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Václav Havlena

Stephanian Series and Cantabrian Stage  
in the Central Bohemian Basin,  
Czechoslovakia

**Geologica 2**

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**Abstract:** The age of the Central Bohemian Nýřany Member and later Carboniferous formations is discussed following the newly published time-ranges of the Spanish, French and German Stephanian floral species (table 1). The Westphalian-Stephanian boundary should be drawn within the youngest strata of the Nýřany Member. The Cantabrian Stage is recognized as a valid stage. In the Central Bohemian Basin, however, both the Cantabrian and Stephanian A stages are not to be distinguished. The flora of the Upper Grey Formation is correlated with the Middle and Upper Stephanian B flora of the Decazeville Basin (table 4). The position of the Stephanian B — Stephanian C boundary within the Central Bohemian strata cannot be pointed out at present.

The proposal of A. Bouroz and R. H. Wagner to recognize the Cantabrian Stage as the lowest stage of the Stephanian Series was agreed 1971 by the IUGS Subcommission on Carboniferous Stratigraphy (SCCS) at the Krefeld Congress unanimsly (T. N. George — R. H. Wagner 1972, p. 144). This fact confront us with the necessity to transfer this new arrangement of the standard time-units at the Westphalian — Stephanian boundary into the relevant Czechoslovak beds.

#### STEPHANIAN BASINS AND FLORAS IN EUROPE

From Spain to the Black Sea the Stephanian deposits occur on the area of Stille's Meseurope. Structurally they may belong to one of the following basinal units:

1. **Taphrogenic basins** (= intramontane basins, = limnic basins, = pre-platform basins, = fault-basins) extending on the uplifted Variscan land. They show purely continental cyclically arranged (sometimes coal bearing) fill a part of which can be developed as red beds. As for shape two types are to be distinguished here, isometric basins and troughs or furrows. Compared with older basinal structures the taphrogenic basins are of inherited or superimposed structural position. The Central Bohemian Basin is an isometric and superimposed taphrogenic basin.

2. **Foreland basins** (= platform troughs, = aulacogens, = parageosynclines, = epicontinental paralic basins) display the Stephanian beds of the same lithofacies as given sub 1. Laterally, the pre-Stephanian fill of the foreland basins passes gradually into the deposits of the third basinal type, viz. into foredeeps. In the Variscan foredeeps the Stephanian strata are primarily lacking.

As for Stephanian flora of Europe JONGMANS (1952) presumed that there were two isochronous but expressively different Stephanian floras to be distinguished, one extending on the Variscan land and known from the fill of the taphrogenic basins, other covering the outside area of the same land. The former should be of Stephanian age and represent the Stephanian Stage, the latter of special Westphalian E age and represent a new para-stage termed Westphalian E.

New investigations performed mainly in Spain, Bulgaria and in the Donets Basin did not prove Jongmans' presumptions. Contrarily to them we want to see the whole area from Spain to the Black Sea and to the Donets Basin inhabited by a uniform Stephanian flora. Locally it has been, however, coloured by the occurrence of various endemites and (or) by lacking of otherwise common species. Neither structural

difference of particular basinal types nor their physico-geographic or paleogeographic position exerted any influence on that uniformity. It implies the possibility to correlate even as spatially remote Stephanian beds and floras as of Spain with the relevant strata and plants of Czechoslovakia.

#### THE WEST EUROPEAN STEPHANIAN (CANTABRIAN, STEPHANIAN A, STEPHANIAN B AND STEPHANIAN C)

The new Stephanian stage, the Cantabrian Stage, has been recognized in both Léon and Palencia provinces of Spain the stratotype having been established in the Palencia province (WAGNER 1969, BOUROZ et al. 1972). In the overwhelming thickness of some 2 500 m the Cantabrian stratotype beds show the paralic development. Comparatively thick sections of purely marine provenience (limestones) alternate here with coal bearing strata yielding opulent fossil floras. Beginning with the Casavegas Coals of the Upper Westphalian D age we find in Palencia going upwards the Lores Limestone (= basis of the Cantabrian Stage), and then Areños, Rosa Maria, San Salvador, Verdeña, San Cristobal and San Felices-Peñacorba Coals. The overlying Carboneros and Calero Coals are of Stephanian A age.

Herewith the Palencia section ends being cut off by the Variscan orogenic movements referred to as Asturian ones (Carboniferous 1971). The younger Stephanian beds of Spain are of „limic“ character only yielding rich floras of the Upper Stephanian A, Stephanian B and Lower and Middle Stephanian C ages in the Peña Cildá, Sabero, Ciñera-Matallana and Villablino basins.

In Spain an almost complete Stephanian floral succession (Upper Stephanian C excluded) is thus to be found. Its newly revised version was given by BOUROZ et al. (1972).

In the French taphrogenic basins the Stephanian floral succession has been established long time ago by R. Zeiller and P. Bertrand. For the modern biostratigraphy these classic works are, however, of minor value as the relevant floral time-ranges are to be traced only roughly. A new biostratigraphic elaboration has been performed here in the Decazeville, Carmaux and Cevennès (= Gard, = Alès) basins only.

In the strongly folded Cevennes Basin a higher part of the Cantabrian seems to be present together with both Stephanian A and B. The Cevennes floral zones 1 and 2 correspond to the Spanish coals below the San Felices-Peñacorba Coals. The zone 3 is correlative with either the Carboneros Coals (= Stephanian A) or even with the Cantabrian San Felices-Peñacorba Coals (BOUROZ et al. 1970, 1972 — table 1).

The Carmaux Basin yielded a rich flora of the Upper Stephanian A (zone Lentin) and of the Lower Stephanian B (zone Tronquié). The flora of the Aubin floral zone of the Decazeville Basin represents both the middle and upper parts of the Stephanian B (DOUBINGER et VETTER 1969).

In the French part of the Saar Basin a „floral break“ has been repeatedly evidenced at the Westphalian — Stephanian boundary being in the German part pointed out by the well-known erosional unconformity of the Holz Conglomerate.

Between the Saar Basin and Czechoslovakia the Westphalian — Stephanian strata extend in the Halle — Saale Basin. Unfortunately these beds do not yield uninterrupted floral succession and, moreover, their fossil flora is rather poor. The only exception is the flora of the Wettin-Löbejün and the Öhrenkammer Member attributed to the Stephanian B — Stephanian C boundary (REMY et al. 1963 — table 1).

Table 1

	Upper Wes- Saar Basin	h an D, Youngest Westphalian D, Spain	an D, Spain	Cantabrian, Cevennes Basin	Stephanian A, Spain	Stephanian A, Cevennes Basin	Stephanian A, Saar Basin	Upper Stephanian A, Carmaux Basin	Stephanian B, Spain	Stephanian B, Carmaux Basin	Stephanian B, Decazeville Basin	Stephanian B-C boundary, Wettin Basin	Lower Stephanian C, Spain
<i>Alethopteris bohémica</i>			×		×			×	×	×			
<i>Alethopteris zeilleri</i>					×		×	×	×	×	×	×	×
<i>Annularia spicata</i>											×		
<i>Callipteridium jongmansii</i>	×	×	×										
<i>Callipteridium pteridium</i>							×	×		×	×	×	
<i>Callipteridium striatum</i>				×	×				×				
<i>Callipteridium zeilleri</i>					×				×	×		×	
<i>Linopteris germarii</i>		×	×		×				×		×		
<i>Linopteris neuropteroides</i>		×	×	×	×			×	×				
<i>Mixoneura neuropteroides</i>											×		
<i>Nemejcopteris feminaeformis</i>				×	×		×	×	×	×	×	×	×
<i>Neuropteris ovata</i> var. <i>ovata</i>		×	×	×	×								
<i>Neuropteris ovata</i> var. <i>grandeuryi</i>				×	×	×							
<i>Odontopteris brardii</i>				×	×				×	×	×	×	×
<i>Odontopteris genuina</i>					×				×		×		×
<i>Odontopteris minor</i>		×			×			×	×	×	×	×	
<i>Odontopteris subcrenulata</i>							×				×	×	
<i>Pecopteris arborescens</i>				×	×	×		×	×	×		×	
<i>Pecopteris candollei</i>				×	×			×	×	×	×	×	
<i>Pecopteris hemitelioides</i>				×	×			×	×		×		
<i>Pecopteris integra</i>					×				×			×	

	Upper Westphalian D, Saar Basin	Youngest Westphalian D, Spain	Cantabrian, Spain	Cantabrian, Cevennes Basin	Stephanian A, Spain	Stephanian A, Cevennes Basin	Stephanian A, Saar Basin	Upper Stephanian A, Carmaux Basin	Stephanian B, Spain	Stephanian B, Carmaux Basin	Stephanian B, Decazeville Basin	Stephanian B-C boundary, Wettin Basin	Lower Stephanian C, Spain
<i>Pecopteris lamuriana</i>			×		×	×		×					
<i>Pecopteris polymorpha</i>	×	×	×	×	×			×	×	×			×
<i>Pecopteris unita</i>	×	×	×	×	×			×	×	×	×	×	×
<i>Pseudomariopteris ribeyronii</i>	×	×	×	×	×		×	×	×	×	×		×
<i>Sigillaria brardii</i>	×	×			×						×		
<i>Sigillaria ichthyolepis</i>					×		×						
<i>Sphenophyllum costae</i>							×		×	×			
<i>Sphenophyllum emarginatum</i>	×	×			×	×	×		×				
<i>Sphenophyllum longifolium</i>											×	×	
<i>Sphenophyllum oblongifolium</i>			×		×	×	×	×	×	×	×	×	×
<i>Sphenophyllum thonii</i>								×		×	×	×	×
<i>Sphenopteris mathetii</i>								×		×			×
<i>Sphenopteris rotundiloba</i>			×		×		×	×	×				×
<i>Taeniopteris jejunata</i>					×			×		×			×

## THE WEST EUROPEAN CANTABRIAN

The geologic data together with the floral lists given by WAGNER (1969), Carboniferous (1971), BOUROZ et al. (1972) made me convinced that R. H. Wagner virtually discovered in Spain a so far not registered time-span between the Westphalian D and the classic French Stephanian A. This time-span coincides with the new Cantabrian Stage.

Paleoflorally, the Cantabrian Stage is characterized as follows: At the basis or near it *Alethopteris bohémica* FRANKE, *Mixoneura raymondii* (ZEILL.), *Pecopteris arborescens* (SCHLOTH.), *P. hemitelioides* BRONGN. and *P. melendezi* WAGNER set on.

These stratigraphically new species appear among other Upper Westphalian D plants persisting through the whole Cantabrian time-span up to the Stephanian A. These species are *Alethopteris grandinioides* KESSLER var. *subzeilleri* WAGNER, *Annularia sphenophylloides* (ZENKER), *A. stellata* (SCHLOTH.), *Callipteridium jong-*

*mansii* (P. BERTRAND), *Dicksonites pluckenelii* (SCHLOTH.), *Neuropteris ovata* HOFFM., *N. planchardii* ZEILL., *N. scheuchzeri* HOFFM., *Pecopteris polymorpha* BRONGN., *Pseudomariopteris ribeyronii* (ZEILL.), *Sigillaria brardii* BRONGN., *Sphenophyllum emarginatum* (BRONGN.), and *Sphenopteris neuropteroides* (BOULAY).

During the Cantabrian time-span among the above-mentioned persisting species first appear *Nemejcopteris feminaeformis* (SCHLOTH.), *Odontopteris brardii* BRONGN., *Pecopteris candollei* BRONGN., *P. viannae* TEIX. and *Sphenophyllum nagelii* GRAND'EURY.

At the Cantabrian — Stephanian A boundary *Alethopteris barruelensis* WAGNER, *A. leonensis* WAGNER, *Callipteridium striatum* WAGNER, *Linopteris germarii* (GIEBEL), *Pecopteris integra* ANDRAE, *P. lamuriana* HEER, *Sphenophyllum oblongifolium* (GERM. et KAULF.) and *Sphenopteris rotundiloba* NĚMEJC set on being richly accompanied by the above-mentioned persisting species.

Apart from the Spanish and French Cantabrian beds there are no other Silesian beds between France and Czechoslovakia where the Cantabrian problem could be studied. Thus if Spanish and French Cantabrian floral records are taken into account the following floral characteristics of the Cantabrian Stage is to be submitted:

Apart from the Westphalian D species *Annularia sphenophylloides* (ZENKER), *A. stellata* (SCHLOTH.), *Linopteris neuropteroides* (GUTB.), *Neuropteris ovata* HOFFM., *Pecopteris polymorpha* BRONGN., *P. unita* BRONGN. and *Pseudomariopteris ribeyronii* (ZEILL.), recorded in both French and Spanish Cantabrian beds no other species are known occurring simultaneously in the Cantabrian strata of both regions. To characterize the Cantabrian Stage in detail Spanish records only have thus to be used. Briefly said, that would imply

1. presence of persisting *Callipteridium jongmansii* (P. BERTRAND), *Sphenophyllum emarginatum* Brongn. as well as of all the above-noted French and Spanish common species;

2. appearance of *Alethopteris bohémica* FRANKE, *A. grandinioides* KESSLER var. *subzeilleri* WAGNER, *Pecopteris arborescens* (SCHLOTH.), and *P. hemitelioides* BRONGN. at the basis of the stage;

3. appearance of *Nemejcopteris feminaeformis* (SCHLOTH.), *Pecopteris candollei* BRONGN. and *Sphenophyllum oblongifolium* (GERM. et KAULF.) at the Cantabrian — Stephanian A boundary. The species *Linopteris germarii* (GIEBEL) and *Sigillaria brardii* BRONGN. are present in the Spanish Cantabrian too.

To characterize the Cantabrian floral succession from the evolutionary point of view R. H. Wagner suggested three important events, 1. gradual transition of *Neuropteris ovata* HOFFM. var. *ovata* WAGNER into var. *grandeuryi* WAGNER, 2. gradual transition of *Alethopteris grandinioides* KESSLER var. *grandinioides* WAGNER into var. *subzeilleri* WAGNER, 3. perseverance of the Westphalian *Praecallipteridium*-group representatives (i. e. mainly of *Praecallipteridium jongmansii*) with the Stephanian A *Eucallipteridia* still yet lacking.

Trying to solve the Cantabrian problem in Czechoslovakia where the typical *Neuropteris ovata* HOFFM. does not practically occur the two last statements are of some importance: First, in the Nýřany Member the Spanish Upper Westphalian D species *Alethopteris grandinioides* KESSLER var. *grandinioides* WAGNER has been found as a very rare element (p.10). Second, Wagner's statement on *Callipteridia* points out their importance for the Stephanian stratigraphy evidenced by P. Pruvost and P. Corsin and underlined by REMY et HAVLENA (1962). The appearance of such *Eucallipteridia* as are *Callipteridium pteridium* (SCHLOTH.), *C. striatum* WAGNER

and *C. zeilleri* WAGNER still will announce the basis of the Stephanian A whilst *Praecallipteridia* setting on in the Westphalian C are distinctly Westphalian D and Cantabrian elements.

#### THE WEST EUROPEAN STEPHANIAN A, B AND C

To characterize the Stephanian A, B and C stages paleoflorally the Spanish, French and German new data have been compiled (table 1).

The strata of the Stephanian A age should yield such persisting Cantabrian species as are *Annularia sphenophylloides* (ZENKER), *A. stellata* (SCHLOTH.), *Linopteris germarii* (GIEBEL), *L. neuropteroides* (GUTB.), *Nemejcopteris feminaeformis* (SCHLOTH.), *Pecopteris hemitelioides* BRONGN., *P. polymorpha* BRONGN., *P. unita* BRONGN., *Pseudomariopteris ribeyronii* (ZEILL.), *Sigillaria brardii* BRONGN., *Sphenophyllum emarginatum* (BRONGN.) and *S. oblongifolium* (GERM. et KAULF.).

First appear here *Alethopteris zeilleri* RAGOT, *Callipteridium zeilleri* WAGNER, *Neuropteris ovata* HOFFM. var. *grandeuryi* WAGNER, *Pecopteris lamuriana* HEER and *Sphenopteris rotundiloba* NĚMEJC. No *Walchias* have been noted here so far.

In the beds of the Stephanian B age following species are common in Spain, France and Germany: *Alethopteris zeilleri* RAGOT, *Linopteris germarii* (GIEBEL) — Spain and France only, *Nemejcopteris feminaeformis* (SCHLOTH.), *Odontopteris brardii* BRONGN., *O. genuina* GRAND'EURY — Spain and France only, *Pecopteris candollei* BRONGN., *P. hemitelioides* BRONGN., *P. polymorpha* BRONGN., *P. unita* BRONGN., *Pseudomariopteris ribeyronii* (ZEILL.), *Sphenophyllum oblongifolium* (GERM. et KAULF.), *S. thonii* MAHR, *Sphenopteris mathetii* ZEILL. Spain and France only, and *Taeniopteris jejuna* GRAND'EURY (Spain and France only). Many current species with an extended time-range accompany that floral assemblage.

The Stephanian C floral assemblage does not essentially differ from the above-noted Stephanian B flora.

#### THE STEPHANIAN IN CZECHOSLOVAKIA

The Czechoslovak deposits in question extend in the both Innersudetic (or Lower Silesia) and Central Bohemian basins. As the latter basin exhibits more pertinent conditions (f. e. well-known stratigraphy, well-known floral succession, unfolded strata etc.). I shall discuss the Cantabrian problem holding mainly to its beds. Their fossil flora has been for a long time thoroughly collected and determined by F. Němejc and thereafter by J. Šetlík. Recently the last author has given a brief modern review of it based on his own unpublished reports (Guide 1973; ŠETLÍK 1968a, b, 1970, ŠETLÍK — RIEGER 1970).

The purely continental fill of the taphrogenic Central Bohemian Basin falls into the Lower Grey, Lower Red, Upper Grey and Upper Red formations, respectively. From the Lower Grey Formation its upper part only — the Nýřany Member — is of interest for us displaying the Westphalian D age.

#### THE NÝŘANY MEMBER

The deposits of the Nýřany Member exhibit an expressive cyclical arrangement with locally coal bearing development. These coals are currently called Nýřany Coals [= Nýřany Member Coals]. Nowadays the stratigraphy of these Nýřany Coals is best investigated in the Plzeň Basin where PEŠEK (1968) distinguishes going upwards

Table 2

LOWER W.D	UPPER VESTPHALIAN D	CANTABRIAN	STEPHANIAN A	
		xxxxxx		ALETHOPTERIS GRANDINOIDES
				▲ ANNULARIA SPHENOPHYLLOIDES
				▲ ANNULARIA STELLATA
				▲ DICKSONITES PLUCKENETII
				LINOPTERIS NEUROPTEROIDES
	oooooo			NEUROPTERIS OVATA (INCL. PPLICATA)
				NEUROPTERIS SCHEUCHZERI
		●●●●●●		PECOPTERIS HEMITELIOIDES
		●●●●●●		▲ PECOPTERIS POLYMORPHA
				▲ PECOPTERIS UNITA
				PSEUDOMARIOPTERIS RIBEYRONII
				▲ SPHENOPHYLLUM EMARGINATUM
		●●●●●●		SPHENOPHYLLUM OBLONGIFOLIUM

1 ▲ 2 — 3 - - - 4 xxxxx 5 ooooo 6 ●●●●●

the Nýřany Main Seam (= Nýřany Seam Proper), Nýřany Roof Seam, Upper Nýřany Seams (1—6 seams) and Nevřeň Seams (1—2 seams). The thickness of the Nýřany Member attains here even 300 m the vertical distance from the basis of the Lower Red Formation being 40—65 metres for the youngest of the Upper Nýřany Seams, and 1—27 metres for the lower of the locally developed Nevřeň Seams correlatives with Stur's Wieskau Coals (NĚMEJC 1962). In other parts of the Central Bohemian Basin as f. e. at Slaný 3 — 11 coal seams are known within the Nýřany Member bearing no special names.

The well-known flora of the Nýřany Member is currently attributed to the Westphalian D. This old statement is here supported by the table 2 where important Nýřany floral species are compared to their time-ranges newly established in Spain. The coincidence of the roughly comprehended Nýřany Member age with the Westphalian — Stephanian boundary is easily to be observed in the table, which would prefer the youngest Westphalian D age of the Nýřany Member. Furthermore it is to be noted that 1. no as typical Stephanian elements as are the „true“ *Callipteridia* (= *Eucallipteridia* sensu R. H. Wagner) have been so far recorded within the Nýřany Member. The Callipteridian Nýřany species *Alethopteris rubescens* STERNB. is to be regarded as belonging to the evolutionarily older Westphalian and Cantabrian *Praecallipteridium*-group (WAGNER 1963). — 2. From the Nýřany Main Seam level the species *Alethopteris kettneri* HAVLENA originates (HAVLENA 1951) assigned by WAGNER (1968) to his *Alethopteris grandinioides* KESSLER var. *grandinioides* WAGNER. This variety is a typical element of the Spanish Upper Westphalian D (Casavegas Coals). — 3. The real *Neuropteris ovata* HOFFM. is surprisingly lacking through the whole Nýřany Member but a similar endemic species *Neuropteris plicata* STERNB. occurs in its lower part.

As stated by ŠETLÍK (1968b) through the whole thickness of the Nýřany Member a typical „Nýřany assemblage“ can be followed. In detail it is given in the Guide (1973). At various levels of the whole thickness among these real Nýřany species the so-called „younger“ or „Stephanian“ elements appear going then up to the Lower Red Formation and even higher. From these „younger“ forms *Annularia spicata* (GUTB.) and *Pseudomariopteris ribeyronii* (ZEILL.) appear just at the basis of the Nýřany Member, and *Pecopteris hemitelioides* BRONGN., *P. lepidorachis* BRONGN. and *P. polymorpha* BRONGN. higher. Beginning with the youngest of the Upper Nýřany Seams *Sphenophyllum oblongifolium* (GERM. et KAULF.) and slightly higher *Sigillaria ichthyolepis* PRESL in STERNB. set o.l.

As the species *Pecopteris polymorpha* BRONGN. and *Pseudomariopteris ribeyronii* (ZEILL.) occur in other European countries even in older Westphalian D strata practically *Sigillaria ichthyolepis* PRESL in STERNB., *Pecopteris hemitelioides* BRONGN. and *Sphenophyllum oblongifolium* (GERM. et KAULF.) only are of really „younger“ or rather „Stephanian“ affinity. The species *Pecopteris lepidorachis* BRONGN. is stratigraphically unimportant.

Our real „Stephanian“ elements are, however, of differing stratigraphic value. A virtual index plant among them is *Sphenophyllum oblongifolium* (GERM. et KAULF.) only recognized as index plant fossil of the Stephanian A basis already by W. and R. REMY (1968). *Sigillaria ichthyolepis*, too, is of definite stratigraphic value occurring in Spain and in the Carmaux Basin not before the Stephanian A (table 1). Implicitly, the Stephanian age may not be inferred before all these real „Stephanian“ elements do not set on. According to ŠETLÍK'S presumption (1968b) this is realized at the level of the Nevřeň Seams whose early Stephanian age has been recognized by NĚMEJC (1962).

On the other hand as typical Stephanian (Cantabrian) elements as are *Alethopteris bohémica* FRANKE and *Nemejcopteris feminaeformis* (SCHLOTH.) — moreover even *Linopteris germarii* (GIEBEL) and *Odontopteris brardii* BRONGN. — are still yet lacking among the records gathered at the Nevřeň Seams and lower. This fact makes the Stephanian age of the Nevřeň Seams not undoubtedly conceivable testifying, of course, the Westphalian D (and not Cantabrian) age of the strata underlying the Nevřeň Seams.

In the above explained concept the Westphalian — Stephanian boundary will coincide with the basis of the locally occurring lowest Nevřeň Seam, i. e. it will be drawn some 50 metres below the basis of the Lower Red Formation. Unfortunately, no lithostratigraphic key horizon is known at that level.

Table 3

	Nýřany Member	Upper Svatoňovice Coals
<i>Alethopteris rubescens</i>	●	—
<i>Annularia sphenophylloides</i>	●	●
★ <i>Ann. spicata</i>	○	—
<i>Ann. stellata</i>	●	●
<i>Callipteridium jongmansii</i>	—	●
<i>Dicksonites pluckenettii</i>	●	●
<i>Linopteris neuropteroides</i>	○	—
<i>Odontopteris genuina</i>	—	●
<i>Odontopteris reichiana</i>	○	—
<i>Pecopteris aspidioides</i>	○	—
★ <i>Pec. hemitelioides</i>	○	—
★ <i>Pec. lepidorachis</i>	○	—
<i>Pec. nyransensis</i>	○	●
★ <i>Pec. polymorpha</i>	○	○
<i>Pec. polypodioides</i>	●	●
<i>Pec. rakonensis</i>	●	○
<i>Pec. unita</i>	○	●
★ <i>Pseudomariopteris ribeyronii</i>	○	—
<i>Sphenophyllum emarginatum</i>	●	●
★ <i>Sphenophyllum oblongifolium</i>	○	○
<i>Walchia</i>	—	○

In the Inner Sudetic Basin the Upper Svatoňovice Seams are of uncertain Upper Westphalian — Lower Stephanian age. If compared to the undifferentiated flora of the whole Nýřany Member rather some locally coloured deviations than any coincidences are found here (table 3). The age difference between the pre-Nevřeň and Nevřeň strata and seams being taken into account the concurrence of *Sphenophyllum oblongifolium* (GERM. et KAULF.) and of some *Pecopterids* appears, which makes the corre-

lation of the Upper Svatoňovice Seams with the Nevřeň Seams (NĚMEJC 1962) very likely. On the other hand the occurrence of both the *Callipteridium jongmansii* (P. BERTRAND) — not scarce in Svatoňovice, common in the Spanish Cantabrian — and the *Walchias* may evidence a slightly younger age of the Upper Svatoňovice Seams. At all events the Stephanian (Cantabrian) age of the Upper Svatoňovice Seams is to be declared at present.

#### THE LOWER RED FORMATION

Its strata extend over the whole area of the Central Bohemian Basin as a comparatively stable and some 200m thick lithologic key horizon of climatic origin. We owe all our knowledge on the flora of these beds to ŠETLÍK (1970).

Just at the basis of the Lower Red Formation *Nemejcopteris feminaeformis* (SCHLOTH.), *Odontopteris subcrenulata* (ROST) and *Walchias* appear, which together with persisting *Pecopteris hemitelioides* BRONGN., *Sphenophyllum oblongifolium* (GERM. et KAULF.) and other Nýřany species sets the Stephanian age of the Lower Red Formation beyond all doubt. The species *Nemejcopteris feminaeformis* (SCHLOTH.) appears in the Spanish Cantabrian and in the French Stephanian A, *Odontopteris subcrenulata* (ROST) at the basis of the Saar Stephanian (Cantabrian is lacking here!) and in the French Stephanian B. Unfortunately, both *Callipteridium* sp. and *Alethopteris* sp. recorded by J. Šetlík just at the basis of the Lower Red Formation are unable to be determined more precisely. In the higher beds of the formation further elements of clearly or preponderantly Stephanian affinity have been recorded so far: *Linopteris germarii* (GIEBEL), *Sigillaria brardii* BRONGN., *Sphenophyllum thonii* MAHR var. *minor* STERZEL.

As the newly appearing floral species set on at various levels of the Lower Red Formation no gap in sedimentation is to be expected within its whole section. There is no evidence of any angular or long-distance erosional unconformity nor at the basis neither later, too. The onset of the red coloured sedimentation is progressive.

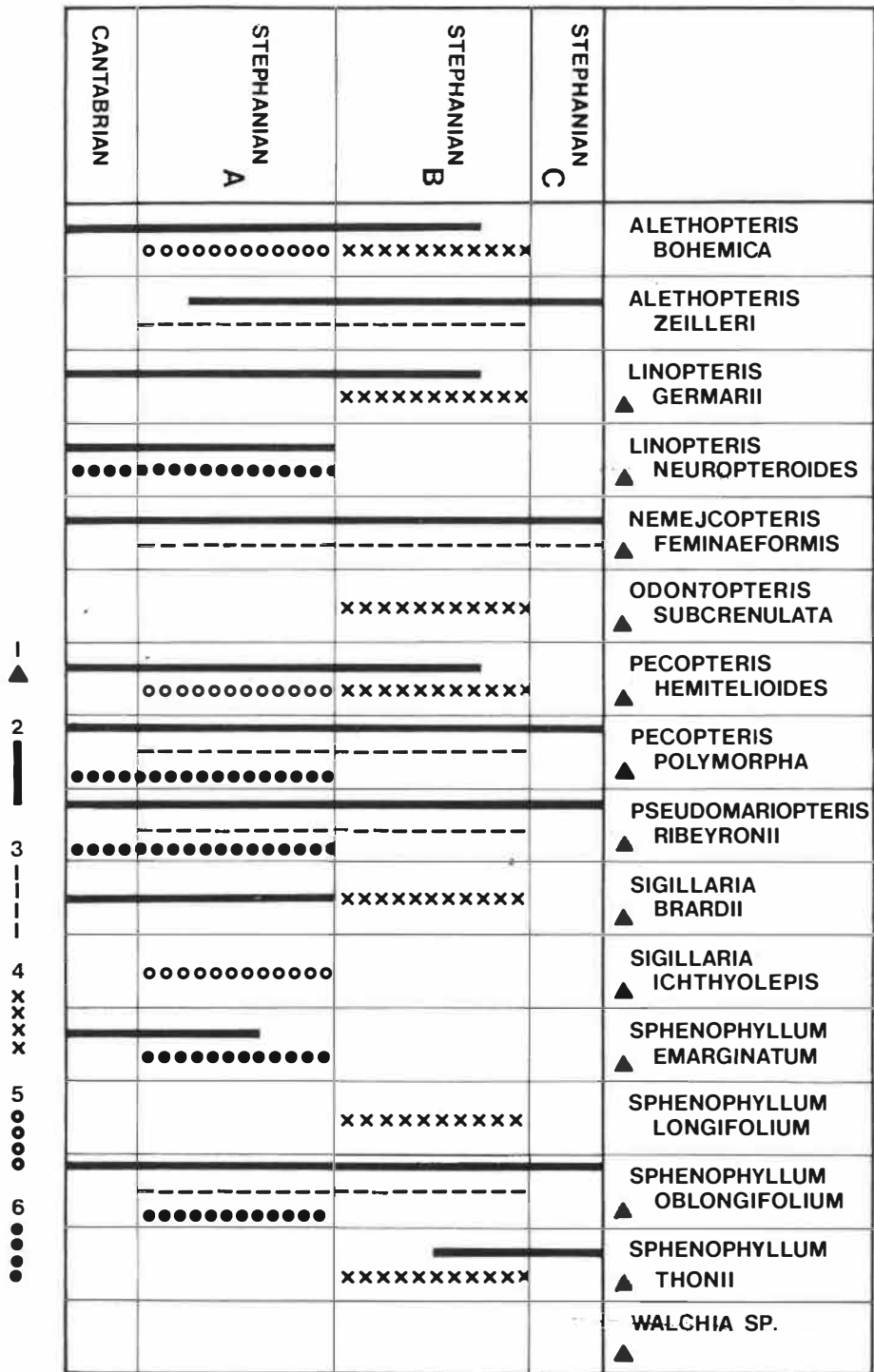
This implies that the floral assemblage ascertained near the basis of the Lower Red Formation should represent — together with the flora of the Nevřeň Seams — the Cantabrian flora. But as a matter of fact no typical Cantabrian species as f. e. *Alethopteris bohémica* FRANKE, *A. grandinioides* KESSLER var. *subzeileri* WAGNER, *Callipteridium jongmansii* (P. BERTRAND), *Mixoneura raymondii* (ZEILL.), *Pecopteris arborescens* (SCHLOTH.), or *P. melendezii* Wagner have been evidenced here so far. We must thus point out that a Cantabrian flora sensu R. H. Wagner does not occur here.

As for the Stephanian A, we are unable to recognize it, too, because no specific Stephanian A species (p.8) have been found within the beds of the Lower Red Formation.

To distinguish and establish both the Cantabrian and Stephanian A stages in the Central Bohemian Basin further records mainly of *Alethopterids* and *Callipteridia* are highly desirable. As for the Cantabrian I can't get rid of the opinion that this stage would more logically belong to the Stephanian A as its lowest part than to represent an independent unit. The lowering of the basis of the classic Stephanian A, however, is against the formal rules and cannot be conceived. The thick Spanish Cantabrian sequence represents an exceptional case — rather a parastatotype than a stratotype.

I suppose that the Cantabrian spans a comparatively short time interval, shorter than f. e. that of Stephanian A. In the semiarid Stephanian climatic period the

Table 4



accumulation of the red beds [red cyclothem] with expressive arcose sandstones and thin siltstones and claystones alternated with longer desiccation periods. Thus a comparatively thin sequence of some 230 metres built up by predominantly clastic red deposits could span both the Cantabrian and Stephanian A time intervals. The thickness of 230 metres means 50 metres of the Nýřany Member and some 180 metres of the Lower Red Formation up to the Stephanian A — Stephanian B boundary.

#### THE UPPER GREY FORMATION

The Mělník Seams of its lowest Jelenice Member are accompanied by a rich flora practically identical with the opulent flora of the youngest Upper Grey Formation Coals, i. e. of the Kounov Seams (ŠETLÍK 1966). There are very slight differences only between the flora of the Jelenice Member and of the Lower Red Formation [compare table 4].

The flora of the Kounov Seams has been first correlated with the oldest flora of the Avaize Coals (Stephanian C), later then with the flora of the Middle St. Etienne Coals, i. e. with „the youngest part of the Middle Stephanian“ (NĚMEJC 1958). Taking into account the comparison of selected Jelenice Member species with the newly given time-ranges of the same species both in Spain and France one could infer even the Stephanian A age to the Jelenice (and Kounov) floras (table 4). Nevertheless discussing the relevant Spanish, French and Czechoslovak floral assemblages in detail one easily finds out a close relationship of the Jelenice flora to the Middle and Upper Stephanian B flora of the Decazeville Basin (DOUBINGER et VETTER 1969). The onset of the Stephanian B-C species *Sphenophyllum longifolium* (GERM.) in the Jelenice Member together with the occurrence of *Zygopteris pinnata* GRAND'-EURY in it as well as the appearance of *Mixoneura neuropteroides* (GOEPP.) slightly higher (Mšec Member) may stress this correlation.

As the flora of the Lower Red Formation does not substantially differ from the Middle and Upper Stephanian B flora of the Upper Grey Formation the drawing of the Stephanian A — Stephanian B boundary within the Lower Red Formation (near its top) is very likely.

#### THE UPPER RED FORMATION

Apart from the well-known paucity of its fossil flora the low degree of information on the European Stephanian C — Autunian floral succession is the main obstacle in establishing the age of this youngest Central Bohemian Carboniferous (and even Permian?) formation. To its scarce flora without *Callipterids* (Guide 1973) one could even attribute the Stephanian B age. Having in mind the correlative possibilities eastwards — to the Podkrkonoší Basin (ŠETLÍK — RIEGER 1970) — one should best denote its age as Stephanian C. It is impossible, however, to give the level of the Stephanian B — Stephanian C boundary at present.

#### SUMMARY

The Stephanian biostratigraphic boundaries of the Central Bohemian Carboniferous Basin are to be drawn as follows: The Westphalian — Stephanian boundary some 50 metres below the basis of the Lower Red Formation, the Cantabrian — Stephanian A and the Stephanian A — Stephanian B boundaries within the strata of the Lower Red Formation, the Stephanian B — Stephanian C boundary within the strata of the Upper Red Formation. One cannot give their positions more precisely at present.

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Table 1 — Occurrence of selected floral species in the French, Spanish and German Westphalian D — Stephanian C strata.

Based on BOUROZ et al. 1970, 1972; DOUBINGER VETTER 1969; REMY et al. 1963; WAGNER 1969; WAGNER — VARKER 1971.

Table 2 — Some floral species of the Nýřany Member compared with their time-ranges in Spain.

Based on BOUROZ et al. 1972; ŠETLÍK 1968b.

1 — Typical plant fossil of the Nýřany Member, 2—6 — time-ranges of the plant fossils 2 — in Spain, 3 — 6 in the Nýřany Member: 3 — persisting through the whole Nýřany Member, 4 — occurring at the Nýřany Main Seam only, 5 — occurring mainly in the lower part the Nýřany Member, 6 — occurring mainly in the upper part of the Nýřany Member.

Table 3 — The Nýřany Member flora compared with the flora of the Upper Svatoňovice Seams. Based mainly on Guide (1973).

● present and comon, ○ — present, not numerous, — so far not found, ★ „younger“ elements of the Nýřany Member flora.

Table 4 Selected Jelenice Member floral species (together with other plant fossils) compared with the occurrence in the Lower Red Formation and with their time-ranges in Spain and France.

Based on BOUROZ et al. 1970, 1972; ŠETLÍK 1968a, 1970; WAGNER — VARKER 1971.

Plant fossils occur in the beds of 1 — Lower Red Formation (or found below and above), 2 — Spanish Stephanian, 3 — Stephanian A of Carmaux, 4 — Cantabrian and Stephanian A of Cevennes, 5 — Stephanian A and B of Carmaux and Decazeville, 6 — Stephanian B of Carmaux and (or) Decazeville.

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V á c l a v H a v l e n a :

#### STEFAN A KANTABR VE STŘEDOČESKÉM KARBONU

Nové poznatky o vertikálním rozpětí významných druhů stefanské květeny, získané ve Španělsku, Francii a Německu (tab. 1), umožňují zaujmout stanovisko k vedení biostratigrafických hranic ve stefanu a jmenovitě k otázce přítomnosti kantabru u nás. Z naší strany k tomu přispívá okolnost, že znalosti o vertikálním rozpětí těchto druhů u nás, v zásadě zjištěné NĚMEJCEM a v poslední době pak doplněné ŠETLÍKEM (1966, 1968a,b, 1970; Guide 1973) dosáhly mimořádně vysoké úrovně.

Autor souhlasí se zavedením kantabru jako nového — zřejmě však časově krátkého — úseku mezi westfalem D a stefanem A, avšak upozorňuje, že ve středočeském svrchním paleozoiku není jeho odlišení pro chudost flóry možné. Stejně tak zde nelze odlišit stefan A.

Hranice westfal — stefan leží v úrovni nevřeňských slojí plzeňské pánve, tj. asi 50 metrů pod bází spodního červeného souvrství. Intrastefanské hranice kantabr — stefan A a stefan A — stefan B spadají dovnitř spodního červeného souvrství, ovšem jejich přesnou polohu nelze pro chudost nálezů flóry stanovit. Flóra svrchního šedého souvrství je velmi dobře srovnatelná s flórou středního a svrchního stefanu B pánve Decazeville ve Francii. Hranice stefan B — stefan C leží ve svrchním červeném souvrství; její přesnou polohu nelze zatím stanovit.

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