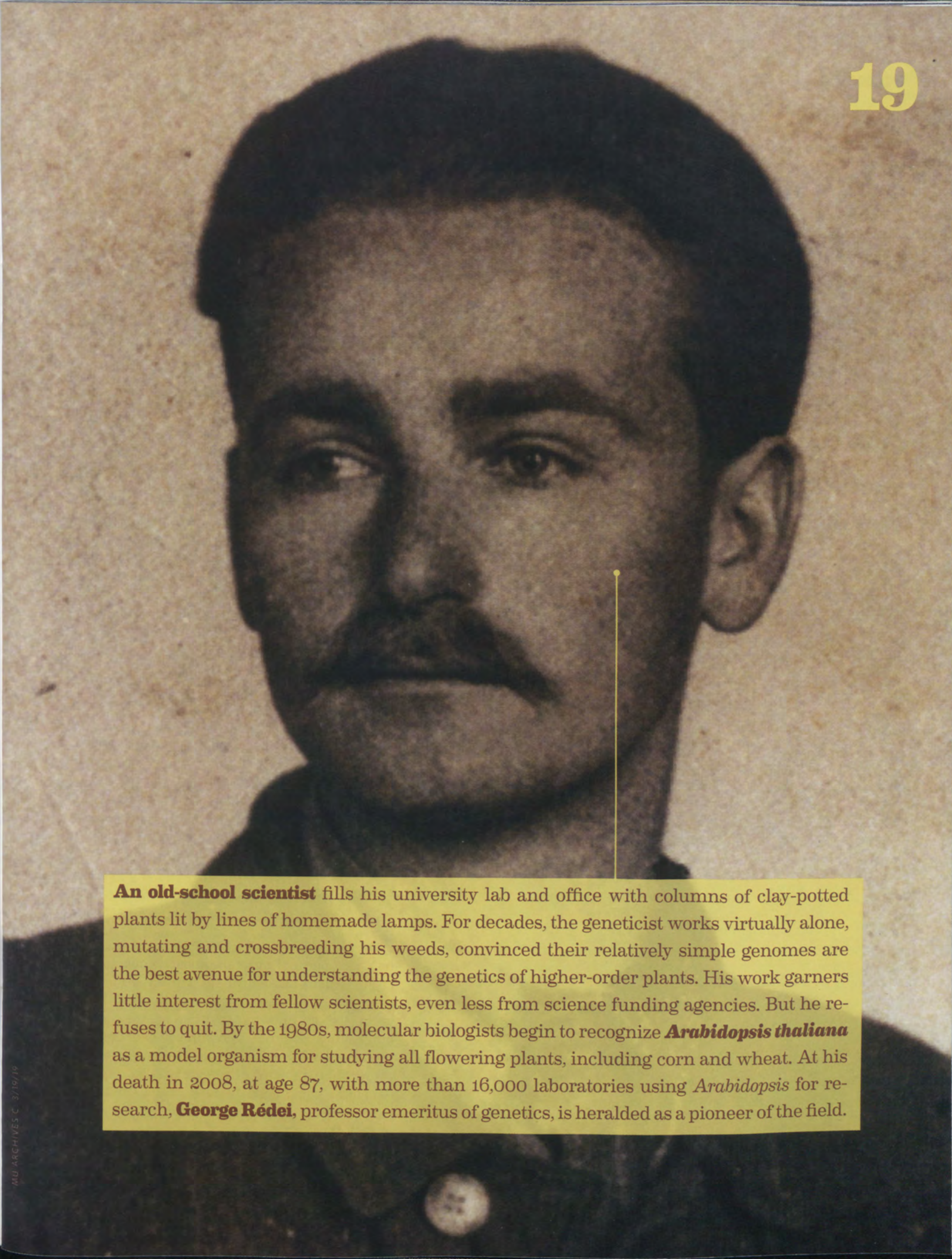
From Apathy to Apogee

Story by Erik Potter

COURTESY TROY UNIVERSITY HERBARIUM

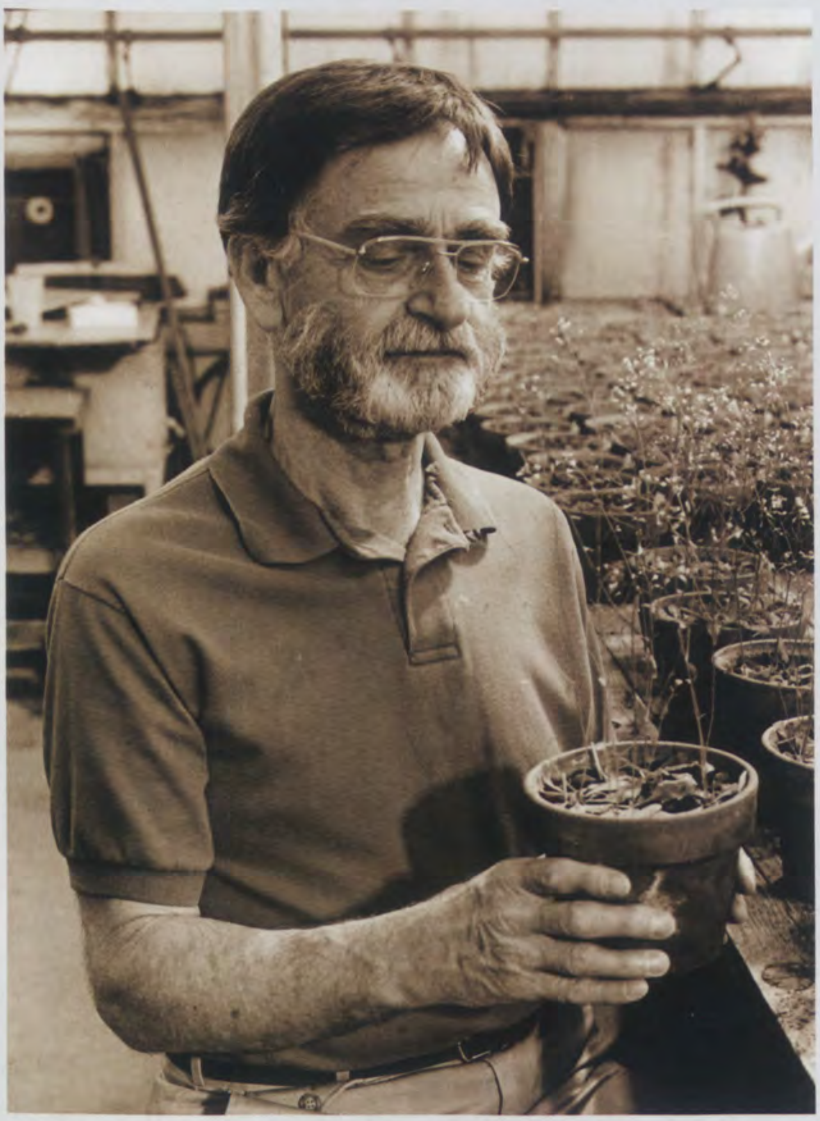


An old-school scientist fills his university lab and office with columns of clay-potted plants lit by lines of homemade lamps. For decades, the geneticist works virtually alone, mutating and crossbreeding his weeds, convinced their relatively simple genomes are the best avenue for understanding the genetics of higher-order plants. His work garners little interest from fellow scientists, even less from science funding agencies. But he refuses to quit. By the 1980s, molecular biologists begin to recognize ***Arabidopsis thaliana*** as a model organism for studying all flowering plants, including corn and wheat. At his death in 2008, at age 87, with more than 16,000 laboratories using *Arabidopsis* for research, **George Rédei**, professor emeritus of genetics, is heralded as a pioneer of the field.

MU ARCHIVES C 3/19/19

György "George" Rédei

was born June 14, 1921, in Vienna. The experiences of his early life were vastly different from his American colleagues. Rédei grew up in Hungary, known then as the breadbasket of Europe, where his father was an agronomist who owned a large estate.



† Ignored by the academic community, the late Professor George Rédei nonetheless persevered for decades in his research on the flowering plant *Arabidopsis thaliana*. His study of plant genetics helped revolutionize the development of food crops.

Rédei followed in his father's plant science footsteps, but while in college during World War II, he was deported to a forced labor camp. He toiled the last two years of the war in a coal power plant before narrowly escaping during the Nazi retreat to Germany in the face of the Soviet Union's advance.

He lost his parents to the war. His brother was one of roughly 700,000 Hungarians taken to Soviet prisoner camps but was not among the half who survived. Hungary fell under the Iron Curtain during the Cold War, and in 1948, the family farm was declared too large for one family and was seized and collectivized.

By 1953, Rédei had made his way to Budapest, the capital, and began his doctoral work at the Institute of Genetics of the National Academy of Sciences. Communist restrictions on the study of classical genetics — the Soviet minister of agriculture had staked his reputation on a countervailing theory — limited his dissertation work to prosaic questions such as the inheritance of weight in tomatoes.

In 1956, during the brutal Soviet clampdown following the thwarted Hungarian Revolution, he and his wife, Magdolna "Magdi" Rédei, were among the 180,000 refugees who fled the country. In 1957, he arrived in Columbia as an assistant professor in what was then the Department of Field Crops in the College of Agriculture.

A focused, serious man, Rédei brought with him a European proficiency with language — he spoke English, Hungarian, German, French and Latin — and a belief that *Arabidopsis*, a small flowering plant in the mustard family, was an ideal organism for studying plant genetics.

The *Arabidopsis* genome is simple; it has only five pairs of chromosomes, compared with corn's 10 pairs and wheat's 21 pairs, making it less complicated to identify genes of interest. Its life cycle is short, allowing multiple harvests a year, quickening research into inherited traits. And the plant itself is small enough to grow in the lab rather than on acres of research fields requiring expensive equipment. Because of this, Rédei saw *Arabidopsis* as the plant version of the lab mouse or fruit fly.

However, throughout most of his career, food crop researchers ignored him. Improving the genetics of corn or wheat, it was thought, required

MU ARCHIVES C: 3/19/19

† **PREVIOUS SPREAD** *Arabidopsis thaliana* is a small plant in the mustard family. Discovered in the 16th century, experimented on in the early 20th century, it was nearly abandoned by the 1970s. The work of George Rédei, shown as a young man in Hungary, helped spark a revival of interest in the 1980s that has made the weed the model organism for plant genetics.

research on corn or wheat, not on *Arabidopsis*. For 20 years, Rédei was the only scientist in the United States working on the weed. For a period, the National Science Foundation quit funding *Arabidopsis* work. Subsisting on internal funding from MU's Agriculture Experiment Station, Rédei relied on his wife as a lab assistant and often on his own pocketbook for supplies. He began to focus on writing, including textbooks and two influential review articles on *Arabidopsis*. The latter review, in 1975, had the ironic effect of quashing newfound interest in funding *Arabidopsis* work by discrediting a study published in the journal *Nature* that purportedly showed a quick and easy way to mutate *Arabidopsis*.

It wasn't until the 1980s, when a new generation of plant biologists was looking to apply molecular genetics to solve real-world questions, that Rédei's *Arabidopsis* got its day in the sun.

When Chris and Shauna Somerville discovered Rédei's research, in 1978, they were in Paris searching for a model organism for molecular genetics. The graduate students spent the spring holed up in the small library at the Institut Pierre and Marie Curie near the Seine River, reading books and journals in the morning and discussing them over coffee in the afternoon. They particularly pored over Rédei's articles, including his 1975 review, whose detailed figures and exhaustive methods sections demonstrated his hallmark meticulousness.

Upon the couple's return to the University of Alberta, they arranged for Rédei to visit campus to speak. As his hosts, they spent three days with him, besieging him with questions.

"I remember him being quite patient and willing to talk it through completely, rather than try to find a quick answer to our questions," says Chris Somerville, now a professor of alternative energy at the University of California, Berkeley.

Inspired, Somerville and his friends began to experiment with the plant and quickly encountered the entrenched viewpoint on it. "A friend sent in an article on *Arabidopsis*, and it was sent back as un-reviewed," Somerville says, remembering the reply letter stated: "There was some interest in this plant at one time, but that interest has dissipated."

But in 1980, Somerville used *Arabidopsis* mutants to demonstrate the main pathway of plant photorespiration, the reverse of photosynthesis, which had been subjected to heated debate in molecular biology. Because flowering plants are closely related, the discovery in *Arabidopsis* provided a road map for making the same discovery in food crops. Somerville's finding opened the eyes of the scientific community to the value of *Arabidopsis* as a research tool.

Soon, *Arabidopsis* papers were flooding plant science literature. The National Science Foundation started funding *Arabidopsis* studies again. By 1987, Somerville organized an *Arabidopsis* conference, and Rédei gave an important talk. "A lot of people were happy to see him," Somerville says. "He was a pioneer."

Interest spiked further when, in 1994, a lab at the Salk Institute in La Jolla, California, attempted to make poplar trees flower sooner by inserting an *Arabidopsis* gene that governs flowering (seed production). *Arabidopsis* produces seeds quickly, whereas poplars don't flower until they are about 10 years old. The two species are so different, however, that no one thought the experiment would work — until the poplar flowered while still in a petri dish.

That experiment, published in *Nature* and heralded in mainstream media, showed that *Arabidopsis* was both a model for scientific discovery and a vehicle for scientific manipulation, a way to take developmental control of other plants.

After decades of hardship and discouragement, one would expect Rédei to puff out his chest and glory in his vindication.

"He didn't change," says Dale Blevins, professor emeritus of plant sciences. "He was still George — the same quiet, modest guy."

Daughter Mari Rédei Tenkhoff, BS ChE '83, of Franklin, Tennessee, says her dad was pleased by the accolades about *Arabidopsis*, but he didn't see it as the end of the journey. "He just kept plugging away," she says. "The recognition for him wasn't that important. It was the ability to keep working and doing what he wanted to do."

In 1991, with interest in *Arabidopsis* still growing, Rédei retired and lost his lab space. "It's ironic that this happens at a time when *Arabidopsis* research has become so fashionable," David Perkins, a colleague at Stanford University, wrote him at the time.

Unwilling to stop his research, Rédei took his equipment home and continued his work. He soon accepted a visiting professor position at the Max

'He didn't change. He was still George — the same quiet, modest guy.'

→ Rédei and former colleague and MU Professor Barbara McClintock, who later won the Nobel Prize in physiology or medicine, attend the Stadler Genomics Symposium at MU in 1978.

MU ARCHIVES C. 3/19/19

Planck Institute for Plant Breeding Research in Germany. He spent several months there with another young researcher, friend and fellow Hungarian Csaba Koncz, who later noted Rédei's bitterness at his situation. He continued to publish, and his eight post-retirement papers received more than 1,000 citations.

But as *Arabidopsis* research progressed further into molecular biology terrain, Rédei decided to step away — sort of. In a 2006 chapter of *Plant Breeding Reviews, Vol. 26* that Koncz wrote and dedicated to Rédei, Koncz recalls a conversation the two men had around 1995. "Now I see that the new generation does this job well, and I'm too old to compete," Rédei told Koncz. "But I think I found something to do [that] might be useful."

That "something" was writing a first-of-its-kind handbook of genetics.

'Suddenly, bam! This is the thing to work on,' Blevins says. 'It went from obscurity to explosion.'

Blevins remembers Rédei's constant presence at Ellis Library during that time, piled deep in books and journals. By 1998, he published *Genetics Manual*, covering 18,000 genetic concepts and terms along with 600 illustrations. Five years later, Wiley-Liss published his expanded *Encyclopedia of Genetics, Genomics, Proteomics and Informatics*, a 2,201-page behemoth that *Nature* called "remarkably clear and up to date" and "one of the best textbooks of general genetics."

In another testament to his old-school roots, Rédei wrote the two-volume book by himself. Most undertakings of that size would involve several authors, says Ed Coe, a collaborator of Rédei's and professor emeritus of plant sciences.

Rédei continued to expand subsequent editions, the last of which was released in 2008, the year he died. The book remains respected in the field and commands a $1,100 price tag.

"George was 20 to 30 years ahead of his time," says Doug Randall, professor emeritus of biochemistry. "He knew the power of *Arabidopsis*, but no one else knew what it could do."

In 2004, MU dedicated the plant growth facilities section of the Christopher S. Bond Life Sciences Center to Rédei. In 1990, Somerville and a group of scientists launched the Multinational Coordinated *Arabidopsis thaliana* Genome Research Project. A few years later, they obtained a commitment from the National Science Foundation to provide up to $100 million to sequence and characterize the *Arabidopsis* genome. In 2000, the species became the first higher-order plant to have nearly its entire genome mapped.

"Suddenly, bam! This is the thing to work on," Blevins says. "It went from obscurity to explosion."

With a sequenced genome, *Arabidopsis* has become a proving ground for solving the genetic challenges involved in developing food crops that can fight off invasive species, grow in poor soil and survive with less pesticide. The most frequently used lab variant is one developed by Rédei, *Arabidopsis Columbia*.

"Essentially everybody uses it," Somerville says. The discoveries *Arabidopsis* has allowed are "too numerous to describe. We've revolutionized the field." **M**