# The Carboniferous Floating Forest — An Extinct pre-Flood Ecosystem

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**ABSTRACT**

*Creationists start from the assumption that the seams of the Carboniferous coal measures are derived from water-borne plant matter. Adherents of historical geology dispute this and affirm that each seam represents an* in situ *buried coal forest Their principal reasons for this claim are the existence of rooted underclays and* in situ *buried erect stems. This paper exposes some of the more obvious mistakes made in interpreting Carboniferous coal seams as having grown in place. Drawing from field experience in both Europe and North America, as well as from a voluminous body of descriptive literature on the subject, it is concluded that the coal forests represented a unique type of floating ecosystem that was primarily composed of arboreal lycopods. At the onset of the Flood, these vegetation mats were dislodged and left to drift. When the Flood waters receded, the coal forest rafts were deposited on top of subsiding sediment piles that had developed after the eruption of the 'fountains of the great deep'.*

## INTRODUCTION

The creationist/evolutionist controversy is ultimately about whether Earth history has had a relatively brief or an immensely long duration. In arguing for one or the other a correct understanding of the processes leading to the deposition of coal is crucial. If the coal seams are autochthonous, that is, have grown in place, and if the lifetime of a forest leading to a coal seam is estimated at 1,000 years on average, the time required for the deposition of the 200 to 300 coal seams in north-west Europe would be in the order of 250,000 years — and this is without allowing time for the accumulation of the intervening sediments. If, on the other hand, the vegetable matter is of allochthonous origin, that is, transported by water, it would be reasonable to assume that all the seams are of approximately the same age. In such a case the time required for the piling up of the coal-bearing sediments would necessarily be reduced.

From the literature of the English-speaking creationist community one might gain the impression that the issue of coal formation has not yet been satisfactorily resolved in favour of the biblical Flood concept. This is not the true state of the art, however. Work on coal has been progressing in Germany and elsewhere steadily. Some of the more important results of the author's research on Carboniferous coals will be presented in this paper.

## THE TYPE OF VEGETATION IN CARBONIFEROUS COALS — THE SAME THE WORLD OVER

At first sight there seems to exist a variety of Carboniferous coals. A 'Euro- American' coal province is distinguished from an 'Angaran' and a 'Cathaysian' province. These three in turn are contrasted with the Permo-Carboniferous 'Gondwana' province as a fourth. Whereas the flora of the latter is widely spread across the Southern Hemisphere, the Euro-American, the Angaran and the Cathaysian floras are confined to the Northern Hemisphere (with an outlier in northern South America). The Gondwana flora is unique. It is chiefly composed of the genus

*Glossopteris.* The remaining three floral units have also one important feature in common: their chief constituents are arboreal lycopods. Whereas Gondwana coals are always deposited without underlying root beds, all coal seams of the Northern Hemisphere are in contact with a rooted underclay. This slightly generalising statement is to remind us that we must give heed to the regular conditions prevailing in coal-bearing rocks if we are to obtain insights into the ecology of the one-time coal forests and the mechanism of their subsequent burial.

## THE TWO OPPOSING VIEWS ON COAL FOREST ECOLOGY IN RETROSPECT

### (a) Arguments of the Autochthonists

During the first half of the last century, about coeval with the decline of biblical convictions among the prominent geologists of the day, the theory of autochthonous growth of the Carboniferous coal forests began to be vigorously promoted by Logan and Lyell in Britain[12] and Goeppert in Germany.[3] Their line of argument rested largely on two observations: firstly, that there is a transition between the root beds and the overlying coal which indicates that the plant matter grew on a soil, that is, that it originated *in situ;* secondly, that erect stems rising from the coal into the barren rocks suggest that the full-grown forests were likewise buried *in situ. A* huge body of descriptive coal literature published up to the present decade assumes that the autochthonous interpretation is valid. Serious attempts at falsifying this theory have not been forthcoming since, in this camp, it is taken for granted that no links exist between the biblical Flood as a geological event and the phenomena observed in the field.

### (b) Arguments of the Allochthonists

The arguments of the allochthonists in favour of the water-borne deposition of Carboniferous coal have been much less straightforward. Although mostly well-documented, their observations are scattered through the literature of the past 175 years. They have had practically no influence on the currently accepted theory of coal formation. Charpentier,[4] dealing with erect stems in the coal measures of Silesia, argued cogently that they could not have grown in the same situations where they are found now. Kuntze,[5] an experienced botanist, considered the arboreal lycopods to have permanently grown from a surface of water. Being also a staunch evolutionist, however, he thought that these aquatic lycopods had evolved from early marine algae(!). Gresley[6] came to the conclusion that the ubiquitous root beds beneath coal seams are clearly water-laid sediments. Schmitz[7] documented lycopod stumps in growth position that had been dumped upon branches of the coal vegetation and could therefore not have grown in place. The papers by Stainier[8-10] contain a further elucidation of the rapid formation of the root-bearing underclays.

Among creationists, Coffin[11] revived interest in the subject with his report on the Joggins exposures in Nova Scotia. In a brief paper on the coiled worm tubes of *Spirorbis* which are frequently attached to objects in the coal measures, he claimed that the coal plants must have drifted in sea water for a time prior to burial.[12] Austin, in his thesis on the Kentucky No. 12 coal,[13] inferred from lithological evidences that the surface of peat deposition of this particular seam (which lacks a rooted seat-earth) could not have been the site of plant growth. He posited a floating forest debris raft as the source of organic fall-out under water, but the principally substrate-dependent growth of the lycopod forests was not questioned. Scheven reported on the sedimentary nature of the Carboniferous underclays, on the information obtained from coal balls about the composition of living coal peat, on the structure of the lycopod tree roots that suggest an aquatic mode of life, and on the prevailing high-energy environments between successive coal seams that make long-term plant growth during the postulated quiet intervals highly improbable.[1416] A fifth reason for the allochthony of Carboniferous coals will be discussed in the course of this paper: the botanical uniformity of the successive hard coal horizons suggests one defined ecological unit, rather than a sequence of evolving floras in an ascending order through the course of a so-called coal age.

## FIVE REASONS WHY CARBONIFEROUS COALS ARE ALLOCHTHONOUS

### (1) Underclays are not Soils

The term underclay or seat-earth *(Wurzelboden* in German) implies that the rock layer represents the petrified remains of the substrate on which an ancient vegetation once germinated, flourished and died. This deep-rooted notion forms one of the pillars on which historical geology rests. If underclays were to be regarded as anything different from soils the currently accepted theory of Carboniferous coal formation would be in serious difficulty. Rooted underclays are the chief reason for claiming that the coals above are autochthonous. As will be shown, this claim is not only poorly founded, but is directly opposed to the facts:-

#### (a) The exclusive occurrence of lycopod roots below coal seams.

Stigmarian roots are the only plant organs that crowd the underclays. Other roots, for example, of ferns, horsetails and *Cordaites,* which are all well known from within the coal, are completely absent. This is a principal difference between lycopods and the roots of other constituents of the coal vegetation. Since the difference is nowhere emphasised in the pertinent literature one might easily miss it. In any modern plant community the member plants are rooted side by side in the substrate. This is not the case with underclays. The obvious conclusion is that the communities of the Carboniferous forests were not rooted in soils.

**(b) The lithological diversity of underclays.**

Probably the most widespread type of underclay is a purplish-black mudstone. Less common are underclays consisting of laminated silt or of pure sandstone. An interesting phenomenon is that the lithology of one and the same underclay may vary below a seam over some distance. In addition, an underclay may also consist of limestone! No living plant is known that would tolerate such a diversity of 'soils'; from nutrient-rich to sterile, and from utterly acidic to utterly alkaline! The different lithologies around the lycopod roots are therefore purely accidental. There exists no relationship between the uniform coal vegetation and the varying composition of its supposed supporting soils!

**(c) Graded bedding and stratification in underclays.**

Many typical underclays of the north-west European coal basins are between 2 and 3 m (6.5 and 10 ft) thick. Permeation by lycopod roots fades gradually towards the base. The lower sections of such root beds are distinctly more coarse-grained than at levels nearer the coal, as can be demonstrated with a simple experiment. Hammering the underclay in a vertical direction produces an audible scale: higher notes occur below and lower ones above. The grading shows that the entire unit of 2 or 3 m was deposited as a whole. That this deposition took place with the stigmariae already present is shown by the countless roots and rootlets that penetrate the laminated or cross-bedded parts of the underclay without disturbing the rock fabric in the slightest. Such a condition would be unthinkable if the coal vegetation had taken root on the surface of the underclay only **after** the arrival of the sediment.

**(d) Non-lycopod plant remains in underclays.**

Although Carboniferous underclays are devoid of root organs other than stigmariae, fine examples of fern pinnules and even parts of whole fronds occur in some root beds. They are more easily detected in sandstones and hardened shale (from drill cores) than in the brittle types that happen to be exposed above the ground. These plant remains are identical to those ordinarily found in the roof shales above the coal. Both are therefore likely to have been buried in the same manner. If recognisable plant parts occur along bedding planes in a sediment with lycopod rootlets penetrating vertically at the same time, it may be safely assumed that their mode of embodiment in the substrate, as well as their mode of preservation as petrifications, was the same. A fresh fern frond in soil will decompose within a very short time. Such remains in underclays are therefore proof that nothing ever grew on these alleged root beds.

More observations could be adduced to show that underclays have nothing to do with soils in the normal sense. Table 1 contains an evaluation of recognised papers on this subject from 1938 till 1977. Although none of the authors question the autochthony of the coals investigated, each one gives one or more reasons why underclays cannot have been true soils.

## (2) The Message of Coal Balls

Certain seams of Carboniferous coals of both the New and the Old World contain limestone concretions that have yielded important information about the composition of the original coal peat. They are known as coal balls (in German, *Torfdolomit).* Inside these coal balls complete plant tissues are preserved with no or very little compaction. On etching a polished surface of a sectioned coal ball with acid a softened acetate foil pressed onto it picks up the cell pattern. The resulting peel replicates the complete cross section of the tissue, which can be examined under the microscope. Besides the carbonate concretions there are also coal balls that consist of pyrite. These are worthless for study since they disintegrate within a short time. In exceptional cases even silicified coal balls have been reported. These petrified

| AUTHOR | YEAR | LOCALITY | CONCLUSION: UNDERCLAYS . . . |
|---|---|---|---|
| Grim and Allen | 1938 | Illinois | — are not the product of atmospheric weathering |
| Spencer | 1955 | Illinois | — show no soil profile; they are transported sediments |
| McMillan | 1956 | Kansas | — are gley formations; can also form below allochthonous coal |
| Parham | 1958 | Illinois | — are of sedimentary origin |
| Schultz | 1958 | USA | — possess no soil profile; cannot be soils to coal vegetation |
| Huddle and Patterson | 1961 | USA | — are sediments of all kinds |
| Nicholls and Loring | 1962 | Wales | — their geochemistry disagrees with a soil profile |
| Röschmann | 1962 | Ruhr area | — possess only a sediment fabric |
| O'Brien the | 1964 | Illinois | — are product of deposition; no atmospheric weathering; grade into lithologies below |
| Parham | 1965 | Illinois, Ohio | — show a regional variation of clay minerals |
| Wilson | 1965 | Wales | — are not formed through *in situ* weathering; are not the soils of the overlying coal vegetation |
| Füchtbauer and Müller | 1977 | overview | — 'with certainty [these are] no soil formations' |

***Table 1.*** *Results of work on underclays between the years 1938 and 1977. None of the authors call into question the essential autochthony of the coals.*

plant tissues give first-hand botanical insights into the taxonomy and anatomy of coal plants. They therefore make an important contribution to our understanding of the ecology of the former coal forest community. In the following we will consider:

(a) the significance of their globular shape,
(b) what can be learnt from their vertical distribution in coal seams, and
(c) what the coal peat must have been like in life.

**(a) The significance of the globular shape of coal balls.**

Not all concretions in coal are ball-shaped, but most of them approach this form. If observed *in situ* the stratified coal on either side is seen to part above and below the concretions. This means that coal balls began to form prior to the compaction of the coal peat beneath the overburden. As we shall see, this has a bearing on the question of whether the coal vegetation was autochthonous or allochthonous.

The formation of coal balls can be explained as follows. Mineral-rich water becomes trapped within the coal peat. Pressure from above causes enclosures of this water to assume a globular form. Carbonate and calcium ions are expelled from the collapsing water-laden peat under extreme pressure and migrate into the pressure-resistant water bubble. There, permineralisation of the peat tissues leads to the preservation of all plant parts in a near-life configuration.

Although difficult to test experimentally, the above mechanism finds a remarkable analogy in the formation of agate nodules. Like coal balls, agate nodules originated in trapped water under extreme pressure. Like coal balls, agate nodules are usually spherical. And like coal balls, precipitation or crystallisation of the mineral matter commenced from the periphery. Unlike normal agate, however, coal balls appear to have been sometimes subjected to earth shocks during formation, as is evident from healed fractures within the precipitates.

This mode of formation of coal balls implies that fresh and even living plant matter was suddenly covered with a sediment pile much thicker than would be expected from a gradual transgression. Rapid subsidence and deposition of one or more vegetation mats in quick succession must be envisaged if the formation of coal balls is to be adequately explained. An autochthonous origin of the coal beds would be impossible under such conditions.

**(b) The vertical distribution of coal balls within a seam.**

The theory of autochthonous coal formation supposes that the plant matter accumulated gradually, that is, the thickness of the peat increased slowly with time. The theory demands that a 'primary peat' at the base of the seam would be succeeded by younger generations of a 'secondary peat'. In analogy to modern peat bogs, a difference in age of successive layers should also be demonstrable in coal seams. This postulate can be tested with coal balls.

Coal balls may occur at all levels in a seam. Among the best documented cases are those by Stopes and Watson[17] and Phillips *et al.*[18,19] The 'infestation' with coal balls may be so heavy that the concretions occur throughout the coal, from top to bottom. Contrary to expectation, however, the plant matter at the lower levels is **not** more compressed than the plant matter further up. It follows that, before burial, the entire mat was a living unit. This conclusion is confirmed by the presence of roots below the seam that, as we have seen, were choked in sediment posthumously.

**(c) The consistence of Carboniferous coal peat in life.**

Coal balls exist in a variety of types. Besides the 'regular' ones that are largely dominated by lycopod root organs, there are others that contain primarily macerals and a jumble of larger plant fragments. A third type is the 'faunal' coal balls that contain mainly shell debris. Here we shall deal with the regular type only.

Root organs of plants that are entirely missing in underclays are regularly encountered in coal balls. Accordingly, ferns, horsetails, *Cordaites* and the like must have grown from the peat only. Arboreal lycopods evidently acted as the pioneer vegetation.

Many of the regular coal balls are developed around a hollow plant axis, for example, a lycopod branch or section of a stigmaria. The water leading to the formation of a coal ball seems to have been trapped inside such hollow cylinders. Next to these the most prominent constituents of a regular coal ball are the hollow lycopod rootlets, the so-called appendices. In a peel they occupy every available space in size range, from maturity down to the recently germinated sporeling. Williamson[20] illustrated as early as 1887 appendices invading foreign plant tissues that had become vacant through death. An ecological explanation of this curious behaviour has never been given.

The first and most obvious lesson to be learnt from the appendices crowding the coal peat is that they grew without a terrestrial soil as such. Instead, the necessary minerals must have been supplied through the water-soaked peat. A second lesson may be learnt from the hollow nature of the appendices: the coal peat contained a large amount of air. There exist a number of modern analogies in root anatomy for air-filled tissues, notably among waterweeds, but none for tissues being filled with water. Indeed, it would be incomprehensible that large plant cavities should contain a liquid. In addition, the theory for the formation of coal balls here proposed would work only if an air-filled tissue was invaded by water. The entire body of coal peat seems to have been composed mainly of a dense wicker-work of air-filled root organs that formed a single unit reaching from the aerial stems down to the free-floating lycopod roots below the peat.

## (3) The Structure of Lycopod Tree Roots

In order to decide whether Carboniferous coals formed in place or were transported from elsewhere, an examination of the root structure of the principal peat-builders may be helpful. Fine sandstone casts of root-bearing lycopod stumps, among them the famous 'Fossil Grove' of Glasgow, bear witness to the essential hollowness of the once living trees — hollow to the very root tips! (see Figure 1). Autochthonists insist that the cavities opened when the tissues inside the stems decayed after death. It will be shown that this explanation for a feature that can be observed universally is ill-founded. For the present purpose we shall limit our attention to the stigmarian axes and their adhering appendices. (The structure of the lycopod stems will not be considered here.)

Stigmarian roots, or rhizophores, occur in clastic rocks in two different versions. Either they are completely flattened, or they are filled with sediment and retain their originally cylindrical shape more or less (see Figure 2). If the allegedly present solid tissue inside the cylindrical type rotted away as is claimed, what happened to the flattened

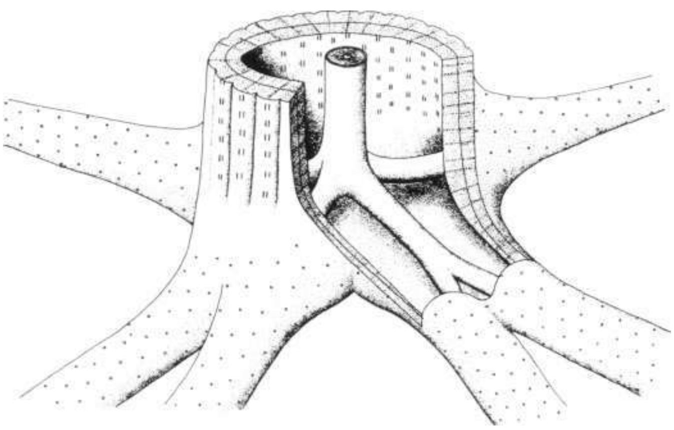

**Figure 1.** *Reconstruction of a lycopod tree stump showing its hollowness between the central cylinder and the outer rind.*

version of stigmaria about which no such claim has been made? Or are we to believe that rotting of the interior occurred under all circumstances? Fortunately, we are not left in uncertainty about this. Stigmariae preserved as cylinders bear, along the whole of their lengths, a groove on their upper sides. This is a collapse structure. The central cylinder (or stele) was already surrounded by clastic material when the increasing overburden caused the soft tissues of the stele to yield. One should expect to find stigmariae that are filled with sediment at so advanced a stage of internal decay that even the stele is missing. Yet this is never the case! The obvious conclusion to be drawn is that an extensive air tissue existed between the stele and the cortex of the stigmaria, an idea confirmed by cross-sections of stigmarian axes in coal balls. A tissue that might be taken for the lycopod root solid is simply not there!

The name 'stigmaria' is derived from the presence of numerous scars spirally distributed all over the surface of the cylinder. Originally, an appendix or rootlet was attached to each. If a stigmaria is observed in an underclay *in situ* the radiation of the appendices in all directions is a striking

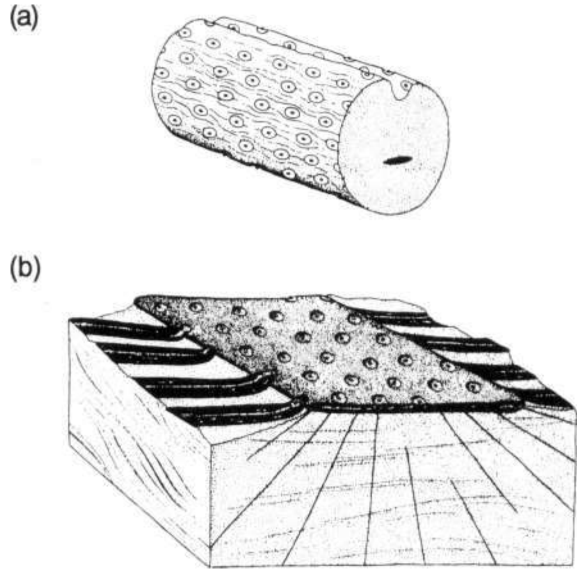


**Figure 2.** *The two different modes of preservation of stigmaria:*
*(a) filled with sediment, and*
*(b) flattened.*
*In both cases the stelae are collapsed.*

sight, for no living underground root system of similar behaviour is known. The tendency of root growth in soil is always downwards. By contrast, the secondary roots (appendices) of arboreal lycopods are arranged in lampbrush fashion around the main axis (see Figure 3). An analogy to this behaviour among living plants may be found in the roots of certain waterweeds. If roots are deeply submerged in water they need not be geotropic. The curious lampbrush arrangement of the appendices on lycopod roots is best explained by assuming an aquatic mode of life.

Few workers seem to have reflected on the significance of the scars over the surface of the stigmaria. Investigations by Frankenberg and Eggert[21] and Jennings[22] on coal ball material have established that true abscission tissues occur

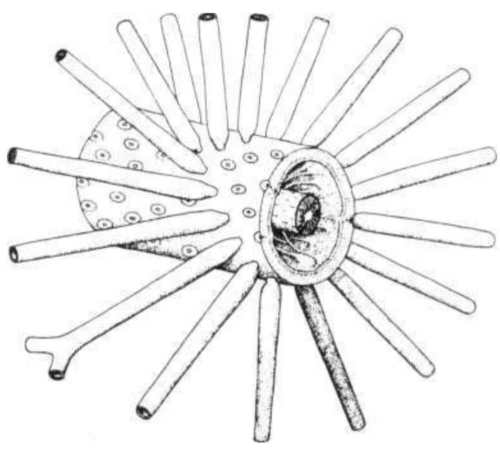

**Figure 3.** *Reconstruction of the central stigmarian root with its radial appendices. Notice again the hollowness around the central cylinder (stele) and the scars on the outer tissue (bark) where the appendices were attached.*

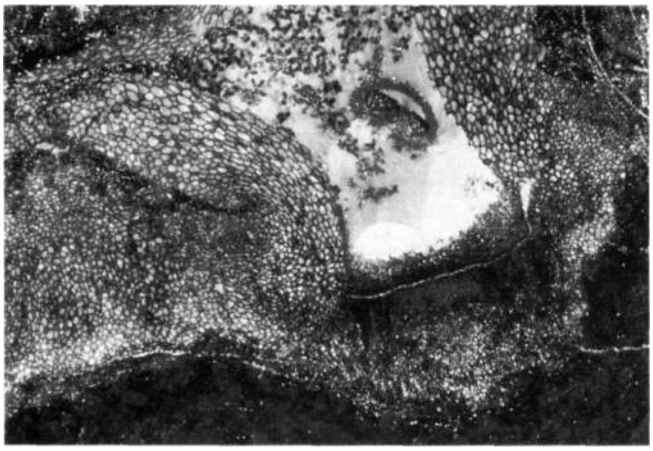

***Figure 4.*** *Longitudinal section through the base of an appendix attached to stigmarian bark. The split of the abscinding appendix is clearly visible. Magnification is approximately 10x.*

at the junction of appendix and stigmarian bark. In rare cases, the split along the scar, arrested in the process of petrifaction, is directly visible (see Figure 4). If the scars are areas where the appendices became detached, one should inquire why they became detached. Do living underground roots shed parts of themselves? Such a separation in soil would seem to serve no purpose. In water, on the other hand, this might be meaningful. Ageing appendices could be discarded like foliage on branches. This interpreted shedding of roots implies that Carboniferous lycopods grew in water — a view strongly supported by the sedimentary nature of the underclays, as pointed out above.

Finally, the condition of the appendices as they appear in the rootbeds also argues for the allochthony of the coal. The appendices inside coal balls are mostly inflated, whereas in underclays they are practically always compressed. In more competent root beds, that is, in limestone or sand, the appendices are occasionally solid and filled with sediment. For foreign material to enter, the slender tubes must have been damaged at burial. Apart from these casts, appendices in underclays are almost invariably so battered and slashed that it is inconceivable that they could have supported vegetation in this degraded state. Lycopod tree roots point unequivocally to a life in water!

## (4) The Prevailing High-Energy Environments between Coal Seams

One reason why the question about the mode of deposition of Carboniferous coal has come to be regarded as settled in favour of autochthony is the philosophy of uniformitarianism. The rates of the almost imperceptibly rising or subsiding crustal plates of the present are applied to geological events of the past which were totally unlike any geological events of the present, including the formation of basins containing coal measures.

All estimates of the duration of the 'coal age' in north-west Europe are geared to the model of the subsiding 'Variscan Deep' that is thought to have bordered an 'Old Red Continent'. Depending on which author is consulted, between 32 and 45 million years are said to have elapsed from its inception to its eventual filling with clastic sediments. The accumulation rate of sediments on the present sea-floor is normally very slow, and reaches sometimes only millimetres per annum. Observations like this, however, must not be transferred to the conditions prevailing when the coal measures were formed. The rate of deposition depends on the amount of sediment suspended in water in proportion to the water's turbulence. In theory, the amount of suspended material as well as the degree of turbulence can increase indefinitely. Seen in this light, the deposition of material many metres thick in one single event becomes understandable.

### (a) Sandstones.

A significant percentage of the lithologies separating individual coal seams consists of sandstones. Usually they contribute 50 or more per cent to the overall thickness of the coal-bearing rocks. Due to its weight sand is deposited invariably under a blanket of fast-moving water. Sandstones are therefore — apart from massive fall-outs at suddenly reduced current speeds — invariably cross-bedded. In general, what happens is that broad foresets of sand with an uneven surface move along with the current and are then planed off from above and superposed by new foreset beds. (At the surface of these beds amplitudes of mega-ripples up to 1 m or about 3 ft have been recorded.[23]) The uniform fabric of the repetitive sandstone units that are normally one to several metres thick leads to the conclusion that the deposition of the entire stack was a continuous process. Dozens of metres of sandstone formations thus become an affair of minutes or, at best, hours!

### (b) Graded bedding and conglomerates in the coal measures.

Graded bedding far exceeding the scale of that reported in the underclays above is known from Carboniferous sandstones. A graded rock unit is the result of one single event. The speed operating during the addition of material by depositional processes may be illustrated by the example of a graded sandstone of 20 m (about 65 ft) thickness from north-west Europe[24] and another of 100 m (about 330 ft) from Upper Silesia.[25] Uniformitarian explanations fail to account for such phenomena.

Sandstones frequently contain conglomerates. These usually have associated with them large stem fragments of lycopods or giant horsetails. Conglomerates indicate extreme high-energy conditions during their formation. The boulder beds between coal seams of the Saar coal measures in West Germany, the 'Holzer Konglomerat', have been described as a 'natural disaster of incomprehensible magnitude'.[26] There is really nothing that argues for the tranquil conditions required by the theory of coal autochthony.

**(c) Fine-grained sediments.**

The second most common sediment type in coal measures is shales. These are horizontally bedded and, in analogy to the slow settling of recent clay suspensions, usually interpreted as having been formed under low-energy conditions. Without the knowledge of the actual suspension density and the amount of electrolytes present during the deposition of Carboniferous shales, however, it is unwise to draw such conclusions.

In a typical pelagic sediment of a modern sea-floor the decrease of the pore spaces as the overburden increases proceeds quite slowly. Accordingly, enclosed fossil structures suffer a certain deformation with time. When investigating two Carboniferous shales in Illinios, Zangerl and Richardson[27] observed, however, that the pressure acting in the compaction of the sediment from above had not actually affected the fragile fossil shells. The process of compaction had obviously been completed soon after deposition. The authors comment:

> *'The mode of sedimentation and compaction of the highly carbonaceous muds that produced these shales differed radically from that currently thought to apply to ordinary fine-grained marine muds. All the evidence indicates that the Mecca and Logan Quarry muds became nearly compacted* ***at the time of their deposition*** *and they suffered very little further compaction under loading. The volume reduction of these muds may well have exceeded 80 per cent. .. but the compaction was effected virtually at the time of deposition . . .'* (Emphasis added.)

Such fast compaction can be explained only by supposing an equally fast settling of sediment. The transport and rapid fall-out of such quantities of sediment cannot be understood as belonging to a low-energy environment.

**(c) Erect lycopod stems.**

The speed with which suspensions not only of sand, but also of argillaceous materials, could settle during formation of the coal measures is exemplified by the casts of lycopod tree trunks that occur in an erect position. Examples are known with lengths of up to 12 m (about 40 ft).[28,29] The authors describing them admit that it was difficult to avoid the conclusion that the rate of sedimentation around these stems must have been high indeed. Considering the relatively flimsy anatomy of these hollow stems it can hardly be assumed that dead specimens stood out in a 'drowning forest' through years or decades. Their burial in mud or sand is more likely to have been accomplished in hours or perhaps days.

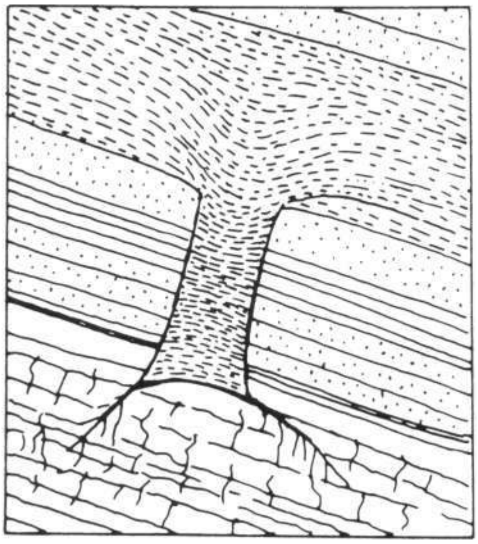

**Figure 5.** *Erect lycopod stem drawn in section. The interior was filled with shale only after the stem had been surrounded with a coarser fraction of sediment. Nova Scotia, Canada, after Dawson, 1882.*

Dawson[30,31] was the first to draw attention to the fact that the infilling of the famous erect hollow stems of Nova Scotia may contrast markedly with the surrounding lithologies. In one of these cases several decimetres of sand rose around the torso of a lycopod stem before the following argillaceous fraction gained entrance to fill its base (see Figure 5). In another case sand reached the interior of a hollow stem whose equivalent outside the column had been fanned away by water before a replacement through mud took place (see Figure 6). The erect stem illustrated by Ferguson,[32] and seen and documented by the present writer in 1981, reveals in its eroded state a cross-bedding of the sand contents that puts the catastrophic burial of these structures beyond question (see Figure 7). Evidence such as this is convincing proof that the coal vegetation was very rapidly buried.

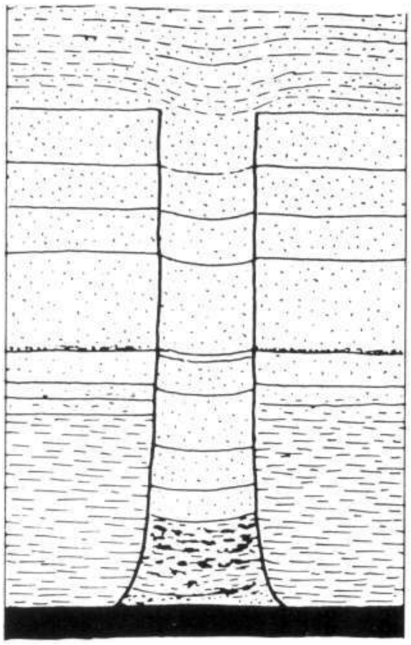

**Figure 6.** *Another example of a lycopod stem buried in the upright position (height about 2.5 metres). In this case the initial entombment by sand was fanned away and replaced by shale. Joggins Coast, Nova Scotia, after Dawson, 1882.*

Further sedimentological evidences for the rapid burial of the coal forests may be found in the author's book, **Karbonstudien — Neues Licht auf das Alter der Erde** (Carboniferous Studies — New Light upon the Age of the Earth).[33]

## (5) The Essential Botanical Uniformity of Successive Coal Deposits

It has become customary to divide the European coal measures into the Namurian, the Westphalian, and the Stephanian. Further subdivisions of these principal units add to the impression that the index fossils on the basis of which they are distinguished

*Figure 7.* *Sandstone cast of an erect lycopod stem exposed at Joggins, Nova Scotia, 1981. Weathering of the contents reveals two intersecting bedding planes attesting the sudden burial of the stem.*

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represent some kind of trend in the evolution of the plant kingdom. The assumption that the concept of 'geological time' is valid becomes thereby reinforced.

However, the taxonomy of Euro-American lycopods, fern allies and horsetail relatives as a whole is far from settled. The connections among the various plant fragments — for example, detached leaves or fern pinnules and axial organs or roots — are to some extent still conjectural. The wider public's acceptance of a demonstrable evolutionary progress of plant life is therefore largely on trust. The subjective judgment of the individual taxonomist and his evolutionary bias must be taken into account if floral lists of coal measures plants are to be read intelligently.

According to Crookall,[34] not less than 75 'species' of arboreal lycopods are recorded from the five subdivisions of the productive coal measures of Great Britain. If these are tabulated with their respective stratigraphic ranges, an interesting correlation becomes apparent (see Table 2). Nearly all the common species extend through the entire sequence of the Westphalian, A through D, (represented in Table 2 by thick lines), whereas the majority of the rarer forms (represented by thin lines on the table) are short-lived. Crookall does not comment upon this pattern. The simplest explanation is, of course, that the appearance of being short-lived is a consequence of their rarity. If the rarer varieties had been more numerous, their ranks from Westphalian A to D would have been closed. In other words, all of the 59 recorded lycopods of the Westphalian may have existed throughout the sequence. This being so, a coal vegetation emerges that is ecologically uniform. Such a situation does not of course suggest the passage of millions of years! The Namurian assemblage in the table, on the other hand, is so strikingly different from the Westphalian assemblage that, again, no evolutionary picture can be construed. The soon-following superposition of floating mats from a different geographic provenance seems far more likely.

## THE ECOLOGY OF THE CARBONIFEROUS FORESTS

As was pointed out in connection with the study of coal balls, each coal seam in its uncompressed state appears to have formed a floating mat built from lycopod roots, upon which the accessory flora of ferns, etc. was seated (see Figure 8). The essential floral uniformity of all coal storeys confirms this view. The observable differences in the prevalence or lack of certain plant species in individual seams can be accounted for by analogy with the distribution of woody plants through a large lowland rainforest of today. Depending on the water table, soil, relief and other factors, the many dozens of timber species participating in such an ecosystem are not evenly mixed, but tend to occur with varying frequencies.

By analogy with modern vascular plants it can be taken for granted that the floating coal forest communities stood on freshwater only. The * marine horizons' so frequently encountered in the coal measures represent an interfingering of the debris of submerged * marine' life communities which occur in much greater concentrations in rocks which bear the names 'Carboniferous Limestone', 'Mississippian/ Pennsylvanian Limestone', or *'Kohlenkalk'* below the coal measures. Whether these habitats were really marine in the modern sense is uncertain because nothing is known about their salinity.

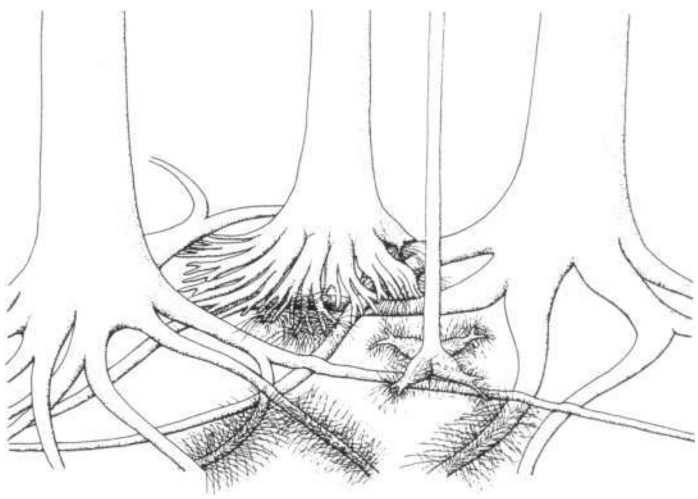

*Figure 8.* *Reconstruction of how a floating lycopod forest might have looked, with stigmariae and appendices interwoven to provide the framework structure for a peat mat. The drawing is based on real trunks in various European museums.*

| NAME | NAMURIAN | WESTPHALIAN A | WESTPHALIAN B | WESTPHALIAN C | WESTPHALIAN D |
|---|---|---|---|---|---|
| *Asolanus* | | | | | |
| *camptotaenia* | | thick | thick | thick | thick |
| *Bothrodendron* | | | | | |
| *depereti* | thick | | | | |
| *kidstoni* | thick | | | | |
| *minutifolium* | | thick | thick | thick | |
| *punctatum* | | thick | thick | thick | thick |
| *wardiense* | thick | | | | |
| *wiikianum* | thick | | | | |
| *Lepidodendron* | | | | | |
| *aculeatum* | | thick | thick | thick | thick |
| *acutum* | | thick | thick | thick | thick |
| *berwickense* | thick | | | | |
| *fusiforme* | | thin | thin | dotted | thin |
| *gaudryi* | | thin | thin | thin | |
| *jaraczewski* | | thick | thick | thick | |
| *jaschei* | thick | | | | |
| *kidstoni* | thick | | | | |
| *lanceolatum* | | thick | thick | thick | thick |
| *loricatum* | | thin | thin | | |
| *losseni* | thick | | | | |
| *nathorsti* | thick | | | | |
| *obovatum* | | thick | thick | dotted | thick |
| *ophiurus* | | thick | thick | thick | thick |
| *peachi* | | thin | thin | | |
| *reticulatum* | | thin | dotted | thin | |
| *rhodeanum* | thin | | | | |
| *rimosum* | | thick | thick | thick | thick |
| *roberti* | thin | | | | |
| *serpentigerum* | | | thin | | |
| *spetsbergense* | thick | | | | |
| *veltheimi* | thick | | | | |
| *volkmannianum* | thick | | | | |
| *wedekindi* | | | thin | | |
| *wortheni* | | thick | thick | thick | thick |
| *Lepidophloios* | | | | | |
| *acerosus* | thick | thick | thick | thin | |
| *laricinus* | thick | thick | thick | thick | thick |
| *scoticus* | thick | | | | |
| *Sigillaria* | | | | | |
| *boblayi* | | thick | thick | | |
| *brardi* | | | | thick | thick |
| *candollei* | | | thin | | |
| *cordigera* | | thin | thin | thin | |
| *cordiformis* | | | thin | | |
| *davreuxi* | | thick | thick | | |
| *decorata* | | thick | thick | | |
| *distans* | | | thin | | |
| *elegans* | thick | thick | thick | | |
| *elongata* | | thick | thick | thick | |
| *euxina* | | | thin | | |
| *ichthyolepis* | | | | thick | |
| *kidstoni* | | | | thin | |
| *kinletensis* | | | thin | | |

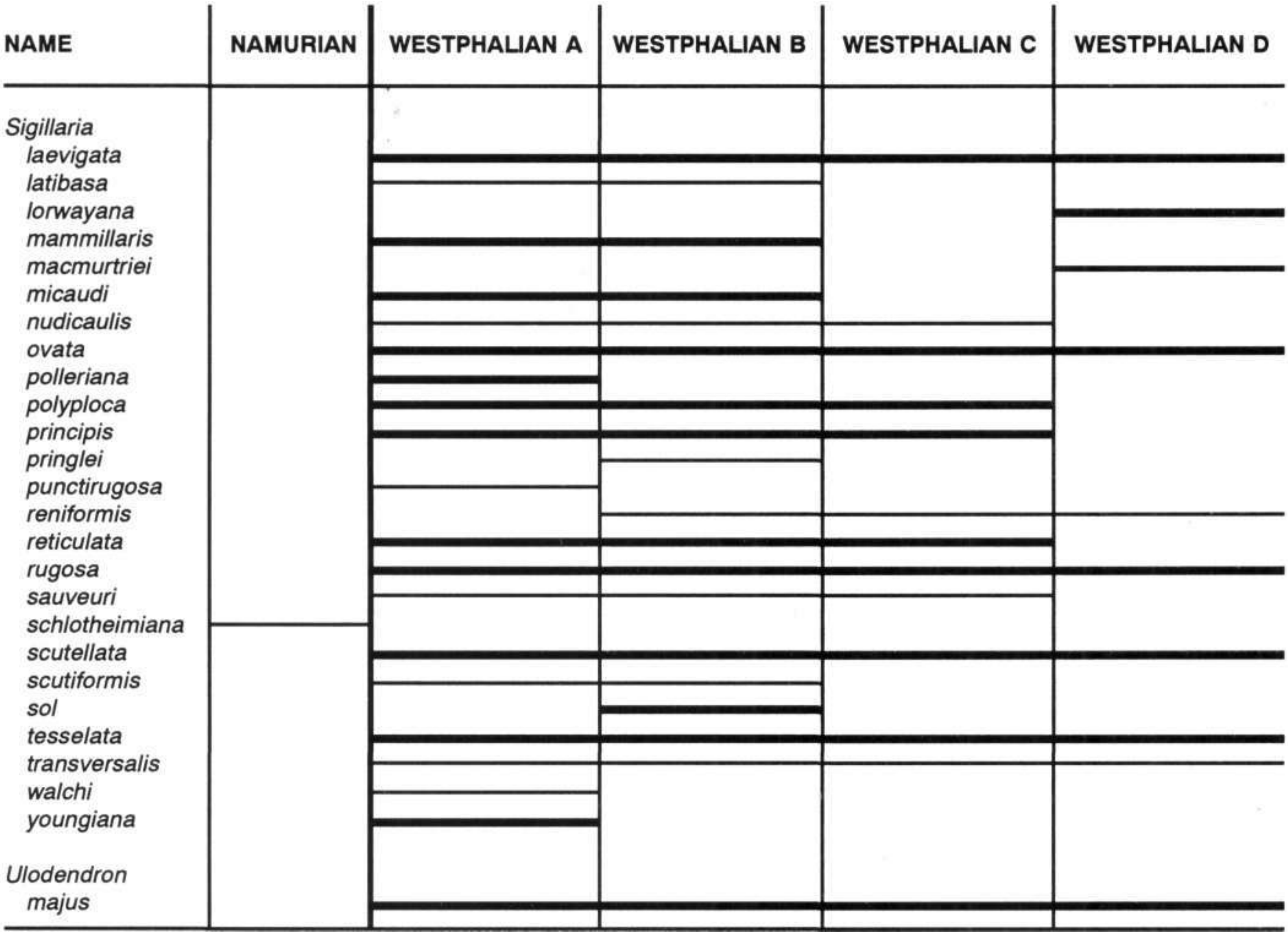


*Table 2. The vertical range of arboreal lycopods through the coal measures of Great Britain from 'oldest' to 'youngest' (after Crookall, 1964). Thick lines indicate that the species is common, thin lines that it is rare. The correlations suggest that all species occur throughout the coal measures.*

Textbooks suggest that the climate of the coal forest was tropical. Apart from the undeniably luxuriant growth, this is concluded from the absence of seasonal growth rings. An equable climate, however, is not necessarily hot and humid. At least two lines of reasoning suggest that the floating forests of the coal vegetation inhabited, in fact, polar regions.

Modern relatives of the very highly organised tree ferns, giant horsetails and arboreal lycopods found in the coal vegetation nearly all tolerate or demand shady situations. We know too little about plant physiology to fully appreciate the significance of the shape of the fern frond in relation to light requirements. The relationship as such is certainly obvious. Since the incidence of sunlight in polar regions is much reduced, a special flora may have been among the created ecosystems that was designed to occupy such quarters. In proposing this thought it is assumed, of course, that before 'summer and winter' were installed the Earth's axis may not yet have been tilted to the degree it is today.

The other line of reasoning is connected with the question, what was the purpose of a coherent floating forest? If four rivers issued from the fountainhead in Eden (Genesis 2:10-14) before the present water cycle began to operate, these huge streams may have possessed inlets whereby the waters returned to their origin and continued the cycle. It is envisaged that such rivers poured their contents beneath the floating vegetation near the poles from whence they were conducted via the caverns of the 'fountains of the great deep' (Genesis 7:11) back to Eden. The curious distribution of two different floating vegetation types, the northern lycopod and the southern *Glossopteris* type,[35] is not a hindrance to such speculations.

## THE DEPOSITION OF CARBONIFEROUS COAL SEAMS IN THE SETTING OF THE FLOOD EVENTS

Flood geology is the study of Earth history from the perspective of events revealed in the Bible. The suppositions of uniformitarian philosophy are deliberately rejected in order to arrive at conclusions that cannot be further falsified. It is the writer's contention that all scientific results that fall short of this goal are not yet in accordance with divine information on the subject. This is, by the way, the reason why a theory that proposes an autochthonous formation of coal should be subjected to scientific testing.

Autochthonists reject the idea that the coal vegetation was rapidly buried on the grounds that to accomplish this the secular subsiding movements of the present are several hundred thousand times too slow. They ignore the revealed mechanism that would allow for a subsidence in the order of kilometres within weeks or months. In the Genesis account of the Flood we are informed that the greater part of the waters erupted from the fountains of the great deep. A collapse of the crustal vaults concealing these fountains would have preceded the eruption. This in turn would have resulted in downward movements of the Earth's surface on a tremendous scale. The deep synclinal troughs filled with Palaeozoic sediments could have originated in this way.

An interesting verse in Genesis 8:2 potentially sheds light on this geological phenomenon. The record suggests that after about five months of unabated torrents the depressions caused by the collapse over the subterranean conduits were gradually concealed from above - 'the fountains of the deep were stopped'. The pre-Flood Carboniferous forest mats that remained unaffected as long as the waters were rising were now, perhaps, drawn into the depressions that were in the process of being 'stopped'. All the strata of the Euro-American coal measures lie on top of usually much thicker Palaeozoic rock piles. As long as the subsiding movements went on, torn-off parts of this floating ecosystem would settle where the current stopped, so that they came to rest on top of each other. One of the most puzzling phenomena about the coal measures (the repetition of coal seams and the pattern of intervening strata) is thus accounted for. The burial of the free-floating lycopod roots in cross-bedded silt or fine-grained mud would result from a complete drainage of the water below each mat through the influence of outgoing tides. Given a steady flux of water and supply of vegetation, up to two seams per day could thus have been produced. Thus, in accordance with the biblical account, the deposition of coal forest rafts would have commenced after the fifth Flood month. Furthermore, it is suggested that the completion of this process may have lasted for the remaining seven months or so. There is wide scope, however, for more detailed study of Carboniferous coal deposition, which may have continued well into the year/years following the Flood.

The deposition of Carboniferous coal is thus inseparably linked to the stages within the Flood in the narrow sense. From this insight it may be concluded that the boundary which separates the geological events of the Flood proper from post-Flood events is to be drawn between the formation of the Carboniferous system and the post-Carboniferous strata. There was only one occasion and only one mechanism that could bury such floating forest mats.

## SUMMARY

The currently accepted theory of the formation of Carboniferous coal adopts, and depends on, the notion of long-lasting geological periods. It is thus at variance with Earth history as outlined in the Bible, a history that is largely shaped by the Flood. Seemingly sound scientific reasons for an autochthonous growth of the coal forests have hindered the development of a consistent concept of Flood geology among many Bible-believing scholars. This paper outlines five reasons why the in-place theory of coal forest growth must be rejected.

(1) The under clays on which practically all coal seams rest are not their fossilised soils but possess the character of undisturbed sediments. The roots of the coal forest vegetation became enclosed in them only just prior to the burial of the whole forest.
(2) Coal balls, being petrified remains of the original peat, reveal that the root-work of the plants during life formed a floating mat. The entire sub-aerial vegetation grew up from this mat, while the larger roots of lycopod trees (stigmariae) extended downwards beyond the peat into the open water. The form of the coal balls and the state of preservation of the tissues suggest that these living mats were buried very rapidly.
(3) The structure of the lycopod roots (stigmariae) precludes any function in a mineral soil. Their air-filled axes, along with their tender air-filled secondary roots (appendices), could not have penetrated a substrate. Ageing appendices were discarded at pre-formed abscission points. Such an arrangement would make no sense if they were rooted in a soil as the autochthonous theory supposes.
(4) The high-energy lithologies between individual coal seams make it unlikely that any substantial amounts of time elapsed between the burial of any two coal seams. The erect lycopod stems in particular point to an extremely fast rate of sedimentation.
(5) The essential botanical uniformity of the coal plants of successive seams is a further indication that we are dealing in reality with a single ecotype piled up in synclinal basins and not with an evolutionary progression of plant life.

Such floating forests must have had a function in the pre-Flood world. Great rivers are mentioned in Genesis 2 as issuing from the Garden of Eden. The vast floating forest mats may have served the purpose of concealing the inlets for the return of water underground to the origin of these rivers in the Garden. It is conceivable that these inlets may have existed in the polar regions of the globe.

Floating forests would have been little affected during the initial phase of the Flood. With the abating of the Flood waters as described in Genesis 8, such mats would have been washed into subsiding basins. The formation of the Carboniferous coal measures provides a convenient demarcation line for distinguishing between geological

events attending the Flood year and the events of the years and centuries following.

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