

Gondwanan Plants of the Sydney Region

Presentation Dr Peter Weston 25/11/2017

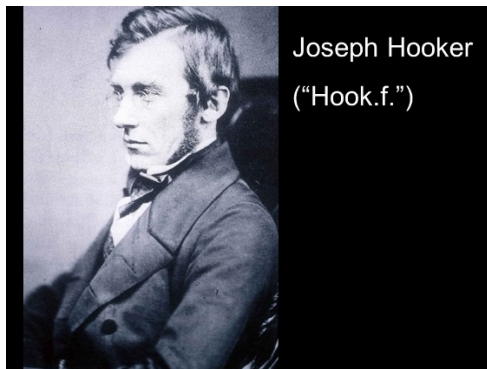
Honorary Research Associate, Science and Conservation Branch, Royal Botanic Gardens and Domain Trust

Summary: Dr Marilyn Cross, Dr Pip Gibian & Tony Maxwell

All Images courtesy of Dr Peter Weston

Early theories: Joseph Hooker (1853) vs. Charles Darwin (1859)

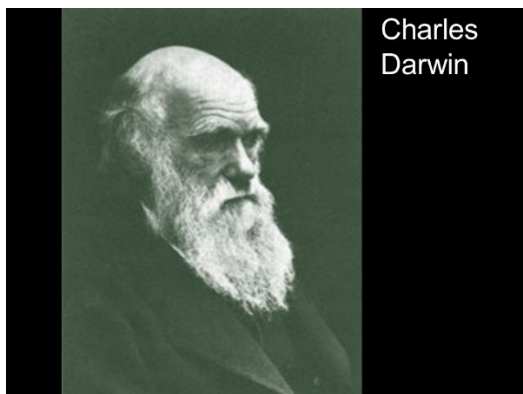
Hooker (1853) suggested that the distribution of genera in the southern latitudes was due to a geological vicariance event [the fragmentation of a widespread ancestral distribution by the appearance of a new barrier].



"There are upwards of 100 genera, subgenera, or other well-marked groups of plants entirely or nearly confined to New Zealand, Australia, and extra-tropical South America."

"Enough is here given to show that many of the peculiarities of each of these three great areas of land in the southern latitudes are representative ones, affecting a botanical relationship as strong as that which prevails throughout the lands within the Arctic and Northern Temperate zones ..."

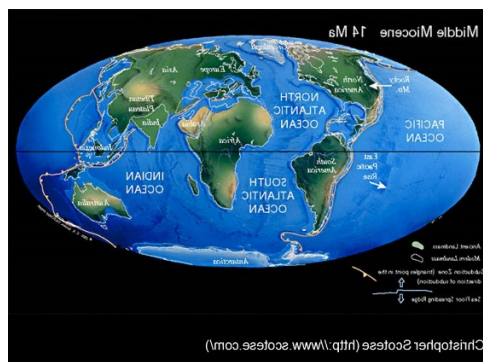
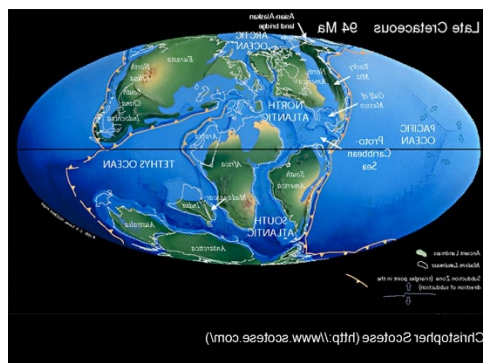
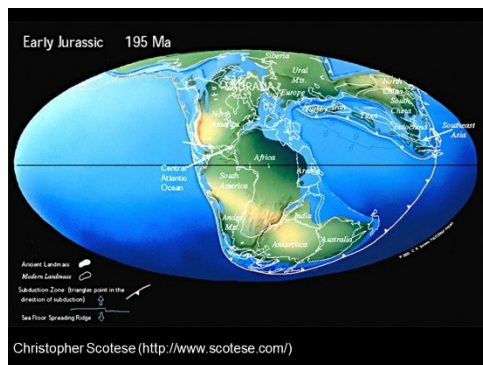
"... and which is not to be accounted for by any theory of transport or variation, but which is agreeable to the hypothesis of all being members of a once more extensive flora, which has been broken up by geological and climatic causes." (J.D. Hooker (1853) 'Introductory Essay' to the 'Flora of New Zealand')



Darwin, however, suggested that each taxon had a centre of origin in one location and the distributions resulted from long distance dispersals across seaways: "If the existence of the same species at distant and isolated points of the earth's surface, can in many instances be explained on the view of each species having migrated from a single birthplace..." (C. Darwin (1859) 'On the Origin of Species').

Break up of Gondwana (tectonic plate movement – late 1960's)

It was not until the late 1960's that the theory of tectonic plates supported the breakup of Gondwana with flora already in place on the continental fragments.



Distribution of Gondwanan Plants

The flowering plant family Proteaceae is putatively of Gondwanan age, with modern and fossil lineages found on all southern continents. The plants of possible Gondwanan origin include members not only of the Proteaceae family, but also some members of the Myrtaceae and Ericaceae families.

Members of the subtribe Embothriinae (Proteaceae) are to be found in Australia, South America and Papua.



Examples of Embothriinae (Proteaceae) include the Waratahs, *Telopea speciosissima* (Sydney Waratah) and *Alloxylon pinnatum* (Dorrigo Waratah) in Australia. In South America, the subtribe includes *Embothrium coccineum*, from S. Chile and Argentina, and *Oreocallis mucronata*, from Peru and Ecuador.

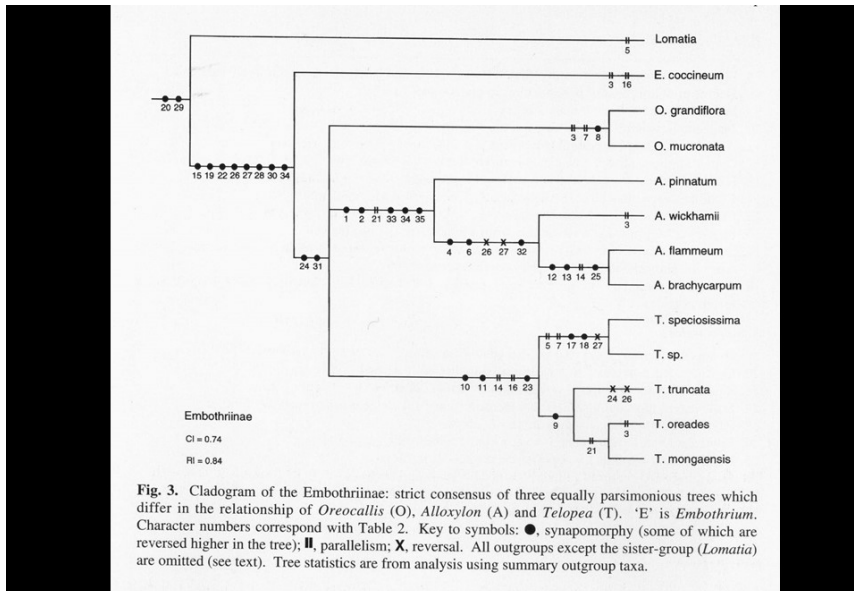


The Gondwanan hypothesis is tested by asking: can the present distribution of Proteaceae be explained by vicariance caused by the break-up of Gondwana, Africa, especially southern Africa, Australia, New Zealand, South America, New Caledonia, New Guinea, Southeast Asia, Sulawesi, Tasmania?

The hypothesis has been tested using Bayesian phylogenetic distribution of botanical features together with molecular dating of both living and fossil material.

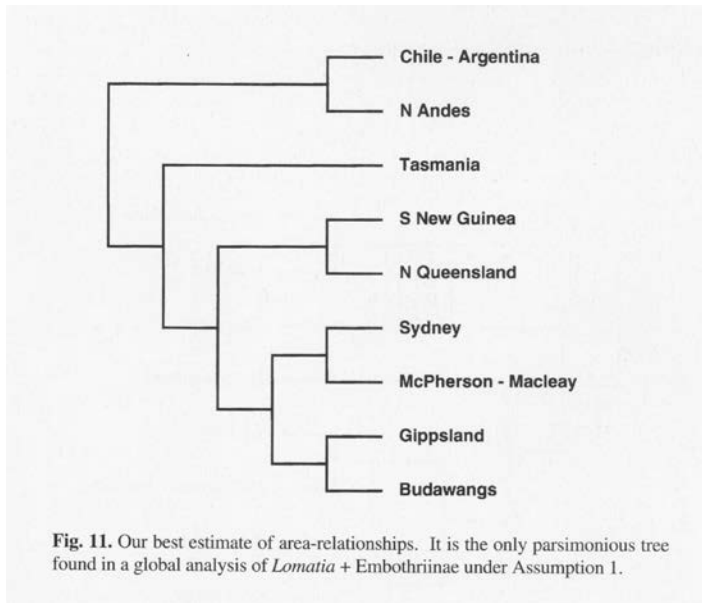
Phylogenetic trees

Phylogenetic or 'family trees' developed using Bayesian statistical methods can indicate when the related genera developed different characteristics and separated from each other viz. the phylogenetic tree for waratahs and their relatives (Weston & Crisp 1994).

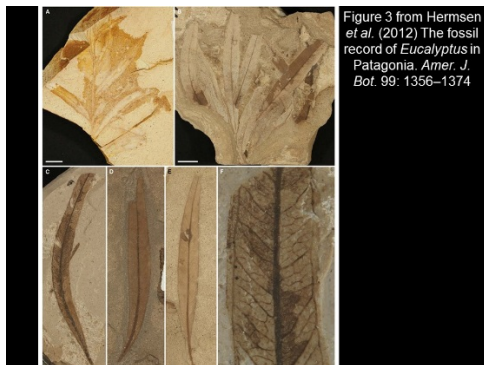


Phylogenetic tree for waratahs and their relatives (Weston & Crisp 1994)

Similar statistical trees can indicate the geographic or area relationships.



Fossil Record



Testing the Gondwanan hypothesis: Findings

The evidence suggests that the Gondwanan hypothesis does hold to some extent but that the story is not so simple. The evidence also suggests that dispersal across oceans has played its part in the distribution of our southern plant genera.

To quote:

“The findings suggest that disjunct distributions in Proteaceae result from both Gondwanan vicariance and transoceanic dispersal. Our results imply that ancestors of some taxa dispersed across oceans rather than rafting with Gondwanan fragments as previously thought. This finding agrees with other studies of Gondwanan plants in dating the divergence of Australian, New Zealand and New Caledonian taxa in the Eocene, consistent with the existence of a shared, ancestral Eocene flora but contrary to a vicariance scenario based on accepted geological knowledge.” (Barker et al, 2007)

So, were Hooker and Darwin both right and wrong?

To sum up: scientific study has supported the Gondwana theory as the origin of some species, while other species arose from individual mutations which were then spread by wind and water. For some species, both processes have played a part.

Barker, Nigel P. , Weston, Peter H. , Rutschmann, Frank and Sauquet, Hervé 2007 Molecular dating of the ‘Gondwanan’ plant family Proteaceae is only partially congruent with the timing of the break-up of Gondwana. *Journal of Biogeography*, 34, 2012-2027.