MARIOPTERIS FROM THE STEPHANIAN OF NORTH-WEST SPAIN

by R. H. WAGNER *and* C. ALVAREZ-RAMIS

ABSTRACT. Three species of *Mariopteris* are described from Stephanian B–C rocks in North-west Spain. The record is based only on five specimens, but it proves that *Mariopteris* was by no means extinct by Lower Stephanian times, as so often has been stated in the literature. The validity of the genus *Pseudomariopteris* is questioned.

WHEN collecting in the Tineo coalfield of Asturias, North-west Spain, one of the present writers (C. A.-R.) discovered and identified a few specimens of well-preserved *Mariopteris* among numerous remains of a well-characterized assemblage of Stephanian B–C flora, probably representing lower Stephanian C (compare Zeiller 1882; Meléndez 1943; Menéndez Amor and Jongmans 1952, 1954; Alvarez-Ramis 1964; Doubinger and Alvarez-Ramis 1963, 1964; de la Vega Rollán 1964; Wagner 1964, 1966). The occurrence of *Mariopteris* in such a Late Carboniferous assemblage seemed most unusual, since it has been repeatedly stated in the literature that Stephanian floras are characterized by the absence of *Mariopteris*, which would be restricted to Namurian and Westphalian strata (Jongmans and Pruvost 1950, p. 343; Gothan and Weyland 1954, p. 438). Such a negative characteristic is obviously unreliable and it has been known for a long time (Huth 1912) that the range of *Mariopteris* extended into Lower Stephanian. However, the record of *Mariopteris zeilleri* Huth is based on a single specimen only, so that it might still be regarded as generally true that *Mariopteris* would not be an element of Stephanian floras. Also records provided by one of the present authors (Wagner *in* Kanis 1956; and Wagner 1964, 1966), relating to the presence of *Mariopteris nervosa* (Brongniart) and *Mariopteris* sp. (cf. *rotundata* Huth) in basal Stephanian rocks of North-west Spain (viz. strata assigned to the newly proposed 'Cantabrian' Stage), do not materially alter the general statement of an absence of *Mariopteris* in the Stephanian proper (i.e. in strata of equivalent age to that of the Stephanian in Central France). An obviously different case is presented by the specimens described in the present paper. Not only have these specimens been found in rocks of fairly late Stephanian age, but they also show considerable diversification. Although the actual number of specimens collected is very small (only four specimens having been recovered from the Tineo coalfield), they are judged to belong to two different species. One more specimen, representing an additional species, has been determined from a collection made by Dr. W. F. M. Kimpe from upper Stephanian B rocks in the eastern part of the Villablino coalfield (province of León). A list of fossils dating this locality is given on p. 702 of the present paper. Only one of the specimens found in Stephanian B–C strata of North-west Spain has been completely identified with a known species of Westphalian age. The other specimens are considered to belong to new species. However, they show a close similarity with some Westphalian species recorded in the literature.

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numerous other plant remains collected in the course of his investigations on the coalfield of Villablino (León). They are also grateful for facilities in the Department of Geology, University of Sheffield, where Mr. B. Pigott took the photographs illustrating this paper.

DESCRIPTION OF SPECIES

Mariopteris cantabrica sp. nov.

Pl. 104, figs. 1, 2; Pl. 105, fig. 1; text-fig. 1

1964 *Mariopteris* cf. *latifolia* Alvarez-Ramis (*non* Brongniart), p. 73, lám. III, fig. 4.

Material. Only one reasonably well-preserved specimen (holotype) and a more fragmentary remnant of this plant are available for description. The holotype is a negative.

Description. Pinnae of the penultimate order with alternate side pinnae inserted at wide angles, varying probably from 70° to 80° (60–90° on the holotype, due to tectonic deformation). Rachides of the penultimate order winged and somewhat grooved longitudinally; 3–4 mm. wide. Pinnae of the last order closely spaced and even partly overlapping; both catadromous and anadromous basal pinnules clearly bilobate in pinnae of average position in the frond. Rachides of the last order rounded, with irregular small costae; rachides up to 1 mm. wide. Pinnules inserted at 60–70° angles; adhering to the rachis with almost the entire basal width in the upper parts of pinnae, and generally becoming more sphenopteroid in the lower parts, though always retaining a relatively broad insertion (never inserted by the midvein only). Pinnules in the upper parts of pinnae probably entire (conjectural because of the fragmentary condition of the holotype), for those in the middle parts possess only slightly undulate margins. Lower pinnules clearly lobed, and basal pinnules clearly bilobate. Pinnules approximately $2\frac{1}{2}$–3 times as long as broad. Lobes rounded, relatively wide, generally about twice as long as broad, and rather steeply inclined to the midvein (approximately 60°). Pinnule lamina apparently rather thin, though not so thin as to appear flat on the rock surface. Midvein decurrent, generally straight, sometimes slightly flexuous. Nervules steeply inclined (approximately 30° to the midvein), repeatedly bifurcate, thin and fairly numerous (approximately 35 veins per cm. on the pinnule border). Fructifications unknown.

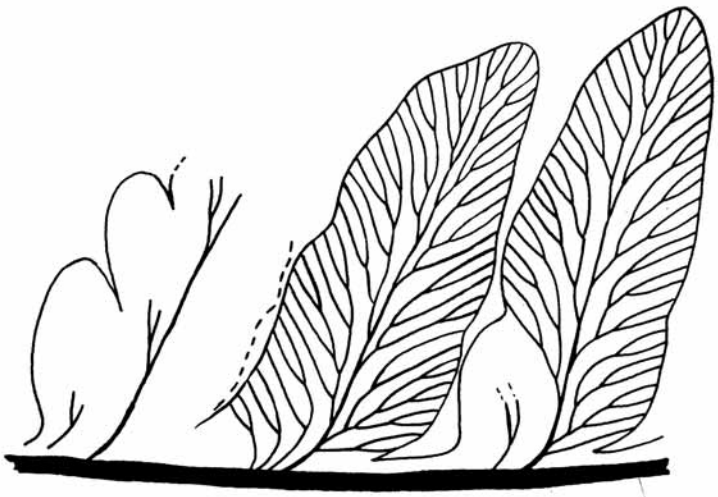
Type. Holotype figured on Pl. 104, figs. 1, 2 (and Pl. 105, fig. 1). Origin: tip of the seam Purita, lower Stephanian C, Tineo coalfield (Asturias, North-west Spain). Repository of holotype and unfigured specimen: Instituto 'Lucas Mallada', Consejo Superior de Investigaciones Científicas, Paseo de la Castellana 84, Madrid (coll. Alvarez-Ramis).

Derivatio nominis. The Cordillera Cantábrica in North-west Spain.

Diagnosis. Winged rachides with closely spaced, partly overlapping pinnae; both catadromous and anadromous basal pinnules clearly bilobate. Ordinary pinnules entire to lobate, with rounded, rather steeply inclined lobes; insertion fairly broad; lamina thin. Midvein decurrent; nervules thin, steeply inclined, fairly numerous.

Comparison. The Westphalian species *Mariopteris guthoerli* Lutz is closely similar in the shape and dimensions as well as the insertion of the pinnules which are also rounded lobed to entire as in *Mariopteris cantabrica* sp. nov. However, the two species differ in

the apparently somewhat thicker lamina of *M. guthoerli* which may also possess rather less steeply inclined nervules. Lutz (1938) observed that the rachides of *M. guthoerli* possessed faintly marked transverse bars, additional to more clearly expressed longitudinal grooves. Such transverse bars have not been found on the rachides of *M. cantabrica*.



TEXT-FIG. 1. Nervation diagram of some pinnules from the holotype of *Mariopteris cantabrica* sp. nov. as figured on Pl. 104, fig. 1 and Pl. 105, fig. 1 (based on a photographic enlargement, ×6). These lobed pinnules occupy a relatively low position in the pinna.

Mariopteris witieri Corsin is also characterized by little lobed, broadly based pinnules, but there the resemblance ends, for this species is further characterized by rachides with strongly marked transverse bars and massive looking, confluent pinnules with a thick lamina. Its basal pinnules are not very strongly bilobate.

Mariopteris sauveuri (Brongniart) Stur has more widely spaced pinnae with relatively broader and more sturdy looking pinnules than those occurring in *Mariopteris*

EXPLANATION OF PLATE 104

Figs. 1, 2. *Mariopteris cantabrica* sp. nov.; from tip of the seam Purita, lower Stephanian C, Tineo coalfield in Asturias, North-west Spain. 1, Holotype, ×1, showing bilobate catadromous and anadromous pinnules; and well-developed ordinary pinnules in probably the lower middle part of pinnae of the penultimate order. 2, Enlargement (×3) of some lobing pinnules in lower part of specimen.

Fig. 3. *Mariopteris melendezi* sp. nov.; from tip of the seam Purita, lower Stephanian C, Tineo coalfield in Asturias, North-west Spain. Holotype, ×1, showing fragments of pinnae with fairly small pinnules characterized by a semi-perpendicular insertion and rounded lobes.

Figs. 4, 5. *Mariopteris colliciaris* D. White; from tip of seam 6, Carrasconte coal group, upper Stephanian B, Villablino coalfield, province of León, North-west Spain. 4, Specimen (×1) showing typically sphenopteroid pinnules with convex, rounded lobes; on the same slab are *Pecopteris jongmansi* Wagner and *Sphenophyllum oblongifolium* Germar and Kaulfuss. 5, Enlargement (×3) of main part of pinna fragment on left side of specimen.

cantabrica sp. nov. The former species also appears to be characterized by a rather thick pinnule lamina. Its pinnules are even more generally entire than those of *M. cantabrica.*

Mariopteris muricata (von Schlotheim) *sensu* Zeiller has generally smaller, more rigid pinnules which are also narrower than those of *Mariopteris cantabrica* sp. nov. They also appear to be generally more entire than those of the latter. The pinnae of *M. muricata* may be less closely spaced than those of *M. cantabrica.*

Remarks. The holotype of *Mariopteris cantabrica* (Pl. 104, fig. 1) shows fragments of pinnae which probably belong to the lower middle parts of pinnae of the penultimate order. Only the lower parts of side pinnae (of the last order) are preserved, but it appears evident that a rather large proportion of the pinnules in the frond were either entire or nearly entire. Lobed pinnules show rather short, rounded lobes of a similar shape to those visible on the type specimen of *Mariopteris guthoerli* Lutz (see Lutz 1938, Taf. XIX, figs. 4, 4A). On the whole, Lutz's specimen possesses more entire pinnules, but this feature may well be ascribed to a slightly higher position within a pinna of the penultimate order than that occupied by the holotype of *Mariopteris cantabrica* sp. nov. This impression is strengthened by the fact that the unlobed pinnules of the latter show exactly the same proportions (i.e. approximately 10×4 mm.) as those of the former, whereas the lobed pinnules of *M. cantabrica* are larger and relatively longer (as can be expected for lobing segments). It would therefore be quite possible to identify *M. cantabrica* with *M. guthoerli*, if it did not appear that *M. cantabrica* possessed a relatively thinner pinnule lamina as well as apparently more widely spaced nervules than *M. guthoerli.* Moreover, Lutz recorded that *M. guthoerli* possessed faint transverse bars on the rachides. Although this feature is hardly visible on the illustration of the holotype of this species (Lutz 1938, Taf. XIX, figs. 4, 4A), it should be an important characteristic, since Danzé-Corsin (1953, p. 53) decided that the subdivision of *Mariopteris* could be to a large extent based on this characteristic. She noted that most of the species of *Mariopteris* were characterized by the presence of transverse bars on the rachides (i.e. the group *Lineae*), whilst only a few species showed only longitudinal striae or grooves on the rachides and climbing stem (group *Alineae*). *M. cantabrica* apparently belongs to the *Alineae* and therefore has to be considered as quite different from *M. guthoerli* (of the *Lineae*), even though the pinnules of both species are rather similar. It may, however, be noted as well that the basal pinnules of *M. cantabrica* are more strongly bilobate than those of *M. guthoerli*, thus adding another means of differentiation.

There is an appreciable difference in stratigraphic age between these two species, for *Mariopteris guthoerli* Lutz has been recorded from the Westphalian C (Saar–Lorraine area), whilst *Mariopteris cantabrica* sp. nov. has been found in lower Stephanian C rocks. Both species are known from single specimens only, however.

As far as known to the present authors, there is only one record in the literature which may point to a wider range for *M. cantabrica.* It deals with a rather fragmentary specimen from upper Westphalian D rocks in northern Portugal, which has been figured under the name of *Mariopteris* cf. *muricata* (von Schlotheim) by Teixeira (1942, Est. IV, figs. 2–3). Unfortunately, this specimen, which shows a marked resemblance to *Mariopteris cantabrica*, appears too fragmentary to be identified with certainty.

Occurrence. Lower Stephanian C, tip of the seam Purita, Tineo coalfield, Asturias, North-west Spain.

Mariopteris melendezi sp. nov.

Plate 104, fig. 3; Plate 105, fig. 2; text-fig. 2

1964 *Mariopteris* sp. Alvarez-Ramis, p. 73, lám. III, fig. 5.

Material. The description is based on two specimens, one of which is a negative (holotype). The second specimen is too fragmentary to be figured.

Description. Rachis of the penultimate order slightly winged, irregularly grooved in longitudinal direction, relatively wide (2 mm.). Pinnae of the last order inserted at angles of approximately 60°; alternating, closely spaced, and partly somewhat overlapping; apparently rather quickly tapering in the apical portions. Rachides of the last order fairly thin (0·5 mm. wide) and irregularly grooved in longitudinal direction. Pinnules small, completely adherent to the rachis, and even decurrent on the basiscopic side; inserted slightly obliquely though nearly perpendicular in the lower parts of pinnae; approximately $2\frac{1}{2}$ times longer than they are broad. Pinnules always lobate, with shallow sinuses. Lobes rounded to somewhat denticulate. Basal catadromous pinnules bilobate. Pinnule lamina probably of average thickness. Midvein almost as thin as the nervules; generally non-decurrent, sometimes rather flexuous. Nervules widely spaced (approximately 10–12 veins per cm. on the pinnule border), repeatedly forked at fairly wide angles; generally not very steeply inclined. Fructifications unknown.

Type. Holotype figured on Plate 104, fig. 3 (and Pl. 105, fig. 2). Origin: tip of the seam Purita, lower Stephanian C, Tineo coalfield (Asturias, North-west Spain). Repository of type as well as unfigured second specimen: Instituto 'Lucas Mallada', Consejo Superior de Investigaciones Científicas, Paseo de la Castellana 84, Madrid (coll. Alvarez-Ramis).

Derivatio nominis. Professor B. Meléndez, University of Madrid, who has consistently furthered research on the Carboniferous of Spain.

Diagnosis. Pinnae probably rather short, and tapering rapidly in the apical part. Pinnules small, inserted at wide angles; adherent with the entire base, and decurrent on the basiscopic side; always lobate, with rounded to slightly denticulate lobes. Only basal catadromous pinnules are bilobate. Nervation wide, with thin, often flexuous midvein and repeatedly forking laterals.

Comparisons. Mariopteris zeilleri Huth appears to have more clearly winged and probably stronger rachides than those occurring in *Mariopteris melendezi* sp. nov. It also possesses bilobate basal pinnules on both the catadromous and the anadromous sides of pinnae, and shows rather strong midveins. *M. melendezi* has apparently only bilobate basal pinnules on the catadromous side, and possesses thin midveins. The shape

EXPLANATION OF PLATE 105

Fig. 1. *Mariopteris cantabrica* sp. nov. Enlargement (×3) of upper right part of holotype, showing bilobate basal pinnules.

Fig. 2. *Mariopteris melendezi* sp. nov. Enlargement (×3) of holotype showing fairly thin pinnule lamina and rounded lobes of pinnules.

Fig. 3. *Mariopteris colliciaris* D. White. Enlargement (×3) of lower right part of specimen figured on Plate 104, fig. 4, showing typically sphenopteroid pinnules with convex lobes.

Localities are given in the explanation of Plate 104.

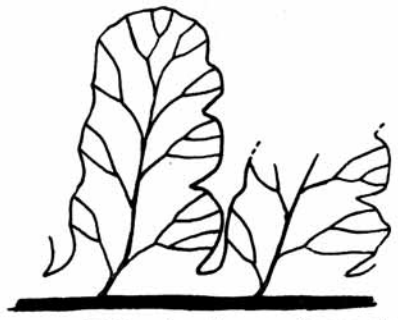
of the pinnules is fairly similar in both species, particularly with regard to the somewhat denticulate lobes (which are perhaps somewhat more strongly expressed in *M. zeilleri*).

Mariopteris guillaumei Corsin shows some similarity to *Mariopteris melendezi* sp. nov. in the general aspect and insertion of the pinnules which are also characterized by rounded lobes. However, its pinnules appear to be generally larger, somewhat more obliquely inserted and, on the whole, more entire than those of *M. melendezi*. It is also noted that the rachides of *M. guillaumei* possess strongly marked, closely set transverse bars.

Mariopteris daviesi Kidston possesses larger pinnules with more clearly pointed lobes, and thus differs markedly from *Mariopteris melendezi* sp. nov., even though in both species the pinnules tend towards a perpendicular insertion. The rachides of *M. daviesi* possess widely spaced transverse bars, a characteristic which has not been observed in *M. melendezi*.

Mariopteris tenuis Bell shows a faint resemblance to *Mariopteris melendezi* sp. nov., but possesses larger pinnules with probably a somewhat thinner lamina than that occurring in the latter.

Mariopteris beneckei Huth possesses somewhat larger, more obliquely inserted pinnules which are also more sphenopteroid than those of *Mariopteris melendezi* sp. nov. Both the catadromous and the anadromous basal pinnules of *M. beneckei* are clearly bilobate.



TEXT-FIG. 2. Nervation diagram of some pinnules from the holotype of *Mariopteris melendezi* sp. nov. as figured on Plate 104, fig. 3 and Plate 105, fig. 2 (based on a photographic enlargement, ×6).

A comparison with *Mariopteris hirsuta* Corsin shows the presence of more roundly lobed pinnules in *Mariopteris melendezi* sp. nov., as well as the absence of hairs on the underside of pinnules (which is a characteristic feature of *M. hirsuta*).

Remarks. The two specimens available for the description of *Mariopteris melendezi* sp. nov. are both fragments of the middle parts of pinnae; thus showing the average type of pinnules occurring in this species. One of the most striking characteristics found is the broad insertion of the pinnules which are even decurrent on the basiscopic side and which appear to be mainly confluent. This insertion is comparable to that of pinnules in the genus *Dicksonites* which also belongs to the Mariopteridaceae (see Corsin 1961; Danzé-Corsin 1953). A comparison with *Dicksonites* is strengthened by the tendency towards an almost perpendicular position of the pinnules in *M. melendezi*. On the other hand, the clearly bilobate basal pinnules, a characteristic which is unfortunately not very well brought out by the photograph on Plates 104, 105, definitely preclude an attribution to *Dicksonites*. The species discussed here also lacks the strong rachides which form one of the salient features of *Dicksonites*.

The occurrence of *Mariopteris cantabrica* sp. nov. and *Mariopteris melendezi* sp. nov. together in the same locality naturally invites speculation on the possibility that they might be conspecific. Both species belong to the same group of *Mariopteris*, viz. the *Alineae* Danzé-Corsin which are characterized by the absence of transverse bars on the

rachides. Furthermore, both species possess rounded lobes, although these tend to be slightly pointed in *M. melendezi*. There the comparison ends however. *M. cantabrica* has relatively larger, more obliquely inserted pinnules with more closely spaced nervules; the nervation being clearly wider in *M. melendezi*. Pinnules of equivalent size in *M. melendezi* are more lobate than those of *M. cantabrica*, which tend to be more entire. Moreover, the basal pinnules of *M. cantabrica* are more distinctly bilobate than those of *M. melendezi*.

Occurrence. Lower Stephanian C, tip of the seam Purita, Tineo coalfield, Asturias, North-west Spain.

Mariopteris colliciaris D. White

Plate 104, figs. 4, 5; Plate 105, fig. 3

1943 *Mariopteris paddocki* var. *colliciaris* D. White, p. 87, pl. 12, figs. 1–2, pl. 13, figs. 1–9.
cf. 1955 *Mariopteris sphenopteroides* Daber (*non* Lesquereux), p. 18, Taf. IV, fig. 3, Taf. XVI, figs. 1–3.

Material. Only a single specimen (positive) is available for description.

Description. Rachides of the penultimate order rather thin (up to 1 mm. wide), grooved and provided with somewhat indistinct transverse bars. Pinnae of the last order short and composed of 5–7 pinnules; pinnae inserted at approximately 50° angle to the rachis. Rachides of the last order thin. Pinnules inserted by part of the basal width only; decurrent on the basiscopic side and often tending towards insertion by the midvein only (sphenopteroid insertion); approximately as long as wide or only a little longer than wide, and rather small; entire or shallowly lobed, with rounded, somewhat oval lobes. Both the catadromous and the anadromous basal pinnules bilobate. Pinnule lamina apparently rather sturdy, since the pinnules are rather markedly convex (vaulted). Midvein little marked or virtually absent. Nervules thin, rather inconspicuous, and repeatedly forked.

Origin and repository of the figured specimen. Origin: tip of the seam 6 of the Carrasconte coal group, upper Stephanian B, Villablino coalfield (province of León, North-west Spain). Repository: Geologisch Bureau voor het Nederlandse Mijngebied, Heerlen, Netherlands, Catalogue No. 47333 (coll. Kimpe, loc. 203).

Diagnosis. Thin rachides, longitudinally grooved with faint transverse markings; bearing short pinnae of the last order consisting of sphenopteroid, shallowly lobed pinnules with rounded, somewhat oval lobes. Midvein virtually absent; lateral veins thin, repeatedly forked.

Comparisons. *Mariopteris colliciaris* D. White is closely similar to *Mariopteris paddocki* D. White, to which it has been supposed to stand in a varietal relationship (D. White 1943). The pinnules of *M. paddocki* are more slender than those of *M. colliciaris*, however.

There is also a close similarity with *Mariopteris sphenopteroides* Daber which is only marginally different from *Mariopteris colliciaris* D. White by the presence of somewhat larger pinnae and a more slender aspect of the pinnule lobes. It should be

noted that *M. sphenopteroides* Daber is a younger homonym of *M. sphenopteroides* Lesquereux.

Mariopteris beneckei Huth is also characterized by markedly sphenopteroid pinnules and thus shows a certain resemblance to *Mariopteris colliciaris* D. White. However, *M. beneckei* has relatively longer pinnules with more angular, sometimes rather pointed lobes which differ clearly from the rounded lobes in *M. colliciaris*.

Mariopteris sphenopteroides Lesquereux (see White 1899) shows relatively broad pinnules with pointed lobes and does not seem nearly as sphenopteroid as *Mariopteris colliciaris* D. White.

Mariopteris loshi (Brongniart) Huth possesses characteristically ovate pinnules (or lobes) which appear somewhat pointed, and thus differ from the more rounded lobes of *Mariopteris colliciaris* D. White.

Remarks. The species described here has been originally recorded as *Mariopteris paddocki* var. *colliciaris* by D. White (1943) in a posthumous work edited by C. B. Read. This paper only contained descriptions and no comparisons. Neither did it state the reasons why *Mariopteris colliciaris* was to be considered a variety of *M. paddocki*, described in the same paper. In the absence of a recorded progression of forms linking *M. paddocki* and *M. colliciaris*, and having regard to the difficulty of determining a varietal relationship in fossil plants, it seems better for the time being to consider both Mariopterids mentioned as separate species.

D. White (1943) figured several well-preserved specimens of *Mariopteris colliciaris* from the Lower Pennsylvanian of West Virginia. Especially his plate 13, fig. 5 is directly comparable with the specimen recorded here from the Stephanian B of North-west Spain (Pl. 104, figs. 4, 5; Pl. 105, fig. 3). Despite the great difference in age, as well as the widely separate geographic occurrence, there is such a complete correspondence in morphological features that identification of the Spanish material with the American species is inevitable.

White (1943) noted in the plate explanation (pl. 13) that 'except for the common heteromorphy of the basal pinnules, this form' (*Mariopteris paddocki* var. *colliciaris*) 'is similar to species here described under the genus *Diplothmema*'. This is undoubtedly a reference to the group of *Sphenopteris obtusiloba* Brongniart which is recorded in White's paper under the name of *Diplothmema*, together with other Sphenopterid species. It is a fact that the rather stiff, rounded lobes of *Mariopteris colliciaris* evoke the image of certain species of the alliance of *S. obtusiloba*, in particular *Sphenopteris rotundiloba* Němejc (*non* Danzé) and *Sphenopteris whitii* Bell. Also the grooved, slender rachides of *M. colliciaris* are characteristically found in this group of *Sphenopteris*. On the other hand, the presence of transverse bars on the rachides (indistinct though they may be) is a characteristic trait of *Mariopteris* of the group of the *Lineae* (Danzé-Corsin 1953). The presence of bilobate basal pinnules is an even more convincing argument in favour of attributing this species to *Mariopteris* rather than to *Sphenopteris*.

Among the various figures of *Mariopteris* recorded in the literature, two fragments illustrated by P. Corsin (1932, pl. CVII, figs. 1–2) under the name of *Mariopteris rotundata* Huth appear rather similar to *Mariopteris colliciaris* D. White. The pinnules of Corsin's specimens are sphenopteroid to a high degree and thus apparently differ from the predominantly pecopteroid pinnules of the type *M. rotundata* as figured by

Huth (1912, figs. 1–3). Corsin also observed that his specimens appeared more sphenopteroid than the types. Furthermore, it is noted that Huth described the rachides of *M. rotundata* as finely punctate, whereas Corsin described them as possessing faintly marked transverse bars. These differences seem to make Corsin's identification of *M. rotundata* Huth somewhat doubtful. With regard to *M. colliciaris*, it seems that Corsin's specimens show relatively larger pinnules which may be almost twice the size of those belonging to D. White's species.

The specimen of *Mariopteris colliciaris* figured in the present paper represents the only example of *Mariopteris* found in the Villablino coalfield, despite the fact that this coalfield has been exhaustively sampled in recent years. The Villablino coalfield contains measures of Stephanian B and lower Stephanian C ages (compare Wagner 1964, table V). *M. colliciaris* was collected by Dr. W. F. M. Kimpe (Geologisch Bureau, Heerlen) in the course of a detailed stratigraphic investigation of the Villablino coalfield which was carried out in the years of 1953 to 1957. It was obtained from the tip of seam 6 in the mining section of Carrasconte (Kimpe loc. 203), where it occurred in association with the following species (after identifications by R. H. Wagner and, where stated, by the late Professor W. J. Jongmans): *Pseudomariopteris ribeyroni* (Zeiller) Danzé-Corsin, *Dicksonites* cf. *pluckeneti* (von Schlotheim) Sterzel, *Pecopteris feminaeformis* (von Schlotheim) Sterzel, *Pecopteris* (*Ptychocarpus*) *unita* Brongniart, *Pecopteris jongmansi* Wagner, *Polymorphopteris villablinensis* Wagner (representing the higher parts of the frond of *Polymorphopteris subelegans* (Potonié) Wagner?), *Acitheca* sp., *Taeniopteris jejunata* Grand'Eury, *Sphenophyllum oblongifolium* (Germar et Kaulfuss) Unger, *Sphenophyllum longifolium* (Germar) Goeppert, *Sphenophyllum thoni* von Mahr, *Annularia sphenophylloides* (Zenker) von Gutbier, *Annularia stellata* (von Schlotheim) Wood, *Calamostachys tuberculata* Sternberg, *Asterophyllites equisetiformis* (von Schlotheim) Brongniart, *Calamites schutzei* Stur (Jongmans *det.*), *Calamites* cf. *schutzeiformis* Jongmans et Kidston (Jongmans *det.*), *Lepidodendron gaudryi* Renault (Jongmans *det.*), *Sigillaria brardi* Brongniart *formae diversae*, *Sigillariostrobus* sp. The assemblage is one of either late Stephanian B or Stephanian C age. However, additional species recorded from the numerous localities explored by Dr. Kimpe in the Carrasconte area, indicate late Stephanian B rather than Stephanian C. They include the following elements, as identified by one of the present writers (R. H. W.): *Neuropteris ovata* Hoffmann var. *grand'euryi* Wagner, *Cyclopteris fimbriata* Lesquereux (= *Cyclopteris* of *N. ovata*), *Callipteridium* (*Eucallipteridium*) *zeilleri* Wagner, *Alethopteris* cf. *pennsylvanica* Lesquereux, *Alethopteris pseudobohemica* Wagner, *Pseudomariopteris busqueti* (Zeiller) Danzé-Corsin, *Dicksonites pluckeneti* var. *sterzeli* Zeiller, *Sphenopteris matheti* Zeiller, *Sphenopteris* ('*Pecopteris*') *leptophylla* Bunbury (= *Ovopteris pecopteroides* Landeskroener), *Pecopteris arborescens* (von Schlotheim) Brongniart, *Pecopteris hemitelioides* Brongniart, *Pecopteris melendezi* Wagner, *Lobatopteris corsini* Wagner, *Polymorphopteris polymorpha* (Brongniart) Wagner, *Polymorphopteris subelegans* (Potonié) Wagner, *Polymorphopteris multifurcata* Wagner, *Lepidodendron* cf. *scutatum* Lesquereux, *Asolanus camptotaenia* Wood, etc.

Occurrence. North America: lower railway cutting, below second sandstone below Raleigh Sandstone (360 ft. below Raleigh Sandstone), Nuttall, West Virginia, U.S.A. (White 1943). North-west Spain: upper Stephanian B, tip of seam 6 of the

Carrasconte mining section of the Villablino coalfield, province of León (Kimpe, loc. 203).

DISCUSSION ON THE PRESENCE OF *MARIOPTERIS* IN STEPHANIAN STRATA

The description of three species of *Mariopteris* from rocks of upper Stephanian B and lower Stephanian C ages in North-west Spain clearly disproves the notion that this genus became extinct at the end of Westphalian or, at the latest, at the beginning of Stephanian times. Of particular interest is the fact that the specimens described here are either identifiable with or closely comparable to Westphalian species of *Mariopteris*. Although the paucity of material (only five specimens among the many thousands collected) indicates that a formerly abundant element of Upper Carboniferous floras has become exceedingly scarce during Stephanian times, the presence of three different species proves its comparative diversity at a time considerably later than that represented by the main occurrence of this group of pteridosperm foliage.

The often repeated statement that *Mariopteris* would be absent from Stephanian strata has thus been proved incorrect. It may, however, be worth while to explore the inadequacy of this statement a little further. In his famous description of the Stephanian flora of Commentry, in Central France, Zeiller (1888) recorded three species of Mariopterid characteristics, viz. '*Diplotmema*' *ribeyroni*, '*Diplotmema*' *busqueti*, and '*Diplotmema*' *paleaui*. These species were assigned to *Diplotmema* by Zeiller because they apparently possessed bipartite fronds. However, Danzé-Corsin (1953) observed that the frond was probably quadripartite in *D. paleaui*, as was generally the case for *Mariopteris*. She also drew attention to the relatively entire, little lobed pinnules of these three species, and mentioned the presence of bilobate basal pinnules which is a characteristic feature of *Mariopteris*. The foliage of *Diplotmema* in the more restricted sense (Danzé-Corsin 1953) is more highly dissected. Previously, Bell (1938) had already referred '*Diplotmema*' *ribeyroni* Zeiller to *Mariopteris* (with an interrogation mark), whilst Teixeira (1939) described a species of the same alliance under the name of *Mariopteris corsini* Teixeira. Furthermore, Stockmans and Mathieu (1939), when describing an East Asian species closely similar to '*Diplotmema*' *busqueti* Zeiller, assigned it to *Mariopteris*? *hallei* Stockmans et Mathieu.

As the result of the considerations mentioned above, Danzé-Corsin (1953) decided to receive the three species described by Zeiller in a special genus called '*Pseudomariopteris*'. This genus would be characterized by bipartite or quadripartite fronds with longitudinally striate axes and generally little lobed, almost entire pinnules, as well as bilobate basal pinnules to the pinnae of the last order. Only the presumed predominance of bipartite, instead of quadripartite fronds in *Pseudomariopteris* would distinguish this genus from real *Mariopteris*. The question automatically arises whether such a difference would be adequate to warrant the recognition of a special genus. However, Danzé-Corsin (1953) did include *Pseudomariopteris* with the family of the Mariopterideae (altered to Mariopteridaceae by P. Corsin 1961).

The genus *Pseudomariopteris* gained almost immediate acceptance in the literature and, in fact, provided a most convenient heading for Mariopterids of Stephanian age. Apart from the three species originally described by Zeiller, the more recently described

Mariopteris corsini Teixeira was referred to *Pseudomariopteris* by Wagner (1962, pl. 33) and, ultimately, Alvarez-Ramis and Doubinger (1965) introduced still another species, *Pseudomariopteris villablinensis*. It is to be noted that *Pseudomariopteris ribeyroni* and, to a somewhat lesser extent, *Pseudomariopteris busqueti* are common elements of Stephanian B and C floras. *Pseudomariopteris ribeyroni* has its first occurrence in Westphalian D strata, but does not really become common before Stephanian B.

Stockmans and Mathieu (1957, p. 17) expressed doubt as to the wisdom of recognizing *Pseudomariopteris* as a genus separate from *Mariopteris*, and it may perhaps be considered an open question whether or not *Pseudomariopteris* should be incorporated with the latter. However, there can be no doubt that Mariopteridaceae of a type closely similar to ordinary *Mariopteris* are among the common constituents of Stephanian floras. The general persistence of this group of Pteridosperms is further underlined by the find of three undoubted species of *Mariopteris* in Stephanian B–C rocks, as reported in the present paper.

REFERENCES

ALVAREZ-RAMIS, C. 1964. Contribución al estudio de la flora carbonífera de Tineo (Asturias). *Bol. Inst. Est. Asturianos* (*supl. Ciencias*), **9** (*Breviora Geol. Astúrica*, VII (1963), 1–4, 69–74, láms I–III).

—— and DOUBINGER, J. 1965. *Pseudomariopteris villablinensis* n.sp. du Stéphanien de Villablino (Léon, Espagne). *Estudios Geológicos*, **20** (1964), 3–4, 235–7, pl. 1.

BELL, W. A. 1938. Fossil Flora of Sydney Coalfield, Nova Scotia. *Mem. geol. Survey Canada*, **215,** 1–334, pl. 1–107.

CORSIN, P. 1932. Marioptéridées. *Études Gîtes Min. France, Sarre–Lorraine*. I. *Flore fossile*, **3,** 109–77, pl. 61–107.

—— 1961. Classification des Ptéridophytes et des Ptéridospermophytes du Carbonifère. *Bull. Soc. géol. France* (7), II (1960), 566–72.

DABER, R. 1955. Pflanzengeographische Besonderheiten der Karbonflora des Zwickau-Lugauer Steinkohlenreviers. A. Pteridophyllen (farnlaubige Gewächse). *Beiheft Geologie*, **13,** 1–44, Tafn. 1–25.

DANZÉ-CORSIN, P. 1953. Contribution à l'étude des Marioptéridées. Les Mariopteris du Nord de la France. *Études géol. Atlas Top. souterraine, Serv. géol. H.B.N.P.C.* I. *Flore fossile*, **1,** 1–269, pl. 1–77.

DOUBINGER, J. and ALVAREZ-RAMIS, C. 1963. Sphénoptéridées du Carbonifère de Tineo (Asturies). *Estudios Geológicos*, **19,** 193–204, pls. 1–4.

—— —— 1964. Sur la flore du bassin houiller de Tineo (Asturies). *C.R. Acad. Sci., Paris*, **259,** 1885–7.

GOTHAN, W. and WEYLAND, H. 1954. *Lehrbuch der Paläobotanik*. Akademie-Verlag, Berlin, 1–535.

HUTH, W. 1912. Die fossile Gattung Mariopteris in geologischer und botanischer Beziehung. *Inaug. Diss.* Berlin, 1–88 (also *in* H. POTONIÉ, 1912. *Abb. u. Beschr. foss. Pflanzen-Reste*, **8,** 141–53).

—— 1912. Mariopteris Loshii, Zeilleri, rotundata, grandepinnata. *In* H. POTONIÉ: *Abb. u. Beschr. foss. Pflanzen-Reste*, **8,** 153–6 (*Preuss. Geol. L.A., Berlin*).

JONGMANS, W. J. and PRUVOST, P. 1950. Les subdivisions du Carbonifère continental. *Bull. Soc. géol. France* (5), 20, 335–44.

KANIS, J. 1956. Geology of the eastern zone of the Sierra del Brezo (Palencia–Spain). *Leidse Geol. Mededelingen*, **21,** 377–445, pl. 1–3, apéndices 1–3 (thesis Leiden 1955) (edición esp. 1960. Investigaciones geológicas en la zona oriental de la Sierra del Brezo. *Estudios Geológicos*, **16,** 109–56; láms I–III, apéndices 1–3).

KIDSTON, R. 1925. Fossil Plants of the Carboniferous Rocks of Great Britain. pt. 6. *Mem. geol. Surv. Gt. Britain, Palaeont.* II, **6,** 523–670, pl. 123–53.

LUTZ, J. 1938. *Mariopteris. Palaeontographica, Suppl.-Bd.* **9**: *Die Karbon-Flora des Saargebietes.* Abt. 4: *Pteridospermales*, 1–34, Tafn 1–20.

MELÉNDEZ, B. 1943. Un fenómeno de coquización en la antracita estefaniense de Asturias. *Bol. R. Soc. Esp. Hist. Nat.* **41,** 103–13, láms 40–45.

MENÉNDEZ AMOR, J. and JONGMANS, W. J. 1952. Contribution à la connaissance de la flore carbonifère des Asturies. *C.R. 3e Congrès Carbonifère, Heerlen 1951*, II, 459–62, pl. 21–23 (trad. esp. 1954. Contribución al conocimiento de la flora carbonífera de Asturias. *Estudios Geológicos*, **10**, 23–24, 307–16, láms 40–45).

STOCKMANS, F. and MATHIEU, F.-F. 1939. La flore paléozoïque du bassin houiller de Kaiping (Chine). *Mus. Roy. Hist. Nat. Belgique*, 49–165, pl. 1–34.

—— —— 1957. La flore paléozoïque du bassin houiller de Kaiping (Chine) (deuxième partie). *Publ. Ass. Étud. Paléont., Bruxelles*, **32**, 1–89, pl. 1–15.

TEIXEIRA, C. 1939. *Mariopteris* do Carbonífero português. *Bull. Soc. port. Sci. nat.* **13**, 7, 31–36, Est. 10–13.

—— 1942. Notas sôbre a Flora westfaliana de alguns afloramentos carboníferos dos arredores do Pôrto. *I Congr. Nac. Ci. Nat. Lisboa 1941*, 1–13, Est. 1–4.

VEGA ROLLÁN, C. DE LA 1964. Contribución al estudio de la flora carbonífera del occidente de Asturias. *Bol. Inst. Est. Asturianos (supl. Ciencias)*, **9** (*Breviora Geol. Astúrica*, VIII, 1–4, 37–51, láms I–IV).

WAGNER, R. H. 1962. A brief review of the stratigraphy and floral succession of the Carboniferous in N.W. Spain. *C.R. 4e Congrès Carbonifère, Heerlen 1958*, III, 753–62, pl. 29–33.

—— 1964. Stephanian Floras in N.W. Spain, with special reference to the Westphalian D–Stephanian A boundary. *C.R. 5e Congrès Carbonifère, Paris 1963*, II, 835–51, pl. 1–3.

—— 1966. Palaeobotanical Dating of Upper Carboniferous Folding Phases in N.W. Spain. *Mem. Inst. Geol. Min. España*, **66** (1965), 1–169, pls. 1–77.

WHITE, D. 1899. Fossil flora of the Lower Coal Measures of Missouri. *Mon. U.S. geol. Survey*, **37**, 1–467, pl. 1–73.

—— 1943. Lower Pennsylvanian species of *Mariopteris*, *Eremopteris*, *Diplothmema*, and *Aneimites* from the Appalachian region. *U.S. geol. Survey Prof. Paper*, **197–C**, 81–103, pl. 8–39.

ZEILLER, R. 1882, Notes sur la flore houillère des Asturies. *Mém. Soc. géol. Nord.* I, 3, 1–22.

—— 1888 (*in* RENAULT and ZEILLER), Études sur le terrain houiller de Commentry. II. Flore fossile, 1re partie. *Soc. Industrie minérale*, 1–366, pl. 1–40.

R. H. WAGNER
Department of Geology,
The University,
St. George's Square,
Sheffield 1

C. ALVAREZ-RAMIS
Laboratorio de Paleontología,
Facultad de Ciencias,
Universidad de Madrid,
Pabellón V (M), Ciudad Universitaria,
Madrid

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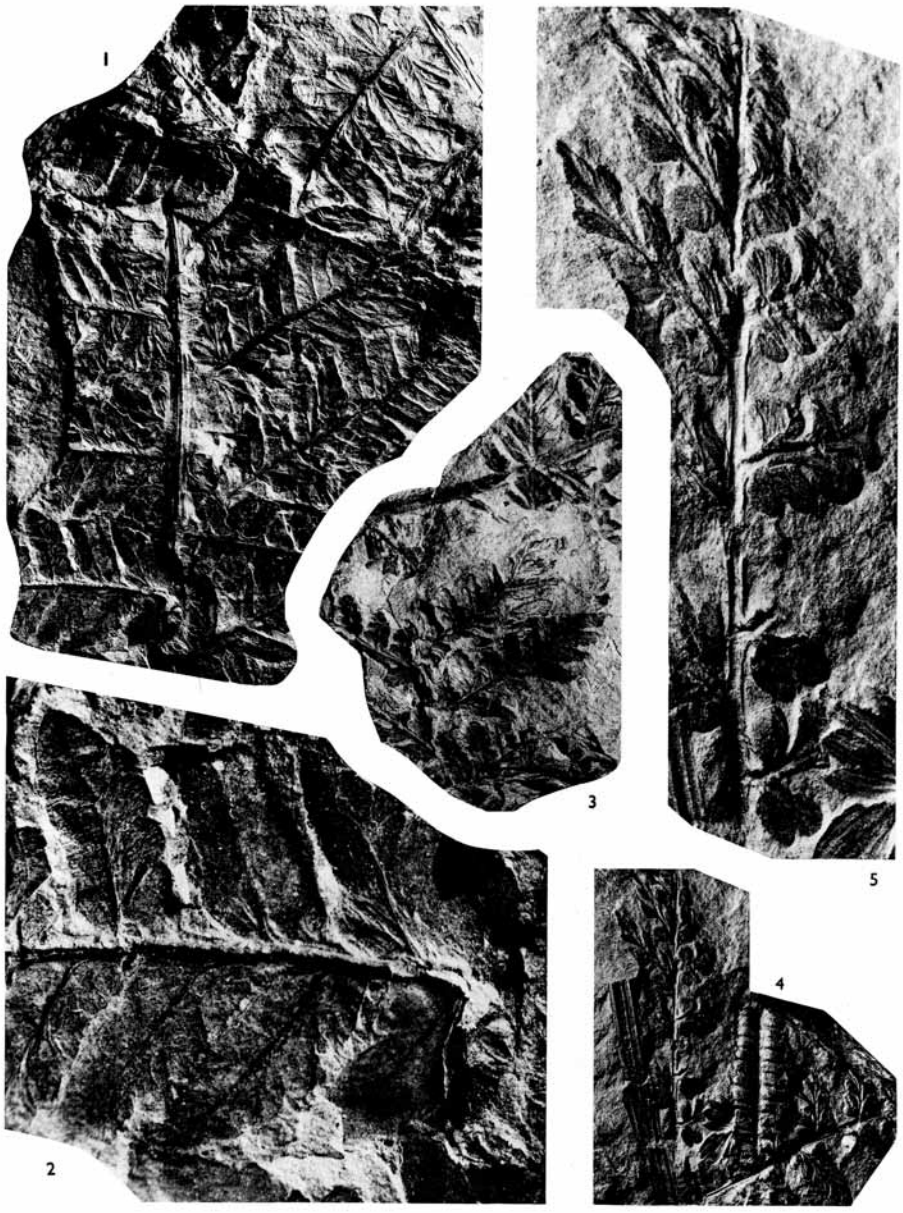

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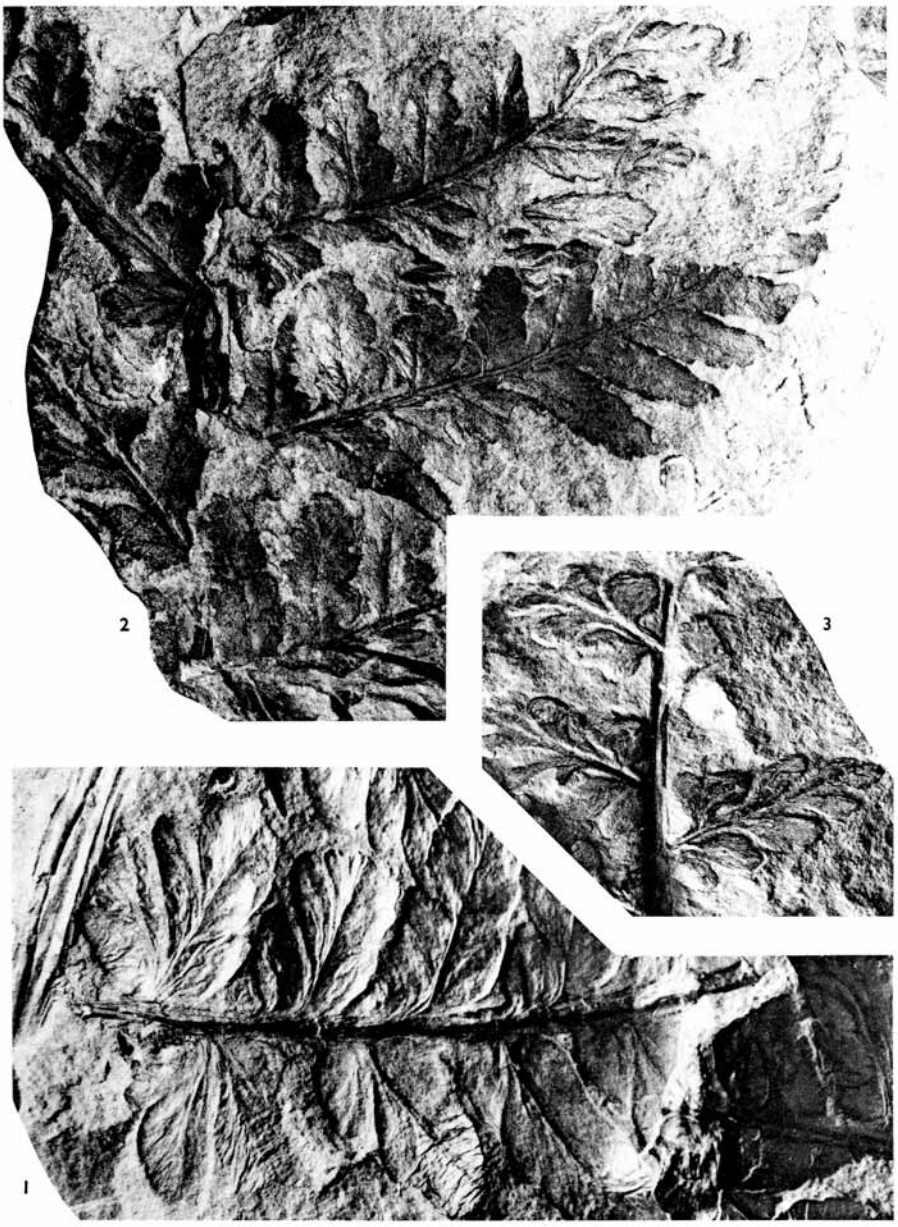

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