The Challenge of Fossil Forests for Creationist Research

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Abstract

The presence of purported fossil forests in the geological record have occupied the attention of creationists ever since they began to publish scholarly articles in the 1970s and 1980s in secular journals on the topic of the Yellowstone fossil forests. Nothing has appeared in secular journals by creation scientists on the general topic of fossil forests since that time. Creationism’s focus on the Yellowstone “fossil forests” has faded into the past as far as field research goes. In the meantime, secular scientists have published scores of studies on purported fossil forests in the last four decades. The central issue among creationists is whether any purported fossil forests are truly in situ, or allochthonous. To help resolve this issue a list of criteria has been developed from a creationist standpoint to identify what is in situ. This can have profound implications for the establishment of Flood models.

Keywords: Allochthonous, autochthonous, in situ, fossil forests, tidal cycles, Stigmaria roots, Pennsylvanian lycopod trees, upright stumps, biomass per hectare, coal, lignite

Introduction

Truly autochthonous fossil forests place constraints on what are, and what are not, Flood sediments. Truly autochthonous forests either post-date the Flood (even if the sediments in which they grew were deposited in the Flood) or they pre-date the Flood (even if the forests themselves were buried by Flood sediments). True autochthony, then, can be used to put constraints on the pre-Flood and post-Flood boundaries. Clarey and Tompkins (2016), for example, argued that if Fossil Grove in Glasgow was autochthonous, the contained sediments represented the beginning of Flood sedimentation in that area. Since fossil forests are claimed from every major geological period starting with the Devonian when forests are first detected, it should be possible to put constraints on the upper and lower boundaries of the Flood in the geologic record. What is needed is a set of good criteria for determining autochthony of fossil forests. Although several creationist studies have already examined fossil forests (for example, Yellowstone fossil forests by Chadwick and Yamamoto 1984; Coffin 1971, 1976, 1983, 1987; Fisk and Fritz 1984; Frits and Fisk 1978, 1979; Fritz 1980a, 1980b, 1980b, Glasgow’s Fossil Grove by Clarey and Tompkins 1996; Wise 1981; Gilboa Fossil Forest by Oard 2014a), and a number of others have discussed models of explanation (for example, Austin and Sanders 2018; Clarey 2015; Lee et al. 2018; Oard 1995a, 1995b, 2008, 2014a, 2014b; Oard and Gieseke 2007; Sanders and Austin 2018; Snelling 2009; Wieland 1995; Woolley 2010, 2011a, 2011b), much more work remains to be done. Creationists who are trained in botany, paleobotany, stratigraphy, sedimentology, and ecology in particular can provide valuable studies towards deciphering the mysteries preserved in what are claimed to be fossil forests.

The Challenge

The major challenge for creationists studying fossil trees is to differentiate clearly between trees that are autochthonous and those that are allochthonous. At times this seems an impossible challenge unless firm criteria are established for such prior to commencing the study. Clarey and Tomkins (2016) give a helpful list of seven criteria that will aid creationists in establishing autochthony. This list has been expanded and elaborated upon in much greater detail by Wise (2018), who has his own list of twelve criteria. As in the Wise paper, this current paper elaborates upon the seven Clarey and Tomkins criteria as a starting point, but to comment upon each of the twelve criteria of Wise would make this study much too complex and perhaps even confusing. An additional nine criteria are established independently of other creationist studies, mainly derived from scholarly studies of claimed fossil forests. The reader is urged to read both the 2016 Clarey and Tomkins study and the 2018 Wise study before attempting to proceed further with the following paper. One must keep in mind that the term “autochthonous” refers exclusively to trees that are buried in position of growth and “allochthonous” is applied exclusively to transported, especially Flood-transported, trees.

Paleobotany is the study of plants within a geological context, that is, the study of fossil plants. Today few creationists are trained paleobotanists with a doctoral or even a master’s degree in paleobotany. There are several botanists, plant physiologists, plant geneticists, or agronomists who are creationists, but what they are lacking is adequate training in either geology or paleontology (Bergman, 2018). Research on the fossil forests of Yellowstone National Park, United States, began with a flurry of published...
Reports in the 1970s by creationists. Renewed interest in the fossil forests of Yellowstone took place following the eruption of Mount St. Helens in May of 1980 (for example, Morris and Austin 2003). That eruption offered ideal analogs for understanding the dynamics of the Yellowstone fossil forests. In this case the present became the key to the past by comparing Mount St. Helens with Yellowstone and its more than 50 levels of “fossil forests” buried in successive volcanic mudflows. In the 1970s and 1980s several creationists were able to publish articles on the Yellowstone fossil forests in professional geological journals (Chadwick and Yamamoto 1984; Coffin 1971, 1976, 1983, 1987; Fisk and Fritz 1984; Fritz and Fisk 1978, 1979; Fritz 1980a, 1980b, 1980c). The early articles on Yellowstone fossil forests included extensive studies of the impact of the 1980 eruption of Mount St. Helens, especially the discovery of upright transported stumps found in Spirit Lake (Austin 1986; Coffin 1983). Later creationist studies have followed up on the earlier studies (Austin 1991, 2010), but unfortunately, all creationist studies have largely ignored the work of Karowe and Jefferson (1987) on the implications of the Mount St. Helens uprooted trees for analyzing fossil forests. These two authors set up helpful criteria for determining which trees are allochthonous and which are autochthonous. Creationists re-examining the Yellowstone fossil forests ought to begin with the purely geological study of Karowe and Jefferson (1987) as well as the published articles by early creationists on the Yellowstone fossil forests. Creationist Leonard Brand (2018) have lamented the fact that few creationist studies have been completed on fossil forests since the quality studies of the 1970s and 1980s and have acknowledged that yet today Yellowstone remains an “uncompleted research project.”

The most significant research on fossil forests recently has concentrated on one site, the Glasgow Fossil Grove (Clarey and Tomkins 2016; Wise 2018). Beyond that the only other recent scholarly creationist studies deal mostly with coal beds and the coal flora (Austin and Sanders 2018; Lee et al. 2018; Sanders and Austin 2018; Snelling 2009, 557–568; Wieland 1995; Woolley 2010, 2011a, 2011b). One recent study looks at the fossil forest at Gilboa, New York, but it is superficial and lacks any field work (Oard, 2014a). Much more needs to be done at Gilboa and other similar sites, especially sites such as Glasgow that are accessible for field work.

Criteria for Establishing Autochthony

Two studies have been published recently in the *Creation Research Society Quarterly* that have reexamined the autochthonous approach to selected fossil forests. The difference between these two studies and previous ones is that they have established criteria for recognizing autochthony in the fossil record from a creationist viewpoint. The first study is by Timothy Clarey and Jeffery Tomkins (2016), who set forth seven criteria for recognizing autochthony in fossil forests. Most of these criteria as summarized below are derived from the writings of secular geologists and can offer a starting point for discussion among creationist geologists. (The two criteria not set forth by secular geologists are numbers 5 and 6 in the list below.)

1a. Monospecific forests—the presence of an entire grove of trees in position of growth representing a single species found at the same stratigraphic level.

1b. Non-random spacing—the presence of multiple trees at the same stratigraphic level that are spaced equidistantly and not in a random arrangement.

2. Non-overlapping roots—the presence of multiple trees at the same stratigraphic level that show a three-dimensional profile that includes roots and/or stigmarian axes.

3. Cross-cutting roots—the presence of roots and/or root structures that crosscut through the bedding plane of sediments.

4. Rapid burial and excellent preservation—dense clusters of mostly upright trees and/or stems, as in *Calamities*, that show catastrophic burial accompanied by good preservation and lack of rotting.

5. Paucity of underlying sedimentary layers—in any creationist Flood model one cannot postulate that Flood sediments are both below and above a purported fossil forest, otherwise the upright trees are not in position of growth.

6. Lack of distortion of bedding layers around trees—transported trees may give evidence of strata bowed downward below the tree stump, even forming a bowl-shaped depression below; in situ trees lack this evidence.

7. Mixture of vegetation—some cases have sphenopsids, such as *Calamites*, crosscutting the same layers preserving the purported in situ fossil stumps of non-sphenopsids.

The above seven criteria have been modified from Clarey and Tomkins (2016, 112–113), who relate all seven criteria to the Glasgow Fossil Grove with its upright lycopsid tree stumps. Their criterion 1 can be broken into two criteria, given as 1a and 1b above. Of the seven criteria number 5 is the most problematic because it allows any Flood model to be superimposed on the interpretation of upright stumps rather than allowing the evidence of in situ upright stumps to assist in the shaping of a particular Flood model. For example, a Flood model that assigns all sedimentary
strata up into the Pleistocene as being diluvial would rule out the possibility a priori of having any in situ fossil forest present in sub-Pleistocene sediments, except for a forest very similar to the Glasgow Fossil Forest. This perhaps may be the only known exception based on a survey of recent literature on “fossil forests” (see accompanying bibliography). Thus, a Cambrian-Pleistocene Flood model disallows the use of any autochthonous criteria unless accompanied by the fifth.

The second study in the Creation Research Society Quarterly, published as a letter to the editor in response to Clarey and Tomkins, is by Warren H. Johns (2017). It proposes two other criteria for detecting autochthony. Criterion 8, added to the list of seven above, is the lack of truncation of roots. In other words, if roots radiate out from the upright stump in all directions without clear evidence of being broken off, the stumps are more likely to be autochthonous. In catastrophic settings, as in the eruption of Mount St. Helens, the roots of trees are snapped off and very rarely extend more than a meter in length (Coffin 1997, figs. 18–21; Fritz 1980c, Karowe and Jefferson 1987). According to fig. 1, the Junggar fossil forest in China shows most stumps with roots extending outward a meter or more and one tree with a root extending outward 12.4 m before it terminates without truncation (Johns 2017; McKnight et al. 1990). None of the 12 Wise criteria for autochthony have non-truncation of roots as a criterion; in fact, he does not discuss truncation of roots at all. Hence, a “truncation criterion” (no. 8) is necessitated for creationist studies.

In addition to the evidence for non-truncated roots radiating out in all directions at Junggar, Johns (2017) proposed that the alignment of the extremely long root with three other stumps along the same axis could be explained in either of two ways: 1) the four trees started their growth along a rotted or rotting “nurse log”; or 2) they all started their growth along a fault expressed at the earth’s surface, where greater moisture would be available for rapid growth. The alignment is approximately in a NE/SW direction.

An article in Geology supports the “nurse-log” scenario based upon several suggested nurse logs found in a permineralized forest at San Juan Province, Argentina (Césari et al. 2010). Contemporary nurse logs are well studied and occur in wet temperate forests (Sanchez, Gallery, and Dalling 2009). The rotted log provides a “safe haven” for sprouting seedlings, which are always under attack by insects and fungi when germinating in soils. Several fossil logs in the late Paleozoic of north-west Argentina show evidence of roots penetrating nurse logs. In addition, one hollow log from the Triassic Petrified Forest of Arizona has been found to have roots penetrating the rotted chamber (Daugherty 1963). But Junggar is perhaps the only known site having four or more upright fossil stumps aligned and spaced properly as if their growth originated with a nurse log. Proof of this, however, is very tenuous without the presence of the original nurse log preserved below the stumps. What makes the nurse-log hypothesis for Junggar more believable is the fact that one stump has a 12.4 m long root extending in the same precise direction as the alignment of the three other upright stumps. The exact alignment of the four stumps is at N50°E direction, which is close to a NE/SW orientation. (See again fig. 1.) Fifteen prostrate logs have been measured in the same stratigraphic level as the stumps, the longest of which reaches 25.3 m in length. The allochthonous model for the Junggar Forest would suggest that the Flood waters in this particular site would have flowed almost directly East/West based on the large majority of the lying logs. The alignment of the four upright trees and the one 12.4 m long root is in direct conflict with the paleocurrent measurements of the horizontal logs, perhaps indicating that Flood waters could not have aligned the four trees in identical alignment with the one long root. By contrast, the 15 prone logs appear to have been transported based on their E/W orientation. Further creationist research is needed from the standpoint of paleocurrents to determine whether the above interpretation has any validity or whether there are better interpretations.

A second criterion is set forth in the CRSQ article (Johns 2017). Designated as criterion 9, it is the evidence of the elevation of the base of the central stump above the level of the roots. In fact, the roots slope downward depicting a “spider-like” arrangement of the roots surrounding the stump. A good example of this is at the Blue Mesa Stump Field in the Petrified National Park, Arizona. The principal authors of this study state that “the upright stumps occur typically in mudstone usually and have long unbroken roots which extend downward some distance below the trunks” (Ash and Creber 1992, 304). This particular stump site is located in the Chinle Formation, a Triassic unit that covers Nevada, Utah, northern Arizona, western New Mexico, and western Colorado. It contains the largest concentration of petrified logs in the world, nearly all of which are prone and thus are allochthonous. In addition to criterion 9 the forest is identified as autochthonous on the basis of criterion 1b, which states that trees on the same stratigraphic level must be spaced equidistantly and not in a random fashion. Fig. 2 illustrates the spacing that is non-random and is strikingly similar to today’s forests with large conifers. Criterion 9 is also applicable to the Jurassic fossil forest at Junggar, China, that has
fossil stumps well elevated above the root level and with roots sloping downward (McKnight et al., 1990; Johns, 2017).

Criterion 9 has been modified from both Clarey and Tomkins and from Wise. Criterion 6 of Clarey and Tomkins (2016, 113) is stated as such: “finding no bowing or distortion of any sedimentary layers beneath the tree stumps,” as an evidence of autochthony. Wise (2018, 250) discounts Criterion 6 by arguing: “Given, then, that the bowing of underlying sediment is not the usual expectation of allochthony, the absence of bowing in underlying sediment is not discriminatory between allochthony and autochthony.” This is a good observation, but what is lacking here is the case where instead of bowing of sediments (forming bowl-shaped sediments below stumps) there is reverse bowing or the inversion of bowl-shaped sediments below fossil stumps. This then is more likely indicative of autochthony instead of allochthony. How will catastrophically-transported sediments deposit stumps on mounds, as found in the Petrified Forest of Arizona or the Junggar deposits of China? One would wish to have many more examples than these two to establish autochthony, however, on the basis of Criterion 9.

Three Additional Criteria Derived from Pennsylvanian Deposits

Criterion 10 is the discovery of fossil trees buried in a tidal or marine setting dominated by purported daily tidal cycles. Many Pennsylvanian “upright fossil forests” in the eastern United States are claimed to have been buried with lunar tidal-cycle deposits because of their proximity to seacoasts and marine sediments. This situation can be interpreted on either a global-flood scenario or in situ local deposition by coastal sediments if the laminated sediments are interpreted to be tidal cycles. However, the global-flood interpretation is challenged by the discovery that many of the claimed tidal deposits in the Eastern United States would have taken many months or even a few years to accumulate.

The clearest evidence of potential tidal influence in connection with coal beds and upright stumps is found in the Dishman and Hopper Quarries, Orange County, southern Indiana in Pennsylvanian deposits that overlie Mississippian marine limestones. The underlying Indiana Limestone because of its purity is famed for its quality building stones transported to all major cities in the Midwest and East Coast of America. Overlying the beds of Salem Limestone is the Mansfield Formation with its Hindostan Whetstone beds and fine-grained siltstone interpreted as showing tidal cycles. Exposed in the Hopper and Dishman Quarries is a full exposure of a layer called the Hindostan Whetstone beds and fine-grained siltstone interpreted as showing tidal cycles. Exposed in the Hopper and Dishman Quarries is a full exposure of a layer called the Hindostan Whetstone beds that have a total thickness of slightly less than ten meters. The Hindostan Whetstone is heavily laminated throughout. The laminations are said to be tied to lunar tidal cycles because of the unequal pairing of two laminae in the sediments (Archer and Kvale 1989; Kvale, Archer, and Johnson 1989). Fig. 3 reproduces a vertical cross-sectional sample from the Whetstone Quarry illustrating the inequality of laminations and an accompanying bar graph also depicting unequal pairs of laminations. Two pairs of laminations when coupled together are assumed to mark a diurnal or daily cycle. Modern tides generally occur twice daily with one tide significantly higher than the other tide. This is called “the inequality of the tides”. The tides are approximately equal when...
the moon is directly over the equator. The moon’s relative position at the same time each day fluctuates every two weeks from being over the southern hemisphere to over the northern hemisphere. When the moon crosses over the equator, this is called the “cross-over,” which happens twice during the lunar cycle or approximately every 14–15 days. What is true in the modern period appears to possibly have been true in what can be called “ancient times.” The cross-over when the moon is said to be over the equator is indicated in the bar diagram by two adjacent laminations being equal in thickness at the center of the diagram.

Secular geologists who first studied these laminations interpreted them as varves, or annual laminations. This was in keeping with the overall estimate that a similar bed of siltstone would take many thousands of years to form, perhaps up to 10,000 years. What was previously estimated as up to 7,000 or even 10,000 years incredibly must be reduced by three orders of magnitude to less than 10 years. (See Archer and Kvale 1989; Kvale et al. 1994.) The application of this new interpretation to other purported tidal cycles laid down in connection with coal beds throughout the eastern United States and Canada means that the clastic sediments could have been deposited in years or scores of years, not tens of thousands or even thousands of years. An estimate for sedimentation rates for the Douglas Group, Upper Pennsylvanian, Kansas is an average of 3.8 meters/year (Lanier, Feldman and Archer 1993). This rate is based on measurements of neap/spring cycles for a restricted basin. When applied to a theoretical 1,000 m of sediments in the Pennsylvanian, such as can be found in the fossil forests of Nova Scotia or elsewhere, the entire sequence could be buried in less than 300 years. Granted, this is an extreme application of uniformitarianism, but it does illustrate the fact that sedimentation rates were much faster in particular settings of the past when the tidal cycles are interpreted as genuine.

The best evidence that quite likely the Hindostan whetstone laminations are tidal cycles is the fact of the alternation of thickness between pairs of laminae. Every other pair is thicker and is surrounded by thinner laminations, except for the point of when the lamination pairs are equal described as the crossover. (See fig. 3 again.) The equality of lamination pairs

Fig. 2. Blue Mesa Stump Field, Petrified Forest National Park, Arizona. Some stumps are twin trees as in modern forests, but others are spaced usually 3-10 meters also as in modern forests. Many stumps have roots sloping downward into the ground. The hatched lines mark the areas of gullying outside of the mesa. (Adapted from Ash and Creber 1992, fig. 10)
occurs every 28th or 29th lamination, which would be every two weeks if indeed these represent tidal cycles. No allochthonous scenario presently known can account for every other lamination pair to be unequal in thickness. Sedimentologist Guy Berthault (1994) has reported that his own flume experiments along with ones involving the giant flume at Colorado State University demonstrate that laminated sediments can be formed in fast flowing waters, but nothing in his many published studies even remotely suggests alternations between unequal pairs of laminations. His experiments used sand, whereas the Indiana whetstone cycles involved silt-sized sediments with slightly smaller grain size than sand. Morris and Austin (2003, 62) note that in volcanic eruptions “varve-like laminae by the multiplied thousands [can be produced] in the span of a few hours.” But nothing in catastrophic mudflows at Mount St. Helens suggests alternations between thick and thin laminae or pairs of laminae. The only valid explanation thus far is that of tidal cycles.

The bigger question is how long it would take for the plant material to accumulate. The answer is based upon whether the coal was autochthonous or allochthonous—a subject too complex to be settled in this paper. The reader is urged to read an excellent, detailed creationist study of the origin of coal published in the last ten years by Andrew Snelling (2009, 557–568). His study advocates the allochthonous interpretation of the upright stumps often found emanating upwards from Pennsylvanian coal beds.

Criterion 11 is the identification of delicate roots and rootlets having penetrated laminated sediments. Some creationists have claimed that *Stigmaria* roots and their appendages do not penetrate well-packed sand, silt, or mud (Snelling 2009, 562–565), although they are surrounded by such sediments. *Stigmaria* is the genus name given to the roots of the giant lycopod
trees, such as *Sigillaria* and *Lepidodendron*, present as a ubiquitous component of Pennsylvanian coal beds. If roots and rootlets do penetrate laminations, that would indicate growth after the underlying sediments have been deposited. Wise (2003, 377) is doubtful whether lycopod roots could “penetrate traditional soils” because of their “rhyzomous nature”. But the Hindostan Whetstone Quarry in southern Indiana yields evidence that lycopod roots and rootlets are found to do so. And Clarey and Tomkins (2016) report evidence of this for Fossil Grove, Scotland. According to figs 4, 5, and 6, the narrow appendages attached to the roots do penetrate through a few laminations below the roots. The laminations remain horizontal despite being penetrated. The long, horizontal depression at the top of each sample was produced by the *Stigmaria* root, below which the thin, strap-like rootlets radiate downward. A putative lycopod forest may have grown on the terrestrial sediments capping the top of the quarry with its 10 m of paired laminations, but the tree trunks have been eroded away, leaving only the *Stigmaria* roots and appendages. Lower down, however, are found upright stumps apparently rooted in the thin layer of coal at the base and underlying the 10 m of laminations.

The Hindostan Whetstone Beds also exhibit an example of Clarey and Tomkins’ Criterion 4, which is excellent preservation and rapid sedimentation without any evidence of rotting or transport damage. Fig. 7 portrays the outer bark impression upon the claimed tidal-cycle laminations preserved as a cast. The impression is from a *Lepidodendron* trunk or branch that is preserved lying at an angle. The fact that it did not lie either horizontal or vertical suggests that it was most likely preserved in place of original growth as the tree/branch fell into the tidal sediments encroaching on land. The preservation too is exceptional, making it much less likely that the *Lepidodendron* was transported any distance. This interpretation is supported by Wise’s 11th criterion: “Autochthonous fossil assemblages should... 11. evidence little to no pre-burial organism decomposition [vs. much pre-burial decomposition]” (Wise, 2018, 251–252). The time this exceptionally preserved fossil took to be totally covered may have been days or even a few weeks at most if indeed the laminations represent twice-daily tidal cycles. An allochthonous floating-forest interpretation would mean that the branch/trunk of fig. 7 was well protected from any wave action while being transported perhaps hundreds of miles on the bed of the floating forest.

One might conclude that the Hindostan Whetstone Beds were quite likely deposited either prior to the

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**Fig. 4.** Appendages in *Stigmaria* roots visible penetrating sediments by downward growth. U.S. silver dollar used for scale.
Flood or after the Flood if the purported tidal cycles are genuine, but under the floating-forest model the forest could have reached its final resting place during the Flood itself.

The purported discovery of possible tidal cycles in Pennsylvanian coal beds has nothing to do with cyclothems, which describe the repetitive sequence of different lithotypes between coal beds, going commonly from shale to limestone to sandy shale and/or sand to clays or claystone and back to coal again. For a thorough creationist study of cyclothems in the Midwest of the United States see Woodmorappe (1978). Another more limited study of cyclothems is found in Coffin (2005, 99–101). Coffin explains twice-daily tides as the principal cause of cyclothems during the Flood, not the rise and fall of sea level as

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**Fig. 5.** One *Stigmaria* root visible in horizontal growth with appendages penetrating sediments by downward growth.

**Fig. 6.** Appendages from a *Stigmaria* root penetrating perfectly horizontal tidal cycles.
conventionally taught. This is a concept he borrowed from George McCready Price. Actual tidal cycles in Pennsylvanian rocks have gone largely unstudied by creationists, although creationist Walter G. Peters (1971) discussed the claimed cyclical black shales of the Pennsylvanian in Illinois, the subject of his master’s thesis. His discovery of possible cyclical patterns in laminations could be interpreted as tidal cycles. Another master’s thesis a few years later reported on the discovery of twice-daily tidal cycles in the same formation (Kuecher 1983). Tidal cycles very similar to the Hindostan Whetstone beds are found in other locations, such as in the Brazil Formation of southern Indiana (Mastalerz et al. 1999) and throughout the Eastern Interior Coal Basin of the United States (Archer, Kuecher, and Kvale 1995; Greb and Archer 1995). These studies are beckoning creationists to reevaluate the other claimed tidal-cycle locations to determine if indeed they are a close match to the Hindostan beds or whether they can even be valid tidal cycles.

Creationist periodicals lack any significant discussion of Pennsylvanian tidal cycles. The Creation-Evolution Literature Database (CELD), the most comprehensive bibliographic database on creationist studies, has nothing on tidal cycles. Tidal cycles can offer a wide-open field of study appealing to those creationists who are well versed in sedimentology as well as in astronomy. The initial publication on Hindostan tidal cycles included an astronomer from Indiana University, Hollis R. Johnson (Kvale, Archer, and Johnson 1989) followed by other publications in which Johnson contributed (Archer, Kvale, and Johnson 1991; Kvale et al. 1995). Creationist astronomers can be invited to link up with creationist geologists in order to correctly decipher possible Pennsylvanian tidal cycles.

Two Additional Criterion Extracted from Multiple Locations

Criterion 12 can be designated a comparison of complete versus incomplete plant ecosystems. A complete ecosystem with great diversity is much superior to an incomplete one for determining autochthony. Criterion 12 is well supported by Wise’s 2nd criterion, stated in this way: “Autochthonous fossil assemblages should... 2. include a very high disparity of higher taxa [vs. monotaxie]” (Wise 2018, 251). Many fossil forest sites have a richness in varieties of flora such that they are considered a “Pompeii-type” fossil forest. The best-known example is the Pompeii flora of the Permian from Inner Mongolia (Wang et al. 2012). The following is just a summary of its wide variety of flora: tree ferns, herbaceous ferns, lycopsids, sphenopsids, noeggerathiales of unknown affinity, cycads, and the most common Paleozoic conifer, Cordiates, in abundance. These all have been preserved in what is interpreted as an “air-fall ash” deposit, which would seem to preclude it from having been transported. Even if the air-fall volcanic ash had descended into Flood waters, the catastrophic movement of the waters would not have allowed much of the ash to preserve the plant life as it descended through the
water column. If the ash had been deposited as a slurry on land, as in Mount St. Helens deposits, it would have swept the terrestrial flora far and wide and would have left its imprint as laminated or cross-beded sediments. The ash is said to have fallen on a “peat” deposit. However, the Mongolian ash-fall interpretation is just an interpretation and needs independent verification. Wise (2018, 254) aptly recognizes the challenge to creationism if this claim is upheld by additional studies: “[A] systematic study of in situ fossil forest claims will certainly include some challenges for creationists (e.g. in situ ash-fall claims, ... ‘tidal’ rhythmites) ...”

Another peat deposit connected with a Pompeii-type Paleozoic deposit is found in a 1000-hectare underground coal mine of Illinois connected with the Herrin (No. 6) coal bed (DiMichele et al. 2007, Johnson 2007). The forest is described as “spectacular,” a term rarely used in geological literature, and was abruptly drowned supposedly in situ when it is theorized that major fault movement dropped a coastal mire below sea level. This mine and neighboring mines have preserved a Pennsylvanian flora surrounded with purported tidal cycles. The sediments are marine in origin and hence could likely be representative of tidal cycles, which are found in nearby coal mines (Falcon-Lang et al. 2009). The flora is rich with “a total of 50 morphotaxa” “representing ~28 whole plant taxa and five major groups” (DiMichele et al., 2007, 417). Tree ferns and lycopsids dominate—typical of Pennsylvanian coal deposits. The richness of this Pennsylvanian flora stands in contrast to the majority of the 67 sites analyzed by DiMichele and Falcon-Lang (2011) that are reported as monotaxic. The monotaxic nature of Carboniferous fossil forests strongly suggests to Wise (2018) that such are allochthonous.

Most creationists suggest that uprooted trees have formed today’s major coal beds. Two main competing creationist theories account for today’s coal beds: 1) the pre-Flood floating forests model, also called by some the floating mats model (Austin 1979; Austin and Sanders 2018; Sanders and Austin, 2018; Scheven, 1981; Wise, 2003, 2018) and 2) the floating logs model (Clarey 2015; Clarey and Tompkins, 2016; Oard 2014a, 2014b). The modern creationist version of the floating forest model originated with Joachim Scheven’s floating forest hypothesis (Scheven 1981, 1996) and the floating logs model originated from studies of the raft of uprooted trees floating on Spirit Lake at Mount St. Helens (Austin 1991; Coffin 1987). The two distinct models have recently been merged into one model (Austin and Sanders 2018; Sanders and Austin 2018), but for this study distinction should be made between the two. Clarey (2015) questioned whether a floating antediluvian forest could trap and retain enough fresh water to make it viable in light of the potential incursion of salt water into the forest. Also, Clarey and Tompkins (2016) object to the concept of lycopod trees with somewhat hollow branches and trunks being able to grow upright on antediluvian seas or as floating vegetation in the open ocean. They conclude “we strongly recommend that the floating-forest hypothesis be abandoned by the creationist community” (Clarey and Tompkins, 2016, 110). Creationists have not yet analyzed the coal mines of Illinois to determine whether their coal beds are allochthonous or autochthonous or perhaps represent both allochthony and autochthony.

Criterion 13 is one of the most valuable for future creationist research. It is a mathematical approach for describing wide spacing of upright fossil trees, using modern forests as analogs. This criterion is similar to, but not identical with, criterion 1b, which is related to the non-random spacing of upright tree trunks. One criterion for autochthony is the finding of fairly-widely spaced upright stumps roughly matching the spacing of living trees in modern forests (Clarey and Tompkins 2016). This contrasts with finding trees gathered in heaps with broken branches being prime evidence for allochthony. The best modern example of this is the pile of broken trees and truncated stumps at the bottom of Spirit Lake, Mount St. Helens, USA (Coffin 1983, 1987). If having heaps of trees is evidence for allochthony, then evidence for autochthony is the wide spacing of upright fossil stumps apparently rooted on the same stratigraphic plane (Clarey and Tompkins 2016; Johns 2017).

Criterion 13 goes beyond previous creationist studies by quantifying mathematically the spacing of upright fossil trees. The distances between trees and their arrangement are crucial for an accurate quantification in order to rightly compare such with modern trees in forests. Often the spacing of fossil forests is quantified as mass per hectare after measuring the diameter of fossil trees and the spacing between trees. When a close match is made with a modern forest, the fossil forest may have been autochthonous. The fossil record has many examples exhibiting this potential spacing evidence for autochthony scattered around the world (Artabe et al. 2007; Ash and Creber 1992; Batten 2002; Brea, Artabe, and Spalletti 2008; Brea et al. 2015; Császár et al. 2009; Cúneo et al. 2003; Davies-Vollum et al. 2011; DiMichele, Eble, and Chaney 1996; DiMichele et al. 2007; DiMichele and Falcon-Lang 2011; DiMichele, Lucas, and Krainer 2012; Falcon-Lang, 2004a; Falcon-Lang 2006; Gastaldo, Stevanovic-Walls, and Ware 2004; Greenwood and Bassinger, 1993; Gulbranson et al. 2012; Hinz et al. 2010; McKnight et al. 1990; Miller et al. 2016; Opluštil et al.
The Challenge of Fossil Forests for Creationist Research

2009a, 2009b, 2014; Pfefferkorn, Archer, and Zodrow 2001; Rinehart et al. 2015; Rößler et al. 2012; Stein et al. 2012; Thorn 2005; Varela et al. 2016; Williams 2002; Williams et al. 2003a, 2003b, 2008, 2009; Wang et al. 2012). Creation scientists need to review these studies from a paleoecological standpoint to determine whether the claims for autochthony have any validity. All these studies were published after creationists had completed original scholarly work on the fossil forests of Yellowstone, which also exhibit wide spacing. None of these studies report on heaps of broken trees, stumps, and branches such as can be found at Mount St. Helens.

The Mathematical Approach for Defining Fossil Forests

Two examples of the mathematical study of spacing are the Upper Triassic corystosperm fossil forest of the Rio Blanco Formation, Mendoza Province, Argentina and the Suihent Petrified Forest, Upper Jurassic, Mongolia. The Argentine corystosperm fossil forest represents an extinct group of seed ferns with a woody axis up to 70 cm. in diameter (Artabe et al. 2007). This forest was found in the La Elcha Mine of the Rio Blanca Formation (Triassic) and consists of two major groups of upright fossil stems separated by about 100 m (see fig. 8). Each major grove has been subdivided into minor stands that depict clusters of older mature trees in some clumps and younger trees in others. The most unique aspect of this fossil forest is that it is monospecific—that is, it has only corystosperms outcropping on a single bedding plane over 600 m long. This alone would suggest autochthony. The first, and perhaps the foremost, of the seven criteria set forth by Clarey and Tomkins (2016, 112) states: “Finding multiple, single-species trees spaced in growth position in the same horizontal plane, nearly equidistantly spaced in all directions...” The Argentine corystosperm forest seems to fit this criterion amazingly well, especially when noticing the spacing of trees in the sub-clusters (see again fig. 8). The two largest oblate circles enclose [not inclose] a group of stumps with a mean nearest-neighbor index of 2.58 and 3.71 m respectively when the spacing is measured in each group.

The density of this corystosperm forest is then 726.74 trees per hectare when the forest is viewed in its entirety, inclusive of spacing between sub-clusters, but the sub-cluster density averages 1503.75 trees per hectare, comparable to mid-latitude mixed forests of the southern hemisphere. The possibility of autochthony in this forest is based not only on it being a monospecific species, but also on the quantitative data. Granted, most “fossil forests” have been assumed to be autochthonous based on non-quantitative data. Creationists should be wary of any determinations that are based without quantitative, measurable data derived from a 3-dimensional view of the “forest”. Regrettably fossil forests, such as those at Yellowstone National Park and at Joggins, Nova Scotia, can be measured only with two dimensions, not three, because their best exposures are on the sides of cliffs. Density can be best determined from fossil forests in three dimensions as at La Elcha Mine, Argentina as well as at Suihent, Mongolia.

The 12 criteria of Kurt Wise (2018) lack a mathematical quantification of the Glasgow Fossil Grove, but perhaps such is not needed in order to decide the issue of autochthony versus allochthony. In other cases, such as the La Elcha Mine “fossil forest” of Argentina the quantification is important. Even when quantification suggests possible autochthony, the data cannot prove whether the trees originally grew where they are found as fossils or whether they were transported as part of an antediluvian floating forest. According to Wise (2018), the second and third criteria would classify a forest as allochthonous if it is “monotaxic.” The La Elcha Mine forest is entirely monotaxic, being composed of a single taxon.
of corystosperm. On this basis alone it should be allochthonous, but the floating forest hypothesis renders it as originally autochthonous before being transported by Flood waters to its present resting site as a unit, not as individual trees. This confronts us with a contradiction that present creationist criteria are not specific enough to resolve.

A schematic diagram of the Suihent Petrified Forest found in Upper Jurassic beds in Mongolia is shown in fig. 9, modified from Keller and Hendrix (1997). The planar view shows 72 stumps, all upright, with an average spacing of 10–40 m, indicating about the proper spacing of an open-savannah forest. An additional 49 prostrate logs (not shown) are mixed throughout this upright-tree forest. Sixty-eight percent of the logs at Suihent are upright stumps (Keller and Hendrix 1997, 285). The prostrate logs that can be measured depict a preferred orientation of northwest to southeast by south, which may indicate transport. Only four of the 72 upright stumps have roots exposed sufficiently to view them as penetrating the subsurface, thus establishing those four as in situ. According to Fritz and Harrison (1985) if 10% to 15% of the total logs are upright, then the probability is high that at least some of them are in situ, based on an analysis of upright and prostrate trees at Mount St. Helens. The trees may have been buried in a volcanic pyroclastic flow, whereas the Yellowstone and Mount St. Helens trees were buried in water-laid deposits containing large amounts of volcanic-eruption sediments. Both the Argentine and Mongolian fossil forests are excellent examples of criterion 13. Of the two, the Argentine forest is more controversial for creationists because it can be interpreted as being allochthonous because of it being monospecific or as autochthonous because of

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**Fig. 9.** The Suihent Fossil Forest, Upper Jurassic, Southeastern Mongolia.
its proper spacing being preserved while transported en toto as an antediluvian floating forest.

**Autochthony in Tertiary Brown Coal Beds**

Above the Pennsylvanian coal beds stratigraphically are Mesozoic coal beds, especially in the western United States, and yet higher in the geologic column are the Cenozoic brown coal beds of the northern great plains of the United States and of the open-pit mines scattered across northern and eastern Europe. The floating mat model flounders today on the discovery of mammoth coal deposits outside of Carboniferous deposits. The Miocene brown coal or lignite deposits of eastern Germany and western Poland are problematic. An open-pit lignite mine near the city of Gross Raschen in Germany preserves the evidence of two fossil forests, one on top of the other, later considered to be in Miocene sedimentary units (see fig. 10 adapted from Stutzer, 1940, 15). The trees are spaced apart as in a modern mixed forest with angiosperms and conifers, thus conforming to criteria 1b. Even the size distribution fits modern forests that have large mature trees interspersed with very young trees. The first criterion of Clarey and Tomkins is proving to be one of the most crucial ones for assisting in the determination of autochthony in fossil forests, but it is not the only significant one.

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**Fig. 10.** Two lignite beds (lower and upper) with some upright stumps over 3.0 m in diameter and some having tree-ring counts of nearly 1000. Location is a strip mine in Germany (Stutzer 1940, 150).
A possible explanation for the Tertiary brown-coal beds of Europe is to invoke the floating mat hypothesis. But the floating mat hypothesis cannot explain where floating mats of Tertiary coals composed mostly of angiosperms and modern gymnosperms may have originated. The two major types of floating mats, Carboniferous and Miocene, are incompatible if both were floating at the same time on diluvial waters. Why is it that without exception the Cenozoic brown or soft coals are always stratigraphically much higher than the Paleozoic hard coals, especially if both floating mats originated at the same time? Why is it that floating mats composed of entirely extinct Paleozoic plants in the one and of modern plants somewhat typical of today’s forests in the other have never intermixed if they were floating at the same time? It could be argued that the floating mats at some point would have collided and even intermixed. Schönknecht (1997) calculates that prior to the Flood the lignite beds represented vegetation that would have covered 40% of today’s land surface, based upon lignite coal deposits today occupying 60 × 10^6 km^2 of land surfaces. He concluded that many of the Tertiary lignite beds may have accumulated as a result of small post-Flood catastrophes. The discovery of upright fossil trees in connection with coal beds presents problems for explaining such as either pre-Flood or post-Flood. Again, much more creationist research is needed.

The Gross Raschen open-pit mine of Germany offers a new twist on criteria 1, which pertains to “finding multiple, single-species trees spaced in growth position in the same horizontal plane…” (Clarey and Tomkins 2016, emphasis added). The German open-pit mine unambiguously has two levels of fossil forests, one superimposed directly on top of the other. This fact alone merits the proposal of a new criterion that is modification of criterion 1. Criterion 14 modified from criterion 1 reads: “finding both conifers and angiosperms nearly equidistantly spaced in all directions from the upright trunks located on two or more levels of peat, lignite, or coal.” Advocates of either the floating-logs or the floating-forest hypotheses will have a most difficult time explaining how the two mats with some very large trees, some having a ring count of nearly 1,000 rings, have been superimposed on two levels perhaps during the Flood. However, the challenge presented here to both the floating-forest and floating-logs hypotheses are quickly resolved if the Miocene “forests” at Gross Raschen are declared to be post-diluvian.

Insights Gleaned from Mount St. Helens

The eruption of Mount St. Helens on May 19, 1980 has created an ideal laboratory for studying fossil trees and establishing two additional criteria for autochthony versus allochthony. The most obvious and convincing evidence for allochthony has been discovered at the bottom of Spirit Lake, the large lake that survived the volcanic explosion. Creationist Harold Coffin studied dozens of upright stumps floating upright in the lake months after the eruption and deposited upright on the lake bottom (Coffin 1983). His historic report was published in Geology. He used side-scan sonar to identify the upright stumps that many times protruded significantly upward from the lake bottom. All of these were clearly allochthonous.

A study almost entirely neglected by creationists was published a few years later by Karowe and Jefferson (1987). It offers two more important criteria for distinguishing allochthonous upright stumps from those that were autochthonous. Criterion 15 is what can be labeled “disparity of sediments.” Rooted in situ stumps are declared in situ if the sediment at the rooted zone and below it is much finer grained than the sediment surrounding the stumps, which often contains boulders and cobbles. This criterion becomes especially significant if it is employed in conjunction with root length in the post-eruption sediments, described as follows: “Upright stumps containing roots which penetrated a finer-grained matrix below the volcani-clastic sediment in which they were buried were considered to be in situ, whereas horizontal logs or upright stumps bearing detached roots were considered to be transported” (Karowe and Jefferson, 1987, 191–192).

Criterion 16 is derived from a comparison of stump height versus width in the post-eruption sediments. The authors state: “Few instances were noted of trees which clearly had been transported in upright position. Those that were seen [at the North Fork Tuttle River, Washington] measured less than two m high and had broad root mats, approximately 1.5 m across…. Root systems often incorporated large boulders and were encased within a mudflow matrix” (Karowe and Jefferson 1987, 197). According to criterion 16, the height/width dimensions of stumps are critical. Stumps having many meters of height and only a meter or so of stump base diameter will more likely to be autochthonous. Allochthony has been assessed where the stumps were bottom heavy, stabilized in a vertical stance by wide root systems that were wider than the height of the stump or by boulders entrapped in the root mass. Another situation of allochthony occurs when whole groves of stumps have been “transported over considerable distances” via a mudflow. One mudflow matrix in the middle of Smith Creek appears to have a dozen or so upright stumps on its surface. The “island” in the creek’s center was estimated to be 10 m. by 20 m., and
it was hypothesized that the island was transported as a single entity from a higher slope. This discovery may offer creationists a new interpretation for the transport of groves of trees as single units in volcanic mudflow deposits, such as at Yellowstone. This especially could help support the floating-forest hypothesis. One should keep in mind that Karowe and Jefferson’s study concentrated solely on mudflow deposits caused by volcanic eruptions at Mount St. Helens and at Yellowstone and may not be applicable to non-volcanic settings.

The Past and Future of Creationist Paleobotanical Studies

One major impetus for the founding of the modern creationist movement was the discussion of fossil forests at the same time the radiocarbon method of dating was first used. The discussions took place in the late 1940s at annual meetings of the American Scientific Affiliation (A.S.A.), an evangelical organization composed entirely of scientists who wished to harmonize the various sciences with the Biblical account. The leader of an attack on the writings and ideas of George McCready Price, the best-known advocate of Flood geology, was a Wheaton College graduate, J. Laurence Kulp. (Kulp later went on to establish the radiocarbon dating lab at Columbia University in 1951.) Kulp’s attacks were both oral and written, which were summarized in a 1950 issue of the society’s journal in an article entitled “Flood Geology.” One of his leading arguments against the short chronology of Price was this: “In Yellowstone Park there is a stratigraphic section of 2000 feet exposed which shows 18 successive petrified forests. Each forest grew to maturity before it was wiped out with a lava flow. The lava had to be weathered into soil before the next forest could even start. Further, this is only a small section of the stratigraphic column in this area. It would be most difficult for flood geology to account for these facts” (Kulp 1950, 11).

One member of A.S.A. in those days was Henry Morris, who ardently attempted to put Flood geology back on their agenda, despite attacks against it by Kulp. Later in the 1950s Morris was joined by the efforts of John C. Whitcomb and others. This culminated with the publication of The Genesis Flood (Whitcomb and Morris 1961), a book that counteracts the arguments of Kulp and A.S.A. associates and advocates many of the arguments of Price. In this work Morris had a considerable discussion of the Yellowstone fossil forests after quoting in full the 1950 passage from Kulp cited above (Whitcomb and Morris 1961, 418–421). Morris even published a schematic diagram of the cliffs at Specimen Ridge, showing the 18 levels mentioned by Kulp. Whitcomb and Morris accepted the fact that today at that one locality there are 18 buried “forests” on top of one another. Undoubtedly, the focus by Morris on these fossil forests caught the interest of creationists at several academic institutions, resulting in much research and numerous publications in secular journals defending a creationist interpretation of the Yellowstone fossil forests. This has not been repeated by any creationist research and subsequent publications on fossil forests since the 1980s other than on the Paleozoic lycopod “forests”. One can conclude that it was the debate about the origin of the Yellowstone fossil forests that gave impetus to the A.S.A. conferences in the late 1940s and spilled over into the 1961 publication of The Genesis Flood. The final ripple effect of this early discussion was the field work done by numerous individuals on the Yellowstone fossil forests.

The proposal of this paper is that creationists ought to rally many of its scientists, especially those trained in botany and its related fields, to carry out joint research projects on fossil forests comparable to the exhaustive studies of the Yellowstone Fossil Forests carried out in the 1970s and 1980s. Since that time a deluge of studies by secular geologists have been published claiming multiple discoveries of purported fossil forests around the world. An exhaustive bibliography is attached to this study in order to facilitate further the efforts of creationists in determining which upright trees are in situ and which are transported.

Conclusion

A total of 16 criteria, including the two additional ones proposed in the neglected Karowe and Jefferson (1987) study, are established for use by creationists in determining the possibility of autochthony in fossil forests below the Pleistocene. Two or more criteria are needed in conjunction with each other to suggest autochthony for each purported fossil forest. Currently, the two fossil forests with the highest probability of being autochthonous are the Junggar Fossil Forest of western China in the upper part of the Jurassic and the Hindostan Whetstone Quarry with its accompanying evidence of lycopsid root and rootlet growth in the Lower Pennsylvanian of southern Indiana. Those two fossil forests mark either the end of the Flood or its beginning if the forests are confirmed in future studies as being in situ. This present study is the first from a creationist viewpoint to combine an analysis of purported tidal cycles with possible Pennsylvanian fossil forests of the Midwestern United States. It is also the first to utilize paleocurrents in a possible forest of western China (Junggar) to distinguish autochthony from allochthony. Mathematical rigor based on field measurements is critical for evaluating the potential of some fossil forests where such data are available.
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The Challenge of Fossil Forests for Creationist Research


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The Challenge of Fossil Forests for Creationist Research


The Challenge of Fossil Forests for Creationist Research


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Appendix

The following quotation from the third edition of Faith, Reason & Earth History: A Paradigm of Earth and Biological Origins by Intelligent Design (2016), by Leonard Brand and Arthur Chadwick, opens the door to the possibility that tidal cycles in Pennsylvanian forests may depict more time than one year:

Cyclical Features That Seem to Require Time: Some sediments contain what are described as tidal cycles (one lamina deposited with each high tide), and if this is correct, they may represent a time frame consistent with short-age geology. Discovery of these tidal cycles has changed interpreted time for deposition of some rocks from thousands or millions of years to a few years—in other words, three or four orders of magnitude than previously thought. This is still a challenge to explain within a one-year event but fits well if it occurred in a portion of the geological record that formed over hundreds or a few thousand years. (418–419)

The authors next discuss other laminated sediments that seem problematic, such as the “varves” of the Eocene Green River Formation in Wyoming. These are rejected as true varves based on scientific evidence. This is followed by a discussion of Milankovitch cycles that are rejected as having any valid imprint upon the geological record. Finally, in this section dealing with “Cyclical Features That Seem to Require Time,” the authors respond to the challenge of ice-core laminations that seem to require 100,000 years (in Greenland) or hundreds of thousands of years (in Antarctica). These also are rejected as having valid time implications.

Postscript

Creationist research can no longer neglect major non-creationist studies of purported fossil forests completed in the last 25–30 years. The accompanying bibliography attempts to collect some of the more important studies to expedite creation research. These fossil forests are found in multiple places across every continent, including Antarctica. This paper is a two-fold call: first, a call for many more creationists trained in botany and its related fields to take up the study of fossil forests. This involves having botanists do additional training in geology, and it also involves supporting young creationists who wish to enter graduate-degree programs in paleobotany. Second, it is a call for creationists to re-visit all their research on fossil forests and supplement that research with extensive, credible field work.

Creationist research on fossil forests must be data driven. Mostly such research has been model-
driven, which is a good starting point for research. But it is not the end point. Model-driven research is qualitative and more theoretical; data-driven research is quantitative and more practical. In terms of finding the truth about fossil forests, the preference should be given to quantitative over qualitative research at least in its incipient stages. The ultimate goal is to develop models and apply those models in a variety of situations utilizing both quantitative and qualitative approaches. The above study is an appeal not to neglect the quantitative aspects of fossil-forest research that provide a solid foundation for further pursuits.