



Ruth Patrick

1907–2013

BIOGRAPHICAL

Memiors

*A Biographical Memoir by
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NATIONAL ACADEMY OF SCIENCES

RUTH MYRTLE PATRICK

November 26, 1907–September 23, 2013

Elected to the NAS, 1970

Ruth Patrick, phycologist (algae scientist) and stream ecologist, passed away on September 23, 2013, at the age of 105 in Lafayette Hill, Pennsylvania. Ruth pioneered the study of streams as ecosystems and gave expression to that perspective by organizing teams of scientists to perform integrated studies of the physical, biological, hydrological, and chemical properties of streams and rivers. A major part of her legacy is her recognition that details of the species composition and functional roles of the bacteria, fungi, protozoa, algae, macroinvertebrates, and fish inhabiting fresh water ecosystems could collectively provide a measure of the relative health of streams and rivers. Her own area of specialization was in diatom systematics and ecology. She gave of herself tirelessly to inform the public of the importance of fresh-water and associated aquatic ecosystems and the need to study, understand, protect, and conserve those ecosystems from degradation. In doing all this, she became a role model for women entering the scientific, political, and industrial arenas and advancing to positions of influence. She was elected to the National Academy of Sciences in 1970, only the twelfth woman at the time to receive that recognition.



Ruth Patrick

By Thomas L. Bott
and Bernard W. Sweeney

Ruth Myrtle Patrick was born in Topeka, Kansas, on November 26, 1907, and raised in Kansas City, Missouri. She often recounted how her father, Frank Patrick, a successful lawyer and banker with strong naturalist leanings, kindled her interest in the world of nature. He took Ruth and her sister on Sunday afternoon walks, during which they collected materials from nearby woods and streams. As she told it, “If [she] had been a good girl,” she could sit on his knee and look through his microscope, where she found a world of utter fascination. When she was seven she received her own microscope. Throughout her youth her interest in science grew, and in 1926 she entered Coker College, in Hartsville, South Carolina, spending summers at the Cold Spring Harbor Laboratory or Woods Hole Oceanographic

Institution and graduating with a B.S. in botany. She went on to the University of Virginia for graduate work in botany and received her M.S. degree in 1931 (thesis title: “A Study of the Diatoms of Charlottesville and Vicinity”) and her Ph.D. in 1934 (dissertation title: “A Taxonomic and Distributional Study of Some Diatoms from Siam and the Federated Malay States”).



Ruth in her laboratory at the Academy of Natural Sciences of Drexel University.

Courtesy Academy of Natural Sciences of Drexel University, Undated.

At Cold Spring Harbor Ruth met her future husband, Charles Hodge IV. They married while she was in graduate school, and the couple moved to Philadelphia after she received her doctorate. Charles, an entomologist, taught zoology at Temple University, and Ruth obtained a teaching position at the Pennsylvania School of Horticulture. Attracted by the diatom collection at the Academy of Natural Sciences of Philadelphia (now associated with Drexel University), in 1933 Ruth became a volunteer at the Academy. In 1937, still as a volunteer, she was appointed

curator of the Leidy Microscopical Collection at the Academy; she finally became a paid member of the Academy staff in 1945. Two years later she founded the Department of Limnology (the study of inland waters), renamed in her honor in 1983 as the Patrick Center for Environmental Research. She chaired that department until 1973, when she assumed the Francis Boyer Chair of Limnology.

As curator of the Leidy Collection she consolidated existing collections into the Diatom Herbarium and oversaw its expansion. She supported the specimen collection by cataloging references to newly identified taxa and to the scientific literature concerning diatoms. Today the Diatom Herbarium is one of the most important collections at the Academy.

In the summer and autumn of 1948 Ruth directed an unprecedented study of streams draining the Conestoga River watershed in Lancaster County, Pennsylvania. She had observed that the diatom species composition reflected the degree of health of a stream, but this study was the first large-scale test of her hypothesis that the biodiversity of a stream reach could be used as a measure of the pollution of that reach. Many reaches of the Conestoga drainage received farm runoff from cropland and pastures, others were affected by septic or municipal sewage effluents or toxic substances from industry, and some were in relatively unpolluted condition. Rather than focusing on the presence or absence of indicator taxa belonging to a single group of organisms (for example, algae or fish) her multidisciplinary team assessed the sources of pollution, the water's chemistry, and the biodiversity of a wide array of organisms, including bacteria, algae, protozoa, rotifers, macroinvertebrates, and fish. The results of the study established that as pollution increased, biodiversity decreased. This finding, confirmed in numerous subsequent investigations, has been labeled the "Patrick Principle" by Dr. Thomas Lovejoy of the H. John Heinz III Center for Science, Economics and the Environment in Washington, D.C., and he considers it the very foundation of the environmental assessments being done today.

Along the way, Ruth devised the diatometer, a clear acrylic device that holds glass microscope slides and is equipped with flotation capability. The diatometer floats near the surface of a stream or river. Diatoms attach to the slides and grow there as they would on natural substrates, but the diatometer reduces variability in many conditions affecting colonization and growth, thus facilitating comparisons between rivers, and cells can be easily harvested for microscopic examination. Using this device on numerous river surveys throughout the United States, Ruth firmly established that the taxonomic structure of the diatom community varied with



Ruth and the 1948 team that studied the Conestoga River, Lancaster County, PA. Standing from left to right): Charles B. Wurtz, James A. Jones, Herbert W. Levi, Ruth, Mary Gojdics, John Cairns, Sarie Lynn Carter, John Wallace, John Rehm, and Thomas Dolan, IV, (with and unidentified person in the truck).

Courtesy Academy of Natural Sciences of Drexel University Archives collection 457.

different types of pollution. A natural diatom community was characterized by a large number of species with small to moderate population sizes. Pollution with organic matter typically resulted in a smaller number of taxa with a few of them having very large population sizes, whereas toxic pollution reduced both the number of taxa and the number of individuals per taxon.

Calls for help in assessing human impacts on streams and rivers began coming in from numerous industrial clients and government agencies. At the request of the Atomic Energy Commission, Ruth led Academy teams in establishing baseline conditions in the Savannah River before the opening of the Savannah River Nuclear Power Plant and in monitoring conditions in the river over the following decades. Ruth and Dr. Robin Vannote were called on by the Army Corps of Engineers to evaluate the effect of channelization on rivers throughout the continental United States. Later, Ruth was asked to assess radionuclide contamination of the Susquehanna River following the Three Mile Island accident in 1979.



Ruth in the mid-1970s, holding a slide removed from a diatometer. Note the prototype diatometer in the foreground as described in Patrick, Hohom & Wallace 1954. Courtesy Academy of Natural Sciences of Drexel University.

Ruth estimated that she studied somewhere between 800 and 900 streams and rivers around the world. She once recounted that after she gave a talk in India, someone in the audience came forward and asked her whether it was really she in a photograph of her research team standing in the river. Her answer was that it most certainly was her and that by getting into the river she learned things she would understand no other way. She participated in the American Philosophical Society expedition to Mexico in 1947 and led an expedition to Peru and Brazil sponsored by the Catherwood Foundation in 1955. While she addressed numerous pollution problems during the subsequent decades, she never failed to be fascinated by new scientific developments and an enlarging and ever

more detailed understanding of stream ecosystem structure and function. She became convinced that the ability to resolve problems created by pollution required thorough

knowledge of how unpolluted stream ecosystems were structured biologically and functioned.

This conviction led to the founding of the Stroud Water Research Center in 1967. The center was named after W. B. Dixon Stroud, who was a member of the Academy board of trustees. He and his wife, Joan Milliken Stroud, worked with Ruth and the Academy to establish this laboratory on the banks of White Clay Creek, a stream that flowed through their property in the pastoral Chester County countryside and that was designated by the Commonwealth of Pennsylvania an Exceptional Value Stream in 1984. The Rockefeller Foundation, the Stroud Foundation, and Francis Boyer provided major funding for the first project at the Center, a five-year study devoted to understanding the biological structure and ecological functioning of a riffle-pool sequence in this stream.

Ruth once again took a multidisciplinary approach, assembling a team of researchers to cover chemistry, microbial ecology, algal community structure, and primary productivity, entomology, hydrology, fish, computer modeling, and watershed science. In addition to biodiversity, research at the Center emphasized energy flow through stream ecosystems and links between a stream and its watershed. The project quickly produced a new paradigm for flowing water systems called “The River Continuum,” which was recently celebrated by the American Society of Limnology and Oceanography as one of the most highly cited papers in the field of stream ecology. The Stroud Water Research Center continues to thrive as an independent institution with a mission consistent with Ruth’s original vision: To advance knowledge and stewardship of fresh water systems through global research, education, and restoration.



Ruth in her greenhouse at the Stroud Water Research Center where she studied the effects of trace nutrients on algal communities.

Courtesy Lawrence Kanevsky, Academy of Natural Sciences of Drexel University.

In the same year as the founding of the Stroud Center, Ruth and the Academy established another field station, the Benedict Estuarine Laboratory, on the Patuxent River in

Benedict, Maryland. This facility focused originally on environmental assessment of the impacts of power plants on estuarine environments. In 1994 the Academy moved the laboratory to a new location downstream on the Patuxent, closer to the Chesapeake Bay in St. Leonard, Maryland. In 2004, oversight and ownership of the facility was transferred to Morgan State University, in Baltimore. Today it is known as the Patuxent Environmental and Aquatic Research Laboratory and is focused on increasing the understanding of coastal ecosystems so that they may be properly managed and protected.



Ruth studying a headwater stream in the Brandywine River drainage (Chester County, PA, with Ken Wood (in white shirt), who was at the time a project manager with the Brandywine Valley Association which produced the “Plan and Program for the Brandywine” in 1968, a forward-reacting stream conservation effort. It was important to Ruth to interest others in stream biology and to engage them in environmental stewardship.

Courtesy Robert Struble., Jr.

Ruth continued to investigate diatom communities at the Stroud Center during the 1970s, performing controlled experiments on the response of diatom communities to individual environmental factors, particularly trace metal concentrations. Natural algal communities were seeded onto and grown on glass slides in replicate clear acrylic “diatom boxes” held under natural light and temperature conditions in a greenhouse. The results of studies with manganese showed, for example, that algal taxonomic composition shifted at concentrations of 40 $\mu\text{g/L}$ (ppb). Diatoms predominated at that or greater concentrations, whereas at lesser concentrations cyanobacteria (blue-green algae) predominated.

Ruth’s approach of continuously linking pollution problems to basic scientific principles and current understanding of stream ecology helped make her an effective spokesperson for the environment to corporations, government regulators, and the larger public. She thrived on being at the nexus of academia (with its basic science), industry, and government (where science could be usefully applied to solve problems and improve the environment). Her intelligence and experience allowed her to get to the heart of a matter, whatever the problem, and her charming manner often went a long way to help her win uncommitted listeners over to her point of view.

In 1970 Ruth became an adjunct professor at the University of Pennsylvania, where, from the 1950s on, she established and taught courses in limnology (now called Introduction to Freshwater Ecology), pollution biology, and phycology (with an emphasis on diatoms). She enthusiastically engaged students in her love of stream ecosystems and her knowledge of how human activities could seriously impair them. Numerous students will trace their pursuit of stream ecology to their exposure to Ruth Patrick. Her status as an extraordinary role model for women seeking careers in science earned her several awards acknowledging this facet of her life.

Ruth invited many renowned scientists of the day, such as Drs. Evelyn Hutchinson, Robert May, Arthur Hasler, Francisco Ayala, E. O. Wilson, Luna Leopold, and George Woodwell, to the Academy to give seminars and discuss ongoing research with Academy scientists. On one particularly memorable occasion Dr. Hutchinson presented a seminar in Ruth's library on an autumn Saturday afternoon. Ruth was a gracious person, often opening her home to colleagues and friends for dinner afterward, giving them opportunities to meet her guests and interact with them personally. Because her busy schedule often dictated that she grab a quick lunch or snack whenever a chance arose, one could sense that she particularly enjoyed these times with associates for the opportunity they offered for relaxed good conversation, laughter, and intellectual stimulation.

Ruth wrote over 200 scientific manuscripts and several books. She and co-author Charles W. Reimer, made



Ruth with W. B. Dixon Stroud in front of her portrait in the Ruth Patrick Conference Room at the Stroud Water Research Center. Ruth is painted holding her trademark field hat with a vista of the Susquehanna River in the background.

Courtesy David Funk.

an enormously significant contribution to the field of diatom taxonomy with the publication of their two-volume reference work, *The Diatoms of the United States*. Her five-volume series entitled *Rivers of the United States* brought together the important characteristics of the major river systems of the United States. Her book *Groundwater Contamination* addressed an important aspect of that valuable aquatic resource.

Ruth was called on for advice throughout her career. She advised President Johnson on water pollution, President Reagan on acid rain pollution, and several Pennsylvania governors on water quality issues. She worked with Congress on anti-pollution legislation and participated in developing the Clean Water Act, passed in 1972. She served on numerous other advisory panels at the federal and state level. In 1973 she became the first woman to chair the board of trustees at the Academy of Natural Sciences of Philadelphia. She was the first woman and first environmentalist elected to the board of directors of the DuPont Company, in 1975. She also served on the boards of the Pennsylvania Power and Light Company, the World Wildlife Fund, and many other organizations.

Ruth did not seek the limelight and recounted more than once the day at the beginning of her career when she hid in the library stacks at the Academy to avoid being photographed for a newspaper story. But the limelight found her. She received over 25 honorary doctorate degrees (from Coker College, the University of Pennsylvania, the University of Virginia, and Princeton, among others) and numerous awards and prizes. A list of honors and awards follows, but among the most notable were her election to the National Academy of Sciences (1970) and to the American Philosophical Society (1974). Among other awards she received the second annual John and Alice Tyler Ecology Award (1975), the gold medal from the Royal Zoological Society of Antwerp (1978), and the National Medal of Science from President Clinton (1996). Buildings or areas within them at the University of South Carolina, the Delaware River Basin Commission offices in Trenton, the Academy, and the Stroud Center are named after her, as is a natural area along the Savannah River.

The list of honors in the appendix, organized by source, highlights the breadth of Ruth Patrick's influence on society.

Those who worked with Ruth could not but be captivated by her enormous energy, intelligence, scientific curiosity, dedication of purpose, and entrepreneurial spirit. Her

first husband, Charles, is quoted as having said that being married to her was like being married to “the tail of a comet,” and those who worked with her knew that she was the hardest working and most dedicated member of the team. Her workday seldom ended at 5 p.m. On several occasions she would schedule a meeting for 7:30 p.m. but would first take the team to dinner. Her scientific collaborators knew that Ruth viewed weekends no differently than weekdays and that a business-related telephone call at 7 a.m. or 8:15 at night could never be ruled out. She seemed to work 24/7 before anyone ever coined the term. No one questioned who was in charge, but she created a working environment in which the input of all the team members was appreciated and each member felt valued.

Ruth was always interested in new scientific findings and approaches. When we visited her in September 2012, when she was 104, the topic that caused her eyes to light up most was when we described the recent development of DNA bar-coding as a tool to identify aquatic insect larvae for water pollution assessment. She inquired if the same molecular approach might be applied to identify diatoms and was delighted to hear that research in that direction was already underway. We both noted after leaving her apartment that the latest copy of the *Transactions of the American Philosophical Society* was lying open on her coffee table.

Ruth was married twice but used her maiden name professionally to honor her father. Her first husband, Charles, died in 1985. She remarried in 1995, to Lewis H. VanDusen, Jr., a Philadelphia attorney. He died in 2004. She is survived by her son, Charles Hodge V, a physician in Leawood, Kansas, three stepchildren, three grandchildren, and many step-grandchildren and step-great grandchildren.

Ruth’s life was defined by a singularity of purpose—to leave the world a better place for having passed through it, to paraphrase Baron Baden-Powell. For her that meant addressing some of the most significant and serious environmental problems of the day. She often accomplished that by doing something that had not been done before. Those who knew her sensed that this hard work was fun and fulfilling for her because she genuinely liked people and enjoyed sharing her knowledge and experience with them, whether to help solve complex environmental problems, or to engage them in appreciating the natural world that she learned to love as a child.

HONORS AND AWARDS**From scientific societies and organizations**

- 1969 Richard Hopper Day Memorial Medal from the Academy of Natural Sciences
- 1970 Elected to the National Academy of Sciences
- 1970 Franklin Institute's Lewis L. Dollinger Pure Environment Award
- 1971 Merit Award from the Botanical Society of America
- 1972 Eminent Ecologist Award from the Ecological Society of America
- 1974 Elected to the American Philosophical Society
- 1975 Elected to Honorary Membership in South Carolina Academy of Sciences
- 1976 Elected to American Academy of Arts and Sciences
- 1978 Gold Medal of the Royal Zoological Society of Antwerp, Belgium
- 1979 Green World Award of the New York Botanical Garden
- 1982 Founders Award of the Society of Environmental Toxicology and Chemistry
- 1985 Environmental Regeneration Award from the René Dubos Center for Human Environments
- 1990 Outstanding Achievement Award of the North American Diatom Society
- 1992 Award of Excellence from the North American Benthological Society
- 1993 Benjamin Franklin Award for Outstanding Scientific Achievement from the American Philosophical Society
- 1996 Inducted into South Carolina Hall of Science and Technology
- 1996 American Society of Limnology and Oceanography Lifetime Achievement Award

From Private Foundations

- 1975 Second Annual International John and Alice Tyler Ecology Award
- 2002 Chairman's Medal from the Heinz Family Foundation

From Other Professional Organizations

- 1975 Gold Medal from the Philadelphia Society for Promoting Agriculture
- 1976 Iben Award from the American Water Resources Association
- 1990 James McGirr Kelly Award from the National Association of Water Companies
- 1995 Environment Award of the Association of Metropolitan Sewerage Agencies

From Civic Organizations

- 1969 Gimbel Philadelphia Award
- 1973 Philadelphia Award
- 1975 Golden Plate Award from the American Academy of Achievement
- 1977 Frances K. Hutchinson Medal from the Garden Club of America
- 1989 Distinguished Citizen Award from Pennsylvania Society

From Women's Organizations

- 1970 YWCA's Gold Medal
- 1988 Girl Scout Award
- 2009 Inducted into the National Women's Hall of Fame

From Government

- 1970 Pennsylvania Award for Excellence in Science and Technology
- 1974 Gold Medal from the Pennsylvania State Fish and Game Protective Association
- 1975 Department of Interior's Public Service Award
- 1977 Honorary Membership in the Water Pollution Control Federation
- 1982 Citation of Merit from the City of Philadelphia
- 1988 Commonwealth of Pennsylvania Governor's Award for Excellence in the Sciences
- 1996 National Medal of Science
- 2006 Pennsylvania Fish and Boat Commissions Ralph W. Abele Conservation Heritage Award

From educational institutions (in addition to honorary degrees)

- 1977 Outstanding Alumni Award from Coker College
- 1977 Outstanding Alumna Award from Sunset Hill School, Kansas City, Missouri
- 1979 Hugo Black Award of the University of Alabama
- 2002 Mendel Medal, Villanova University's highest honor

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