

**Plant Physiology 90th Anniversary**

*Plant Physiology* is inseparable from its parent society. The American Society of Plant Physiologists (ASPP), as it was known until a decade and a half ago, had its foundations in a splinter group of the Botanical Society of America during the early years of the 20th century. A small group of plant physiologists—Charles Shull, then of the University of Kentucky, along with Robert Harvey, the secretary of the Physiological Section of the Botanical Society of America, Burton Livingston, the permanent secretary to the American Association for the Advancement of Science, and J.B. Overton of the University of Wisconsin—led the move, despite opposition from some quarters. From its start in 1924, the emphasis of ASPP was on community. Shull noted later that the Society was *of*, not *for*, plant physiologists: the Society *was* the community. This distinction played an important part in the early growth of the Society and of the journal, as it does now. *Plant Physiology* was founded as the official publication of ASPP. Its first issue appeared in January 1926 with Shull as Editor-in-Chief.

The birth of *Plant Physiology* coincided with world events that mark both its roots in the past and its future. The year 1926 saw the passing of Rudolph Valentino; Robert Todd Lincoln, son of President Abraham Lincoln; and the physician and Nobel Laureate Camillo Golgi, after whom the subcellular organelle is named. That year was also marked by the introduction in the United States of the first numbered highway system, including the now famous Route 66. It saw the birth of both the naturalist and presenter David Attenborough and the biochemist Paul Berg who, with Walter Gilbert and Frederick Sanger, received the Nobel Prize in Chemistry in 1980 for contributions to understanding nucleic acids.

Serendipitously, 1926 was the year that Fritz Went reported his discovery of the plant hormone auxin. The idea that plant growth might be regulated by hormones met resistance within the plant physiological community at first—there was much stronger evidence for the effects of minerals on growth—but its importance was soon recognized. In the years following WWII, articles devoted to auxin, hormones, and plant development came to make up 20% of the content of *Plant Physiology*. Auxin, mineral nutrition, plant growth, development, and morphogenesis remain the foci of much research published in the journal today, although the tools available to study these topics have changed beyond recognition.

Even though it was the official publication of ASPP, *Plant Physiology* was much more than a newsletter for the Society. From the start, its aims were “to aid in the advancement of all of the plant sciences where a physiological attack must be employed … either as a fundamental science or as an aid in applied scientific work.” The first volume of *Plant Physiology* included 30 scientific papers. Ten years later, the journal had grown to publishing some 800 pages per year. Within 12 months of its first issue, the journal had secured 86 subscriptions from libraries, not just in the United States but also in Canada, Europe, and Japan. Today, *Plant Physiology* is recognized around the world as the single most widely read and most highly cited of all research journals in the plant sciences. It clearly filled an important niche within the global plant biology community then as it does today.

Then, as now, the contents and focus of *Plant Physiology* placed a lead emphasis on experimental science, although the journal’s emphases have shifted along with the interests of the field. In its first 5 years, roughly 25% of articles in *Plant Physiology* were devoted to methods alone and another 25% to mineral nutrition. By contrast, barely 10% focused on biochemistry and much less on respiration, photosynthesis, and pathology. By the 1960s, methods had taken second place. Many more articles focused on plant biochemistry, development, and photosynthesis. Emphasis was on fundamental understanding of enzymatic processes, carbon and nitrogen metabolism, herbicides, and, of course, hormones.

The importance of drawing together knowledge within an area of research was long a focus of the journal. By the 1930s, it was publishing occasional reviews, and in the 1940s it initiated a series of monographs, later to be superseded by the *Annual Reviews of Plant Physiology* (now the *Annual Reviews of Plant Biology*), first published in 1950. Over the past 3 decades, *Plant Physiology* has continued to publish short reviews and special Focus Issues, each devoted to a scientific theme, as an aid for teachers and researchers alike. In 2010, Editor-in-Chief Don Ort initiated the annual Founders’ Review to highlight individual plant physiologists whose work has come to define a research topic. And in 2013, I introduced the Topical Reviews series that addresses, in depth, key research topics of broad interest to the community.

Editorial practices and handling evolved over the decades, too. Initially, submissions were reviewed in house. Throughout his 20 years as Editor-in-Chief, Shull read every article published in *Plant Physiology* and frequently *rewrite* much of what was submitted for style and clarity. These practices continued under Editors-in-Chief Loehwing, Goddard, and Brown through the 1940s and 1950s. Such an exercise would be unheard of, indeed impossible, today. Yet there is much that remains unchanged in the ethos of *Plant Physiology*. In Volume 1, Shull called for papers with a “brief and pointed approach to the problem, succinct statements of the methods used, clear cut presentation of data, and
critical discussion of the problem as a whole.” Such editorial admonition is familiar even today.

Changes in *Plant Physiology* over the years reflected the developing expectations and demands of publishing, sometimes with unexpected effect. During WWII, shortages of paper and staples occasionally delayed publication. For a period, wartime censors required that galleys be submitted in advance to vet and redact text—their ignorance of the content no doubt a source of frustration and occasional amusement—before journal issues were shipped overseas. Later *Plant Physiology*, like many other journals, came into conflict with the U.S. Postal Service. Legislation had defined as “advertisement” articles for which a surcharge was made, and this was deemed to include charges for high-resolution images such as micrographs. Articles in scientific journals, the USPS insisted, would need to be labeled accordingly. Eventually, some journals did mark articles as advertisements with a footnote explaining why this was necessary. *Plant Physiology* simply ignored the matter and was never challenged. And, when the printer, Conover Press, went into liquidation in 1969, ASPP staff hailed out of bed in the dead of night, driving the 4 h to Kutztown, PA, to rescue the galleys for the next two issues of *Plant Physiology*, barely 30 min ahead of the IRS agents, who padlocked the printers.

The journal grew rapidly following WWII, as did science across all disciplines in the United States and abroad. The war had fostered awareness that basic as well as applied science was important for industrial and societal growth. At the same time, new technologies, including the tools of radiotracers, brought approaches to the physiological sciences that were breaking down previously insurmountable barriers to research. Funding grew rapidly; the U.S. National Science Foundation was formed in 1950, the Deutsche Forschungsgemeinschaft was reestablished in 1951, and the U.K. Agricultural Research Council and the Science Research Council were formed in 1965. Growth in demand for trained scientists and teachers was not far behind.

As a focus for the global plant physiology community, again ASPP led the way. Membership grew rapidly throughout the 1950s, 1960s, and 1970s, and an increasing proportion came from outside North America. Today more than 40% of the membership, some 50% of the *Plant Physiology* editors, and more than 80% of submissions to the journal are from outside the United States. *Plant Physiology* and ASPP also sparked interest in regional societies. The period between 1948 and 1958 saw the formation of similar societies in Scandinavia, the United Kingdom, Japan, the Soviet Union, Argentina, and Canada, among others.

To keep pace with the growing submission rate, the Editorial Board expanded, initially with close ties to the membership. A substantial proportion of the board was elected by the membership on 3-year rotation, a practice that became unwieldy following WWII as membership grew and the field of plant physiology diversified along with the Editorial Board. Under Marty Gibbs, who served as Editor-in-Chief for 29 years, the Editorial Board rose from 12 to more than 250 members. A small group of Associate Editors took responsibility for all submissions, accepting or rejecting papers. The majority of editors served as reviewers, later combining their assessment of each paper with that of an external reviewer.

Gibbs brought to *Plant Physiology* a strong focus on understanding what is fundamental behind plant physiology, especially enzymatic processes. Gibbs was a biochemist himself, and his work, post-WWII, embraced the new radiotracer technologies to understand carbon metabolism. Yet, at a time when the electron microscope and ultrastructural studies were opening entirely new vistas on cell biology and later developments saw the introduction of restriction enzymes that fueled work in molecular biology, the journal retained a conservative focus on the whole plant.

The transition to the journal as we recognize it today began with Editor-in-Chief Maarten Chrispeels. He restructured the Editorial Board, trimming its number to some 30 editors, each with responsibilities for engaging external reviewers and for decisions on acceptance. The Editorial Board subsequently grew to 75 under Editors-in-Chief Natasha Raikhel and Don Ort, with a smaller group of Associate Editors engaged to help assess and assign incoming manuscripts. In large part, I have retained this structure, with responsibilities for handling and decision making shared equally among the editors. All manuscripts submitted to *Plant Physiology* are still read by one or more editors, but with the breadth of modern plant biology, the Editorial Board relies extensively on the expertise of specialist reviewers.

Whereas Gibbs pushed the focus toward fundamental questions in plant physiology, Chrispeels added to the journal a renewed focus on cellular and molecular biology, a focus that was strengthened by Natasha Raikhel and Don Ort. If this transition was late for the heyday of ultrastructural cell biology and the initial developments in molecular cloning, it was in good time for the developments in molecular physiology, cell biology, and confocal microscopy of the 1990s. It was in good time, too, for the explosion of work on the model plant Arabidopsis. If no one had heard of this small weed in the 1970s, the opposite was true by the time that the Arabidopsis genome was published in 1999. Indeed, for a while it became difficult to justify research on anything else, especially in any work with a molecular genetics aspect. The sequencing of the genomes of several model crops has followed since, and will no doubt accelerate research and field applications in the coming decades. Yet even now as Editor-in-Chief, it is often difficult to strike a balance between gaining an understanding of a specific process in a crop species and advancing fundamental knowledge through work in Arabidopsis.

The 21st century brings new opportunities as well as new challenges. The world of academic publishing and scientific communication is changing rapidly, *Plant Physiology* with it. Under Don Ort, the journal in 2006...
began to publish articles early online; these now appear within 24 h of acceptance. Since I took over as Editor-in-Chief, the journal has linked submissions with bioRxiv for open, prepublication dissemination of manuscripts; it went online only in 2015; it has assumed a broader and generic look; and it takes an integrated approach across scales and methodologies that reflects the cross-disciplinary nature of research today. Behind the scenes, too, tools are continually explored and developed to enrich reading and access, to enhance dynamic interchange between articles and large-scale databases, and to facilitate submission, handling, and reviewing. None of this would be possible without the dedication of my coeditors and of staff members Nancy Winchester, Patti Lockhart, Ashton Wolf, and Jon Munn.

Feeding a growing population in the face of climate changes will demand a truly integrated understanding of plant physiology, cross-disciplinary approaches to biological problems, and the ability to handle, analyze, extract, and model enormous amounts of data. Indeed, if nothing else, the 21st century is certain to become the century of big data. Plant physiologists today strive to anticipate how plants will respond to ever-increasing levels of atmospheric CO2 with its associated impacts on temperature, rainfall, and soil erosion, among others. Here Plant Physiology is at the forefront of research that will enable predicting traits based on knowledge of plant genomes. Such knowledge will be vital to inform decisions about plant breeding and crop management for decades to come.

Many of the trends are obvious; like an expanding leaf, their patterns are already well defined. Plant physiologists today embrace a much broader range of model plants than they did a decade ago. With the international focus on climate, global environmental change, and sustainability, the journal, too, is returning to questions of whole-plant physiology, soil-microbe interactions, and water relations, but now with a range of molecular, biophysical, biochemical, “omic,” and systems technologies that would have seemed fantasy barely 2 decades ago. These drivers are well represented by my introduction of generic research themes, including Ecophysiology and Sustainability, Signaling and Response, and Systems and Synthetic Biology.

Other trends are only just emerging from the substratum, their morphology still barely discernible. The strife over genetic modification is likely to be forgotten, a thing of the past, as gene editing technologies go mainstream. But how will these and other technologies impact on the now rapidly expanding knowledge of epigenetic regulation in plant development? Equally, synthetic tools for engineering whole arrays of metabolic, transport, and other activities are gaining attention. As these tools are transferred from model microbes to multicellular organisms, how might they be integrated with epigenetics to develop our understanding of plants? How might our knowledge of plant systems and chemistry be harnessed through “omic” technologies to engineer plants with new traits?

What will Plant Physiology look like at 100?

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