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Ernst Caspari

STEVENS, NETTIE MARIA (*b.* Cavendish, Vermont, 7 July 1861; *d.* Baltimore, Maryland, 4 May 1912), *cytology, heredity.*

Nettie Maria Stevens came from solid New England stock. The first American Stevens came from Chelmsford, England, to Boston; his eldest son went to Chelmsford, Massachusetts, in 1663. The family remained in the area for five generations; Nettie's father, Ephraim, was born on 24 March 1833. He married Julia Adams of Cavendish, Vermont, in 1854. Their first two children, both sons, died before Nettie's birth. They had one more child, Emma Julia, in 1863. The family lived in Cavendish until after Julia's death and Ephraim's remarriage, whereupon they moved to Westford, Vermont. Nettie's father reportedly was a hardworking and reasonably successful carpenter and handyman.

Stevens' education began in the Westford public schools and continued at the Westford Academy, from which she graduated in 1880 as a college preparatory student. She and her sister both performed consistently well, achieving nearly perfect grades in all subjects. After graduating, Stevens taught high school, including zoology and physiology, in Lebanon, New Hampshire, for three terms. She then completed in two years (1881–1883), with nearly perfect grades, the four-year program at Westfield Normal School in Westfield, Massachusetts. She taught school until 1892 and again in 1895 and 1896, acquiring a reputation as an excellent teacher. In 1896 Stevens entered Stanford University, where she quickly decided to major in physiology. After the year 1897–1898, when she determined to work with Frank Mace MacFarland, she moved into histological work. She spent four summers (1897–1901) at Stanford's Hopkins Seaside Laboratory, working with marine organisms. After receiving the A.B. degree in 1899, Stevens remained at Stanford, working in experimental physiology under Oliver Peebles Jenkins. She spent 1900 in the investigator's room at the Hopkins Laboratory and completed her master's thesis (her first publication). She credited MacFarland with having assigned her to pursue cytological studies, a focus she followed in her later major work on sex determination and chromosomes.

After Stanford, Stevens went to Bryn Mawr College, where she began working under Joseph Weatherland Warren on the physiology of frog contractions and the influence of chemicals on the force of contractions. She quickly moved, however, to work with Thomas Hunt Morgan, who was then studying regeneration in various organisms. Stevens became involved in that work and in 1901 published two regeneration studies. At first she worked with material that Morgan had brought back from Naples; then she traveled to Woods Hole in 1901 to pursue cell division in regeneration of Tubularia. From 8 October 1901 to 1 April 1902, at Morgan's suggestion, she worked at the Naples Zoological Station, where she occupied the American women's table and pursued studies of cut eggs, with a particular interest in the relations of cuts to the chromosomes.

Later in 1902 Stevens went on to Würzburg, to work in the laboratory of Theodor Boveri, where she began to study ovogenesis and spermatogenesis. This contact with Boveri at a particularly productive point in his chromosome studies likely had a major directive impact on Stevens' work. She completed her Ph.D. from Bryn Mawr in 1903 and retained a

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professional tie with the school: as research fellow in biology (1902–1904), reader in experimental morphology (1904–1905), and associate in experimental morphology (1905–1912). She would have occupied a research professorship the next year had she not died from cancer.

In 1904 Morgan and Stevens began studying the behavior of chromosomes in aphids, work that she pursued with the support of a fellowship from the Carnegie Institution of Washington in the year 1904–1905. Several studies of germ cells in aphids appeared as a result. One paper of 1905 brought Stevens an award of $1,000 for the best scientific paper written by a woman. Another work, *Studies in Spermatogenesis*, marked her entry into the increasingly promising arena of sex-determination studies and chromosomal inheritance. In 1901 and 1902, Clarence Erwin McClung had suggested that there exists an extra, or accessory, chromosome in the male and that the presence of the accessory determines the male sex. In 1903 Morgan reported in his "Recent Theories in Regard to the Determination of Sex" the general opinion that an individual's sex is not determined by external (or environmental) factors.

But scientists were not at all sure what internal factors prevailed, Morgan concluded, nor even at what point sex is determined. McClung's suggestion had gained little support. Yet by the year 1904–1905 Stevens was actively pursuing the hypothesis that chromosomes determine sex, though not in the simple way that McClung envisioned. Both Stevens and Edmund Beecher Wilson sought to discover what role chromosomes do play. In a study that appeared as Carnegie Institution of Washington Publication 36, Stevens examined spermatogenesis in five insect species from four different groups. Two species had an extra or "accessory" chromosome in the male. But she felt that the common mealworm (*Tenebrio molitor*) proved most interesting for questions of sex determination because it exhibited a difference in size rather than in number of male and female chromosomes. Though cautious in her general conclusions, Stevens clearly felt that her work of 1905 on *Tenebrio* established that males have nineteen large chromosomes and one small one, and females twenty large ones, which implied a correlation of chromosomes with sex determination.

The period 1905 to 1908 brought a series of papers on germ cells, heterochromosomes, and the determination of sex in an attempt to elucidate the details of spermatogenesis for the unequal or "hetero" chromosomes in a range of additional species. Stevens explored what effect the different chromosomes might have, and she suggested that the evidence supported William Castle's modified version of Mendelian heredity as well. After a leave of absence and a return research visit to Boveri's laboratory in the year 1908–1909, Stevens continued to bring her cytological concern with chromosomes, especially heterochromosomes, and their behavior in synapsis to her work on regeneration and reproduction. Her death left this series of studies uncompleted.

Nettie Stevens achieved the highest respect from the leading biologists of her time. She failed to gain a full regular university position, no doubt largely because she was a woman. Yet she achieved an admirable career of research at the leading marine stations and laboratories. Her record of at least thirty-six publications written alone and four with a coauthor includes several major contributions and a group of studies that together constitute a central addition to the emergence of ideas of chromosomal heredity.

This woman scientist from Vermont deserves recognition as one of those providing critical evidence for a Mendelian and chromosomal theory of heredity. As Morgan wrote in his obituary note, "Her single-mindedness and devotion, combined with keen powers of observation; her thoughtfulness and patience, united to a well-balanced judgment, account, in part, for her remarkable accomplishment."

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Jane Maienschein

STEVENS, STANLEY SMITH (*b.* Ogden, Utah, 4 November 1906; *d.* Vail, Colorado, 18 January 1973), *experimental psychology, psychophysics.*

Stevens was the only child in a Mormon family. After mission service abroad, he took his B.A. at Stanford in 1931. He received his doctorate under Edwin Garrigues Boring at Harvard in 1933 for experimental work on audition. As a spokesperson for "operationism" in psychology, he helped spark the "unity of science" movement in 1935.

His book *Hearing* (1938) refined Hermann von Helmholtz's place theory by incorporating the electrical response recording of E. G. Wever and C. W. Bray and the basilar membrane hypothesis of Georg von Békésy. By 1940, Stevens also had begun to replace indirect methods of defining sensation with direct scaling methods.

During World War II, Stevens was codirector of Harvard's federally funded "defense research" project to design communications systems for military applications. His Psycho-Acoustic Laboratory trained a postwar generation of sensory psychologists. He edited the authoritative *Handbook of Experimental Psychology* (1951), featuring his own classic chapter on scales of measurement. In 1953, Stevens proposed the power law to describe the growth of sensation intensity with the increase of physical intensity. Ignoring age-old criticism that sensory experience cannot be quantified, he spent two decades determining the power exponents for more than two dozen sensory continua.

Stevens' "new psychophysics" set off debates about psychological methods, data, and theory. Probabilistic choice and signal detection theory grew from radar detection and took over threshold measurement. Stevens' theory of four scales of measurement was extended into an axiomatic derivation of fundamental measurement. His program of describing power laws on all sensory continua has been extended to support the "unity of the senses" in consequence of invariant features of the environment.

Ancestry, Childhood, and Education. Stevens was raised in a family of industrious English immigrants to Utah. Smith Stevens, as he was called, graduated from high school in 1924, the same year in which his mother, Adeline, died from a lingering heart ailment and his father, Steven, was killed in an automobile accident. After a short period in the family's electrical business, he did a three-year stint (1924–1927) as a Mormon missionary in Belgium, Switzerland, and eastern France. Returning to study at the University of Utah, Stevens was introduced to behavioral psychology in a course that used J. B. Watson's *Behavior: An Introduction to Comparative Psychology*. In the summers he worked for the Idaho Power Company. Transferring in his junior year (1929) to Stanford University, he turned toward medicine after a successful anatomy laboratory course. On 28 March 1930, Stevens and Maxine Leonard of Salt Lake City were married; she joined him for his last year at Stanford.

After postgraduate summer courses in statistics (with H. E. Garrett) and the history of psychology (with J. F. Dashiell) at the University of Southern California, Stevens enrolled at Harvard in the Graduate School of Education, and Maxine studied philosophy at Radcliffe. In his first year, 1931–1932, he took statistics (with T. Kelley), systematic psychology (with E. G. Boring), and physiology (with W. J. Crozier). He switched to psychology after one semester, and took the preliminary examinations for the doctorate in the spring of 1932. Having done well, Stevens was awarded a fellowship of $900. Under the supervision of Boring, director of the psychological laboratory, he performed research on audition for his doctorate in the department of philosophy and psychology in 1933.

Psychological research and theory drew from different "schools" in the 1920's. Edward B. Titchener at Cornell had promoted "structural psychology," which emphasized systematic experimentation on the senses. Boring, Titchener's student, had sought an accommodation with behaviorism by redefining the "attributes" of sensation in terms of their physical dimensions. A former engineering student, Boring in turn encouraged his student Stevens toward "a physics of the living organism" (Boring to Stevens, 26 October 1935). Stevens and Edwin B. Newman produced sounds with an electronic oscillator that had recently been pioneered by Harvey Fletcher at