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TRIBUTE

Prasanna K. Mohanty (1934–2013): a great photosynthetiker and a wonderful human being who touched the hearts of many

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Abstract Prasanna K. Mohanty, a great scientist, a great teacher and above all a great human being, left us more than a year ago (on March 9, 2013). He was a pioneer in the field of photosynthesis research; his contributions are many and wide-ranging. In the words of Jack Myers, he would be a "photosynthetiker" par excellence. He remained deeply engaged with research almost to the end of his life; we believe that generations of researchers still to come will benefit from his thorough and enormous work. We present here his life and some of his contributions to the field of *Photosynthesis Research*. The response to this tribute was overwhelming and we have included most of the tributes, which we received from all over the world. Prasanna Mohanty was a pioneer in the field of "*Light Regulation of Photosynthesis*", a loving and dedicated teacher—unpretentious, idealistic, and an honest human being.

Keywords Chlorophyll · Cyanobacteria · Chlorophyll fluorescence · Electron transport · Photosynthesis

Prologue

A short man, only five feet four inches in height, Prasanna Mohanty nevertheless stood tall among his peers. He was respected and loved by students and staff of the universities he worked in, although his forthright manner did not always garner the support of his peers and administrators. He was not the type to change according to the direction of the wind; he always spoke his mind in his inimitable way, leaving sentences unfinished and people guessing at times. However, as one got to know him better, one could interpret him and, at times, be totally captivated by the depth of what he was telling as several incidences have indicated to us. We refer the readers to an obituary by Prakash and Tiwari (2013) that was published right after his death. Rudra N. Mohanty, a nephew of Prasanna wrote to us, after reading this tribute: "This looks absolutely fine; thank you very much for writing this wonderful tribute; all in our family will always be grateful for this." Kalyani Mohanty, a niece of Prasanna, echoed this sentiment and wrote: "I

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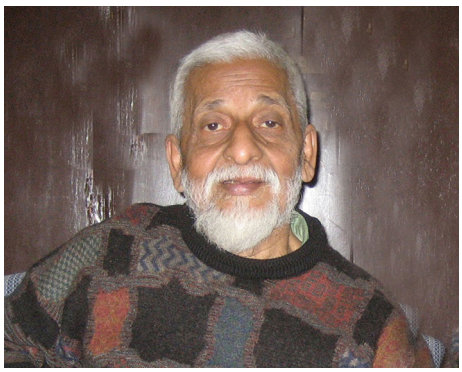

Fig. 1 An informal portrait of Prasanna Mohanty taken in New Delhi, India. Photo, ~2010, by Rajni Govindjee

approve the content of this tribute and I am eagerly waiting for it to be published".

This tribute was read, edited and accepted by Barbara Demmig-Adams, Associate Editor, of Photosynthesis Research. She wrote "I never met Prasanna, but this tribute makes his persona come to life and should be valuable reading for young scientists. It is inspiring to see that Prasanna approached his life, his teaching, and his science with love, passion, and humility. I also believe it is important for young scientists to see that the community of great science is world-wide and welcomes a diversity of contributors and view points. I personally loved to hear about Prasanna's thinking in simple terms and his consideration of mechanisms in the context of the whole plant in its environment."

"Grandpa is no more..", a very brief e-mail message, on March 9, 2013, from Prasanna's niece's son Arujash, and daughter Neha, brought the sad news to all of us about Prasanna Mohanty's passing away in Cuttack, Odisha, India (see Fig. 1 for an informal photograph).

Early life and education

Prasanna died after 2 years of illness in the house of his niece Kalyani Mohanty and her physician husband Pratap Chandra Mohanty. He was born on April 1, 1934 in Kadaliban, Keshpur village of Kendrapara District of Orissa (now called Odisha), a culturally rich state of India. Prasanna was the youngest son of the family and had two elder brothers—Golak Chandra and Chandramani and a sister—Sulochana. His father, Haladhara Mohanty, passed away when Prasanna was fairly young. Most children from small villages of India of that time spent their entire lives in the village of their birth; however, Prasanna's life turned out to be different. In the memory of his beloved mother Champaphula, Prasanna had initiated, after his own retirement, a Merit Scholarship for students in Kadaliban High School. He had told one of us (Das) about his early life. "After my father's death I avoided my elder brother Chandramani as he would tell me to read studiously; he was a teacher at that time. I was very lean and thin; my eyes would be red and tears would often come rolling down; my mother used to organize daily rituals for the improvement of my health and for my good fortune. However, when I came to Cuttack from my village to attend college there, doctors discovered that I had nutritional deficiency; it was overcome with proper diet."

Although, Prasanna attended primary school in his village, he went to Cuttack for his secondary school at the Ravenshaw Collegiate School. A classmate from that time, Pramod Nath Nayak, recalls "We called Prasanna as '*Chita*' (i.e., tiger) because he used to put '*Tilak*' (red powder mark) on his forehead during school time—perhaps it was placed by his mother as a part of some religious ritual". He remembers Prasanna to have presence of mind, an indomitable spirit and sincerity even at a young age and wrote that "His (Prasanna's) inherent, invincible and fighting spirit later blossomed to carry him through the vicissitudes of life."

In 1952, Prasanna joined Ravenshaw College in Cuttack, where he obtained his Intermediate Science degree in 1954. In 1956, he finished his Bachelor's degree (B.Sc.) in Science (Chemistry, Mathematics and Botany) with distinction, and in 1958, he completed his Master's degree (M.Sc.) in Botany with specialization in Plant Physiology from the same college that was then affiliated with Utkal University.

All through his studies in Cuttack, Prasanna lived in the home of Pandit Banamali Mishra, a fighter for freedom from the British; it is he who helped him financially throughout his studies. We cannot help but speculate that this association must have had an influence on his mind. To support himself, Prasanna also coached (tutored) students to earn his livelihood during his studies at Ravenshaw College. During 1958–1960, he served as an Assistant Teacher at Ravenshaw Collegiate School in Cuttack, where he taught high school math and general science. In 1960, after a brief stint in Ravenshaw College as lab manager, he was appointed as a Lecturer in Botany at Gangadhar Meher College, Utkal University, and then at Rourkela College, Rourkela (Utkal University), Odisha. Here, he taught Pre-University Biology and B.Sc. Botany courses.

In 1964, Prasanna was married, in Puri, Odisha, to Basanti, a down-to-earth and extremely kind person with a gentle smile who was a wonderful match for Prasanna in taking care of all the students he would later gather around him wherever he went. His brother-in-law, Lalit Mohan Das, recalls, "Prasanna was married on the 14th of July,

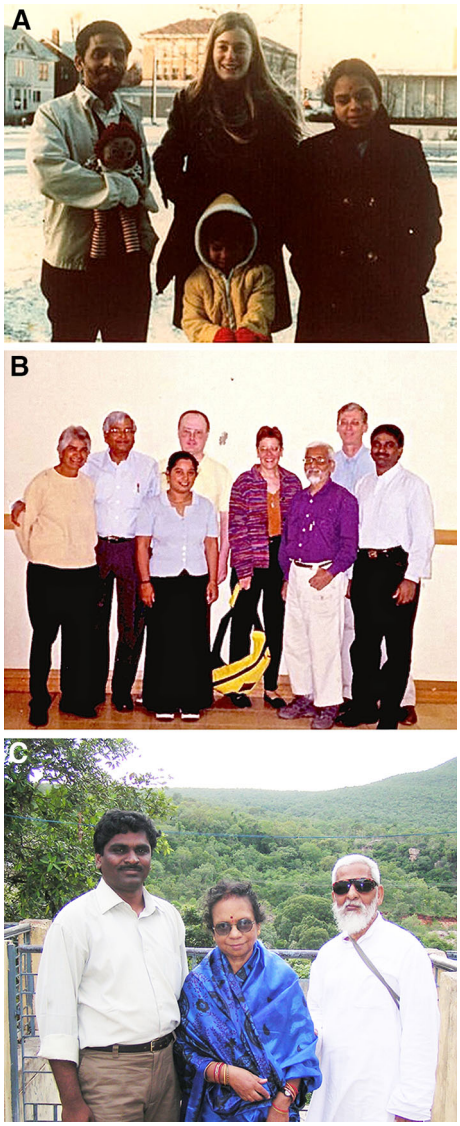

Fig. 2 Three photographs of Mohanty in USA, Australia and in India. **A** *Left* to *right* Prasanna (holding Meeta's doll), Ann Mangel (Walter Mangel's wife) and Basanti (Prasanna's wife). Meeta, the daughter is in front of Ann. Photo taken by Walter Mangel in 1960 in Urbana, Illinois. **B** Prasanna (3rd *front right*) with daughter Meeta (third from left), behind Meeta is her husband Steve Clarkin. Others are: *Left* to *right* Rajni Govindjee, Govindjee, Maria Ghirardi, Michael Seibert, and Rajagopal Subramanyam. Photo taken in 2001 in Brisbane, Australia. Photo is a courtesy of Rajagopal Subramanyam. **C** *Left* to *right* Rajagopal Subramanyam; Basanti Mohanty; and Prasanna Mohanty. Photo taken in August 2005 in Tirumala, during a visit to Balaji Temple when Mohanty was a visiting faculty at the University of Hyderabad, India. Photo is a courtesy of Rajagopal Subramanyam

1964. I vividly remember that date. We have a social practice that the bride's brother goes to the groom's house (to invite him formally for marriage). I had the privilege of doing this job. Even during that brief interaction, I already had the impression that he was a rare gem of a person."

Banchhanidhi Mishra, a friend of Prasanna from his Ravenshaw College days, recalls an interesting story about Prasanna's wedding: "In those days, there were few cars and fewer telephones in India. When the groom's wedding procession was going to Puri, the car in which he and his family were travelling broke down. By the time the car was repaired and the wedding procession reached Puri, it was late at night and Prasanna was so tired that he was half asleep during his marriage!"

For additional information on Prasanna, see a Tribute, at the end, by his classmate Sadanand Torasia.

We show here three photographs of Mohanty at different times of his life (Fig. 2): the first one (A) is with his family at the University of Illinois at Urbana-Champaign, in USA (see the Tribute by Walter Mangel at the end), the second one (B) is with his daughter Jyotsna (Meeta) Mohanty-Clarkin and his son-in law Steve Clarkin, among others, in Australia, and the last one (C) is with his wife Basanti, and Rajagopal Subramanyam (see Subramanyam's Tribute at the end) in India.

An early beginning: papers in Science and Nature

It is remarkable and, perhaps, an early indication of Prasanna's keen sense of scientific enquiry that even with only very rudimentary facilities available at his College, he published two papers, one in Science (Mohanty and Mishra 1962) and one in Nature (Mohanty and Mishra 1963); the Science paper dealt with the beneficial effect of riboflavin and ascorbic acid treatment on *Vigna catjang* seeds. The Nature paper addressed stomatal distribution in relation to xeromorphy in an aquatic plant, *Ipomoea carnea*. Xeromorphy increased stomatal number, particularly on the lower surface of the leaves, by three to fivefold. Others exploited these discoveries later, but he had moved away from this area to do "photosynthesis research".

At the University of Illinois at Urbana-Champaign: a tryst with light emission in cyanobacteria

Prasanna left India in 1966 to become a graduate student at the University of Illinois, Urbana-Champaign (UIUC), USA, under the mentorship of Govindjee in Plant Biology (then called Botany). Govindjee recalls: "Prasanna's dedication to work and his cooperative spirit impressed me the day he arrived in my laboratory, then in the basement of Natural History Building on Matthews Avenue in Urbana." Mohanty had decided to first work on a second Master's degree in Botany, with a minor in Biochemistry. He then did his PhD in Biology (specializing in Plant Physiology) and finished his thesis in 1972, studying "*Regulation of*

Chlorophyll a Fluorescence during Photosynthesis"; his thesis was one of the most detailed and thorough ever written under Govindjee's supervision. Prasanna's main thesis research was published in several major research papers, including the following two: (1) the very first demonstration of the fast (up to one second) chlorophyll *a* fluorescence changes in cyanobacteria (Mohanty and Govindjee 1973a) and (2) a thorough analysis of relationship of slow chlorophyll *a* fluorescence changes (up to 5 min) in cyanobacteria with structural changes (Mohanty and Govindjee 1973b; see also a review on chlorophyll fluorescence by Govindjee et al. 1973, written at about the same time).

Prasanna's unique cooperative spirit had led to his doing outstanding additional research in Govindjee's laboratory with several other graduate students, including John C. Munday, Jr. (experiments on phenomena discovered by G.C. Papageorgiou, in 1967, in green algae and cyanobacteria, which were soon related to what is now known as "state changes"; Mohanty et al. 1970); Ted Mar (on the action of hydroxylamine in red algae; Mohanty et al. 1971a); George Papageorgiou (on the understanding of slow fluorescence changes in red algae; Mohanty et al. 1971b); Barbara Zilinskas (a detailed understanding of fluorescence changes in isolated thylakoids; Mohanty et al. 1972a, b, 1973); and Thomas J. Wydrzynski (salt-induced fluorescence changes in green algae; Mohanty et al. 1974). As if this was not enough, Mohanty participated with Govindjee in writing a general review for the American Instrument Company (Govindjee and Mohanty 1971), a chapter in a book on cyanobacteria, published in India (Govindjee and Mohanty 1972), and a review for the Plant Biochemical Journal in India (Mohanty and Govindjee 1974). He published during his tenure as a PhD student a total of ten papers and three reviews, which was very impressive and unmatched in Govindjee's laboratory. While Prasanna was his graduate student, Govindjee wrote in 1970 to the Head of the Department of Botany (Dominick J. Paolillo): "Prasanna is one of my best students. Also, he is one of the most liked and also one of my most cooperative students. He is intelligent, and does his research independently. He is dedicated to high quality of teaching and research. Only one negative thing about him was commented on by several of my colleagues that his handwriting is quite difficult to read. But, so was that of many well- known leaders."

The following individuals, who were in the area of photosynthesis then at UIUC, have also provided Tributes (see the alphabetical list at the end): Charles Arntzen, Maarib Bazzaz, Patrick Breen, Raymond Chollet, Rita Khanna, John C. Munday, Jr., and George C. Papageorgiou; for an insight into Prasanna's time and life at UIUC, as seen by a fellow student, see the Tribute and stories by Walter Mangel. Figure 3A shows a photograph of Prasanna with Govindjee (his mentor), George Papageorgiou and Julian Eaton-Rye, also former graduate students at UIUC (see Eaton-Rye 2013). Figure 3B is with his former student Udaya Biswal and Fig. 3C is with his first Ph.D. student Baishnab C. Tripathy (see below).

Postdoctoral research

With John S. Boyer

Prasanna was acutely aware of the impact of drought on Indian agriculture. Therefore, after finishing his PhD, he joined John S. Boyer who was working on the drought response of photosynthesis in several crops. John found Prasanna to be "hard-working, thoughtful, quiet, and very kind". John had noticed that in chloroplasts isolated from plants that were slightly or moderately water deficient, light reactions, particularly Photosystem II, and photophosphorylation were inhibited. Prasanna suggested to Boyer that water deficiency might decrease the quantum yield of photosynthesis in vivo and could be measured in intact plants, thus giving a rigorous test of the findings of Boyer in chloroplasts. With a small grant from the US National Science Foundation (NSF) that John had, they embarked on this test using a gas-exchange apparatus in John's lab that could measure photosynthesis in leaves attached to sunflower or soybean plants growing in soil. As Prasanna predicted, the quantum yields of photosynthesis declined as water deficiency developed, giving strong evidence that chloroplasts were indeed responding to the changed conditions in the cells.

John S. Boyer recently e-mailed us a note: "We wrote the results in a manuscript and submitted it to Plant Physiology. After a few weeks, the manuscript was rejected. Both the anonymous reviewers said that water deficient plants were abused and Plant Physiology should not publish results from abused plants. I was upset and finally wrote to the editor pointing out that water frequently becomes limiting for plants because leaves must decrease in water potential every day before water can be absorbed from the soil. Water deficits are perhaps more common than non-deficits. The editor responded by asking whether I would agree to a re-review. I agreed. A few weeks later, a letter arrived with two reviews saying 'Accept without change'. Prasanna and I were astonished! I hung the contrasting reviews on the lab wall for everyone to see". The paper was published as Mohanty and Boyer (1976).

Boyer continued, "It was a pleasure working with someone so dedicated and rigorous. Prasanna and his wife

Fig. 3 **A** Prasanna Mohanty with three others who had been in Urbana, Illinois. *Left* to *right* George Papageorgiou, Govindjee, Julian Eaton Rye, and Prasanna Mohanty. This photo was taken in 2008 in Indore at the "International Conference on Photosynthesis in the Global Perspective". It is reproduced, with permission, from Eaton-Rye (2013). **B** A moment at an international conference on "Plant Science in Post Genomic Era" held at School of Life Sciences, Sambalpur University, Odisha during 17–19 February, 2011, where Mohanty was specially invited to attend. From *left* to *right*: Udaya Biswal, and Prasanna Mohanty during a tea break. Photo provided by Govindjee. **C** Prasanna Mohanty (*left*) with Baishnab C. Tripathy (*middle*) and Stefan Hortensteiner (*right*) at the concluding session of the 2011 conference

Basanti (also deceased) with daughter Meeta remained close personal friends of our family ever since, and Jean, my wife, and I were delighted to become re-acquainted with Meeta in Canberra, Australia, years later when she had grown into a lovely mother herself."

With James (Jim) R. Bolton

After working with Boyer, Prasanna went to Canada as a Fellow of the National Research Council (NRC), Canada, in the Chemistry Department at the University of Western Ontario. Here, he worked with James Bolton who was interested in using Electron Paramagnetic Resonance (EPR) spectroscopy to study the primary photochemical processes in photosynthesis. Prasanna studied the EPR signal arising from photochemistry of Photosystem I (PS I) at cryogenic temperature (Warden et al. 1974).

James Bolton recently e-mailed us a note: "Prasanna was a very hard worker, but what I remember most about him was his gentle disposition—nothing bothered him—he was a man at peace and stimulated peace around him."

Return to India: his work place Jawaharlal Nehru University (JNU)

Prasanna returned to India in 1973 and joined the School of Life Sciences (SLS) at JNU, New Delhi, as an Associate Professor. Initially, he worked closely with Gauri Shankar Singhal, who was already on the faculty there. Singhal had also been trained at UIUC (see Ghosh 2004). At JNU, Prasanna taught Biochemistry, Cell Biology, Membrane Biology and Bioenergetics at graduate level. He was a very popular teacher and his examination system was unique; he asked questions that were thought provoking and challenging. He focused his research on two major areas: (1) Chloroplast structure and function and (2) Impact of environmental stress on primary processes of photosynthesis. At the time, several well-trained scientists were actively pursuing research on various aspects of photosynthetic processes at several places in India. Vallabhaneni Sita Ramadas had already established his group at Sri Venkateswara University in Tirupathi, and Suresh Kumar Sinha (see Chopra 2002) at the Indian Agricultural Research Institute (IARI), New Delhi. Further,

Arumugham Gnanam had started establishing his laboratory at Madurai Kamraj University, Madurai, Tamilnadu, and Prafullachandra V. (Raj) Sane had initiated his work at the Bhabha Atomic Research Centre at Mumbai. And, Gauri Singhal had begun establishing his research group, also at JNU, mentioned above (see Andley et al. 2005).

Prafullachandra Vishnu (Raj) Sane recalls "While I had met Gauri Shankar Singhal, it took much longer for me to meet Prasanna. I was impressed in my first meeting with him by his interest in research in photosynthesis, his depth of knowledge and also that he had interest in many areas of plant physiology. One was overwhelmed by his simplicity. I gradually got to know him more and more not only through his work but also by many personal meetings at Delhi, at conferences and funding agency meetings. Returning to India and starting a functional group was not as easy then as there was hardly any money or equipment available for starting your work. One had to look for what was around and then initiate the work suiting to whatever was available and not necessarily one's interest. Prasanna was quick in adapting to the existing conditions and choosing his research areas using his PhD students. With limited facilities and funding his group became active very quickly."

Udaya Biswal joined as Prasanna's PhD student, but he submitted his thesis under Singhal (see Fig. 3B for Udaya's photograph with Prasanna). Using barley as an experimental material, Prasanna began his studies on senescence and aging in plants. His group demonstrated that activities of membrane-bound enzymes and electron-transport activities underwent changes during ageing and senescence (Biswal and Mohanty 1976a, b, 1978). Prasanna's ability to influence young minds, combined with a thorough training in the scientific method, is reflected in the fact that many of his students remained associated with academic pursuits, including Udaya Biswal. Udaya credits his interest in plant physiology to his interactions with Prasanna. Udaya continued his studies on aging of plants and, together with his wife, Basanti Biswal, a scientist with similar interests, established an active research laboratory in Sambalpur, Odisha (see Biswal and Biswal 1988).

Udaya and Basanti Biswal wrote a joint letter to us: "Prasanna was a very affectionate and lovable person. As a scientist, he had strong conviction about the science he was doing and never compromised on what he felt about it. We cannot forget his critical analysis of scientific data and his forceful logical arguments at scientific meetings." Udaya recalled his interactions with Prasanna at JNU, New Delhi, and how he developed interest in whole plant biology. Prasanna started working on chloroplast development, senescence and stress responses of plants just after joining JNU and published several excellent papers in these areas. Biswal continued, "Rightly suggested by Govindjee, his mentor and Series Editor, we, the editors of volume 36 of the Advances in Photosynthesis and Respiration Series, Springer, have dedicated this volume that deals with plastid development in leaves during growth and senescence to Prasanna's memory (Biswal et al. 2013). We also remember him as a person who was primarily responsible for opening of several new centers of photosynthesis research in India and how his impressive scientific personality was a strong motivating force and inspiration for many young plant biologists to work on the primary photochemistry of photosynthesis."

Prasanna continued to study the effects of a variety of stress factors in both higher plants and cyanobacteria. Another area that attracted Prasanna relates to environmental pollution. He initiated studies on the effects of heavy-metal pollutants on the structure and function of the photosynthetic membranes.

Prasanna's first PhD student was Baishnab Charan Tripathy, who later became one of the leading scientists in the area of photosynthesis in India (see a 2012 photograph of Tripathy with Mohanty; Fig. 3C). Tripathy and Mohanty (1980) concluded that zinc, at concentrations as low as 1 mM, blocked electron transport in isolated barley chloroplasts on the oxidizing side of Photosystem II (PSII) prior to where hydroxylamine or diphenylcarbazide donates electrons since the effect could not be reversed by the addition of manganese or benzedine, but only by the donors just mentioned. Removal of Zn^{2+} by washing chloroplasts with isolation buffer restored PSII-mediated oxygen evolution. This method, thus, substituted Tris treatment of chloroplasts that inhibits electron flow at the oxygen evolving side of PSII, especially because it is extremely difficult to restore O_2 evolution in Tris-washed chloroplasts. This paper is a highly cited paper from Mohanty's group. Tripathy et al. (1981, 1983) showed that, while Ni^{2+} inactivated light-harvesting antenna irreversibly, Co^{2+} inhibited Photosystem II (PS II) but did not affect PS I. Further, Tripathy and Mohanty (1981) showed that heavy metals fail to inactivate PS II reaction if thylakoid membranes are treated with glutaraldehyde. Aluminum (Al^{3+}) was one of the pollutants, Mohanty had selected for his studies with his student Ramakrishna Wavare. They demonstrated that, at low concentrations, Al^{3+} uncoupled phosphorylation and stimulated Hill activity (Wavare and Mohanty 1982).

Baishnab C Tripathy remembers Prasanna Mohany as his teacher, mentor and an excellent colleague in the School of Life Sciences, JNU, as the person who has molded and sharpened his academic career and has positively shaped his personal and professional life.

Prasanna revived his interest on senescence and aging with other post-doctoral fellows: Anil Grover (Grover et al. 1986), Surendra Chandra Sabat (Sabat et al. 1989a, 1989b;

Sabat and Mohanty 1989), and Jogadhenu Shyamsunder Prakash (Prakash et al. 2001a, 2001b). These studies demonstrated that, during leaf senescence, various long-wavelength forms of chlorophyll were differentially affected, whereas, during ageing, specific segments of electron transport underwent changes. Further, using *Cucumis* cotyledons, Prakash et al. (2001a) showed that senescence was associated with the degradation of thylakoid membrane proteins in a temporal sequence. An interesting observation in these *Cucumis* studies was that, during ageing, Light-Harvesting Complex II (LHC II) migrated to stroma lamellae and associated itself with PS I, changing, among many things, the electron-transfer equilibrium between the two PS II electron acceptors, the bound plastoquinone molecules Q_A and Q_B.

Prasanna added mercury to the group of metals he used. Using *Spirulina* cells, he, together with his student S.D. Srinivasa Murthy, demonstrated that low levels of mercury affected energy transfer within the phycobilisomes, while higher levels affected whole-chain electron transport. Murthy et al. (1990) further observed that mercury had three distinct effects on chlorophyll a fluorescence at low, medium and high concentrations. Prasanna looked at problems in a holistic manner. He would use different organisms, different techniques and different pollutants, and generate information on their effects. Aware that many pollutants are also essential micronutrients and, as a result of adsorption to the soil, are sometimes present at supra-optimal, rather than toxic levels, Prasanna studied the short and long-term adaptive responses to sub-lethal concentrations of the essential micronutrient cobalt in *Synechocystis PCC 6803*. Together with Swati Tiwari, he showed that under these conditions there was an increase in PSII-catalyzed Hill reaction activity. This effect was due to multiple changes in the cells that included a small increase in PSII to PSI ratio, enhanced funneling of energy to PSII and an increase in PSI electron transport, decreased PSI cross section, and reduced intersystem pool size (Tiwari and Mohanty 1993, 1996).

Prasanna also went on to characterize the effects of UVB (Kolli et al. 1998; Sah et al. 1998; Rajagopal et al. 2000a, b) on cyanobacteria. He had a strong interest in "state changes" in thylakoids in response to environmental changes. [We note that the so-called "state changes" were discovered earlier by Norio Murata (1969), and by Bonaventura and Myers (1969).] Mohanty et al. (2002) observed that there was a physical movement of LHCIIb from PSII to PSI due to increased phosphorylation of LHC in response to increased temperature (see review by Mohanty et al. 2012). Together with P. Pardha Saradhi, Prasanna showed in several papers that proline accumulation protected thylakoid membranes against photodamage including that due to UV (see, e.g., Alia et al. 1997). Prasanna became aware of the global issues and wondered what to do for the future. He thus explored whether algae and cyanobacteria could be used for hydrogen production (see Dawar et al. 1998; and a review by Ghirardi and Mohanty 2010).

In summary, his research included effects of metal ions on electron transport and on energy transfer in photosynthesis, and probed effects of drought, salinity, osmotic and high temperature treatment in vivo by spectroscopic methods. Also, his research identified phycbilisomes (PBS) as a target of UV-B stress in cynobacteria. In addition, his group also studied electron transport and energy transduction in buffalo-heart and cockroach coxal mitochondria. Prasanna has published an enormous number of research papers in peer-reviewed journals and mentored several post-doctoral and many PhD students. His first official PhD student was Baishnab Charan Tripathy. In an interesting turn of events, Tripathy has recently served as the Vice Chancellor of Ravenshaw University where Mohanty had studied and worked several decades earlier.

Several other students, who were also at JNU at the time in addition to Swati Tiwari and Baishnab Tripathy, have also provided their tributes (see messages from around the world): A. Alia, Usha Andley, and Potluri Prasanth; Usha has given a very touching tribute to Prasanna. In addition, others in India who knew him (besides those cited above and Norio Murata) also sent messages: Yash Pal Abrol, Rachna Agrawal, and Pramod Yadav (who was Prasanna's postdoc associate then).

Collaborative research in USA and in Japan

At the Carnegie Institute, Stanford, California

From September 1982 to February 1984, Prasanna was a senior fellow at the Carnegie Institution of Washington, Department of Plant Biology, Stanford, California, and collaborated with David C. Fork (see e.g., Brand et al. 1983; Fork et al. 1985; Hoshina et al. 1984; Mohanty et al. 1985a, b). To top it all, Mohanty wrote a comprehensive review on chlorophyll a fluorescence in algae (Fork and Mohanty 1986). During his stay at Stanford, Prasanna, together with Jerry Brand (University of Texas), investigated the effect of Ca^{2+} depletion in *Anacystis nidulans*, using fluorescence spectra at room and liquid-nitrogen temperatures. He demonstrated that Ca^{2+} depletion eliminated state changes and suggested that energy transfer from phycobilisomes to chlorophyll was blocked upon Ca^{2+} depletion (Mohanty et al. 1985a). After the latter series of studies of the effect of Ca^{2+} depletion, Prasanna, together with Satoshi Hoshina, another Carnegie senior fellow from Kanazawa University of Japan, studied the effect of heat on

fluorescence spectra of *Anacystis nidulans* cells. He observed that heat treatment at 55 °C dramatically increased the level of fluorescence emission at 683–685 nm prior to an increase in level of the 695-nm emission. (For a background on these fluorescence studies, see Govindjee et al. 1986.) Prasanna suggested that heat treatment blocked excitation-energy transfer from phycobilisomes to chlorophyll (Mohanty et al. 1985b). These studies at the Carnegie Institution were published in five papers in Photochemistry and Photobiology, Photosynthesis Research, and FEBS Letters.

During his collaborative study at Stanford, Prasanna showed his special talent of an unusual memory. He remembered detailed careers of almost all leading researchers of photosynthesis and details of important and interesting publications including numbers of volumes, years, and pages. The collaborators at the Carnegie Institution, David Fork, Jerry Brand, and Satoshi Hoshina all admired this special talent. They argued that there must be a special computer in his brain (see comments by Hoshina at the end of this Tribute).

At the National Institute for Basic Biology, Okazaki, Japan

From 1990 to 2001, Prasanna was a visiting professor at the National Institute for Basic Biology, Okazaki, Japan, for several months each year for almost 10 years. Here, he collaborated with Norio Murata. During the early time of his stay, Prasanna, joined in an ongoing research project on the protective effect of glycine betaine, in particular, on its specific effect on the stabilization of PSII complexes, together with George Papageorgiou (from Greece), Mahir Mamedov (from Russia), and Hidenori Hayashi (now at Ehime University). This research group demonstrated that glycine betaine stabilized the oxygen-evolving activity via a tightening of the association of the extrinsic proteins to the PSII complex (Papageorgiou et al. 1991; Mamedov et al. 1991; Murata et al. 1992). Further, Prasanna demonstrated that glycine betaine stabilized the $CaMn_4O_5$ cluster of oxygen-evolving complexes from which the extrinsic proteins had been removed (Mohanty et al. 1993). After the latter series of study on the action of glycine betaine, Prasanna's research moved to the elucidation of the mechanism of photoinhibition in collaboration with Suleyman I. Allakhverdiev (from Russia). The most prominent aspect of Prasanna's research on this topic was the use of treatments at low temperature, such as 10 °C, to "dissect" the photodamage process as well as the repair process. He demonstrated the presence of an intermediate state during photodamage; further, he demonstrated that, at low temperature, proteolytic degradation of photodamaged D1 and processing of the precursor (pre-D1) to the mature D1 protein were blocked, whereas synthesis of pre-D1 still proceeded, albeit only slowly (Allakhverdiev et al. 2003; summarized in a review by Mohanty et al. 2007). Finally, he and Allakhverdiev combined the effect of glycine betaine with their scheme for the mechanism of photoinhibition, and demonstrated in transgenic *Synechococcus* PCC 7942, which synthesized glycine betaine de novo, alleviation of the inhibitory effect of moderate heat stress on the repair of PSII during photoinhibition (Allakhverdiev et al. 2007). These studies were published in ten papers in highly reputed journals, such as EMBO Journal, Biochemistry, and Biochimica et Biophysica Acta.

During the long-lasting collaboration in Japan, Prasanna and Norio organized an India-Japan Binational Seminar in 1998 in New Delhi. Figure 4 shows a group photograph of the participants at this conference. Scientific achievement of the seminar was wonderful and the seminar was influential, in particular, for the young Indian researchers and students who attended the seminar with sharp concentration and "fully opened eyes".

Just as all the authors of this tribute, Norio was also shocked and saddened to learn of the passing of Prasanna Mohanty. Norio writes, "Prasanna was one of my best friends and I have admired his excellent talent for research and [his] wonderful personality. I have known him for more than 40 years, since I met him the first time in 1970 when I was visiting Govindjee at the University of Illinois at Urbana-Champaign. Prasanna and I discussed our mutual interest in the area of chlorophyll fluorescence kinetics. Since then, he and I have been good friends."

Figure 5A shows Mohanty's photograph with Murata, while they were together at a conference, whereas Fig. 5B shows his photograph with Yorinao Inoue, also from Japan at another conference, and Fig. 5C shows his photograph with Academician Alexander Krasnovsky of Russia (see Karapetyan and Govindjee 2014).

Murata writes "During Prasanna's frequent visits to Japan, we enjoyed our joint research and experiments. I also visited, several times, his laboratory at Jawaharlal Nehru University, New Delhi. During our collaboration, Prasanna showed his sharp and deep thoughts in research. He was highly respected by researchers in the institute; also, many people in the city loved him. Although they could not easily communicate with him due to the language problem, they loved his elegant personality. Prasanna has positively influenced me not only because of his science, but also because of his excellent personality and character. I miss him with all of my heart. Professor Prasanna Mohanty, I thank you for your friendship and will never forget the time we spent together."

Besides Norio Murata, Prasanna also met, as mentioned above, Suleyman Allakhverdiev (from Russia). Among many other places, Prasanna also visited Germany (Ulrich

Fig. 4 A group photograph at an India-Japan conference on "Stress in plants" held in 1998 at the Indian National Science Academy, New Delhi. Several friends and students of Prasanna were present at this meeting. Names are listed from *left* to *right* in each row; those unidentified are listed with dashes (—). *First row* Renu Khanna-Chopra, Keishiro Wada, Gauri Singal, Norio Murata, Prasanna Mohanty, Kailash C. Bansal, P. Pardha Saradhi, and Akhilesh K. Tyagi. *Second row* Tatsuo Omata, Teruo Ogawa, Arjula R. Reddy, Narendra Mohanty, Anath Bandhu Das, —, A.S. Raghavendra, B.P. Shaw, Amarendra Mishra, Baishnab Charan Tripathy, Bhagvatula Vani and Potluri Prashant. *Third row* Anjana Jajoo, —, Uday Chand Basak, Sidharth Kumar Palai, —, Hiromichi Morikawa, Ichiro Terashima, Kozi Asada, —, —, J.S.S. Prakash, Hidenori Hayashi, Abhay Singh and Akiho Yokota. *Fourth row* Hidehiro Sakurai, —, —, Kolli Balakrishna —, —, —, Indra Brata Jha, —, —, Sangeeta Mendiratta, —, —

Schreiber, in the late 1980s) and the USA (Bacon Ke, Patrick Breen, David Fork [see above]. He also spent a sabbatical with Michael (Mike) Seibert in the Solar Energy Research Institute (now National Renewable Energy Institute, NREL) in Colorado, USA, starting in 1992; more in Mike Seibert's detailed account of Prasanna's visit to Golden, Colorado (see the tributes at the end).

Prasanna: the teacher and the person that he was

Prasanna lived and breathed for his students and they returned the sentiment as evident from the tributes received from them. These tributes are listed at the end of this article, including those from his friends, colleagues and advisors (also see Prakash and Tiwari 2013). As is evident from many tributes we received from many of his students, he was a teacher in every sense of the word to all his students. However, two incidents stand out to show his disciplined teaching style and the honesty with which he performed his duties as a professor.

Devinder Sehgal recalls an interesting encounter with Prasanna: "While I was a Master's student, I saw Prasanna coming out of the school library tearing a pile of papers and throwing them in the dustbin; when I asked what was it that he was tearing, the reply was that he was tearing the notes that he had prepared for the class that he was going to teach." Devinder was puzzled and wanted to know what was the purpose of making the notes in the first place when they had to be thrown away? Prasanna's reply was, "I am throwing the notes away so that I do not become lazy in updating myself the next semester. Secondly, if I cannot remember what I have to teach, then how can I expect my students to remember what I have taught them?'' One wonders how many such outstanding teachers are left in the world today.

A second incident that many students remember is the time when he was serving as the President of the JNU Teacher's Association and there was a call for a strike by the association. All classes were suspended. Prasanna did not want the students to suffer due to this. Therefore, he joined the protesting teachers in the morning and asked the students to come in the afternoon and he taught them through all those difficult days. In this way, he fulfilled both roles and the responsibilities associated with them.

Prasanna was always annoyed with people who asked him how many PhD students he had "supervised" or "guided". His standard reply used to be that he "studied" with x number of students, and he truly believed that this is what each PhD thesis means – a continuation of a teacher's learning along with his students. We wonder how many professors think like this and if they even think about this at all, and how many acknowledge this with so much humility.

Prasanna was a person who respected all human beings and treated everybody as an equal. This earned him a lot of respect and affection from everyone he met. He respected all religions and, though he was a devout Hindu, considered himself to be an Indian first. A hilarious incident related to this belief was narrated to Swati Tiwari by one of

Fig. 5 Photographs of Prasanna Mohanty with others. **A** With Norio Murata; **B** with Yorinao Inoue, and others; and **C** with Academician Alexander A. Krasnovsky

his neighbors who had visited Prasanna once in Bhubaneshwar, Odisha. During the census of India, Prasanna was asked by the officials collecting the data, about his name and religion. Mohanty gave his name that everybody in the state knew to be that of a Hindu, but he said that he was a Muslim. The officials were puzzled and asked him how could that be? He indicated towards his beard and asked them whether it was not proof enough of his religion! The census officials were puzzled and confused, but left after noting down "Hindu" as Mohanty's religion. This was Prasanna's way of protesting against identification, either overt or covert, by religious identity. It did not matter to him that perhaps this data is useful to the government for many developmental work needed for the myriad populations of India.

Several have talked about the type of person Prasanna was, but we have reproduced below some of the thoughts by four (Raj Sane, Anjana Jajoo, Walter Mangel and Sadanand Torasia).

Raj Sane wrote: "I cannot forget the interest with which Prasanna edited a book in my honor when I retired from National Botanical Research Institute (NBRI) at Lucknow, Uttar Pradesh. His comments were always very constructive. At Govindjee's invitation, [the] two of us wrote a review together with Raghavendra about photosynthesis research in India (see Raghavendra et al. 2003)".

Raj continued "Throughout his career and whatever interactions I had with him and his students during not just PhD defense of his students, but also informally, he always protected his students but not at the cost of scientific quality of the work or training. Prasanna was all [there] for his students and would fight at the academic meetings for their rights and privileges. This did not always go well with the administration but he was steadfast with his views. JNU is considered a hot bed of politics for students and Prasanna always provided a wiser view to the students and also the faculty. He was a very simple and down to earth person and did not believe in showmanship. This had made him popular with students not only in JNU but also elsewhere. While he had tremendous respect for his teacher/guide (Govindjee) he did contradict him whenever he did not agree with him whether it was science or any other matter. I cannot forget his speech at Indore in 2008 when he told the audience that before going to the University of Illinois, he was making serious mistakes in writing English, and it was Govindjee who would spend hours and days to correct his language, for which he was highly thankful. I have very fond memories of my interactions with Prasanna and in him I have lost a true scientist friend and a very good human being. One does not [often] come across such capable but simple persons who hold on to their views irrespective of authorities in the opposition."

Anjana Jajoo recalls Prasanna in following words: "Whenever I think back at the years which groomed and molded my academic career, I am always reminded of the towering presence of several, particularly Prasanna Mohanty, who had inspired me tremendously. His image has dominated my mind ever since the day I began my career as a research scholar, deriving constant inspiration from him. I vividly remember my first interaction with him when, in 1988, I was visiting JNU, New Delhi, to attend a workshop. While climbing the stairs, I saw a short man with [a] white beard wearing a wrinkled shirt, indulged in discussion with a student. Being young, and a bit naughty student, it clicked in my mind 'Oh! this is how big scientists are like!!.' After half an hour I met him face to face and was astonished by his simple and caring attitude. Then I just thought 'Those who look like great scientists can be very simple and sweet too'. His simplicity and enthusiasm

always fascinated and inspired me and many other students I know."

Anjana Jajoo added "After this first meeting, I visited his lab several times to do experiments. He always tried to make me feel comfortable. Although he was very busy in his work, yet he was always available for discussion related to my research work".

Walter Mangel told us "I have spent some time thinking about Prasanna. I so wish I had seen the review article he wrote in 2003 on 'Photosynthesis Research in India: transition from yield physiology into molecular biology' (Raghavendra et al. 2003). I just read it and was much impressed by its depth and breadth. Any paper that starts with a poem from 2600 BC says its writer is probably a wise man. And for someone I knew who mostly measured absorption and fluorescence spectra to write about photosynthesis and molecular biology just reinforces my opinion about the wisdom of the author. I miss Prasanna. He was gentle, respectful, and curious. His family should be very proud of him, and I am proud of them for the way they took care of Prasanna after his stroke. To arise in Odisha and spread throughout the whole world and then to return to Odisha, leaving in his wake an impressive, important body of work and colleagues who will pass on the Prasanna mystique like DNA to the next generation, is an amazing and admirable achievement."

Sadanand Torasia told us: "As a friend he shared many of his feelings with me, particularly when his wife Basanti was suffering, as well as, when he himself was convalescing during the last stage of his life. He reciprocated his services of his dear wife when she was suffering and the pangs of her departure drained out his mundane interests in life. He was poor in worldly wealth, but rich in degrees, awards, honors and accolades; he struggled for his education but freely distributed his acquired knowledge. He however remembered his grandchild until his last breath. With his demise we lost a good human being."

At JNU, Mohanty not only did excellent research, but was an excellent teacher as well. Professor Prasanna Mohanty retired from JNU in 1999—the same year his PhD mentor Govindjee retired from the University of Illinois at Urbana-Champaign (see Eaton-Rye 2013). Steven C. Huber (USA), who visited Prasanna at JNU, has also provided a Tribute; additional tributes (see the list at the end) were sent by Gyozo Garab (Hungary), Hazem Kalaji (Poland), David Knaff and Louis Sherman (both from USA).

After his retirement

From 1999, Prasanna Mohanty was engaged in collaborative studies on (a) salinity tolerance-strategies in mangroves at Regional Plant Research Centre (RPRC) at Bhubaneshwar, Odisha, and (b) metal-ion-induced signaling and on the nature of plant-growth enhancement upon removal of UV components from solar radiation as an Honorary Scientist of INSA (Indian National Science Academy) in the School of Life Sciences at Devi Ahilya University in Indore, Madhya Pradesh (MP). Further, Prasanna taught innovative courses at the University of Hyderabad under their UPE (University Potential for Excellence) program and established collaborative research in Plant Biophysics. He then taught at the Orissa University of Agriculture and Technology (OUAT), where he was an INSA Senior Scientist starting in 2009.

Indore and Hyderabad

Even after his retirement, Prasanna continued to work in the area of photosynthesis. With his vast experience in the instrumentation and knowledge of photosynthesis he helped initiate several studies by collaborating with groups at the University of Hyderabad (Rajagopal et al. 2000a, b, 2005), at Devi Ahilya Vishwavidyalaya, Indore (Jajoo et al. 2001), and at Bhubaneswar (see below). Prasanna Mohanty was a very inspirational and influential teacher even in his retired life. He would spend most of his time in the lab during his visits to Indore and Hyderabad interacting freely with the students in the lab. Not only students, but senior scientists also found him to be a great teacher wherever he went.

Figure 6 shows photographs of Mohanty during his retirement life. (A): when he was at the University of Hyderabad (with J.S.S. Prakash); (B) with Reto Strasser in Bhubaneshwar; and (C) with A.B. Das and others, also at Bhubaneshwar.

We note that after his retirement, Prasanna had donated hardcopies of many of his books, and reprints of research papers, that are treasures of a scientist, to the "Photosynthesis laboratory" at the University of Indore, where Anjana Jajoo had been working. Sudhakar Bharti, her mentor, brought a mini-truck loaded with these books and other things to the Department. As a student then, Anjana felt *'Wow, what a treasure we have got for free*!!' They felt themselves to be very lucky indeed at that time!!"

Later, University of Indore organized an international symposium honoring Govindjee in which Prasanna played a major role. Prasanna was instrumental in bringing out a book from this conference (see Itoh et al. 2012). Figure 7A shows a group photograph taken at this international conference in Indore (see Jajoo et al. 2009); and Fig. 7B shows Prasanna's photo with James (Jim) Barber and K.N. Guruprasad at the same conference.

From Indore, K.N. Guruprasad and Rakesh Sinha have added their tributes. Additional tributes from Hyderabad were received from Samsree Naelapalli (also known as N.

Fig. 6 Photographs of Mohanty in Hyderabad and Bhubaneshwar, India. **A** J.S.S. Prakash and Prasanna Mohanty. This photo was taken at the Department of Plant Sciences, University of Hyderabad, India in 2008 when Mohanty worked there as a short term visiting faculty. Photo shows Mohanty and Prakash discussing their joint research. Photo by Pilla Sankarakrishna. **B** Prasanna (*left*) with Reto Strasser (*right*) during a lunch break at the lawn of the guesthouse of the Regional Plant Research Centre (RPRC). Photo provided by A. B. Das. **C** A 2010 photograph of Prasanna Mohanty with others in front of the Department of Agricultural Biotechnology, College of Agriculture, Orissa University of Agriculture and Technology, Bhubaneswar, India. *Front row* (*left* to *right*) Ishwar Chandra Mohanty, Gyana Ranjan Rout, Prasanna Mohanty, Anath Bandhu Das, Lingraj Sahoo, and Gyanlok Das. *Back row* Kailash Chandra Samal. Photo provided by A.B. Das

Samsree) J.S.S. Prakash and Rajagopal Subramanyam (also known as S. Rajagopal; see "Messages from around the world"). From many conversations with the entire Hyderabad group, it is clear that they all cherished his stay there, and that they have the highest regard for him.

Bhubaneshwar

Anath Bandhu Das recalls Prasanna's days in Bhubaneshwar: "He was quite lonely at his last residence since both Basanti, his wife, and Chandramani Mohanty, his elder brother, Kalyani's father, had passed away in 2010. My wife Neelima and I were very fortunate to have associated with Prasanna Mohanty in his day-to-day life for the last 14 years. I was around to take him to a hospital in Bhubaneswar, after his stroke. He had the stroke soon after attending the International Conference on "Plant Science in Post Genomic Era", held during February 17–19, 2011 at the School of Life Science, Sambalpur University, Odisha, where his mentor Govindjee was a keynote speaker, and had honored him with a shawl, a traditional custom."

Figure 8 shows two photographs of Prasanna with Govindjee, honoring each other at the 2011 International Conference on "Plant Science in Post Genomic Era" at the School of Life Science, Sambalpur University, Odisha. In one photo (A), a book on "Photosynthesis" is being "released" by Govindjee and in the other (B), Govindjee is honoring Prasanna with a shawl.

A.B. Das continued: "Prasanna's image has dominated my mind ever since I began my research on mangrove physiology, having shifted from Cytology and Genetics. In 1999, Premananda Das, then director of the Regional Plant Research Centre (RPRC), had brought Prasanna to Odisha after his retirement from JNU to help motivate young scientists. Under Prasanna's guidance, my interest in mangrove physiology began to flourish, His ignited, enthusiastic and untiring personality is responsible for

Fig. 7 **A** A group photograph at the "International Conference on Photosynthesis in the Global Perspective", held in honor of Govindjee, during November 27–29, 2008, in Indore, India. *1st Row* (*left* to *right*) Gyozo Garab, Tessa Pocock, Basanti Biswal, Julian Eaton Rye, Rajni Govindjee, Govindjee, Prasanna Mohanty, Prafullachandra Vishnu (Raj) Sane, Shigeru Itoh, and Reto J. Strasser. *2nd Row* (*left* to *right*) Sylvian Dube, Eva Mari Aro, Asako Kawamori, Michael Seibert (*wearing sunglasses*), Ralphreed Gasanov (with *white beard*), Arumugham Gnanam, Louis Sherman, Norm Huner, James (Jim) Barber, George Papageorgiou, Munna Singh, Kastoori Hingorani, K.N. Guruprasad, and Prabhat Kumar Sharma (*wearing glasses*). Since there are no clear rows, we have left out the names of others except to point out the location of a few: Anjana Jajoo is behind and between Kawamori and Sylvian Dube; Baishnab C. Tripathy is behind and between Gnanam and Huner; A.R. Reddy is behind and between Huner and Barber; right above Reddy is Rajagopal Subramanyam (in *blue shirt*); and right above Rajagopal is Sudhakar Bharti (with *moustache*; and in *white shirt*). This photograph is reproduced from Jajoo et al. (2009); it was taken by Mahendra Rathore of Indore. **B** A photograph at Indore, India. *Left* to *right*: Prasanna Mohanty, James Barber (*middle*) and K.N. Guruprasad, arriving for the Indore Conference in 2008 (see Jajoo et al. 2009)

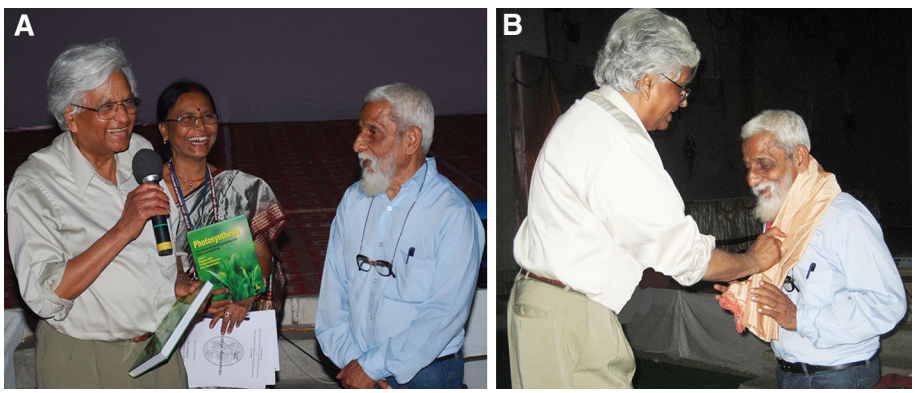

Fig. 8 Govindjee and Mohanty at a conference in Sambalpur, India. **A** Govindjee (*left*) releasing the book "Photosynthesis: Overviews on Recent Progress and Future Perspectives", edited by Shigeru Itoh, Prasanna Mohanty, and K. N. Guruprasad, and printed to honor him. Next to Govindjee is Basanti Biswal (convener of the 2011 conference) and then Mohanty. **B** Govindjee is honoring Prasanna Mohanty in traditional Indian way with a shawl. *Venue* International Conference on "Plant Science in Post Genomic Era", held February 17–19, 2011, at the School of Life Science, Sambalpur University, Odisha, India. Photo provided by Basanti Biswal

molding and sharpening my academic career. His simplicity and enthusiasm has always fascinated and inspired me to work harder. Prasanna had requested K.N. Guruprasad to publish the book he had planned to honor his mentor Govindjee, and was very glad to see the published book during 2012 (Itoh et al. 2012) (see

above). When I handed over this book to him, he turned the pages quickly like a child and tried to read something but could not. He wept like a child as he could not read and write at this stage. Besides his scholarly guidance, his simple life, honesty, humbleness, and concern for the poor, earned him great respect. He will be remembered for long as a unique person in the world of academics.

Prasanna was very curious not only about chloroplasts, but also about mitochondria in cacti, and in pneumatophores of mangroves. After several round of discussion, I was astonished by his simple, friendly, logical and caring attitude. After interacting with him, my perception about great scientists is that '*Those who are great scientists are simple, honest and sweet and can logically put complex natural phenomena in simple ways to solve the mystery of nature'*. His simplicity and enthusiasm always fascinated and inspired me to work hard and harder and to learn to struggle with any situation of life like a monk to illuminate the truth of science. It was Prasanna Mohanty who would call me 'AB Sir' to reciprocate my use of 'Sir' for him."

A.B. Das described some important findings of his research with Prasanna Mohanty, done entirely during his retirement days. The main focus of their studies was on salt stress in mangrove plants. They showed that exposure to high salt results in elevated levels of some anti-oxidative enzymes (Parida et al. 2004a). They identified certain isoforms of these enzymes that undergo changes during salt stress and these could be potentially used as markers for recognizing salt stress in mangroves (Parida et al. 2004b). These changes were accompanied by changes in the fast chlorophyll a fluorescence transient (Das et al. 2013).

During Reto Strasser's visit to Cuttack, Prasanna said to Reto: 'I feel pain in speaking in English, but I do remember my old friends like you very well'. He was a model teacher by profession who encouraged and took care of his students and associates with love. All of them around him admired and respected him from the bottom of their hearts. I also had an opportunity to interact with his most beloved teacher Govindjee, a towering personality in the field of Photobiology, called by some 'Mr. Photosynthesis' as well as "defacto Ambassador of Photosynthesis to the world" at several occasion, as well as with many other national and international scientists, such as Norio Murata, Reto Strasser, A.S. Raghavendra, K.N. Guruprasad, Satoshi Hoshina, Suleyman Allakhverdiev, Baishnab. C. Tripathy, Udaya C. Biswal, Basanti Biswal and his [many] talented students and associates, such as J.S.S. Prakash, N. Raghuram, Anjana Jajoo and Rajgopal Subramanyam.

Prasanna Mohanty came in a wheel chair to listen to Govindjee's lecture at Ravenshaw University, Cuttack, at the 37th Annual Conference of Orissa Botanical Society & P. Parija Memorial National Conference on Recent Advances in Plant Biotechnology", held on December 22–23, 2012. The scene was serene without much talk by him, only with tears, which was his last 'Good Bye' to his beloved teacher Govindjee, and his wife Rajni, and friends from different parts of the world and from Cuttack; this was his last public appearance. Prasanna Mohanty's demise has created an utter void for generations of students who grew up getting inspired by his deep and penetrating insight in scientific research. We all only hope that the volume of work he has left behind will continue to light the path of future scholars of photosynthesis. We have lost a unique man of science. His unassuming nature, simple life, ego-less personality, obsession with the welfare of students, respect for the intellectuals and finally his commitment to quality research in science has made him a scientist without any comparison. What makes Prasanna Mohanty a remarkable person is not just his scientific output, but his human qualities; unpretentious, idealistic, honest, strong, tenacious, kind and helping. He stood tall among his peers. A great and dedicated teacher, he gently nudged his students to go the extra mile.

In true sense the tribute of A.B. Das to Prasanna Mohanty has been to fulfill his last desire to publish the book jointly authored by two of them on "*The Biology and Biogeography of Mangroves*" (Das and Mohanty 2014). All the struggles of Prasanna Mohanty and prayers of all of us came to [an] end at 10:30 A.M. on March 9, 2013 in Cuttack after the arrival of his daughter Meeta a day before (i.e., on March 8, 2013). Perhaps, Prasanna Mohanty was looking for her to be there before he left this World. A.B. Das went to Cuttack, with Sadanand Torasia, to see Prasanna Mohanty at his last rites. His prayers are with him, his family, all his friends, and all the photosynthesis researchers.

Prasanna Mohanty lost his wife due to a long illness that left her incapacitated. He served her with a lot of care and tenderness all through and was a broken man after she passed away. Meeta brought her son to India when Prasanna was ill and could not travel. This brought a smile and cheer to his life for sometime. Throughout his illness, his niece (Kalyani Mohanty) along with her family took care of Prasanna. This was a selfless service that all of us who know Prasanna will always remember with deep gratitude.

Awards, honors and other activities

Prasanna won many awards and laurels during his distinguished career. He received the Robert Emerson Award of the University of Illinois at Urbana-Champaign

in 1970, while he was a PhD student. He was a recipient of Gold Medal of the National Academy of Sciences (India), Allahabad, of the Hari Om Trust's Jagadish Chandra Bose Award of UGC (University Grants Commission) of India, and of the Panchanan Maheshwari Memorial Lectureship of INSA, the Indian National Science Academy, and of the P. Parija Memorial Lectureship of Utkal University. He was a Fellow of the National Academy of Sciences (India), Allahabad, Founder Fellow of the National Academy of Agricultural Sciences (India) and Founder Member of the Society for Scientific Values.

He was a born leader for international collaborative research; he was very active in bilateral programs with Russia, Japan and USA. See above for recollections of Norio Murata. Prasanna co-edited several books and special issues of journals, and served on the Editorial Boards of several national and international journals (e.g., Indian Journal of Experiment Biology, Indian Journal of Biochemsitry and Biophysics, and Photosynthesis Research). As examples of his edited books, we mention two, one edited by Singhal et al. (1989) and the other by Abrol et al. (1993). Raghavendra et al. (2003) provides a discussion of the contributions Mohanty made in the context of "Photosynthesis Research in India", as mentioned above.

During his illness, and 2 months before his death, his mentor Govindjee along with Prasanna's PhD student Baishnab C. Tripathy visited him in Cuttack, Odisha. His last public appearance was at Ravenshaw University, Cuttack in February, 2013 where he, inspite of his ill health, came on a wheel chair to attend Odisha Botanical Society Meeting to listen to the lecture of his mentor Govindjee, delivering a plenary lecture. The entire audience of Odisha Botanical Society and people attending the conference from different parts of India paid a standing ovation to Prasanna as he entered the lecture hall!

Messages from around the World

An alphabetical list of tributes, other than those presented above

We have received an overwhelming response from many who wanted to write a tribute for Mohanty, a proof of his reach and popularity from all sections of society. We have included almost all the messages received in alphabetical order by the last names, but only a few photos. Figure 9A shows a photograph of Mohanty with several scientists in South Korea, Fig. 9B with Uli Schreiber (from Germany), and Fig. 9C with Mike Seibert (from USA).

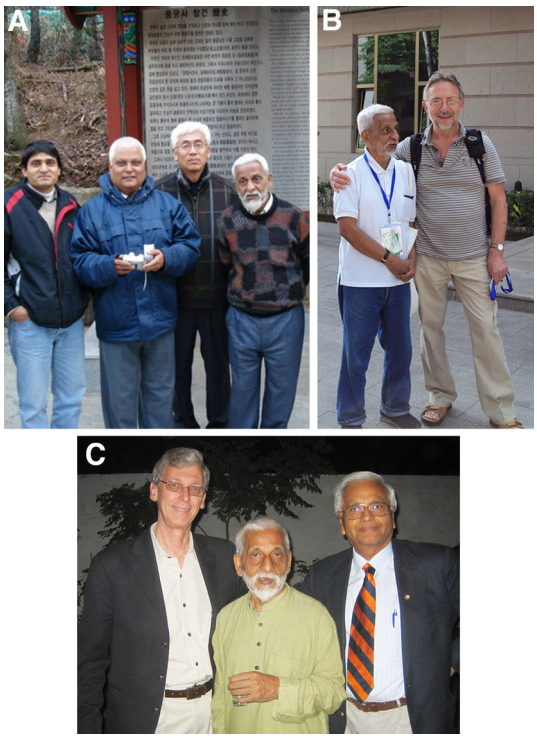

Fig. 9 **A** A 2007 photograph of Mohanty when he visited Pusan National University in South Korea. *Left* to *right* Krishna Nath, Mukund Ranjit, Chuan Hwan Lee, and Prasanna Mohanty. Photo provided by Choon-Hwan Lee. **B** A 2010 photograph of Prasanna Mohanty with Ulrich Schreiber. **C** A 2008 photograph of Prasanna Mohanty (*middle*) with Michael Seibert (*left*) and Govindjee (*right*). Photo taken at the Indore Conference (see Jajoo et al. 2009)

Yash Pal Abrol (India)

"Prasanna Mohanty was a totally academically oriented scientist; he was always with one project or the other [until] almost the last year of his life."

Rachna Agarwal (India)

"I met Prasanna Mohanty for the first time when he came as an expert for my interview at BARC (Bhabha Atomic Research Center, Mumbai, India) in 2007. Knowing him was a pleasure; he treated me like a daughter and always encouraged me in my work. I met him for the last time in 2010 at the Photosynthesis International Congress in Beijing, where his zeal for climbing the Great Wall was amazing!"

Suleyman Allakhverdiev (Russia)

"It is our deep personal grief, sorrow and pain that we learned about the irreplaceable loss that befell the Mohanty family. Prasanna Mohanty was a highly distinguished

colleague, and my very close and best friend. I express my deepest sympathy with the family at this tragic hour …. At this difficult time, we all are together with you. We surely miss our dear Prasanna." Suleyman had collaborated actively with Prasanna and wrote, in addition to papers cited by Norio Murata, one on irreversible photoinhibition (Allakhverdiev et al. 2005) and three wonderful educational reviews on "Heat Stress in Plants" (see Allakhverdiev et al. 2008, 2012; and Mohanty et al. 2012).

A. Alia (Germany)

"I received the sad news that Prasanna Mohanty passed away. He was like a father to me and it is really hard to accept that he is no more. May his soul rest in peace; my deep condolence to his family, his friends and all his students. Jörg Matysik and I will always remember Prasanna's kindness and wisdom. He visited us two times in The Netherlands. We liked him very much and felt always very comfortable in his company. He was one of our most favorite persons. We really lost a great scientist and wonderful man. I mention 2 papers that he and Jörg Matysik published together on the effect of proline on reactive oxygen species (Matysik et al. 2002; Alia et al. 2001). Further, I worked with him on the effect of stress on photosynthesis and published several research articles and reviews (see e.g., Alia et al. 1991, 1992a, b, 1993, 1997)."

Usha Andley (USA)

"Prasanna Mohanty was a brilliant and inspirational scientist. We published two papers together (Andley et al. 1977, 1981). He inspired me with his wisdom and kindness everyday when I was a graduate student in the School of Life Sciences at Jawaharlal Nehru University in New Delhi, India. Prasanna showed me how to plan and execute meaningful experiments. I was inspired and fascinated by reading his thesis under the mentorship of Govindjee, and it influenced my entire career. Reading all of Prasanna's published work was a very motivating and educational experience. He influenced me greatly in the lab, but his dedication extended far beyond the ordinary- he even accompanied me to the Biophysics Department of the All India Institute for Medical Sciences, several miles from our School, to use their fluorescence equipment. Prasanna taught me some very basic things about experimental work which I still apply to this day; and I teach that to my own students: '*to label is to survive*', and '*if you can pour, you are a chemist*'. He is the only person who has called me 'Usha ji'. He was always respectful and kind, and exceptionally motivating. He invited me into his home; his wife Basanti and Prasanna were wonderful hosts. Meeta, their only child, was a lovely seven-year-old girl when we first met and we spent much time together, and for her I have great affection. It was an honor that Prasanna stayed with us in our home in Boston in 1986. Prasanna's legacy is his excellent science, his humanity and his humble nature, and it will live forever in our hearts and minds. I am so very saddened by his passing. A wonderful light has gone from the life of those he touched with his presence. We will miss him much."

Charles (Charlie) Arntzen (USA)

"I knew Prasanna when he was a PhD student in the Photosynthesis group of Govindjee, at the University of Illinois at Urbana. He was such a gentle and intelligent person. I remember him fondly."

Maarib Bazzaz (USA)

"Prasanna Mohanty was not only a great scientist as his scientific publications demonstrate. But, he was also one of the greatest human beings I have known. I got to know him while we were graduate students in the Photosynthesis laboratory of Govindjee. Prasanna was always helpful, selfless, and ready to share his extensive scientific knowledge and research experience. I also had the pleasure of getting to know his family—his wife, the late Basanti, and his daughter Meeta. My daughter Sahar used to play with Meeta, and Basanti was kind enough to watch my daughter when sometimes my after-school caregiver was not available and I was in the laboratory working. The whole family exemplified the highest level of goodness and generosity. I am honored to have known Prasanna and his family and I will always cherish their friendship."

Glenn W. Bedell (USA)

"I have always admired and respected Prasanna. I wish we had more contact after we left Urbana, Illinois."

Patrick (Pat) Breen (USA)

"He truly was a wonderful person. I was in Varanasi (India) when I received an email from Arujash (Prasanna's brother's grandson) that Prasanna had fallen into a coma. I had never told Prasanna that I would be in India because I was going with a tour group and I knew that I could not

visit him in Odisha. Many years ago Prasanna had worked a few months in Corvallis (Oregon, USA) and before he returned to India, he put several thousand dollars in a bank account, and we both were on the account. Once, at his request I had sent some of the money to his daughter Meeta, whom I had never met; she lives in Australia. On many occasions I would mention to Prasanna that he still had money in Corvallis and I would like to send the funds to his daughter but I did not have any way to contact her. It was only after Prasanna's death, Govindjee was able to get me to contact Meeta and arrange to transfer the funds to her."

Raymond (Ray) Chollet (USA)

"Thanks, Govindjee, for alerting me of the very sad news concerning Prasanna. I remember him well from our graduate days together at the University of Illinois at Urbana-Champaign, most especially in the Photosynthesis class and the laboratory taught by you (Govindjee) & Bill Ogren during early 1969. It was a great experience. Readers of this Tribute to Prasanna may see this photograph in this class (he is 3rd from right in the last row in Fig. 1 in Ogren 2003)."

Gyozo Garab (Hungary)

"I speak for many of us; we all appreciate very much that you, Govindjee, together with many others, have composed this tribute to Prasanna, a highly respected colleague and friend, and a master to many scientists in India (and indirectly or directly) to many international students, too, and a spiritual master for many of us - who showed the way how to stand and help make progress; also, being a scientist who dedicated his life to photosynthesis research. In his philosophy and humanism, he was great, not only an excellent scientist. We all miss Prasanna a lot, but carry in our hearts the spirit and friendship what he meant to us, and I am grateful that I had the chance to meet him several times, and know him and have his (albeit remote, but I feel, warm) friendship; also indirectly via his students and friends."

In short, he was an outstanding scientist and an exceptionally good person and friend, the best 'Ambassador' of India –the Photosynthesis Community will miss him but will cherish many memories of him. I mention here a short collaboration with him on UV-B effects in cyanobacteria (see Jha et al. 2000). My deepest sympathy and condolence to all his colleagues, his friends and his family members."

Sridharan Govindachary (Saudi Arabia)

"It is very sad indeed to hear the news that Prasanna Mohanty is no more with us. He was my external PhD Examiner during 1990s while I was at the University of Madras (Chennai, India). We spent nice time in Trois-Rivieres (Canada) and also at the International Photosynthesis Congress, held in Montreal, Canada. I am writing from Saudi Arabia, where we are establishing a Center focusing on Chemicals from Microalgae. I am sure Prasanna would be delighted to hear that. We miss him."

K. N. Guruprasad (India)

"We lost a scholar and a dedicated scientist in the field of Photosynthesis with the sad demise of Prasanna Mohanty. He had made very important contributions through his research that has helped us understand how photosynthesis changes during temperature and salt stress. Mohanty taught and guided research of many students in India, and developed a great rapport with them. Besides his scholarly guidance, his simple life, honesty, humility, and concern for the poor, earned him a great respect. He will be remembered for long as a unique person in the world of academics."

Satoshi Hoshina (Japan)

"I keenly felt sad when I heard the passing of Prasanna. However, I am now proud that I shared with Prasanna an enjoyable and academically important time in the Department of Plant Biology of the Carnegie Institution of Washington for more than one year from 1982 to 1984, at Jawaharlal Nehru University for three months in1986, and in Kanazawa, Japan, when he visited me several times in 1990s while he stayed at the National Institute for Basic Biology in Okazaki, Japan. From Prasanna, I received a lot of knowledge about photosynthesis research and strong spirits in pursuing scientific research. I never will forget his kind friendship and the heart-warming memory of Prasanna."

Steven (Steve) C. Huber (USA)

"I had the very good fortune to meet Prasanna many times, together with Govindjee, during the 1980s on USAID (United States Agency for International Development) - sponsored visits to India, and continued to see him at various meetings over the following many years. I will always remember him as a very warm person, full of enthusiasm, and

eager to talk about photosynthesis. He will be sorely missed by his many colleagues and friends around the world."

Hazem Kalaji (Poland)

"Govindjee, I am very sorry to hear this sad news about Prasanna Mohanty. Please accept my deepest condolence and convey my sorrow to his family in the loss of such a prominent man and scientist. I shall pray for him."

Rita Khanna (USA)

"It is indeed a very sad news that Prasanna is no more. He was a real gem of a person. Our thoughts and prayers are with his family. I am sure it made a big difference to him knowing that you, Govindjee, were thinking about him and were able to meet with him during your last visit to India."

David B. Knaff (USA)

"I'm so very sad to hear this news about Prasanna Mohanty, who was a gem of a person and a great scientist."

Choon-Hwan Lee (South Korea)

"Prasanna Mohanty was a teacher who encouraged and took care of his students and associates, with love and smile, and all of them around him admired and respected him from the bottom of their hearts. I thank him and respect him as a model teacher for myself, trying to become a teacher "who goes beyond giving only knowledge."

Walter Mangel (USA)

"I entered Graduate School at the University of Illinois in the Biophysics program, and it was then when I met Prasanna. As an undergraduate at the University of Illinois at Urbana-Champaign, I had majored in Philosophy with minors in English and Economics. Near the end of my senior year, I decided I liked Science more than Philosophy and entered Graduate School in the Biophysics program. A time came to find a subject for a Ph.D. thesis. During my last year of course work, I took a course in "Biophysics of Photosynthesis" taught by Govindjee. I really enjoyed it. It was a great combination of Math and Physics applied to an important biological process. So, it appeared I was headed to do a Ph.D. thesis in photosynthesis in Govindjee's laboratory. I met Prasanna and we became instant friends. There was a photosynthesis meeting at Brookhaven National Laboratory, a federal government laboratory on Long Island in New York, and Govindjee kindly asked me if I wanted to go to the meeting. Govindjee, his group of students, and I flew to New York City where the Department of Energy had a car waiting to drive us down Long Island to the meeting. During the meeting, I had several discussions with Prasanna. He was very friendly and intellectually curious. It was then that I obtained a new name. After one of the meeting sessions, he asked me to explain to him the Franck- Condon principle as applied to fluorescence. I explained it to him. Ever since then, he called me Franck, and I would sign my letters to him 'Franck.' Eventually I decided not to do a thesis in photosynthesis. I reasoned that it was a three-dimensional, structural problem for which there were no techniques that could be used to study it. Parenthetically, over the years, I have made numerous trips to the Max Planck Institute in Martinsried (near Munich, Germany) and there have had several interesting conversations with Robert Huber, the person who showed how wrong I was about "no techniques could be used to study it. It was Hatmut Michael, Johannes Deisenhofer and Huber who solved the structure of the bacterial reaction center (Nobel Prize in 1988) by X-ray crystallography, a technique I most respect. I eventually had ended up doing a Ph.D. thesis in Molecular Biology and Prasanna did his thesis in Photosynthesis under Govindjee in 1972."

Some of Walter's main thoughts about Prasanna are already in the main text of this Tribute, but he added more: "I have certain memories of Prasanna and his family in Urbana, Illinois. I believe soon after this family arrived, they were taken to the local K mart store to buy items they needed in their apartment. His wife Basanti, in particular, liked the blue light specials at Kmart. Without notice, a blue light would shine somewhere in the store to point to the location of a special sale. I had the feeling they spent a considerable amount of time waiting for the blue light to appear in certain sections of the store. Their apartment was located in a building where most international students lived. Every time I visited them in the building, I enjoyed the unusual aroma from the apartments, the best being from the cooking of Indian food."

Walter added "After my Ph.D. thesis, my wife Anne and I moved to the University of California, Berkeley. I do not remember where Prasanna went. Throughout the years, we corresponded by mail. I was very impressed by the number of different places he worked. He must have had a lot of friends who had great respect for his work. He visited us several times in different places. His last visit was when he came from a meeting in Canada to New York. He stayed in our home on Long Island. He was the same lovable Prasanna. By that time we had been cooking Indian food most

every night. During his visit, Prasanna introduced us to new dishes. Once he retired from Jawaharlal Nehru University and returned to Orissa (now called Odisha), we began discussing plans to visit him. This was something we were looking forward to."

John C.Munday, Jr. (USA)

"I shall remember him, as I knew him during graduate student days, a delightful kind person with a passion for science education and reaching the goal of a PhD. We published a paper together (Mohanty et al. 1970) on what was to be related to the so-called state-changes in photosynthesis, as was discovered by Murata (1969) and Bonaventura and Myers (1969)."

Samsree Naelapalli (Japan)

"Govindjee, you have introduced a great personality, great scientist and a great human being to this world. We had strong association with Prasanna Mohanty and Basanti Ji at the University of Hyderabad. He taught us many things. For us he was like a God. Every day we used to spend so much of time to learn many things from him. I was very curious to see his Ph.D. thesis. Whenever, I requested him about it he told me that it was difficult to get. But I am so lucky you (Govindjee) made my dream come true. Thank you so much for your wonderful gift. For me Prasanna looked like a mobile library. He many times discussed the strong association that he had with many of his colleagues. He taught me the word "state shift". If I am correct he is one of first scientist who told "state shift" can be an early abiotic stress response event". He told me many times that he wants to write a review article on this topic. I will mention here just one paper that I wrote with him on heat-induced state transition in Arabidopsis (see Nellaepalli et al. 2011). He helped many of the students at University of Hyderabad, and inculcated scientific temper. Now he left all of us and reached Basanti Ji. We pray to God 'may his soul rest in peace'."

George C. Papageorgiou (Greece)

George wrote to Prasanna's niece's family in Cuttack: "I am deeply saddened by the loss of our friend and colleague of long long time, Prasanna Mohanty. As he came out of the coma, 2–3 days ago, I felt that his health may improve further. Unfortunately, it did the opposite. With Prasanna I shared many happy and interesting moments in the USA, Japan, India, Greece and many other places. We published many papers together while at Urbana, Illinois (see e.g., Mohanty et al. 1971b). Prasanna was a truly warm friend and a highly respected, inspiring and unforgettable colleague. My deepest condolence to Meeta, to you and to the extended family; also from my wife Sophie, a long time friend of Prasanna. I do, also, feel very thankful to you for taking such a good and loving care of Prasanna in his difficult times." Papageorgiou is planning a Tribute to Mohanty that will be published in "*Photosynthetica*".

Peddisetty Pardha-Saradhi (India)

"At the outset, I wish to state that whatever little I know today about photochemical events in photosynthesis, I owe it to Prasanna Mohanty, a unique, simple, wonderful, caring perfectionist professor. We all miss him. It was in 1988 that I had approached him to ask if proline has any influence on photochemical reactions of photosynthesis, since it is synthesized in chloroplasts in large quantities under stress. Inspite of his being a renowned professor, at JNU, in the area of light reactions of photosynthesis in India, he gave me much time and discussed at length this problem. I was overwhelmed with joy when he agreed to educate me and allow me to work in his laboratory; at that time, I was just a beginning lecturer at Jamia Millia Islamia University (JMIU). To begin with, Mohanty along with his post-doc associate Surendra C. Sabat taught me basics of photosynthesis and protocols for measuring photochemical reactions. Mohanty would walk into the lab any time, even late in the night just to see how we were performing our experiments. He was very particular about the protocols, perfection in experiments, and in making sure that experiments were repeated many times before conclusions were reached. We also remember that the project funds were never to be misused and often he would spend his own personal funds for research."

Pardha-Saradhi added "Our research collaboration included participation by JMIU graduate students Alia (one name only; see above for her write-up), Neelima Atal and Bhagavatula Vani. We found that (1) proline protects photosynthetic machinery against photodamage (Alia et al. 1991), specifically, PS II by scavenging reactive oxygen species (Alia et al. 1993), specifically singlet oxygen (Alia et al. 1997); (2) cadmium inhibits PSII activity, specifically the electron acceptor side of PS II (Atal et al. 1991); (3) salt stress in cotyledonary leaves of *Brassica juncea* seedlings showed enhancement in PSII- mediated photoreaction, as well as high pH stability in thylakoids (Alia et al. 1992a; cf. Alia et al. 1992b for NaCl effects); (4) mild heat stress (40 °C for 24 h in dark) caused no significant alterations in the composition of the intrinsic thylakoid membrane proteins, but made significant structural changes, inducing significant loss in the ability to capture and utilize light

energy efficiently, specifically for electron transport on the electron acceptor side of PSII, as well as in intersystem electron transport between the two photosystems (Vani et al. 2001)."

Potluri Prasanth (India)

"Professor Mohanty used to call me his "*Ekalavya shishya*!" I was the last student of Late Professor Gauri Shankar Singhal; he had retired before I could finish my thesis and I was stuck with the departmental indifference. Prasanna Mohanty's counseling and generosity saw me through that ordeal. I was not even his student and I was not the only beneficiary of this great man's kindness. Last time I was in Hyderabad in 2007, he came from Cuttack to see how this wayward student of his was doing."

Addressing Prasanna, Prasanth said "Rest In Peace Mohanty Sir. You will be missed for your benevolence and humility."

J.S. S.Prakash (India)

"Govindjee, You might already know about the sad demise of Prof. Prasanna Mohanty, my teacher, who taught me not only science, but how to live. Please convey this message to other international friends of Prof. Prasanna Mohanty. It is best for me to refer to that Tribute that we published soon after his death (see Prakash and Tiwari 2013). As an example of our joint research, see Prakash et al. (2003) that deals with senescence- induced changes in Light harvesting complex II."

Constatin A. Rebeiz (USA)

"I have known Prasanna Mohanty personally and through my postdoctoral trainees for a long time. One of Mohanty's doctoral students was Baishnab Tripathy (currently Vice Chancellor of Ravenshaw University, Cuttack, India) who spent several years as a postdoctoral associate in my Laboratory. Baishnab's outstanding performance in my Laboratory reflected his solid training in Prasanna's laboratory. Mohanty was a kind, modest, humble, and a highly competent person which are the main attributes of outstanding scientists."

Ulrich (Uli) Schreiber (Germany)

"My memories of Prasanna Mohanty date 40 years back to the dawns of chlorophyll fluorescence research, when he published his first papers together with Govindjee. Alan Stemler (another student of Govindjee) introduced him to me as a friend when both of us were post-doctoral fellows at the Carnegie Institution in Stanford. He impressed me as an exceptionally kind human being, radiating at the same time modesty, enthusiasm for science and empathy for other human beings. When he visited Würzburg in 1989 to get trained in PAM (Pulse Amplitude Modulation) fluorometry, we had many interesting discussions- not only on chlorophyll fluorescence, but on many other topics. Since then we have enjoyed seeing each other at the International Photosynthesis meetings. I will miss him".

Michael Seibert (USA)

"When I told my wife the sad news that Prasanna Mohanty had passed away after prolonged illness, her first words were, "he was a truly gracious man". We spent some time reflecting on the unique person that he was and remembering the time that he spent with us in Colorado.

Prasanna sent me a bitnet (an old e-mail communication system) message on May 23, 1991, asking if he could spend a sabbatical with me at the Solar Energy Research Institute (renamed the National Renewable Energy Laboratory [NREL] by the time he arrived). We met Prasanna at the Denver airport in the middle of June 1992, and he stayed with our family for about a week while we looked for an appropriate apartment for him close to the lab. During the week that he was in our home, he made special impressions on our daughters, talking with each of them extensively about the differences for girls growing up in the India and the US (his daughter, Meeta, was born in Urbana, Illinois, but grew up in India). The wonderful memories of him remain with my daughters today as adults. My wife, of course, remembers the evenings in the kitchen receiving instructions on how to cook Indian, vegetarian food.

Prasanna started officially at NREL on June 22nd, 1992, the recipient of a Fulbright Fellowship and funding at NREL from the Basic Energy Sciences part of the United States Department of Energy.

In the lab, Prasanna wanted to examine the effects of crown ether complexes, synthesized at JNU (Sabat et al. 1991a), on spinach PSII membrane fragments and O_2-evolving PSII core complexes that we made at NREL. We initially thought that K-crown (18-crown-6 potassium picrate) might bind calcium or affect chloride binding in the PSII membrane, thus interfering with O_2 evolution, but this turned out not to be the case. Fluorescence studies for which Prasanna was well known showed that the complex actually inhibits electron transport on the electron acceptor side of PSII after Q_A at or near the Diuron-binding site on Q_B. Consistent with his interest and talent in educating

young scientists, he also took on the challenge of mentoring one of my young graduate students, who was working on the inhibitory effects of cadmium on PSII membranes and the kinetics of calcium displacement by the ion.

While at NREL, Prasanna got on extremely well with everyone in the laboratory. He was very willing to give of his time and expertise to anyone who needed him. This was not restricted to inside the lab; for example, one of my colleagues in the building was going on vacation and needed someone to watch her house. Prasanna happily volunteered as a house sitter, and the place was spotless when she returned. He spent many evenings and weekends at our house as well as with others in the lab and was never without a student to talk with at our lab meetings and parties.

Unfortunately, due to circumstances beyond Prasanna's control (issues related to a change in administration at JNU), he had to return prematurely to India at the end of December 1992. However, the legacy that he left at NREL was one of an intelligent, honest, unassuming, kind, unpretentious man, who could be counted on to finish what he started. As an example of the last characteristic, the paper that we wrote on the work he started here (Mohanty and Seibert 1997) was not published for almost five years (he had to complete the work back at JNU due to his early departure and with many distractions at home did so as soon as he could). In my report to DOE after he left, I noted that Prasanna was the best liked sabbatical visitor that we had ever had in the lab, and I can't think of a more loved visitor since. We saw each other subsequently at 5 international meetings and were able to talk by phone several times over the last two years of his life, but it was still a shock to learn of his passing. He will be very much missed in Colorado as around the world."

Arindam Sen (USA)

"I was saddened to learn from Usha Andley that Prasanna Mohanty has passed away. "Prasanna", that's how he insisted that we addressed him when we were graduate students at JNU. He would never allow us to address him as either "Sir" or "Dr. Mohanty", which reflected his humility and he always treated us as his equal. I will always cherish fondest memories of him, remembering his kindness, his humility and willingness to help."

Louis A. Sherman (USA)

"Let me just follow upon the elegant words of Govindjee and George Papageorgiou and give my deepest condolences to all in the family. I was glad that I was able to see him 4 years ago in India, attending a meeting in honor of Govindjee, and we were able to talk about old times."

Rakesh Sinha (India)

"I met Prasanna Mohanty a few times while I was a student in Indore (at the University there), India. He was a gifted human being. It is a big loss for the Photosynthetic community. He lives in our hearts and he leaves behind his memories."

Rajagopal P. Subramanyam (also known as S. Rajagopal; Hyderabad, India)

"Prof. Mohanty passed away after long ill health. I pray that his soul would rest in peace; I send my deep condolence to his family, friends and students. We had fun doing research together. For examples of our research dealing with UV effects, see Rajagopal et al. (2000a, 2000b, 2005). Also see, Sireesha et al. (2012) for mechanisms behind regulation of excitation energy redistribution."

Sadanand Torasia (India)

"I have known Prasanna Mohanty for almost six decades. I was his classmate from his days at Ravenshaw College. I met him first in the year 1954, when we were both graduate students, though from different streams (I was in Physics; he was in Biology). Our acquaintance developed into friendship, as we were both day scholars residing in nearby localities. He stood, so-to-say, on his own legs for pursuing his studies. I was first separated from Prasanna when he left Cuttack to join as a Lecturer in Botany; then we had a long separation when he left India for higher studies in USA in 1965. Later we were extremely happy to know that after his return from abroad in 1973, he joined as Associate Professor at JNU. Our contacts became more frequent after 1983, when I joined the newly formed Department of Science Technology and Environment of Government of Odisha. Prasanna was inducted as a member of the State Council of Science Technology and Environment of Odisha, as one of the eminent scientists and made valuable contributions, during deliberations of the council. I knew of him for his strong academic pursuits, erudite scholarship, fame as a teacher, who never compromised with quality and standard of research. With his love for Odisha, his place of birth, he agreed to settle at Bhubaneswar, after his retirement, and accepted an assignment at the Regional

Plant Research Center and Orissa University of Agricultural Technology. He conducted several experiments utilizing the natural resources of Odisha and cherished it until his last breath. He was a person without ego but with self-respect; he had many acquaintances, but a very few friends; he was simple by nature and religious minded with a broad outlook. Though somewhat an introvert, he was a keen observer with a fine sense of humor. Beyond science, he loved literature and poetry (including that of Urdu). He dreamt and strived for the development of science and scientific institutions in Odisha until his death." (Also see the main text.)

Pramod Yadav (India)

"I joined Prasanna Mohanty's Photobiology group as a Post-doctoral Research Associate in 1979 following an interview for a DST (Department of Science and Technology, Government of India) sponsored project "Primary Processes in Photosynthesis". Two other post-doctoral fellows Nikhil Kumar and M. Krishnan were recruited along with me. I was privileged to have had very good lessons (for our times) in Photosynthesis from the Late Rama Nagina Singh (of Bananas Hindu University) during our M.Sc. Yet the discourses by Prasanna would add one or the other things to unexplored problems in each of the weekly group meetings. Also it was wonderful to be having, under Prasanna's dedicated guidance, hands-on assays of partial and whole chain electron transport reactions, or other aspects of the Z scheme of electron transport including quantum conversion efficiency, which we had studied only in theory. We had a herbicide (diuron)-resistant strain of *Synechococcus cedrorum* before the target of this herbicide was characterized in detail. Our finding on the effect of 2-deoxy-D-glucose on this strain was published (Yadav and Mohanty 1984) albeit with lower rates of electron transport at low light intensities, presumably due to smaller size of light harvesting antenna. Mohanty's understanding of energy transfer between molecules and kinetics of re-emission of light was remarkably much better than anyone else's I had till then. This is what he had worked on for his Ph.D. under Govindjee at the University of Illinois in Urbana-Champaign. One holds strong opinions as one's conviction and Prasanna was no exception. I think he was ultra-logical to the extent of being atheistic (although others thought he was religious); however, he was not averse to cite sayings like '*Vasudhaiv Kutumbakam*'(all the world is one family). He was known for his apparently deviant, but wonderful, ways of teaching simplifying most complicated phenomena using analogies from day-to-day experience. This also gave him the capability of putting most demanding questions in the simplest words. He therefore experimented with open book examination where the students had the option to consult a book if required. He was an excellent teacher but would sort of gobble up part of what he had to say and it took some time to get used to his kind of conversation. He led a simple life and did not care for fancy clothing. He would generally wear *khadi* (home-spun) *kurta* and *pyjama* and have slippers as his favorite footwear. He never owned a car or a scooter during his active life. During his tenure as Dean of SLS, JNU (1987–1989), he would treat visiting guests at his own expense rather than getting the officially provided tea or snacks. At times it was humbling to see that he was feeling his pockets for some money to pay for the tea one had just sipped. Prasanna mentored many students, some of whom have already retired. For his own reasons, he preferred to interact with other institutions, particularly the University of Hyderabad for his collaborative research work after his retirement from the School of Life Sciences, JNU, and remained productive till about a year before his final departure leaving behind no equivalents. We miss this great human being who walked our campus in JNU for many years. He has left a lot of legacy here."

Concluding remarks

The best honor to Prasanna comes from his students, some of whom we could not reach. We are listing most of his students here. This list includes (in alphabetical order): Neelima Atal, Udaya Biswal, Sangeeta Dawar, Manoj Joshi, Narendra Mohanty, S.D. Srinivasa Murthy, Jogadhenu S.S. Prakash, Jerome F. Sah, Sabeer A. Sayeed, Madhulika Srivastava, Swati Tiwari, Baishnab C. Tripathy, Bagawatula Vani, and Ramakrishna A. Wavare. We have provided in this Tribute only representative publications of some of these students. In addition to those already cited, we mention a few more: Dawar et al. (1998) studied hydrogen production from algae; Sayeed and Mohanty (1988) studied rhythmic oscillations in photochemical activities; Sabat et al. (1991b) described a new electron donor (N, N Diethylhydroxylamine) to PS II; Joshi et al. (1994) studied the effect of SAN 9785 treatment on photosynthesis; Srivastava et al. (1994) studied changes in excitation energy distribution in cyanobacteria; Murthy et al. (1995) studied the effect of mercury in altering excitation energy in chlorophyll-protein complexes in cyanobacteria.

Prasanna Mohanty leaves behind many friends, relatives, especially the family that took care of him during his last days, his daughter Jyotsna (Meeta), her husband Steve Clarkin and grand-son Rahul, who live in Canberra, Australia. We end this Tribute with a photograph of Swati Tiwari, the first author of this Tribute, with Basanti, Prasanna's wife (Fig. 10).

Fig. 10 A 1999 photograph of Swati Tiwari (author) and Basanti Mohanty in New Delhi. Photo by Devinder Sehgal

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