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Returning (to) the roots of dendrochronology – Requiem for Jacobus Cornelius Kapteyn (1851–1922)

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ABSTRACT

The need to understand natural climate variability and improve weather forecasts gave birth to the first tree-ring reconstructions more than a century ago in Europe and North America, and still defines a central motivation for modern paleoclimatology: learning from the past to prepare for the future.

What an exciting time this must have been when Wilhelm Röntgen detected electromagnetic radiation in 1895, Nikola Tesla made important steps towards electricity supply systems in the 1890s, the Wright brothers flew the first aircraft in 1903, Albert Einstein published four ground-breaking papers in 1905, and Marie Curie received two Nobel Prizes in 1903 and 1911 – just to name a few giants that changed the world we live in.

On Sunday, the 19th of January 1851, Jacobus Cornelius Kapteyn was born in the small town of Barneveld in the Netherlands. At the age of 27, Kapteyn was appointed to the first full Professor of Astronomy and Theoretical Mechanics at the University of Groningen, where he founded the Astronomical Laboratory in 1896 and became its director. From then on, Kapteyn devised the parallactic method, measured the position and magnitude of almost 500,000 stars (van der Kruit, 2014), and made fundamental discoveries of the rotation of our Galaxy (van der Kruit, 2020). Later, he devoted his career to the problem of the construction of the Heavens and the structure of the Sidereal System. Accuracy and patience were the main pillars of his success. Before his death on the 18th of June 1922 in Amsterdam, Kapteyn developed the first reliable model of the Milky Way, which made the Universe internationally famous. Among his most prominent students was Jan Hendrik Oort, after whom a solar minimum during medieval times was named (Usoskin et al., 2003).

While Kapteyn was a talented student of mathematics and physics at the University of Utrecht, Andrew Ellicott Douglass was born on the 5th of July 1867 in the northeast of the United States. Like Kapteyn, Douglass also became a famous astronomer, Director of the Steward Observatory, and, most importantly, the founder of 'modern' dendrochronology and creator of the 'first' Laboratory for Tree-Ring Research at the University of Arizona in Tucson (McGraw, 2000). Referring to Kapteyn in *Scientific Monthly*, Douglass wrote in 1922 "the first two serious attempts to trace climatic fingerprints in trees were made by astronomers". His initial dendro studies were motivated by the idea of detecting climate-induced patterns of solar cycles in the annual growth rings of trees.

Between 1908 and 1914, Kapteyn and his wife Elise Kalshoven spent each summer at Mount Wilson Observatory in Los Angeles, California, the world's largest such facility where he was a Research Associate (van Maanen, 1922). During this time, Kapteyn not only worked on the configuration and motion of the stellar system (Crommelin, 1922; van Rhijn, 1951), but also presented results from the tree-ring research he started in 1879 across central Europe (Fig. 1). Following a lecture he gave in Pasadena, California, his first paper on tree rings and climate was published in *The Pasadena Star* on 19th December 1908 (Fig. 1), which then transformed into Kapteyn's seminal dendroclimatological article a few years later (Kapteyn, 1914). Modest to his own work and generous to others, Kapteyn immediately refers to Douglass ("in June 1909, Prof. H. E. Douglas published a similar investigation in the *Monthly Weather Review*."). In "Tree-growth and meteorological factors", Kapteyn describes the dendrochronological and -climatological principles of cross-dating, chronology development, site selection, and correlation coefficients (as acknowledged by Schulman, 1937). Kapteyn's (1914) article contains several figures, tables, and data, but no further tree-ring study was published by him afterwards. Kapteyn's daughter wrote "He was also busy with meteorologic studies, and he travelled to Worms and to Paris to do research on the growth of trees in relation to the climatic circumstances. He sent a request to the government to ask the French government for slices of two hundred year and older trees

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from the surroundings of Paris. That was where the weather station was located that had the longest historical records of meteorological data of amounts of rain. He occupied himself for some time with research into growth rings of trees, but he never came to formulate a theory. Only much later did he publish the results. But all this did not satisfy him. It was only child's play and he wanted to do something much greater, and he knew he was able to do that. Then, suddenly the solution came, and it gave an entirely new direction to his life." (Hertzsprung-Kapteyn, 1928). One can only imagine what advanced tree-ring experiments Kapteyn would have conducted had he lived to witness the first programmable computer by Konrad Zuse in 1941, which became a trailblazer for the Golden Age of scientific discoveries and technological advancements. Like Zuse, Douglass invented an analogue computer, the "cycloscope" that he used for the detection of cyclical patterns in tree-ring series due to changes in solar activity.

While the original tree-ring studies by Kapteyn remain largely unknown to dendrochronologists, he became a worldwide renowned astronomer and physicist (van der Kruit, 2015, 2021). In contrast, Douglass is still widely respected and frequently cited by an ever-growing tree-ring community (Douglass, 1909, 1914, 1919, 1920, 1922). Although, there is no doubt about Douglass' extraordinary impact on the field, it is unknown how much his early work was influenced by others. In his *opus magnum* published by the Carnegie Institution of Washington (Douglass, 1919), the author provides an extensive bibliography, though fails to cite Kapteyn (properly). The reference list further reveals several scholars in Europe and the US that have started investigations into the climatic drivers of annual tree growth during the first two decades of the 20th century, including E. Antevs, E.E. Bogue, H.

Fig. 1. Portrait of Jacobus Cornelius Kapteyn, his first article about tree rings and climate in *The Pasadena Star*, and a timeline of relevant achievements and publications.

R. Mill, and E.A. Vinson. Another review of the beginning of quantitative tree-ring research shows that the concept of dendroclimatology reaches back to the mid-19th century (Glock, 1941), but also ignores Kapteyn. Edmund Schulman, however, cites Kapteyn in his monumental work on dendroclimatic changes in semiarid America (Schulman, 1956).

Motivated by the need to understand natural climate variability and improve weather forecasts, Kapteyn and Douglass started (and published) their revolutionary dendroclimatology in 1879 and 1906 (1908 and 1909), respectively. It is arguably not a coincidence that some of the most innovative tree-ring studies at the crossroads with archaeology, astronomy and solar physics are still receiving major contributions from Groningen and Tucson (Kuitems et al., 2022; Pearson et al., 2022; Zhang et al., 2022). The epilogue about two astronomers that became the first dendrochronologists should inspire young scholars to dig deeper into the roots of their discipline and branch out to other fields. The fascinating histories further reflect the modern mantra of publish or perish, emphasizing the importance of sharing data and ideas for academic careers. Following a curiosity-driven journey that started more than a century ago, tree-ring researchers are more than ever in a position to advance our understanding of climate variability and human history.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

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