

*Katherine Esau*

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April 3, 1898 — June 4, 1997

By Ray F. Evert

KATHERINE ESAU, WORLD RENOWNED botanist, recipient of the National Medal of Science, author of six textbooks, and teacher par excellence, died June 4, 1997, at her home in Santa Barbara, California. She was ninety-nine years young.

Her work on plant structure covered seven-plus decades and led to much of the current research on plant function. Throughout her career, Esau continued research on phlo-em both in relation to the effects of phloem-limited viruses on plant structure and development and to the unique structure of the sieve tube as a conduit for food. She demonstrated an exceptional ability for attacking basic problems and she set new standards of excellence for the investigation of anatomical problems in the plant sciences.

Esau was born on April 3, 1898, in the city of Yekaterinoslav, now called Dnepropetrovsk, in the Ukraine. She lived there until the end of 1918, when she and her family fled to Germany during the Bolshevik Revolution. Her family was Mennonite, descendants of the German Mennonites that Catherine the Great invited to Russia to promote agriculture on the Ukrainian steppes. Naturally suspicious of anyone from the outside, the Ukrainians ostracized the Mennonites, who lived in colonies, developed very successful farms, schooled their children, and practiced their religion. To break down this wall of distrust, the Ukrainian authorities asked the Mennonites to send some of their children to Russian schools. Esau's uncle and father were the first from their colony to study in Russian schools. Her Uncle Jacob studied medicine. Her father Johan trained as a mechanical engineer and became the city engineer of Yekaterinoslav. Building the city's waterworks, a streetcar line, and large city buildings, including several schools, he worked very hard to make the city more liveable. Consequently, he was well liked by the citizenry, who elected him mayor. An innovation of his was to borrow money from France for the building projects. With the turmoil of the Bolshevik Revolution and being a city leader, it was a only matter of time before the Bolsheviks marked him for execution. The revolutionary government removed him from his post and kept him under constant surveillance. The Esau home was searched for banned goods, and valuable items were taken.

With the advent of World War I, the German Army advanced and succeeded in occupying the Ukraine. Most of the peaceful population welcomed this turn of events, because it saved them from Bolshevik occupation and from invasion by the unorganized bands that were massacring people and destroying property. John Esau was reinstated as mayor. As the war wound down, the German officers warned that the Esau family would be in great danger after the army left and advised them to flee with them to Germany. This was heartbreaking for the older Esaus, because their roots were in Yekaterinoslav, where their children Katherine and Paul and Mrs. Esau (the former Margrethe Toews) were born. The Esaus, along with many other people, followed the German advice. Paul was an administrator on a ship in the Black Sea and was unable to go with them on the journey, but he joined them soon after they arrived in Berlin. They traveled third class in a train with wooden benches, together with the officers, the injured, and other refugees. The journey to Berlin lasted two weeks rather than the usual two days because of various difficulties and obstacles put in their way by the revolutionary government in the cities through which they passed. The day after the Esaus left Yekaterinoslav, posters appeared in the city proclaiming that the new city managers

were looking for her father, whom they characterized as a member of the counterrevolutionary bourgeoisie and an enemy of the country.

During the turbulent last years the family spent in Russia, Esau's father gave money to a family friend to deposit in a Swiss bank in case the Esaus needed to leave the country in a hurry. The friend proved worthy of their friendship, and the money was there when the family reached Berlin. Later when the friend needed money to develop a patent on an oil-well part, Esau's father staked him. That investment provided the means for the Esaus to live comfortably for the rest of their lives.

When the Esaus fled Russia, Katherine Esau had completed her first year of study at the Golitsin Women's Agricultural College in Moscow. Fortunately, she had asked for a transcript of her course work and grades at the end of the term, and upon the family's arrival in Berlin, she registered in the Berlin Landwirtschaftliche Hochschule (Agricultural College of Berlin), where she resumed her studies, this time in German, not Russian. Her brother Paul also made the transition and studied chemistry. As part of her studies, she spent two semesters in Hohenheim near Stuttgart, where she enrolled in various agricultural courses. After two more semesters in Berlin and a final examination, she received the title "Landwirtschaftslehrerin." Following additional studies, she passed a Zusatzprüfung in plant breeding given by the famous geneticist Erwin Bauer, who urged her to return to Russia, saying that the country needed her. Fortunately for the world and the advancement of science, she did not heed his advice.

From Berlin, Esau went to a large estate in northern Germany that housed a model seed-breeding station for wheat. She joined the workers there in the fields and barns doing various chores. The son of the farm's owner was very smitten with Katherine, but he could not persuade her to marry him. She returned to Berlin, where a teaching assistantship awaited, but by then the Esaus had decided to settle in the United States, and preparations were underway to do so. The political situation in Germany was deteriorating and John Esau felt his family would be safer in the United States.

The Esaus left for America in mid-October of 1922. Brother Paul stayed behind to finish his last year of studies in chemistry. The Esaus crossed the continent by train and the ocean by boat; like so many other immigrants, they entered the United States at Ellis Island. Their destination was Reedley, California, where there was a large Mennonite community. Esau's father wanted to buy a farm for her to manage, but she convinced him that she needed more working knowledge of California agriculture and American-style management. At first, she worked as a house cleaner and childcare worker in Fresno, California, all the while perfecting her English and learning American customs.

When Esau felt comfortable with the language and American practices, she took a job with Sloan Seed Company in Oxnard, California. She later moved to the Spreckles Sugar Company in the Salinas Valley, where she bred strains of sugar beets for resistance to the virus causing curly-top disease. At that time, she began to consider continuing her education. It was serendipity that Professor Wilfred Robbins of the University of California, Davis, campus made a visit to the company, and Esau was asked to show him her research project. She inquired about the possibility of study and later an invitation was extended to her to do graduate work at Davis.

Esau arrived in Davis in the fall of 1927, registering as a graduate student in the College of Agriculture for the 1928 spring semester. (The Davis campus did not award a Ph.D. at that time, so the degree was awarded from Berkeley.) She intended to develop a sugar beet that was resistant to curly-top virus. However, that would have required releasing the beet leafhopper into the university fields to infect the sugar beets. This was opposed by other plant researchers and growers, and she was told that it was incompatible with other crop research going on at Davis. Accordingly, she changed the direction of her research to the study of the transmission of curly-top virus and its effect on the sugar beet phloem, directing her research from applied to the more basic study of plant anatomy as it relates to the disease.

Esau received her Ph.D. in 1932 from Berkeley. She remained at Davis as an instructor, later becoming professor of botany. Esau left Davis in 1963, close to her official retirement date, to join her long-time research collaborator Vernon I. Cheadle at the University of California, Santa Barbara, where he was chancellor. She remained actively engaged in research for twenty-four more years! Esau considered the years in Santa Barbara her most productive and fulfilling. She had been introduced to electron microscopy just before leaving Davis, and she was interested in applying this new tool to her anatomical research. She collaborated and published with many people during this period. Today the electron microscope facility bears her name.

During her tenure at Davis, Esau studied both diseased and healthy plants, including celery, tobacco, carrot, and pear. Her work with Cheadle on the comparative structure of the secondary phloem of dicotyledons in the 1950s provided valuable information regarding the evolutionary specialization of the phloem tissue in relation to function. In 1953 her classic *Plant Anatomy*--known worldwide as the bible of plant anatomy--was published. This was followed by *Anatomy of Seed Plants* in 1960. Both of these books have been published in several languages, including Russian, and have extended her influence on the quality of instruction of plant anatomy into classrooms all over the world. The developmental aspects of her studies matured into *Vascular Differentiation in Plants* (1965) and her interest in virus-plant host relations into *Plants, Viruses and Insects* (1961) and *Viruses in Plant Hosts* (1968). In 1969 Gebrüder Borntraeger published *The Phloem*. In it Esau reviewed the structure and development of phloem beginning with the earliest records of the tissue. She redrew many of the old illustrations from the original articles and books. Her mastery of languages, including French, Spanish, English, Russian, German, and Portuguese, allowed her to prepare a thorough review of the very early and important German, Russian, and French articles.

Esau was a superb teacher, in part because she genuinely liked students. She never failed to reply to a note or letter from a student, offering encouragement and praise. Even in her early nineties she answered any correspondence she received from a student. She once said to a friend, "Don't they know I'm retired?"

Her course in plant anatomy was exceptional. A gift for story telling, total command of and enthusiasm for the subject matter, and a delightful sense of humor made her a truly outstanding teacher. On one occasion when she began a lecture humorously

with "Once upon a time," a graduate student quipped, "Aha, another of Esau's fables!" Her abilities as a teacher and researcher were recognized by fellow staff members when in 1946 while still an associate professor she was selected to give the Faculty Research Lecture at Davis.

Although she served as major professor to only fifteen doctoral students, there are numerous botanists, including many who have never met her but have studied her papers and books, who consider themselves her students. She instilled in her students an appreciation of precision and rigor that go into truly excellent studies of plant structure and development. In every aspect of her work she set new standards of excellence.

Esau served as president of the Botanical Society of America in 1951, and in 1956 was one of the original recipients of the Merit Award of that society at its fiftieth anniversary meeting. The Certificate of Merit read: "Katherine Esau, plant anatomist and histologist, for her numerous contributions on tissue development of vascular plants and in particular for her outstanding studies on the structure, development, and evolution of phloem."

Katherine Esau was the personification of excellence and integrity. Despite her numerous successes and many honors, she remained modest and close to her Mennonite roots. In 1959, when questioned about her election to the National Academy of Sciences, she commented "I never worried about being a woman. It never occurred to me that that was an important thing. I always thought that women could do just as well as men. . . . My surprise at being elected to the National Academy of Sciences was not because I was a woman, but because I didn't think that I had done enough to be elected." Some of her other honors include honorary degrees from Mills College, Oakland, California (1962) and the University of California (1966) and election to the American Academy of Arts and Sciences, the American Philosophical Society, and the Swedish Royal Academy of Science.

In 1989, she was awarded the National Medal of Science. The citation accompanying the medal read: "In recognition of her distinguished service to the American community of plant biologists, and for the excellence of her pioneering research, both basic and applied, on plant structure and development, which has spanned more than six decades; for her superlative performance as an educator, in the classroom and through her books; for the encouragement and inspiration she has given a legion of young aspiring plant biologists; and for providing a special role model for women in science."

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