IN THE COMPETITIVE and sometimes contentious race to develop a safe and effective vaccine against poliomyelitis, David Bodian earned respect for his diplomacy as well as for his scientific acumen and signal discoveries. His tactful disposition, intellectual generosity, and professional camaraderie made him a central contributor to the endeavor and, years later, an invaluable guide to its history. In the late 1980s, Elizabeth Fee conducted a series of interviews with Dr. Bodian in which he reviewed the key developments in polio research in the late 1940s and early 1950s. “I think that there was a greater interplay and mutual stimulation during that period than you find in most fields,” he recalled, a spirit he helped to foster at the Johns Hopkins University and in the wider research community. Combining neurological research with the study of the pathogenesis of polio, he developed an expert understanding of the disease, and made a series of crucial discoveries that paved the way for the development of a vaccine.

David Bodian was born in St. Louis, Missouri, on 15 May 1910. His Jewish parents, Harry and Tillie (Franzel) Bodian, had recently emigrated from the Ukraine, and David was the first child to be born in America. He, his four sisters, and a brother grew up in Chicago, where he attended public school. His father died in 1929, and the already poor family became reliant upon the two eldest daughters for financial support. They encouraged the other children to pursue a good education, and David Bodian launched into a productive period of study at the University of Chicago. He received a bachelor of science in zoology in 1931, a Ph.D. in anatomy in 1934, and an M.D. in 1937. This unusual combination may have equipped him especially well for his later research—it certainly brought him into contact with some leading scientists, including Frank R. Lillie, Paul Weiss, Benjamin Willier, and Sewall Wright in the Department of Zoology. All four became members of the American Philosophical Society. A talented student and researcher, Bodian received a small scholarship in 1931 and a fellowship in 1933. He was able to support himself through the rest of his studies by working as an assistant in anatomy for the medical school, having done well as a student in the neuroanatomy course.

By the age of twenty-six, just prior to graduating with his M.D. degree, Bodian had already developed an innovative new technique for staining nerve fibers in paraffin sections. For his Ph.D. thesis on the visual pathways of the opossum, he had worked closely with George Bartelmez to learn microscopy and histology of the nervous system. Initially, he used his mentor’s “Protargol” staining solution, in which silver hydroxide was used to deposit silver on sectioned nerve fibers, but Bodian found the technique unreliable. Testing whether the brass frames he had constructed to hold slides during the staining procedure
would affect the silver stain, he added a penny to the Protargol solution. The resulting nerve fiber staining was a great improvement, and Bodian published his new technique in the *Anatomical Record* in 1936. A year later, he published his results from applying the Bodian stain method to studies of the brain of goldfish, a process that revealed much more detail than previously detectable.

After completing his M.D. in 1937, and spending some months as a National Research Council Fellow at the University of Michigan, Bodian wrote to Howard Howe to inquire about a postdoctoral position in the Department of Anatomy at the Johns Hopkins University. Although he later joked that the ice and snow in Michigan drove him to Hopkins, Bodian was also intrigued by his and Howe's shared interest in the action of the poliovirus on the nervous system. Combining the various aspects of his previous training in zoology and anatomy with his interest in neurological research, he had been studying monkey brains from Howe's laboratory while still at the University of Michigan. After visiting Baltimore and discussing possible joint research topics, he joined Hopkins as a research fellow in 1939. From the moment he arrived, Bodian was immersed in new projects, taking charge of the Hopkins laboratory briefly while Howe was hospitalized with a peptic ulcer, and launching into intensive research. Over the next twenty years, the Hopkins team made a series of key discoveries, several of which were crucial for the development of a vaccine against polio.

Bodian remembered this period as an immensely exciting time, with one project leading to another and a proliferation of new ideas. In 1940, he read about an outbreak of paralytic polio among chimpanzees in a German zoo and a group of children who had visited them. He theorized that the infected children had transmitted the virus through the food they gave the animals, which meant the virus must infect through the alimentary canal, and not the olfactory system as had been previously thought. Bodian also recommended that the Hopkins laboratory conduct research using chimpanzees, rather than the rhesus monkey, as their reaction to the poliovirus was similar to the human response, resulting in more severe paralysis. Using the chimpanzee as a model for human polio would lead to many future discoveries.

In 1941, the Commonwealth Fund stopped supporting the anatomical laboratory, so Bodian left to accept an assistant professorship at Western Reserve Medical School. A year later, the National Foundation for Infantile Paralysis awarded funding to Dr. Kenneth Maxcy, chair of the Department of Epidemiology at the Hopkins School of Hygiene and Public Health, to support research on polio. Bodian returned to Hopkins, and he and Howe joined the School of Hygiene to continue their research. They published *Neural Mechanisms in Poliomyelitis*. 
in 1942, drawing on the previous five years of experimental investigation at Hopkins and synthesizing the new neurological and immunological knowledge for polio researchers.

Along with Isabel Morgan, who arrived in 1946 after meeting Bodian at Woods Hole, the Hopkins team made a number of crucial breakthroughs in the 1940s and 1950s. They discovered that there were three basic immunological types of poliovirus, clarifying the phenomenon of second infections and explaining that artificial immunity to only one strain would not protect against infection with one of the others. Their classic article, “Differentiation of Types of Poliomyelitis Viruses,” was published in the *American Journal of Hygiene* in 1949. This discovery showed why previous efforts to develop and test a polio vaccine had proved unsuccessful.

In 1952, David Bodian at Hopkins and Dorothy Horstmann at Yale, working independently, reached the same conclusion regarding the generally accepted theory of the progression of polio pathogenesis. The assumption had been that poliovirus passed directly from the alimentary tract to nerve fibers and thus to the nervous system. Bodian and Horstmann demonstrated that there was a transient middle phase: the virus moved from the digestive system to the blood and, if not destroyed by antibodies, it then moved from the blood to the nervous system. The transit of the poliovirus through the blood, during the asymptomatic stage of polio infection, provided an opportunity for the creation of a polio vaccine. Isabel Morgan then produced a killed virus vaccine that was successful in protecting monkeys against polio. Howard Howe also produced a formalin-killed trivalent vaccine, which proved capable of raising the antibody level in chimpanzees and also in children.

The contributions of Bodian, Morgan, and Howe thus laid much of the necessary scientific groundwork for the subsequent development of the Salk and Sabin polio vaccines. David Bodian described their accomplishments (in a letter to A. McGehee Harvey, professor of medicine at Johns Hopkins) in the following terms:

In summary, the major contributions were 1) the elucidation of the pathogenesis and pathology of poliovirus in monkeys, chimpanzees and man; 2) the introduction of the chimpanzee into poliomyelitis research, as a model for the disease in human beings; 3) the demonstration that experimental primates and man could be successfully immunized with formalin-treated virus, and that immunity in monkeys was correlated with the presence of serum antibody; 4) the discovery of the three basic immunological poliovirus types. These studies were crucial for setting the stage for vaccine development; 5) the demonstration of a viremic phase of poliovirus infection in the pre-symptom-
adic period, and its relationship to poliovirus invasion of the central nervous system; and 6) the demonstration that minimal levels of serum antibody were sufficient to protect against poliovirus invasion of the central nervous system, after virus feeding, by blockage of viremic invasion.¹

Bodian’s expertise and his measured approach to decision-making made him a valuable member of advisory committees in the critical years of research on a viable vaccine, and he served on key committees of the National Foundation for Infantile Paralysis, the National Institutes of Health, and the National Academy of Sciences. His was a calm, thoughtful, and influential voice in the highly charged discussions on the use of the live virus vaccine, and during the investigation of the Cutter incident, when improperly processed lots of the Salk vaccine caused more than two hundred cases of polio and eleven deaths. In the intense competition to develop and test rival polio vaccines, Bodian remained an impartial, careful, and conscientious adviser.

At Hopkins, Bodian had met Elinor Widmont, a medical illustrator and painter who contributed illustrations to some of Bodian’s published articles, and the two were married in 1944. They had five children, and remained residents of the North Charles Street area of Baltimore for the rest of Bodian’s career. Dr. Bodian advanced from assistant professor in epidemiology to associate professor in 1946, and became Bayard Halsted Professor of Anatomy and director of the department in 1957. Using electron microscopy, he focused on the development and structural intricacies of the spinal cord, and when he accepted the position of professor emeritus of anatomy and neurobiology in the Department of Laryngology and Otology in 1977, he ran an electron microscopy laboratory. In his later work, Bodian studied the spiral structure within the cochlea known as the organ of Corti.

Bodian served as the managing editor of the American Journal of Hygiene (later the Journal of Epidemiology) from 1947 to 1957 and as associate editor of Virology, Experimental Neurology, and the Anatomical Record. In 1941 he received the E. Mead Johnson Award in Pediatrics from the American Academy of Pediatrics. In 1955, he was inducted into the Poliomyelitis Hall of Fame at the Georgia Warm Springs Foundation. He was elected to the National Academy of Sciences in 1958, the American Academy of Arts and Sciences in 1968, and the American Philosophical Society in 1973. In 1985, the Society

¹The David Bodian Collection, The Alan Mason Chesney Medical Archives of The Johns Hopkins Medical Institutions.
honored him with the Karl Spencer Lashley Award. Dr. Bodian was an honorary member of the Anatomical Society of Great Britain and Ireland, the Société Française de Neurologie, and the Mexican Society of Anatomy, and he served as president of the American Association of Anatomists from 1971 to 1972.

In 1980, the Johns Hopkins University dedicated the Bodian Room in recognition of his contributions to polio research. He received an honorary doctorate from the university in 1987, and the year before his death, in the spring of 1991, the School of Hygiene and Public Health named him one of seventy-five “Heroes of Public Health.” Bodian was diagnosed with Parkinson’s disease in the early 1980s, and he died of the illness on 18 September 1992.

David Bodian loved his life in scientific research, working to elucidate the mechanisms of polio infection, and contributing to the vaccines that would one day eliminate the threat of this most feared disease of children. A modest and unassuming man, he did not seek the limelight, or compete for public and scientific recognition. He particularly enjoyed collaborative research and was distressed by the competitive and secretive attitude of some researchers. As he commented in an interview toward the end of his life, in discussing the development of a polio vaccine, “What I had in mind was that there would be the same kind of effort that we had in the typing program, where half a dozen labs got together and solved problems as they came by committee, and that was probably the way to do a vaccine faster than any other way. That didn’t work out because . . . it seems that [some] people prefer to go it alone.”

Elected 1973; Committee on Lashley Award 1977–79

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