTÍNEZ CHACÓN (1977, 1979, and *in* SÁNCHEZ DE POSADA, 1977):

*Schizophoria resupinata* (MARTIN)  
*Schuchertella sajakensis asturica* MARTÍNEZ CHACÓN  
*Rugosochonetes acutus* (DEMANET)  
*R. skipseyi* (CURRIE)  
*Rugosochonetinae* gen. et sp. indet.  
*Globosochonetes waldschmidtii* (PAECKELMANN)  
*Megachonetes* ? cf. *zimmermanni* (PAECKELMANN)  
*Tornquistia* cf. *polita* MCCOY  
*Avonia echidniformis* (CHAO)  
*Alitaria nasuta* (PAECKELMANN)  
*Kozłowska* cf. *pusilla* (SCHELLWIEN)  
*Productus carbonarius* de KONINCK  
*Antiquatonia hindi* (MUIR-WOOD)  
*Linoproductus cora* (D'ORBIGNY)  
*L.* cf. *neffedievi* (DE VERNEUIL)  
*Cancrinella craigmarkensis* (MUIR-WOOD)  
*C. retiformis* (MUIR-WOOD)

These faunas were regarded as belonging to the *Alitaria-Karavankina* and *Cancrinella-Tornquistia* zones of WINKLER PRINS (1968), of the Lower Moscovian.

Most important stratigraphically is the palynological investigation (miospores) carried out by HORVATH (1985) which, unfortunately, has remained unpublished. This study modified the range of stratigraphic ages given by NEVES (1964). It was based on 58 coal samples which were supplemented by 14 shale samples from the inaccessible lower part from Seam E downwards. Only the principal taxa were given in a table showing the distribution of species throughout the

succession. Some of the species in this chart were illustrated, as well as a few additional ones. Horvath distinguished between four biozones (SB 1-4) which, together with two additional ones (SB 5, 6), constituted the basis for correlations throughout a fairly substantial part of the Cantabrian Mountains in Asturias as well as in León.

Significant species were given as follows (HORVATH, 1985, Table 3):

*Calamospora* spp.

*Punctatisporites sinuatus* (ARTÜZ) NEVES

*Planisporites granifer* (IBRAHIM) KNOX

*Anapiculatisporites minor* (BUTTERWORTH & WILLIAMS) SMITH &  
BUTTERWORTH

*Pustulatisporites pustulatus* POTONIÉ & KREMP

*Convruccosporites armatus* (DYBOVA & JACHOWICZ) SMITH &  
BUTTERWORTH

*Raistrickia fulva* ARTÜZ

*Dictyotriletes bireticulatus* (IBRAHIM) POTONIÉ & KREMP

*D. muricatus* (KOSANKE) SMITH & BUTTERWORTH

*Campotriletes bucculentus* (LOOSE) POTONIÉ & KREMP

*C. superbus* NEVES

*Lycospora noctuina* BUTTERWORTH & WILLIAMS

*L. pusilla* (IBRAHIM) SOMERS

*L. rotunda* (BHARADWAJ) SOMERS

*Densosporites* spp.

*Cingulizonates loricatus* (LOOSE) BUTTERWORTH *et al.*

*Radiizonates striatus* (KNOX) STAPLIN & JANSONIUS

*Knoxisporites semiradiatus* NEVES

*Reticulatisporites polygonalis* (IBRAHIM) SMITH & BUTTERWORTH

*R. reticulatus* (IBRAHIM) IBRAHIM

*Savitrissporites nux* (BUTTERWORTH & WILLIAMS) SMITH & BUTTERWORTH

*Crassispora kosankei* (POTONIÉ & KREMP) SMITH & BUTTERWORTH

*Cirratriradites saturni* (IBRAHIM) SCHOPE, WILSON & BENTALL

*Reinschospira triangularis* KOSANKE

*Triquitrites bransonii* WILSON & HOFFMEISTER

*T. tribullatus* (IBRAHIM) SCHOPE, WILSON & BENTALL

*Ahrensissporites guerickei* (HORST) POTONIÉ & KREMP

*A. beeleyensis* NEVES

*Endosporites zonalis* (LOOSE) KNOX

*E. ornatus* WILSON & COE



*Remysporites magnificus* (HORST) BUTTERWORTH & WILLIAMS

*Alatisporites pustulatus* (IBRAHIM) IBRAHIM

*Vestispora costata* (BALME) SPODE

*V. tortuosa* (BALME) SPODE

*V. pseudoreticulata* SPODE

*Laevigatosporites vulgaris* (IBRAHIM) ALPERN & DOUBINGER

*Punctatosporites minutus* (IBRAHIM) ALPERN & DOUBINGER

*Florinites* spp.

*Schopfipollenites ellipsoides* (IBRAHIM) POTONIÉ & KREMP

The miospore zones distinguished by HORVATH (1985) are broadly similar to those established by NEVES (1964), but differ in the limit between SB 2 and SB 3 which lies below that between the *Dictyotriletes bireticulatus* and *Vestispora tortuosa* zones of Neves, and in the suppression of his *Endosporites globiformis* Zone, which Horvath incorporated within her zone SB 4. Horvath also modified the range of stratigraphic ages admitted by Neves, attributing a late Namurian age to the lower part of the succession (from Seam N to Seam A) and a Westphalian A age to the upper part (Seams 1-25). Horvath admits the possibility that the lowermost strata in the La Camocha succession belong to the upper Namurian B (read Marsdenian), whilst the highest strata are attributed to the top Westphalian A. These appreciations shorten the range admitted by NEVES (1964), who suggested a late Namurian A (Chokierian-Alportian) age for the lowermost seams sampled and a possible basal Westphalian B age for the highest seams.

A sedimentological investigation of the upper part of the succession in the La Camocha Mine, i.e. from a little below Seam 1 to above Seam 25, was carried out by CORRALES *et al.* (1985). These authors described a deltaic system dominated by fluvial facies including distributory channel deposits, mouth bars and river overbank/floodplain deposits, as well as occasional marine limestones and marls. It is noted here that the thickness and frequency of occurrence of limestones increases in the lower part of the succession not accessible for sedimentological study. Altogether, these facies are quite similar to those found at a higher stratigraphic level (upper Westphalian) in the Central Asturian Coalfield, and it is apparent that the succession found at La Camocha developed in the context of a wider basin with deltaic sediments being produced by a rising hinterland and extending progressively onto a foreland coincident with the Cantabrian Block in the central part of the present-day arcuate fold belt of the Cantabrian Mountains. CORRALES *et al.* (1985) discussed the palaeogeographic position of La Camocha relating this area with the Naranco hills immediately northwest of Oviedo and Santofirme at a short distance north of the Naranco.

## LISTS OF MEGAFLORAL TAXA

A revision of the plant remains collected by Jongmans and Wagner in the 1,300 m of strata worked by the La Camocha Mine shows the presence of the following taxa:

- Paripteris gigantea* (STERNBERG) GOTHAN  
*Paripteris asturiana* (JONGMANS) LORENZO  
*Neuropteris obliqua* (BRONGNIART) GÖPPERT  
*Alethopteris* sp.  
*Linopteris* cf. *neuropteroides* (VON GUTBIER) POTONIÉ  
*Potoniea* sp.  
*Alethopteris* cf. *edwardsii* STOCKMANS & WILLIÈRE  
*Karinopteris acuta* (BRONGNIART) BOERSMA  
*Eusphenopteris neuropteroides* (BOULAY) NOVIK  
*Renaultia crepinii* (STUR) ZEILLER  
*Renaultia footneri* (MARRAT) KIDSTON  
*Renaultia rotundifolia* (ANDRAE) ZEILLER  
*Renaultia schatzlarensis* (STUR) ZEILLER  
*Sphenopteris obliqua* (MARRAT) KIDSTON  
*Zeilleria avoldensis* (STUR) KIDSTON  
*Corynepteris coralloides* (VON GUTBIER) ZEILLER  
*Corynepteris essinghii* (ANDRAE) ZEILLER  
*Senftenbergia plumosa* (ARTIS) STUR  
*Sphenophyllum cuneifolium* (STERNBERG) ZEILLER  
*Sphenophyllum* cf. *kidstonii* HEMINGWAY  
*Sphenophyllum* cf. *wingfieldense* HEMINGWAY  
*Sphenophyllostachys* sp.  
*Annularia ramosa* WEISS  
*Asterophyllites grandis* (STERNBERG) GEINITZ  
*Asterophyllites charaeformis* (STERNBERG) GÖPPERT  
*Asterophyllites longifolius* (STERNBERG) BRONGNIART  
*Calamostachys charaeformis* (STERNBERG) JONGMANS  
*Calamites carinatus* STERNBERG  
*Calamites cistii* BRONGNIART  
*Calamites circularis* JONGMANS  
*Calamites suckowii* BRONGNIART  
*Lepidodendron aculeatum* STERNBERG  
*Lepidodendron acutum* (PRESL.) KIDSTON

*Lepidophloios laricinus* (STERNBERG) STERNBERG  
*Bothrodendron minutifolium* (BOULAY) ZIEGLER  
*Lepidostrobos ornatus* BRONGNIART  
*Lepidostrobophyllum lanceolatum* (LINDLEY & HUTTON) BELL  
*Lepidostrobophyllum majus* (BRONGNIART) HIRMER  
*Lepidophylloides morrisianum* (LESOUEREUX) CROOKALL  
*Cantheliophorus waldenburgense* (POTONIÉ) BASSLER  
*Sigillaria elegans* (STERNBERG) BRONGNIART  
*Sigillaria* cf. *schlotheimiana* BRONGNIART  
*Cyperites bicarinatus* LINDLEY & HUTTON  
*Stigmaria ficoides* (STERNBERG) BRONGNIART  
 seeds (*Trigonocarpus* sp., *Samaropsis* sp.)

The distribution of species in the succession worked by the La Camocha Mine shows that only minor differences exist between the floral assemblages found at the various levels sampled (Fig. 2). The total number of species recorded is forty. This is probably less than half the number of taxa that may have been present, and it is noted that only a few localities have yielded more than three species. The collection thus cannot be regarded as fully representative. This being the case, it seems reasonable to regard the total succession, from seam groups A, B, C to the core of the syncline, as corresponding to a single stratigraphic age, as far as megafloreal evidence is concerned.

Most of the taxa recorded range throughout Langsettian and Duckmantian. However, the presence of *Karinopteris acuta* and *Sigillaria elegans* (the latter found in the upper third of the succession) suggests that the coal-bearing strata of La Camocha do not go beyond the Langsettian. Both species are characteristic of Yeadonian and Langsettian. On the other hand, the presence of several species of *Renaultia* tends to eliminate the upper Namurian. As a matter of fact, *R. footneri* and *R. rotundifolia* are not recorded below the Langsettian. Also the two species of *Corynepteris*, *C. coralloides* and *C. essinghii*, are restricted to the Westphalian. The same is true of *Sphyropteris obliqua*, but this is a rare species of lesser stratigraphic importance.

It thus appears that the entire succession of 1,300 m worked in the La Camocha Mine belongs to the Langsettian. This confirms the conclusion reached by HORVATH (1985) on the basis of miospore assemblages.

A small collection was made in 1961 from strata exposed temporarily in a cross-cut which explored a succession below that worked by the mine. Plant fossils were obtained from shales associated with Seam J, at 560 m below Seam C (Fig. 1) (localities 1150, 1151):

*Paripteris asturiana* (JONGMANS) LORENZO  
*Neuralethopteris schlehanii* (STUR) CREMER  
*Eusphenopteris* sp.  
*Lyginopteris* sp. (cf. *L. hoeninghausii* (BRONGNIART) POTONIÉ)  
 cf. *Senftenbergia aspera* (BRONGNIART) STUR  
*Sphenophyllum cuneifolium* (STERNBERG) ZEILLER  
*Lepidophloios laricinus* (STERNBERG) STERNBERG  
 «*Lepidodendron*» cf. *lossenii* WEISS  
*Lepidostrobophyllum lanceolatum* (LINDLEY & HUTTON) BELL

This small assemblage is rather incomplete, but it seems characteristic of the upper Namurian. HORVATH (1985), on the basis of more complete palynological data, indeed referred this interval to the upper Namurian.

## FLORAS OF COMPARABLE AGE

Early Westphalian floras are found in a number of places in the Iberian Peninsula. The most complete megafloral record is that from the Peñarroya Coalfield in the province of Córdoba, SW Spain. This ranges from upper Langsettian to upper Duckmantian (CAV *in prep.*). Practically all the species found at La Camocha exist also in the Peñarroya Coalfield, the only undoubted exception being *Neuralethopteris schlehanii*.

The Langsettian is also present at Villanueva del Río y Minas (Sevilla), but the floras recorded from this coalfield (GOTHAN *in* SIMON, 1953; GARCÍA-LOYGORRI & ORTUÑO, 1969; WAGNER *et al.*, 1983) are too incomplete to warrant a comparison.

Strata of approximately the same age may also be represented in south Portugal (TEIXEIRA & PAIS, 1976), but the drifted stem remains illustrated only allow to conclude on a general Namurian to Westphalian age.

In the Cantabrian Mountains, NW Spain, there are several localities with lower Westphalian strata. The most complete floral assemblages have been obtained from the Curavacas Conglomerate Formation in the province of Palencia, in the southeastern part of the Palaeozoic core of the Cantabrian Mountains. First described as belonging to upper Westphalian B (WAGNER, 1960), an age determination maintained in WAGNER & BOWMAN (1983), these floras are currently assigned an early Duckmantian age by the present authors. STOCKMANS & WILLIÈRE (1965) determined a late Westphalian A (= Langsettian) flora from the basal part of the Curavacas Formation near Cardaño de Arriba (Palencia). It was doubted by WAGNER & BOWMAN (1983) that the Cardaño de Arriba locality would really

belong to the Curavacas Formation (locality details are scanty and difficult to verify), but the present writers are prepared to admit the attribution to this formation, the age of which apparently ranges from late Langsettian to early (middle?) Duckmantian. The Curavacas floras are less complete than those known from the more exhaustively sampled Peñarroya Coalfield, but the species contents are identical.

There are a few minor differences with La Camocha which is of late Namurian (Yeadonian) and Langsettian ages and therefore, on the whole, earlier than Peñarroya and Curavacas. One of the most common species at La Camocha is *Paripteris asturiana*, a form with small, straight-sided pinnules, which Laveine (in MARTÍNEZ DÍAZ *et al.*, 1985) compared with *Paripteris pseudogigantea*. This is replaced by *Paripteris gigantea* (mainly the form recorded in the literature as *Paripteris linguaefolia*) in the Peñarroya Coalfield and in the Curavacas Formation of Palencia. Also *Neuralethopteris schlehanii*, present in the lower part of the Namurian succession at La Camocha, has not been seen in either Peñarroya or the Curavacas Formation. This may be due either to collecting failure or, more likely, to its absence at the high levels of Langsettian present in these areas.

Indeed, at a level corresponding to the Carmen Formation, below the major unconformity associated with the Curavacas Conglomerate Formation, at the locality of Dobres (Cantabria Province), *N. schlehanii* has been found (WAGNER, 1959, p. 400). This small locality was assigned a late Namurian or early Westphalian A age (*op. cit.*). The same locality was referred to the Westphalian A by Álvarez-Vázquez (in HEREDIA *et al.*, 1990, p. 71). The Carmen Formation overlies the Perapertú Formation which contains lower Moscovian (Vereisky) foraminifera (RUMYANTSEVA in WAGNER & BOWMAN, 1983) and Atokan goniatites (WAGNER-GENTIS, 1985).

Floras characterised by *Paripteris asturiana* also occur in the Naranco hills near Oviedo (LORENZO, 1977), Quirós, Asturias (LAVEINE & BROUSMICHE in LEYVA *et al.*, 1985), at Teverga, Asturias (JONGMANS in WAGNER, 1959; LAVEINE & BROUSMICHE in LEYVA *et al.*, 1985) and at San Emiliano, León (JONGMANS in WAGNER, 1959; STOCKMANS & WIJLLIÈRE, 1965; WAGNER & BOWMAN, 1983). These rather incomplete floral records have been ascribed to Westphalian A and B, but, most likely, all belong to the Langsettian.

Finally, strata containing *Neuralethopteris schlehanii*, have been recorded as Westphalian A (= Langsettian) from Huesca in the axial zone of the Pyrenees (GOTHAN in SCHMIDT, 1931, p. 61; WAGNER in WENSINK, 1962, p. 27). Similar assemblages with *N. schlehanii* have been figured and described by LAVEINE (in DELVOLVÉ & LAVEINE, 1985) from the French Pyrenees, also

from its axial zone. The French assemblages have been assigned a middle Namurian age on the basis of associated goniatite faunas.

## COMMENTS ON SELECTED TAXA

*Paripteris asturiana* (JONGMANS) LORENZO - A species with blunt, straight-sided pinnules, similar to those of *Paripteris pseudogigantea* (POTONIÉ) GOTHAN, but showing an average pinnule size smaller than that found in *P. pseudogigantea*. In view of the large amount of size variation in the pinnules of different species of *Paripteris*, it is still an open question whether *P. asturiana* should be maintained as a separate taxon (compare ZHANG *et al.*, 1992).

*Lyginopteris* cf. *neuropteroides* (VON GUTBIER) POTONIÉ - This is the form with relatively broad pinnules which is commonly identified under this name in the paralic coal belt of NW Europe. A more slender form of *L. neuropteroides* occurs in Stephanian strata. The species as described originally from Zwickau, Saxony (compare DABER, 1955) appears intermediate in character.

*Lyginopteris* sp. cf. *L. hoeninghausii* (BRONGNIART) POTONIÉ - Fragmentary remains showing the larger rachises with spines and, separately, pinna fragments of the last and penultimate orders. Pinnules are small, characteristically trilobate and fairly uniform in size and dimensions. They appear less vaulted than the pinnules of typical *L. hoeninghausii*, but are otherwise quite similar.

«*Lepidodendron*» cf. *lossenii* WEISS - Older stems or branches with false leaf scars corresponding to a raised area; leaf cushions with transverse wrinkles; smaller branches with widely based, almost perpendicularly inserted, slender leaves, up to 6-7 mm long. This species differs from *Lepidodendron worthenii* Lesquereux because of the absence of a proper leaf scar. It is very similar to the lower Carboniferous species «*Lepidodendron*» *lossenii* WEISS, which also displays false leaf scars on raised areas and wrinkled leaf cushions disposed in what appears to be the same phyllotaxis. Until a full description has been made of the reasonably well preserved material from La Camocha, and the still rather poorly known species «*Lepidodendron*» *lossenii* can be analysed more completely, the present writers prefer to compare the specimens in hand with *L. lossenii* rather than identify them with this species outright.

Recibido el día 21 de Febrero de 1994

Aceptado el día 17 de Mayo de 1994

## REFERENCES

- ADARO, L. DE (1914). Emplazamiento de sondeos para investigar la probable prolongación de los senos hulleros por bajo de los terrenos mesozoicos. *Boletín Instituto Geológico España*, **XXXIV**: 9-79.
- ALMELA, A. & RÍOS, J.M. (1962). Investigación del Hullero bajo los terrenos mesozoicos de la Costa Cantábrica (zona de Oviedo-Gijón-Villaviciosa-Infiesto). *E.N. Adaro Investigaciones Mineras*, 171 pp., láms I-VII, mapa y cortes.
- ÁLVAREZ RAMIS, C. (1974a). Consideraciones sobre el nivel estratigráfico de la cuenca hullera de «La Camocha» en relación con el estudio de los *Sphenopteris*. *Acta Geológica Hispánica*, **IX** (2): 50-51.
- ÁLVAREZ RAMIS, C. (1974b). Nota sobre la distribución de los *Sphenopteris* del Carbonífero superior (Silesiense) en las cuencas carboníferas asturianas. *Bulletin Société belge Géologie, Paléontologie, Hydrologie*, **83** (2): 109-111.
- ÁLVAREZ RAMIS, C. (1977). Segunda aportación al estudio de los *Sphenopteris* del Carbonífero español; Westfaliense. *Estudios Geológicos*, **33**: 141-165.
- ÁLVAREZ RAMIS, C. (1985). Les frondes sphénoptériennes du Carbonifère du Nord de l'Espagne. *C.R. 9<sup>e</sup> Congrès Carbonifère, Washington and Champaign-Urbana 1979*, **1**: 127-141.
- BLESS, M.J.M (1969). On a case of dimorphism in the last juvenile stage of a hollinid ostracode from the Namurian B-C of the La Camocha Mine (Gijón, N. Spain). *Breviora Geológica Astúrica*, **XIII** (3): 31-38.
- BONET, M.C. & DIJKSTRA, S.J. (1956). Megasporas carboníferas de La Camocha (Gijón). *Estudios Geológicos*, **XII**, 31-32: 245-266, láms XLVIII-LVII.
- CORRALES, I.; FLOR, G.; PELLO, J. & PEÓN, A. (1985). Facies y secuencias sedimentarias en el Carbonífero de La Camocha (Gijón, NO de España). *Trabajos de Geología*, **15**: 19-27.
- DABER, R. (1955). Pflanzengeographische Besonderheiten der Karbonflora des Zwickau-Lugauer Steinkohlenreviers. A. Pteridophyllen (farnlaubige Gewächse). *Geologie*, **13**: 1-95, Tafel I-XXV.
- DELVOLVÉ, J.-J. & LAVEINE, J.-P. (1985). Sur quelques flores du Carbonifère des Pyrénées béarnaises. *Geobios*, **18** (3): 281-304, pl. A, pls 1-7.
- EAGAR, R.M.C. & WEIR, J. (1971). Some Spanish Upper Carboniferous non-marine bivalve faunas: a preliminary statement with emphasis on facies in north-west Spain and in Britain. *In*: R.H. WAGNER (Ed.). *The Carboniferous of Northwest Spain*. *Trabajos de Geología*, **3**: 87-99, pls 1, 2.
- FELGUEROSO, L. (1932). Trabajos realizados por la Sociedad «Felgueroso Hermanos» para reconocer los terrenos hulleros que se extienden bajo los estratos triásicos del Concejo de Gijón, y noticia sobre la profundización del pozo de «La Camocha».

- consecuencia de aquellos trabajos. *Revista Industrial-Minera Asturiana*, **XVII**: 57-59, 71-74, 107-109, 114-117, 133-135.
- GARCÍA-LOYGORRI, A. & ORTUÑO AZNAR, G. (1969). Estudio geológico de la cuenca carbonífera de Villanueva del Río y Minas (Sevilla). *III Jornadas y Primeras Internacionales Minero-Metalúrgicas, Gijón 1967*: 821-864, Text-figs 1-6, Fotos 1-27, Planos 1-4.
- HEREDIA, N.; RODRÍGUEZ FERNÁNDEZ, L.R.; SUÁREZ RODRÍGUEZ, A. & ÁLVAREZ MARRÓN, J. (1990). *Memoria del Mapa Geológico de España E. 1:50.000 núm. 80 (Burón)*. Segunda Serie MAGNA. Primera edición. Instituto Tecnológico GeoMinero España, Madrid. 144 pp.
- HORVATH, V. (1985). Apports de la palynologie a la stratigraphie du Carbonifère moyen de l'Unité structurale de la Sobia-Bodón (Zone Cantabrique - Espagne). *Thèse Troisième Cycle, Université Sciences Techniques Lille*, 137 p., pls I-V (unpublished thesis).
- JONGMANS, W.J. (1951). Las floras carboníferas de España. *Estudios Geológicos*, **VII**, 14: 281-330.
- JONGMANS, W.J. (1952). Documentación sobre las floras hulleras españolas. Primera contribución: Flora carbonífera de Asturias. *Estudios Geológicos*, **VIII**, 15: 7-19, láms II-XXVIII.
- JONGMANS, W.J. (1957). Revision of some species of *Calamites* related with *C. wedekindi* Weiss. *Mededelingen Geologische Stichting*, (N.S.), **10** (1956): 35-41, pls 12-16.
- LACHKAR, G. (1976). Associations de mégaspores dans les charbons de la Mine «La Camocha» (Province de Oviedo Espagne) Applications stratigraphiques. *Revista Española Micropaleontología*, **VIII** (1): 123-137, pls 1-3.
- LEYVA, F.; GRANADOS, L.F.; SOLOVIEVA, M.N.; REITLINGER, E.A.; MARTÍNEZ-DÍAZ, C.; LAVEINE, J.P.; LOBOZIAK, S.; BROUSMICHE, C.; CANDILIER, A.M. & HORVATH, V. (1985). La estratigrafía del Carbonífero medio en el sector central de la unidad estructural de la Sobia-Bodón (Cuencas de Quirós y Teverga). *C.R. 10<sup>e</sup> Congrès Carbonifère, Madrid 1983*, 1: 213-230, láms I-IV.
- LORENZO, P. (1977). Sobre el manchón carbonífero oriental del Monte Naranco, (Oviedo, Asturias). *Breviora Geológica Astúrica*, **3**: 33-37.
- MCCALEB, J.A. (1968). Lower Pennsylvanian Ammonoids from the Bloyd Formation of Arkansas and Oklahoma. *Geological Society America, Special Paper*. **96**: 1-91, pls 1-12.
- MARTÍNEZ CHACÓN, M.L. (1977). Contenido en braquiópodos (Orthida, Strophomenida y Rhynchonellida) de algunas formaciones del Carbonífero cantábrico. *Breviora Geológica Astúrica*, **XXI** (3): 41-48.
- MARTÍNEZ CHACÓN, M.L. (1979). Braquiópodos carboníferos de la Cordillera



- Cantábrica (Orthida, Strophomenida y Rhynchonellida). *Instituto Geológico Minero España*, Memoria **96**: 291 pp., láms 1-32.
- MARTÍNEZ DÍAZ, C.; GRANADOS, L.F.; LEYVA, F.; LAVEINE, J.P.; SOLOVIEVA, M.N.; REITLINGER, E.A.; GERVILLA, M.; LOBOZIAK, S.; BROUSMICHE, C.; CANDILIER, A.M.; PENDÁS, F. & HORVATH, V. (1985). Aportaciones a la cronoestratigrafía del Carbonífero medio de Asturias y nuevos datos para un intento de correlación de las escalas marinas y continentales. *C.R. 10<sup>e</sup> Congrès Carbonifère, Madrid 1983*, **1**: 269-280.
- MELÉNDEZ, B. (1952). Actividades del Prof. W.J. Jongmans, de Heerlen. *Estudios Geológicos*, **VIII**: 397-398.
- NAVARRO VÁZQUEZ, D.; LEYVA CABELLO, F.; RODRÍGUEZ FERNÁNDEZ, L.R.; MARTÍNEZ CIENFUEGOS, F.; VILLA OTERO, E.; HORVATH MARDONES, V. & HEREDIA CARBALLO, N. (1988). Cuencas carboníferas ocultas por la cobertera mesozoico-terciaria en Asturias. *Instituto Geológico Minero España, Colección Informe*, 110 pp., mapas.
- NEVES, R. (1964). The stratigraphic significance of the small spore assemblages of the La Camocha Mine, Gijón, N. Spain. *C.R. 5<sup>e</sup> Congrès Carbonifère, Paris 1963*, **III**: 1229-1238, pls I-III.
- PATAC, I. (1920). La Formación Uraliense Asturiana. Estudios de Cuencas Carboníferas. *Compañía Asturiana de Artes Gráficas, S.A., Gijón*: 50 pp. (privately printed).
- PATAC, I. (1933). La Cuenca Carbonífera de Gijón. *Riquezas Minerales de España*: 15 pp. (privately printed).
- RUIZFALCÓ, M. (1916). El sondeo de Caldones en Asturias. *Boletín Instituto Geológico España*, **XXXVII**: 1-26.
- SAMPELAYO, P.H. (1944). Datos para el estudio de las hojas del Mapa Geológico 1:50.000, Gijón (14), Oviedo (29). *Instituto Geológico Minero España*, 111 pp., láms 1-16.
- SÁNCHEZ DE POSADA, L.C. (1976). Quelques remarques au sujet de la répartition des faunes d'Ostracodes carbonifères dans la Chaîne Cantabrique. *Annales Société géologique Nord*, **XCVI**: 407-412.
- SÁNCHEZ DE POSADA, L.C. (1977). Ostracodes from the upper Carboniferous of La Camocha Coal Mine (Asturias, N. Spain). *Revista Española Micropaleontología*, **IX** (3): 411-438, pls 1-6.
- SCHMIDT, H. (1931). Das Paläozoikum der spanischen Pyrenäen. *Abhandlungen Gesellschaft Wissenschaften Göttingen, Mathematische-Physische Klasse*, **III** (5): 980-1065. Tafn I, II (Traducción española 1943: El Paleozoico del Pirineo español. *Publicaciones alemanas sobre Geología de España*, **II**, 1944: 99-195, láms I, II).
- SCHMIDT, H. (1955). Einige Goniatiten aus spanischem Oberkarbon. *Publication Association Études Paléontologie Stratigraphie houillères* (volume hommage F. Demant), **21** (Hors Série): 47-59, Taf. A.

- SIMON, W. (1953). Zur Geschichte der spanischen Sierra Morena. 5. Variscische Sedimente der Sierra Morena, Das Kohlenbecken von Villanueva. *Senckenbergiana*, **31** (5-6): 299-311 (Traducción española - Datos para la historia de Sierra Morena. Sus sedimentos variscos. La cuenca carbonífera de Villanueva. *Publicaciones extranjeras sobre Geología de España*, VII (1): 47-68).
- STOCKMANS, F. & WILLIÈRE, Y. (1965). Documents paléobotaniques pour l'étude du houiller dans le Nord-Ouest de l'Espagne. *Mémoires Institut Royal Sciences Naturelles Belgique*, (2), **79**: 1-92, pls I-XXXVIII.
- TEIXEIRA, C. & PAIS, J. (1976). Vegetais do Carbónico de Vale de Corvos (Portimão). *Comunicações Serviços Geológicos Portugal*, **LX**: 163-170, Est. I, II.
- TRUYOLS SANTONJA, J. & SÁNCHEZ DE POSADA, L. (1983). El Carbonífero inferior y medio de la Región de Pliegues y Mantos. In: C. MARTÍNEZ DÍAZ (coordinador). Carbonífero y Pérmico de España, *X Congreso Internacional de Estratigrafía y Geología del Carbonífero*. Instituto Geológico Minero España: 39-59.
- WAGNER, R.H. (1959). Flora fósil y estratigrafía del Carbonífero de España NW. y Portugal N. *Estudios Geológicos*, **XV**: 393-420.
- WAGNER, R.H. (1960). Middle Westphalian floras from northern Palencia (Spain) (in relation with the Curavacas phase of folding). *Estudios Geológicos*, **XVI**: 55-92.
- WAGNER, R.H. (1962). A brief review of the stratigraphy and floral succession of the Carboniferous in NW. Spain. *C.R. 4<sup>e</sup> Congrès Carbonifère, Heerlen 1958*, III: 753-762, pls 29-33.
- WAGNER, R.H. & BOWMAN, M.B.J. (1983). The position of the Bashkirian/Moscovian boundary in West European chronostratigraphy. *Newsletters Stratigraphy*, **12** (3): 132-161.
- WAGNER, R.H.; COQUEL, R. & BROUTIN, J. (1983). Micro- and megafloreal remains of early Westphalian age from Villanueva del Río y Minas (Prov. Sevilla, Spain). In: M.J. LEMOS DE SOUSA (Ed.). *Contributions to the Carboniferous Geology and Palaeontology of the Iberian Peninsula*, Universidade Porto, Faculdade Ciências, Mineralogia Geologia, 1983: 241-251, pls 1, 2.
- WAGNER-GENTIS, C.H.T. (1985). A possible Atokan goniatite fauna from basal Moscovian (Westphalian A) deposits at Piedrasluengas, N.W. Spain. *Senckenbergiana lethaea*, **65** (4/6): 337-345, Taf. 1.
- WENSINK, H. (1962). Paleozoic of the upper Gállego and Ara valleys, Huesca province, Spanish Pyrenees. *Estudios Geológicos*, **XVIII**: 1-74.
- WINKLER PRINS, C.F. (1968). Carboniferous Productina and Chonetidina of the Cantabrian Mountains (NW Spain): Systematics, Stratigraphy and Palaeoecology. *Leidse Geologische Mededelingen*, **43**: 41-126, Tab. I-VIII, pls I-IX.
- ZHANG, S., HUO, F., CAO, J., LIU, Z., LAVEINE, J.P. & LEMOIGNE, Y. (1992). The Carboniferous flora of the Zhongning district, Ningxia Region, North China. *Revue de Paléobiologie*, Vol. Spéc. n° 6: 1-93, pls 1-29.