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Special issue in honor of Prof. Győző Garab

In appreciation of an ingenious scientist and a great friend: Győző Garab

G. GOVINDJEE

Department of Plant Biology, Department of Biochemistry, and Center of Biophysics and Quantitative Biology, University of Illinois at Urbana Champaign, Urbana, IL 61801, USA

Abstract

To express my appreciation of Győző Garab, I describe below our association over the years, followed by a brief description of his fundamental research in the area of biophysics of photosynthesis.

Keywords: Jan Anderson; Rajni Govindjee; Wolfgang Junge; Hartmut Lichtenthaler; Paul Mathis; Hartmut Michel; Reto Strasser.

The 1980s – When we met

Győző Garab (who is being honored) and I have had a long association since 1983 when we first met at the US–Hungarian binational meeting, in Szeged, Hungary. It was one of the best meetings I have attended. I enjoyed participating in it and interacting with many, especially Győző. Soon thereafter, he visited the University of Illinois at Urbana-Champaign; there, at coffee time, we had great fun discussing research on various aspects of photosynthesis, and that too with great fervor. Győző was always full of new ideas; then, he invited me to Szeged to do experiments together. In 1988, we established that the lack of bicarbonate has a clear effect on the thermoluminescence (from photosystem II) in intact spinach leaves, and we explained this effect by bicarbonate stimulating electron flow from water to the plastoquinone pool (Garab *et al*. 1988; for a review on the bicarbonate effect, *see* Shevela *et al*. 2012).

The 1990s – Photographs with other photosynthetikers

Fig. 1 shows our photograph, together with Jan Anderson (1932–2015), at the 11th International Congress on Photosynthesis held in Budapest in 1998 (Govindjee and Yoo 2007; for Jan Anderson, *see* Chow and Osmond 2015). Fig. 2 shows Győző lecturing in Budapest at this congress, Fig. 3 shows him with Hartmut Lichtenthaler and Wolfgang Junge (both from Germany; for Lichtenthaler,

Fig. 1. *Left to right*: Győző Garab, Joan (Jan) Anderson, and Govindjee, at the 1998 Photosynthesis International Conference in Budapest, Hungary.

Highlights

- Győző Garab is a highly original researcher and never afraid to test innovative ideas
- He is a pioneer in the area of structure and function of lipids and proteins in photosynthesis
- Garab has worked on often ignored areas such as the role of alcohol, chlororespiration, *etc*.

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e-mail: gov@illinois.edu

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Fig. 2. Győző Garab at the opening ceremony of the 11th International Congress on Photosynthesis (1998) – welcoming all the participants.

Fig. 4. *Left to right*: Győző Garab, Hartmut Michel, and Paul Mathis at the 11th International Congress on Photosynthesis, in Budapest, Hungary.

Fig. 3. *Left to right*: Győző Garab, Hartmut Lichtenthaler, and Wolfgang Junge at the 11th International Congress on Photosynthesis, in Budapest, Hungary.

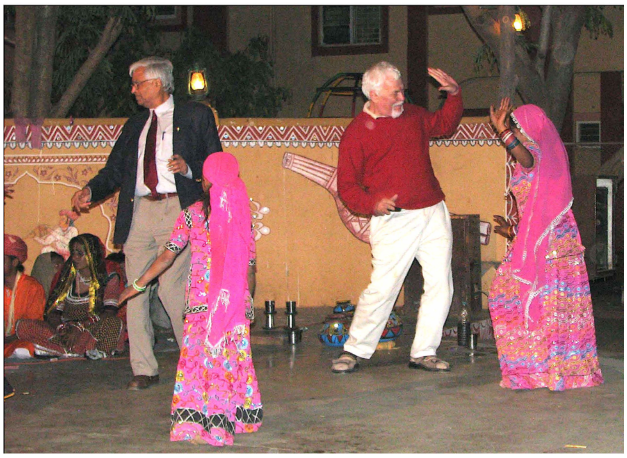

Fig. 5. Govindjee (wearing a red tie) and Győző Garab (wearing a red sweater) dancing at a social – after the academic sessions at the 2008 "International Congress on Photosynthesis in the Global Perspective", held in Indore, India.

see Govindjee 2021), and in Fig. 4, Győző is with Hartmut Michel (the 1988 Nobel laureate, from Germany) and Paul Mathis (from France).

The 2000s – At conferences and collaboration in editing the NPQ book

Then, in 2008, the two of us met again at the international conference on "Photosynthesis in the Global Perspective" held in Indore, India (*see* Jajoo *et al*. 2009). Fig. 5 shows us dancing there after all the talks were over.

Fig. 6 shows Győző, together with Reto J. Strasser and Rajni Govindjee at the 15th International Conference of Photosynthesis, held in 2010 in Beijing, China (*see* Kuang *et al.* 2013 for the proceedings of this congress; *see* Balashov *et al.* 2023 for Rajni; and Govindjee *et al.* 2019 for Reto Strasser).

Six years after the conference in Indore, we had a real intellectual collaboration when we decided to co-edit a 28-chapter book on all aspects of NPQ (nonphotochemical quenching) of the excited state of chlorophyll *a* (Demmig-Adams *et al*. 2014), *i.e.*, how plants, algae, and cyanobacteria protect themselves against excess light. We argued and edited several chapters with great vigor. For his many novel ideas on the relation of NPQ with the structural and molecular changes in chloroplasts, *see* his in-depth review (Garab 2014) in this book.

In 2016, we attended another international conference on photosynthesis – this time in Pushchino, Russia (Tsygankov *et al*. 2017). Here, again, two of us had good time together.

The above conferences (*see* their proceedings) were followed by both of us appreciating the discoveries, on the intricate relation of chlorophyll *a* fluorescence

Fig. 6. *Left to right*: Reto J. Strasser, Rajni Govindjee, and Győző Garab, in 2010, at the 15th International Photosynthesis Congress in Beijing, China.

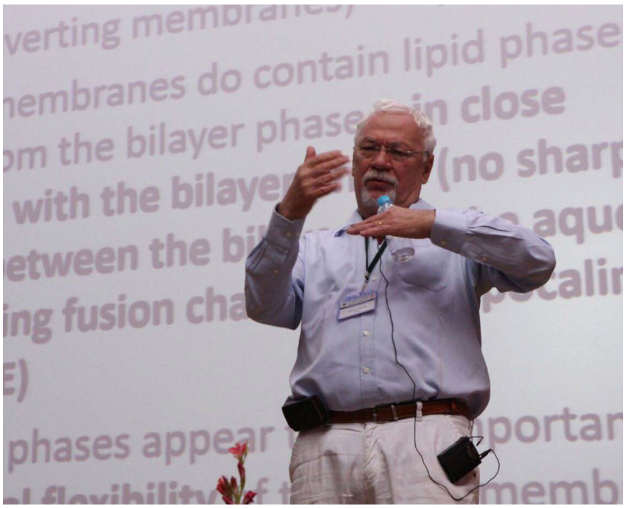

Fig. 7. A 2017 photograph of Győző Garab lecturing in Hyderabad, India.

to photosynthesis, by George C. Papageorgiou (*see* Stamatakis *et al*. 2016).

Fig. 7 shows G. Garab lecturing, in 2017, on his research at a conference in Hyderabad, India (*see* Allakhverdiev *et al*. 2019).

All this was followed by, together with me, Győző recognizing the life and research contributions of Jean Lavorel in relating chlorophyll *a* fluorescence changes to photosynthesis (Govindjee *et al.* 2022). Recently, I was extremely touched and delighted when Győző co-authored an article on my receiving a Lifetime Award from the International Society of Photosynthesis Research (Jajoo *et al*. 2023).

Below, I summarize briefly Garab's research contributions.

Győző Garab's scientific contributions

Győző is an author or co-author of an enormous number of highly influential publications on photobiology, bioenergetics, biochemistry, and biophysics of photosynthesis. To give an idea of the impact of his research, I have chosen to mention five of his major contributions.

(*1*) *On chlororespiration*: It was Garab *et al.* (1989) who provided the first experimental evidence for the functioning of chlororespiration in chloroplasts of higher-plant cells.

(*2*) *On structural changes in light-harvesting antenna*: Garab *et al.* (2002) demonstrated the thermo-optically induced trimer-to-monomer transition of LHCII (light-harvesting complex II), both *in vitro* and *in vivo*; these changes were shown to be driven by the dissipation of excess excitation energy, which causes an ultrafast local thermal transient; the system showed a sizeable T (temperature) jump induced fast decay of about 20–200 ps duration – in the close vicinity of the dissipation site.

(*3*) *On thylakoid assembly*: Using electron tomography, Mustárdy *et al.* (2008) provided convincing evidence for the quasi-helical model of the granum–stroma thylakoid membrane assembly.

(*4*) *On primary photochemistry of photosystem II*: Sipka *et al.* (2021) discovered the gradual formation of the light-adapted charge-separated state of PSII with significantly increased stability of the charges; these results led to providing the physical mechanism of the variable chlorophyll *a* fluorescence on new grounds.

(*5*) *On the structure and function of the lipids in thylakoids*: Garab *et al.* (2022) provided a novel theoretical understanding of how bulk lipids work in functional thylakoid membranes; in addition to the bilayer phase, the theory also assumed the existence of non-bilayer lipid phases, which was interpreted within the Dynamic Exchange Model (DEM), an extension of the 1972 'standard' fluid-mosaic membrane model of Seymour Jonathan Singer and Garth L. Nicolson. Further, Garab *et al.* (2022) suggested that in DEM, the strong non-bilayer propensity of the thylakoid lipids self-regulates the membrane homeostasis, safe-guarding the remarkably high protein-to-lipid ratio of thylakoid membranes providing high structural plasticity to the system.

To give an idea of Győző's current research, I mention six of his recent publications – that are of personal interest to me. They are:

(*1*) Innovative approaches to understand and exploit quantitatively chlorophyll *a* fluorescence for photosynthesis measurements (Garab *et al*. 2023);

(*2*) Novel experiments on the effects of salinity stress on the photosynthetic apparatus (Devadasu *et al*. 2023);

(*3*) New results on the physiological responses of algae (Farkas *et al*. 2023);

(*4*) New information on the rate-limiting steps in the dark-to-light transitions when the PSII reaction center is closed (Magyar *et al.* 2023);

(*5*) Description of steps after the ultrafast excitation quenching by the oxidized PSII reaction center, which is of great importance to the understanding of the photochemistry of PSII (Akhtar *et al.* 2022); and

(*6*) New information on an interesting physiological role of alcohols in cells (Wang *et al.* 2022).

I am sure that Győző Garab will continue to make discoveries of great importance for the benefit of us all. I wish him the best of luck.

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