Schweingruber’s cosmos of inspiration

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ABSTRACT

Born 29th February 1936 near Bern, Switzerland, Fritz Hans Schweingruber worked as a teacher until 1965, obtained a PhD in botany from the University of Basel in 1972 (where he also obtained a Professorship in 1976), and started his lifelong career at the Swiss Federal Research Institute WSL in Birmensdorf right afterwards. Fritz developed a dendrochronological network across much of the Northern Hemisphere, expanded wood (xylem) science beyond forests, implemented wood anatomical techniques into dendroecology and paleoclimatology, and enthusiastically trained thousands of students, of which hundreds remained actively involved in the still emerging field of tree-ring research. Though Fritz died 7th January 2020 after an extraordinary academic career, his intellectual legacy will continue to inspire scholars around the world.

1. Chronology development, anatomical assessment and impact study for a fulfilled life

Fritz had a near-perfect photographic memory that allowed him to store huge amounts of data sustainably and access all kind of information rapidly. Of the sheer infinite number of trees, shrubs, dwarf shrubs and herbs he sampled and/or collected during the past five decades from a range of biogeographic habitats between 0 and 6150 m asl on six continents, he was able to tell short, though almost always inspiring stories. Together with his tremendous diligence, he catalysed his scientific memories and generated 39 fascinating books, of which many were published by Springer (e.g. Schweingruber et al., 2011). His opus magnum “Tree Rings and Environment. Dendroecology” (Schweingruber, 1996) is a standard for any tree-ring researcher, and his last book – an anatomical atlas of aquatic and wetland plant stems – was published just recently (Schweingruber et al., 2020). Fritz contributed to more than 200 journal articles, often as the senior author, and his numerous ring width, density and anatomy data will continue to play an important role in many studies.

Right from the beginning of his academic career in the 1970s, it was essential for him to make all data freely available; this generosity, unfortunately, was not infectious to everybody and many scholars are still not convinced by the mutual benefits of open data access. Fritz’s liberal attitude, however, pathed his international success. In providing chronologies since 1970s, Fritz became the most prolific contributor to the International Tree-Ring Data Bank (ITRDB). As a role model for many of us, he is credited as principal investigator for 451 collections and co-investigator for another 75. Rigorously advocating open data accessibility and the unprejudiced exchange of intellectual property, Fritz was essential for the collegial sprit of our community. The immense paleoclimatic value of Schweingruber’s Northern Hemisphere tree-ring width and density networks is best reflected in three out of several highly-cited and hugely influential articles published in Science and Nature (Esper et al. (2002) and Briffa et al. (1998a) demonstrated the ability of well-replicated and carefully standardized tree-ring chronologies to preserve and capture low-frequency growth and temperature variability as well as the rapid response to volcanic activity during the past centuries, while probably being affected by reduced climate sensitivity since the 1980s (Briffa et al., 1998b). Another Nature article still describes the scientific benchmark for disentangling biotic and abiotic drivers of boreal forest productivity (Vaganov et al., 1999). Numerous ring width and maximum latewood density chronologies Fritz had developed since the early-1970s formed the backbone of various IPCC reports (https://www.ipcc.ch/), and his early work on species identification, wood provenance and cross-dating was crucial for the creation and maintenance of modern dendroarchaeology (Schweingruber, 1975).

Fritz was a virtuoso on the microtome, a subtle craftsman, and an obsessive collector. He was a passionate explorer of epistemological concepts. Using transverse, tangential and radial sections of tens of

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by intensively lignified fiber belts (200:1). (j) Dicot Orobancheaceae (Euphrasia minima), stem of a 5 cm tall therophyte. All xylem cells are lignified (200:1). (k) Dicot Brassicaceae (Arabidopsis thaliana), root collar of a 20 cm tall therophyte. Only vessels in the central part of the xylem are lignified. In the peripheral part fibers and vessels are lignified but not the paratracheal parenchyma cells (200:1). (l) Dicot Fagaceae (Fagus sylvatica), 40 m tall tree. Fibers and vessels are lignified but not the apotracheal parenchyma cells and the unieriate rays (200:1). (m) Dicot Apiaceae xylem rhizome (Seseli annuum), 80 cm tall hemicyrptophyte. Fibers and vessels are lignified but not the rays and the marginal parenchyma cells (200:1). (n) Dicot Caryophyllaceae polar root (Cerastium arvense), 10 cm tall hemicyrptophyte. Only vessels are slightly lignified (200:1). (o) Dicot Fagaceae bark (Fagus sylvatica), 20 m tall tree. Sclereids in the cortex and the dilated rays are intensively lignified (200:1). (p) Dicot Linaceae bark (Linum suffruticosum), 40 cm tall upright dwarf shrub. Only one fibre in the phloem is lignified within the principally non-lignified cortex (200:1). (q) Dicot Brassicaceae bark (Braya sativa), 40 cm tall therophyte. All cells are non-lignified (200:1). (r) Dicot Ceratophyllaceae, 40 cm tall hydrophyte. Not a single cell is lignified (100:1).

Fig. 1. Examples of Schweingruber’s sampling sites: Temperature-constrained, northern most limit of plant growth in east Greenland around 73 °N, aquatic limitation of terrestrial plant growth at 0 m asl in north-western France, drought-induced, arid limit of plant growth in the desert of Libya, upper distribution limit of plant growth in Ladakh, western Himalaya (from left to right).

Fig. 2. Examples of Schweingruber’s xylem science: (a) Bryophyta (Neckera crispa), 5 cm tall prostrate perennial moss. A thick-walled and intensively lignified cortex surrounds a vessel-free parenchyma tissue (200:1). (b) Lycopodiaceae (Lycopodium annotinum), 40 cm tall prostrate hemicyrptophyte. A thick-walled and intensively lignified cortex surrounds a central cylinder (stelle). The xylem consists of tracheids with lignified cell walls (100:1). (c) Selaginellaceae (Selaginella sp.), stem of a 20 cm upright hemicyrptophyte. A thick-walled and intensively lignified cortex surrounds a non-lignified parenchyma tissue and irregularly formed vascular bundles consisting of partially lignified tracheids (100:1). (d) Equisetaceae (Equisetum hyemale), rhizome of a 20 cm upright hemicyrptophyte. A thick-walled and intensively lignified cortex surrounds a thin walled parenchyma arelenchymatic tissue and non-lignified vascular bundles (100:1). (e) Cupressaceae (Juniperus communis), xylem of a 4 m tall tree. Characteristic features include lignified tracheids and rays, as well as and non-lignified axial parenchyma cells (200:1). (f) Cupressaceae (Juniperus communis), phloem of a 4 m tall tree. Mainly non-lignified sieve cells and parenchyma cells. A few isolated lignified fibers are arranged in tangential lines (200:1). (g) Monocot Poaceae (Carex alba), annual shoot of a 20 cm upright hemicyrptophyte. Intensively lignified groups of fibers surround the vascular bundles. Xylem vessels are slightly lignified (200:1). (h) Monocot Orchidaceae (Epipactis atrorubens), annual shoot of a 20 cm upright geophyte. A lignified belt within the cortex surrounds vascular bundles with lignified belts (200:1). (i) Monocot Palmaeaceae (Phoenix dactylifera), central part of a 10 m tall palm tree (tree). Vascular bundles consist of lignified vessels surrounded thousands of plant samples from almost all biomes on six continents (Fig. 1), Fritz revealed the large anatomical variability of stems (Crivellaro and Schweingruber, 2013; Schweingruber and Börner, 2018) (Fig. 2), including bark and pith (Crivellaro et al., 2013). His emerging interest in combining wood anatomy, plant physiology and dendroecology (Schweingruber et al., 2011) inspired a generation of young scholars worldwide to advance their scope beyond trees (Schweingruber and Büntgen, 2013). The nuanced interpretation of anatomical features, of which many have been described for the first time by Fritz, however, was only possible due to the refinement of cutting and staining techniques (Gärnér and Schweingruber, 2013; Gärnér et al., 2014, 2015). Due to this global xylem database (Büntgen et al., 2020) the nuanced interpretation of anatomical features, of which many have been described for the first time by Fritz, however, was only possible due to the refinement of cutting and staining techniques (Gärnér and Schweingruber, 2013; Gärnér et al., 2014, 2015).
diligence, pragmatism, directness and stamina, which enabled him to collaborate. Fritz had established a distinct value system, driven by his teaching experiences and research. 

Knowledge accessible in an easy way was always his prime goal (Kaennel and Schweingruber, 1995). Due to many teaching experiences and research collaborations, Fritz had established a distinct value system, driven by diligence, pragmatism, directness and stamina, which enabled him to differentiate between constructive scientific criticism (Büntgen and Schweingruber, 2010) and personal animosity.

With much vision and spirit, Fritz had the ambition to introduce time to plant ecology. He therefore proposed a different type of dendroecology based on collecting as much samples as possible from different age classes and species across the landscape (including herbs and grasses), preparing anatomical thin sections, and ignoring cross-dating, thus breaking a taboo in dendrochronology. With this disciplinary expansion in mind, Fritz emphatically suggested to prioritize five research avenues at the interface of wood anatomy and dendroecology:

1. determine individual plant ages and community age structures;
2. consider site- and species-specific differences in plant morphological characteristics and stem anatomical features;
3. expand stem anatomical and xylem chronological investigations from tundra shrubs to herbs;
4. estimate historical changes in biomass production and carbon allocation within and among plant species; and
5. apply community-based dendroecological studies to associate changes in age structure and recruitment intensity with environmental and climatic factors.

Fritz was highly creative and always searching for new frontiers and inspiration. During the recent past, he explored linkages between art and nature, for which he developed innovative models of realising (macroscopically) and explaining (ecologically) form and function from the cell to the globe. Gifted with the rare ability to see the unknown, he invented an exciting cosmos of novelty.

Fritz’s lifetime achievement would have been impossible without his wife. His thoughts were sharp until the very end, and his last decisions were an obvious continuation of his oeuvre, respectfully demonstrating character strength, pragmatism, far-sightedness, and con-jugal security. Those who knew Fritz will never forget him, and generations of scholars will be inspired by his legacy.

Declaration of Competing Interest

Authors declare no conflict of interest.

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