

families of flowering plants (along with Chloranthaceae) on the basis of fossil pollen types assigned to modern families. The Cretaceous fossil pollen genus *Walkeripollis* from the late Barremian – early Aptian of Gabon and the late Aptian – early Albian of Israel is winteraceous^{2,3}. Winteraceae persisted in continental Africa until at least the lower Miocene in the southwestern Cape, represented there by two different pollen types associated with modern-day *Bubbia* and *Tasmannia* (sometimes considered *Drimys* section *Tasmannia*), both now restricted to Australo-malesia⁴. The pollen of *Takhtajania*, which is the largest reported in the family, has been compared to that of *Drimys* sensu stricto, which is distributed only in the New World⁵.

Recent molecular phylogenetic studies utilizing internal transcribed spacer (ITS) sequences of ribosomal DNA aimed at resolving genetic relationships within Winteraceae⁶ largely corroborated proposed relationships based on morphological features⁷, but also clearly illustrate how widely divergent *Tasmannia* is from *Drimys*. Preliminary analysis of the *Takhtajania* ITS sequence indicates a basal position for the genus within Winteraceae (Elizabeth Zimmer, personal communication).

Takhtajania perrieri was originally described in 1963 by the French forest botanist René Capuron in the genus *Bubbia*, known from Australia, New Caledonia and the Lord Howe Islands⁸. On the basis of several anomalous features unique within Winteraceae, including a putative bicarpellate ovary and a primitive arrangement of undifferentiated cells surrounding the stomata, Leroy and Baranova in 1978 created a new genus and subfamily to accommodate the species, naming it in honour of the Russian plant systematist Armen Takhtajan⁹. Recent anatomical studies utilizing the type material support the hypothesis of a compound bicarpellate ovary¹⁰. In St Louis in June 1997, while celebrating his 87th birthday and the publication of his latest synthesis on the classification of flowering plants¹¹, Takhtajan was presented with a specimen of *Takhtajania* for the Komarov Botanical Institute in St Petersburg.

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Changed perceptions in Braille readers

The mature mammalian nervous system has a striking capacity for plastic remodeling in response to environmental changes, but little is known about the perceptual and behavioural relevance of this phenomenon. Using magnetic source imaging we show that the cortical somatosensory representation of the fingers is topographically disordered in blind Braille readers who use three fingers on both hands to read. In addition, they frequently misperceive which of these fingers is being touched. This correlation is suggestive of a functional role for cortical reorganization in the perceptual experience of these individuals.

The somatosensory cortical representation of fingers expands when the amount of sensory input arriving in that part of the brain is increased^{1–6}. Indeed, we have previously used magnetic source imaging to

show that the somatosensory cortical representation of the left hand of string players, which engages in the complex and demanding task of fingering the strings, is expanded¹. To test the hypothesis that fusion of cortical representations is caused by increased simultaneous stimulation^{7–9}, we tested the somatotopic representations of four blind Braille readers who used three fingers (digits 2–4) of both hands simultaneously for reading, and were instructors of the method typically engaged in this practice for several hours a day. We also tested six Braille readers who employed one finger for reading, and five sighted non-Braille-reading subjects. Magnetic source imaging was used to determine the centre of cortical magnetic responsivity to light tactile stimulation of the finger tips (left and right D1, D2 and D5) and right and left lower lip¹.

There was a substantial enlargement of the hand representation in the three-finger Braille readers compared with the other two groups (three-finger readers, 14 mm; one-finger readers, 8 mm; sighted, 7 mm; $F_{2,12} = 16.6$, $P < 0.001$). The three-finger readers also differed from sighted subjects in the topographical arrangements of the finger representations along the postcentral gyrus (Fig. 1). In all sighted subjects the expected homuncular pattern was observed; D1 being inferior (lateral), D2 being more medial, and D5 being the most superior (medial). In each of the three-finger Braille readers, this pattern was changed in one or both hemispheres. Only one of the one-finger Braille readers' cortical topography of finger representations was disordered. These are significant differences ($P < 0.005$, Fisher's exact test, 2-tailed),

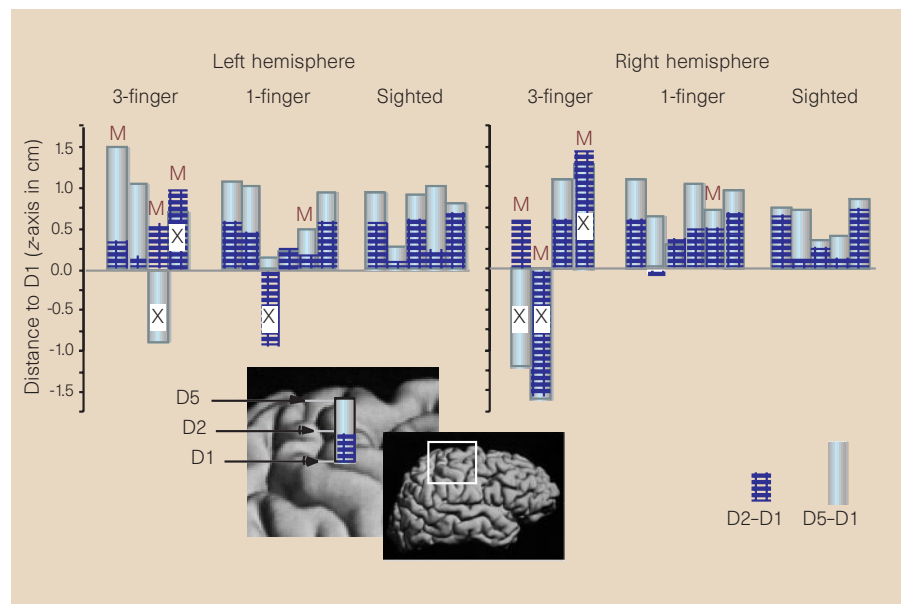


Figure 1 Distances between centres of cortical responsivity: D1, thumb; D2, index finger; D5, little finger. Distances are displayed with reference to the D1 location, which is graphed at the zero-line. The inset shows the centre of responsivity for D1, D2 and D5 superimposed on the brain of a sighted subject. X, Hemispheres in which the homuncular organization of the cortical representations of the fingers was disordered; M, cortical representation of hands in which the location of tactile stimulation was mislocalized.

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with the three-finger readers differing significantly from the one-finger readers ($P < 0.02$) and sighted controls ($P < 0.008$), whereas the latter groups were not significantly different from one another.

Each of the three-finger readers had a strong tendency to misidentify which finger was being touched during tactile sensory threshold determination, although there was no difficulty in determining that one of the fingers had been touched. In contrast, none of the sighted subjects and only one of the one-finger readers reported such difficulties. Again these are significant differences (for the three groups, $P < 0.005$; three-finger against one-finger, $P < 0.02$; three-finger against sighted, $P < 0.008$; Fisher's exact test, 2-tailed). Sensory threshold testing was also conducted in five other sighted individuals, none of whom had difficulty in localizing tactile stimuli.

A striking feature of the data was the coincidence between the digital topographic disorder in the cerebral cortex and the mislocalization of tactile stimulation of the fingers. This relationship was significant when the data from all individuals were pooled (Fisher's exact test, $P = 0.017$). For the three-finger Braille readers, the hand opposite each of the hemispheres in which there was disorder exhibited a corresponding tactile mislocalization.

'Smearing' of the digital cortical representation could be adaptive for Braille readers who use three fingers in that it serves to fuse input transmitted over different fingers, so that the incoming information can be processed as a whole. Thus, use-dependent cortical reorganization can be associated with functionally relevant changes in the perceptual capacity of the individual.

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Ancient trees in Amazonia

The ages of tropical rain forest trees provide critical information for understanding the dynamics of tree populations, determining historical patterns of disturbance, developing sustainable forestry practices and calculating carbon cycling rates. Nevertheless, the ecological life history of most tropical trees is unknown and even the ages of the largest trees remain to be determined. Tree ages are typically measured by counting annual rings, but in tropical forests rings can be non-existent, annual or irregular¹. In the absence of annual rings, ¹⁴C dating is the only way to determine the age of a tree directly. We have ¹⁴C-dated twenty large, emergent trees from a central Amazon rain forest and find that, contrary to conventional views, trees in these forests can be more than 1,400 years old.

There is debate over how ages are distributed in rain forest trees, although there are almost no direct measurements. Typically, ages are based on extrapolations from growth or mortality rates compiled from permanent plots where observation intervals are short (usually less than 15 years), compared with the longevity of most trees. Because rates vary within a species, and over time within an individual, age estimates are subject to error. Using permanent plot data for 21 canopy species, a study² in Costa Rica calculated that the greatest time required to grow from a diameter of 10 cm to the maximum was 440 years. Another study in Costa Rica estimated that, on the basis of maximum and median growth rates for five emergent species, it would take between 90 and 600 years to reach 100 cm in diameter³.

Supporting younger age estimates, it has been suggested that only trees that exhibit optimum growth rates emerge from the canopy, and that most suppressed individuals are destined to die⁴. In contrast, on the basis of mortality rates, a study in Panama suggested that some trees can live for more than 1,000 years⁵. Our understanding of tropical tree age demographics can be advanced by measuring ages directly, yet the only previously ¹⁴C-dated tree in the Amazon is a 500-year-old⁶ Brazil nut tree (*Bertholletia excelsa*) that is 225 cm in diameter.

To determine the distribution of ages between some large emergent trees in the central Amazon, we ¹⁴C-dated twenty trees from thirteen species harvested in a 80,000-hectare logging operation near the city of Manaus, Brazil. Some trees were very old, with calibrated⁷ ages (± 80 years) ranging from 200 to 1,400 years. Tree size was significantly correlated with age, but most variability was accounted for by other fac-

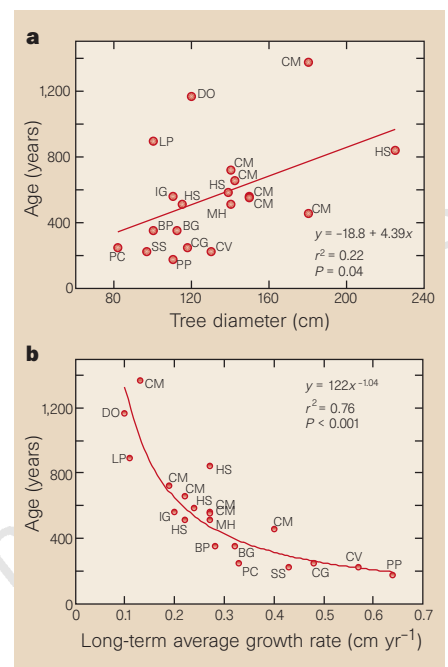


Figure 1 Radiocarbon dates for central Amazon trees. Measurements were made at the Center for Accelerator Mass Spectrometry at Lawrence Livermore National Laboratory. Long-term average growth rates were calculated as diameter divided by age. Although significant, size is not a reliable predictor of age (a). For large trees, growth rate is probably a much better predictor of age (b). Species are: BG, *Bagassa guianensis*; BP, *Brosimum parinarioides*; CM, *Cariniana micrantha*; CG, *Caryocarp glabrum*; CV, *Caryocarp villosum*; DO, *Dipteryx odorata*; HS, *Hymenolobium* spp.; IG, *Iryanthera grandis*; LP, *Lecythis poiteaui*; MH, *Manilkara huberi*; PP, *Parkia pendula*; PC, *Peltogyne catingae*; SS, *Sclerolobium* spp.

tors (Fig. 1a). Long-term average growth rate was highly correlated with age and the relationship was nonlinear (Fig. 1b).

Average growth rates varied from 1.0 to 6.4 mm yr^{-1} , and within one species alone (*Cariniana micrantha*) rates varied from 1.3 to 4.0 mm yr^{-1} . This suggests that trees can emerge from the canopy by rapid growth, presumably in gaps; by protracted slow growth; or by some combination of both, and the strategy is probably highly species-dependent. At a larger scale, ages for the oldest trees in a region set the minimum time since the last catastrophic disturbance. There is evidence that extensive drought, and perhaps widespread fires, linked to large El Niño events occurred in the Amazon basin 1,500, 1000, 700 and 450 years ago⁸. If the central Amazon was affected, some trees must have survived a number of these events.

Age data also provide important information for foresters. If commercial-sized trees are many centuries old, developing sustainable forest management practices that result in limited forest structural changes will require either huge tracts of forests or very long harvest cycles. Finally,