Contents lists available at ScienceDirect



Review of Palaeobotany and Palynology

journal homepage: www.elsevier.com/locate/revpalbo

A new species of *Protophyllocladoxylon* from the Upper Cretaceous (Cenomanian–Turonian) portion of the Winton Formation, central-western Queensland, Australia



Tamara L. Fletcher^{a,*}, David J. Cantrill^b, Patrick T. Moss^c, Steven W. Salisbury^a

^a School of Biological Sciences, The University of Queensland, Brisbane 4072, Australia

^b Royal Botanic Gardens Melbourne, National Herbarium of Victoria, Birdwood Avenue, Melbourne 3000, Australia

^c School of Geography, Planning and Environmental Management, The University of Queensland, Brisbane 4072, Australia

ARTICLE INFO

Article history: Received 7 February 2014 Received in revised form 28 April 2014 Accepted 4 May 2014 Available online 22 May 2014

Keywords: Cretaceous Fossil wood Winton Formation

ABSTRACT

Leaf floras in fluvial–lacustrine sediments of the Upper Cretaceous (Cenomanian–Turonian) portion of the Winton Formation suggest a community with co-dominance of angiosperms, conifers, ginkgo and other seed plants. To date wood floras associated with the Winton Formation have not been examined in detail. Winton Formation wood has been presumed to comprise araucarian, podocarp and taxodiaceous components, but this has been based largely on the identification of other plant macro and microfossils. Here we describe a new species of podocarp fossil wood from the genus *Protophyllocladoxylon* based on eleven specimens of silicified wood found as surface material at two broadly coeval sites in the Cenomanian–Turonian portion of the Winton Formation: QM L311 and Bladensburg National Park. The new species is characterised by the presence of araucaroid tracheid pitting and phyllocladoid oopores, the absence of oculipores, and the paired arrangement of the oopores within the crossfields. The recognition of *Protophyllocladoxylon* in the Winton Formation supports previous palynological frequency counts that suggest a dominance of podocarp conifers.

© 2014 Published by Elsevier B.V.

1. Introduction

Silicified wood is typically found on the surface at exposures in some parts of the Eromanga Basin of central-western Queensland, where terrestrial sediments of the late Albian–Turonian Winton Formation are exposed or partially overlain unconformably by Cenozoic alluvia. Because the rocks of the Winton Formation comprise the youngest Cretaceous strata of the Eromanga Basin (Gray et al., 2002; Tucker et al., 2013), and because the wood is more indurated compared with the surrounding sediment even where that sediment has been lithified (pers. obs.), this surface wood is considered to represent lag from upper portions of the Winton Formation that have previously eroded. Perhaps due to perceived uncertainty regarding its origin, and that it is not found in situ, this wood has received little attention in the published literature.

More broadly, the flora preserved in the Winton Formation provides an opportunity to understand Late Cretaceous floristic change from this part of the Southern Hemisphere (McLoughlin et al., 2010). Some of the earliest major works on the flora of the Winton Formation

* Corresponding author.

E-mail addresses: t.fletcher1@uq.edu.au (T.L. Fletcher), David.Cantrill@rbg.vic.gov.au (D.J. Cantrill), patrick.moss@uq.edu.au (P.T. Moss), s.salisbury@uq.edu.au (S.W. Salisbury).

focussed on the palynological record (Dettmann and Playford, 1969), which has been revisited and revised several times since (Peters, 1985; Dettmann and Clifford, 1992; Dettmann et al., 1992; Burger, 1993; Dettmann, 1995; Martin, 1998). Recognised taxa include lycopsids, bryophytes, pteridophytes, gymnosperms and angiosperms. Angiosperms comprise both monocotyledons and dicotyledons, while gymnosperms comprise gnetophytes, podocarps, araucarians and taxodioid conifers. Despite this diversity. Dettmann et al. (2009) determined that 87% of the material at one of the better-sampled localities (QM L311) pertained to Podocarpaceae based on pollen counts. The first macrofossil assemblage (also from QM L311) from the Winton Formation was described by Peters (1985), and included wood, reproductive structures and isolated foliage. These fossils were permineralised and dating has been problematic. They comprise araucarian, podocarp and taxodioid material, with very little representation of angiosperms. Notably, although pollen frequency at this site suggests a dominant podocarp component, of the 15 kinds of cones Peters (1985) described, only five were assigned to Podocarpaceae.

More recently authors have described macrofossil floral assemblages from other sites in the Winton Formation. McLoughlin et al. (1995, 2010) recorded ferns (*Cladophlebis, Sphenopteris, Microphyllopteris* sp. cf. gleichenioides, Phyllopteroides macclymontae), sphenopsids (*Equisetites*), bennettitaleans (*Otozamites, Ptilophyllum*), conifers (podocarps and araucarians based on cone and leaf impressions), angiosperms (nine morphotypes) and other seed plants (*Gingko, Taeniopteris*). Similarly Pole (1999, 2000) and Pole and Douglas (1999) recorded cuticular specimens of bennettitaleans, conifers (Cheirolepidiaceae, araucarians, podocarps), monocotyledonous and dicotyledonous angiosperms, along with other seed plants (*Ginkgo*, a possible cycad).

In addition to the above, Bose (1955) described equisetalean rhizomes and nodal diaphragms; White (1966, 1974) and Chambers et al. (1998) have described araucarian leaf impressions; Peters and Christophel (1978) fern pinna aff. *Lygodium*, and Cupressaceae leaf scales; Dettmann and Clifford (2000) discoid liverwort gemmae; Clifford and Dettmann (2005) *Tempskya judithae* Clifford et Detmann, a permineralised false trunk of a treefern; and more recently Dettmann et al. (2009) described permineralised flowers.

Although much research has been conducted on the flora of the Winton Formation, most of this work has concentrated on pollen, leaf impressions and silicified material from QM L311, few studies have documented the silicified wood flora. Fossil wood is significant as it provides an insight into the canopy-forming vegetation and may give a different perspective from that seen in the leaf floras (Cantrill and Poole, 2005). Incorporating information on fossil wood would thus facilitate a more robust reconstruction of the Winton Formation flora.

Only two unpublished studies have focused on the wood in any detail. Recently Dawson and Pole (unpublished) completed a preliminary study using two samples of fossil wood from the Winton Formation to determine climate. They identified one specimen as *Araucaria*-type wood and one specimen as a possible podocarp. From the figures provided, this second specimen appears similar to the material described herein. Peters (1985) described four *Araucarioxylon* – "parataxon" 1–4 – and one Coniferae-incertae sedis – "parataxon" 1 – from QM L311. We consider these assignments in need of review as the described characters of some of the *Araucarioxylon* – "parataxa" suggest podocarpalean affinities.

We describe the wood from the Queensland Museum and University of Queensland collections from the upper portion of the Winton Formation. The samples that have sufficient preservation to be identified are from a genus considered to be podocarp, but could not be assigned to currently described species. Thus, we describe a new species of *Protophyllocladoxylon* here.

1.1. Geological setting

The Eromanga Basin is a major component of the larger Great Artesian Basin. The Great Artesian Basin covers 1.7 million km² or approximately 1/5th of Australia's landmass (Zhang et al., 2007). During the Early Cretaceous the Great Artesian Basin was inundated by an epeiric seaway (Draper, 2002), which may have extended across central Australia, linking the Great Artesian Basin and the Carnarvon Basin (Frakes et al., 1987). The timing of the cycles of inundation and regression is difficult to relate to global events, and may be related to regional tectonic events (Gallagher and Lambeck, 1989).

The Winton Formation represents a richly fossiliferous sediment infilling of the Eromanga Basin. The formation consists of complex and repetitive fluvial–lacustrine sediments, including fine- to mediumgrained feldspatholithic or lithofeldspathic arenites, siltstones, mudstones and claystones (Fielding, 1992; Romilio and Salisbury, 2011; Romilio et al., 2013; Tucker et al., 2013) with very minor coal seams (Senior et al., 1978). These sediments have been interpreted as accumulating in a freshwater, broad fluvial-lacustrine environment, deposited on an extensive coastal plain as the epicontinental Eromanga Sea withdrew (Exon and Senior, 1976; Tucker et al., 2013). At the time the upper portion of the Winton Formation was deposited, centralwestern Queensland would have been at approximately 50°S (Li and Powell, 2001).

The Winton Formation crops out over an area from north-western New South Wales, to north-eastern South Australia and throughout central-western Queensland (Fig. 1; Gray et al., 2002). It consists of Albian to Turonian strata (Tucker et al., 2013), representing the youngest part of the preserved basin fill. Exposures of this formation are scattered due to deep weathering and overlying alluvium. Until recently correlation between these scattered fossil-bearing surface exposures had been difficult. A recent study using U-Pb isotope dating of detrital zircons by laser ablation by Tucker et al. (2013) has been able to constrain the ages of many of the fossiliferous sediments of the upper-most exposed portions of the Winton Formation close to the Cenomanian-Turonian boundary. This includes QM L311 and Bladensburg National Park, from which the holotype and paratypes of this study were collected. Trenches excavated at fossiliferous sites suggest that the facies below the surface are similar to those at Lark Quarry and Bladensburg (Tucker et al., 2013).

2. Materials and methods

The material prepared for this study was preserved as silicified surface material ranging from approximately half a metre in diameter to small, isolated pieces. All material collected from the field by the authors or available from the Queensland Museum was sectioned. It is important to note that approximately half of all wood samples prepared for this study could not be identified as they have poor cellular-scale preservation.

Preparation of the specimens was by conventional rock thin section, ground to varying thicknesses to account for the unique preservational characteristics of each specimen, averaging ~70 μ m. The sections were oriented in transverse, radial longitudinal and tangential longitudinal planes. These sections were examined under a Nikon eclipse 50ipol and images captured using a Nikon DS-Fi1. Descriptions are primarily from the holotype, but where proportions were given, these have been sampled from both holotype and paratype specimens.

3. Systematic palaeontology

Family Podocarpaceae

Protophyllocladoxylon Kräusel

Type species Protophyllocladoxylon leuschii Kräusel

Protophyllocladoxylon owensii sp. nov. Fletcher, Cantrill, Moss and Salisbury (Plate I, 1–10)

Holotype: QM F44339, one section in each of transverse, tangential longitudinal, and radial longitudinal planes (Plate I, 1–10).

Paratypes: QM F44330, QM F44331, QM F44332, QM F44333, QM F44334, QM F44335, QM F44336, QM F44337, QM F44338, and QM F1359.

Repository: Geoscience Collection, Queensland Museum, Queensland, Australia.

Type locality: QM L311, between Lovelle Downs Station and Elderslie Station, 38 km WNW of Winton and 8 km east of the Diamantina River (see Fig. 1), central western Queensland, Australia.

Plate I. Photographs of the key features of the holotype, QM F44339, 1 – ray cells and tracheids, tangential section; 2 – taphonomic features, likely partial degradation of cell walls, radial longitudinal section; 3 – pairs of phylocladoid oopores in earlywood crossfields, radial logitudinal section; 4 – pairs of oopores, some circulopores, in earlywood crossfields, radial longitudinal section; 5 – uniseriate and biseriate tracheid pits, alternate where biseriate, radial longitudinal section; 6 – ray cells, tangential section; 7 – a series of alternately arranged, biseriate, sub-hexagonal, araucaroid-type tracheid pits, radial longitudinal section; 8 – overview of a portion of radial longitudinal section showing earlywood to latewood transition and latewood to earlywood to latewood to earlywood boundaries; 10 – overview of trans-





Fig. 1. A map of Australia showing the area where the Winton Formation crops out (in grey), which broadly corresponds to the Eromanga Basin. Also marked are the localities from which the holotype (QM L311) and paratype specimens (QM L311 and Bladensburg National Park) originate.

Other: Bladensburg National Park, central western Queensland, Australia.

Stratigraphic horizon: Late Cretaceous (Cenomanian–Turonian) portion of the Winton Formation of the Rolling Downs Group, central-western Queensland, Australia (see Fig. 1).

Etymology: The specific epithet is named after the current Mayor of Longreach Regional Council, and former Mayor of Isisford Shire Council Cr., R.L. (Joe) Owens, who has been a significant supporter of our team's research in the region since 2001.

Diagnosis: Growth ring boundaries are distinct. Tracheid radial pitting is predominantly alternate and contiguous (araucarian), uniseriate in latewood, biseriate, rarely triseriate, in earlywood. Crossfield pits are typically phyllocladoid oopores or more rarely circopores; two per crossfield in earlywood, one in latewood. Rays are uniseriate, variable in height, and the walls are smooth. Axial parenchyma and resin canals are absent.

Description: In RLS, the tracheid pitting is predominantly alternate and contiguous. In the earlywood it is biseriate, rarely triseriate (Fig. 2C), in the latewood, uniseriate (Fig. 2D). Some tracheid cells walls appear to be partially degraded (Plate I.2). The bordered tracheid pits are approximately 21 µm (horizontal) by 16 µm (vertical) and vary from elliptic to sub-hexagonal. Tangential tracheid walls are blank. Rays are abundant throughout. The crossfield pits are typically phyllocladoid oopores (Fig. 2A) or more rarely circopores (Fig. 2B), with grading between the two, but oculipores are absent. The phyllocladoid oopores are approximately 17 µm (longest axis, oblique) by 11 µm (shortest axis), while the circopores are 15 μ m (longest axis, oblique) by 14 μ m (shortest axis). The crossfields in this species have a high frequency of two oopores per crossfield pit in earlywood (0.93 as a proportion, as determined from this specimen and paratypes), and a high frequency of single pores in latewood (0.98 as a proportion, as determined from this specimen and paratypes). In TLS rays are uniseriate, and variable in height (2–18, in the holotype: Fig. 2E). The ray cells are 17 µm (vertical) by 14 µm (horizontal). Ray walls are smooth (though see Pujana et al., 2014, notes on SEM and tangential pitting). Axial parenchyma are absent. No resin canals were observed. In TS and RLS the growth ring boundaries are distinct (Fig. 2F). The tracheids are subrectangular to irregular polygonal and approximately 65 µm (length) by 33 μ m (width) in the earlywood, 30 μ m (length) by 38 μ m (width) in the latewood. Tracheids are sometimes resin filled. In TS this seems to vary between specimens, with some having large sections of both early and latewood filled, some with only small irregular patches of resin filling, and others with an apparent bias to latewood cells being filled more than earlywood cells. In RLS, it appears to be biassed to resin filling of only latewood. However, where earlywood is also infilled with resin, the characteristics for identifying the wood are difficult if not impossible to see with transmitted light.

3.1. Comparison

According to Philippe and Bamford (2008), the araucaroid tracheid pitting, the presence of phyllocladoid oopores and lack of oculipores are features that distinguish *Protophyllocladoxylon* from other taxa of fossil wood. Based on these characteristics we have determined that the material can be assigned to *Protophyllocladoxylon*.

Of the 29 species of *Protophyllocladoxylon* thus far described (Zhang et al., 2010; Pujana et al., 2014) only four have the following characteristics in common with the specimens described here: marked growth rings, uniseriate rays with heights including approximately 2–18 cells, uniseriate and biseriate (rarely triseriate) tracheid pitting, alternate where biseriate or triseriate, oval and/or sub-hexagonal, and 1–2 simple circular to ovoid pits per crossfield and lack axial parenchyma. These species are *Protophyllocladoxylon francisiae* Punjana, Santillana et Marenssi (Pujana et al., 2014), *Protophyllocladoxylon indicum* Pant et Singh (Pant and Singh, 1987), *Protophyllocladoxylon dolianitii* Mussa (Mussa, 1958) and *Protophyllocladoxylon lechangense* Wang (Wang, 1993).

However, the following characters differentiate *P. owensii* from the previously described taxa. *Protophyllocladoxylon francisiae* (Pujana et al., 2014) is dissimilar from the specimens here in that the crossfield pits are elongated and contiguous where two are present, unlike those of *P. owensii*, and come from the Eocene of Antarctica. *Protophyllocladoxylon indicum* (Pant and Singh, 1987) has irregular size and position of the crossfield pits within the crossfield, with pairs often conjoined, and some stacked vertically, whereas those of *P. owensii* are not conjoined, are not stacked vertically and are of a similar size throughout. *Protophyllocladoxylon indicum* comes from the Permian of India. *Protohyllocladoxylon dolianitii* (Mussa, 1958) differs in that is usually has only one elliptic oopore in the centre



Fig. 2. Schematics of the key features of the holotype, QM F44339, and paratypes; A – phyllocladoid oopores in radial crossfields; B – circopores in radial crossfields; C – earlywood tracheid pitting in radial section; D – latewood tracheid pitting in radial section; E – rays in tangential longitudinal section; F – a growth ring boundary in transverse section.

of the crossfield, not two in each crossfield in the earlywood and one in each crossfield in the latewood as is the case in *P. owensii*. *Protophyllocladoxylon dolianitii* is from the Late Carboniferous of Brazil. *Protophyllocladoxylon lechangense* Wang (Wang, 1993) appears to be different from the specimen described based on the description of Zhang et al. (2010), which states that the crossfield pits are both elliptic, like those described in *P. owensii*, but also rectangular with rounded corners (fenestral), which is not reported for the new morphospecies; however, the fenestral appearance may be a taphonomic feature. The images are of poorly preserved material, but they show that the crossfield pits were also horizontally aligned, and possibly continuous, compared to the oblique and spaced crossfield pits of *P. owensii*. *Protophyllocladoxylon lechangense* is from the Triassic of China.

The most similar taxon to *P. owensii* described by Peters (1985) is *Araucarioxylon* — "Parataxon 1". Despite some similarities, there are differences such as the prevalence of uniseriate tracheid pitting in Peters' (1985) specimens, with only occasional biseriation and the description of the crossfield pits as cupressoid rather than phyllocladoid, which is found in the new species. While these features may be correlated with age, we consider the specimens different enough that they should not be assigned to the new species.

4. Discussion

Protophyllocladoxylon contains 29 described species, in addition to the new species P. owensii, with a cosmopolitan distribution and temporal range that extends from the Carboniferous to the Eocene (Zhang et al., 2010; Pujana et al., 2014). Protophyllocladoxylon is generally considered to be allied to Podocarpacae, but some features, such as araucarian tracheid pitting, suggest affinities with Araucariaceae. The taxon also displays a high amount of morphological diversity (Pujana et al., 2014). Some species, including the type species, have only araucarian type tracheid pitting, while others have the mixed type (e.g. Protophyllocladoxylon cortaderitaense; Menéndez, 1956; Wang, 1993; Philippe and Bamford, 2008; Zhang et al., 2010), are predominantly multiseriate (e.g. Protophyllocladoxylon subdiphterium; Duperon-Laudoueneix, 1976), or predominantly or exclusively uniseriate (e.g. Protophyllocladoxylon oolithicum; Vogellehner, 1966). Pujana et al. (2014) state that pitting arrangement is a key feature for classifying at ranks such as family and genus, and thus this diversity of character states may be problematic in a taxonomic context. Alternatively, the differences may be correlated to developmental stage or age of the tree, or due to environmental impacts on growth. For example, the narrow tracheids in P. owensii produce single-file rows of tracheids, whereas the wider tracheids produce alternately arranged araucarian type pitting, and in rare, very wide tracheids, even three across. Wider tracheids are commonly found in juvenile wood and in wood growing in optimal conditions (Falcon-Lang, 2005), and thus identifications made on single pieces of fossil wood may not represent the true diversity of characters in the species in other age classes or growing conditions.

Wood assemblages give a unique insight into past communities and offer insight into canopy structure, in a way that coeval palynological or leaf assemblages do not (Cantrill and Poole, 2005). Integrating information from pollen, leaf and wood assemblages can be used to disentangle community structure, with the wood representing the canopy-forming element. The wood from the region directly around the town of Winton, at QM L311 and in Bladensburg National Park appears to be dominated by podocarps (as represented by material assigned to P. owensii). Wood assignable to araucarian taxa is rare but present, as are the false trunks of tree ferns (Clifford and Dettmann, 2005), but taxodiaceous conifers, angiosperms and gingko wood are thus far absent. The dominance of podocarp wood is supported by limited pollen count data that also documents abundant podocarp pollen, but leaf and permineralised assemblages indicate that other canopy forming trees such as Taxodiaceae were also likely to have been present. A re-evaluation of Peters' (1985) material, and further survey of the wood found throughout the Winton Formation is needed to determine community structure over its extensive geographic and temporal distribution.

Extant podocarps have a wide diversity of morphologies, but primarily inhabit rainforest or wet montane environments (Hill and Brodribb, 1999). *Protophyllocladoxylon* appears to have predominantly inhabited warm and wet areas throughout its long record (Zhang et al., 2010). This is in agreement with previous estimates of palaeoclimate for this portion of the Winton Formation that suggest mean annual temperatures of above 16 °C and mean annual precipitation between 1300 and 1600 mm (Fletcher et al., 2013, in press).

Araucarian trees are also present (Peters, 1985), mostly likely as infrequent canopy emergents, a role they play in many modern southern forest ecosystems (Hill and Brodribb, 1999). Interestingly, a mismatch between the composition and abundance of araucarian wood and leaf floras has been observed previously (Cantrill and Falcon-Lang, 2001), and the same pattern is apparent in the Winton Formation. Whether this is due to taphonomic biases that preferentially preserve araucarian foliage over that from podocarps, or alternatively that araucarian wood is more readily degraded than podocarp wood and so biassing the assemblages remains to be determined. However, as noted above, approximately half of all wood samples prepared for this study were unable to be identified due to poor cellular-scale preservation. The potential for taphonomic bias to affect estimates of community structure should therefore not be dismissed.

4.1. Conclusion

The Winton Formation wood flora appears to be dominated by Podocarpaceae, including a new species described as P. owensii. The composition of the leaf, cone and pollen flora on the other hand indicates the presence of araucarians, taxodiaceous conifers, ginkgos, cycads, ferns and angiosperms. This contrasts with the wood assemblage that is rich in one taxon, likely placed in Podocarpaceae. Thus, although previous studies found that the Winton Formation plant assemblages were broadly coeval and differ only slightly in taxonomic composition (McLoughlin et al., 1995), these results suggest that there may be spatial heterogeneity across the landscape. Falcon-Lang et al. (2001) found that low density podocarp and taxodioid conifers dominated the mobile alluvial plains of Alexander Island, Antarctica, which were subjected to regular catastrophic flooding, while the more stable and protected sediments boasted a more diverse flora in a podocarp-araucarian rainforest. It may be that the discrepancy between the wood flora composition and other macro- and microfloral evidence from the Winton Formation is representative of a bias towards the preservation of podocarp wood during flooding events because these trees were more dominant in flood prone areas. This possibility highlights the importance of interpreting individual aspects of the ecology of an environment, such as the taxonomic diversity of the wood, in the broader context of the palaeoenvironment. In this case it requires the interpretation of the wood taxa in the context of other plant macrofossils, spores and pollen, and sedimentological evidence to accurately reconstruct palaeo-landscapes.

Acknowledgements

We would like to thank the Longreach Regional Council for their ongoing support of our research in central-western Queensland, and particularly for their funding contribution that allowed us to have this material prepared. We would also like to thank Feliz Farrajota for her efforts in preparing our often difficult material.

Additional funding for this research (to SWS) was provided by the Australian Research Council (LP0347332 and LP0776851) and The University of Queensland, in association with Isisford Shire Council, Longreach Regional Council, Winton Shire Council, Land Rover Australia, the Queensland Museum and Carnegie Museum of Natural History.

References

- Bose, N.M., 1955. Some Tertiary plant remains from Queensland, Australia. Bot. Notiser 108, 381–390.
- Burger, D., 1993. Early and Middle Cretaceous angiosperm pollen grains from Australia. Rev. Palaeobot. Palynol. 78, 183–234.
- Cantrill, D.J., Falcon-Lang, H.J., 2001. Cretaceous (late Albian) Coniferales of Alexander Island, Antarctica. 2. Leaves, reproductive structures and roots. Rev. Palaeobot. Palynol. 115, 119–145.
- Cantrill, D.J., Poole, I., 2005. Cretaceous patterns of floristic change in the Antarctic Peninsula. In: Crame, J.A., Owen, A.W. (Eds.), Palaeobiogeography and Biodiversity Change: the Ordovician and Mesozoic–Cenozoic Radiations. Geological Society of London Special Publication, 194, pp. 141–152.
- Chambers, T.C., Drinnan, A.N., McLoughlin, S., 1998. Some morphological features of Wollemi Pine (*Wollemia nobilis*: Araucariaceae) and their comparison to Cretaceous plant fossils. Int. J. Plant Sci. 159, 160–171.
- Clifford, H.T., Dettmann, M.E., 2005. First record from Australia of the Cretaceous fern genus *Tempskya* and the description of a new species, *T. judithae*. Rev. Palaeobot. Palynol. 134, 71–84.
- Dettmann, M.E., 1995. Ultrastructure and biogeography of *Balmeisporites* Cookson and Dettmann, 1958. Rev. Palaeobot. Palynol. 89, 287–296.
- Dettmann, M.E., Clifford, H.T., 1992. Phylogeny and biogeography of *Ruffordia*, *Mohria* and *Anemia* (Schizaeaceae) and *Ceratopteris* (Pteridaceae): evidence from in situ and dispersed spores. Alcheringa 16, 269–314.

- Dettmann, M.E., Clifford, H.T., 2000. Gemmae of the Marchantiales from the Winton Formation (mid-Cretaceous), Eromanga Basin, Queensland. Mem. Queensland Mus. 45, 285–292.
- Dettmann, M., Playford, G., 1969. Palynology of the Australian Cretaceous. In: Campbell, K.S.W. (Ed.), Stratigraphy and Palaeontology. Essays in Honour of Dorothy Hill. Australian National University Press, Canberra, pp. 174–210.
- Dettmann, M.E., Molnar, R.E., Douglas, J.G., Burger, D., Fielding, C., Clifford, H.T., Francis, J., Jell, P., Rich, T., Wade, M., Rich, P.V., Pledge, N., Kemp, A., Rozefelds, A., 1992. Australian Cretaceous terrestrial faunas and floras: biostratigraphic and biogeographic implications. Cretac. Res. 13, 207–262.
- Dettmann, M.E., Clifford, H.T., Peters, M., 2009. Lovellea wintonensis gen. et sp. nov. Early Cretaceous (late Albian), anatomically preserved, angiospermous flowers and fruits from the Winton Formation, western Queensland, Australia. Cretac. Res. 30, 339–355.
- Draper, J.J.E., 2002. Geology of the Cooper and Eromanga Basins. Queensland Department of Natural Resources and Mines, Queensland,.
- Duperon-Laudoueneix, M., 1976. Étude d'un bois homoxylé Mésozoique du Cameroun. CR 101 Congrès National des Sociétés Savantes, Section Sciences, 1, pp. 147–163.
- Exon, N.F., Senior, B.R., 1976. The Cretaceous geology of the Eromanga and Surat Basins. BMR J. 1, 33–50.
- Falcon-Lang, H.J., 2005. Intra-tree variability in wood anatomy and its implications for fossil wood systematics and palaeoclimatic studies. Palaeontology 48, 171–183.
- Falcon-Lang, H.J., Cantrill, D.J., Nichols, G.J., 2001. Biodiversity and terrestrial ecology of a mid-Cretaceous, high-latitude floodplain, Alexander Island, Antarctica. J. Geol. Soc. 158, 709–724.
- Fielding, C.R., 1992. A review of Cretaceous coal-bearing sequences in Australia. Geol. Soc. Am. Spec. Pap. 267, 303–324.
- Fletcher, T.L, Greenwood, D.R., Moss, P.T., Salisbury, S.W., 2014. Palaeoclimate of the Late Cretaceous (Cenomanian–Turonian) portion of the Winton Formation, centralwestern Queensland, Australia: new observations based on CLAMP and bioclimatic analysis. PALAIOS (in press).
- Fletcher, T.L., Moss, P.T., Salisbury, S.W., 2013. Foliar physiognomic climate estimates for the Late Cretaceous (Cenomanian–Turonian) Lark Quarry fossil flora, central-western Queensland. Australia. Aust. J. Bot. 61, 575–582.
- Frakes, L.A., Burger, D., Apthorpe, M., Wiseman, J., Dettmann, M., Alley, N., Flint, R., Gravestock, D., Ludbrook, N., Backhouse, J., Skwarko, S., Scheibnerova, V., McMinn, A., Moore, P.S., Bolton, B.R., Douglas, J.G., Christ, R., Wade, M., Molnar, R.E., McGowran, B., Balme, B.E., Day, R.A., 1987. Australian Cretaceous shorelines, stage by stage. Palaeogeogr. Palaeoclimatol. Palaeoecol. 59, 31–48.
- Gallagher, K., Lambeck, K., 1989. Subsidence, sedimentation and sea level changes in the Eromanga Basin, Australia. Basin Res. 2, 115–131.
- Gray, A.R.G., McKillop, M., McKellar, J.L., 2002. Eromanga Basin stratigraphy. In: Draper, J.J. (Ed.), Geology of the Cooper and Eromanga Basins, Queensland, vol. 1. Department of Natural Resources and Mines, Brisbane, p. 94.
- Hill, R.S., Brodribb, T.J., 1999. Turner review no. 2. Southern conifers in time and space. Aust. J. Bot. 47, 639–696.
- Li, Z.X., Powell, C.M., 2001. An outline of the palaeogeographic evolution of the Australasian region since the beginning of the Neoproterozoic. Earth Sci. Rev. 53, 237–277.
- Martin, H.A., 1998. Late Cretaceous–Cainozoic palynology of the Poonarunna No. 1 well, central Australia. Trans. R. Soc. S. Aust. 122, 89–138.
- McLoughlin, S., Drinnan, A.N., Rozefelds, A.C., 1995. A Cenomanian flora from the Winton Formation, Eromanga Basin, Queensland, Australia. Mem. Queensland Mus. 38, 273–313.
- McLoughlin, S., Pott, C., Elliott, D., 2010. The Winton Formation flora (Albian, Cenomanian, Eromanga Basin): implications for vascular plant diversification and decline in the Australian Cretaceous. Alcheringa 34, 303–323.
- Menéndez, C., 1956. Protophyllocladoxylon cortaderitaensis sp. nov. tronco fósil del Triásico de Barreal (Provincia de San Juan). Rev. Asoc. Geol. Argent. 11, 273–280.
- Mussa, D., 1958. Conífera fóssil do Carbonífero Superior de Sanata Catarina. Div. Geol. Min. (Rio De Janeiro) Bol. 182, 1–23.
- Pant, D.D., Singh, V.K., 1987. Xylotomy of some woods from Raniganj Formation (Permian), Raniganj Coalfield, India. Palaeontogr. Abt. B 203, 1–82.
- Peters, M.D., 1985. A taxonomic analysis of a Middle Cretaceous megafossil plant assemblage from Queensland, Australia. (PhD thesis) University of Adelaide.
- Peters, M.D., Christophel, D.C., 1978. Austrosequoia wintonensis, a new taxodiaceous cone from Queensland, Australia. Can. J. Bot. 56, 3119–3128.
- Philippe, M., Bamford, M.K., 2008. A key to morphogenera used for Mesozoic conifer-like woods. Rev. Palaeobot. Palynol. 148, 184–207.
- Pole, M., 1999. Latest Albian–earliest Cenomanian monocotyledonous leaves from Australia. Bot. J. Linn. Soc. 129, 177–186.
- Pole, M.S., 2000. Mid-Cretaceous conifers from the Eromanga Basin, Australia. Aust. Syst. Bot. 13, 153–197.
- Pole, M.S., Douglas, J.G., 1999. Bennettitales, Cycadales and Ginkgoales from the mid Cretaceous of the Eromanga Basin, Queensland, Australia. Cretac. Res. 20, 523–538.
- Pujana, R.R., Santillana, S.N., Marenssi, S.A., 2014. Conifer fossil woods from the La Meseta Formation (Eocene of Western Antarctica): evidence of Podocarpaceae-dominated forests. Rev. Palaeobot. Palynol. 200, 122–137.
- Romilio, A., Salisbury, S.W., 2011. A reassessment of large theropod dinosaur tracks from the mid-Cretaceous (late Albian–Cenomanian) Winton Formation of Lark Quarry, central-western Queensland, Australia: a case for mistaken identity. Cretac. Res. 32, 135–142.
- Romilio, A., Tucker, R.T., Salisbury, S.W., 2013. Re-evaluation of the Lark Quarry dinosaur tracksite (late Albian–Cenomanian Winton Formation, central-western Queensland, Australia): no longer a stampede? J. Vert. Paleontol. 33, 102–120.
- Senior, B.R., Mond, A., Harrison, P.L., 1978. Geology of the Eromanga Basin. Bull. Bur. Mineral Resour. Geol. Geophys. 167, 1–102.

- Tucker, R.T., Roberts, E.M., Hu, Y., Kemp, A.I.S., Salisbury, S.W., 2013. Detrital zircon age constraints for the Winton Formation, Queensland: contextualizing Australia's Late Cretaceous dinosaur faunas. Gondwana Res. 24, 767–779.
- Vogellehner, D., 1966. Zwei neue Vertreter der fossilen Sekundärholzgattung Protophyllocladoxylon Kräusel aus dem deutschen Mesozoikum. Geol. Jahrb. 84, 307-326.
- Wang, S.J., 1993. Late Triassic Plants from Northern Guangdong Province, China. Universitatis Sunyatseni Press, Guangzhou.
 White, M.E., 1966. Report on 1965 plant fossil collections. Bureau of Mineral Resources, Geology and Geophysics, Australia, Record 1966/111, pp. 1–10.
- White, M.E., 1974. Plant fossils from the Gilberts River and Winton formations, and the
- White, M.E., 1974. Plant fossils from the Gilberts River and Winton formations, and the Pascoe River area, Queensland. Bureau of Mineral Resources, Geology and Geophysics, Australia, Record 1974/159, pp. 1–5.
 Zhang, M., Frape, S.K., Love, A.J., Herczeg, A.L., Lehmann, B.E., Beyerle, U., Purtschert, R., 2007. Chlorine stable isotope studies of old groundwater, southwestern Great Artesian Basin, Australia. Appl. Geochem. 22, 557–574.
 Zhang, Y., Wang, J., Liu, L., Li, N., 2010. Protophyllocladoxylon jingyuanense sp. nov., a gymnospermous wood of the Serpukhovian (Late Mississippian) from Gansu, Northwest China. Acta Geol. Sin. Engl. Ed. 84, 257–268.