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Francis Hallé (1938–2025), founder of the study of tree architecture

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ABSTRACT

Francis Hallé (1938-2025) was one of the most influential French botanists of the last century. He founded plant architectural analysis, showing that post-embryogenic development follows intrinsic, species-specific rules, and that the immense diversity of tree forms can be captured by a finite set of recurring architectural models. He also co-invented the Radeau des Cimes, a canopy-access platform that transformed tropical forest research by making the canopy directly observable and sampleable, and by catalysing ambitious, multinational expeditions. Beyond research, Hallé was an extraordinary communicator: through books, drawings, and public talks, he fought plant blindness and taught generations to look at plants differently. In his final years, he led a major project with the aim to recreate a large, primary forest in Western Europe. Hallé died on 31 December 2025, leaving a scientific, cultural, and ecological legacy that will long outlive him.

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Francis Hallé (Figure 1) was one of the most influential French botanists of the last century. His legacy rests on four main achievements. First, he established a new field – plant architectural analysis – and made a series of paradigm-shifting discoveries into how plants and in particular trees develop. Second, he co-developed the so-called "Radeau des Cimes", a method to study forest canopies by placing a raft platform on top of it, using a hot air balloon. Third, with more than thirty books and hundreds of seminars, Francis Hallé was an exceptional public communicator of botany, where he fought plant blindness and eminently illustrated the uniqueness of plants. Fourth, in the last years of his life, he dedicated his energy to the protection of primeval forests in Western Europe, founding an association that now continues this task. Francis Hallé died on 31 December 2025, surrounded by his family, leaving an immense legacy.

Born 15 April 1938 in Seine-Port (Seine-et-Marne), Francis Hallé grew up as the youngest of seven children in a family where natural history and arts intertwined: his father was an agronomy engineer (and, during the war, cultivated a suburban plot to feed the family), while his mother was the daughter of the painter and engraver André Dauchez (later *peintre officiel de la Marine*, i.e. official painter of the French navy). Drawing, which was so important to both his science and his work of scientific communication, had a long tradition in his family; in addition to his maternal grandfather, his lineage included earlier painters such as Noël Hallé (1711–1781), a 18th-century French artist known for major commissions for royal residences. Guided by his older brother Nicolas (11 years his senior, and subsequently a professor at the *Muséum national d'Histoire naturelle*, Paris), Francis was drawn early to botany – germinating tropical seeds his brother brought back from the tropics, a passion that helped bring him to the attention of professors. He studied biology at the Sorbonne, Paris, and completed a doctorate at the University of Abidjan (Côte d'Ivoire) in 1966, became *maître de conférences* (lecturer) at the University of Brazzaville (Republic of the Congo) in 1968, then professor at Lovanium University in Kinshasa (DR Congo) from 1969, before taking up a long professorship in botany at the University of Montpellier from 1971 to 1999. Here he built a generation's tropical botanical training and developed the research program that would make plant and tree architecture central to modern botanical thought, following on his work started from the mid-1960s. In 1979 and 1980, he was assigned for two years in Indonesia as a "Team Leader" at the Biotrop/SEAMEO Center for Tropical Biology in Bogor. Beside exploring forests and plants in Sumatra and Borneo, he discovered the astonishing agroforests of Indonesia forest farmers, about which he would later communicate extensively in his lectures and conferences. He explored the world's forests and in particular tropical rainforests for over 50 years and conducted field work in Argentina, Australia, Brazil, Brunei, Cameroon, Chile, China,

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Figure 1. Francis Hallé botanizing at Belvedere, Campomoro, Corsica, September 2024.

Cuba, Colombia, Comoros, Côte d'Ivoire, Democratic Republic of the Congo, Ecuador, French Guiana, French Antilles, Réunion, New Caledonia, Gabon, Indonesia, Japan, Laos, Madagascar, Malaysia, Mexico, New Zealand, Panama, Papua New Guinea, Peru, Poland, Portugal, Republic of the Congo, Solomon Islands, Singapore, South Africa, Spain, Sri Lanka, Tanzania, Thailand, UK, USA, Vanuatu and Venezuela.

Francis became immediately obsessed by the tropics and, indeed, moved to Côte d'Ivoire to complete his PhD. He was initially frustrated by botany's long-standing fixation on reproductive structures (a Linnean legacy) rather than vegetative forms – an emphasis obviously ill-suited to tropical forests, where flowers and fruits are usually stranded high in the canopy (F. H. pers. comm. to G. C., 2018). From this frustration came two breakthroughs: a new botanical discipline (plant architecture) and, later, the *Radeau des Cimes*, an ingenious raft to explore the canopy (see below).

Plant developmental biologists have traditionally bound plant development to two phases: embryogenesis from the fertilized egg to the embryo in a seed, and post-embryogenesis from germination onwards where a plant's open *bauplan* continue to develop indefinitely thanks to meristems. This second phase, often regarded as plastic, and a paradigm shift that Francis Hallé brought was to show that developmental patterning also occurs post-embryogenesis. The activity of these meristems is not simply influenced by environmental cues but is patterned in an intrinsic way that is species-specific, but convergent across many unrelated taxa. Francis Hallé's work from the mid-1960s onward established the conceptual foundations of modern plant architectural analysis, identifying a small, limited numbers of growth patterns to which a majority of plant species conform. His early paper on *Hevea brasiliensis* growth rhythms (Hallé and Martin 1968) introduced the notions of growth unit and unit of morphogenesis, describing the sequence of organs produced during one uninterrupted elongation phase. This developmental view culminated in the seminal *Essai sur l'architecture et la dynamique de croissance des arbres tropicaux* (Hallé and Oldeman 1970), which formalized the architectural model as a species-specific set of rules governing key morphological traits such as axis differentiation, growth determinacy, branching mode, and phyllotaxis. Each architectural model represents a coherent genetic blueprint of the plant's construction, and Hallé and Oldeman demonstrated that the immense morphological diversity of trees could be described by a finite number of such

combinations – eventually 24 models – each defining a recurrent developmental strategy. A further influential, much-cited book, *Tropical Trees and Forests: An Architectural Analysis* (Hallé F, Oldeman RAA, et al. 1978) as well as subsequent work (Hallé 1978, 1986, 2004; Hallé and Ng 1981; Hallé and Keller 2019) systematized the method, provided long taxonomic lists of examples for each of the 24 architectural models, and discussed many other concepts including that of reiteration, the partial or total reproduction of the architectural model within an individual – a concept developed in 1972 with his former PhD student Roelof Oldeman (1937–2022). His work on plant architecture has left important legacies and continue to structure research in plant morphology and evolution (Barthélémy and Caraglio 2007; Chomicki et al. 2017).

Francis Hallé is also one of the inventors of a technical approach that revolutionized the study of forest canopies – the *Radeau des Cimes*, together with aeronaut Dany Cleyet-Marrel and architect Gilles Ebersolt. He made the first balloon reconnaissance of a European forest canopy at Uzès, France in 1981 and then developed the *Radeau des Cimes* into an operational canopy research platform. In 1985, trials in the Parc du Pilat (France) proved that a pneumatic "raft" and netting could be floated onto treetops, and finally the decisive leap to the tropics with the first operational deployment in French Guiana at Crique Couleuvre in 1986, where researchers could build canopy herbaria and insect collections from a platform set directly onto crowns. He then championed the move to a purpose-built hot-air dirigible, which made heavier payloads and repeat operations feasible and he oversaw the move from a prototype to a repeatable research platform – alongside complementary devices such as the luge – during major multinational campaigns including Petit-Saut, French Guiana (1989), Akok, Cameroon (1991), Paracou/Voltaire, French Guiana (1996), Makandé, Gabon (1999), and Masoala, Madagascar (2001). This new approach opened up new avenues for canopy research (Lowman and Schowalter 2012), and led to many

Figure 2. 'A strangler fig in Peruvian Amazonia'. Drawing by Francis Hallé of a tropical forest, linking its artistic elegance and the implicit emphasis on plant organisation patterns.

discoveries, including new insights into tropical canopy physiology (Kesselmeier et al. 1993; Koch et al. 1994), patterns of arthropod abundances in tropical canopies (Basset et al. 1992, 2001), and even the discovery of the first succulent bamboo (Haevermans et al. 2020). Francis Hallé served as head of the *Radeau des Cimes* missions and led the scientific dimension of tropical canopy research from 1986 to 2001, directing work across French Guiana, Brazil, Cameroon, Gabon, and Madagascar, and his canopy leadership extended into later raft-based programs in Panama (San Lorenzo, via IBISCA) and Laos (Nam Hinboun, Khammouane).

In France, and well beyond, Francis Hallé stood out for his outreach work that tackled plant blindness head-on, by showing masterfully what makes plants biologically singular, as well as for awakening the general public to the importance of tropical forests and the urgency to conserve them. He pursued this on two fronts: first through over thirty fascinating popular science books that captivated generation of readers, young and old alike, promoting careers and passions. Especially notable publications are *L'éloge de la plante* (1999) (translated into English in 2002: *In praise of plants*), where he draws comparisons between plants and animals to illustrate how unique plants are, and how many concepts – for instance individuality, excretion, death or even evolution – have long been zoo- and anthropocentric and need a rethink when it comes to plants. *Plaidoyer pour l'arbre* (2005) focuses on the uniqueness of trees. Two books are dedicated to the uniqueness of the tropics (Hallé 1993, 2014). He also used his artistic skills (Figure 2) to reach the general public, for instance in the exhibition *Trees* by the foundation Cartier in Paris, but also insisted on the beauty of life in his 2024 illustrated book on *La beauté du vivant* (Hallé 2024), culminating his overlooked career of artistic draftsman. Throughout his travels and expeditions, he remained deeply attentive to the relationships between people and plants, especially the ways forest-dwelling communities know, use, and depend on them. Francis had a natural talent to communicate science to the general public, both through the style and drawings in his books, and a compelling, deeply engaging speaking voice. Until last November, aged 87 years, he was still travelling over France and beyond, signing books, speaking on French TV and contributing to podcasts and videos online.

Late in his career, Francis Hallé turned a lifetime of field botany into a concrete political-ecological project: to bring back a true primary forest in Western Europe, at a scale large enough to matter. At his initiative, supporters organized around the idea in 2018–2019, framing it as a response both to the collapse of tropical primary forests and to the widely publicized damage inflicted on Europe's last major primary forest, Białowieża (Poland). Francis Hallé insisted on a simple, radical specification: a very large, European-scale reserve (~70,000 ha minimum) placed in strict non-intervention (*libre évolution*) so that forest dynamics, biodiversity, and structural complexity could rebuild over many centuries (often expressed as ~800–1000 years) – a timescale meant to match what "primary" actually implies. He set the project down in print as a short manifesto – *Pour une forêt primaire en Europe de l'Ouest* (Hallé 2021a) – and carried it to mass audiences, notably through a TEDx talk (Hallé 2021b), "Faire renaître une forêt primaire en Europe, projet utopique", which distilled the plan into a public call for institutional commitment and citizen backing. With this aim, he created an association, which will continue to guide this project (https://www.foretprimaire-francishalle.org/en/).

Francis Hallé was awarded an honorary doctorate from Florida International University, Miami, in 2003, the David Fairchild Medal for Plant Exploration in 2004, the Lowell Thomas award from the Explorers Club in New York in 2006 and the Dutch Het Kronendak Foundation's Mr C. Th. F. Thurkow Prize in 2016. His scientific outreach work also received several distinctions, including the Prix P.-J.-Redouté awarded twice, once in 2006 for his book *Plaidoyer pour l'arbre* and once jointly with Luc Jacquet in 2014 for the documentary film *Il était une Forêt*. The book of the movie, with the same title, received the prix Emile Galle in the same year. His book *Le Radeau des Cimes*, narrating the history of canopy exploration through these canopy rafts, received the Prix André Soubiran in 2001. His most distinguished literary prize was the Académie française's Prix Jacques de Fouchier for *Essais de botaniste* in 2011. The botanical society of France awarded him its lifetime achievement recognition in 2021.

Beside these honours, Francis Hallé loved simple life, sailing in French Brittany or in the Mediterranean Sea or sharing time and discussions with friends. Above all, he liked being in the field, especially in the tropics. Francis Hallé conducted tropical fieldwork until the end of his life, always studying and drawing plants. To all who learned from him – in lecture halls, under or above the forest canopy – Francis was both a generous mentor and friend. His loss will be deeply felt by tropical botanists and ecologists, and all who care about plants and forests worldwide. We will all remember an outstanding botanist and a gifted communicator, but above all a truly remarkable human being.

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