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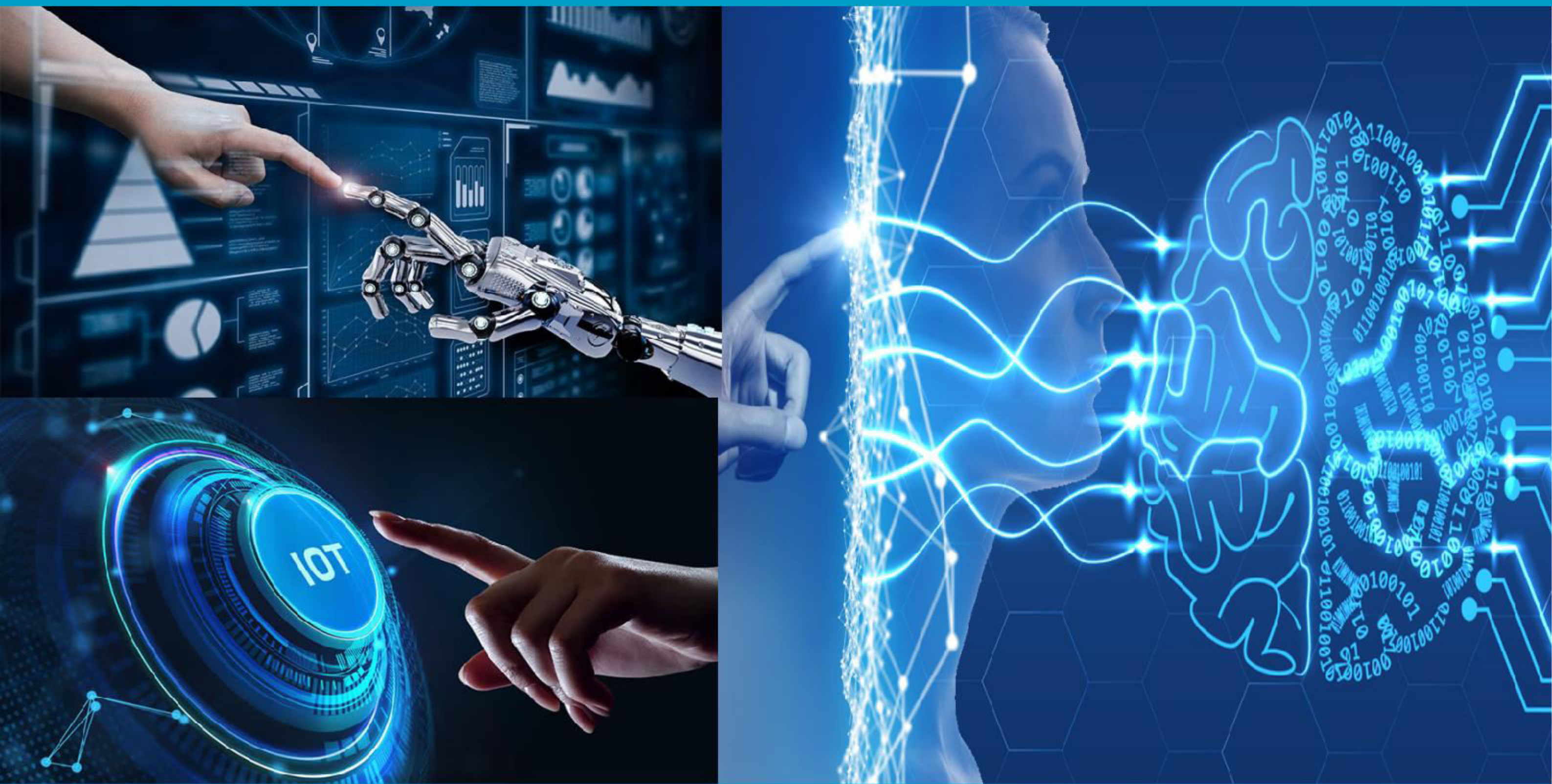

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A Review on Paleobotanical Studies Conducted in Countries other than India

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ABSTRACT: Paleobotany, which is also spelled as palaeobotany, is the branch of botany dealing with the recovery and identification of plant remains from geological contexts, and their use for the biological reconstruction of past environments (paleogeography), and the evolutionary history of plants, with a bearing upon the evolution of life in general. A synonym is paleophytology. It is a component of paleontology and paleobiology. The prefix *palaeo-* means "ancient, old",[1] and is derived from the Greek adjective παλαιός, *palaios*.[2] Paleobotany includes the study of terrestrial plant fossils, as well as the study of prehistoric marine photoautotrophs, such as photosynthetic algae, seaweeds or kelp. A closely related field is palynology, which is the study of fossilized and extant spores and pollen.Paleobotany is important in the reconstruction of ancient ecological systems and climate, known as paleoecology and paleoclimatology respectively; and is fundamental to the study of green plant development and evolution. Paleobotany has also become important to the field of archaeology, primarily for the use of phytoliths in relative dating and in paleoethnobotany.[3]The emergence of paleobotany as a scientific discipline can be seen in the early 19th century, especially in the works of the German palaeontologist Ernst Friedrich von Schlotheim, the Czech (Bohemian) nobleman and scholar Kaspar Maria von Sternberg, and the French botanist Adolphe-Théodore Brongniart.[4][5]

KEYWORDS: paleobotanical, countries, scholar, scientists, ancient, climate, reconstruction, life

I.INTRODUCTION

Macroscopic remains of true vascular plants are first found in the fossil record during the Silurian Period of the Paleozoic era.

Fig.1. An unpolished hand sample of the Lower Devonian Rhynie Chert from Scotland

Some dispersed, fragmentary fossils of disputed affinity, primarily spores and cuticles, have been found in rocks from the Ordovician Period in Oman, and are thought to derive from liverwort- or moss-grade fossil plants (Wellman, Osterloff & Mohiuddin 2003). An important early land plant fossil locality is the Rhynie Chert, found outside the village of Rhynie in Scotland. The Rhynie chert is an Early Devonian sinter (hot spring) deposit composed primarily of silica. It is exceptional due to its preservation of several different clades of plants, from mosses and lycophytes to more unusual, problematic forms. Many fossil animals, including arthropods and arachnids, are also found in the Rhynie Chert, and it offers a unique window on the history of early terrestrial life.[1]

Plant-derived macrofossils become abundant in the Late Devonian and include tree trunks, fronds, and roots. The earliest tree was thought to be *Archaeopteris*, which bears simple, fern-like leaves spirally arranged on branches atop a conifer-like trunk (Meyer-Berthaud, Scheckler & Wendt 1999), though it is now known to be the recently discovered *Wattieza*.[6]

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Widespread coal swamp deposits across North America and Europe during the Carboniferous Period contain a wealth of fossils containing arborescent lycopods up to 30 meters tall, abundant seed plants, such as conifers and seed ferns, and countless smaller, herbaceous plants.Angiosperms (flowering plants) evolved during the Mesozoic, and flowering plant pollen and leaves first appear during the Early Cretaceous, approximately 130 million years ago.[2]

Fig.2. *Ginkgoites huttonii*, Middle Jurassic, Yorkshire, UK. Leaves preserved as compressions. Specimen in Munich Palaeontological Museum, Germany.

Plant fossils almost always represent disarticulated parts of plants; even small herbaceous plants are rarely preserved whole. Those few examples of plant fossils that appear to be the remains of whole plants in fact are incomplete as the internal cellular tissue and fine micromorphological detail is normally lost during fossilisation. Plant remains can be preserved in a variety of ways, each revealing different features of the original parent plant.[3]

Because of these difficulties, palaeobotanists usually assign different taxonomic names to different parts of the plant in different modes of preservation. For instance, in the subarborescent Palaeozoic sphenophytes, an impression of a leaf might be assigned to the genus *Annularia*, a compression of a cone assigned to *Palaeostachya*, and the stem assigned to either *Calamites* or *Arthroxylon* depending on whether it is preserved[4] as a cast or a petrifaction. All of these fossils may have originated from the same parent plant but they are each given their own taxonomic name. This approach to naming plant fossils originated with the work of Adolphe Brongniart[7] and has stood the test of time.

For many years this approach to naming plant fossils was accepted by palaeobotanists but not formalised within the *International Rules of Botanical Nomenclature*.[8] Eventually, Thomas (1935) and Jongmans, Halle & Gothan (1935) proposed a set of formal provisions, the essence of which was introduced into the 1952 International Code of Botanical Nomenclature.[9] These early provisions allowed fossils representing particular parts of plants in a particular state of preservation to be referred to organ-genera. In addition, a small subset of organ-genera, to be known as form-genera, were recognised based on the artificial taxa introduced by Brongniart (1822) mainly for foliage fossils. Over the years, the concepts and regulations surrounding organ- and form-genera became modified within successive codes of nomenclature, reflecting a failure of the palaeobotanical community to agree on how this aspect of plant taxonomic nomenclature should work (a history reviewed by Cleal & Thomas (2010)). The use of organ- and fossil-genera was abandoned with the *St Louis Code* (Greuter et al. 2000), replaced by "morphotaxa".[5]

The situation in the *Vienna Code* of 2005[10] was that any plant taxon whose type is a fossil, except Diatoms, can be described as a morphotaxon, a particular part of a plant preserved in a particular way. Although the name is always fixed to the type specimen, the circumscription (i.e. range of specimens that may be included within the taxon) is defined by the taxonomist who uses the name. Such a change in circumscription could result in an expansion of the range of plant parts and/or preservation states that can be incorporated within the taxon. For instance, a fossil-genus originally based on compressions of ovules could be used to include the multi-ovulate cupules within which the ovules were originally borne. A complication can arise if, in this case, there was an already named fossil-genus for these cupules. If palaeobotanists were confident that the type of the ovule fossil-genus and of the cupule fossil-genus could be included in the same genus, then the two names would compete as to being the correct one for the newly emended genus.[6]

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Fig.3. *Rhynia*, Lower Devonian Rhynie Chert, Scotland, UK. Transverse section through a stem preserved as a silica petrifaction, showing preservation of cellular structure.

Morphotaxa were introduced to try to overcome the issue of competing names that represented different plant parts and/or preservation states. What would you do if the species-name of a pollen-organ was pre-dated by the species name of the type of pollen produced by that pollen organ. It was argued that palaeobotanists would be unhappy if the pollen organs were named using the taxonomic name whose type specimen is a pollen grain. [7]

Fig.4. *Crossotheca hughesiana* Kidston, Middle Pennsylvanian, Coseley, near Dudley, UK. A lyginopteridalean pollen organ preserved as an authigenic mineralization (mineralized *in situ*). Specimen in Sedgwick Museum, Cambridge, UK.

As pointed out by Cleal & Thomas (2010), however, the risk of the name of a pollen grain supplanting the name of a pollen organ is most unlikely. Palaeobotanists would have to be totally confident that the type specimen of the pollen species, which would normally be a dispersed grain, definitely came from the same plant that produced the pollen organ. We know from modern plants that closely related but distinct species can produce virtually indistinguishable pollen. It would seem that morphotaxa offer no real advantage to palaeobotanists over normal fossil-taxa and the concept was abandoned with the 2011 botanical congress and the 2012 International Code of Nomenclature for algae, fungi, and plants.[8]

II.DISCUSSION

Some plants have remained almost unchanged throughout earth's geological time scale. Horsetails had evolved by the Late Devonian,[11] early ferns had evolved by the Mississippian, conifers by the Pennsylvanian. Some plants of prehistory are the same ones around today and are thus living fossils, such as *Ginkgo biloba* and *Sciadopitys verticillata*. Other plants have changed radically, or became extinct.

In the strictest sense, the name *plant* refers to those land plants that form the clade Embryophyta, comprising the bryophytes and vascular plants. However, the clade Viridiplantae or green plants includes some other groups of photosynthetic eukaryotes, including green algae. It is widely believed that land plants evolved from a group of charophytes, most likely simple single-celled terrestrial algae similar to extant Klebsormidiophyceae.[1]

Chloroplasts in plants evolved from an endosymbiotic relationship between a cyanobacterium, a photosynthesising prokaryote and a non-photosynthetic eukaryotic organism, producing a lineage of photosynthesizing

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eukaryotic organisms in marine and freshwater environments. These earliest photosynthesizing single-celled autotrophs evolved into multicellular organisms such as the Charophyta, a group of freshwater green algae.

Fossil evidence of plants begins around 3000 Ma with indirect evidence of oxygen-producing photosynthesis in the geological record, in the form of chemical and isotopic signatures in rocks and fossil evidence of colonies of cyanobacteria[9], photosynthesizing prokaryotic organisms. Cyanobacteria use water as a reducing agent, producing atmospheric oxygen as a byproduct, and they thereby profoundly changed the early reducing atmosphere of the earth to one in which modern aerobic organisms eventually evolved. This oxygen liberated by cyanobacteria then oxidized dissolved iron in the oceans, the iron precipitated out of the sea water, and fell to the ocean floor to form sedimentary layers of oxidized iron called Banded Iron Formations (BIFs). These BIFs are part of the geological record of evidence for the evolutionary history of plants by identifying when photosynthesis originated. This also provides deep time constraints upon when enough oxygen could have been available in the atmosphere to produce the ultraviolet blocking stratospheric ozone layer. The oxygen concentration in the ancient atmosphere subsequently rose, acting as a poison for anaerobic organisms, and resulting in a highly oxidizing atmosphere, and opening up niches on land for occupation by aerobic organisms.[10]

Fossil evidence for cyanobacteria also comes from the presence of stromatolites in the fossil record deep into the Precambrian. Stromatolites are layered structures formed by the trapping, binding, and cementation of sedimentary grains by microbial biofilms, such as those produced by cyanobacteria. The direct evidence for cyanobacteria is less certain than the evidence for their presence as primary producers of atmospheric oxygen. Modern stromatolites containing cyanobacteria can be found on the west coast of Australia and other areas in saline lagoons and in freshwater.[11]

Fig.5 Artist's impression of *Cooksonia pertoni*

The first fossil records of vascular plants, that is, land plants with vascular tissues, appeared in the Silurian period. The earliest known representatives of this group (mostly from the northern hemisphere) are placed in the genus *Cooksonia*. They had very simple branching patterns, with the branches terminated by flattened sporangia. By the end of the Silurian much more complex vascular plants, the zosterophylls, had diversified[3] and primitive lycopods, such as *Baragwanathia* (originally discovered in Silurian deposits in Victoria, Australia),[4] had become widespread.[12]

By the Devonian Period, the colonization of the land by plants was well underway. The bacterial and algal mats were joined early in the period by primitive plants that created the first recognizable soils and harbored some arthropods like mites, scorpions and myriapods. Early Devonian plants did not have roots or leaves like the plants most common today, and many had no vascular tissue at all. They probably relied on arbuscular mycorrhizal symbioses with fungi to provide them with water and mineral nutrients such as phosphorus.[5] They probably spread by a combination of vegetative reproduction forming clonal colonies, and sexual reproduction via spores and did not grow much more than a few centimeters tall.[5]

By the Late Devonian, forests of large, primitive plants existed: lycophytes, sphenophytes, ferns, and progymnosperms had evolved. Most of these plants have true roots and leaves, and many were quite tall. The tree-

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like *Archaeopteris*, ancestral to the gymnosperms, and the giant cladoxylopsid trees had true wood. These are the oldest known trees of the world's first forests. *Prototaxites* was the fruiting body of an enormous fungus that stood more than 8 meters tall. By the end of the Devonian, the first seed-forming plants had appeared. This rapid appearance of so many plant groups and growth forms has been called the "Devonian Explosion". The primitive arthropods co-evolved with this diversified terrestrial vegetation structure. The evolving co-dependence of insects and seed-plants that characterizes a recognizably modern world had its genesis in the late Devonian. The development of soils and plant root systems probably led to changes in the speed and pattern of erosion and sediment deposition.[7]

The 'greening' of the continents acted as a carbon dioxide sink, and atmospheric concentrations of this greenhouse gas may have dropped.[6] This may have cooled the climate and led to a massive extinction event. see Late Devonian extinction.

Also in the Devonian, both vertebrates and arthropods were solidly established on the land.

III.RESULTS

Early Carboniferous land plants were very similar to those of the preceding Latest Devonian, but new groups also appeared at this time.

The main Early Carboniferous plants were the Equisetales (Horse-tails), Sphenophyllales (scrambling plants), Lycopodiales (Club mosses), Lepidodendrales (arborescent clubmosses or scale trees), Filicales (Ferns), Medullosales (previously included in the "seed ferns", an artificial assemblage of a number of early gymnosperm groups) and the Cordaitales. These continued to dominate throughout the period, but during late Carboniferous, several other groups, Cycadophyta (cycads), the Callistophytales (another group of "seed ferns"), and the Voltziales (related to and sometimes included under the conifers), appeared.[9]

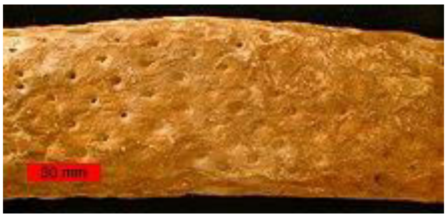

***Fig.6 Stigmaria*, a fossil tree root. Upper Carboniferous of northeastern Ohio**.

The Carboniferous lycophytes of the order Lepidodendrales, which were cousins (but not ancestors) of the tiny club-mosses of today, were huge trees with trunks 30 meters high and up to 1.5 meters in diameter. These included *Lepidodendron* (with its fruit cone called *Lepidostrobus*), *Halonia*, *Lepidophloios* and *Sigillaria*. The roots of several of these forms are known as *Stigmaria*.

The fronds of some Carboniferous ferns are almost identical with those of living species. Probably many species were epiphytic. Fossil ferns include *Pecopteris* and the tree ferns *Megaphyton* and *Caulopteris*. Seed ferns or Pteridospermatophyta include *Cyclopteris*, *Neuropteris*, *Alethopteris*, and *Sphenopteris*.

The Equisetales included the common giant form *Calamites*, with a trunk diameter of 30 to 60 cm and a height of up to 20 meters. *Sphenophyllum* was a slender climbing plant with whorls of leaves, which was probably related both to the calamites and the modern horsetails.[11]

Fig.7 External mold of *Lepidodendron* from the Upper Carboniferous of Ohio.

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Cordaites, a tall plant (6 to over 30 meters) with strap-like leaves, was related to the cycads and conifers; the catkin-like inflorescence, which bore yew-like berries, is called *Cardiocarpus*. These plants were thought to live in swamps and mangroves. True coniferous trees (*Walchia*, of the order Voltziales) appear later in the Carboniferous, and preferred higher drier ground. The Permian began with the Carboniferous flora still flourishing. About the middle of the Permian there was a major transition in vegetation. The swamp-loving lycopod trees of the Carboniferous, such as *Lepidodendron* and *Sigillaria*, were replaced by the more advanced conifers, which were better adapted to the changing climatic conditions. Lycopods and swamp forests still dominated the South China continent because it was an isolated continent and it sat near or at the equator. The Permian saw the radiation of many important conifer groups, including the ancestors of many present-day families. The ginkgos and cycads also appeared during this period. Rich forests were present in many areas, with a diverse mix of plant groups. The gigantopterids thrived during this time; some of these may have been part of the ancestral flowering plant lineage, though flowers evolved only considerably later.[8]

IV.CONCLUSIONS

On land, the holdover plants included the lycophytes, the dominant cycads, Ginkgophyta (represented in modern times by *Ginkgo biloba*) and glossopterids. The spermatophytes, or seed plants came to dominate the terrestrial flora: in the northern hemisphere, conifers flourished. *Dicroidium* (a seed fern) was the dominant southern hemisphere tree during the Early Triassic period. The arid, continental conditions characteristic of the Triassic steadily eased during the Jurassic period, especially at higher latitudes; the warm, humid climate allowed lush jungles to cover much of the landscape.[7] Conifers dominated the flora, as during the Triassic; they were the most diverse group and constituted the majority of large trees. Extant conifer families that flourished during the Jurassic included the Araucariaceae, Cephalotaxaceae, Pinaceae, Podocarpaceae, Taxaceae and Taxodiaceae.[8] The extinct Mesozoic conifer family Cheirolepidiaceae dominated low latitude vegetation, as did the shrubby Bennettitales.[9] Cycads were also common, as were ginkgos and tree ferns in the forest. Smaller ferns were probably the dominant undergrowth. Caytoniaceous seed ferns were another group of important plants during this time and are thought to have been shrub to small-tree sized.[10] Ginkgo-like plants were particularly common in the mid- to high northern latitudes. In the Southern Hemisphere, podocarps were especially successful, while Ginkgos and Czekanowskiales were rare.[9][11] Flowering plants, also known as angiosperms, spread during this period, although they did not become predominant until near the end of the period (Campanian age).[12] Their evolution was aided by the appearance of bees; in fact angiosperms and insects are a good example of coevolution. The first representatives of many modern trees, including figs, planes and magnolias, appeared in the Cretaceous. At the same time, some earlier Mesozoic gymnosperms, like Conifers continued to thrive, although other taxa like Bennettitales died out before the end of the period.[10]

Fig. 8 Artist's restoration of *Archaeamphora longicervia*, the earliest known carnivorous plant

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The Cenozoic began at the Cretaceous–Paleogene extinction event with a massive disruption of plant communities. It then became just as much the age of savannas, or the age of co-dependent flowering plants and insects. At 35 Ma, grasses evolved from among the angiosperms. About ten thousand years ago, humans in the Fertile Crescent of the Middle East develop agriculture. Plant domestication begins with cultivation of Neolithic founder crops. This process of food production, coupled later with the domestication of animals caused a massive increase in human population that has continued to the present. In Jericho (modern Israel), there is a settlement with about 19,000 people. At the same time, Sahara is green with rivers, lakes, cattle, crocodiles and monsoons. At 8 ka, Common (Bread) wheat (*Triticum aestivum*) originates in southwest Asia due to hybridisation of emmer wheat with a goat-grass, *Aegilops tauschii*. At 6.5 ka, two rice species are domesticated: Asian rice, *Oryza sativa*, and African rice *Oryza glaberrima*.[12]

REFERENCES

1. Del-Bem, Luiz-Eduardo (2018). "Xyloglucan evolution and the terrestrialization of green plants". New Phytologist. 219 (4): 1150–1153. doi:10.1111/nph.15191. PMID 29851097.
2. ^ Labandeira, C. (2007). "The origin of herbivory on land: Initial patterns of plant tissue consumption by arthropods". Insect Science. 14 (4): 259–275. doi:10.1111/j.1744-7917.2007.00152.x.
3. ^ Kotyk, M.E.; Basinger, J.F.; Gensel, P.G. & de Freitas, T.A. (2002), "Morphologically complex plant macrofossils from the Late Silurian of Arctic Canada", American Journal of Botany, 89 (6): 1004–1013, doi:10.3732/ajb.89.6.1004, PMID 21665700
4. ^ Lang, William H.; Cookson, Isabel C. (1935). "On a flora, including vascular land plants, associated with Monograptus, in rocks of Silurian age, from Victoria, Australia". Philosophical Transactions of the Royal Society of London B. 224 (517): 421–449. Bibcode:1935RSPTB.224..421L. doi:10.1098/rstb.1935.0004.
5. ^ Simon, L.; Bousquet, J.; Levesque, C.; Lalonde, M. (1993). "Origin and diversification of endomycorrhizal fungi and coincidence with vascular land plants". Nature. 363 (6424): 67–69. Bibcode:1993Natur.363...67S. doi:10.1038/363067a0. S2CID 4319766.
6. ^ Beerling, David (2008). The Emerald Planet: How Plants Changed Earth's History. Oxford University Press. ISBN 9780199548149.
7. ^ Haines, Tim. 2000. Walking with Dinosaurs: A Natural History, (New York: Dorling Kindersley Publishing, Inc.) ISBN 0-563-38449-2. Page 65.
8. ^ Behrensmeyer, Anna K., Damuth, J.D., DiMichele, W.A., Potts, R., Sues, H.D. & Wing, S.L. (eds.). 1992. Terrestrial Ecosystems through Time: the Evolutionary Paleoecology of Terrestrial Plants and Animals, (Chicago & London: University of Chicago Press), ISBN 0-226-04154-9 (cloth), ISBN 0-226-04155-7 (paper). Page 349.
9. ^ Behrensmeyer et al., 1992, 352
10. ^ Behrensmeyer et al., 1992, 353
11. ^ Haines, 2000.
12. ^ Herendeen, Patrick S.; Friis, Else Marie; Pedersen, Kaj Raunsgaard; Crane, Peter R. (2017-03-03). "Palaeobotanical redux: revisiting the age of the angiosperms". Nature Plants. 3 (3): 17015. doi:10.1038/nplants.2017.15. ISSN 2055-0278. PMID 28260783. S2CID 205458714.

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