

Letter to the editor

## Comments on a statement in W. Junge (Photosynth Res 80: 197–221, 2004)

In an historical issue of *Photosynthesis Research* I read a personal perspective by Wolfgang Junge of his career and the ATP synthase (Junge 2004). I do realize that this perspective was in a special historical issue edited by Govindjee et al. (2004) where the authors were given the leeway to present their 'version of the facts' (see the preceding introductory statement by Govindjee). This is my chance to give my version of the facts concerning the section entitled 'A model for torque generation by a rotary proton translocator'. Readers were led to believe that his 'proton motor' (Junge et al. 1997) served as the inspiration for a similar model we published in 1994 (Vik and Antonio 1994). While it is true that my group attended the lecture by John Walker at the University of Texas Southwestern Medical School in Dallas in the September of 1994, our paper showing a model for rotation of *c* subunits had already been submitted by that time. Therefore, when the model of Junge's 'proton motor' was presented in that lecture, we were surprised at the physical similarities between his and our own model. This included, as it turned out, a correct guess of the direction of rotation.

Before the publication by Walker's group of the 6.5 Å crystal structure of  $F_1$  in 1993 (Abrahams et al. 1993), I had not considered rotary motion in  $F_o$  very seriously, although others had proposed models including rotation of  $F_o$  subunits (Cox et al. 1984; Oosawa and Hayashi 1984). The formulation of our model in the summer of 1994 came after much thought for nearly 10 years about how the key amino acids of single-copy subunit *a* might be used in a proton translocation mechanism with the oligomeric *c* subunits. The eventual visualization of our model was probably facilitated by

memories of the thermally driven rotary motor described by Feynman in his 'Ratchet and Pawl' lecture (Feynman et al. 1966), but it was in no way derived from the 'proton motor' of Junge.

This letter was read by David Knaff and edited by Govindjee.

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## On Vik's letter concerning comments on a statement in W. Junge (2004)

In his letter Steve Vik refers to an article that I wrote as a personal perspective for a series on the history of photosynthesis research (Junge 2004 in Govindjee et al. 2004). For those interested in the history let me add the following:

In 1991, at the early dawn of a rotary mechanism of the ATP synthase, I was working on proton conduction by its  $F_0$ -portion and became interested in the functioning of  $F_0$  as a rotary electromotor. Inspired by the pioneering work of Howard Berg and his coworkers on the flagellar motor (Meister et al. 1989), I conceived a viable model for  $F_0$  as a rotary proton carrier. It was based on rotary Brownian fluctuations of the known ring of proton carrying groups (subunits c) against the larger subunit a, two non-colinear access channels creating chirality, and certain electrostatic constraints (see Junge et al. 1997; Dimroth et al. 1999). At the end of 1991 one of my students, the late Klaus Lakomiak, embarked on experimentally testing this model using advanced Laser-stimulation and detection of proton flow. Although the experiments were technically mastered, the enzyme didn't behave as expected and we postponed publication of the hypothetical model. Only in October 1993 at an EMBO conference in Freiburg (Germany) and during a heated discussion on John Walker's structure of the  $F_1$ -portion, did I expose the model and explain its features. John wished to use it in his lectures and I asked him to keep my name-tag attached to the graph. He consistently did including the lecture, attended by Steve, on September 22nd, 1994, at the South Western Medical Center in Dallas (Texas). On December 2nd, shortly after submission of his manuscript, the model appeared as Figure 5 in Steve's article (Vik and Antonio 1994).

New scientific concepts emerge when the time is ripe, and often they are independently discovered by two or more groups. I accept Steve's statement of independent conception. It has remained that Steve knew of, but, for some reasons, was unable

to mention my activities in his article before it went into print. Scientific progress has not suffered; instead the field of the rotary electromotor blossoms with two fresh high resolution structures (Meier et al. 2005; Murata et al. 2005), both rather supporting the above two-fathered model (see Junge and Nelson 2005).

This letter was read by David Knaff and edited by Govindjee.

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