ing of T. D. Lee and C. N. Yang) got the coveted Nobel honour!

One omission in this rather complete overview on Chandra, I believe, is the stellar role he played as the editor of *The Astrophysical Journal* (*APJ*), a position he held continuously for 19 years, and how single-handedly he turned the *APJ* into a world-class, high-impact publication in the field. And those days with no internet and computers, journal editing must have been both intellectually demanding as well as physically exhausting. In this task of great quality and distinction, Chandra was aided by just one efficient secretary for the entire editorial task. Once again, this illustrates the level of seriousness Chandra always brought to bear on any task he undertook.

The documentary is a fine tribute, with a well-edited, visually pleasing photography and professional quality of production. We can feel proud about the timely project and are indebted to IISER Pune and its Director K. N. Ganesh, for this initiative.

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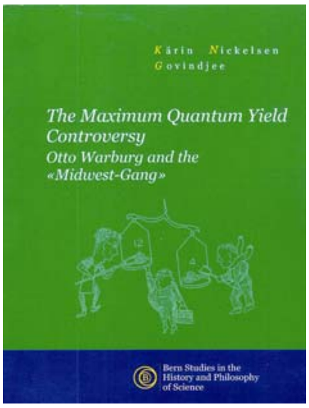


The Maximum Quantum Yield Controversy: Otto Warburg and the «Midwest-Gang». Kärin Nickelsen and Govindjee. Bern Studies in the History and Philosophy of Science, Institute für Philosophie, University of Bern, Switzerland. 2011. ii + 138 pp. Price: 10 Euros.

About five years ago, I had the opportunity of reviewing the great work *Discoveries in Photosynthesis* published by Springer (*Curr. Sci.*, 2007, **92**, 246–248). This is a work in which the principal editor was Govindjee (http://www.life.illinois.edu/govindjee). He is also an author of the book under review. Govindjee, who has now been in the area of photosynthesis for more than half a century, has earned our deep admiration and respect for his dedication to research and teaching, the magnitude of his efforts and ceaseless productivity. Within the covers of that earlier book, I found a great treasure trove of the history of great many discoveries and the work of hundreds of investigators.

I had thought that the publication of that monumental work running into more than 1300 pages would have exhausted the possibility of other books on the history of photosynthesis, at least for some time to come. I was thus pleasantly surprised to learn about yet another book relating to the history of research in photosynthesis. The first author of the book under review is Kärin Nickelsen. Though not a specialist in the field of photosynthesis herself, she has nevertheless had earlier research experience in plant physiology that led her to the broader study of the history of science in general. After teaching and doing research as a 'Assistenzprofessorin' in History and Philosophy of Biology at the University of Bern, Switzerland, she is currently Professor of History of Science at the University of Munich in Germany. With impressive earlier publications in this area, which include application to technology (one of her books is on Theodore von Karman, the great Hungary-born German scientist, who later emigrated to USA to lead the Aeronautical Engineering Group at Caltech and then establish the present Jet Propulsion Lab in Pasadena), she has teamed up with Govindjee to make this extraordinarily valuable contribution to the history of photosynthesis research.

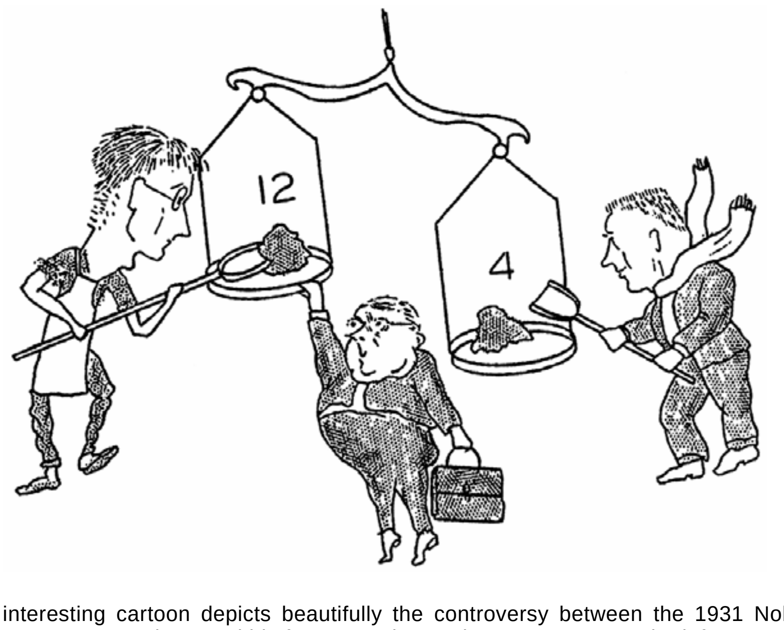
This book deals exclusively with just one aspect of photosynthesis research. But it is welcome, since the determination of the minimum quantum requirement (inversely the maximum quantum yield) of oxygen yield has been so central to the formulation of the 'Z scheme' and development of current concepts of photosynthesis. To explain to the general readers of this review, quantum requirement is simply the number of quanta required to split water molecules and form a single molecule of oxygen. The emphasis on oxygen evolution, rather than on the capture of a photon and excitation of a chlorophyll molecule, simply derives from the fact that in photosynthesis this is what one can measure most easily, and it is one of the products of oxygenic photosynthesis. Although chlorophylls, rather than water molecules, absorb quanta, and to be precise a manganese–calcium–water complex holds a crucial intermediary position, one can take an overall view. And in essence, there has to be a simple one-to-one numerical relationship between every excitation event and the resulting 'extraction' of an electron held between hydrogen and oxygen in the water molecule. Quantum requirement can be determined with respect to any photochemical reaction. Precise determination of quantum requirement of a reaction allows one to decipher the mechanism of that reaction (whether, for example, a photochemical process comprises one, two or more steps), and such work became popular after Albert Einstein published his law of photochemical equivalence with respect to photoionization or photooxidation reactions.

Following the work of Sam Ruben and Martin Kamen published in 1941, it became clear that the photosynthetic equation was $2H_2O + CO_2 + \text{light} \rightarrow \{CH_2O\} + H_2O + O_2$. (Multiply all reactants and products by six to formulate the more common equation for synthesis of one glucose molecule.) Thus, there was renewed emphasis to determine how many quanta are required to split the molecules of water. As would be evident to the readers, theoretically, four quanta are minimally required to split the two molecules of water and release of a single oxygen molecule, since four electrons are removed from two molecules of water to get one molecule of oxygen. However, in reality the process has turned out to be less efficient, since transfer of one electron from water to CO_2 requires two photons.

The above conclusion has come basically from the quantum yield determinations as most investigators, particularly Robert Emerson, found a minimal requirement of 8–10 quanta for the evolution of one oxygen molecule. Already during the 1940s, Nobel laureate James Franck and later Eugene Rabinowitch (the grand master of photosynthesis) suggested a two-light reaction scheme to explain the quantum requirement of 8–10. In 1960, Robin Hill and Fay Bendall formally proposed a Z-scheme for the transfer of electrons from water to CO_2 incorporating a downhill reaction that will also lead to ATP synthesis independent of the mitochondria.

The current scheme as given in popular textbooks is based on the work of many other investigators, particularly of Bessel Kok, Louis N. Duysens and Horst Witt in the early 1960s. But the very basic idea that it requires two steps for the low-energy electron from water to reach the level – through excitation of chlorophyll – to reduce NADP and then carbon dioxide was derived from the results of quantum requirement studies of Robert Emerson and his colleagues that started in the 1940s and culminated in 1957, when Emerson also discovered the enhancement effect of short-wave light on photosynthesis in far-red light (the so-called Emerson enhancement effect). It is worth recalling that Emerson obtained his doctorate under Warburg in Berlin in 1928, but continued these studies in USA. I may add that Emerson in turn was a professor of Govindjee, who joined his laboratory when these measurements were being concluded. Clearly, if two quanta were necessary to release each electron from water, there had to be a two-step process. This is how the two photosystems, PSI and PSII, with their independent reaction centres, P680 and P700, came in ultimately and the scheme began to be illustrated in all textbooks of biochemistry and of plant biology.

It is all fine and simple so far – work on the determination of quantum yield began in Berlin and concluded in USA. Yet, if we go back in the last century, all through from 1920s to around 1960s, a major controversy persisted among the investigators of photosynthesis (ironically, the controversy ended only with the death of one of the leading investigators). Warburg who initiated these studies in Berlin, maintained that only four quanta were required for the release of one oxygen molecule. The controversy, in principle, could have been due to complexity of measurements. Although oxygen evolution is relatively easy to measure by manometry, there are problems because of somewhat unusual behaviour of algae during transition from darkness to light and obtaining steady state of photosynthesis. Also, for determination of quantum requirement, the light that impinges upon photosynthesizing material and then absorbed must also be accurately measured using a bolometer or a thermopile. Quantum yield is obtained by dividing the number of oxygen molecules by all quanta absorbed and then determining the yield per quantum. The basic procedure was worked out by Warburg (he also devised the manometer); yet, he got values of around only four, whereas the American investigators who followed him in this research got average values of 8–10. The book under review provides a detailed and fascinating look into this controversy.



This interesting cartoon depicts beautifully the controversy between the 1931 Nobel-laureate Otto H. Warburg and his former student Robert Emerson. On the left, Emerson, wearing his lab apron, is telling us that a minimum of 12 quanta is needed for the evolution of one oxygen evolution, whereas Warburg, a well-dressed authority, is telling us that the number is 4, instead. In between the two combatants is the master of photosynthesis, Eugene Rabinowitch, also a member of the 'Midwest Gang' (in Warburg's eyes); he is shown here, carrying his brief case that has all the published papers on this topic, and is attempting to suggest a compromise between the two camps in this great controversy. We now know that this number is 8–12. Source of the Photo: Archives, Department of Plant Biology, University of Illinois, Urbana, Illinois, USA; photo and legend provided by Govindjee, a former student of Emerson, and an author of the book 'The Maximum Quantum Yield Controversy: Otto Warburg and the «Midwest-Gang»', reviewed here.

Even though in earlier days investigators were yet to accept the new equation of photosynthesis formulated after Ruben and Kamen's epochal work with H_2O, Warburg interpreted this to mean that there was just one photochemical reaction in photosynthesis and the process was highly efficient – the photosynthetic machinery could be considered a marvel of nature in terms of physical chemistry. The controversy between Emerson (joined by many other American workers) and Warburg is particularly poignant because there was the original teacher–taught relationship.

Few living investigators would have the background and knowledge to analyse this controversy. Warburg's publications were mostly in German. However, together, Nickelsen and Govindjee have gone at great length to study Warburg's original papers, and to explain how the great master of quantum yield determinations committed errors of judgement. There appear to be a number of reasons why Warburg got results so different. Certain paragraphs in the book are really too technical and require familiarity or experience with the Warburg manometry. But it appears that finally it was a matter of ego. Warburg was greatly impressed by the discovery by Einstein (then himself a Professor in Berlin) of the law of photochemical equivalence and the way Nature constructed cellular machinery. The four quanta requirement just fitted with the new discoveries and the laws of physics and chemistry then being made. And it is likely that Einstein's commanding presence (and his own father Emil Warburg's results on the quantum requirement in simple photochemical reactions) led Warburg to think of four quanta and defend his ideas till the last. The book throws much light also on the personality of this great investigator, who worked on both photosynthesis and respiration (cytochrome oxidase was discovered by Warburg; he was a Nobel Prize winner in Physiology or Medicine). Overall, one learns that despite many accomplishments, human beings have their weaknesses and stubbornness to give up old ideas. Actually, the controversy was never resolved between Warburg and the others across the Atlantic – it just came to an end with Warburg's demise in Berlin in 1970 – and acceptance by the rest of the world, of the model of two-light reactions, and two-pigment systems.

Not too long ago, I too had the opportunity of visiting Warburg's Institute in Berlin-Dahlem (it now houses the Archives of the Max Planck Society, which is the former Kaiser Wilhem Gesellschaft), and the book immediately brought back memories of my own pilgrimage there, touring also the office in which Warburg sat. I am delighted that Nickelsen and Govindjee have given such an absorbing and historically significant account with many photographs not only of Warburg but also of Emerson. I was personally thrilled to read about the involvement of Govindjee in this controversy, who himself became a member of the 'Midwest-Gang', when he along with his wife, Rajni Govindjee and Eugene Rabinowitch showed in 1968 that Emerson was right and Warburg was wrong, when they did the experiments with young synchronous cultures of the green alga *Chlorella* under 10% CO_2, conditions dictated by Warburg after Emerson's death. And lastly, in 1969, Warburg published, just before his death, a paper in the *American Journal of Botany* measuring 12 quanta per oxygen evolution, but calculating, in a hideous way, to mean the number to be 3–4, as was exposed by Govindjee in 1999.

I am sure many serious students of plant sciences will find this book most valuable. Once again, compliments to both the authors for this great piece of historical work. I recommend this book to all graduate students in science, and to all the major libraries in the world.

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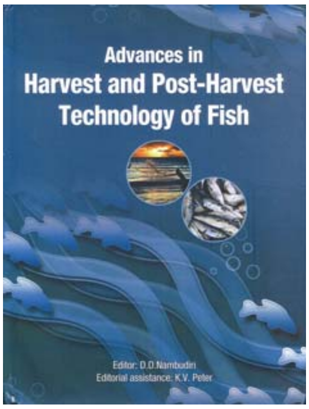

Advances in Harvest and Post-Harvest Technology of Fish. D. D. Nambudiri and K. V. Peter (eds). New India Publishing Agency, 101, Vikas Surya Plaza, CU Block, L.S.C. Mkt, Pitam Pura, New Delhi 110 088. 2012. xxiv + 444 pp. Price: Rs 2150.

The fisheries sector in India is growing rapidly compared to other agricultural sectors. This growth encompasses increased production from aquaculture and capture, diversification of processing methods, better storage, transportation and marketing. Increased attention of national financial planners to this sector has led to greater resource support for R&D, HRD and infrastructure development. While old establishments have got a fresh lease of life, establishments like the National Fisheries Development Board are already in place along with various new initiatives. This book has hit the shelves at the right time and is expected to come in handy for HRD institutions in India.

The book carries 400-plus pages, of which 15% has been devoted to harvest and does great justice to let readers know of the advances in navigation and safety equipments, on-board improved mechanization and advances in gear technology for responsible harvesting. The chapter on tuna harvesting and handling method could be helpful to students, since India is taking initiatives to harvest this untapped resource. The vessel-tracking system and other recent technologies related to the safety of the crew have got good mention in the book. The global concerns on responsible harvesting have probably prompted the editors to include a chapter entitled 'Technologies for responsible fishing'. Relevant measures to ensure long-term sustainability of aquatic resources outlined by FAO's CCRF article 8 have been described in this chapter. While India hardly harvests a quarter of its tuna resources and there are national and international initiatives to promote tuna utilization, the chapter entitled 'Tuna harvesting and processing technology' is useful.

Fish is valued as a food item basically for its proteins and health food for its fat. Two chapters, one on proteins and one on lipids describe the structure, function and nutritional importance. Though the chapters are complete in their own rights, they do not carry information on the recent advances. The chapter entitled 'Microbiology of fish spoilage' describes fish spoilage in great detail. The author has made a good attempt to relate different stages of spoilage with specific values of chemical, and bacterial parameters and organoleptic indicators. However, separating fresh fish spoilage from marine fish spoilage would have made better reading.

Among the chapters covering processed foods, frozen foods are conspicuously missing while surimi-based products, canned products and value-added products have found their respective places in the book. When majority of the exported products are frozen, and domestic market is warming up to frozen fish products, a chapter devoted to freezing technology would have further enriched the book. Surimi and surimi-based industries in India are slow-growing while the canning industry, though holds a lot of promise, is rather stagnated. Yet as a product category, canned food hold its turf. The advancement in the field is more on thermal processing of retortable pouch than that of rigid cans. Retortable pouch processing has not got any mention in the fish canning chapter. Aseptic packaging and flexible retortable pouch packaging are a few aspects for which readers may have to consult other books.

Markets of ready-to-eat and ready-to-cook products are fastest growing among the processed foods. Coated fish products have hit the market in the last couple of years and are doing exceedingly well. Fish processors want that students passing out from fisheries colleges be equipped with knowledge on these aspects before they join them. The chapter on coated products and the following chapter on value-addition heavily depend on surimi-based products. The editors could have done better in segregating the contents among the authors.