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IRVING WIDMER BAILEY

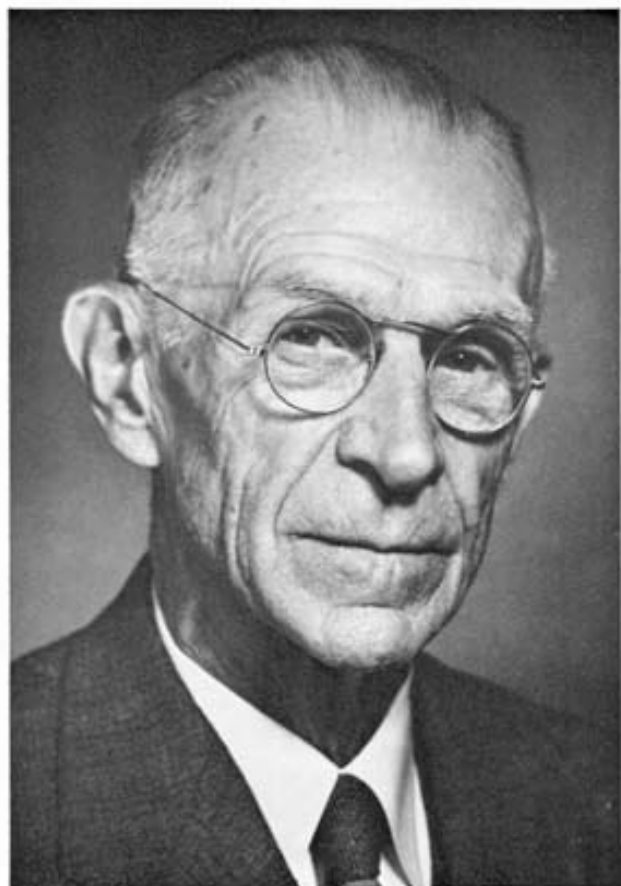
1884—1967

A Biographical Memoir by
RALPH H. WETMORE

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Biographical Memoir

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J. W. Bailey

IRVING WIDMER BAILEY

August 15, 1884–May 16, 1967

BY RALPH H. WETMORE

IRVING BAILEY died on May 16, 1967, in his eighty-third year. He had had symptoms of a cardiac disability for some years, but no serious problem had arisen until he was subjected to a subterminal coronary occlusion in the laboratory one morning.

His early arrival that day was as usual. For the fifty-eight years of his successive appointments at Harvard University, the institution at which he had spent his entire professional life, he was always the first or one of the first to arrive each morning. His hours were long, and his concentration on the task at hand was complete. This intentness of purpose along with a natural ingenuity and mechanical ability permitted him in those depression years between the two world wars to master his field. He became nationally and internationally recognized as expert in all aspects of morphological botany, ranging from cytology to anatomy, from evolutionary trends to phylogeny and taxonomy, from organic chemistry to wood structure and wood technology, and from silviculture to preservation of forests. Newer instrumentation and improved quantitative methods have extended the margins of the wide range of knowledge that emanated from I. W. Bailey's laboratories, but little modification has become evident as yet in those fundamental principles and those patterns of organization and function in plants to which he gave his full attention.

To understand how much Irving Bailey's entire life was influenced by his early life, to envision the man and his chosen field of endeavor, one must have a view of his early years. The only son of Solon Irving Bailey and Ruth Elaine (Poulter) Bailey was born in Tilton, New Hampshire, on August 15, 1884. His father, at that time thirty years of age, was Headmaster of Tilton Academy. He had been awarded his B.A. degree at Boston University in 1881 and had already shown a predisposition toward astronomy, initiated when he was twelve years of age in his excitement, it is said, over the last great display of the Leonid meteors on November 13 and 14, 1866.

In the year of Irving's birth his father, then teaching a course in elementary astronomy at Tilton Academy, had written to President Eliot of Harvard University asking about possible opportunities to pursue studies in astronomy at that institution. President Eliot turned the letter over to Professor Edward C. Pickering, Director of the Harvard Astronomical Observatory, who was forced to write Solon Bailey that no opening then existed. Three years later, however, Mr. Bailey again wrote Director Pickering that, since he understood the observatory had received sizable funds in the intervening years, he was still hopeful of pursuing graduate study there. Pickering's reply intimated that Bailey might begin his studies for the master's degree if it was also possible for him to act as an unpaid assistant in the observatory.

Enrolled as a degree candidate in 1887, Solon Bailey agreed to spend about forty hours weekly as an assistant. Within a few weeks, Pickering found Bailey's work so satisfactory that he began paying him a small salary and recommended that he be given course credit toward his degree, which he obtained in 1888. He was at once appointed to head a two-year expedition to Peru to find a site and make plans for a high mountain observatory for study and photography of stars in both southern and northern hemispheres under as favorable meteorological conditions as possible.

Pickering and Bailey chose a part of the Andes near the town of Chosica as promising for temporary study, this area being reasonably near the city of Lima with its port facilities at nearby Calleo. Careful planning enabled Solon Bailey with his wife and their three and one-half year-old son to arrive in San Francisco and embark for Peru on February 2, 1889, aboard the S.S. *San Jose* of the Pacific Mail Company. They were joined in Panama by Solon Bailey's brother, a professional photographer. It is stated that the accompanying baggage and material for building a planned, prefabricated observatory and living quarters for the family and staff comprised one hundred units, all of which had to be landed at Calleo and eventually transported over an eight-mile mountainous trail. At times, the trail had to be specially constructed to permit movement of equipment to a then-unnamed peak—later named Mount Harvard—above Chosica, some 16,500 feet above sea level. The next two months were spent in the selection of an exact site, in moving equipment and material, and in setting up the buildings and apparatus. The ensuing winter and early spring—May to October—were very satisfying to the astronomers. On the four-year-old Irving this all made a lasting impression; he had no time to be lonesome. Memories of these experiences persisted throughout his life and indeed enriched both his teaching and research.

Irving's father and uncle utilized the following rainy and foggy season to explore for and select a more favorable site, both inland and at high altitude, for a permanent observatory station. Their reports resulted in Pickering's choosing a site above Arequipa at an altitude of more than 8,000 feet above sea level.

The task of dismantling and moving buildings and equipment, and the valuable photographs and data not yet sent to Cambridge, was carried to a successful conclusion just before William Pickering, brother of the director, arrived in January 1891, with his staff to operate the station. The Baileys with

young Irving were able to leave on May 9, sailing through the Strait of Magellan on their way to Europe before returning to Cambridge.

Two years later, on February 25, 1893, Solon Bailey, with his wife, his eight and one-half year-old son, and two staff members, arrived again in Arequipa, this time for a first five-year sojourn, to replace William Pickering and his staff. By May (autumn), all was in order at the mountain station for productive work. Life at the station was busy around the clock. Because of arrangements made with the Peabody Museum at Harvard, archaeology became a recreational occupation. Investigation of Inca tombs and ruins proved fascinating to Professor Solon Bailey and had a profound and lasting effect on Irving. The latter in those early years accumulated many significant artifacts that he always took great pride in showing, and only in late life did he ultimately turn them over to the Peabody Museum.

The second expedition of the Baileys to Peru was extended to 1905. In these twelve years, among other happenings, the personnel of the Arequipa Station had been subjected to a local revolution and to temporary isolation and privation. They were out of contact with the world for more than two weeks.

This account of the early life of Irving Bailey during the two expeditions to Peru has been reported in order that the reader may visualize its enduring effect on him. He himself states in his fifty-year Harvard class report, "I now realize that my reactions and activities in college and subsequent to graduation were profoundly influenced by the fact that eight of the first thirteen years of my boyhood were spent in remote parts of South America rather than in the environment of New England. Having no formal and stereotyped education until the age of thirteen, having no playmates of my own race and age, I was forced to rely upon my own resources for interests and activities" His self-reliance, independence, ability to make decisions, powers of observation, quick reaction time, necessity

for considered judgments—all were important characteristics that, if not acquired, were enhanced in his lonely boyhood and served him well throughout his life. Irving Bailey was never timid in his actions; he was, however, never gregarious. He had many acquaintances; he had fewer friends, but to these he was lastingly close.

In early 1897, when Irving was thirteen, he was sent back to Cambridge to begin an orderly pattern of education. From Cambridge Latin School he was admitted to Harvard College in 1903. He received his A.B. degree in 1907, *magna cum laude*, having also earned membership in Phi Beta Kappa. In his fifty-year Harvard class report he also stated, "In college, I browsed around in history, chemistry, geology and meteorology, but it was not until my senior year that speeches of Gifford Pinchot and President Eliot induced me to undertake a career in forestry, particularly owing to the appeal of an out-of-door profession." So he registered in the Division of Forestry of the newly designated Graduate School of Applied Sciences and received his M.F. degree in 1909. During his second year of graduate study he served as assistant in botany in a course conducted by Professor E. C. Jeffrey. Upon obtaining his master's degree he was appointed instructor in forestry, and in this role he studied lumbering and wood-using industries in the course of preparation for his teaching in forestry.

In 1912, Bailey was appointed assistant professor in the School of Forestry, a unit in the recently aggregated Graduate Schools of Applied Sciences at Harvard. Since undergraduate training of foresters ceased with this reorganization, Bailey's teaching obligations were further reduced. In 1914, the status of the Bussey Institution and that of the School of Forestry were again altered, these two being segregated from the other Graduate Schools of Applied Science as codepartments in a new Graduate School for Research in Applied Biology. Both departments were officially housed in the Bussey Institution,

though progressively more and more of the activity in forestry, because of the small number of graduate students involved, was conducted at the Harvard Forest in Petersham, some seventy miles west of Boston.

The eminence of the Graduate School for Research in Applied Biology grew until, in the late teens and early twenties, the Bussey Institution had attained both national and international importance. Though Bailey was appointed associate professor of forestry in 1920, his commitments were entirely to research in the interpretive aspects of plant anatomy rather than to silvicultural practices or to economic aspects of forestry.

During the eight years of his assistant professorship, however, the direct lines of the research Bailey was formulating for himself were retarded. In fact, when they had been little more than initiated they were almost put aside by three important sets of circumstances. In the life of a sensitive young man, the first was devastatingly and lastingly disturbing; the other two were exciting and challenging.

The first of these circumstances stemmed from his two years of stimulative graduate study in the laboratory of Professor E. C. Jeffrey. Here he was in close association with other graduate students, especially Edmund W. Sinnott and Arthur J. Eames, who had been fellow undergraduates at Harvard. All three, as was inevitable in Jeffrey's laboratory, had become strong proponents of evolutionary theory. They were finding in Jeffrey's comparative morphological outlook on plants and animals a challenging *modus operandi* for examining those structural variations that could be correlated collectively with the survival and persistence of groups of organisms under naturally altered environmental stresses.

Bailey and Sinnott were engrossed with the problems presented by numerous cases of herbaceous species and contrasting arboreal species placed taxonomically in the same family. Which of these arose first in geological time and conceivably had given

rise to the other? Adherents to both points of view existed. Assiduous collecting of data from groups of fossil and living vascular plants provided abundant material for comparative morphological and anatomical studies. Examination of worldwide distributions of woody and herbaceous taxa in geological periods were made. Published results indicated that Jeffrey and his students had convinced themselves that arboreal plants had preceded herbaceous forms. However, despite this agreement as well as agreement that climatic changes had played a significant part in the survival of the short-lived annual herb, Bailey and Sinnott, on the one hand, and Jeffrey and R. E. Torrey, another of his students, on the other, disagreed on the causal relations of the developmental structural changes by which the annual herbs were enabled to complete their life histories and reproduce within a single favorable season. Arguments were not conducted amicably and reasonably in the laboratories, but were spread publicly in the scientific press. The issues should have been resolved, but the Canadian Scottish Jeffrey found it difficult to envision two sides to any question. The controversy between E. C. Jeffrey and Irving Bailey remained unresolved, and the estrangement persisted throughout their lives.

The second circumstance affecting Bailey's research plans arose with the United States' becoming involved in World War I. In 1918 the Federal Aircraft Production Bureau requested and obtained Irving Bailey's services in a tour of duty at Wright Field, Dayton, Ohio. Bailey was placed in charge of the Wood Section of the Materials Engineering Division of Aircraft Production with the challenge of selecting woods for the manufacture of airplanes. He was later cited for his contribution. He resigned in 1919, as soon as possible after the Armistice, and returned to the Bussey Institution.

Bailey had hardly settled into his research routine, however, when the third circumstance arose. He was strongly attracted

by a request of his senior colleague, the Dean of the Graduate School for Research in Applied Biology, Professor William Morton Wheeler, the specialist on ants and related insects. Would Bailey accompany him to the American tropics to study the peculiar and interesting relationships between ants and certain groups of tropical plants, the so-called "ant-plants"? The answer was, "Yes!" Bailey therefore spent much of 1920 in the tropics. The ants to be studied lived in hollow pith or comparable cavities in the younger branches of certain species of plants, mostly trees. When disturbed, they attacked all invaders viciously. From this trip to British Guiana there resulted seven papers, some jointly with Professor Wheeler, reporting on the habits of the ants and their methods of obtaining ingress and egress to their domiciles in the appropriated plant cavities. Once Bailey was initiated in a problem, his interest persisted. One can note in his bibliography a paper in a posthumous publication of Wheeler's in 1942—five years after his death—on British Guiana ant-plants with a section contributed by Bailey.

The period of the 1920s was very significant in Irving Bailey's career. He had found himself impelled to move beyond the then-general conception of the training of foresters and of personnel for forest management and for industrial users of forest products. He was anxious to turn his attention to the little-understood basic problems underlying the growth of trees and their anatomical and physiological organization. The enlargement of his outlet as a result of the demands put upon his knowledge during World War I, coupled with his experiences with the exceedingly diversified arboreal flora of the rain forests of tropical America, had further convinced him that the time was overdue for understanding more of trees if the practice in the United States was to be other than to cut down our forests and exploit their products.

Bailey's studies on the cambium, the circumferential growing layer of woody plants, whether tree, shrub, or woody vine, were

begun in 1918–1919. This followed an extensive systematic investigation initiated with a graduate student, Walter W. Tupper, of the range of size variations in vascular elements found in different groups of vascular plants, especially gymnosperms and angiosperms. Considering that all cells of the plant are derived from the isodiametric cells of the apical meristem, the queries, of course, were raised by Bailey, “How do the seemingly organized cell differences arise to produce the heterogeneity within a tree?” and “How much of the heterogeneity is hereditary and how much of the development and differentiation of cell types in the individual is influenced by local cellular conditions?”

Bailey’s authoritative knowledge was being called upon increasingly outside of Harvard University. In 1926 he was appointed a member of the Committee on Forest Research of the National Academy of Sciences. This committee, formed at the request of the Chief of the United States Forest Service, Colonel W. B. Greeley, was assigned the task of studying the nation’s forest resources to assess our future needs in the production of timber, pulp, paper, and other wood products. A supporting grant was provided by the General Education Board of the Rockefeller Foundation. Professor Bailey was given a leading part in this study. He traveled extensively over the United States and Canada and then spent most of a year in Europe investigating the relative significance of laboratories, tree nurseries, and experiment stations. He wanted to determine what was being done domestically in the conservation and replacement of our progressively disappearing forests and what was being pursued constructively in Europe that would help to enlighten a seemingly little-concerned, forest-destroying group of industrial enterprises in the United States.

As a result of these studies, Bailey and Dr. Herman A. Spoehr of the Carnegie Institution of Washington’s laboratory at Stanford University published in 1929 a significant small

volume, *The Role of Research in the Development of Forestry in North America*. Bailey always considered this study and report one of the most significant efforts in which he had participated. The carefully considered findings should have had a profound influence on the establishment of a national policy aimed at maintaining a balance of reforestation with cutting and the utilization of our forest resources. The recommendations of the percentages of publicly owned forests versus those in private holdings that should be maintained on a sustained yield basis were considered sound, as were the recommended protective measures against forest fires. The authors were convinced that "the existing economic, social and political status in North America was such as to inhibit for many years an extensive application of intensive European silvicultural methods." Moreover, the greater number of species of trees in the forests of the entire United States, with their naturally different responses to different climates, precluded a simple or single policy pattern. The authors believed that the nation needed a number of research establishments in the climatically diversified parts of our country, preferably in proximity to but not limited by the restrictions of larger academic institutions. The stimulation that would arise from proximity to laboratories in the basic sciences was considered to be a *sine qua non* for broad training and tolerant appreciation of natural problems. The organization and physiology of trees was in need of extensive investigation; Bailey's earlier convictions were carried to a larger audience.

The reports of the Committee on Forest Research of the National Academy of Sciences were turned back to a committee of American foresters, but the problems raised still exist more than forty years later, although some enlightened industries and limited government regulation, state and federal, have followed the main directions pointed out by the Bailey and Spoehr report.

Bailey often spoke of the twenties and early thirties as the

best years of his scientific life. In 1927 he was named professor of plant anatomy; this time his appointment was as a full-time member of the research staff of the Bussey Institution, not of the Department of Forestry. Essentially, he continued what he had been doing, in the same laboratory, except when on some outside assignment such as the National Academy project noted above. The joint study program and report by Bailey and Herman Spoehr ended in a close friendship, a friendship that led to an annual summer appointment for Bailey over a ten-year period (1930–1940) as research associate of the Carnegie laboratory at Stanford University. For those ten years, Bailey spent two months each summer carrying on his own work, but at Stanford rather than at the Bussey Institution.

Apart from his accepted external commitments, Bailey worked assiduously with one group of graduate students and research fellows, using newly devised techniques and methods to study the vascular cambium of conifers and angiosperms. With a second group he attempted to discover whether variations in vascular patterns and in diversification of the vascular elements within these patterns had evolutionary significance. The evidence suggested tendencies toward structural and histological similarities among members of a family and striking dissimilarities between taxa that the systematists considered only distantly related. Of course, the fundamental questions arose, "Do variations in structure have survival value? If they do, could one find evidence for an evolutionary or phylogenetic system built on vascular structural–functional elements associated in transport and storage? If so, how would this structural–functional system compare with that system conceived and used by taxonomists, a system based primarily on flowers, or reproductive parts?" As the evolution of flowers unquestionably is related closely to systems of pollination, whether by air, by insects, or by other agents, this idea raised the very important question as to whether the angiosperms could have followed

the above-mentioned dual evolutionary pattern, or whether the two patterns would prove to have the same survival of the fittest groups. Fortunately, an excellent statistically minded botanist, Dr. F. H. Frost, arrived as a research fellow in the early 1930s with an urge to tackle this large question. Bailey and Frost increased the existing collections of documented samples of woods from different forested areas of the world, studied the samples microscopically, and tabulated their findings in a statistically controlled pattern. By the mid-thirties, it was evident from their investigations that correlations did exist and that a phylogenetic system of families of angiosperms could be arranged and that, in all likelihood, the system could be followed to subfamilies and even genera as more species became available for study. Moreover, the system so envisioned agreed with that in current use by the taxonomists. In fact, as more research fellows joined the Bailey group, it was increasingly evident that anatomical approaches to taxonomic problems oftentimes resolved the difficulties of the more formal taxonomists. It would seem that this phase of the studies in Bailey's laboratory will continue and that wood collections will become adjuncts to many important herbaria.

During this same period the cambium studies had been progressing steadily. Cell division of cambial cells, many times as long as wide, measuring several thousand microns in length in certain species of conifers, is an amazing cytological phenomenon. The two ends of the dividing cell may still be undivided apparently for hours or days after the two daughter nuclei in the middle of the cell are in interphase stage in seemingly separate cells. Bailey demonstrated for the first time how the single cell-layered cambial cylinder, constantly being pushed outward by the new increments of the internally growing and differentiating tissue of wood, which the cambium leaves behind and within itself, is able to increase its circumferential extensibility by a geometrically complex pattern of cell

division and cell elongation, thereby increasing the circumference of the expanding stem or root of the plant. Concomitant studies of physiological parameters in cambial cells, by Bailey and a visiting colleague, Professor Conway Zirkle, were equally revealing. Not only might the physical conditions in vacuoles (liquid-containing cavities in the cells' protoplasm), including the acidity, change from season to season; but not infrequently both acidic and basic vacuoles could be found in different compartments of the same cell.

In the early 1930s, capital funds available to the Bussey Institution for Research in Applied Biology had become so reduced that the university had included space for the Bussey staff and students in its plans for the new Biological Laboratories. Bailey moved from the Bussey Institution in Forest Hills to Cambridge in the summer of 1936.

Bailey's cytological studies on living cells of the cambium of many trees were rapidly made possible by a simple microtome technique he devised for producing sections of live cambial tissue for microscopic examination. The growth of cambial derivatives into new xylem or phloem cells caused him to turn his attention from cell division to the structure of the cell wall itself, wherein is reflected the degree of differentiation of manifold types of cells.

The eleven papers on cell wall structure were the joint effort of Professor Bailey and Dr. Thomas Kerr, a research fellow and close associate of Bailey for some years. The deposition of secondary walls, their sculpturing, and their lignification were studied so penetratingly by differential solubility techniques that, for the first time, cell wall chemistry gave evidence of becoming an interpretable subject. Lignin as a basic constituent in the chemistry of higher plants was shown to be deposited in the interfibrillar capillaries of the wall, between and among the macromolecules of cellulose. Electron micrography in recent years has added to and supplemented the Bailey-Kerr

model, but in no basic way has modified it. Polarizing microscopic studies, supplemented by x-ray diffraction investigations, gave support to the interpretation set forth by Bailey and Kerr. Bailey's paper "The Walls of Plant Cells" was given at Stanford University in 1939 in a symposium commemorating the one-hundredth anniversary of the cell theory. It was recognized as one of the outstanding papers of the symposium.

With World War II, academic life for I. W. Bailey gave way, at least in part, to wartime and emergency needs. Like a number of botanical staff members at Harvard, Bailey directed his attention to an Army Engineers' camouflage project. The work entailed utilized much of his and others' time and effort until he was asked by the Provost of Harvard University to prepare a broad and soundly conceived plan for the reorganization and closer integration of the nine establishments constituting Harvard's botanical resources. Bailey accepted this responsibility in the full knowledge that the financially competing, mutually independent organizations, built up by strong individualists, were singly and collectively in financial stress. These establishments originally had been neither envisioned nor planned with concern for the instruction of Harvard's undergraduate or, in most cases, of its graduate students.

To this task, Irving Bailey gave two full years; in it, he had the complete and enthusiastic cooperation of his colleagues as well as the support of administrative officials of the university. In 1945, he finally submitted the results of the study with a proposed plan in a confidential report, *Botany and Its Applications at Harvard*, more commonly known as the "Bailey report." This report commanded the respect of all concerned. It was approved by the Harvard Corporation, and its full implementation was initiated promptly.

First came the planning of a recommended new building, to be located in Cambridge near the Biological Laboratories, to house the combined herbaria and their associated libraries

and collections. It was constructed in 1953–1954. The great advance came in the fulfillment of the second part of the plan, the creation of two budgetary and administrative botanical areas: the Institute for Research in Experimental and Applied Botany and the Institute for Research in General Plant Morphology. Professor Bailey was appointed chairman of the latter. The university's reorganization of available finances and the new proximity of professorial staff members, now all members of the Department of Biology, were conducive to a common concern for an overall curriculum and a balanced biology staff. The next few years proved not only the wisdom of the Bailey report in resolving the previous botanical dilemma, but also the success of Bailey's first effort in administration. The careful study and consideration, the group discussions, the final decisions that went into his report proved his administrative capacity.

The reorganization brought much acclaim to Bailey, despite a long-drawn-out court case over the interpretation of the university's handling of a recognized trust, the Arnold Arboretum. This action deeply hurt the sensitive Bailey throughout the ten years before the charge against Harvard was finally denied. In some ways, perhaps, the event that meant most to him personally was the honorary degree conferred upon him by his alma mater in 1955, the year of his retirement. The citation accompanying the award was "Your University salutes you for your direction of botanical study and for your accomplishments in searching in the anatomy of plants, for clues to the miracle of growth." That the degree singled out his international scientific attainment—more than any administrative success he may have achieved—meant much to Irving Bailey, how much only his close friends and his family knew.

In 1946, having modestly and quietly enjoyed the success of his administrative venture, Bailey turned back to his research, perforce neglected for some years. When World War II started,

he had been contemplating the return to a question on which he had initiated some work in 1915–1916: Are the vesselless angiosperms primitive? Bailey held the conviction, since proven in his laboratory, that the vascular and associated storage and supporting tissues of plants offer comparative documentary evidence of an evolutionary level of attainment of the plant in the overall phylogenetic history of higher plants. He had thus been awaiting an opportunity to return to the joint study of the vesselless genera: *Drimys*, *Trochodendron*, and *Tetracentron* (reported on by W. P. Thompson and Bailey in 1916 and 1918). He had found added excitement in the discovery, in Fiji, by a Harvard colleague, Dr. A. C. Smith, of what proved to be a new family of angiosperms which they jointly named the Degeniaceae in 1942. Bailey decided that it was timely to examine the old and continuously baffling issue of the origin of angiosperms. Would an investigation of all available knowledge of both anatomical and floral organizational patterns of all suspected primitive living angiosperms provide adequate information to suggest the probable nature of the primitive angiospermous plant and its flower? Could this information be correlated with evidence from the tracheid-bearing secondary xylem—that is, would this angiosperm prove to have no vessels or, if vessels did exist, would they be the long, tapering, scalariform, primitive elements?

These studies commanded the full attention of the entire personnel of Bailey's laboratory through the late forties and the fifties until his retirement in 1955. In this decade of assiduous application of new approaches and new techniques in detailed studies of developing flowers, mature flowers, and fruits, of younger and older stems, numerous findings were published that added much to the body of available information. Bailey's group reported six woody genera of the so-called "Ranalean complex," that is, the complex of plants directly or less certainly related to the Ranales—the buttercups and magnolias and

their putative relatives—which lacked vessels, possessing only long, tapering, scalariform tracheids as water-conducting elements. These six were in addition to the three genera—*Drimys*, *Trochodendron*, and *Tetracentron*—established earlier as lacking vessels.

An extensive study of floral organization enabled Bailey and his co-workers, Dr. B. G. L. Swamy and Dr. Charlotte Nast, to develop a new concept of the organization of a primitive flower. The floral parts of these plants proved to be even more foliar in nature than Bailey and his associates had conceived them to be on the basis of earlier, inconclusive evidence. Even the carpels with their ovaries, each enclosing a seed or seeds, were clearly foliarlike appendages that had never opened flat as leaves do, but had remained folded on their midribs. In numerous species, however, the carpels were open at the contiguous margins, the seeds being borne on their upper inner surface, and therefore enclosed, being connected with branches of the three carpellary veins by which they were nourished. Pollen grains, upon being transferred by insect or wind to the glandular apex or margins of the open, conduplicately folded carpels, reached the ovules by developing pollen tubes and growing down along the glandular margins or inner surfaces of the folded carpels, or in many species, along the conduplicate or tubular upper part of the carpel. The stamens also in some species were somewhat foliar, bearing the pollen sacs or anthers embedded in the “foliar tissues,” also close to branch veins. *Degeneria vitiensis*, the newly discovered species, proved to be nearest to a hypothetical prototype of a primitive flower, but all degrees of transition to modern stamens and carpels could be found in the various genera and species of these vesselless plants and related species, all with primitive vascular systems. As Bailey suggested in critical papers, early or primitive angiosperms must have been vesselless with flowers of component parts resembling leaves that persisted in flowers or other assemblages, because of

the added protection given to their reproductive ovules, which were formed within conduplicately folded foliarlike carpels. The pollen was nourished in its growing microgametophyte or pollen tube stages via the inner tissue of the carpel, along or through which it grew. If plants of the "Ranalean complex" were not the most primitive of living angiosperms, Bailey indicated, they represented at least one main evolutionary line of origin and elaboration, providing the angiosperms should prove to be polyphyletic.

All of these exploratory studies were in hand in 1955 when Bailey reached seventy, the mandatory retirement age. In his laboratory on the first floor of the new herbaria building, with his microtome and his microscope and the wood collection around him that Wetmore and he and certain graduate students had built up to approximately 30,000 microscopic slides, he wrote a few articles, as his bibliography between 1955 and 1959 shows, but to those who saw him daily he was restless.

It was not long before he turned back to the old problem of the development and organization of cactus plants, especially those that were leaf-bearing. Were these leaf-bearing species primitive among cacti? As the Cactaceae, the family of cacti, are generally considered to be vesselless, were they among the primitive angiosperms? These questions raised the research flag again and provided Bailey with the kind of problem he liked. He studied the organization of the leaf-bearing cacti using material provided in part by Professor Norman Boke, an authority on cacti, with whom he had discussed the problem in 1959. In fact, Bailey continued these investigations of leaf-bearing cacti until a few months before his death, the last manuscript being published posthumously. He found that the leaf-bearing cacti possessed vessels in the xylem, but that these were not of the primitive, long, scalariform-pitted type. In the remaining cacti, without leaves, vessels do not generally occur. In substance, Bailey concluded with others that the absence of

vessels in the Cactaceae is a secondary and derived modification, correlated with their desert habitats. He did convince himself, however, that the leaf-bearing types with vessels were members of the most primitive tribe of cacti.

His task completed, Bailey cleaned and cleared up his laboratory in early 1967. He did not seem restless or disturbed over not having a research job ahead. However, he continued to arrive early every morning as usual for the short time left to him. He had reported that for some years he had had warnings of a heart ailment. Often he had to sit down on the Cambridge Common to rest during his mile walk to the laboratory. Cold weather aggravated the condition.

Early in May 1967 Irving Bailey was stricken with a heart attack in the herbarium building. As soon as he was found, he was moved to the Harvard Infirmary. There he tentatively recovered, but some days later a second attack caused his death, on May 16, 1967.

Irving Bailey reached international recognition early. His meticulous care in drawing conclusions kept him from publishing erroneous results. The present author knows of no published material of Bailey's that has had to be explained or reinterpreted later because of faulty observation or experimentation or inadequate checking. More recent technical improvements and new approaches have extended the horizons he reached. His judicious evaluation of facts and his self-critical habits left no doubt in his mind of the soundness of his findings, for if there were any doubts, no publication would ensue. Moreover, his succinct, direct, simple writing could not be misunderstood. His one hundred forty-three publications may serve as models of scientific prose.

In addition to his much appreciated and well deserved honorary degree from his alma mater in 1955, Irving Bailey received honorary doctorates in science from the University of Wisconsin in 1931 and from the University of Syracuse in

1961. He was awarded the Mary Soper Pope Medal of the Cranbrook Institute of Science in 1954 as "an outstanding plant anatomist and one of America's truly great botanists." In 1955, a *Festschrift* (published in a special number of the *Journal of the Arnold Arboretum*, volume 36), a collection of papers by colleagues, botanical friends, and former graduate students, was presented to him at a retirement dinner. In 1954, he was honored by Dr. Frans Verdoorn, editor of *Chronica Botanica*, with a specially prepared volume of his own writings, with the enthusiastic approval of his colleagues. As chapter headings the volume was provided with decorative motifs, cleverly designed by one of Bailey's research fellows, Dr. B. G. L. Swamy of India.

Bailey was elected to membership in the National Academy of Sciences in 1929. He was a member of the American Academy of Arts and Sciences and the American Philosophical Society and was a fellow of the American Association for the Advancement of Science. He was a member of the Botanical Society of America (president, 1945), the American Society of Foresters, the International Society of Plant Morphologists, the International Association of Wood Anatomists, the American Society of Naturalists, and others. Outside of the United States, he had been elected to honorary membership in the Swedish Royal Academy of Sciences, in the Linnean Society of London, and in the Indian Botanical Society. He had served as vice president of the Seventh and Eighth International Botanical Congresses. In 1956, Professor Bailey was one of fifty outstanding botanists of the United States to be recognized on the occasion of the Fiftieth Anniversary of the Botanical Society of America, his certificate of merit stating, "plant anatomist and inspiring teacher, for his outstanding contributions on the structure of the cell wall and the histology of the cambium, for his application of anatomy and morphology to problems of evolution of angiosperms." It was Irving Bailey and his colleagues, with their cool, deliberate,

fair, and analytical approach to departmental and university affairs, that gave the Department of Biology in the thirties, forties, and early fifties the prestige it had within Harvard University as well as outside.

Within his family, Irving Bailey was truly in his own world. On June 15, 1911, while a young instructor in the School of Forestry, Irving Bailey married Helen Diman Harwood, daughter of a prominent family of Littleton, Massachusetts. Two sons were born to them, Harwood and Solon Irving. Both grew up in Cambridge. Harwood attended the Harvard School of Business Administration and became successful in business in Boston. The younger, Solon, selected the field of architecture and became associated with the well-known Boston firm Shepley, Bullfinch, Richardson and Abbott. Solon participated in planning and supervising certain of the buildings at Harvard University. As both sons married and settled in the greater Boston area, the grandparents found great pleasure in their children and grandchildren. Irving and Helen Bailey had acquired the 45-acre estate of his father on the North River in Norwell, Massachusetts. The large New England white house, situated on a hillock and fronting on a big curve in the tidal North River, was beautiful at all seasons of the year. The river was flanked on both sides by wide acres of marshland that, in turn, graded into shrubs and then into higher, former farmland, now white pine woodland. The marsh in summer, the autumn with its acres of highly colored shrubs and vines against the browning green of the pines all helped the beautiful restful quality of the Bailey summer home.

After his ten summers as an associate at the Carnegie laboratories at Palo Alto, Irving spent at least two months each summer at Norwell. Here he recuperated from the strenuous regime he set for himself in Cambridge. He cleared and made lawns of the seven acres of mixed shrub and marsh border vegetation of the unwooded area surrounding the house. This

required not only cutting of bushes, but grubbing out their roots and then making smooth grassed areas where they had been. After the devastating hurricane of 1955, which laid low literally some hundreds of large white pine trees in the quarter mile between the house and the road, Irving made a driveway and flanked it by a picturesque fence made of short sections of white pine trunks for fence posts (12 inches or more in diameter) with sections of the trunks, some 10 feet in length, in between. All of this maintenance work he did himself, except, on occasion, when one of the sons might be available. Moreover, the attractive gardens that Mrs. Bailey maintained were a concern of his as well.

The results of Bailey's summer sojourns at Norwell were obvious. When he returned to Cambridge in the fall, his tanned features, the easy vigorous stride of his tall, lean body showed clearly that the summer had been good for him. The vacations of the sons and their families with the Baileys, especially the visits of the grandchildren by themselves, the dropping in of their friends, impromptu or planned, gave one a chance to see a happy family at peace.

This curve of the North River had been the site of a shipyard, run by Oliver Cromwell's nephew, about which Irving liked to talk and the remains of whose old forge, anvil, and tools he liked to show. The river was lined with bushes, among them being many beach plums. The fruits of these Irving gathered in the late summer; his friends could always count on jars of beach plum jelly made by Irving himself.

This summer place, some twenty-five miles from Irving's home in Cambridge, was a very necessary part of the Bailey family life. They went there often out of season. The big fireplaces provided heat for the late fall and early spring occupancy. The living room had walls of pine boards more than 2 feet in width, an indication of the size of trees that had grown

on the earlier New England homestead; some of these virgin pines still could be found in the woodland, having survived the recent hurricanes. This beautiful site with its house, its huge barn, and its carriage house and woodshed, which had become out-of-door eating and resting places, has been sold since Irving's death. The younger son, Solon, who cherished the place, died very suddenly at age fifty, a short time after his father's death, also of a coronary occlusion.

Irving Bailey is fully remembered. His somewhat formal greeting, offset by his very warm smile, his strong voice, his noticeable New England accent, and his careful enunciation, made his presence known. Although he would seldom accept a speaking commitment, his lectures, whether to a class or to a scientific gathering, given without notes but with his clear voice and superb illustrations—he was a superb craftsman in photomicrography—were impressive. At the age of eighty-two, his vision was excellent, his hearing unimpaired. Men like him, personally deliberate, sound in judgment, industrious, and with the same continuing habits to the very end, admired and liked by students, staff, and administration, are sorely missed, as is Irving Bailey himself.

THE AUTHOR expresses his gratitude to his colleagues, Professor Elso S. Barghoorn, Jr., and Professor Reed C. Rollins, who, like himself, counted themselves among Professor Irving W. Bailey's close friends as well as colleagues. Conferences with them have helped much with sequences of events and questions of interpretation both in discussion and in editing the manuscript.

To Mrs. Howard Mumford Jones and Mrs. Lyle Boyd, authors of *History and Work of the Harvard Observatory* (McGraw-Hill Book Co., New York, 1971), the author would like to indicate how much of the boyhood life of Irving Bailey he obtained from their vivid portrayal of Irving's father's two expeditions to Peru. The isolated mountaintop family life there while they set up and ran a temporary and then a more permanent southern hemisphere

astronomical observatory for Harvard University was both informative and exciting. It provided both gains and losses for a sensitive boy.

To his wife, Olive Hawkins Wetmore, to whose knowledge of the Bailey family and whose cooperative aid the author owes much in the preparation of this article on our close friend of many years.

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KEY TO ABBREVIATIONS

- Am. J. Bot. = American Journal of Botany
 Ann. Bot. = Annals of Botany (London)
 Bot. Gaz. = Botanical Gazette (Chicago)
 Chron. Bot. = Chronica Botanica
 Forestry Quart. = Forestry Quarterly
 J. Arnold Arbor. = Journal of the Arnold Arboretum of Harvard University
 J. Forestry = Journal of Forestry
 J. Gen. Physiol. = Journal of General Physiology
 Proc. Nat. Acad. Sci. = Proceedings of the National Academy of Sciences
 Trop. Woods = Tropical Woods

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