



HISTORY & BIOGRAPHY

The story of my life into and through the science of photosynthesis: a personal perspective

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Abstract

I present here the story of my personal and scientific life. I provide information on my parents, my childhood, schooling, education at the Wageningen Agricultural University, and the work for my PhD degree on the action of some herbicides on photosynthesis under the guidance of Professor Evert Christiaan Wassink. After graduation, I obtained a position as a professor. In 1977, I spent a one-year sabbatical with Professor Govindjee at the University of Illinois at Urbana-Champaign, USA. This was the start of a long-time and successful cooperation on the effects of bicarbonate on Photosystem II. The research on the impact of herbicides on photosynthesis was extended in cooperation with Professor Ko Wakabayashi and his co-workers at the Tamagawa University at Machida-shi, Tokyo, Japan. Another topic of my research was the photoinhibition of PSII by too much light; for this, I worked with Professor Christa Critchley at the University of Queensland in Brisbane, Australia. At the end, I list my service in several professional committees.

Keywords: bicarbonate; Christa Critchley; Govindjee Govindjee; herbicides; Bessel Kok; photoinhibition; Photosystem II; Ko Wakabayashi; Otto Warburg; Evert Christiaan Wassink.

About my parents

My father Jan van Rensen and his fiancée Lies Alberts had planned their wedding date on the May 10, 1940. However, on that very day, the German army walked across the Dutch borders and, thus, The Netherlands entered World War II (1939–1945). Jan had to join the Dutch army and was posted at the Grebbeberg. At this defense line, the Dutch could stop the Germans for several days. After the German air forces completely destroyed the center of the seaport city of Rotterdam on May 14, Queen Wilhelmina (1880–1962) surrendered. As a consequence, the fight was over, and the Dutch army personnel were sent home. Also, Jan returned home. It took some time for Jan to recover from the *Hell* of the Grebbeberg. But finally, he got married to

his Lies in August 1940 (*see Fig. 1*). And on July 17, 1941, their son (the current author of this perspective) was born; they named me Jacobus Johannes Servatius (JJS), after my grandfather.

My early days and education

I (Jacobus, informally Jack) grew up, and went to the kindergarten, the elementary school, the middle school, and the high school, all in Venlo, a small city in the southeast of The Netherlands. After I graduated from high school, the question came: what should I do next? Venlo is the center of a large and important area with many vegetable growers. There was an information center where the farmers could be advised on their problems by

Highlights

- My journey into the science of photosynthesis
- Cooperative research with scientists in the USA, Japan, and Australia
- Contributed important knowledge on the action of herbicides and bicarbonate on photosynthesis

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Fig. 1. A photograph of the newly-married Jan and Lies, August 1940. Source: family archives.

scientists from the Agricultural University of Wageningen. I decided to become a scientist. In 1959, I was admitted to the Agricultural University of Wageningen.

At that time, the study at the university had three levels: *Propaedeuse* (a diploma given after completion of the first year's study), *Kandidaats* (this took about two years). The third part of our course was called the *Ingenieurs* which took about two more years. The latter included a major (requiring one year of laboratory training), and three minors, each included three months of laboratory work. I chose plant virology as a major and phytopathology, biochemistry, and plant physiology as minors. I graduated with my *Ingenieurs* degree in 1964 from the University of Wageningen.

With Professor E.C. Wassink – and my PhD in 1971

For my minor in plant physiology, I was guided by Professor Dr. E.C. Wassink (1904–1981) who was famous in the field of photosynthesis; for his obituary, see Vredenberg (1981). I studied the effects of selected herbicides on photosynthesis. For this, I measured oxygen evolution from suspensions of the green alga *Scenedesmus*, using a Warburg apparatus, which was a common instrument at that time [for Otto Warburg (1883–1970) see https://en.m.wikipedia.org/wiki/Otto_Heinrich_Warburg, and for his doctoral student Robert Emerson, see Govindjee (2004)]. After I graduated with my *Ingenieurs* degree, Professor Wassink offered me a position as a research assistant with the possibility to work for a PhD. Thus, I could continue and advance the work I had done earlier for my minor.

The time of my PhD period was great. I had all the time for research and had complete freedom about what to do.

It was great to think about theories, plan experiments, and carry them out. I did everything by myself: growing the unicellular green alga *Scenedesmus*, making photosynthesis measurements, and doing intricate calculations. Many experiments were done with the Warburg apparatus. This was, in all likelihood, built by Bessel Kok [1918–1979; see Myers (1987)]. In 1949, Bessel Kok joined the Solar Energy Research Group under Professor E.C. Wassink at the Agricultural University in Wageningen. However, in 1958, Kok moved to the RIAS (Research Institute of Advanced Science) of Martin Marietta Co, in Baltimore, MD, USA.

In 1969, I demonstrated that polyphosphate (cf. Wassink 1957) formation in *Scenedesmus* under pure nitrogen represents cyclic photophosphorylation *in vivo*. I studied the mode of action of some herbicides on photosynthesis, including DCMU (diuron), simetone, and diquat. [Note that DCMU [3-(3,4-dichlorophenyl)-1,1-dimethylurea] is one of the urea-type herbicides, whereas simetone [2-methoxy-4,6-bis(ethylamino)-1,3,5-triazine] is one of the triazine-type herbicides, and diquat is 1,1'-ethylene-2,2'-bipyridylium dibromide; further that the more well-known paraquat, is also a bipyridylium-type herbicide.]

By studying the effects of these herbicides on oxygen evolution and cyclic photophosphorylation, I showed that DCMU inhibits oxygen evolution much more strongly than it does cyclic phosphorylation (50% inhibition at 0.2 μM for the former, vs. 40 μM for the latter). Although simetone behaved like DCMU, it was somewhat less effective. My results with diquat were consistent with the hypothesis that it is reduced to a free radical in the photosynthetic process and also, to a smaller extent, in respiration. The reaction of this free radical with water and oxygen leads to the formation of toxic peroxide radicals. In addition, these peroxides were assumed (and later shown) to disrupt cellular organization, the structure as well as the function of the overall system. The results of my PhD work led me to provide specific suggestions for the photosynthetic electron transport scheme; for details, see my thesis “*Action of some herbicides in photosynthesis of Scenedesmus as studied by their effects on oxygen evolution and cyclic photophosphorylation*” (van Rensen 1971). Fig. 2 shows a photograph of my mentor and PhD advisor Professor E.C. Wassink.

For me, it was a great pleasure to have my first scientific paper published (van Rensen and van Steekelenburg 1965) and to have participated (van Rensen 1969), for the first time, in an International Congress on Photosynthesis, held in Freudenstadt, Germany, organized by Professor Helmut Metzner (1925–1999).

Post PhD days: research and teaching

After the end of my graduation, with a PhD, Professor Wassink offered me a position as *Wetenschappelijk Medewerker* (Assistant Professor). It was great for me since I had much time for research. Among other areas, I investigated the effects of N-(phosphonomethyl)glycine (glyphosate). It appeared to have a much less inhibiting effect on photosynthetic oxygen evolution in isolated



Fig. 2. A photograph (about 1970) of Professor Dr. Evert Christiaan Wassink. Source: personal archives.

chloroplasts than DCMU did; glyphosate inhibited 50% at 2 mM, whereas DCMU did it at only 0.2 μ M (van Rensen 1975). Glyphosate works by blocking the shikimate pathway for the synthesis of three aromatic amino acids (tyrosine, phenylalanine, and tryptophan); thus, due to the absence of these amino acids, plants cannot synthesize proteins and they slowly die.

After the retirement of Professor Wassink

In 1974, Professor Wassink retired and there was no successor. I was asked to fill the position temporarily, which meant that I had to be the Interim Director of the Department. This included the responsibility of running the science program, for the personal and financial affairs, and for the entire staff (about 40 persons). I was soon thereafter promoted to *Wetenschappelijk Hoofdmedewerker* (Associate Professor). In this position, most of the time had to be spent at administrative meetings, and some at teaching, but there was very little time for research. I was not happy with that situation and looked for a way to get back to research. Fig. 3 shows a photograph of the building where I spent many years of my academic life.

Sabbatical in Govindjee's laboratory at the University of Illinois in Urbana, Illinois

Thinking of a sabbatical leave of absence, I considered several scientists and laboratories abroad. Yes, “my” herbicides acted on PSII, and the research group of Professor Govindjee at the University of Illinois at Urbana-Champaign (UIUC), Illinois, USA, worked on the effects of bicarbonate on PSII. Thus, I expected to expand my knowledge about PSII by working for a year in Govindjee's laboratory. After he agreed to my joining his lab, I applied for a NATO (North Atlantic Treaty Organization) science fellowship. This fellowship was awarded; in addition, I received a leave of absence from my university. After a lot of organization, I arrived with my wife and three children



Fig. 3. A photograph of the Laboratory of Plant Physiological Research four years after its construction was finished in 1922. The building is an architectural monument in the so-called Amsterdam Style. Source: personal archive.

in April 1977 in Urbana-Champaign, USA. Govindjee and his wife Rajni (see Fig. 4) were extremely helpful in getting us all settled.

In the laboratory of Govindjee I met three of his PhD students: Thomas (Tom) Wydrzynski [who passed away at the age of 71 in 2018; see Conlan *et al.* (2019)], Daniel Wong, and Rita Khanna (see <https://www.life.illinois.edu/govindjee/g/GraduateStudents.html>). There was a very friendly atmosphere in Govindjee's research group on the 2nd floor of Morrill Hall at the University of Illinois at Urbana-Champaign. I could spend all my time on research. This year was a turning point in my career. The review paper on the “Bicarbonate effects on Photosystem II”, was published in *Biochimica et Biophysica Acta*, of which I was a coauthor (Govindjee and van Rensen 1978). This paper is highly cited. Among other things, we studied the effects of 4,6-dinitro-*o*-cresol (DNOC) on photosynthesis (van Rensen *et al.* 1978). In Wageningen, I was used to growing spinach for the isolation of chloroplast membranes; however, in Govindjee's lab, they used pea plants, which



Fig. 4. A 2017 photograph of Professor Govindjee and his wife Dr. Rajni Govindjee. Source: family archives of Govindjee.

were much easier to grow. After this sabbatical year in Urbana, I returned to Wageningen and continued research on the action of bicarbonate and herbicides in PSII. The sabbatical in Govindjee's laboratory was the beginning of a long-time fruitful cooperation and friendship with him. Govindjee visited me in Wageningen several times for several days or weeks. I also visited Govindjee's laboratory several times for 3 to 6 months. This cooperation resulted in many publications. For information on the research done there, see: Robinson *et al.* (1984), Govindjee *et al.* (1989), Govindjee and van Rensen (1993), and Govindjee *et al.* (1997). For a photograph of Govindjee, see Fig. 5.

Once, during a summer when Govindjee visited us in Wageningen, I had organized an office for him on the top floor of our laboratory; this building was located on a small hill along the river Rijn. At Wageningen, this river is about 50 meters wide. However, sometimes the river gets flooded and becomes more than 200 meters wide between the dikes on the south and north sides. It happened that at the time of Govindjee's visit in Wageningen, the river was indeed flooded and Govindjee had a magnificent view of the river and the flat land on the other side of the river. A few days later, the flooding was over, and Govindjee came to ask me: Where is the river gone? It speaks of his simplicity!

Back to teaching, training students, research, and more in Wageningen

After the sabbatical in Govindjee's laboratory, and the return to Wageningen, my position was very stable for really a long time lasting many years. About one third of my time was devoted to teaching, one third to research, and the rest to administration and committee meetings.

The teaching included lectures on photosynthesis and on the mode of action of herbicides. I enjoyed participating in giving lectures not only on photosynthesis but also on weed science, phytopharmacy, crop protection, and integrated biology. About 50 students worked with me in their study for the *Ingenieurs* degree. Among my PhD students, some well-known ones in the field of photosynthesis are: Marcel Jansen, Gert Schansker, Jan Snel, and Willem (Wim) Vermaas. Wim was a special student. A large part of the research for his PhD he had done in the laboratory of Professor Govindjee at the University of Illinois, Urbana-Champaign, USA. He also worked with Professor Charles J. Arntzen, who was then in the Plant Research Laboratory at Michigan State University, East Lansing, Michigan, USA. In addition, Wim worked with Professor Gernot Renger, Max-Volmer-Institut für Biophysikalische und Physikalische Chemie, Technische Universität, Berlin, Germany. Wim later became a Foundation Professor in the School of Life Sciences at the Arizona State University (ASU), Tempe, Arizona, USA, (see: <https://search.asu.edu/profile/11214>). For a photograph of Wim Vermaas, see Fig. 6.

I have enjoyed doing research along three lines: on the role of bicarbonate, how herbicides function, and how photoinhibition affects plants; all related to PSII. For this, I had the fortune of working with many MSc and



Fig. 5. A photograph of Professor Govindjee, Source: family archives of Govindjee.

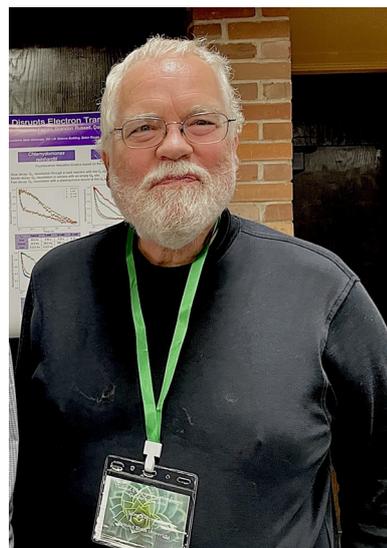


Fig. 6. A photograph of Wim Vermaas, taken by Govindjee in October 2024 during the 50th Midwest Southeast Photosynthesis Conference at Turkey-Run Inn, in Marshall, Indiana, USA. Source: Govindjee.

PhD students. Their results were successfully published. Instead of describing their work, I provide some selected references (in chronological order): van Rensen and Kramer (1979), van Rensen and Vermaas (1981), Vermaas and van Rensen (1981), Snel and van Rensen (1984), Naber and van Rensen (1991), Curwiel and van Rensen (1993), Schansker and van Rensen (1996).

For administration and committee activities, see Appendix 1.

A special conference

In 1983, Chris Sybesma [1928–2018; see Vredenberg and Govindjee (2020)] had organized the 6th International Congress on Photosynthesis in Brussels, Belgium. It was then, and still is, a system to organize satellite meetings before or after these large congresses. Following the above-mentioned congress in Brussels, I organized an International Workshop on the “*Mode of Action of Herbicides in Photosynthesis*” in Wageningen. Although

it was a lot of work, I enjoyed it as it was very successful with 80 participants from all over the world! The congress papers were published: *see van Rensen et al. (1984)*.

Below, I focus on our research during specific periods, beginning with the 1980s.

Research in the 1980s

During this period, research has been very fruitful indeed. In 1986, Dr. Abdur Rashid (University of Chittagong, Bangladesh) came to Wageningen to work with me on photosynthetic control and photoinhibition in triazine-resistant and susceptible *Chenopodium album* plants (*see: Rashid and van Rensen 1987*). Further, we measured flash-induced pH changes in isolated chloroplast membranes (*van Rensen et al. 1988*). We observed that the proton yields exhibit a binary oscillation with a period of four. However, in CO₂-depleted chloroplasts, the binary oscillation disappeared. Only the period four pattern remained, which can be described by proton liberation in the water-oxidizing system. We concluded that bicarbonate is involved in the protonation of Q_B²⁻. The affinity of bicarbonate to its binding site was much lower in the presence of dithionite, a reducing compound. It was suggested that bicarbonate exerts its influence through being a ligand to the non-haem iron between Q_A and Q_B (*see, e.g., Shevela et al. 2012*). Several more papers were published. I presented many (often invited) lectures during this time. Frankly, I felt honored to be invited, in 1986, to present the opening lecture of the session “*Herbicides and Antidotes*” at the 5th FESPP (Federation of European Societies of Plant Physiology) Congress, held in Hamburg, Germany, organized by Dr. Hartmut Lichtenthaler.

A fun job was editing, together with Prof. Dr. E.J. Ariëns (University of Nijmegen) and Dr. W. Welling (Institute



Fig. 7. A photograph of a get-together during the 1992 Omiya symposium. *Top row (left to right):* Gerhard Sandmann, Ko Wakabayashi, Hartmut Lichtenthaler, unidentified, unidentified. *Bottom row (left to right):* Jack van Rensen, Peter Böger, S. Matsunaki, and Charles Arntzen. Source: personal archives.

of Pesticide Research, Wageningen) an interesting book “*Stereoselectivity of Pesticides*” (*Ariëns et al. 1988*).

Further research, lectures, and conferences in the 1990s and the 2000s

Dr. Manoj Joshi [of Jawaharlal Nehru University (JNU), New Delhi, India] joined my research group in 1992. We published a paper on the effects of SAN 9785 treatment on alterations in characteristics of the photosynthetic apparatus (*Joshi et al. 1994*) together with Salil Bose and Prasanna Mohanty [1934–2013; *see Tiwari et al. (2014)*], in addition to a few others, *e.g.*, *see a paper Joshi et al. (1995)* on the relation between partial inhibition of PSII and the size and number of PSII units.

I am happy to mention that I have really enjoyed participating in congresses and satellite meetings. An example is the 1992 symposium on “*Molecular Regulation of Chloroplast Functions*” held in Omiya, Japan. This symposium preceded the 9th International Photosynthesis Congress, held in September 1992 in Nagoya, Japan. Fig. 7 shows a group photograph from that symposium.

Further, in August 1995, I participated in the Congress “*Photosynthesis from Light to Biosphere*”, held in Montpellier, France, organized by Paul Mathis (*Mathis 1995*). Fig. 8 shows a photograph of some of the participants at this congress.

Long before the above congress, I had been contacted, in 1988, by Professor Dr. Ko Wakabayashi, Chair of Physiology and Biochemistry of the Faculty of Agriculture, at Tamagawa University, Tamagawa Gakuen, Machida-shi, Tokyo, Japan. Ko-San had, long ago, his PhD in organic chemistry at the University of Utrecht, and, interestingly for me, he was looking for cooperation with a scientist working with herbicides in The Netherlands. This was the beginning of a very fruitful cooperation in research on the effects of herbicides on photosynthesis, and led to several mutual visits between Tamagawa University and the University in Wageningen. Fig. 9 shows a 1999



Fig. 8. Some participants at a break during the Montpellier Congress on August 18, 1995. *From left to right:* Mitsue Miyao, Norio Murata, Jack van Rensen, James (Jim) Barber, Vyacheslav (Slava) Klimov, Imre Vass, and Gotthard Heinrich Krause. Source: personal archives.

photograph of Dr. Ko Wakabayashi with me. Unfortunately for all of us, Ko-San passed away on March 5, 2023 at the age of 85.

During March and April 1998, Ko-San and his colleague Professor Dr. Hitoshi Kohno (Faculty of Agriculture, Tamagawa University, Machida-shi, Tokyo), obtained a fellowship for me from The Japan Society for the Promotion of Science. Using this fellowship, I worked at the Tamagawa University in Machida-shi, which is a small town close to Tokyo. Further, on April 3, 1988, Dr. Stephen O. Duke (USDA, Mississippi, USA) and I presented the two keynote opening lectures at the Annual Meeting of the Weed Science Society of Japan and the Japan Association for the Advancement of Phyto-Regulators in the JA (Japan Association) Hall in Tokyo. Then, at the laboratory of the Faculty of Agriculture, I worked with several students and scientists, *see, e.g.*, a paper by Ohki *et al.* (2001) on the effects of pyrimidines and pyridines substituted with benzylaminomethyl and trifluoromethyl groups on photosynthetic electron transport.

In September 1999, Hitoshi-San visited Wageningen to work with me. He investigated the activities of 2-benzylamino-1,3,5-triazines and related chemicals on photosynthetic electron transport in atrazine-resistant *Chenopodium album* plants (Kohno *et al.* 2000). In April 2002, Dr. Masaki Hiraki came to work with me for a year as a post-doc; he had been earlier supervised by Prof. Dr. Ko Wakabayashi and had received his PhD just a month before in March 2002. His research was on the effects of PSII-inhibiting herbicides on chlorophyll *a* fluorescence; for details, *see* Hiraki *et al.* (2003) and Hiraki *et al.* (2004). Fig. 10 shows a photograph of Masaki Hiraki with me and Wim Vredenberg.

Meanwhile, apart from my activities related with “Japan” and my regular work in my laboratory in Wageningen, I had the possibility to visit and work in several international laboratories. This became possible by a special arrangement for senior scientists: when one kept working during vacation holidays, one could use these days for a “sabbatical”, paid by the university. The first time I used this opportunity was in 1992. In August, I went to Japan and participated at the symposium on herbicides in Omiya and attended the International Congress on Photosynthesis in Nagoya, Japan. Then, during September, I was at the Tamagawa University, also in Japan, for scientific discussions with Prof. Ko Wakabayashi and his staff. Then, from October to December, I worked with Prof. Govindjee in his laboratory at the University of Illinois at Urbana-Champaign, and wrote a detailed review on the function of bicarbonate in PSII (Govindjee and van Rensen 1993).

From about 1990, I became interested in the process of photoinhibition in plants; for details, *see*: Curwiel and van Rensen (1993) and Schansker and van Rensen (1996). Since the most sunshine on Earth is in Queensland, Australia, it is a good place to study the inhibition of photosynthesis by excess light. Thus, in 1997, from August to November, I worked on this topic with Professor Christa Critchley [for information on Critchley, *see* Govindjee (2024)], and with Lesleigh Force (a graduate student of



Fig. 9. A 1999 photograph of Professor Ko Wakabayashi and Jack van Rensen (the author). Source: personal archives.



Fig. 10. A 2002 photograph in the office of Jack van Rensen at the University in Wageningen. *From left to right*: Jack van Rensen, Masaki Hiraki, and Wim Vredenberg. Source: personal archives.

Critchley), at the Department of Botany, University of Queensland, Brisbane, Australia. During 1999–2000, Lesleigh Force came to Wageningen and worked on the so-called “JIP-test” of the chlorophyll *a* fluorescence induction curve (Force *et al.* 2003). From August to November 2001, when I was on a sabbatical in Brisbane, we exposed wild-type and triazine-resistant plants of canola (*Brassica napus* L.) to very high light intensities which, as expected, caused “photoinhibition”. Data from this research was analyzed much later and published (*see* the next section for further information).

Retirement

On 1 August 2002, I formally retired, but I was allowed to keep my office and laboratory. I examined carefully all

my unpublished results, organized them, and published them, *see, e.g.*, Force *et al.* (2003) and Hiraki *et al.* (2003). Also, with Vyacheslav (Slava) Klimov (1945–2017), we wrote a detailed review of all aspects of the function of bicarbonate in PSII (van Rensen and Klimov 2005). And, many years later, we published a detailed and critical review (McConnell *et al.* 2012) on the same topic; this was together with Julian Eaton-Rye of New Zealand, who had long ago done his PhD under the mentorship of Govindjee (Eaton-Rye 1987).

After 2002, there came a very hectic time for the Wageningen University. Many buildings in the town of Wageningen were closed and a completely new campus was built on the north of Wageningen with many sky-high buildings with enormous space for teaching and research. The building of my old laboratory was transformed into an art gallery by the new owner who used it to exhibit artistic statues. Gradually, I stopped doing research. However, for many years, Professor Dr. Wim Vredenberg and I met, on Monday mornings, and had discussions on various scientific topics. It was during this time that we analyzed the data I had obtained in Brisbane in 2001, using a fluorescence induction algorithm to study the adaption of PSII to high and low light (van Rensen and Vredenberg 2011). With the mention of this paper, I come to the end of the story of my life in and through the science of photosynthesis.

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Appendix 1. A list of administration and committee activities.

- (1) Member (or secretary) of selection committees for a professional chair at the Wageningen University (several times).
- (2) Member (and for a period, Secretary) of the Standing Science Committee of the Wageningen University (1981–1985).
- (3) Coordinator of the science program on the *Molecular Mechanisms of Photosynthesis* (1984–1989).
- (4) Elected member of the Wageningen University Council and chairman of the “Centrale Lijst” (science workers) faction (1989–1992 and 1994–1998).
- (5) Supervisor of the research group on agrochemicals within SON-NWO [Scheikundig Onderzoek Nederland (chemical division) within the National Science Organization (1988–1992)].