

## Books on “Plant Respiration”(1932-1960): From Walter Stiles to Felix Frost Blackman to W.O. James to Harry Beevers

Personal and informal notes of Govindjee ([gov@life.uiuc.edu](mailto:gov@life.uiuc.edu))

5 July 2004

### **W. Stiles and W. Leach (1932) Respiration in Plants. Methuen’s Monographs on Biological Subjects. Chemical Publication Company, Inc, 26 Court Street, Brooklyn, NY**

Walter Stiles and William Leach (1932) wrote in the *Preface* of their 124 page small (6 7/8 inch x 4 3/8 inch) book “*Respiration in Plants*”: “The supreme importance of respiration, being as it one of the most universal and fundamental process of living protoplasm, is recognized by all physiologists. In spite of this, students of botany frequently give respiration little more than a passing consideration. The curious state of affairs is largely due to the fact that most of the existing accounts of respiration in plants are unsatisfactory because they are either insufficiently comprehensive or insufficiently lucid.”

Stiles and Leach, after discussing at length respiratory quotients and respiration rates as a function of temperature, CO<sub>2</sub> concentration, of O<sub>2</sub> concentration (air, 100% or nitrogen), presented the then (1932) known mechanism of respiration. 143 references were cited—these included papers by F.F. Blackman, G. Embden, D. Keilin, S. Kostychev (also spelled as Kostyschew, who had a written a book on “Plant Respiration” in 1927\*), O. Meyehof, W. Palladin, P. Parija, M. Thomas, O. Warburg, H. Wieland, among others.

\*Plant Respiration. Authorized Edition in English. Translated and Edited by Charles J. Lyon. Philadelphia.

### **The Late F.F. Blackman (1954) Analytic Studies in Plant Respiration. The University Press, Cambridge, UK**

In 1954, G. E. Briggs (of Cambridge University; who later was a host to Robert Emerson when he had worked on his famous 1955 paper on the quantum yield of photosynthesis, Plant Physiology) published a 231 page (10 1/8 inch by 7 inch) book “*Analytic Studies in Respiration*” (Cambridge University Press, Cambridge) based on the notes and papers F.F. Blackman had left after his death in 1947. The contributions of J. Barker in assembling this book is recognized. The book has a nice portrait of Blackman.

Briggs wrote in his *Preface* “The experimental work on which the writings of Blackman are founded was done by one of his research students, P. Parija.” I find it

ironic and unusual that Briggs decided (although with the consent of Parija), not to put Parija's name on the book as a co-author. The book is authored by F. F. Blackman only, 7 years after his death in 1947. Having known the personality of Blackman through one of his other students, Shri Ranjan\*\*, I feel that Blackman would not have done it this way himself. Without the experimental work of Parija, Blackman's approach "the compulsion of theoretic possibilities pushed to their logical conclusion" would not have meant much.

The book contains 9 chapters and 2 appendices. (Strangely, none of the papers have any references!):

- Chapter I (The respiration of a population of senescent ripening apples, by F.F. Blackman and P. Parija (1928) Proc Roy Soc B 103: 412-439; pp 1-28, this book);
- Chapter II (The respiration of apples in nitrogen and its relation to respiration in air, by P. Parija (1928) Proc Roy Soc B 103: 446-471; pp. 29-54);
- Chapter III (Formulation of a catalytic system for the respiration of apples and its relation to oxygen, by F.F. Blackman (1928) Proc Roy Soc B 103: 419-517; pp. 55-81);
- Chapter IV (Formulation of the effects of low oxygen supply upon carbon dioxide production in apples, by P.Parija and F.F.Blackman; unpublished manuscript, although it was passed by Blackman for publication on 4 October, 1937 (pp. 82-105);
- Chapter V (The analysis of respiratory metabolism by the intensive study of the air ratio, no authors were mentioned, pp. 106-125);
- Chapter VI (The metabolic interpretation of the observed rates of carbon dioxide production; August, 1937; no authors were mentioned; pp. 126-135);
- Chapter VII (Examination of the physiological determinants of carbon dioxide production by apples in low concentration of oxygen; August, 1935; no authors were mentioned; pp. 136-156);
- Chapter VIII (The physiological determinants of carbon dioxide production by apples on low concentration of oxygen; 18 August, 1935; no authors were mentioned; pp. 157-188);
- Chapter IX (The interaction of factors controlling respiration and fermentation in the higher plants; a note by Blackman stated that a paper #IX on comparison with formulations of Meyerhof and Warburg for animal respiration had not yet been written, 27 July, 1935; pp. 189-217);
- Appendix I (pp. 218-229: Records of the primary data analysed in the nine chapters; no references); and
- Appendix II contains a list of 45 of Blackman's students (6 of them, from the Indian subcontinent, are italicized in the following list): L. Audus; J. Barker; H.R. Barnell; T.A. Bennet-Clark; L.R. Bishop; G.E. Briggs; J. Caldwell; R.E. Chapman; A.R.Clapham; E.J. Collins; N. Darwin; E.M. Delf; J.M.F. Drummond; *T. Ekambaram*; R.M. Ferguson; D.F. Forward; C.E. Foweraker; R.E. Girton; H. Godwin; C.S. Hanes; S.P. Hawkey; G.A.C. Herklots; A.C. Hulme; *R.S. Inamdar*; A.A. Irving; W.O. James; F. Kidd; E.J. Maskell; G.L.C. Matthaei; *P.Parija*; *Rafiq Ahmad Khan*; *Shri Ranjan*; E.R. Roux; *S.B. Singh*; A.J.M. Smith; F. Sumners; D. Thoday; E.G. Torrance; J.S. Turner; M. C. Vyvyan; D.T. Watson; and A.J. Wilmoth.

\*\*Note: Shri Ranjan was my professor of plant physiology when I was a student at Allahabad University (1952-1954); and was my research supervisor (1954-1956) when I was a Lecturer at Allahabad University.

## **W.O. James (1953) Plant Respiration. Clarendon Press, Oxford, UK**

W.O. James, one of Blackman's students, published a 9 2/4 inch x 6 1/4 inch 282 page book in 1953 (Oxford, At the Clarendon Press) "*Plant Respiration*". This book is divided into 10 chapters and contains a separate bibliography just as Stiles and Leach (1932) did.

- Chapter I discusses the respiring system where 'No life without respiration' is upfront (pp. 1-15);
- Chapter II presents a discussion on the rate of respiration and the temperature effects (pp. 16-39);
- Chapter III discusses respiratory drifts in detached leaves, detached roots, germinating seedlings, fruits and young and adult shoots (pp. 40-81);
- Chapter IV summarizes research on the respiratory quotient (changes with temperature, drifts and CO<sub>2</sub> fixation; pp. 82-97);
- Chapter V summarizes what is known on respirable materials (feeding experiments, analysis of carbohydrates; interconversion of the carbohydrates; pp. 98-117);
- Chapter VI focuses on glycolysis and describes the biochemical schemes in yeast & muscle systems as well as in higher plants (pp. 118-141);
- Chapter VII contains a discussion of oxygen effects (varying concentrations of O<sub>2</sub>; Blackman's hypothesis and Pasteur effects; pp. 142-178);
- Chapter VIII discusses all the oxidation-reduction mechanisms and the enzymes involved (dehydrogenases; oxidases; cytochromes; the ascorbic acid system, and the flavoproteins; pp.179-215);
- Chapter IX surveys oxidation steps in respiration, especially the terminal oxidases and the links between glycolysis and oxidation; finally; pp. 216-240); and
- Chapter X provides the connection between respiration and other processes (heat production and work; protein levels; photosynthesis; and salt uptake; pp. 241-257).

Finally, there is an extensive bibliography (pp. 258-276). Included are references, among others, to Harry Beavers (see his book, below); J. Bonner; Robert Emerson; F.F. Blackman and several of his students (J. Barker; H.R. Barnell; T.A. Bennet-Clark; G.E. Briggs; J. Caldwell; D.F. Forward; H. Godwin; C.S. Hanes; G.A.C. Herklots; A.C.Hulme; w.O. James; F. Kidd; G.L.C. Matthaei; P. Parija; S. Ranjan; E.R. Roux; A.J.M. Smith; D. Thoday; J.S. Turner; and D.J. Watson).

Personally, I am quite happy to note that the unpublished work of my professor in India (Shri Ranjan), who had been a student of Blackman, was discussed by James on pages 99-100 (Chapter 5) of the 1953 book. James wrote in his discussion on “respirable materials”: “A possible objection to the experiments of Spoehr and McGee [H.A. Spoehr and J.M. McGee, Carnegie Institute of Washington Publication # 325, 1923] is that their sugar solutions, although initially sterilized, may have become contaminated during the run of the experiments which lasted about 3 days. Ranjan [unpublished] used a technique which made contamination less likely. He kept detached cherry-laurel leaves on water until their respiration rate was slow and more or less constant. He then weighed the leaves and vacuum infiltrated them with sugar solutions, afterwards drying the surfaces and weighing again to obtain the amount of solution injected. Leaves injected with sugar solutions showed additional CO<sub>2</sub> –production over those injected with water. The effect was temporary and all returned after varying times to the same rate of CO<sub>2</sub> –emission. Positive and closely similar results were obtained with sucrose, glucose, and fructose; maltose and lactose had little effect and mannose proved strongly toxic. The amount of extra CO<sub>2</sub> production due to any of the three sugars increased until the internal sugar concentration was raised to about 1.5 percent. of the leaf fresh weight; further increases to 4 percent. made no difference. Of the sugars injected, one-tenth to one-third was recovered as additional CO<sub>2</sub> by the time the output returned to normal, the remainder apparently being built into the leaf reserves.”

## **H. Beevers (1960) Respiratory Metabolism in Plants. Row Peterson in Plants, Evanston, IL**

Harry Beevers (of Purdue University) published, in 1960, his 5 3/8 inch x 8 2/8 inch 232 page book “*Respiratory Metabolism in Plants (Row Peterson and Company, Evanston, IL)*”. From today’s vantage point, it might be considered the first modern book on plant respiration. In this book, Beevers reviewed the then available knowledge of respiratory metabolism in plants for advanced undergraduate and graduate students. Its emphasis was on the biochemical events of respiration in higher plants. The book has an Introduction, followed by Part I (The Respiratory Mechanism: Chapters 2-6), an Part II (Relationship of Respiration to Other Processes in the Plant: Chapters 7-12) :

- Chapter 1 (Introduction; pp. 1-12);
- Chapter 2 (The initial stages of glucose metabolism; pp. 13-44);
- Chapter 3 (Tricarboxylic acid (TCA) cycle: The utilization of pyruvate; pp. 45-64);
- Chapter 4 (Electron transfer and oxidase systems; pp. 65-118);
- Chapter 5 (The energetics of respiration; pp. 119-129);
- Chapter 6 (Intracellular localization of respiratory enzymes; pp. 130-146);
- Chapter 7 (The internal regulation of respiratory rates; pp. 147-160);
- Chapter 8 (Respiration in relation to solute transfer; pp.161-176);
- Chapter 9 (Relationship to nitrogen metabolism; pp. 177-184);
- Chapter 10 (Relationship to growth; pp. 185-197);

- Chapter 11 (Relationship to photosynthesis; pp. 198-206);and
- Chapter 12 (Relationship to fat metabolism; pp.207-220).

All of the chapters have references. The book has 26 tables; a list of abbreviations in the very beginning; 29 illustrations; and an Index.

I am particularly pleased with the discussion on the relationship of respiration with photosynthesis. Beevers discussed the work of Melvin Calvin; James Bassham; Martin Gibbs; Dan Arnon; N.E. Tolbert; Otto Kandler; Otto Warburg; R.H. Burris; Allan Brown; E. Kessler; R.G.S. Bidwell; G. Krotkov; and I. Zelitsch, among others. Further, in his introductory chapter, Beevers did cite the three books (by Stiles and Leach (1932); Blackman (1954); and James (1953) that I have just described above.

Note that Harry Beevers did his Ph.D. in New Castle in 1947, and had worked with W.O. James. Thus, there is a connection between Blackman, James and Beevers.