

Wim Vredenberg - CV & Research



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Personal data

Date of birth
7 March 1937

Qualifications

“doctorate” experimental physics, mathematics and applied mathematics,
University of Utrecht, 1960

PhD Biophysics, thesis ‘Spectrophotometric Studies on Primary and Associated
Reactions in Photosynthesis, University of Leiden, 1965 (promotor Prof Dr L.N.M.
Duysens)

Full Professor of Plant Physiology (physical aspects), WAU, 1979

Career

1960: junior scientist Biophysics Department University Leiden

1967: principal scientist Center for Agrobiological Research, Wageningen

1970: visiting lecturer Dept Physiology and Biophysics University of Illinois,
Urbana, USA (1 year)

1979: professor of Plant Physiology (physical aspects) WAU

Membership of Professional Organizations

Nederlandse Natuurkundige Vereniging

Vereniging voor Biofysica, Chairman 1988-1994

American Society of Plant Physiologists

European Society of Biophysicists

Commissie Biochemie Biofysica van de KNAW 1986-1994

Biologische Raad van de KNAW 1990-1994

Editor Photosynthetica

Research programs

Achievements

From 1979 till 1994(5) the chair of (biophysical) plant physiology at the Wageningen Agricultural University (since 2000 renamed as Wageningen University and Research (WUR)) has focused its research primarily on the interaction of plants with light as a source of energy (photosynthesis) and of information (photomorphogenesis), with special emphasis on the molecular, (bio-)physical and (eco-) physiological aspects thereof. After the merging in 1993 of the till then existing two physiological departments in the new department of Plant Physiology, the emphasis of the chair has become limited mainly to the field of photosynthesis. Research on photomorphogenesis) is now continuing within the research theme Regulation and Differentiation.

Research projects on photosynthesis have been:

Electrogenesis, energy trapping and energy coupling in chloroplasts.

The chloroplast is a perfect model of a photoelectric energy transducer. Changes in the photocurrent profiles (amplitude, rate constant) caused by single turnover or continuous energisation point amongst others to changes in conductance of longitudinal lumenal and stromal phases of the intensity folded thylakoid membrane system. They are found to be accompanied by changes of the internal chloroplast structure as concluded from EM micrographs. The dynamic properties of the thylakoid are apparently of importance for spatial distribution of generated currents and consequently for the bioenergetic performance of the plastid.

Transit sequence-triggered responses in chloroplast envelope membranes

The project aims at getting information on the nature of the membrane responses that are associated with and/or involved in the recognition and following translocation of the precursor across the envelope.

Photosystem II of photosynthesis in chloroplasts

Photosystem II not only selectively senses but also adapts efficiently to environmental stressors. Study of photometric properties of PSII in vivo (fluorescence, luminescence, absorption) offers a sensitive means to study the impact of and defensive strategies of plants against environmental factors (coordinated by Dr. J.J.S. van Rensen)

UV-B interaction with plants

Research focusses on three aspects of this interaction (i) identification of protective mechanisms,(ii) elucidation of the role of protective mechanisms in

plant and ecosystem productivity, and (iii) PSII as a target for UV-B radiation

Regulation of photosynthesis in vivo

Modelling of photosynthetic light- and dark reactions and their feed-back interactions is used as a means to simulate the potential and time response of energy production *Photosynthetic energy conversion in phytoplankton*

The efficiency of photosynthesis, as measured with chlorophyll fluorescence, is documented to be a good measure for the efficiency of CO₂-uptake or O₂-production in (a population of) marine algae and cyanobacteria. (coordinated by Dr J.F.H. Snel)

Current Research and Prospects

After the expiration of the chair of plant physiology (physical aspects) in 1998 the biophysical research on the key role of the photosynthetic membrane in primary and secondary energy conversion reactions is continued on a free lance basis (so-called 0.0 appointment) and carried out in cooperation with the biophysical research groups in Moscow (Alexander Bulychev) and in Trebon (Ondrej Prasil) and Novy Hradý (Lada Nedbal).

Renewed focusing on fluorescence measurements and techniques has been (re-)started by me in the late 90's when photocurrent measurements with single turnover excitations in dark adapted intact chloroplasts showed evidence for photo-electrochemical control of the fluorescence yield of photosystem II (Bioelectrochemistry 54, 2001, 157-168). A new theoretical three-state trapping model (TSTM) of PS II was developed and applied to allow quantitative analysis of fluorescence (and photo-electrical) behavior in intact leaves, for which current 'classic' views, models and interpretations are inadequate. TSTM can do the job properly with relevant physical and physiological parameters. The model is described extensively in chapter 6 in the handbook 'Chlorophyll fluorescence: a signature of photosynthesis' (eds. Govindjee and George C. Papageorgiou), Springer Dordrecht, the Netherlands (see Bibliography).

Using twin single turnover flashes (TTFs) we have found that the fluorescence increase in plant chloroplasts induced by the first twin-partner is followed by an increase of approx. similar size when the second partner is applied within 30 to 100 μ s after the first one. The amplitude of the twin response, the maximum of which corresponds with $F_v/F_m \sim 0.8$, shows a pronounced 4-periodic oscillation associated with the 4-step oxidation of water in the Kok cycle (S states) and titrates with a life time of a trapping competent state of 200 to 300 μ s.

Our results demonstrate that PSII acts as a two photon trapping entity This has far-reaching consequences for current views on so called intersystem energy transfer (connectivity) between PSII units and on PSII heterogeneities with amongst others characteristics and properties of functional PSUs different in antenna size or electron transport activity. It is anticipated that double exciton- and electron trapping in PSII is advantageous for the plant. It serves the depression of electron transport in QB-nonreducing RCs, associated with electrochemically coupled proton transport, by an increased electron trapping efficiency in these centers (see Bibliography).

Some key refereed papers (1996-2006)

Voorthuysen, T. van, H.A. Dassen, J.F.H. Snel and W.J. Vredenberg Patch clamp study on flash-induced secondary electrogenic transport in the thylakoid membrane: Interpretation in terms of a Q-cycle/semiquinone cycle *Biochim. Biophys. Acta* 1277, 1996, 226-237.

Van den Wijngaard, P.W.J. and W.J. Vredenberg, A 50-picosiemens anion channel of the chloroplast envelope is involved in chloroplast protein import. *J. Biol. Chem.* 272 (1997) 29430-29433

Vredenberg, W.J., J.F.H. Snel and J.H.A. Dassen. A sizeable decrease in the electric conductance of the thylakoid lumen as an early event during reaction center and Q cycle turnover. *Photosynthesis Res.* 1998, 58, 111-121

Vredenberg, W.J.. A three-state model for energy trapping and chlorophyll fluorescence in photosystem II incorporating radical pair recombination. *Biophys. J.* 79(1), 2000, 26-38

(<http://www.biophysj.org/cgi/reprint/79/1/26>)

Vredenberg W.J. and Bulychev A.A. (2002) Photo-electrochemical control of photosystem II chlorophyll fluorescence in vivo. *Bioelectrochemistry* 57: 123-128

Vredenberg W.J. System Analysis and Photo-Electrochemical Control of Chlorophyll Fluorescence in Terms of Trapping Models of Photosystem II: A Challenging View, in: Papageorgiou, G. and Govindjee (eds) *Chlorophyll Fluorescence: A Signature of Photosynthesis*, Springer, Dordrecht, the Netherlands , (2004). - p. 133-172

List of invited reviews/ proceedings/bookchapters

Struik, P.C., W.J. Vredenberg, J.A. Renkema, and J.E. Parlevliet, eds. *Plant production on the threshold of a new century*. Kluwers Academic Publishers, Dordrecht, The Netherlands, 1993, ISBN 0-7923-2903-1, 1

Vredenberg, W.J. Electrogenesis in the Photosynthetic Membrane: fields, facts and features Bioelectrochem. Bioenerg. 44 (1997) 1-11

Snel J.F.H. and W.J.Vredenberg The electrochemical properties of the thylakoid membrane in: Photosynthesis and Plant Biology (eds. G.S. Singhal, G.Renger, S.K. Sopory, K.-D Irrgang and Govindjee) - New Delhi: Narosa Publishing House 1999 p. 364-385.

Bulychev A.A. and W.J.Vredenberg Light-triggered electrical events in the thylakoid membrane of plant chloroplasts. Physiol. Plant. 105,1999, 577-584

Vredenberg, W.J. System Analysis and Photo-Electrochemical Control of Chlorophyll Fluorescence in terms of Trapping Models of Photosystem II in :Chlorophyll fluorescence: A Signature of Photosynthesis Eds: George C. Papageorgiou and Govindjee, Advances in Photosynthesis and Respiration Series, Springer, Dordrecht, the Netherlands , (2004). - p. 133-172

International cooperations

Research Cooperation Russia and The Netherlands (NWO-program 047.01.008.96)

Program: Diagnostics of Photoelectric Phenomena in Plant Chloroplast Membranes in Relation to Photosynthetic Biomass Production

Participants:

Moscow State University, Biophysics Department

Russ. Acad. Sci., Laboratory of Membrane Biophysics, Institute of Photosynthesis, Puschino

Moscow I.S. Sechenov Medical Academy, Department of Medical and Biological Physics

Joint Research with Biophysics Groups in Czech Republic (partly financed by the Academy of Sciences of the Czech Republic and by the Grant Agency of the Czech Republic)

Program: Fluorescence Kinetics in Single Turnover Flash Trains of variable Length and Frequency in Plant Chloroplasts

Participants:

·University of South Bohemia, Faculty of Biology , Ceske Budejovice,

·Inst. of Microbiology, Academy of Sciences Czech Republic, Laboratory of Photosynthesis, Trebon, Czech Republic

Institute of Physical Biology of the University of South Bohemia, Nove Hrad

Wim Vredenberg - Publications & Links



Publications W.J. Vredenberg, LUW, 1978-2008

Vredenberg, W.J. and A.H.C.M. Schapendonk. Evidence for a light-induced blue band shift of part of the P515 pigment pool in intact chloroplasts. *FEBS Lett.* 91, 1978, 90-93.

Schapendonk, A.H.C.M. and W.J. Vredenberg. Activation of the Reaction II component of P515 in chloroplasts by pigment system 1. *FEBS Letters* 106, 1979, 257-261.

Schapendonk, A.H.C.M., W.J. Vredenberg and W.J.M. Tonk. Studies on the kinetics of the 515 nm absorbance change in chloroplasts. I. Evidence for the induction of a fast and slow P515 response upon saturating light flashes. *FEBS Letters* 100, 1979, 325-330.

Tonk, W.J.M., A.H.C.M. Schapendonk and W.J. Vredenberg. A double-compartment mixing cuvette for measuring light- and chemically-induced absorbance changes in suspensions of energy-conserving particles. *J. of Biochemical and Biophysical Methods.* 1, 1979, 193-194.

Schapendonk, A.H.C.M., A.M. Hemrika-Wagner, A.P.R. Theuvenet, H.W. Wong Fong Sang, W.J. Vredenberg and R. Kra. Energy-dependent changes of the electrokinetic properties of chloroplasts *Biochem.* - 19, 1980, 19-22.

Vredenberg, W.J. and A.H.C.M. Schapendonk. Reaction kinetics of P515 in chloroplasts. Transmembrane (reaction I) and inner membrane (reaction II) electric fields. In: Photosynthesis Vol. I, (G. Akoyunoglou ed.) Balaban Int. Sci. Serv. Philadelphia, 1981, 489-499.

Vredenberg, W.J. P515: A monitor of photosynthetic energization in chloroplast membranes. *Physiol. Plant.* 53(4), 1981, 598-602.

Kooten, O. van, F.A.M. Leermakers, R.L.A. Peters, and W.J. Vredenberg. Indications for the chloroplasts as a tri-compartment system: Micro-electrode and P515 measurements imply semi-localized chemiosmosis. In: Proc. Vith Int. Congr. on Photosynthesis, (C. Sybesma ed.) 1983, II4, 265-268.

Kooten, v. O., A.G.M. Gloudemans, and W.J. Vredenberg. On the slow component of P515 and the flash-induced reduction of cytochrome b563 in chloroplast membranes. *Photobiochem. Photobiophys.* 6, 1983, 9-14.

Peters, R.L.A., M.E. Bossen, O. van Kooten, and W.J. Vredenberg. On the correlation between the activity of the ATP-hydrolase and the kinetics of the flash-induced P515 electrochromic bandshift in spinach chloroplasts. *J. Bioenerg. Biomembr.* 15, 1983, 337-346.

Peters, R.L.A., O. van Kooten, and W.J. Vredenberg. The kinetics of the flash-induced P515 electrochromic bandshift in dependence of the energetic state of the thylakoid membrane and the ion concentration in the outer aqueous phase. In: Proc. Vith Int. Congr. on Photosynthesis, (C. Sybesma ed.) 1983, II4, 269-272.

Vredenberg, W.J., O. van Kooten, and R.L.A. Peters. Electrical events and P515 in thylakoid membranes. In: Proc. Vith Int. Congr. on Photosynthesis, (C. Sybesma ed.) 1983, II4, 241-246.

Peters, A.L.J., R.H.M. van der Pal, R.L.A. Peters, W.J. Vredenberg, and R. Kraayenhof. Studies on well-coupled Photosystem I -enriched subchloroplast vesicles. Discrimination of flash-induced fast and slow electric potential components. *Biochim. Biophys. Acta* 766, 1984, 169-178.

Peters, R.L.A., O. van Kooten, and W.J. Vredenberg. The effect of uncouplers (F)CCCP and NH₄Cl on the kinetics of the flash-induced P515 electrochromic bandshift in spinach chloroplasts. *FEBS Lett.* 177, 1984, 11-17.

Peters, R.L.A., O. van Kooten, and W.J. Vredenberg. The kinetics of P515 in relation to the lipid composition of the thylakoid membrane. *J. of Bioenergetics and Biomembranes* 16, 1984, 283-294.

Peters, R.L.A., O. van Kooten, and W.J. Vredenberg. The kinetics of the flash-induced P515 response in relation to the H⁺-permeability of the membrane bound ATPase in spinach chloroplasts. *J. of Bioenergetics and Biomembranes* 17-4, 1985, 207-217.

Kooten, O. van, J.F.H. Snel, and W.J. Vredenberg. Photosynthetic free energy transduction related to electrical potential changes across the thylakoid membrane. *Photosynth. Res.* 9, 1986, 211-227.

Peters, R.L.A., O. van Kooten, and W.J. Vredenberg. Onset of ATP synthesis in spinach chloroplasts after single turnover flashes in relation to adenylate kinase activity. *FEBS Lett.* 202, 1986, 361-366.

Vredenberg, W.J. Fluorescence and absorbance measurements in leaves: sensors of photosynthetic performance. In: *Advanced agric. instrumentation, design and use*, NATO ASI ser., (W.G. Gensler, ed.) Martinus Nijhoff Publ. Dordrecht, 1986, 107-132.

Buurmeijer, W.F., Th.A. Roelofs, and W.J. Vredenberg. Some aspects of altered structure and functioning of the photosynthetic apparatus in phytochrome-less mutants of tomato. In: *Progress in Photosynth. Res.*, II, (J. Biggins ed.) Martinus Nijhoff Publ., Dordrecht, 1987, 383-386.

Hove, L.W.A. van, A.J. Koops, E.H. Adema, W.J. Vredenberg, and G.A. Pieters. Analysis of the uptake of atmospheric ammonia by leaves of *Phaseolus vulgaris* L. *Atmospheric Environment* 21, 1987, 1759-1763.

Kooten, O. van, J.F.H. Snel, and W.J. Vredenberg. Modelling of photosynthetic energy conversion.III.Electrochemical events at the membrane. In: *Progress in Photosynth. Res.*, II, (J. Biggins ed.) Martinus Nijhoff Publ., Dordrecht, 1987, 621-624.

Snel, J.F.H., O. van Kooten, and W.J. Vredenberg. Modelling of photosynthetic energy conversion.II.Charge separation and secondary electron flow. In: *Progress in Photosynth. Res.*, II, (J. Biggins ed.) Martinus Nijhoff Publ., Dordrecht, 1987,

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Vredenberg, W.J., O. van Kooten, and J.F.H. Snel. Modelling of photosynthetic energy conversion. I. Description and basic principles of the model. In: Progress in Photosynth. Res., II, (J. Biggins, ed.) Martinus Nijhoff Publ. Dordrecht, 1987, 613-616.

Bossen, M.E., J.H.A. Dassen, R.E. Kendrick, and W.J. Vredenberg. The role of Ca²⁺ in phytochrome-controlled swelling of etiolated wheat protoplasts. *Planta* 174, 1988, 94-100.

Vredenberg, W.J., J.J.J. Ooms, and W.F. Buurmeijer. Electrogenesis in chloroplast membranes: Evidence for two slow components in the P515 signal after flash excitation. In: The Ion Pumps, Structure, Function and Regulation, (W.D. Stein ed.) Alan R. Liss Inc., Publ. New York, 1988, 293-298.

Hove, L.W.A. van, O. van Kooten, E.H. Adema, W.J. Vredenberg, and G.A. Pieters. Physiological effects of long-term exposure to low and moderate concentrations of atmospheric NH₃ on poplar leaves. *Plant Cell Environ.* 12, 1989, 899-908.

Hove, van L.W.A., W.J.M. Tonk, G.A. Pieters, E.H. Adema, and W.J. Vredenberg. A leaf chamber for measuring the uptake of pollutant gases at low concentrations by leaves, transpiration and carbon dioxide assimilation. *Atmospheric Environment* 22, 1988, 2515-2523.

Hove, van L.W.A., E.H. Adema, W.J. Vredenberg, and G.A. Pieters. A study of the adsorption of NH₃ and SO₂ on leaf surfaces. *Atmospheric Environment* 23(7), 1989, 1479-1486.

Ooms, J.J.J., W.J. Vredenberg, and W.F. Buurmeijer. Evidence for an electrogenic and a non-electrogenic component in the slow phase of the P515 response in chloroplasts. *Photosynth. Res.* 20, 1989, 119-128.

Bossen, M.E., R.E. Kendrick, and W.J. Vredenberg. The involvement of a G-protein in phytochrome-regulated Ca²⁺-dependent swelling of etiolated wheat protoplasts. *Physiol. Plant.* 80, 1990, 55-62.

Buurmeijer, W.F., J.H.A.M. Wonders, and W.J. Vredenberg. State-transitions in photomorphogenetic mutants of tomato. In: Current Research in Photosynthesis, Vol. II, (M. Balltscheffsky, ed.) Kluwer, Dordrecht, Boston, London, 1990,

8.891-894.

Hove, L.W.A. van, W.J. Vredenberg, and E.H. Adema. The effect of wind velocity, air temperature and humidity on NH₃ and SO₂ transfer into bean leaves (*Phaseolus vulgaris* L.). *Atmospheric Environment* 24A,5, 1990, 1263-1270.

Kooten, O. van, L.W.A. van Hove, and W.J. Vredenberg. The effect of prolonged exposure to air-borne pollutants on the photosynthesis of Douglas fir (*Pseudotsuga menziesii*) studied with in vivo chlorophyll fluorescence. In: *Current Research in Photosynthesis, Vol. IV*, (M. Baltscheffsky ed.) Kluwer, Dordrecht, Boston, London, 1990, 19.611-614.

Ooms, J.J.J. and W.J. Vredenberg. Analysis of the slow component of the flash-induced P515 response in chloroplasts. In: *Techniques and New Developments in Photosynthesis*, (J. Barber and R. Malkin eds.) 1990, 267-270.

Ooms, J.J.J., P.H. van Vliet, and W.J. Vredenberg. The slow P515 signal in relation to the status of innermembrane proton domains. In: *Current Research in Photosynthesis, Vol. III*, (M. Baltscheffsky, ed.) Kluwer, Dordrecht, Boston, London, 1990, 9.213-216.

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Snel, J.F.H., M. Kooijman, and W.J. Vredenberg. Correlation between chlorophyll fluorescence and photoacoustic signal transients in spinach leaves. *Photosynth. Res.* 25 1990, 259-268.

Tretyn, A., R.E. Kendrick, M.E. Bossen, and W.J. Vredenberg. Influence of acetylcholine agonists and antagonists on the swelling of etiolated wheat (*Triticum aestivum* L.) mesophyll protoplasts. *Planta* 190, 1990, 473-479.

Vredenberg, W.J., W. Versluis, and J.J.J. Ooms. Flash-induced absorbance changes in thylakoid membranes. The gramicidin insensitive component. In: *Current Research in Photosynthesis, Vol. II*, (M. Baltscheffsky ed.) Kluwer, Dordrecht, Boston, London, 1990, 8.883-886.

Bossen, M.E., A. Tretyn, R.E. Kendrick, and W.J. Vredenberg. Comparison

between swelling of etiolated wheat (*Triticum aestivum* L.) protoplasts induced by phytochrome and α -naphthaleneacetic acid, benzylaminopurine, gibberellic acid, abscisic acid and acetylcholine. *J. Plant Physiol.* 137, 1991, 706-710.

Hove, L.W.A. van, O. van Kooten, K.J. van Wijk, W.J. Vredenberg, E.H. Adema, and G.A. Pieters. Physiological effects of long term exposure to low concentrations of SO₂ and NH₃ on poplar leaves. *Physiol. Plant.* 82, 1991, 32-40.

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