Family Araucariaceae—an 'icon' of evolution, but the storyline doesn't fit

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Evolutionary theory presents the family Araucariaceae as being a group of dinosaur-age plants that are on a path to extinction because of competition from the 'more advanced' angiosperms. However, where there has been a decline in the geographic spread of Auracariaceae it is not due to them being 'primitive' (a false evolutionary concept), but due to the introduction of fire and the clearing of land for agriculture. The many examples of the family Araucariaceae's association with angiosperms, and that it has representatives occupying zones of extreme soils and temperatures, thwarts evolutionary tale-telling.

An evolutionary view of the Araucariaceae

Just as the evolutionary storyline posits that there was a golden age for the dinosaurs, so too in the plant world with the family Araucariaceae. One of its number, *Wollemia nobilis*, the Wollemi Pine, is even referred to as the 'dinosaur tree'.[1,2] And just as evolutionary theory says the dinosaurs came to be replaced by the mammals, so the Araucariaceae are often portrayed as 'primitive', 'relict' vegetation struggling to hold on against the rise of the flowering plants, the angiosperms.

An example of such a portrayal can be seen on the front and back covers of the proceedings of a major symposium held in Auckland, New Zealand, in 2002, which was published in 2009.[3] The front cover is dominated by a picture of a grove of *Araucaria araucana* from Argentina (figure 1). It is a stark picture of about a dozen trees growing on a bare outcrop of volcanic rock, without any understory other than a few dry tufts of grass among the rocks. The description of the grove is "Relict *Araucaria araucana* from Lonco Luan, Argentina", with the word 'relict' obviously intended to emphasize that the Araucarias are on their way out.

On the back cover, Araucariaceae are described as having somehow survived, from the age of the dinosaurs to the present day, against all odds.

The symposium was organized by the International Dendrology Society, which was celebrating the 50th anniversary of its foundation. The chairman of the Society stressed in the opening remarks for the symposium that the family was the most important conifer family of the southern hemisphere, the true relict of Gondwana, which played a crucial role in the evolutionary chain, from the fossil record to today's species.

But when we consider information presented in the pages of the symposium's proceedings (and elsewhere), evolution's 'big picture' of the Araucariaceae struggling to hold on against angiosperms fails to stand up to scrutiny.

The data doesn't support the story

While there are many articles in the proceedings that maintain the chairman's emphasis on the relictual nature of Araucariaceae, particularly the contributions of the paleontologists, there are other articles that present data that clearly undermines the claim that Araucariaceae cannot compete with angiosperms.

For example, in their description of Araucariaceae in New Caledonia, Manaute *et al.*[4] describe the real situation in the field, namely that Araucariaceae are a prominent element in the vegetation of New Caledonia. They also describe how the angiosperm associates of the Araucariaceae vary according to the ecological conditions, in particular soils and altitude. The list of angiosperm associates of the Araucariaceae is extensive and is definitely not restricted to those angiosperms that are normally dismissed as being primitive. Even that list is dwarfed by the list of the associates of Araucariaceae given by Wilcox[5] in his description of the post-conference tour of New Caledonia.

The richness of the angiosperm associates of the Araucariaceae in New Caledonia would probably be glossed over by saying that New Caledonia is an isolated island in which evolution has not caught up with the rest of the world, where Araucariaceae are unable to compete with angiosperms. However, the symposium proceedings also include an article which the author wrote, entitled "Araucariaceae, angiosperms and people".[6] It deals with the Araucariaceae/angiosperm relationship worldwide, reviewing the ecological literature on this topic from all the countries in which the family Araucariaceae exist today. It is not just a literature review, as it includes my own observations of the Araucariaceae on the ground in South America (Chile, Argentina, and Brazil), South-East Asia (Malaysia and Indonesia) and New Caledonia. The article examines the relationship in the context of underlying physical environment (climate, soil, topography) and of the impact of human activities on the vegetation. It spans many

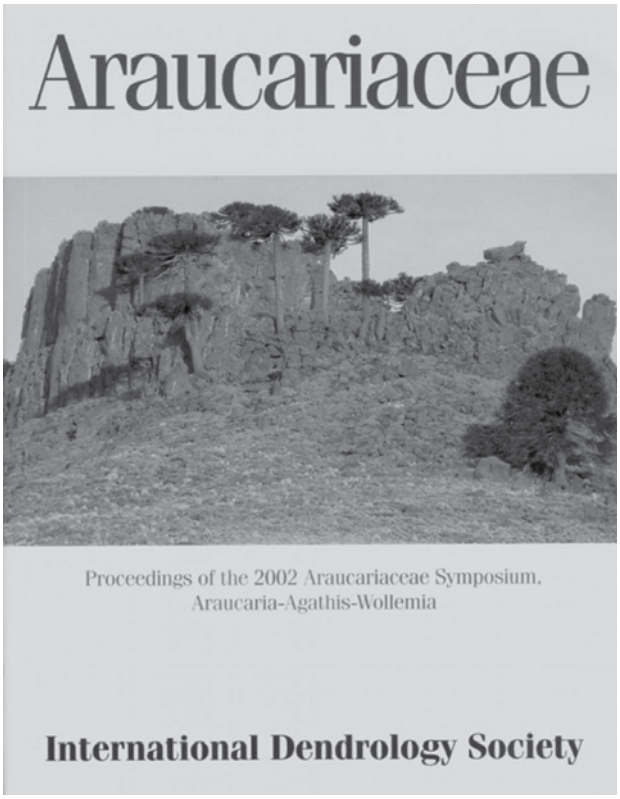

Figure 1. The front cover of the *Proceedings of the 2002 Araucariaceae Symposium*, published in 2009

years of observations, given that I first carried out ecological studies of the Araucariaceae in New Guinea in the 1950s, also at that time closely observing them in Australia, New Zealand, and Fiji (and since). I later published my studies (1965,[7] 1971,[8] 1972[9]). In the 1990s I returned to New Guinea to see first-hand if, how, and where the situation had changed. (And it turned out that where it *had* changed, it was not because of competitive pressure from angiosperms. Rather, it was because the ecology had been powerfully impacted by factors related to human activity, as I shall discuss later.)

Abundant angiosperms—benign companions

Family Araucariaceae associations with angiosperm species are abundant, in all the regions of the world where Araucariaceae are present. For example, the island of New Guinea (to Australia's north) where Araucariaceae can be found growing mainly in the middle altitudes on the mountain ranges, i.e. between the lowland tropical rainforest and the alpine tundra. (They are generally not found in the wet lowlands, the southern dry and fire-prone lowlands, and frost-prone high mountains.) Where Araucariaceae occur, it is in association with a large number of angiosperm species. To save space, instead of enumerating individual species, only the families to which they belong are given. The angiosperm families occurring in association with Araucariaceae in New Guinea include: Datiscaceae, Combretaceae, Mimosaceae, Sterculiaceae, Euphorbiaceae, Flacourtiaceae, Ulmaceae, Meliaceae, Sapotaceae, Moraceae, Lauraceae, Malvaceae, Rutaceae, Magnoliaceae, Burseraceae, Ebenaceae, Elaeocarpaceae, Urticaceae, Rhamnaceae, Boraginaceae, Apocynaceae, Fagaceae, Juglandaceae, Clusiaceae, Himatandraceae, Proteaceae, Myrtaceae, Theaceae, and Casuarinaceae.

For readers who want further detail on this, along with a much more extensive listing of the many angiosperm families associated with Araucariaceae in numerous other regions of the world, please see the online supplementary information to this article.[10]

Why the apparent contraction of the Araucariaceae?

The contraction of a group of plants needs to be defined in terms of time and mode. The most commonly used timescale for the contraction of the Araucariaceae is the long one—in terms of geological time, especially from the time of the dinosaurs to the present. As supposed evidence, evolutionists claim that in the rocks assigned to the Cretaceous era the family Araucariaceae was more widespread, not largely confined to the southern hemisphere as now. There is also a greater proportion of fossils assigned to the Araucariaceae compared to those assigned to angiosperm families, though in Patagonian Cretaceous rocks Menendez in (1972)[11] recorded quite an impressive suite of angiosperm families alongside the fossil Araucariaceae. These included: Monimiaceae, Lauraceae, Menispermaceae, Saxifragaceae, Anacardiaceae, Vitaceae, Myrtaceae, Sterculiaceae, Araliaceae, Bignoniaceae, Poaceae, and Cyperaceae.

The changed proportion of Araucariaceae and angiosperms is then interpreted in evolutionary terms, namely that the primitive Araucariaceae have been, or are being, displaced by the more advanced angiosperms. This is the position taken by Womersley (1958),[12] Robbins (1962),[13] and Aubreville (1965)[14]—the 'big names' in academic study of Araucariaceae when I was first embarking upon my own studies—and more recently by van der Burgh (2009),[15] who considers the family Araucariaceae to be too specialized or too adapted to humid climate. He contrasts them to the family Pinaceae of the northern hemisphere, which by comparison has flourished and occupies extensive areas of that hemisphere. However, this ignores the fact there are very limited bioclimatic regions in the southern hemisphere that Pinaceae could occupy, just as there are limited bioclimatic regions, such as the Malay Peninsula and the adjacent island groups, which Araucariaceae can occupy in the northern hemisphere.

Though van der Burgh identifies the similarities (bract scale complex and inverted seed) and differences (disintegration vs retention of cone on maturity) between Araucariaceae and Pinaceae, he does not recognize the

ecological significance of the differences. Cones that do not disintegrate on maturity and are retained for a number of years (serotinous) can provide long-term protection for the seeds, which can be shed after fire and provide the basis for the subsequent regeneration. This is what happens repeatedly to extensive pine forests in Eurasia and North America. The fact that Araucariaceae lack this capability handicaps them in fire-prone continental climates, particularly when the frequency of fire is increased by human activity. Some have suggested that fire might open the way for colonization by certain angiosperms which then begin to outnumber the Araucariaceae and so begin to outcompete them, i.e. that it is a combination of fire and angiosperms which suppresses the Auracariaceae. However, the author's assessment is that it is *fire*, directly and indirectly promoted by *human activity*, that is the chief cause of the current observable contraction of the Araucariaceae, and that it cannot be ascribed solely by any measure to the putative competition by angiosperms.

There are many pointers to the importance of fire, rather than the presence of angiosperms, as being a major determinant of Araucariaceae distribution. For example, Kershaw and Wagstaff in 2001[16] presented a range of evidence indicating that a principal control on Araucariaceae abundance is frequency of fires. They pointed to widespread decline in Araucariaceae during periods of high fire frequency associated with aboriginal burning, and also with episodes of dry climate and high incidences of lightning strikes igniting fires. During periods of wetter climatic conditions and fewer fires the Araucariaceae become widespread, often coming to dominate a forest. And another commentator, musing on the distribution, diversity, and success of the Araucariaceae in Australasia, wrote:

> "This is a striking pattern because it means that *this family of conifers has been most successful in precisely the environment where angiosperms are generally thought to have most successfully replaced conifers*—in the tropical rainforests [emphasis added]."[17]

Reality of the Araucariaceae/angiosperm balance

Although the displacement of Araucariaceae by angiosperms is often mentioned and even pushed as a religious mantra by many writers, the identity of the angiosperms that have the capacity to cause this displacement appears to be a trade secret. It is only in localized ecological studies like Whitmore (1966),[18] Webb and Tracey (1967),[19] Havel (1971),[8] Enright (1995),[20] Jaffre *et al.* (2001),[21] and Ogden and Stewart (1995)[22] that the coexistence of Araucariaceae and angiosperms is acknowledged and recorded. The families of angiosperms coexisting with Araucariaceae as recorded in my article in the 2009 proceedings,[6] and in the supplementary information to this article,[10] is an impressive list—and there may be many others yet to be identified. Therefore it is a reasonable question to ask: which are the mysterious angiosperms that are pushing Araucariaceae toward extinction?

A 'complex ecological setting' influenced by soils, climate, human activity

There are other studies of present-day coexistence of angiosperms and Araucariaceae. In addition to those mentioned in the preceding paragraph for south-west Pacific Region, there are similar studies from South America of Armesto *et al.* (1995),[23] Armesto *et al.* (1997),[24] Dimitri (1972),[25] Veblen (1982),[26] and Veblen *et al.* (1995),[27] which record the coexistence of the Araucariaceae and angiosperms and analyze the conditions that influence the regeneration patterns. Even in these studies assumptions are inevitable, such as what history is reflected in the diameter distribution within the stands that are being studied.

This leads to the recognition that angiosperm/gymnosperm competition does not occur within a vacuum, but within a complex ecological setting in which physical factors such as climatic changes, and social factors, such as changes in human subsistence (Golte, 2009),[28] also play a part. Golte's study points out three major regions (Chile, southern Brazil and south-east Queensland), in which Araucarias of the subsection Araucaria, which have large edible seeds, once formed the subsistence basis of indigenous societies and influenced the structure of these societies. The subsequent European colonization did not just diminish the bulk of the Araucarias and the angiosperms associated with them, but also dramatically impacted the people dependent on them.

Araucariaceae can tolerate extremes of temperature, soils—bye-bye extinction theory

Nix's (1991) study of climatic determinants of the occurrence of plant species[29] shows that in terms of temperature tolerance Araucariaceae in Australia are predominantly mesotherms. However, *Araucaria araucana* is a microtherm and some species of *Agathis* are macrotherm. So in total, the Araucariaceae have a wide temperature tolerance. Similarly, in terms of rainfall, although Araucariaceae have preference for moderately high, non-seasonal rainfall, they range from the relatively dry climate of southern Queensland, western New Caledonia and western Argentina, to the very wet climate of Chile, Malesia and the mountains of New Caledonia.

In terms of soil extremes, the Araucariaceae range from the soils derived from ultrabasic rocks in New Caledonia and Borneo, to infertile and acid soils derived from sediments in Borneo and New Zealand. Such broad tolerances to extreme environmental conditions are hardly indicative of a relict family on the way to extinction.

The Araucariaceae-angiosperm nexus

The real relationship between Araucariaceae and angiosperms can be summarized by three main points:

a. The claim that angiosperms are responsible for the current discontinuous distribution of the Araucariaceae, which is a reduction of their former broader distribution, is not supported by actual evidence, but is conjecture.
b. The distribution of the Araucariaceae and their numerous angiosperm associates at the beginning of the modern era 200–300 years ago was largely determined by interplay of environmental factors, particularly through their effect on the frequency and intensity of fire.
c. That distribution was already affected by human activity over the previous millennia. The degree of impact varied between the many regions in which Araucariaceae occur. However, the main human impact has occurred over the past 200–300 years, i.e. mainly since European colonization, with its associated land settlement activities and increased intensity of wildfires.[30]

The real reason for the perpetuation of the myth of the inferiority of the Araucariaceae?

Given the lack of observable and measurable evidence for the inferiority of the Araucariaceae, and their displacement by the angiosperms, the obvious question is: What is the motive for continuing to espouse that line? Could the likely primary motive be the strategic defence and promulgation of evolutionary theory? And as typically occurs, the attempts to prop up evolutionary theory are not consistently applied. For example, if angiosperms are outcompeting Araucariaceae because angiosperms are more 'advanced', then why doesn't the same 'argument' hold for the Pinaceae as well? (Pinaceae continue to dominate a large proportion of the northern hemisphere land masses.)

Araucariaceae as 'props' for another evolutionary 'icon'—the dinosaurs

Where do the Araucariaceae get their main exposure? Probably most people do not recognize them as objects of a merit of their own, but as strange looking props in the so-called scientific documentaries about dinosaurs—the ultimate evolutionary 'icon'. Given the strong and unusual structure of Araucariaceae tree crowns, they make the ideal props for dinosaur tales (figure 2). Seeing that dinosaur fossils occur in the same deposits as the Araucariaceae, and seeing that all dinosaurs are extinct, then evolutionary theory dictates that Araucariaceae must be living fossils heading for extinction. This would account for the emphasis on *Wollemia*, the genus with its only species (the already-mentioned so-called 'dinosaur tree', *W. nobilis*) occurring in one gorge. It is hardly consistent with the numerous species

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Figure 2. The striking crown shapes of *Araucaria araucana*

of the genera *Araucaria* and *Agathis*, spread over ranges of hundreds of kilometers.

Observational science versus storytelling

Science focusing on the occurrence and distribution of the Araucariaceae should be based on objective experimental studies or at least on detailed ecological surveys. Experiments require sufficient replications to support statistical analysis and test hypotheses. That at least was the way that I did my studies on *Araucaria hunsteinii* autecology and synecology 50 years ago.

True, even 100 years or more ago there were popularizers of science like H.G. Wells and Jules Verne, who spun fantastic yarns, but most readers knew the difference between those yarns and the real science, like that done at that time by Louis Pasteur in the field of microbiology. Now, in large measure likely because of the influence of propaganda organizations such as the BBC, many people today evidently do not know the difference between storytelling and truth.

Recognizing propaganda

I am conscious that describing the BBC as a 'propaganda organization' may date me as being 'old and grumpy', but over the past eight decades I have come across a lot of propaganda and I recognize it when I see it. I experienced both the Nazi theory on the superiority of the Germanic race and the communist theory on the just dictatorship of the proletariat. I learned that each propaganda effort needs to have a picture capable of grabbing attention. Nowadays we call them icons. I have some of these pictures strongly imprinted in my mind.

Figure 3. Adolf Hitler was neither tall nor blonde, but that did not stop him appealing to those who were. But what were the foundations of Hitler's ethics that were so attractive to so many?

Propagandist Hitler

In 1942, my high school in Kralupy, in what is now the Czech Republic, was kicked out of the ground storey of its building to accommodate a group of German refugee children from Romania. Their classrooms were decorated with large, coloured images of tall, blonde, blue-eyed youths doing heroic things. There was a slight mismatch, in that the children using the classrooms were generally neither tall nor blonde. They were no heroes, just refugees. The prophet of that theory, Hitler (figure 3) was not tall, blonde, or heroic, but that did not stop him from being a very effective propagandist who fooled a lot of people for over a decade.

From Czech to 'mate'

In 1948, I ran into another effective propaganda machine. In this case, the icons were muscular men with hammers and scythes, wearing clothes with red stars. The cause they were promulgating was the dictatorship of the proletariat. The people in the iconic pictures and statues were probably actors. They did not look much like my grandfather, who was a miner, as were his forefathers for the four generations that I can trace, and probably beyond that. The minister pushing the propaganda and controlling the education, Nejedly, was no proletarian worker, but a middle-class communist intellectual. However, he was an effective propagandist who became a powerful man, whilst I became a stateless refugee until Australia gave me a new home.[31]

Exposing the evolutionary propaganda effort—and thwarting it

It is because of these experiences that I view the dinosaur/*Araucaria* icons, and the insistence that Araucariaceae are being pushed toward extinction by angiosperms, as a propaganda effort for evolution. After all, it is a more spectacular icon than mono-cellular eubacteria emerging from warm muddy water, which is the basic postulate of evolution. The link with Pasteur's experiments again comes to mind, as he proved conclusively that no life emerges from sterilized water. Obviously, such facts are not allowed to interfere with the propaganda effort.

In that light, scientists should re-evaluate the purported relict stand of Araucarias in western Argentina on the front cover of the book. As an icon it is superb—few surviving trees in a stony desert might superficially suggest an approaching end point. However, if the front cover picture were to be quantified in terms of vegetative cover, my rough assessment would be something like: Araucariaceae 10%, angiosperm herbs 2%, angiosperm trees 0%, with the remainder being bare rock. This is hardly a demonstration of the common claim that the Araucariaceae are relict because of having been displaced by the evolutionarily superior angiosperm trees. An article within the Proceedings by Sanguinetti *et al.* (2009)[32] from the same region of Argentina attributes the current paucity of *Araucaria* regeneration to human activity, principally intensive grazing and frequent intentional fires, which has been going on for the past 150 years. Dimitri (1972)[25] commented that because of its thick bark, *Araucaria* copes better with fire than, say, ecologically comparable angiosperms such as *Nothofagus* spp. In the cover picture of the *Proceedings*, the only angiosperm to survive the human pressure is the grass *Stipa speciosa*. The fact that only the Araucariaceae and no angiosperm trees have survived, and that any decline was likely due to abusive land use, is not allowed to spoil the story.

Unfortunately, this picture of the relict Araucariaceae stand may be prophetic. Most articles have focused on what might have happened to the Araucariaceae 'since the Cretaceous era', instead of within the last 200–300 years. Accordingly, much has been postulated about the impact of the angiosperms and not enough attention focused on addressing the human-induced extermination of the Araucariaceae that is still underway. As such, the situation may be symptomatic of a more widespread problem in present-day science—whereby ideological bias stimulates a lot of misdirected effort, resulting in propaganda rather than problem-solving.

Conclusion

The claims made by proponents of evolutionary theory regarding its ability to explain the world in which we live should be recognized as the propaganda that it clearly is. For when one considers the 'hard data' of the real world, evolutionary ideas fail under scrutiny. The Araucariaceae provide a clear demonstration of that, as unbiased data points to the Araucariaceae's ability to thrive alongside

angiosperms, rather than being out-competed by them. The ability to tolerate a range of soil and temperature extremes is hardly the characteristic of 'relict' vegetation, but of plants eminently fit for survival. Attempts to render the Araucariaceae as an 'icon' of evolution will certainly fail in the eyes of those who are alert to propagandists' spin and to the fact that the evolutionary storyline just does not fit with real-world observation. Rather, the evidence of the Araucariaceae today is that this family of plants were among all the vegetation created by God to grow out of the earth on Day 3 of Creation Week, subsequently reproducing according to their various kinds. Growing and reproducing is something that the Araucariaceae and other plants evidently continue to do to this day, and do very well indeed.

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