

## IN MEMORIAM

# Carl Nelson Cederstrand (1927–2022): A Biophysicist, an Innovator and a Wonderful Person

Laura Cederstrand<sup>1\*\*</sup> and Govindjee Govindjee<sup>2\*</sup>

<sup>1</sup>Department of Geological Sciences, California State University Fullerton, Fullerton, CA, USA

<sup>2</sup>Department of Biochemistry, Department of Plant Biology, and Center of Biophysics & Quantitative Biology, University of Illinois at Urbana, Champaign, Urbana, IL, USA

(\*Corresponding author) email id: \*gov@illinois.edu, \*\*lceder@yahoo.com

Received: 10-01-2022; Accepted: 20-04-2022

## ABSTRACT

We provide a glimpse of the personal and professional life of Carl Nelson Cederstrand, most of the personal part is contributed by the daughter Laura Cederstrand (LC), and his research part in the Life Sciences is provided by Govindjee, his early collaborator and friend. Carl is remembered for his critical contributions to the discovery, in 1957, of the Emerson Enhancement Effect that led to the current Z-Scheme of photosynthesis, and later to the absorption and fluorescence spectroscopy of algae through his design and construction of a unique spectrophotometer, at the University of Illinois at Urbana Champaign (UIUC). After receiving his PhD at UIUC, he worked at Beckman Instrument's research division in California, where he designed an oxygen analyser that went to the Moon as part of one of the Apollo missions. Carl is best known for designing many infrared and ultraviolet detectors and creatively applying these in various ways in the life sciences, for which he is listed as inventor in nearly a dozen patents. Above all, Carl is remembered for his inventions that have significantly impacted many areas of the life sciences. We have included here his great insight into and fascination with MG cars. We end this Tribute to Carl with a reminiscence by his wife Darlene Kelly, and our summary of his personal family life.

**Keywords:** HAM license, Soapbox derby, Beckman instruments company, University of Illinois at Urbana-Champaign, MG cars, Photosynthesis, Emerson enhancement effect

## EARLY LIFE AND A FASCINATION FOR BUILDING THINGS

Carl Nelson Cederstrand was born on 4 July 1927, in Baltimore, Maryland. He died on 19 January 2022, in Tustin, California, of congestive heart failure. Early in life, Carl first lived at 3719 Appleton St., Baltimore, and then on Greenleaf Street, Wilmette, Wisconsin. He graduated from New Trier High School in Wilmette, Illinois. Carl's talent and interest in instruments and

equipment date back to his childhood days. When he was 14, he had already received his HAM license for his deep involvement with radios (note: HAM is named after three amateurs of Harvard Radio Club: Hyman, Almy and Murray). Beyond the radios, Carl was fascinated with cars. He even built a car, together with his father, and won the Soapbox Derby in Washington, DC, receiving his award at a ceremony in Akron, Ohio <<https://www.soapboxderby.org/akron-area.aspx>>. A story from the family is that when Carl was just 16 years old, he

built a submarine, in which he nearly drowned! During World War II (WWII), Carl served as a Seaman first class and as an Electronic Technician's Mate (ETM; Service Number 947 57 12), from 9 July 1945 to 6 February 1946) at the Great Lakes Naval Station in the USA.

### ACADEMIC TRAINING

After service in the US Navy, Carl worked as a radio and television repairman for 3 years, before entering George Washington University, in Washington, DC, where he obtained his BS (in Physics) in 1953; he then moved to the University of Illinois at Urbana-Champaign, obtaining his MS (in Physics) in 1955. At this time, he met Robert Emerson (1903–1959; see Govindjee and Govindjee, 2021) and joined his laboratory as a full-time research assistant. Carl designed and built most of the instrumentation that led to the discovery of the 'Emerson Enhancement Effect' in oxygenic photosynthesis (Emerson *et al.*, 1956, 1957). This landmark discovery led later to the concept of the 'two-light reaction- two-pigment system concept' in photosynthesis (see Govindjee *et al.*, 2017). In Govindjee's personal view, without Cederstrand's instrumentation skills, discovery of the Emerson Enhancement would have been delayed. We note that, while living in Champaign-Urbana, Carl continued his lively interest in cars by actively participating in the Champaign County Sports Car Club.

Carl Cederstrand was a notable alumnus<sup>1</sup> of the University of Illinois at Urbana-Champaign, having received his PhD in 1965 in Biophysics on the absorption and fluorescence characterisation of the two pigment systems in photosynthesis (Cederstrand, 1965) working with Govindjee and with Eugene Rabinowitch (1898–1973; see Govindjee *et al.*, 2019), as described below.

### RESEARCH DURING DOCTORAL WORK

After Emerson's tragic death in a plane crash on February 4, 1959, Cederstrand joined the PhD programme in Biophysics, working under the mentorship of Eugene Rabinowitch. His very first experiments were done on

projects initiated by Govindjee, which led to the discovery of the two-light effect in chlorophyll *a* fluorescence (Govindjee *et al.*, 1960), and to the existence of new absorption bands in the far-red region, particularly prominent at 750 nm in the cyanobacterium *Anacystis nidulans* (Govindjee *et al.*, 1961).

This was followed by Cederstrand's own PhD research, with continued collaboration with Govindjee, on the spectral characterisation of the two pigment systems in photosynthesis: Cederstrand and Govindjee (1966) described the spectral properties of the two pigment systems obtained by digitonin solubilisation of chloroplasts, whereas Cederstrand *et al.* (1966a) obtained the same by using different detergents/solvents. Further, Cederstrand *et al.* (1966b) were the first to directly demonstrate the existence of different spectral forms of chlorophyll *a* (e.g. Chl *a* 670 and Chl *a* 680, and more) in the direct absorption spectra of algal suspensions, measured at high resolution with a home-built special dodecahedron 'sphere'; this unique instrument was built by Carl Cederstrand (see Diana Yates interview of Govindjee at UIUC <<https://news.illinois.edu/view/6367/801235>>).

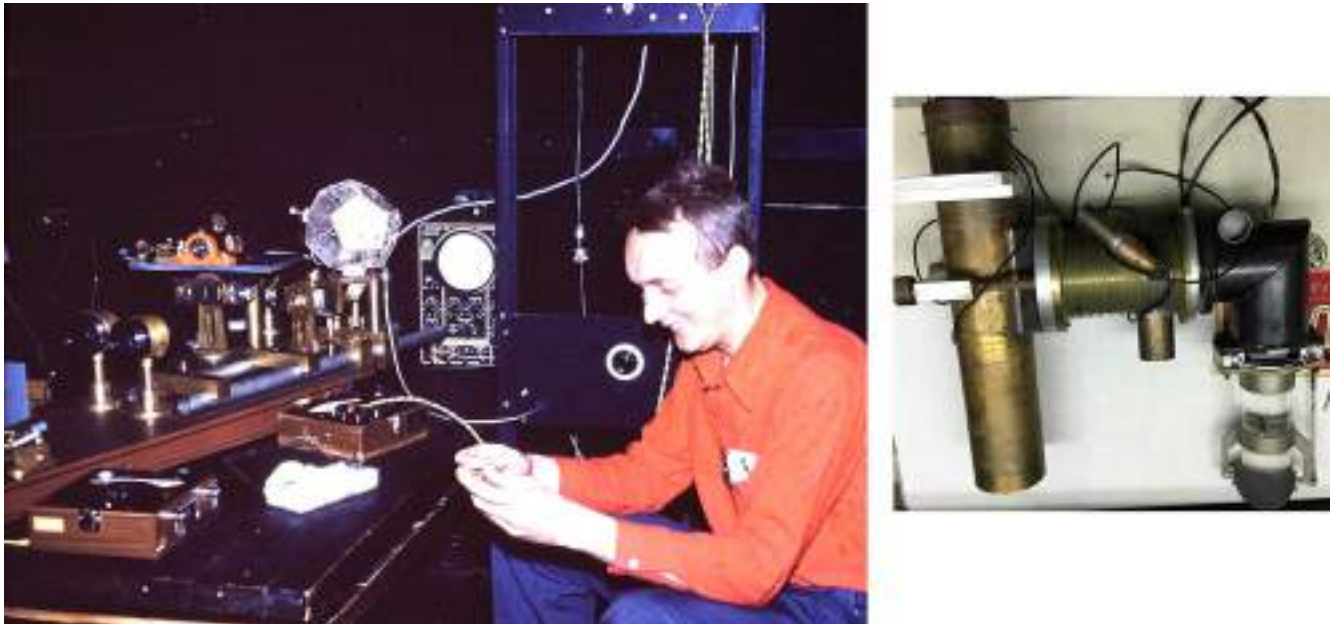
Figure 1 shows Carl Cederstrand with his home-built absorption spectrophotometer, during his PhD days in Urbana, Illinois.

### RESEARCH AND PATENTS AT BECKMAN INSTRUMENTS COMPANY IN CALIFORNIA

We briefly present below Carl Cederstrand's extraordinary achievements at the Beckman Instruments Company in California, where he invented novel instruments of importance in science and engineering, which yielded numerous patents.

After receiving his PhD at UIUC, Carl joined, in late 1965, the research division of the Beckman Instruments in La Habra, California, retiring from there in the early 1990s. Dr Neti Radhakrishnan Murty, a chemist and a former research associate of Eugene Rabinowitch, joined Carl at Beckman, where they both worked, in different areas, until their retirement. Carl had new ideas on instruments

<sup>1</sup>For tributes to three other PhD students of Eugene Rabinowitch, see Laws *et al.* (2018) for Thomas (Tom) Bannister; Hirsch *et al.* (2010) for Steve Brody; and M.G. Latimer *et al.* (2017) for Paul Latimer.



**Figure 1:** *Left:* Carl Cederstrand with the special absorption spectrophotometer he had built that allowed direct observation of the absorption peaks of Chl a 670 and Chl a 680 (Cederstrand *et al.*, 1966b). *Right:* Emerson's metal housing, also built by Cederstrand, used to give the second beam of light in the Enhancement studies (Emerson *et al.*, 1957). Photo by Govindjee.

*Source:* Figure 2 in Govindjee (2019)

and more. He served as Head of Research and Development at Beckman, inventing many instruments, the source of more than a dozen patents (see below). He worked mostly on infrared detectors, but an oxygen analyser he had designed went to the moon on one of the Apollo missions. That was a great thrill for his first wife Joan, who passed away many years ago (see below for 'Personal Family Life'). Indeed, Joan typed up Carl's paper for the infrared detector since the secretaries at Beckman had difficulties with the mathematical symbols as well as the technical description in the paper. In addition, Carl worked in optics, particularly at the ultraviolet end of the spectrum, designing UV detectors.

### Patents

To give the reader a glimpse of patents by Carl and his collaborators, we list below just a few from his patent files (randomly arranged); for details, see <<https://patents.justia.com/inventor/carl-n-cederstrand>> [Further, his co-inventors included (in alphabetical order): Hoke R. Chism, Jr; James C. Davis; Charles A. Keenan; Jerold H. Randall; Rolf W. Siemon; Sharam M. Salimian; and Dale F. Warnke, among others.]

*\*On a (new) spectrophotometer and optical system; \*Infrared gas analyser having detector elements of differing types; \*Method and apparatus for negating measurement effects of interferent gases in non-dispersive infrared analysers; \*A method and apparatus for selectively determining by non-dispersive infrared techniques the concentration of a gaseous constituent in a sample gas mixture; \*Non-dispersive Infra-Red analyser and a method for calibrating it; \*Dual lighthouse detector; \*Split detector; \*A gas analyser with a dual-channel capability for the simultaneous determination of the presence and concentration of two gases in a stream of sample gas, with a single infrared source; \*Focused infrared radiation source, and more!*

### FASCINATION WITH MG CARS

Any tribute to Carl Nelson Cederstrand would be incomplete without a mention of his deep interest in cars, particularly of the British automotive MG marque. We know that these cars were named after William Morris, and the use of 'G' (Garages) is still disputed (later owned by Nuffield organisation). Carl was a founding member

of the Vintage MG Club of Southern California. He was a member of this club until his death in 2022. Also, Carl owned an MG, before Govindjee had arrived in the USA in 1956. Carl taught Govindjee how to drive a car, but not in his precious MG! Carl was fascinated with his MG and took care of it as if it was his own child! He had even written a booklet on MG, a very comprehensive text, titled 'Ring and Pinion Interchanges for the MG TD/TF'; it is available through 'Moss Motors' (contact e-mail: moss.sales@mossmotors.com). It is the manual for MG drivers—some call it the 'bible for MG owners'. We are told by MG enthusiasts that it is exceptionally precise in the information that Carl included there. We end with a quote from <<http://www.ttalk.info/RearEndConversion.htm>>:

'All of a sudden you find yourself and your T-car on that frightening creature called an Interstate Highway. Certainly not the conditions for which the folks at Abingdon [UK] designed the TD or TF. Probably the pre-eminent expert in this area is Carl Cederstrand of the Vintage MG Club of Southern California (VMG). – I have had the distinct pleasure of spending some time with Carl [Cederstrand] – He is a fantastic individual with an extremely sharp technical mind who enjoys little more than helping others. Carl describes his authoring of the booklet [on MG] saying - the whole thing was a labor of love.'

#### **PERSONAL REMINISCENCE OF DARLENE KELLY**

'Carl had a wonderful sense of humour and could laugh at himself. He knew many silly songs and with his off-pitch singing voice, was quite hilarious. He enjoyed the Opera, especially Richard Wagner's Ring. For years, on Saturdays, he listened to the Metropolitan Opera. We attended almost all the opera series at the Performing Arts Theater in Orange County, California; he also enjoyed Broadway plays and classical concerts.

Carl's birthday was on the Fourth of July (US Independence Day) and for years; we celebrated it with his friends at the Hollywood Bowl. We picnicked on the lawn, and then attended the concert which always ended with Beethoven's 1812 Overture with cannons and fireworks. In recent years, we celebrated Carl's birthday

in our home with family and friends. We lived at the end of a *cul- de- sac* which was a perfect setting for the fireworks that August, Carl's son, lit.

Carl was a person of many interests. He was a member of a society for watches and owned many pocket watches; he was also a member of a toy train society and for several years had his childhood trains set up in our home, so my grandchildren and great-nieces and nephews could run them. He also enjoyed his 1950 MG TD and was a founder of the Vintage MG Club of Southern California. In addition, history was his favourite hobby. He spent hours reading and watching television programmes about World War II. I teased Carl about how frequently he watched war programmes. I would say that we knew how the story ended, but he seemed to never fail to learn something new about the World War II each time he saw the programme.

Dinosaurs were a favourite of Carl's. Recently, there was a large drive-through Jurassic Quest attraction to which my granddaughter took us. Most cars were full of excited children, but not our car. There in the centre of the procession was a delighted 94-year-old man Carl Cederstrand analysing how the dinosaurs were constructed and working. Always the scientist!

Carl was very good at lecturing and giving talks at the Vintage MG club meetings. He had the ability to explain things in a simple manner so that the subject could be understood. He spoke to my kindergarten students several times about stars and atoms. I was amazed at how he could get down to a five-year-old's level. Usually at the end of one of these kindergarten talks, the boys would ask 6 feet 6 inch tall. Carl if he could lift them to see if their heads would touch the classroom ceiling. On one such occasion, he lifted each of my 33 students. He did not do that a second time!

Carl's health had been deteriorating during the last several years of his life. At 94, he was just worn out. A bit of sunshine left my life with Carl's passing. He was such a loving and caring husband, and I will truly miss that dear man. But I am grateful for his final peace. 'No Service' was requested by Carl. So, if you want to remember him, please enjoy a root beer float or a large dish of ice cream!'



**Figure 2:** Photographs of Carl Cederstrand, at different times, with his favourite MG car(s). *Top left:* Carl is busy fixing his MG while camping on the Mogollon Rim, Arizona, 1974; *top right:* With his first wife, Joan and their baby Laura; *bottom left:* Carl teaching Laura how to drive on the Mogollon Rim, 1974; *bottom right:* Carl with his second wife Darlene Kelly, ~2000.

*Source:* Laura Cederstrand.

## PERSONAL FAMILY LIFE

We (Laura-Carl's daughter; and Govindjee-Carl's colleague and friend) conclude this Tribute with a few remarks on Carl's personal family life. Carl married Joan Marlowe Smith in 1954, while in Maryland. Rumour has it that the two had eloped at the urging of a friend, Alan Blankfield, before marrying each other. Joan was a chemist at the US Geological Survey in Washington, DC, and later at the Sanitary Engineering Lab at UIUC, in Urbana, authoring a scientific paper there on coal. Their first child, daughter Laura (co-author of this article), was born 5 years later in 1959. It was in 1956 that Joan had bought Carl his beloved MG TD with her own life savings. And there was a running joke, among Carl's friends, as to whether the car would be painted before the baby was born. The baby (Laura) won the bet. In 1965, the

Cederstrands moved to Brea, California. Carl and Joan were good friends with Govindjee and Rajni, and with Neti Radhakrishna Murty and his family at UIUC. After finishing his work in Rabinowitch's laboratory, Murty joined Carl in California with his family, purchasing a house across the street from the Cederstrands. Their children grew up together and both families were always very close. Joan and Carl's son, August, their second child, was born in California in 1968. Carl and Joan divorced in 1983, and in 2001, Carl married Darlene A. (Wenger) Kelly, a kindergarten school teacher and graduate of the University of Southern California at Los Angeles. They were devoted partners until Carl's recent death. Carl is survived by Darlene Kelly, and by Laura and August Cederstrand, the daughter and son of Carl and Joan Cederstrand, his first and predeceased wife.





**Figure 3:** *Left:* Carl Cederstrand celebrating his 94th birthday along with the 245th US Independence Day; *right:* Left to right: daughter Laura, Carl and son August.  
*Source:* Darlene Kelly.

We end this tribute by showing Carl at his 94th birthday on 4 July 2021, Orange, CA (Figure 3). We dearly miss Carl Cederstrand.

#### ACKNOWLEDGMENTS

We thank Ashwani Kumar, chief editor of the International Journal of Life Sciences, for inviting us to write this Tribute, and Reema Bagga of Diva Enterprises Pvt. Ltd, for her editing and typesetting services. We are grateful to Barbara Zilinskas, Arthur Nonomura and Robert Blankenship for their highly valuable editorial suggestions. We thank Rajni Govindjee for reading this Tribute and for approving it for publication. Laura remembers Carl as a great Dad until his very last days. Darlene Kelly, a long-time companion of Carl, is the one who gave us the sad news of Carl's death. She wrote: 'Carl was a great person and a very dear man. How fortunate I was to have been loved by him. A little sunshine left my life with Carl's passing.' Govindjee and Rajni are grateful to have been befriended by Carl since the day the two arrived, in mid-1950s, in Urbana, Illinois, from India.

#### REFERENCES

- Cederstrand C, Govindjee [G] (1966) Some properties of spinach chloroplast fractions obtained by digitonin solubilization. *Biochimica et Biophysica Acta* 120:177–180.
- Cederstrand C, Rabinowitch E, Govindjee [G] (1966a) Absorption and fluorescence spectra of spinach chloroplast fractions obtained by solvent extraction. *Biochimica et Biophysica Acta* 120:247–258.
- Cederstrand C, Rabinowitch E, Govindjee [G] (1966b) Analysis of the red absorption band of chlorophyll *a in vivo*. *Biochimica et Biophysica Acta* 126:1–12.
- Cederstrand CN (1965) Spectrophotometric and spectrofluorometric characterization of the two pigment systems in photosynthesis (PhD thesis in Biophysics). University of Illinois at Urbana-Champaign, 107pp (Doctoral Committee: Eugene Rabinowitch (Biophysics); [G.] Govindjee (Biophysics); Abbott BC (Biophysics); Laughnan JR (Botany); and Lyman EM (Physics)]
- Cederstrand CN (1977) *Ring and Pinion interchanges for the MG TD*, 3rd edition. The Vintage MG Club of Southern California, Moss Motors Ltd, PO Box MG Goleta, CA, part no. 212–350.

- Emerson R, Chalmers R, Cederstrand C (1957) Some factors influencing the long-wave limit of photosynthesis. *Proceedings of the National Academy of Sciences of the United States of America* 43:133–143.
- Emerson R, Chalmers R, Cederstrand C, Brody M (1956) Effect of temperature on the long-wave limit of photosynthesis. *Science* 123:673.
- Govindjee [G], Ichimura S, Cederstrand C, Rabinowitch E (1960) Effect of combining far-red light with shorter wave light on the excitation of fluorescence in *Chlorella*. *Archives of Biochemistry and Biophysics* 89:322–323.
- Govindjee G (2019) A sixty-year tryst with photosynthesis and related processes: An informal personal perspective. *Photosynthesis Research* 139:15–43. <https://doi.org/10.1007/s11120-018-0590-0>
- Govindjee G, Govindjee R (2021) Personal reminiscences of Robert Emerson and Eugene Rabinowitch. *Journal of Plant Science and Research* 37(1):101–106.
- Govindjee G, Papageorgiou GC, Govindjee R (2019) Eugene I. Rabinowitch: A prophet of photosynthesis and of peace in the world. *Photosynthesis Research* 141(2):143–150. DOI 10.1007/s11120-019-00641-w
- Govindjee G, Shevela D, Björn LO (2017) Evolution of the Z-scheme of photosynthesis. *Photosynthesis Research* 133:5–15. DOI 10.1007/s11120-016-0333-z
- Govmdjee [G], Cederstrand C, Rabinowitch E (1961) Existence of absorption bands at 730–740 and 750–760 millimicrons in algae of different divisions. *Science* 134:391–392.
- Hirsch RE, Rich M, Govindjee [G] (2010) A tribute to Seymour Steven Brody: In memoriam (November 29, 1927 to May 25, 2010). *Photosynthesis Research* 106:191–199.
- Latimer MG, Bannister TT, Govindjee [G] (2017) Paul Henry Latimer (1925-2011): Discoverer of selective scattering in photosynthetic systems. *Photosynthesis Research* 134:83–91. DOI 10.1007/s11120-017-0390-y
- Laws E, Weidemann A, Hoch G, Bannister H, Knox RS, Govindjee [G] (2018) In memory of Thomas Turpin Bannister (1930-2018). *Photosynthesis Research* 138(2):129–138.

**How to cite this article:** Cederstrand L, Govindjee [G] (2022) Carl Nelson Cederstrand (1927–2022): A Biophysicist, an Innovator and a Wonderful Person. *LS - An International Journal of Life Sciences* 11(1):1-7.