

## Chapter 1

### Paper:

Cúneo, N. Rubén, Edith L. Taylor, Thomas N. Taylor, and Michael Krings. "In situ fossil forest from the upper Fremouw Formation (Triassic) of Antarctica: palaeoenvironmental setting and palaeoclimate analysis." *Palaeogeography, Palaeoclimatology, Palaeoecology* 197, no. 3 (2003): 239-261.

### Questions:

- 1. The Transantarctic Mountains of Antarctica have yielded many important fossil plant discoveries and have yielded fossil plants displaying different types of fossilization. Name three different types of fossilization that have been recognized in the Transantarctic Mountains and briefly outline the biological information that can be gleaned from each.**  
ANSWER: The different types of fossilization include compression fossils with cuticle, permineralized fossils where whole peat seams have been preserved and *in situ* fossil forests. Compression fossils with cuticle yield morphological, anatomical and chemical information. Permineralization preserves cellular structures and so can yield anatomical information whilst *in situ* forest deposits can provide detailed information on the ecology of the living forest such as tree spacing distance, tree heights, age structure, health and estimated biomass etc.
- 2. The paper aims to reconstruct a Middle Triassic aged fossil forest from the Transantarctic Mountains. What type of data have the authors collected to achieve this aim?** ANSWER: The authors have collected tree ring data from fossilized wood in order to investigate growth patterns, fossil structure data such as spacing between trunks along a transect, and trunk diameters in order to estimate original tree height and details of the sedimentology. The sedimentological study was undertaken in order to understand the environments of deposition into which fossil plants were preserved.
- 3. Cellulose acetate peels were performed on sections of fossilized trunks. Explain briefly how this method is carried out and what type of biological information it can yield from fossils.** ANSWER: The cellulose acetate peel technique can be applied to permineralized fossils where the original organic content of the cell wall is preserved but all intracellular content is replaced by minerals. The technique firstly involves polishing the cut surface of the permineralized fossil, then the surface is etched with an acid (in the case of this paper with hydrofluoric acid), which breaks down the silicate filled matrix within each original plant cell to leave a slightly raised cell wall outline behind. The etched surface is then flooded with a solvent such as acetone and an acetate sheet is placed on top of the surface. The acetone reacts with the acetate sheet causing it to stick firmly to the etched surface off the fossil. The acetate sheet is then peeled away from the fossil, taking with it one cell layer thick of cell wall outlines of the fossilized plant material. The 'peels' can then be studied under the microscope to observe exquisitely detailed plant cells and tissues.

4. **What methodology did the authors follow to obtain ecological information about the forest floor vegetation?** ANSWER: The quadrat method of Scott (1978) was used to estimate the relative cover of different species on the fossilized bedding plane of the fossil forest. Because the fossil forest is preserved *in situ* it can be assumed that the percentage cover data obtained from analysing the bedding plane where the fossil leaves and other structures are preserved provide a good approximation of the relative abundances of leaf litter that would have been present in the living forest. The method involves placing a 50cm by 50cm quadrat onto a cleared fossil bedding plane and recording the identity and number of individuals belonging to each species within the quadrat. This is replicated five times to get a representative sampling of forest floor leaf litter.
5. **What is the depositional setting of the fossil forest? What information does this provide about the landscape setting of the living forest?** ANSWER: The depositional setting of the fossil forest is a series of river (fluvial) channels deposited by a braided stream system with low-sinuosity (i.e. relatively straight and not frequently bending). The fossil tree stumps were preserved in river bank (levee) and flood plain (crevasse splay) deposits, whilst other fossils such as *Neocalamites*, which is a relative of living *Equisetum*, were found in the peat swamp deposits. Collectively the authors suggest in Figure 6 that the broader landscape was one of a braided river system on an alluvial plain with frequent flooding events and levee collapses. The forest proper occupied the drier levees, whilst more poorly drained back swamp areas were occupied by *Neocalamites*.
6. **What age is the fossil forest being studied in this paper and what type of dating method is this age assignment based on?** ANSWER: It is estimated that the fossil forest is early Middle Triassic in age based on correlation with a nearby permineralized peat deposit from Fremouw Peak, which is dated based on the occurrence of pollen and spores to Middle Triassic (Anisian) age.
7. **How were the tree stumps of the Gordon Valley fossil forest preserved?** ANSWER: The base of the living tree trunks were most likely buried rapidly with sediment during a levee burst and/or flooding event. Sometime after burial, the tree trunk bases were rapidly inundated by silica rich waters and the trunks were permineralized with silica. The high silica content probably originated from weathering of silica rich basalts nearby. The tree would have died rapidly after this leaving behind just the *in situ* permineralized tree trunk base.
8. **Do the fossilized tree stumps and fossilized leaf litter associated with the Gordon Valley fossil forest represent autochthonous or parautochthonous preservation?** ANSWER: Autochthonous as they are all more or less *in situ*.
9. **What is the average canopy height of the Gordon Valley fossil forest? What method was used to estimate individual tree height?** ANSWER: Tree height was estimated from measured fossil trunk diameters by applying scaling equations of Niklas (1994). These enable researcher to estimate height from trunk diameter using the scaling relationships that are

observed for living trees between measured diameters and known heights. Using these approaches it is estimated that the average height of the forest was between 14 and 25 m.

10. **What is the age profile and general ecology of the fossil forest? What methods were these inferences/estimates based on?** ANSWER: The fossil forest is reconstructed as a mature forest stand with a canopy varying in height between 14 and 25 meters. This is based on estimating tree height from trunk diameter. Analysis of fossil growth rings of a subset of individual trees showed highly variable growth rate throughout the life time of the trees. The oldest trunk analysed had 86 growth rings indicating that it was nearly a century old. Different phases in growth of the forest are indicated by clustering of trunk diameters in different parts of the landscape. Comparison of fossilized tree ring width data with both modern and other fossil forests suggests that the capacity of the Gordon Valley forest to gain biomass (as indicated by ring width) was not hampered by the polar light regime at such high latitudes and was on average two times higher than observed today in equivalent high latitude polar environments. The fossil forest was quite open with a tree spacing or density similar to that seen today in modern temperate deciduous forests of oak and maple.