Looking Back at Mendel's Discovery

Fundamenta Genetica. The Revised Edition of Mendel's Classic Paper with a Collection of 27 Original Papers Published during the Rediscovery Era. Selection and commentary by JAROSLAV KRIZENECKY with an introduction by BOHUMIL NEMEC. Czechoslovak Academy of Sciences, Prague, 1965. 400 pp., illus.

Iconographia Mendeliana. Moravian Museum, Brno, Czechoslavakia, 1965. 73 pp., 119 figures. $7.00.

The Origin of Genetics. A Mendel Source Book. CURT STERN and EVA R. SHERWOOD, Eds. Freeman, San Francisco, 1966. 197 pp., illus. Cloth, $4.50; paper, $2.25.

A Short History of Genetics. The Development of Some of the Main Lines of Thought, 1864–1939. L. C. DUNN. McGraw-Hill, New York, 1966. 285 pp., illus. Cloth, $7.50; paper, $3.95. Reprint, 1965 edition.

G. Mendel Memorial Symposium, 1865–1965. Proceedings of a symposium held in Brno, August 1965. MILAN SOSNA, Ed. Czechoslovak Academy of Sciences, Prague; Werner Flach, Frankfurt, Germany, 1966. 311 pp., illus.

Heritage from Mendel. Proceedings of the Mendel Centennial Symposium, Fort Collins, Colorado, September 1965, sponsored by the Genetics Society of America. R. ALEXANDER BRINK and E. DEREK STYLES, Eds. University of Wisconsin Press, Madison, 1967. 467 pp., illus. Cloth, $10; paper, $2.95.

In 1865 Gregor Mendel first reported, and in 1866 he published, his discovery of what are at present known as Mendel's laws of heredity. Centennials of these events were commemorated in many countries, including Mendel's native Czechoslovakia and the United States. The U.S.S.R. had shaken off the Lysenkoist nightmare just in time to honor Mendel's centenary. Several books have been published dealing with Mendel and his heritage. Some are mainly collections of historical documents relevant to Mendel's discovery, its subsequent neglect, and its rediscovery in 1900. Among these are: *Fundamenta Genetica,* a collection of papers, including Mendel's, edited by Jaroslav Krizenecky and Bohumil Nemec; *Iconographia Mendeliana*; and *The Origin of Genetics,* a collection of papers and letters, edited by Curt Stern and Eva R. Sherwood. L. C. Dunn's *A Short History of Genetics* deals with genetics chiefly from Mendel on. And finally, two books are proceedings of symposia held in Czechoslovakia and in the United States, respectively, which attempted to present panoramas of genetics as it is today. The *G. Mendel Memorial Symposium 1865–1965,* edited by Milan Sosna, includes papers by 43 authors (36 Europeans, six Americans, one Pakistani). Twenty-eight authors (14 Europeans, 12 Americans, two Japanese) have contributed to *Heritage from Mendel,* edited by R. Alexander Brink and E. Derek Styles.

Barring unexpected discovery of some lost documents, the published materials are probably all the information about Mendel and his work that will ever be available. He emerges as one of the tragic, and in some ways puzzling, figures in the history of science. C. Zirkle (in the symposium edited by Sosna) says that "Any historian of science, who investigates the pre-Mendelian descriptions of heredity, can discover with very little effort that every single discovery of Mendel's had been made earlier and that some of them had been made many times. No one before Mendel, however, ever put the discoveries together and no one ever saw their significance." And no one who read Mendel's publication saw its significance either, until de Vries, Correns, and Tschermark "rediscovered" Mendel in 1900. This purblindness is least comprehensible in Carl Nägeli, who was the foremost authority on plant hybrids and to whom Mendel not only sent his publications but also wrote, between 1866 and 1873, several (ten) very dignified and, at least in retrospect, pathetic letters (printed in translation in Stern and Sherwood's book and commented upon in Dunn's) explaining his ideas. Nägeli's letters have not been preserved and are known only through references in Mendel's replies. The blindness of his contemporaries makes all the more impressive the depth of Mendel's insight, his brilliant planning of the experiments, the perceptive analysis of the results, and a clear apprehension of the causal nexus which these results revealed. Though not a professional scientist, Mendel was evidently familiar with the biological science of his time, including the books of Darwin. His experiments on the hybridization of peas, as well as the unpublished experiments on hybridization of mice of different coat colors, were, however, begun well before the appearance of Darwin's classical work (1859) and could by no stretch of imagination have been inspired by Darwin. Nor did Mendel send a reprint of his paper to Darwin; speculations on "what might have been" if Mendel had communicated with Darwin instead of with Nägeli are amusing but hardly profitable.

There is no doubt that Mendel had a perfectly clear idea of the significance of his results for the theory of heredity (though probably not for the theory of evolution). At least towards the conclusion of his experiments on peas, he knew what these experiments were expected to yield. And this may have led to unfortunate mistakes. Analysis by R. A. Fisher of Mendel's numerical data on the segregation ratios in the pea crosses (reprinted by Stern and Sherwood with further remarks by Sewall Wright; also commented upon in Dunn's book) disclosed that the observed ratios fit the expected ones far better than sampling errors would seem to make plausible. Mendel has accordingly been accused, at least implicitly, of fraud and deliberate falsification of the data. Since Darwin has also in recent years been accused of conscious plagiarism, Mendel is surely in good company! A variety of explanations to exonerate Mendel from this monstrous accusation have been suggested by Fisher himself and by the other authors mentioned above. One explanation is that Mendel had an unknown helper in his experiments, who did the cheating to please Mendel. This is possible, but I believe that a far simpler explanation is at least as plausible. Few experimenters are lucky enough to have no mistakes or accidents happen in any of their experiments, and it is only common sense to have such failures discarded. The evident danger is ascribing to mistakes and expunging from the record perfectly authentic experimental results which do not fit one's expectations. Not having been familiar with chi-squares and other statistical tests, Mendel may have, in perfect conscience, thrown out some crosses which he suspected to involve contaminations with foreign pollen or other accidents. Had he known how punctiliously his paper would be scrutinized many years after his death, he might have published a far more detailed record of his experiments, with all the

real and assumed mistakes duly included! Mendel was able to recognize and acknowledge results that did not fit his theory when he accepted Nägeli's advice to use the hawkweeds, *Hieracium*, instead of peas for his experiments. The advice was disastrous, because neither Nägeli nor Mendel knew the fact, discovered half a century later, that the hawkweeds frequently produce seeds by parthenogenesis (apogamy) rather than by sexual crossing.

A fine collection of original papers of the pioneers of Mendelism in the early years following the rediscovery (de Vries, Correns, Tschermak, Bateson, Castle, Cuenot, Garrod, Boveri, Wilson, Sutton, Cannon, McClung) are found, in the original languages and with the original pagination indicated, in the Krizenecky-Nemec volume. Critical discussions of these formative years are given in the introductory part of the Sosna volume and in Dunn's book.

In his book, Dunn, approaching more recent history, of course uses a broader canvas: part 3 of the book is entitled The Theory of the Gene: 1910–1939, and among its chapters are: Genetics in 1939—Mileposts of Progress, The Cytological Basis of the Chromosome Theory, Cytogenetical Analysis, The Experimental Study of Mutation, The Physiology of the Gene, Development and Genetics, The Rise of Population Genetics, and Concluding Reflections. Taking 1939 as a cutoff point is admittedly arbitrary but, as Dunn writes, "by this time the theory of the gene had taken on a more general character. The gene had become an essential term in describing continuity, function, evolution. This expansion in the range of phenomena encompassed by the idea, much greater than could have been foreseen in 1900, had been accomplished by about 1939 without losing the fundamental unity implicit in the original concept of the gene." Nevertheless, Dunn adds a short Postlude: Old and New in Genetics, which sounds almost like a preface to what a historian of genetics might write some decades hence.

The two Mendel memorial symposia contain a great variety of articles, ranging from historical essays to critical reviews of certain problems to descriptions of original research. Only some of the highlights can be mentioned, in full realization that their selection is an arbitrary procedure. In Sosna's volume, Dubinin discusses Some Cardinal Problems of the Contemporary Theory of Mutations, and there are papers by F. Jacob on Génétique Cellulaire chez les Bactéries, C. H. Waddington on Mendel and Evolution, I. M. Lerner on Mendelism and Animal Breeding, and C. Stern on Mendel and Human Genetics. In the Brink-Styles volume one finds Genes and Gene Complexes, by E. B. Lewis, Properties of Genes, by M. Demerec, An Experimental Analysis of the Genetic Code, by Matthaei and co-workers, The Operon, by Buttin, Jacob, and Monod, Gene Action at the Level of the Chromosome, by W. Beermann, Human Populations, by L. L. Cavalli-Sforza, The Evolutionary Integration of the Genetic Material into Genetic Systems, by T. M. Sonneborn, and, finally, H. J. Muller's valedictory address The Gene Material as the Initiator and the Organizing Basis of Life. Neither symposium, nor both together, can be said to give an inclusive overview of modern genetics; this is not intended as a criticism, since probably no symposium can be organized to accomplish that much. What the collection of books here reviewed does show is how some geneticists viewed the history and the state of their science a century after Mendel's discovery.

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History of Physics

Sources for History of Quantum Physics. An Inventory and Report. THOMAS S. KUHN, JOHN L. HEILBRON, PAUL FORMAN, and LINI ALLEN. American Philosophical Society, Philadelphia, 1967. 190 pp. $5.

This is an inventory of about 100 tapes of interviews with leading quantum theoreticians and of about 100 microfilms full of data and of biographical sketches littered with references. Copies of these sources are available in Philadelphia and in Berkeley. The rest is a brief technical report and a sample. The compilers honestly describe the shortcomings of their work and confess inability to assess its future usefulness. As is often the case with hastily collected material, selection will be the chief problem of future users.

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Books Received

Absorption Spectra in the Ultraviolet and Visible Region. vol. 7. L. Lang, Ed. Academic Press, New York, 1967. 412 pp. Illus. $23.

Abstract Algebra. Andrew O. Lindstrum, Jr. Holden-Day, San Francisco, 1967. 223 pp. $9. Series in Mathematics.

The Actinomycetes: A Summary of Current Knowledge. Selman A. Waksman. Ronald, New York, 1967. 286 pp. Illus. $12.

The Admiralty Chart: British Naval Hydrography in the Nineteenth Century. G. S. Ritchie. Elsevier, New York, 1967. 400 pp. Illus. $15.

Advances in Clinical Chemistry. vol. 9. Harry Sobotka and C. P. Stewart, Eds. Academic Press, New York, 1967. 422 pp. Illus. $16. Six papers.

Alcoholism. David J. Pittman, Ed. Harper and Row, New York, 1967. 286 pp. Paper, $3.75. Readers in Social Problems Series. Seventeen papers.

America's Natural Resources. Charles H. Callison, Ed. Ronald, New York, ed. 2, 1967. 228 pp. $5. Eleven papers.

Analysis Instrumentation. vol. 4. Proceedings of the Twelfth Annual Analysis Instrumentation Symposium (Houston, Tex.), May 1966. Lewis Fowler, Raymond G. Harmon, and David K. Roe, Eds. Plenum Press, New York, 1967. 246 pp. Illus. $17.50. Twenty-five papers.

Analysis of Engineering Cycles. R. W. Haywood. Pergamon, New York, 1967. 292 pp. Illus. $6.50. Commonwealth and International Library.

The Analysis of Silicates. I. A. Voinovitch, J. Debras-Guedon, and J. Louvrier. Translated from the French by R. Kondor. E. Seijffers, Translation Ed. Israel Program for Scientific Translations, Jerusalem; Davey, New York, 1967. 397 pp. Illus. $24.

Analytical Trigonometry. Thomas J. Robinson. Harper and Row, New York, 1967. 198 pp. Illus. $6.

The Anatomy of Achievement Motivation. Heinz Heckhausen. Translated from the German by Kay F. Butler, Robert C. Birney, and David C. McClelland. Academic Press, New York, 1967. 235 pp. $5.95. Personality and Psychopathology Series.

Annual Review of Medicine. vol. 18. Arthur C. De Graff and William P. Creger, Eds. Annual Reviews, Palo Alto, Calif., 1967. 567 pp. Illus. $8.50.

Another View of the City. A chronicle of a heritage besieged. Russell Peterson. McGraw-Hill, New York, 1967. 236 pp. Illus. $6.50.

Applied Stress Analysis. A. J. Durelli. Prentice-Hall, Englewood Cliffs, N.J., 1967. 196 pp. Illus. $12. Civil Engineering and Engineering Mechanics Series.

Astronomischer Jahresbericht. vol. 65, *Die Literatur des Jahres 1965.* W. Lohmann, F. Henn, and U. Güntzel-Lingner, Eds. De Gruyter, Berlin, 1967. 760 pp. Paper, 80 DM.

Autoimmunity: Clinical and Experimental. J. R. Anderson, W. W. Buchanan, and R. B. Goudie. Thomas, Springfield, Ill., 1967. 501 pp. Illus. $19.50.

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