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IN MEMORIAM

In memoriam: R. Bruce Nicklas (1932–2025)

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Dr. Robert Bruce Nicklas, who spent over 50 years unraveling the mysteries of how chromosomes move during cell division, died on February 19, 2025, at the age of 92. To the broader scientific community, Bruce was the researcher who uncovered fundamental rules of accurate chromosome segregation by micromanipulating chromosomes. To those of us who worked alongside him, he was a mentor, a polymath with a great sense of humor, and a link to the beginnings of chromosome research.

Bruce's path started in Westlake, Ohio, where he developed a childhood love for chemistry. He intended to pursue it while an undergraduate at Bowling Green State University, but exposure to coursework in chemistry, combined with his interest in a sophomore course in microtechniques in biology, changed that plan (Sedwick, 2012). The microtechniques course opened a door to a microscopic world he found absorbing. Bruce moved on to major in biology, becoming a leader in the campus community as president of the branch of Beta Beta Beta, the biology honors society. After earning his B.A. in 1954 and a brief stint at Western Reserve University (now Case Western Reserve University), he moved to Columbia University, where he earned his M.A. in 1956 and completed his Ph.D. in 1958. R. Bruce Nicklas. Photo courtesy of the Leocadia Paliulis.

At Columbia, Bruce worked with Franz Schrader and Sally Hughes-Schrader, who both had long careers studying chromosomes. In joining their lab, Bruce became a member of a line of pioneers in the study of chromosomes that started with Edmund Beecher Wilson, under whom both Franz Schrader and Sally Hughes-Schrader worked in their dissertation research. In this environment, Bruce dug deep into his study of cell division. His doctoral work established him as an expert in the field. In addition, it provided him with a comprehensive understanding of chromosome diversity across the evolutionary spectrum. His scientific lineage and interest in the historical studies of chromosomes gave Bruce a thorough, comparative understanding of chromosome diversity across species. His breadth of knowledge allowed him to pick exactly the right organism—most famously the grasshopper—to answer the most complex questions.

Where the work of his scientific ancestors (Wilson, Schrader, and Hughes-Schrader) was generally observational and comparative, typically based on observations of fixed, stained specimens, Bruce observed and directly manipulated chromosomes of living cells, and made conclusions based on the cells' responses to those manipulations. Starting his first faculty position at Yale in 1958, he studied chromosome movements in living grasshopper spermatocytes and then began to physically manipulate chromosomes in the process of cell division. Inspired by early measurements of ciliary force, he adapted micromanipulation tools for chromosomes and spindles (Sedwick, 2012). Using an incredibly fine glass needle, he discovered he could reach into a living cell and physically detach a chromosome (Nicklas and Staehly, 1967). One can only imagine the sheer wonder of that moment—for the first time pulling on the chromosome until, suddenly, it was free and easy to move and then observing its movements as it eventually reattached to the spindle!

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In 1965, Bruce joined the faculty at Duke University along with his wife, developmental biologist Sheila Counce. It was at Duke that Bruce's lab did its defining work. He and his students, postdocs, and technicians discovered the importance of tension on kinetochores for stability of chromosome attachment to the spindle and progression from metaphase to anaphase (Nicklas and Koch, 1969; Li and Nicklas, 1995). They learned that, in some systems, repositioning some chromosomes in the cell impacts the positions of others (Camenzind and Nicklas, 1968). They measured the forces exerted by the spindle onto chromosomes in anaphase (Nicklas, 1983). They micromanipulated cells and then fixed them for examination using electron microscopy or immunofluorescence (Nicklas et al., 1982; Ault and Nicklas, 1989; King and Nicklas, 2000). They linked tension status to variations in the molecules present at the kinetochore, and also linked tension status to the number of microtubules associated with the kinetochore (Nicklas et al., 1995; Li and Nicklas, 1997; King and Nicklas, 2000; King et al., 2000). They studied how chromosome behavior is built into chromosomes and how progression through meiosis alters kinetochore position and chromosome cohesion (Paliulis and Nicklas, 2000, 2004, 2005). The work was and remains consequential and foundational to the field, and the scope of his scientific legacy extends far beyond the topics noted above. Bruce's accomplishments were honored when he was awarded the E.B. Wilson Medal in 1995. The E.B. Wilson Medal is the highest honor awarded by the American Society for Cell Biology. It is fitting that Bruce earned the honor named after his "scientific grandfather."

Bruce chose to keep his lab small. This meant that if you were in his lab, you had daily close interactions with him. I feel incredibly lucky to have had 7 years of my life overlap with his while I was a graduate student, and I am deeply honored to have been his last student.

Bruce guided me as I learned how to ask a question and how to design an experiment to answer it (he never told me what to do; he instead encouraged me to imagine). He gave me the space to get lost in the microscope. He was remarkably generous with his time, particularly during the writing of my first paper—a process that stretched over many months. He used that time to ensure I fully understood every implication of what I was doing and guided me in coming up with a thorough interpretation of the results. I remember some of my friends' graduate advisors writing all the papers that came out of their labs. Bruce knew that my graduate education would be incomplete without my mastering how to communicate my results in writing.

Our days were not just about spindles and chromosomes; we talked about opera, music, and everything we were reading—from Richard Feynman's biographies to the novels of Jane Austen. I remember being in the final stretch of writing my dissertation when Bruce handed me a copy of *The No. 1 Ladies' Detective Agency* by Alexander McCall Smith, telling me quite firmly that I needed to read it immediately.

Bruce and Sheila were also wonderful hosts, sharing their love of food at their favorite Durham restaurants and telling stories of their trips to Italy or the wildlife in their backyard. I continued to communicate with Bruce after graduating, through my postdoc and after becoming a faculty member. I miss all my time with him, and every day I think about conversations I would love to have with Bruce.

The field of cell biology is different because Bruce Nicklas was in it. His papers are foundational, his experiments are still taught in classrooms, and his curiosity lives on in the people who worked with him. I miss our conversations, but I see his influence every time I look through the eyepiece or use the micromanipulator to push chromosomes around. He leaves behind a field forever changed by his discoveries and a group of scientists who will continue to be inspired by his work.

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