BIOGRAPHICAL MEMOIRS

Ellis B. Cowling

December 11, 1932–September 23, 2021
Elected to the NAS, 1973

A Biographical Memoir by James N. Galloway, Cari S. Furiness, Peringe Grennfelt, and Richard A. Haeuber

Ellis B. Cowling discovered a mechanism for isolating lignin from wood that was a fundamental (ecosystem science) and practical (wood industry) contribution to the field of lignin chemistry. For this work, he was elected to the National Academy of Sciences fourteen years after completing his first Ph.D. and three years after his second. In 1970, he met agricultural scientist Svante Odén in Sweden. Cowling was so struck by Odén's observations of acidification of precipitation and surface waters in Europe that it changed his research interests and mission for the rest of his life. After returning to the United States, he brought acid rain to the attention of the North American community. During the subsequent decades, he became a key scientist for developing science and monitoring in support of improving air quality.

Figure 1 Cowling during a 2011 interview at Chautauqua Institution. *Photo credit: Ellie Haugsby/*The Chautauquan Daily

Childhood and Family Life

Ellis Brevier Cowling was born in Waukeegan, Illinois, on December 11, 1932, the eldest son of Rev. Ira Ellis Cowling and Marion Cowling. Most of his formative years were spent in the town of Pompey in upstate New York; the family moved there in 1948 when his father became minister at Pompey United Church. Cowling honed his significant work ethic and handyman skills by working in the parsonage, church (as janitor and rebuilding the church organ!), and at area farms. He attended Syracuse University, where he met Evelyn B. W. "Bettsy" Wright, also the child of a minister, who became his wife and cherished partner in life. They courted during summers at the Chautauqua Institution in western New York and retained a lifelong connection, spending most summers attending lecture series, often with friends and family. They raised two daughters, Evelyn Blackley and Emily Price. Bettsy worked in childhood education during each of their moves in Cowling's career. Family was of great importance to Cowling. In his later years Cowling created a three-ring binder titled "Remembrances in the Family of Bettsy and Ellis Cowling," a series of letters and other documents that would be of interest to his daughters, grandchildren, and great-grandchild. The documents include the Christmas letters they wrote every year except one beginning in 1958 as well as philosophical perspectives such as "The Importance

NATIONAL ACADEMY OF SCIENCES

Figure 2 Cowling, during a visit with Svante Oden in June 1982 in Sweden. *Photo by James N. Galloway.*

of Modesty." Cowling and Bettsy shared moral values deeply and strove to instill these in their family and convey them to their friends.

Education and Early Career

Cowling earned a bachelor's degree in wood technology from Syracuse University in 1954 and a master's degree from Syracuse in 1956. He entered graduate school at the University of Wisconsin, Madison and earned a Ph.D. in 1959. The following year, he earned a second master's degree from Uppsala University in Sweden. In 1960, he was hired as an assistant professor at Yale University to oversee a newly created Ph.D. program in forest pathology. In 1965, he was hired as an associate professor at North Carolina State University, where he was quickly promoted to full professor (1968) with appointments in the Departments of Forestry, Plant Pathology, and Wood and Paper Science. Ever curious, Cowling returned to Uppsala University on a sabbatical leave and earned a second Ph.D. in physiological botany (1970).

Research and Later Career

Throughout most of his career, Cowling's scientific curiosity was focused on the interactions between forest trees and fungi that destroy cellulose and lignin in wood. Cowling uncovered evidence for several co-evolved nitrogen conservation mechanisms in this tree-fungus relationship: first, controlled allocation of available nitrogen to the enzymes that process cellulose and lignin in wood; second, autolytic decomposition of cytoplasm; and third, extremely conservative mechanisms for repeated reuse of available nitrogen. His discovery of a mechanism for isolating lignin from wood was a fundamental and practical contribution in lignin chemistry[1]; it remains the accepted method for structural study and has important applications for the wood products industry.[2] This work was important enough that Cowling was elected to the NAS in 1973, only nineteen years after graduating from college. That same year, he also proposed the creation of what would become a long-running scientific facility in Ashville, North Carolina: the Resistance Screening Center, which the U.S. Forest Service initiated and continues to fund as a service to tree improvement programs throughout the South.[3] Cowling became the first associate dean for research of the School of Forest Resources at North Carolina State University in 1978, with the charge to coordinate the school's research programs and act as assistant director for the North Carolina Agricultural Experiment Stations. In 1989, he was named a University Distinguished Professor At-Large, the only NCSU faculty so appointed. This position allowed Cowling to address numerous issues relevant to the University, including improving graduate education; redesigning faculty promotion and tenure processes; defining responsibilities to the land-grant mission including community engagement; providing guidance in selection of and advising of provosts, chancellors, and presidents; student diversity; issues of global change and sustainability; and processes of faculty governance. He also fulfilled requests for public service to the state of North Carolina, such as studying the relocation of the Cape Hatteras lighthouse.

During his sabbatical in Uppsala, Sweden, Cowling had an encounter that would prove consequential. He was introduced to Svante Odén, who he recalled as "a person that you absolutely should meet" and noted that "his life was never the same!" Cowling was so struck by Odén's findings on the acidification of precipitation and ecosystems in Europe that it changed his research interests and mission for life.

Returning to the United States post-sabbatical, Cowling helped to establish a broad network connecting scientists in North America with those in Europe to raise public awareness of acid rain, stimulate scientific exchange, and point toward solutions. An initial outcome of this effort was the First International Symposium on Acid Precipitation and the Forest Ecosystem, held in Columbus, Ohio, in May 1975. Cowling was a member of the organizing committee, and Odén was a keynote speaker. The participants concluded at the close of the meeting that knowledge at the time was "inadequate for any overall assessment of the atmospheric acidity problem" and called for further research on acid precipitation and other atmospheric contaminants, including "long-term atmospheric monitoring of precipitation and related atmospheric pollutants."[4]

The acid rain conference initiated a significant new phase in Cowling's career. Beginning in 1975, he led the development of a proposal to establish a national network to characterize precipitation quality.[5] By 1977, the project was a reality. Funded by the U.S. State Agricultural Experiment Stations, the National Atmospheric Deposition

Program (NADP) began operation in 1978 with the goal of providing data on the amounts, trends, and geographic distributions of acids, nutrients, and base cations in precipitation. The network grew in the ensuing decades, becoming one of the world's premier organizations to measure atmospheric deposition and study its effects on the environment. The NADP has grown over time to include other contaminants, such as mercury, ammonia and, most recently, PFAS (per- and polyfluoroalkyl substances). The network remains a critical source of science and data and a platform for discussion and the development of environmental policy and regulation in the United States and internationally.

A hallmark of Cowling's career, starting with his work focusing on acid rain, has been bringing science to public awareness and the policy arena.[6] In his 1982 paper, Acid Precipitation in Historical Perspective, Cowling provided a thorough and extensive review of the history of acid rain.[7] The paper exemplifies how Cowling was able to synthesize the wide range of science necessary to obtain a full understanding of the problem and the evolution and links between industrial society and threats to ecosystems. In the paper, he pointed to the historic observations and publications on acid rain as a transboundary problem that had been overlooked by the scientific community and society.

Cowling also ensured that this scientific knowledge made its way into the policy process through active participation in the National Acid Precipitation Assessment Program (NAPAP), a decade-long research endeavor that directly informed development of the Acid Deposition Control Program as a key part of the 1990 amendments to the Clean Air Act.[8] Cowling co-authored the original draft plan for the program,[9] mentored many participating scientists, managed multiple program reviews, and served as liaison between the NAPAP II Oversight Review Board and NAPAP Office of the Director.

With acid rain controls underway following emissions reductions included in the 1990 Clean Air Act amendments, Cowling focused on the emerging ramifications of air pollution. His leadership in large-scale research collaborations, particularly the Southern Oxidants Study, significantly advanced scientific understanding of ground-level ozone, including the importance of precursors in its formation. These scientific advances came at a time when the nation was struggling with high ozone concentrations over large areas and adverse effects to the health of millions of Americans. His work to advance the science underlying our understanding of ozone had a direct impact on air-quality policy formulation, including the first state-level regional-scale nitrogen oxide emissions reduction program and decades of federal regulatory efforts.

Given his broad expertise in air pollution and nitrogen effects, Cowling was invited to participate in the steering committee for the First International Nitrogen Conference in Noordwijkerhout, the Netherlands, in March 1998. The conference was chaired by Jan Willem Erisman, who had this to say about Cowling: "I was impressed when I met him at the conference by his kindness, the sparkling eyes and the knowledge, experience, and drive!" And he must have been very impressed, because on the last day of the conference he asked Cowling and Jim Galloway to organize the Second International Nitrogen Conference. At that conference, held in Potomac, Maryland, in October 2001, the unanimous view of the 400 participants was that an international program was required to optimize the benefits of nitrogen and minimize associated problems. This recommendation led to the formation of the International Nitrogen Initiative (INI) in 2003, which was sponsored by the Scientific Committee on Problems of the Environment (SCOPE) and the International Geosphere-Biosphere Program (IGBP). It is a tribute to Cowling's leadership that the INI now has centers all over the world.

Figure 3 From left, Cowling with his colleagues Svante Oden and Bert Bolin in Sweden. *Ellis B. Cowling Papers, MC 00435, Special Collections Research Center, North Carolina State University Libraries, Raleigh, NC.*

Awards and Honors

In addition to his early election to the NAS, Cowling was recognized for his early work on wood decay through his election as a Fellow of the International Academy of Wood Science in Vienna, Austria, in 1971, and for his career in environmental sciences and forestry with Syracuse University's Graduate of Distinction Career Achievement Award in

2011. In keeping with his compassionate view of humanity, Cowling was also recognized for work with the broader scientific community through his election as a member of the North Carolina State University Academy of Outstanding Faculty Engaged in Extension in 2007 and the broader public through his recognition as a Collaborative Founder of the National Academy of Community Engagement Scholarship, in Birmingham, Alabama, in 2017.

Final Thoughts

As a self-described "devoted multi-disciplinarian," Cowling's unswerving focus on developing and applying science to achieve tangible environmental goals drove policy and regulation that continue to this very day and provide a foundation for the future. Ellis Cowling passed away on September 23, 2021.

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