

# Palaeobotany of the Bunya Pine

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The bunya pine (*Araucaria bidwillii* Hook) is one of the most interesting species of the family Araucariaceae, a typical Southern Hemisphere conifer (Table 1) family that includes three living genera: *Araucaria* de Jussieu, *Agathis* Salisbury and the recently described genus *Wollemia* Jones, Hill and Allen. *Araucaria bidwillii* is traditionally classified in the Section *Bunya* of genus *Araucaria*. In addition to the section *Bunya*, there are three more sections in the genus *Araucaria*: *Eutacta* Endlicher and *Intermedia* White from Australasia, and *Araucaria* (= *Columbea*) Wilde and Eames from South America.

A large, perennial, woody tree with large, flat, spreading or slightly imbricate leaves *Araucaria bidwillii*, like other conifers, produces reproductive structures in cones. These are of two types: seed cones (female) and pollen cones (male). Seed cones are some of the largest known in conifers (over 30 cm in length, Plate 1) and their large seeds were highly prized as a food source by Aboriginal people. Seed cones have an axis that bears several bract-scale units with one seed that may be removed from the scale at maturity. Pollen cones are smaller, more cylindrical and axillary, but still larger than pollen cones of most Northern Hemisphere conifers.

In the present day, the Southern hemisphere conifer family Araucariaceae has a very restricted distribution. In the distant past it was far more widespread and fossils related to the *Araucaria bidwillii* have been found in both the Northern and Southern Hemispheres.<sup>1</sup> The genus *Araucaria* is represented by fossil material dating back to the Jurassic in both hemispheres and a suite of araucarian cones with affinities to sections of the genus *Araucaria* have been described from England, Japan and North America.<sup>2</sup> However, *Araucaria* Section *Bunya* has not been reliably reported since the Mesozoic, suggesting that this was its time of widest distribution and that its range has been contracting since that time. (Table 1)

The bunya fossil record is limited, being based principally on seed cones but other organs such as leaves, twigs and 'seedlings' are also known.<sup>3</sup> In Australia the association of modern araucarians including *A. bidwillii* with drier rainforest types appeared to hold true in the Australian Quaternary in general. These conditions are not suitable for easy fossilisation, except perhaps as volcanic casts, so any record for Australia is likely to be incomplete. This problem is a barrier to understanding the development of many Australian plant groups.<sup>4</sup>

*Araucaria sphaerocarpa* Carruthers from the Middle Jurassic Inferior Oolite Formation, Bruton, Somerset, UK displays the external morphology and internal

anatomy of the seed cone. This cone is large (up to 15 cm, Plate 2) and composed of an axis that bears a series of large winged bracts that are partially free from the ovuliferous scale. Seeds are borne on ovuliferous scales that are similar anatomically to the seeds of the bunya pine.<sup>5</sup>

The best evidence of relatives of the bunya pine comes from the Cerro Cuadrado Petrified Forest of Patagonia in Argentina.<sup>6</sup> This fossil locality has plants of Jurassic age and yields a large number of seed cones, 'seedlings', wood, twigs and leaves of the species *Araucaria mirabilis* (Spegazzini) Windhausen as well as other conifer remains.<sup>7</sup> Seed cones range from 2.5 – 8.0 cm long (Plate 3) and show the internal anatomy of the cone axis, bracts, ovuliferous scales, and seeds (Plate 4). The seeds are so exquisitely preserved that two stages of cone development (mature and immature) have been described and analysed helping us to understand the life cycle of this plant.<sup>8</sup> Originally it was thought that the small woody corm-like structures preserved in the Cerro Cuadrado were seedlings of *Araucaria mirabilis*. However, recent investigations reveal that these small woody structures are lignotubers and may be similar to the bunya burls produced under the bark of *Araucaria bidwillii*.<sup>9</sup>

These two species *A. sphaerocarpa* and *A. mirabilis* share several characteristics that show their relationship to the bunya pine, suggesting that this type of conifer was once more widespread in the past.<sup>10</sup> Cones belonging to the fossil species *Araucarites bindrabunensis* Vishnu-Mittre<sup>11</sup> from the Jurassic Rajmahal Hills, India may also be related to the bunya tree but their affinities are not yet clear.<sup>12</sup> Other species of araucarian cones and leaves have been described from both hemispheres and have been included in the sections *Eutacta* (e.g. *Araucarites rogersii* Seward),<sup>13</sup> *Intermedia* (e.g. *Araucaria haastii* Ettingshausen),<sup>14</sup> or they may belong to extinct groups that share characteristics with more than one section (*Araucaria brownii*;<sup>15</sup> *Araucaria nihongii*;<sup>16</sup> *Araucaria nipponensis*).<sup>17</sup>

Due to the fragmentary nature of the fossil record there is still much to learn about the evolution of *Araucaria* and the bunya pine in particular. We do know that their relatives go back as far as the Jurassic period, 175 million years ago (Table 1). More work needs to be done to find, study and understand fossil remains of bunya pines and the other representatives of the family Araucariaceae. To date much of our knowledge has been gathered from a relatively small number of localities and studied by a small number of palaeobotanists. As more fossil material is discovered we will come closer to an understanding of the evolution and relationships of the living bunya pine and its precursors.



**Plate 5:** *Araucaria bidwillii* seed cone from Auckland, N.Z. showing general morphology with large bracts and ovuliferous scales. Photographed Ruth A. Stockey. Reproduced with permission.



**Plate 6:** *Araucaria sphaerocarpa* seed cone showing external morphology. The Natural History Museum, London, no. V41036. Photographed Ruth A. Stockey. Reproduced with permission.

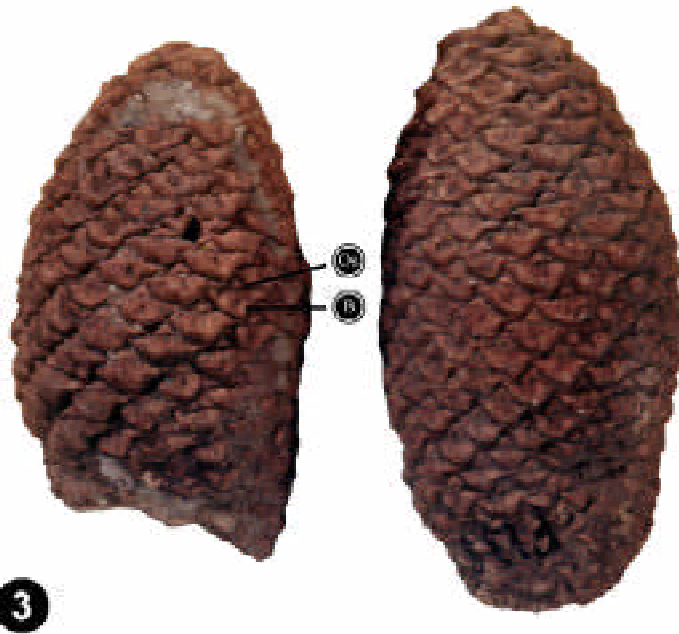


Plate 7: *Araucaria mirabilis* seed cones showing external morphology, Field Museum of Natural History, Chicago, no. P13813. Photographer Ruth A. Stockey. Reproduced with permission.

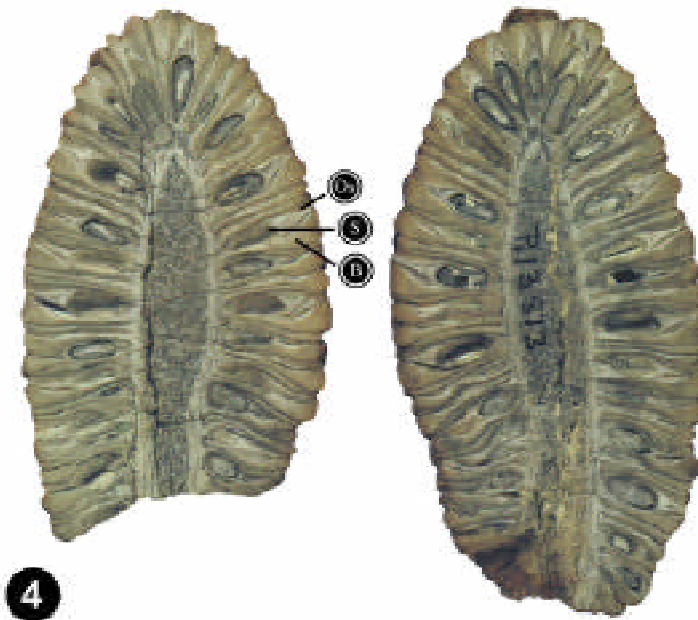
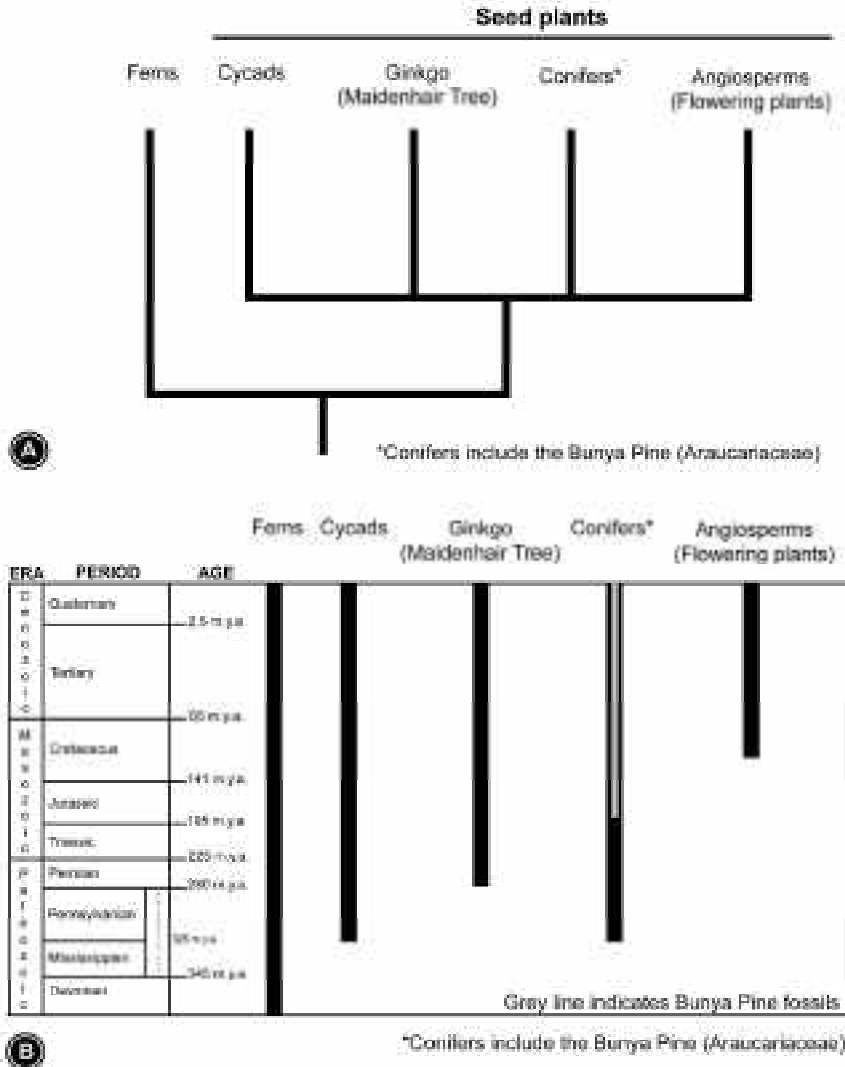


Plate 8: *Araucaria mirabilis* seed cones showing internal anatomy, Field Museum of Natural History, Chicago, no. P13813. Bract = B, Ovuliferous scale = Os, Seed = S. Photographer Ruth A. Stockey. Reproduced with permission.

**Table 1: Botanical classification and geological time line for *Araucaria bidwillii***



**Notes**

- 1 R. A. Stockey, 'Anatomy and morphology of *Araucaria sphaerocarpa* Carruthers from the Jurassic Inferior Oolite of Bruton, Somerset', *Botanical Gazette* 141 (1980a), 116-124; R. A. Stockey, 'The Araucariaceae and evolutionary perspective', *Review of Palaeobotany and Palynology* 37 (1982): 133-154; R. A. Stockey, H. Nishida & M. Nishida, 'Upper Cretaceous araucarian cones from Hokkaido and Saghalien: *Araucaria nipponensis* sp. nov.', *International Journal of Plant Sciences* 155 (1994): 800-809.
- 2 R. A. Stockey, [www.botanik.uni-bonn.de/conifers/refs/stockey94htm](http://www.botanik.uni-bonn.de/conifers/refs/stockey94htm).

- 3 R. A. Stockey, 'Seeds and embryos of *Araucaria mirabilis*', *American Journal of Botany* 62 (1975): 856-868; R. A. Stockey, 'Reproductive biology of the Cerro Cuadrado fossil conifers: Ontogeny and reproductive strategies in *Araucaria mirabilis* (Spegazzini) Windhausen', *Palaeontographica B* 166 (1978): 1-15; Stockey 1982, op.cit., 133-154; R. A. Stockey and T. N. Taylor, 'On the structure and evolutionary relationships of the Cerro Cuadrado fossil conifer seedlings', *Journal of the Linnean Society London (Bot.)* 76 (1978): 161-176.
- 4 Information provided by Ian Smith from A. P. Kershaw, 'Evidence for vegetation and climatic change in the Quaternary' in *The geology and geophysics of Northeastern Australia*, eds. R. A. Henderson and P. J. Stephenson, (Queensland: Geological Society of Australia, 1980), 399-402; R. S. Hill, Pers. Comm., Hobart: University of Tasmania, 1999.
- 5 Stockey 1980a, op.cit.
- 6 Stockey 1975, op.cit., 1978, op.cit., 1982, op.cit.; Stockey and Taylor 1978, op.cit.
- 7 R. A. Stockey, 'Reproductive biology of the Cerro Cuadrado (Jurassic) conifers: *Pararaucaria patagonica*', *American Journal of Botany* 64 (1977): 733-744.
- 8 Stockey 1978, op.cit.
- 9 R. A. Stockey, '*Araucaria*: the fossil record', *IDS International Araucariaceae Symposium*, Auckland, New Zealand, (2002): 9-10.
- 10 Stockey 1982, op.cit; R. A. Stockey, 'Mesozoic Araucariaceae: morphology and systematic relationships', *Journal of Plant Research* 107 (1994): 493-502.
- 11 Vishnu-Mittre, '*Araucarites bindrabunensis* sp. nov., a petrified megastrobilus from the Jurassic of Rajmahal Hills, Bihar', *Palaeobotanist* 3 (1954): 103-108.
- 12 Stockey 1994, op.cit.
- 13 J. T. Brown, 'On *Araucaria rogersii* Seward from the Lower Cretaceous Kirkwood Formation of the Algoa Basin, Cape Province, South Africa', *Palaeontologia Africana* 20 (1977): 47-51.
- 14 M. N. Bose, '*Araucaria haastii* Ettingshausen from Shag Point, New Zealand', *Palaeobotanist* 22 (1975): 76-80.
- 15 R. A. Stockey, 'Jurassic araucarian cone from Southern England', *Palaeontology* 23 (1980b), 657-666.
- 16 R. A. Stockey, H. Nishida, H. and M. Nishida, 'Upper Cretaceous araucarian cones from Hokkaido: *Araucaria nihongii* sp. nov.', *Review of Palaeobotany and Palynology* 72 (1992): 27-40.
- 17 Stockey et al. 1994, op.cit.

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