PERIOD PALAEO PLANTS

of SOUTH-EASTERN AUSTRALIA

Following will be a series of posts in which fossil vascular plants for each of the Geological Periods from Late Silurian to Quaternary will be presented. These posts will include the Gondwana floras of the Permian Glossopterids and Triassic Dicroidium floras. These Gondwanan floras, so well represented locally, are not well represented in publications which largely originate in the Northern Hemisphere.

While not all members of each flora can be shown, where specimens are available, some representative examples will be.

PERIOD PALAEO PLANTS

of SOUTH-EASTERN AUSTRALIA

1. THE BARAGWANATHIA FLORA

LATE SILURIAN—EARLY DEVONIAN (c. 425—395 Ma)

Vascular plants are plants with a structure in the stem enabling the plant to stand vertically and to transport water and minerals from the roots upwards to the leaves. These are the dominant land plants. The oldest known vascular plant in the world, *Baragwanathia longifolia,* a lycopod, was discovered at this site (**Photo 1**) on Limestone Road, Yea, Victoria. This photo also shows the small quarry formed during road widening of this crest on a narrow country road. **Photo 2** shows the steeply dipping attitude of the host siltstone sediments on the immediately opposite side of the road. The specimens shown were collected from this site well before it was declared a heritage site. On subsequent visits when photos 1 and 2 were taken not a single specimen was seen.

Photo 1

Photo 2

Photo 3 (left) shows the tip of a young frond of ***Baragwanathia longifolia.***

Photo 4

Photo 5

Photos 4 & 5 show fronds of *Baragwanathia longifolia* (5mm wide on specimen, 3mm in 'Greening of Gondwana' by Mary White) which (under the binocular microscope) show in places patches of sporangia at a spacing of about 6 across the width of the frond.

Photo 6

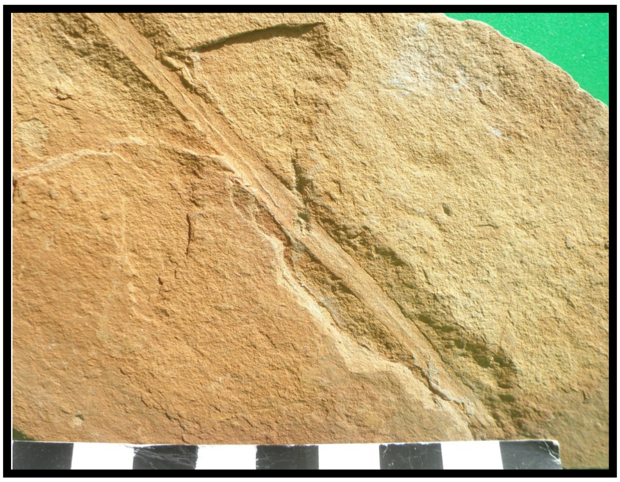


Photo 7

Photos 6, 7 & 8 show a possible stem of *Baragwanathia longifolia* with a distinct midrib but lacking the leaf scars as in Photo 70 in 'Greening of Gondwana' by Mary White. In Photo 7 the stem is 25mm in width but in the specimen here is only 4 mm in width.

Photo 8

2. The GIANT CLUBMOSS (Lycopod—*Leptophloeum)* FLORA

Late DEVONIAN—Early CARBONIFEROUS (c. 395—350 Ma)

The late Silurian—Early Devonian Baragwanathia Flora had evolved dramatically, producing extra thickening, strengthening and conducting tissues so enabling plants to grow into tall trees. Their spores were then able to be released higher into the air column and so be spread further. As the small inconspicuous leaves fell, the leaf cushions continued to grow with the secondary growth of the branch, and so the pattern of leaf scars expanded. By Mid Devonian times the main groups of higher plants were already delineated. The spore-producing plants were Lycopods (Clubmosses), Articulates (Horsetails) and ferns.

3. The GIANT CLUBMOSS (Lycopod— *Lepidodendron*) FLORA

Early CARBONIFEROUS - Mid CARBONIFEROUS (c. 350—320 Ma)

By the Late Devonian the Australian land mass had moved by 35^0 of latitude from its Silurian— Early Devonian position and was heading southwards. The climate was cooling and stressing the Giant Clubmoss Flora which needed a tropical, swampy and high rainfall habitat for survival. The dominant lycopod in South-east Australia at this time was *Lepidodendron*. Other flora included the arborescent horsetail *Calamites.*

Photo 1 shows a plaster cast of a latex mould of a poorly reserved specimen on top of a very large boulder of the Flagstaff Formation, 25 km north of Dungog, NSW. The Flagstaff Formation is a medium grained, thickly bedded, marine lithic sandstone of Early Carboniferous (Visean, c. 335 Ma) age.

Photo 2 shows a photo of *Lepidodendron mansfieldense* taken from 'Australian Fossil Plants' by Mary E White, and in which the bark pattern of elongated lens-shaped leaf bases can be more clearly seen.

Photo 1

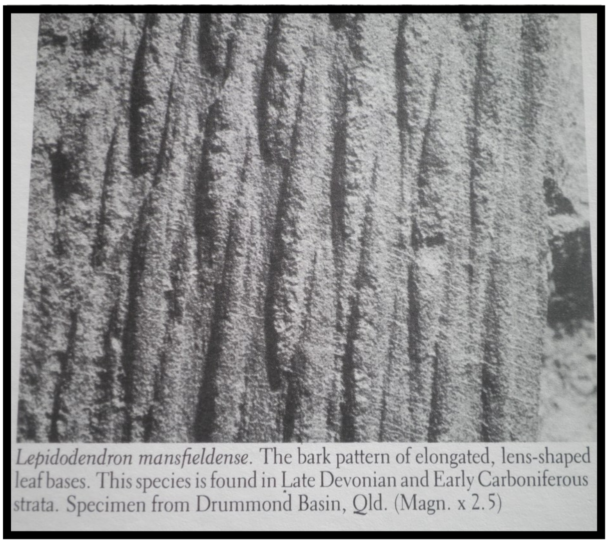


Photo 2

4. The RHACOPTERIS FLORA

Mid CARBONIFEROUS - Late CARBONIFEROUS (c. 335—300 Ma)

During this time, the Carboniferous, South-eastern Australia was experiencing periglacial conditions with the deposition of fluvio-glacial sediments. The Giant Clubmosses were unable to survive here and only the continental blocks which are now parts of North America, Britain, Europe and parts of Asia were located in low tropical latitudes. This promoted growth of the extensive, lush and densely forested swamplands which became the extensive coalfields of the Northern Hemisphere. However South-eastern Australia was now continuing southwards and also rotated through 90 degrees. The climate was becoming increasingly provincial with polar ice caps forming and expanding. In the Late Carboniferous a few small lycopods remained. The Rhacopterids, seedferns with primitive leaf structure and venation, became the dominant vegetation form typified by *Rhacopteris ovata*. Two other forms representing the opposite ends of a range of forms also arose, *Dactylophyllum* and *Botrychiopsis*. The Rhacopterids, low bushy plants, had a tundra-like habitat and the occasional thin carbonaceous shales and poor coaly beds in the Late Carboniferous of South-eastern Australia probably formed in a similar environment to the modern peat bogs of northern Canada and Siberia. The specimens shown are of *Rhacopteris ovata* . Photos 1 & 2 from the Mingaletta Formation (c. 310 Ma), Kew, NSW, and Photo 3 from the Mt Johnston Formation (c.333Ma), Paterson, NSW.

Photo 1

Photo 2

Photo 3

5. The GLOSSOPTERIS FLORA (Part 1)

PERMIAN (300 —252 Ma)

In South-eastern Australia from the Early to the Late Carboniferous was a period of significant tectonic events including the docking of the New England Fold Belt (NEFB) onto the Gondwanan part of the Supercontinent of Pangea via the Lachlan Fold Belt (LFB). The NEFB and the LFB became separated by extension and crustal thinning which initiated the Sydney—Gunnedah Basin at the commencement of the Permian, and which is now flanked by highlands of the LFB in the west and of highlands of the NEFB in the east. GLOSSOPTERID classification of genera is form based on leaf morphology as leaves are so plentiful on deciduous trees and leaves attached to branches and fruiting structures so rare. There is a spectrum of forms as follows: GLOSSOPTERIS (Photo 1) has a clearly defined mid rib consisting of several parallel veins. Between the leaf veins there are cross connecting veinlets forming a mesh or net veination. GANGAMOPTERIS (Photo 2) has no clearly defined mid rib and several parallel veins in the centre of the tongue-shaped leaf blade which may have a median groove and a few cross connecting veinlets. PALAEOVITTARIA (Photo 3) has no mid rib, no median groove, almost parallel veins and rare cross connecting veinlets. NOEGGERATHIOPSIS (Photo 4) is not a Glossopterid but a Cordiate which is a common associate of the Glossopterids. It has an elongate strap-like leaf with strong parallel ribs which occasionally bifurcate so that the leaf sides slightly diverge. It is distinguished from Horsetails by its lack of nodes.

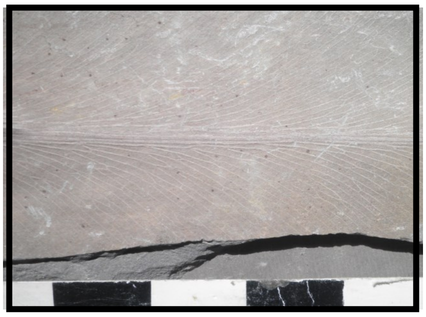


Photo 1. ***PGlossopoteris***

Photo 2. ***Gangamopteris***

Photo 3. ***Palaeovittaria***

Photo 4. ***Noeggerathiopsis***

6. The GLOSSOPTERIS FLORA (Part 2)

PERMIAN (300 —252 Ma)

GANGAMOPTERIS

In South-east Australia crustal extension, through thinning, caused crustal sag initiating the Sydney — Gunnedah Basin. At this time the continent was still rotated 90 degrees so that the south-eastern part was in the high latitudes. The Basin lowlands between the LFB and the NEFB became the site of extensive cool temperate swamplands. The vegetation contained Botrychiopsis, the only survivor of the Rhacopteris Flora which otherwise was unable to adjust to the slowly warming climate. The changing climate enabled the growth of more shrub -like vegetation, the first appearance, at the commencement of the Permian, of the Glossopterid Gangamopteris (Photos 1 to 3). As the climate continued to warm, although still cool and temperate, Glossopteris, with its tree structure became the dominant vegetation. Its annual leaf fall produced the 'autumnal bank' deposits, with layers of leaves on top of more leaves (Photos 4 to 6), which are common in the strata. As the climate continued to slowly warm the polar ice cap melted. This caused a sea level rise and a marine transgression throughout most of the Basin and which covered the swamplands. As the Glossopteris appeared, Botrychopsis, the last of the Rhacopteris Flora, became extinct.

Photo 1

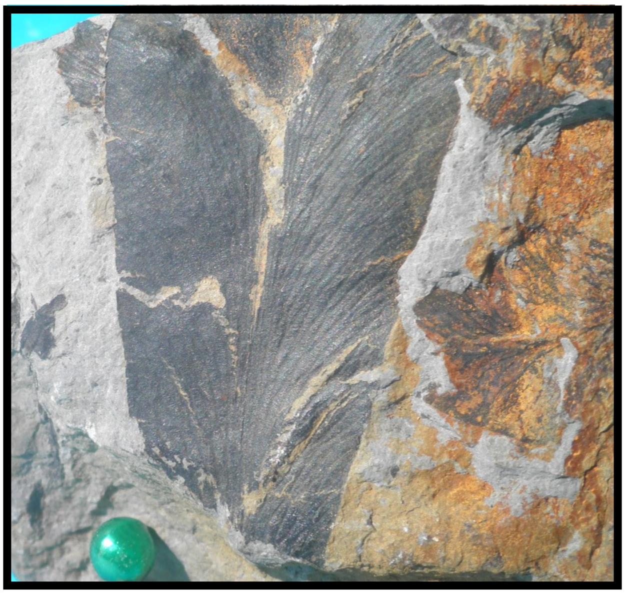


Photo 2

Photo 3

Photo 4

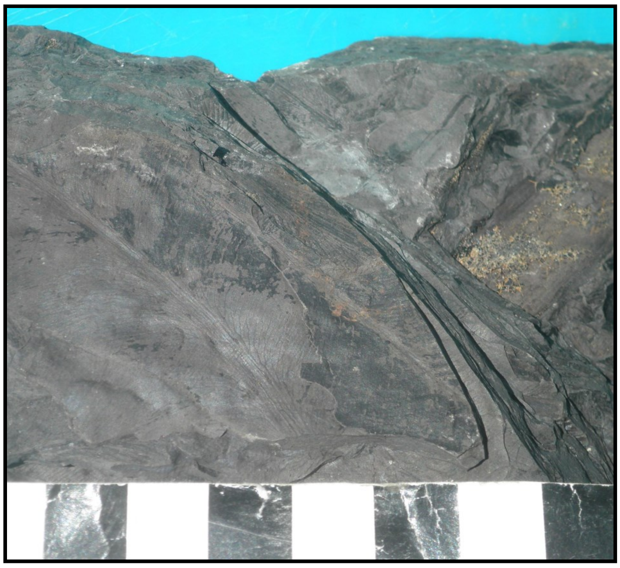


Photo 5

Photo 6

7. The GLOSSOPTERIS FLORA (Part 3)

PERMIAN (300 —252 Ma)

VERTEBRARIA

Glossopteris is the dominant member of the Glossopteris Flora. The next few articles will detail the component parts of the Glossopteris tree commencing with the roots, Vertebraria. In the mid Permian an east-west compressive event uplifted the floor of the Sydney—Gunnedah Basin causing the marine incursion to recede and the vast coastal/deltaic/fluvial swamplands to be re-established and be supplemented by deposition of terrestrial sediments shed from the flanking highlands. These vast cool temperate swamplands became extensive coalfields. The climate had now warmed to the extent that large Glossopteris trees, sufficiently spaced to allow sunlight to promote a lush understory of subordinate plants. Vertebraria is an elongate cylindrical-shaped structure which penetrates the substrate almost vertically. This root structure has a thin vertical column from which 6 (in *V. australis*) and 8 (in *V. indica*) (see Photos 7 to 9) vertical partitions (septa), paired diametrically, connect the column to the encasing thin epidermal tissue (rarely reserved). Horizontal partitions at regular intervals form chambers. This structure is believed to be an adaption for aeration of tissues, necessary in the waterlogged habitat of swamps. If the chamber filled with water which then froze, the expanding ice would severely damage the structure so the plant would not survive in a very cold climate in which the soil water froze. When split across the paired septa, the regular segments on either side of the column resemble a vertebral column, hence the name Vertebraria (see Photos 1 to 6). All specimens are from the Newcastle Coal Measures.

Photo 1

Photo 2

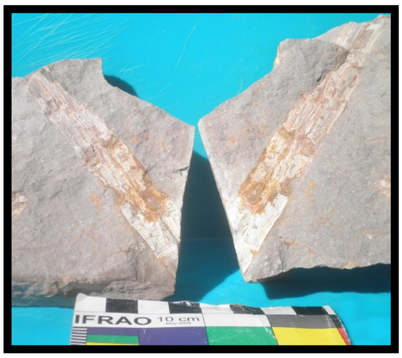


Photo 3

Photo 4

Photo 5

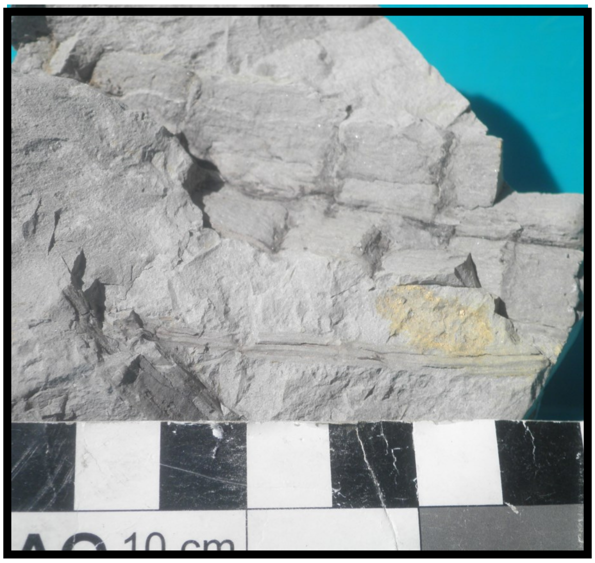


Photo 6

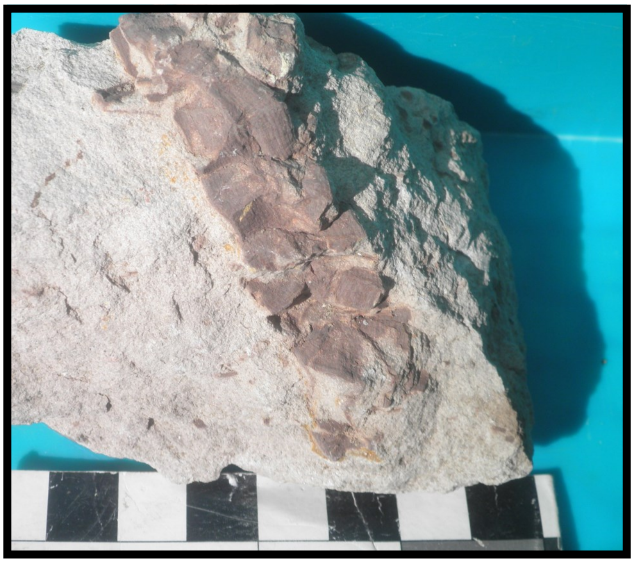


Photo 7

Photo 8

Photo 9

8. The GLOSSOPTERIS FLORA (Part 4)

PERMIAN (300 —252 Ma)

STUMPS

Photos 1 to 4 show the stumps of Glossopteris trees on the rock platform at Swansea Heads, NSW, Australia. They are preserved in a welded tuff deposited by a pyroclastic flow which smashed the trees at their bases. The stumps are about 8 to 10 m apart and the logs are predominantly orientated in the W-NW— E-SE sector. Structures within the flow are evident in Photo 5 of the adjacent cliff face. Photos 6 to 8 are at Dudley Head rock platform. Photos 7 an 8 show the primary roots from which the Vertebraria grew in some cases, it has been suggested, upwards as in some mangrove species. All photos are from the Late Permian Newcastle Coal Measures.

Photo 1

Photo 2

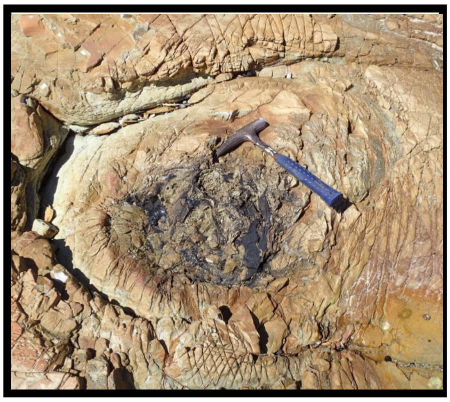


Photo 3

Photo 4

Photo 5

Photo 6

Photo 7

Photo 8

9. The GLOSSOPTERIS FLORA (Part 5)

PERMIAN (300 —252 Ma)

TRUNKS

The following photos were taken at the Dudley Rock Platform in the Late Permian Newcastle Coal Measures, NSW, Australia. The Glossopteris tree was a tall (some have been measured in excess of 15 metres), straight and slender tree (without lower branches) as seen in Photos 1 to 3. It s thought to have masses of deciduous leaves on short branches forming a crown. Photo 8 (with stump and primary roots in left foreground) shows members of the Hunter Valley Amateur Geological Society at the outcrop.

Photo 1

Photo 2

Photo 3

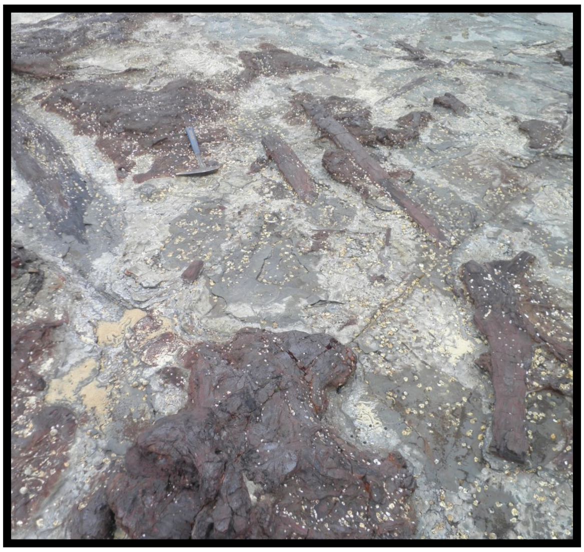


Photo 4

Photo 5

Photo 6

Photo 7

Photo 8

10. The GLOSSOPTERIS FLORA (Part 6)

PERMIAN (300 —252 Ma)

WOOD

The generic terms Dadoxylon and Araucarioxylon have been confused due to the classification of Glossopteris being based on leaf morphology. As the Glossopteris wood anatomy is of the Araucarioxylon type (a gymnospermous wood with regular sized water conducting cells) Araucarioxylon is now the generally accepted term.

All photos are of Glossopteris wood from Late Permian Coal Measures in the Sydney — Gunnedah Basin from Scone (Photos 1 to 6), Boggabri (Photos 7 and 8) and Wollongong (Photo 10).

Photos 1 & 2, 3 & 4, & & 6, 7 & 8, each pair is an end and side view of the same specimen while Photo 9 is a close p of 7 & 8 showing tissue grain. Photo 10 is of a silicified pebble, originally of petrified wood which has been eroded from its matrix, buried and silicified in quartz sand, uncovered and rounded by the sand and surf and finally polished in a tumble polisher.

Photo 1

Photo 2

Photo 3

Photo 4

Photo 5

Photo 6

Photo 7

Photo 8

Photo 9

Photo 10

11. The GLOSSOPTERIS FLORA (Part 7)

PERMIAN (300 — 252 Ma)

LEAVES

Glossopteris species classification is based on leaf morphology and there are over 100 species. There is a wide variety of the spoon-shaped leaves from long (G. ampla is up to 1m in length) to short, from wide to narrow (Photos 2 & 3) and all combinations in between. Most have a smooth regular edge. There is considerable variation in the angle at which the veins leave the midrib from almost right to acute angles (Photos 4 & 5) and there is considerable variation in the degree and positioning of the veinlet mesh. The Glossopteris trees were deciduous and the leaves shed in the autumn fall form ‘autumnal bank’ fossils (Photo 8) in which the whole rock is composed of layer upon layer of leaf fossils. It is probable that some of the many species adapted to less waterlogged habitats where fossilisation is less likely to occur. Photo 5 is from Dunedoo, NSW, while all of the others are from the Newcastle Coal Measures.

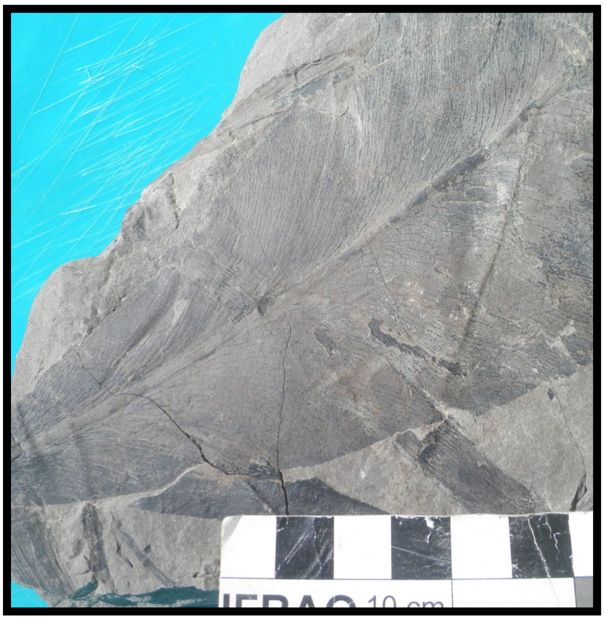


Photo 1

Photo 2

Photo 3

Photo 4

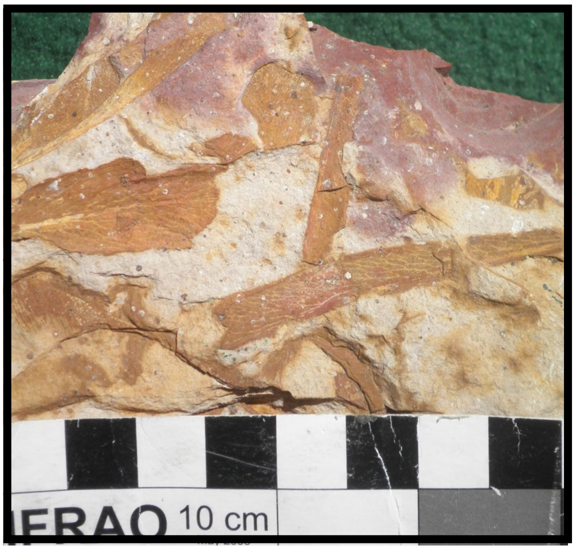


Photo 5

Photo 6

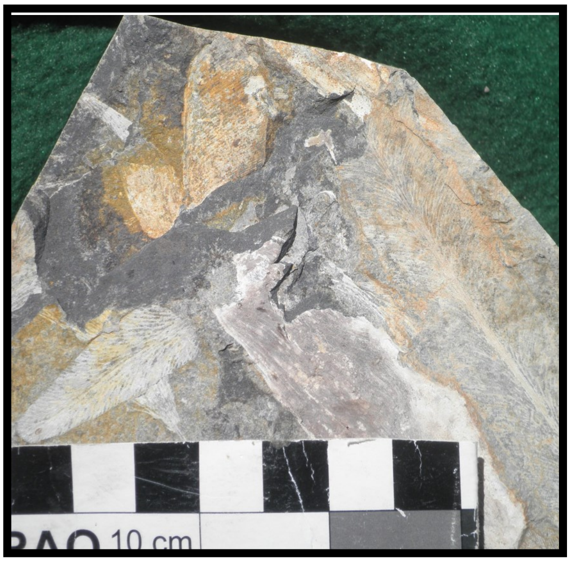


Photo 7

Photo 8

12. The GLOSSOPTERIS FLORA (Part 8)

PERMIAN (300 —252 Ma)

SEEDS

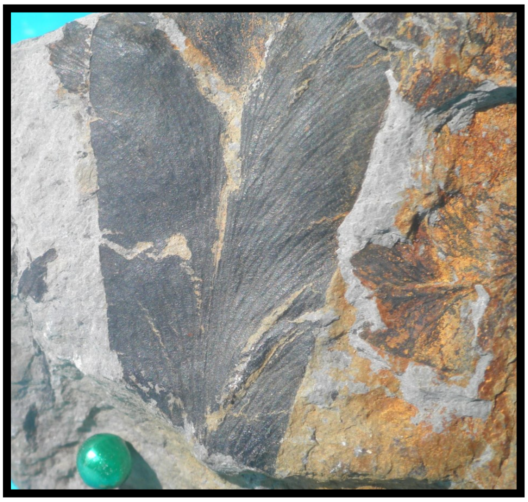
A recent account of Glossopteris reproductive structures was presented by McLoughlin & Previc in 'Alcheringa" (Aust. Jour. Palaeo.) V43 (4) pp 450-510. One female structure 'Scutum' comprises a stem originating from the base of the leaf midrib, extending parallel to the midrib and ending in an ovoid concave disc facing the leaf blade. This disc is covered with seeds on the concave side of the disc facing the leaf. In the Photo, the leaf on the right has a dimpled surface which, I think, may be the impressions (moulds) of the seeds of the Scutum. There are no impressions on the midrib and this would suggest the leaf blade tissue was soft enough to be imprinted during compression while the midrib was harder than the seeds.

13. The GLOSSOPTERIS FLORA (Part 9)

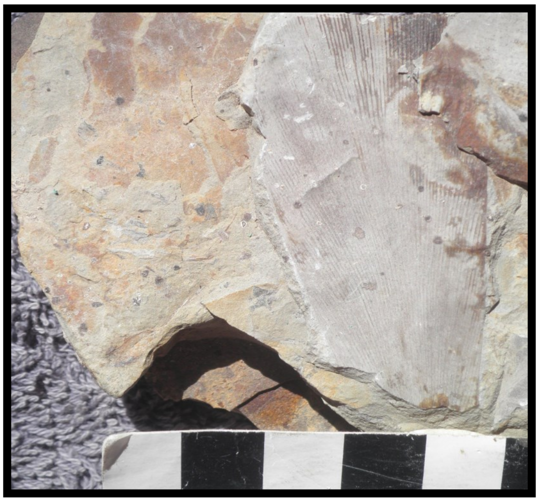
PERMIAN (300 —252 Ma)

MINOR COMPONENTS (1)

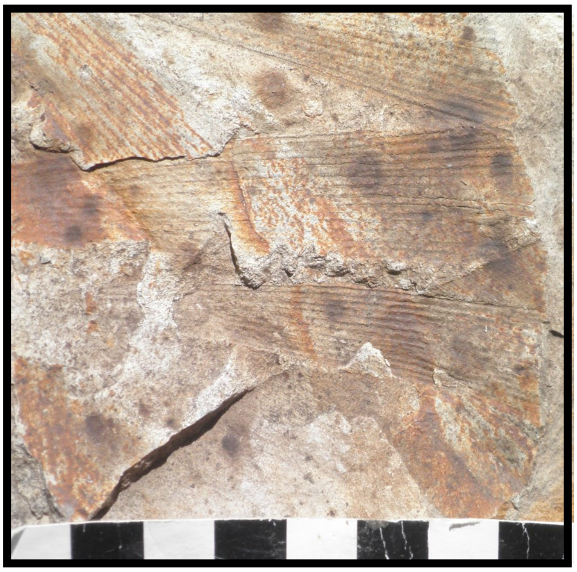
Together with the Glossopteris trees there were several other components of the Glossopteris Flora. These included the Gangamopteris shrubs (Photo 1), and Palaeovittaria (P2), the Cordaite tree Noeggerathiopsis (P3) with its strap-like leaves and its probable Cordaite seed Samaropsis (P4) (wings may be not exposed or not preserved), the Conifer Walkomiella (P5), the fern Sphenopteris (P6) and the Equisetaleans Neocalamites (P7) and Phyllotheca (P8), together with lesser Cycad ancestors, Ginkoes and Lycopods.



Gangamopteris



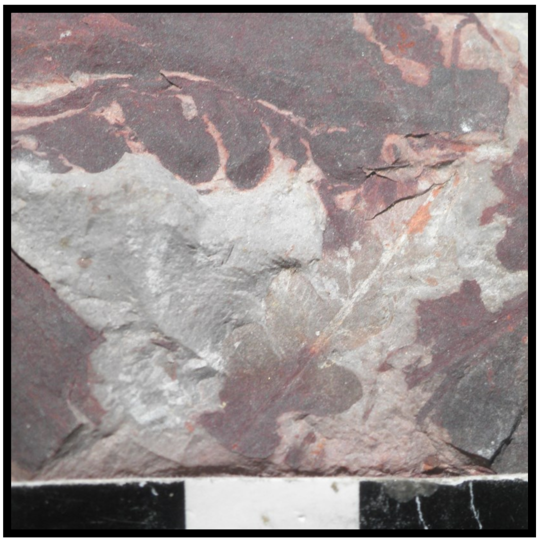
Palaeovittoria



Noeggerathiopsis

Samaropsis

Walkomiella



Sphenopteris

Neocalamites

Phyllotheca

14. The GLOSSOPTERIS FLORA (Part 9)

PERMIAN (300 —252 Ma)

MINOR COMPONENTS (2)

PHYLLOTHECA

The herbaceous Equisitalean Phyllotheca (Photo 1) formed thickets in the waterlogged environment of the Glossopteris forests. These Phyllotheca thickets, including P. australis, were a significant contributor to the formation of the coal and also provided fodder for the dicynodont reptiles of the Late Permian. The leaf circlets which form around the stem are called Annularia. Photo 2, Annularia australis, is the leaf circlet of Phyllotheca australis and Photos 3, 4 & 5 show Annularia etheridgei. While some Phyllotheca species survived into the Triassic Period, it is believed that P. australis did not.

1. Phyllotheca

2. Annularia australis

3, 4 & 5 Annularia etheridgei

15. The DICROIDIUM FLORA (Part 1)

TRIASSIC (252 — 200 Ma)

INTRODUCTION

In South-eastern Australia, at the close of the Permian, the climate had continued to warm and was still quite moist. The Glossopterids became extinct in the Permian/Triassic mass extinction and a new flora of seed-ferns, the Dicroidium Flora, was established. Some genera from other groups did survive including conifers, ferns, equisitaleans, ginkoes, cycads and lycopods. However early in the Triassic the climate experienced continued warming and alternating long periods of dryness, producing 'Red Beds', and more moist periods. No coal swamps were established at this time. The Dicroidium Flora flourished on the coastal river flats and lowlands. Photos 1 & 2, from the Burralow Formation at Terrigal, NSW, are of the most common species, Dicroidium zuberi var. feistmantelii. Dicroidium leaves show a wide range of pinule forms with intermediates grading from one type to another and showing adaptation to arid conditions. Retallack presents in 'Alcheringa' V1, pp. 247-2778, four diagrams (Photos 3 to 6) suggesting the environments from Late Permian to Middle Triassic. He gives a more detailed account in Ch. 21, Bulletin 26, 1980, Geol. Survey NSW.

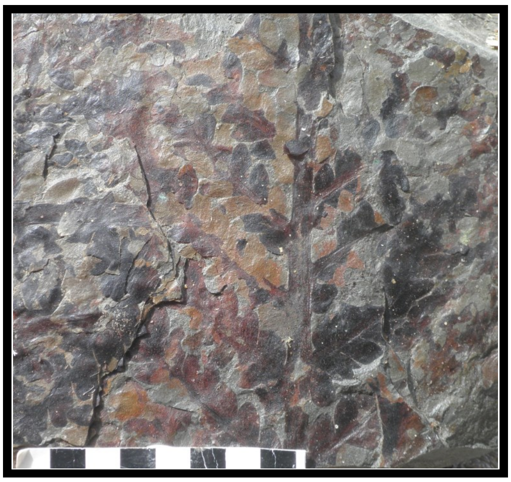
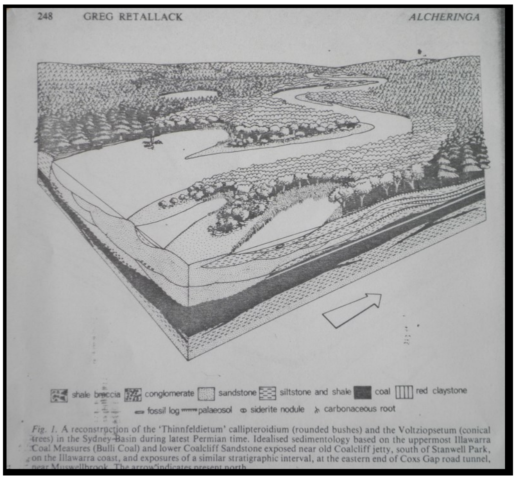


Photo 1

Photo 2



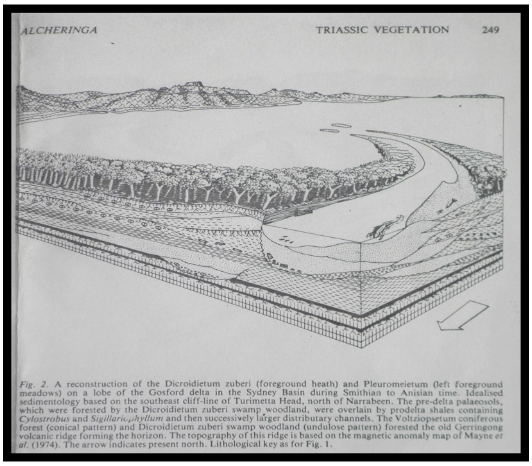
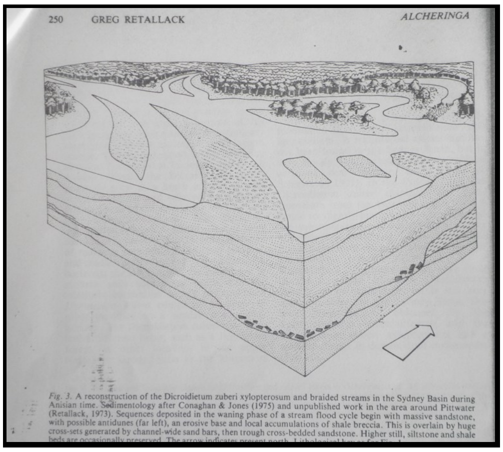


Photo 3 **Photo 4**



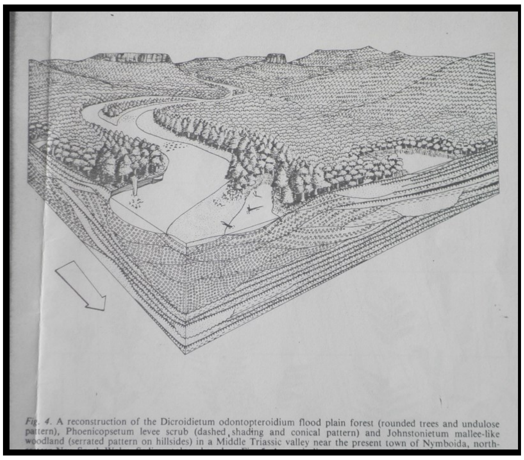


Photo 5 **Photo 6**

16. The DICROIDIUM FLORA (Part 2)

TRIASSIC (252 — 200 Ma)

DICROIDIUM ZUBERI

In the Sydney Basin of South-eastern Australia, the Permian—Triassic boundary is placed at the top of the uppermost Permian coal seam. The earliest Dicroidium species, Dicroidium callipteroides (formerly 'Thinnfeldia') appears in shales immediately overlying the top coal seam. This species has fronds (rachis) which fork several times, whereas all subsequent species only fork once (Photos 1 & 2). D. callipteroides was soon replaced by D . Zuberi, the most common and widespread species. The specimens of D. zuberi var. feistmantelii (Photos 3 to 6) from the Burralow Formation, Terrigal, NSW, are preserved as a flakey film of carbonaceous material, suggesting a fleshy pinule with a strong soft and smooth cuticle as it leaves only a very slight impression on the mudstone matrix.

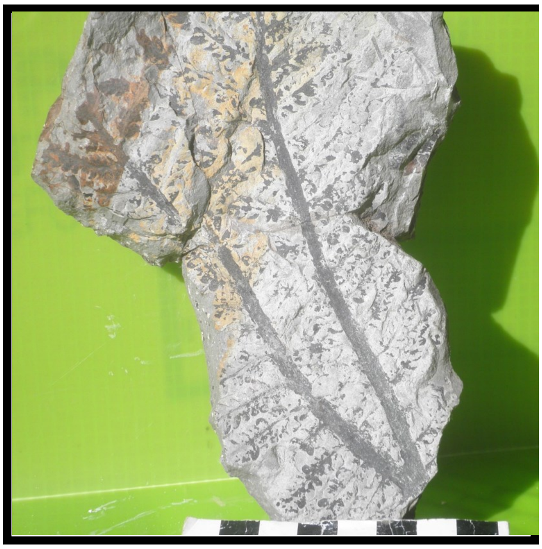


Photo 1

Photo 2

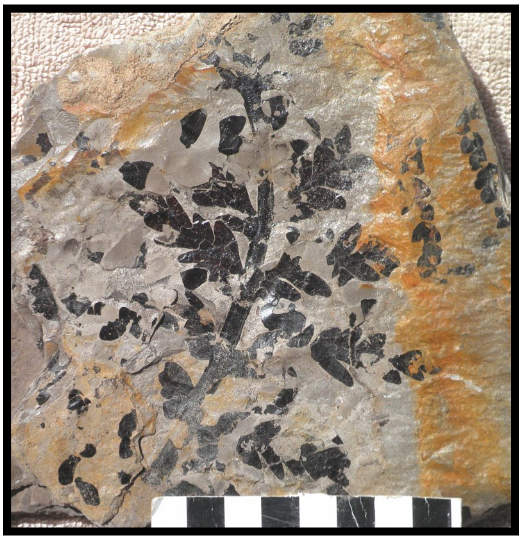


Photo 3

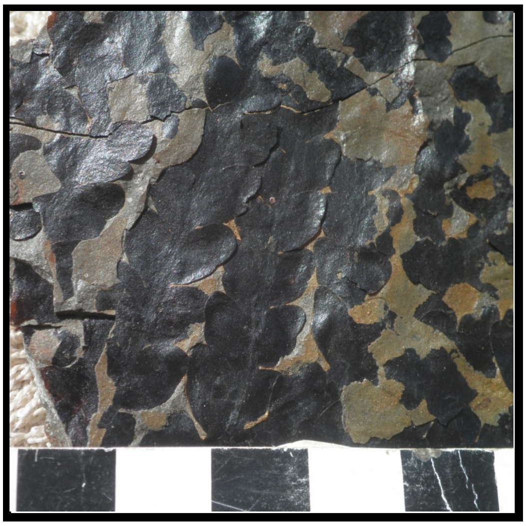


Photo 4

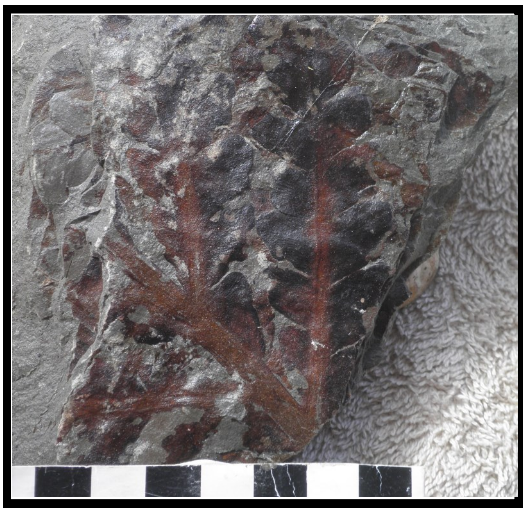


Photo 5

Photo 6

17. The DICROIDIUM FLORA (Part 3)

TRIASSIC (252 — 200 Ma)

MINOR COMPONENTS (1)

Together with the Dicroidium plants there were several other components of the Dicroidium Flora, many from groups which survived the Permian—Triassic mass extinction. These included the more drier adapted Xylopteris (Photo 1), the Fern Rienitsia (P2), the Equisetaleans Phyllotheca (P3) and Neocalamtes (P4) and (P5). Equisetaleans are mostly identified by several factors related to their nodal and leaf configurations. Photos 1 to 5 are from the Sydney Basin. Photo 6 shows unidentified branches from the Middle Triassic Digby Conglomerate, the basal Triassic formation in the Gunnedah Basin. These branches suggest that the drier uplands harboured sizeable shrubs and trees in an environment not amenable for fossilisation. The specimens shown were washed down from the neighbouring New England Fold Belt highlands about 10 Km to the east. The conglomerate source rocks are from the NEFB about 50 Km further eastwards. I have never seen branches of this size in Sydney or Lorne Basin sediments.

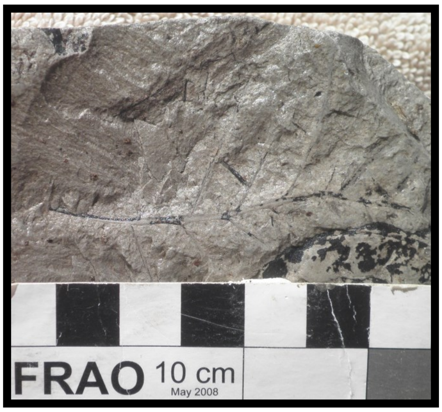


Photo 1

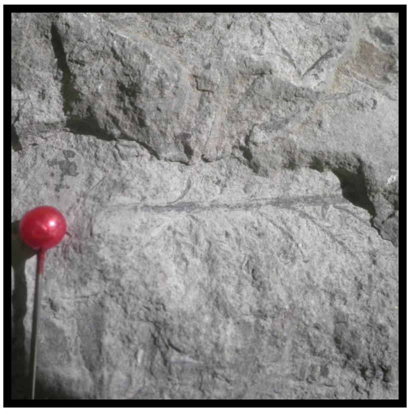


Photo 2

Photo 3

Photo 4

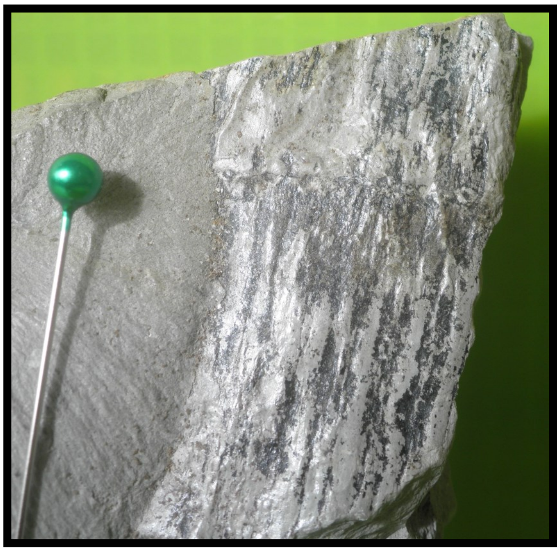


Photo 5 **Photo 6**

18. The DICROIDIUM FLORA (Part 4)

TRIASSIC (252 — 200 Ma)

MINOR COMPONENTS (2)

Lycopods (descendants of the Giant Clubmosses of the Carboniferous) are another component of the Dicroidium Flora. In the Sydney Basin of South-eastern Australia there are several species of the Lycopod genus Cylomeia. These plants grow to about 1 m and have an unbranched stem with vertical ridges with leaf attachment scars (Photo 1), a lobed bulbous base (rhyzophore) with attachments for stigmarian rootlets (Photos 2 & 3), a circlet of leaves and a cone at the top. Photos 4 & 5 show the circlet of very fine leaves of C. capillamentum. (Photos 1, 3, 4 & 5 are from the Burralow Formation, Terrigal, NSW. Retallack (see my post Dicroidium Flora (Pt 1), 3 to 6) notes that in various parts of the world Cylomeia formed dense meadows around coastal lakes, lagoons and protected seashores (see my Dicro. Flora (Pt 1) post, Photo 4), although it could survive in some conditions intolerable to other plant associations. A tiny unnamed species (Photos 6 to 8) has been recorded across the Sydney Basin. It is noted that the Terrigal specimens have a mudstone matrix whereas the tiny species from Wollombi has a fine sandstone matrix.

Photo 1

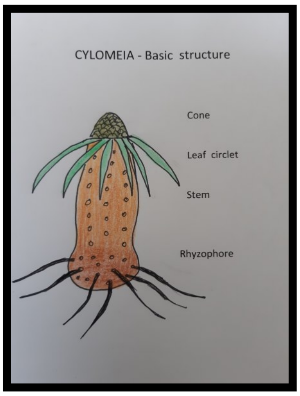


Photo 2

Photo 3

Photo 4

Photo 5

Photo 6

Photo 7

Photo 8

18. The TALBRAGAR FLORA (Part 1)

JURASSIC (200 — 145 Ma)

MAJOR COMPONENT

The Jurassic Period was uniformly warm and wet worldwide with a luxuriant cosmopolitan vegetation. This vegetation was the last to be composed of plants only from ancient groups. In the Jurassic, the current E-W axis of Australia was still orientated N-S with South-eastern Australia, the focus of this series, being furthermost south and at a latitude of about 70 degrees. Jurassic plants were widespread in Australia but very rare in South-eastern Australia with only two tiny locations at Lune River, southern Tasmania, and Talbragar in central NSW. The Talbragar Fish Beds location is on the southern edge of the Surat Basin. This tiny (approx. 150 x 280 m) laucustrine deposit subparallels the topographic slope and is probably associated with the Early—Mid Jurassic Purlewaugh Formation which crops out in the area. The site was quarried for decorative stone (Photos 5 & 6), used locally and in Sydney, and worked by fossil collectors and merchants (the source of specimens shown) until it was declared a Heritage Site and, also being on private property, is now inaccessible. The lake was surrounded by a forest dominated by a Kauri Pine (Agathis jurassica, Photos 1 to 4). The minor components will be presented in the next section.

Photo 1

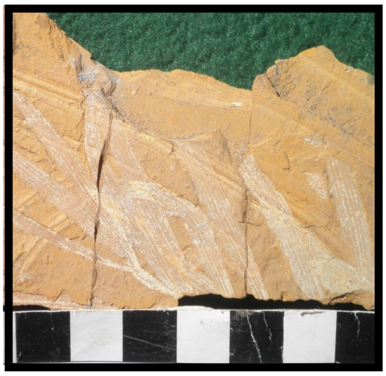


Photo 2

Photo 3

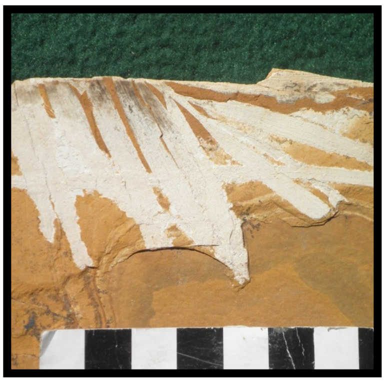


Photo 4

Photo 5 **Photo 6**

20. The TALBRAGAR FLORA (Part 1)

JURASSIC (200 — 145 Ma)

MINOR COMPONENTS

The conifer Elatoclatus planus (Photo 1) is a fairly common component of the Talbragar Flora. The leaf shown in Photo 2 was originally designated Taeniopteris spatula but was subsequently found to be the leaf of the Cycadophyte Pentoxylon australis. Some species of the seed fern (Photo 3) formerly described as Pachypteris, have now been reassigned to a newly constructed genus Komlopteris. At the present time on Queensland's Atherton Tablelands and in small relic Kauri forests in other parts of the State, a vegetation of the same basic composition as the Talbragar Flora still flourishes 200 Ma after the Talbragar location. Although plants form a small part of the study, Beattie & Avery present a very detailed account of the palaeoenvironment and palaeoecology of this unique location in 'Alcheringa' V36 (4) 2012, Journal of the Australasian Association of Palaeontologists.

Photo 1

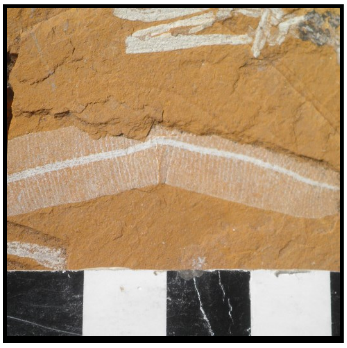


Photo 2

Photo 3

PERIOD PALAEO PLANTS

of SOUTH-EASTERN AUSTRALIA

21. The WOLLEMI PINE (Pt 1)

CRETACEOUS (145 — 66 Ma)

The Period of the evolution of flowering plants

The uniform warm and wet conditions of the Jurassic continued uninterrupted into the Early Cretaceous. However then the climate cooled abruptly, with the possible formation of ice caps, and the ancient floral groups were placed under severe stress and many did not survive. This was followed by a eustatic sea level rise which inundated about one third of the Australian continent, wiping out vegetation and forming several large disconnected islands, including South-eastern Australia. These geographically isolated islands had restricted gene pools which allowed advantageous mutations to quickly establish and produce dominant new families, genera and species, including the evolution of the flowering plants. As the seas retreated, the various island floras intermingled and promoted the diverse Australian floras together with world wide spreading. In South-eastern Australia, the only existing Cretaceous sediments are in the southern Victorian Gippsland and Otway Basins which formed in rift valleys as the Gondwanan Continent fragmented. Unfortunately I do not have any Cretaceous plant fossils so, as a surprise, I will present a living fossil from this Period, the Wollemi Pine (Wollemia nobillus). The oldest known Wollemi type fossils are 90 Ma old and it was thought to be extinct, until a stand of about 100 trees were discovered in 1994 in a remote wilderness area, yet only 140 Km from the Sydney CBD. Photo 1 is a cloned Wollemi Pine growing in open ground and Photo 2 is growing in a pot.

Photo 1

Photo 2

PERIOD PALAEO PLANTS

of SOUTH-EASTERN AUSTRALIA

22. The WOLLEMI PINE (Pt 2)

CRETACEOUS (145 — 66 Ma)

In 1994 two bushwalkers (one a National Parks Ranger) found and took samples of a stand of about 100 unusual trees in a remote wilderness area 140 Km from the Sydney, NSW, CBD. Once identified as a 'living fossil' thought to be extinct for over 66Ma, the location was kept secret and entry into the area strictly prohibited. This was to prevent both human disturbance and the introduction of adverse plant diseases. Also to satisfy human curiosity, the tree was cloned so that a Wollemi Pine could be purchased at any local plant nursery throughout the state and beyond for a modest price which included a levy to fund future protection and research.

The Wollemi Pine can shoot additional trunks from a common root system (coppicing). In Photo 1 a coppiced trunk can be seen on the right and adjacent to the primary trunk. During the winter the Wollemi extrudes a waxy capping over the growing tip of the tree and frond tips. This capping is reabsorbed in the warmer months. Photo 2 shows the growing tip during summer and Photo 3 the waxy capping during the winter. The leaves on the frond also reduce in size during onset and waning of winter and this produces a 'sausage-like' sequence on the frond ('botanical boudinage'). This can be seen in the Wollemi in Photo 4 and better in Photo 5 on the close relative, the Bunya Pine. The juvenile leaves on both trees are light green, mature leaves are mid-green on the Wollemi (Photo 4) and dark green on the Bunya (Photo 5). In transverse section the leaves of both trees form a '+' section on the frond, Photo 6 Wollemi and Photo 7 Bunya.

Photo 1

Photo 2

Photo 3

Photo 4

Photo 5

Photo 6

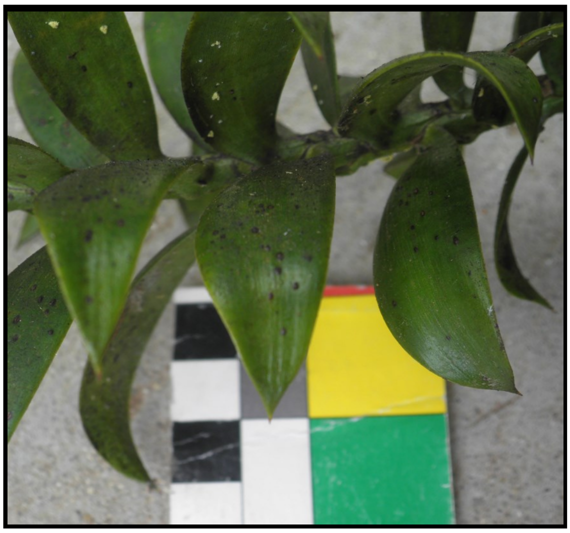


Photo 7

PERIOD PALAEO PLANTS

of SOUTH-EASTERN AUSTRALIA

23. The WOLLEMI PINE (Pt 3)

CRETACEOUS (145 — 66 Ma)

The Wollemi Pine is a member of the family Araucariaceae which has 3 genera. 1. Agathis with 1 species A. robustus (Kauri Pine). 2. Araucaria with 4 species A. cunninghamii (Hoop Pine), A. hetrophyllia (Norfolk Island Pine), A. bidwilli (Bunya Pine) and A. araucana (Monkey Puzzle Pine). 3. Wollemia with 1 species W. nobilus (Wollemi Pine). I do not have Kauri of Monkey Puzzle material. The following photos show in turn the tree, leaves and bark of each for the Hoop Pine, Norfolk Island Pine and the Bunya Pine. Notice particularly that the leaves and bark of each of the Araucaria species are very different from their genus siblings.

Hoop Pine

Norfolk Island Pine

Bunya Pine

PERIOD PALAEO PLANTS

of SOUTH-EASTERN AUSTRALIA

24. The WOLLEMI PINE (Pt 4)

CRETACEOUS (145 — 66 Ma)

While noting the differences particularly between the leaves and the bark of 3 of the genera of the Araucaria, namely the Hoop Pine, the Norfolk Island Pine and the Bunya Pine, this part will compare the Bunya and Wollemi Pines. The leaves of the Bunya Pine (Photo 1) are short, wide and have a very sharp spike at the leaf tip and are different to the elongate leaves of the Wollemia genus Wollemi Pine with the smooth ovoid leaf tip (Photo 2) and bark described as like 'bubbly chocolate'. However the bark and leaves of he Bunya Pine and the Wollemi Pine, although slightly different, are more similar to each other than those of the Araucaria genus. The Bunya Pine has the largest cone of any pine tree, being about 300 mm in length and weighing up to 10 Kg (falling cones are a hazard), Wollemi cones are about 120mm in length. Photo 3 is of the Certificate issued with each of the first batch of cloned pre-ordered Wollemi Pines issued to the public. Unfortunately I had to pot mine and it died during a heatwave about 5 years later. I subsequently bought a replacement which was the one shown in a pot previously, and it struggled in the 2019-2020 heat wave.

Photo 1

Photo 2

Photo 3

PERIOD PALAEO PLANTS

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25. The WOLLEMI PINE (Pt 5)

CRETACEOUS (145 — 66 Ma)

On 28 October 2019, the Gospers Mtn Fire, Australia's largest 'megafire' and the largest fire started by a single natural (dry lightening) ignition, started to the north-west of Sydney, NSW. The fire burnt in excess of 150,000 ha and took 79 days to control and a few more weeks to extinguish, with the help of some rain. The fire had the potential to threaten the Wollemi Pines, so a crew of specialist fire fighters and their equipment, together with National Parks Rangers, was helicoptered in to set up protective equipment and photo and assess the trees. The following photos of this top secret location were released to the media by the NSW Government. Photos 1 and 2 show the fire ravished plateau surface with the Wollemis surviving in the gorge. Note the depth of the gorge (the trees are about 30 m tall), the narrowness of the gorge and the density of the trees. As there are only about 100 trees in the wild, almost all of them are covered by this single photo of 'the World's Rarest Tree'. Photos 3 to 5 show NP Rangers who were helicoptered in to retrieve equipment and to assess and photo the trees after the fire. Note the 'bubbling chocolate' bark of the Wollemis.

Photo 1

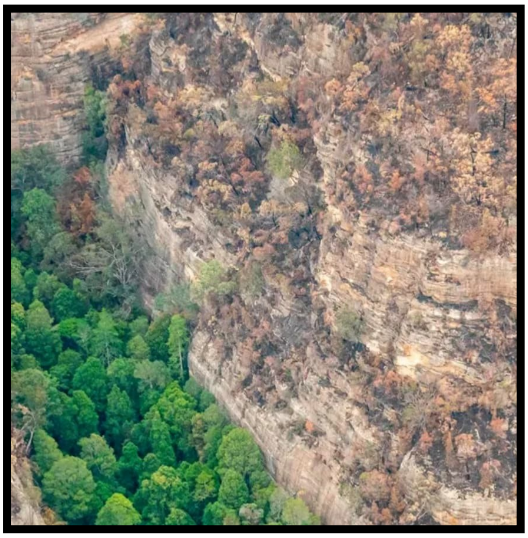


Photo 2

Photo 1

Photo 2

Photo 3

PERIOD PALAEO PLANTS

of SOUTH-EASTERN AUSTRALIA

26. The 'CINNAMOMUM FLORA'

PALAEOGENE (65 — 23 Ma)

During both the Paleogene and Neogene Periods, the Eastern Highlands of NSW were subject to the extrusion of extensive flood basalts, mostly now eroded and leaving scattered residuals. Lava flows dammed watercourses and formed many small lakes in which their sediments may contain fossils. In the early 1880's, a landowner discovered leaf fossils in a silcreted sandy conglomerate near the village of Dalton, NSW, 100 Km north Canberra. The specimens were eventually, in 1888, identified by Baron von Ettingshausen of the Uni. Of Graz, Austria. He estimated their age at about 34—55 Ma (Eocene) and that the leaves were similar to European ones.

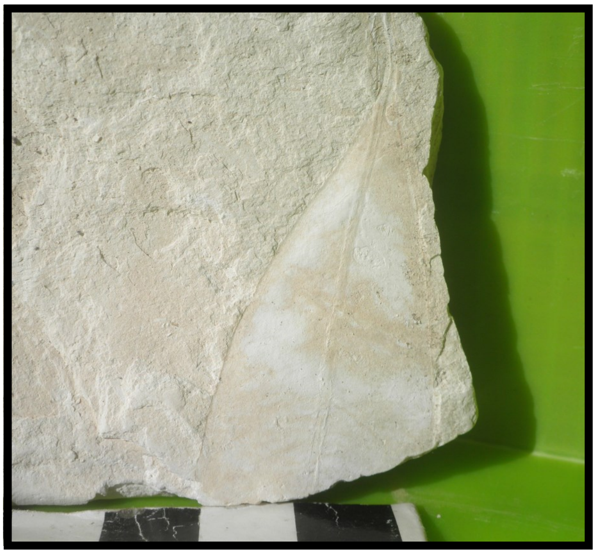
Over time most of the fossils were removed by collectors. In 1918 the last slab was taken into town and used as a doorstop at a local shop before the local council removed it to the local Park where it is still on display in a covered enclosure. All photos are of this slab. Ettingshausen's original specimens are housed in the Australian Museum, Sydney. Dean, in 1896 noted that the flora more closely resembled Australian rather than European plants and termed the deposit the 'CINNAMOMUM FLORA'. Recent research indicates that the upper limit of the forest is 21 Ma (earliest Miocene).

PERIOD PALAEO PLANTS

of SOUTH-EASTERN AUSTRALIA

27. PALAEOGENE (65 — 23 Ma)

In the previous section I noted the extensive extrusion of flood basalts and the creation of many small lava dammed lakes throughout eastern NSW, Australia, during both the Palaeogene and Neogene Periods. The waters of these lakes were frequently silica rich which promoted the growth of diatoms, a form of plankton found in both fresh and marine waters . Diatoms are microscopic single celled plants which require soluble silica to form their frustules (skeletons). After the plant dies the frustules sink to the bottom and may accumulate as a diatomite deposit. In NSW there are over 20 known deposits scattered over the eastern part of the state and most are overed by overburden. Diatomite has a wide range of industrial uses, particularly as filter material, fillers and in the manufacture of refractory bricks. Leaves fall into these lakes and are sometimes preserved as fossils. Photos 1 and 2 show leaves from the Comboyne, NSW, deposit which is composed solely of the diatom Melosira granulata. The two leaves shown are all which resulted from splitting a pile of diatomite for over an hour. They are neither common or photogenic.



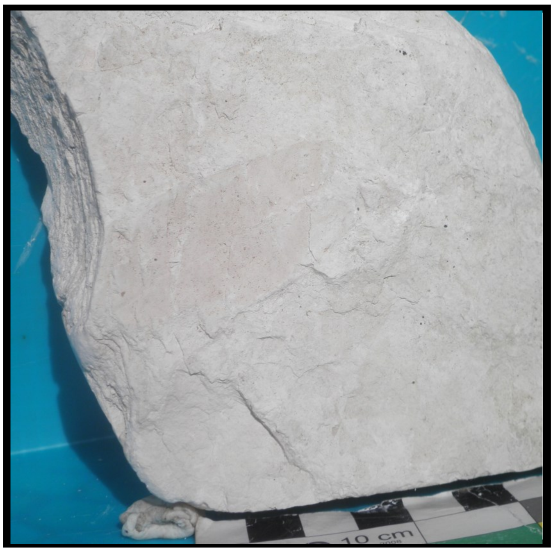


Photo 1 **Photo 2**

PERIOD PALAEO PLANTS

of SOUTH-EASTERN AUSTRALIA

28. QUATERARY (2.6 — 0 Ma)

NOT JUST BURIED BUT FOSSILISED

About 10 Km south of Wagga Wagga, NSW, Australia, is a large rounded granite hill, aptly named 'Plum Pudding Hill'.   As the granite weathers the feldspars decompose into clay (often kaolinite) which then washes out during rain and so releases the quartz grains and other component minerals. This material accumulates in an apron around the base of the hill to form a deposit composed mostly of very angular quartz grains, weathered feldspar fragments, and bleached biotite mica in a clayey matrix. This sandy sediment is called an arkose. Whilst walking in a deep erosion gully in the arkose, I noticed a piece of wood about a metre or so below the ground level. I dug it out and noticed that all of the organic material had been replaced by inorganic material (clay) through a metasomatic process. In this process organic material is replaced, minute particle by minute particle, by inorganic material so that the detailed structure of the original material is retained. (Photos 1 & 2) I believe that percolating groundwater is involved in this process. Although this piece of woody branch is of a recent age, it is nevertheless a fossil in that it retains the structure but no original organic material.

Photo 1

Photo 2

PERIOD PALAEO PLANTS

of SOUTH-EASTERN AUSTRALIA

29. FINALE

In the 1960's I was given this piece of fossilised wood by an Oldtimer Prospector from Queensland, Australia. The age is unknown but is probably Cretaceous. It has been preserved by the process of metasomatism by which the organic material is replaced, minute particle at a time, by an inorganic material. In this case the wood has been replaced by translucent opalite. Not only have the cell structures been preserved exactly but, by using a hand lens, the translucent opalite enables a view even into the hollow elongate water or nutrient transport cells. Photos 1 & 2 show the scale of the specimen. Photo 3 shows the longitudinal section at the top and the transverse section at the bottom. Photos 4 & 5 show the longitudinal cells while Photos 6 & 7 show the transverse section through the cells.

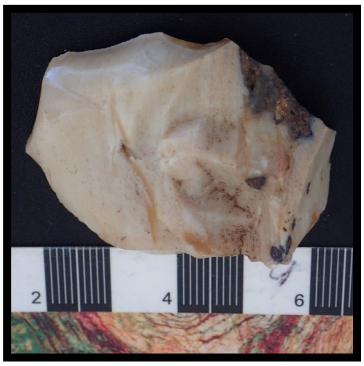


Photo 1

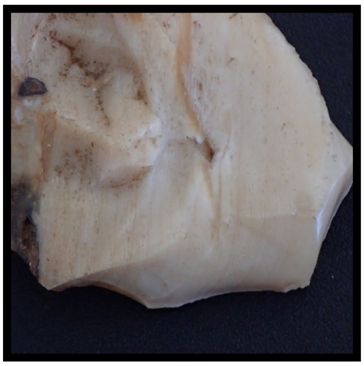


Photo 2

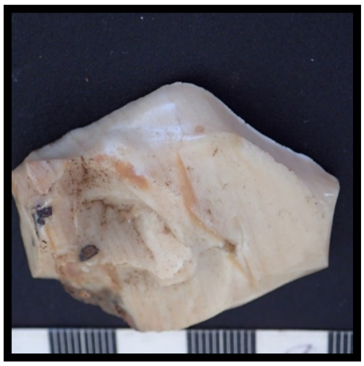


Photo 3

Photo 4

Photo 5

Photo 6

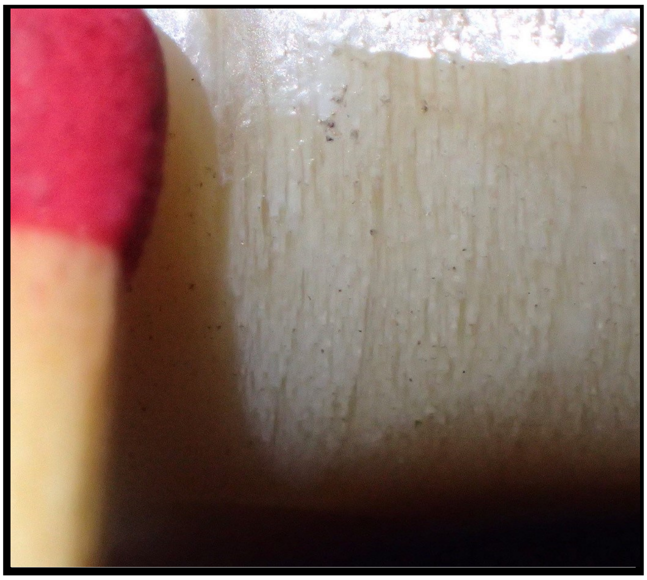


Photo 7

I hope that you have enjoyed this series tour of some of the plants of South-eastern Australia through each of the Geological Periods from Silurian to Quaternary and illustrated with my own specimens.

Winston Pratt