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OBITUARY

John Moffit Gosline, BA, PhD, FRSC (1943–2016)

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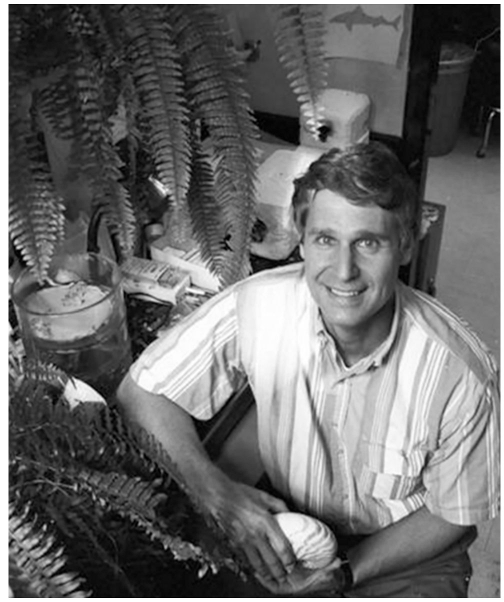
John M. Gosline, Professor Emeritus in the Department of Zoology at the University of British Columbia (UBC), Canada, died on 7 November 2016 at home in Vancouver after a protracted battle with cancer. John had a research and teaching career spanning five decades, during which he established himself as a world expert in biomechanics, an outstanding teacher, an exceptional mentor, and a wonderful colleague. Although John worked broadly in animal biomechanics, he is perhaps best known for his important work on the mechanisms of elasticity in structural proteins such as spider silk, elastin, resilin, collagen and keratin. John also had a long association with Journal of Experimental Biology, starting with the publication of two of his PhD papers in 1971, adding 31 others up to 2013, and serving as an active reviewer and a member of the Editorial Advisory Board from 1988 to 2016.

John grew up in Oakland, California, USA, and attended the University of California at Berkeley, where he studied chemistry and zoology, completing an honors BA in 1966. Following a summer research experience in marine biology in Hawaii, John moved to Duke University, USA, to begin his PhD studies with Steve Wainwright, a new professor in the Zoology Department. Wainwright and his colleague Steve Vogel were just starting to promote the application of modern engineering approaches to the study of animal function (as had McNeill Alexander in the UK). John was one of the first young students to embrace this emerging field. With his strengths in physical sciences as well as invertebrate zoology, John completed a now classic study that showed that the highly extensible body wall of sea anemones could be explained by using the engineering theory of viscoelastic discontinuous fiber-reinforced composites (Gosline, 1971a,b). With an approach that would become a hallmark of his research career (designing and building the appropriate test apparatus), John generated the mechanical data to complement the model: functional morphology had become comparative biomechanics.

In 1970, John took up a postdoctoral appointment at Cambridge University, UK, with Professor Torkel Weis-Fogh, who was Head of Zoology. Weis-Fogh, a graduate of August Krogh's lab in Copenhagen, Denmark, had made his name investigating the physiology and aerodynamics of locust flight and discovering the elastic cuticle protein he called resilin. Weis-Fogh elegantly demonstrated that resilin was a highly efficient elastomer and used thermodynamic experiments to show that the elasticity was based on changes in conformational entropy, just like natural rubber. John was interested in resilin but soon turned to applying the same theory to study the physical chemistry of elastin (a vertebrate elastomer), investigating the hypothesis that it, too, was fundamentally an



John Gosline in 1998. Photo credit: University of British Columbia Public Affairs.

entropic rubber, although complicated by its highly hydrophobic nature. Using a home-made microcalorimeter, John designed experiments to measure the heat released by purified elastin stretched in water, with the aim of formulating a thermodynamic model for the elasticity. Interestingly, the acuity of his insight at that time later caused problems. He predicted that, under certain conditions, the heat released by elastin during extension should precisely equal the mechanical work required to stretch the sample. He was overjoyed when, upon analyzing the results of his first experiment to test this hypothesis, the ratio of heat to work equaled 1.000. The second trial again produced a ratio of 1.000, as did the third. He became increasingly annoyed, knowing that no one would believe results that precise and diligently repeated the experiment again and again until he finally recorded some minor variation.

Work on protein elastomers continued when John joined the Zoology Department at UBC in 1973 as an Assistant Professor. His first purchase for the new lab was unconventional: a Maximat combination milling machine and metal lathe for the fabrication of customized test instruments. The usefulness of this machine was soon demonstrated to John's skeptical Zoology Department colleagues. It became a focal point of the lab and was used by virtually all John's trainees and visitors over his career to build experimental rigs for studies on slug slime, spider silk, octopus arteries, horse hooves, jellyfish mesoglea, hagfish slime and much more; it is still in operation in the lab today. As a retirement project, John's final Maximat creation was a high-precision impact tester that imposed very rapid extensions on strands of spider silk, to mimic what occurs when a web is struck by a flying insect. Doing

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this, John found that, because of viscoelasticity, the silk stiffness was much greater than what has typically been measured with conventional extensometers.

Complementing his knack for building equipment, John maintained a firm belief that recalcitrant devices would respond to delicate physical persuasion. In his hands, the 'six-inch drop' became a standard method for fixing chart recorders and frequency analyzers. Occasionally, a well-placed blow with a ball-peen hammer (aka BMFBPH) or a forearm shiver was used to resurrect amino acid analyzers, which, in those days, were the size of refrigerators.

John rose through the ranks to full Professor and served briefly as Head of his department, which gave him license to exercise his love of a party and of hosting visiting faculty and students. Among his many contributions to the Zoology Department was the December 'third floor party', featuring his highly acclaimed mulled wine, which is a continuing annual tradition today. John retired in 2008, bringing to a close a career during which he developed a well-funded world-class research program on the structure and mechanical properties of biological materials, as well as functional systems across a range of species. Studies included animals such as cnidarians, slugs, mussels, cephalopods, spiders, jellyfish, hagfish, and cetaceans and other mammals. The recurring interest in biological elasticity was evident in John's long-standing research contributions on arterial elastin and spider silks, among others. In recent years, he turned his attention to resilin, finally conducting the experiments he had imagined in Cambridge and showing that the elastic energy recovery of this protein was better than any other known natural or man-made elastomer, nearly 100% over a wide range of operating frequencies.

John received many honors for service and research, including a Senior Killam Fellowship, a Killam Research Prize and a UBC Faculty of Science Achievement Award. He was appointed a Fellow of the American Association for the Advancement of Science and a Fellow of the Royal Society of Canada. John was a strong contributor to the Biology teaching program at UBC, typically carrying an above-average teaching load and lecturing in a variety of courses, including cell biology, biochemistry, biomechanics, zoological physics, electronics and scientific measurement, and directing numerous honors BSc students. He developed a new undergraduate program in Integrated Sciences, where students create their own cross-disciplinary curriculum of study for a BSc, which has grown to be extremely popular.

Looking back, we see John's research as consistently characterized by interesting questions, innovative experimental approaches, and very critical and thorough evaluation of data. He published more than 100 scientific papers in top peer-reviewed journals, wrote books on biomechanics and biomaterials, and held a patent on how to transform hagfish slime threads into silk. Along with Steve Wainwright, Bill Biggs and John Currey, John was a co-author of the classic 1976 text *Mechanical Design in Organisms*, which many cite as the cornerstone of biomechanical research. Near the end of his life, he returned to the theme of design, willing himself to hold cancer at bay while he finished a book-length synthesis of the principles of biomaterials science, which will be published posthumously.

John's contributions as a mentor and educator are equally impressive, having trained more than 35 graduate students and postdocs and served on advisory committees for many more. Always very generous with his time to help colleagues and students, John was much sought after for his breadth of knowledge and innate problem-solving abilities. Indeed, John seemed to have an answer for any question that started out as 'How does XXX work?'. After his mental gears had turned for a moment, he would begin by saying, 'Well, as you remember from high school physics ….', and then produce a back-of-the-envelope calculation that, much to the bemusement of students and colleagues alike, was often both qualitatively correct and quantitatively accurate. As much as John was admired for his intellect, he was valued even more for his kind and gentle manner and his infectious optimism, characteristics that defined him to his final day. His devotion to his profession was matched by his devotion to his family and friends; he was loved by all who knew him.

In memory of John and to honor his important scientific contributions, friends and colleagues have established the John M. Gosline Biomechanics Endowment Fund to support an annual lecture in Comparative Biomechanics as well as student research projects in the Zoology Department at UBC.

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