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OF

EDWARD MURRAY EAST

1879–1938

BY

DONALD F. JONES

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Edwin East

EDWARD MURRAY EAST

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BY DONALD F. JONES [1]

Since Edward Murray East was one of the world's distinguished students of heredity, it seems especially appropriate to begin a review of his life with a consideration of his hereditary background.

There is a tradition in the East family that Sir Isaac Newton was numbered among the collateral ancestors, but this is difficult to prove, since his grandfather, Isaac Newton East, left his home in boyhood and spoke but little of his people. There is, at least, no doubt that the distinctive name recurs in several generations, also the name of William Harvey, showing an interest and appreciation of men of science. On his mother's side the immigrant paternal ancestor was Matthew Woodruff, who in 1640 was a member of the colony which established Farmington, Connecticut. A great uncle, Ebenezer Bushnell, was a Congregational minister and an administrative officer in Western Reserve University. The biographer and poet, William Sloane Kennedy, was a cousin once removed on his mother's side. East's father, William Harvey East, was a man of considerable mechanical ability who studied mechanical engineering at the University of Illinois in 1875-1876 and later worked as a machinist, a manufacturer of machinery and chief engineer for a clay products firm. William Harvey East married Sarah Granger Woodruff; their only son, the subject of this sketch, was born at Duquoin, Illinois, on October 4, 1879.

With such an hereditary background, it is not surprising that East should have become interested in creative and scholarly pursuits or that the mental energy, the independence of thought

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and the strong desire for perfection, which characterized his later life, should have been foreshadowed in his ancestry and anticipated in his own precocious childhood. At an age when the majority of children were using the traditional childhood alphabet blocks for toys, young East was already framing words with the letters embossed upon them. Later he had the inevitable boyish collection of birds' eggs, but he also possessed, and studied diligently, a comprehensive treatise on birds purchased with money which he had earned by working in a grocery store during a summer vacation. Like many boys of his age, he eventually acquired a .22 rifle, but few ever became so expert as he as a marksman.

East finished high school at the age of fifteen and for two years worked in a machine shop. Here he became proficient in mechanical drawing and shop methods and gave evidence of inventive ability. After earning enough money to start in college he entered the Case School of Applied Science in Cleveland in 1897, partly because of a family interest there. He often mentioned to his own students, the mathematics professor at Case School who gave him a grade of zero on an examination paper because he had made a single error, explaining that a bridge or other mechanical structure with only one error in design might easily be worthless. This apparently made a deep impression upon him and may well have been a factor in the care which he always exercised in verifying all important statements of fact and in his insistence that his students maintain a high degree of accuracy. It should be noted, however, that his concept of accuracy was a flexible one. He avoided refinements in measurements which would be cancelled by the experimental error and he also quoted, at appropriate moments, a statement of a former chemistry instructor that "there is little to be gained by weighing a ton of hay on an analytical balance".

Finding that his interests were more in general science than in applied mechanics, he transferred, after one year at the Case School, to the University of Illinois. From this institution he received the degree of Bachelor of Science in 1900, Master of Science in 1904 and Doctor of Philosophy in 1907. His Master's thesis was based on chemical and bacteriological studies on

the self-purification of running streams. While working on this subject he devised an original method for obtaining samples of water.

Trained as a chemist, East became actively interested in genetics as a result of a combination of circumstances which deserve a brief review. Investigations in animal nutrition were being actively pursued at the turn of the century. Nutritive ratios were in the forefront and research in nutrition centered upon the proper balance of carbohydrates, fats and proteins. Indian corn, the great American feed crop, was usually deficient in both proteins and fats, but showed great variability in chemical composition. As early as 1892 Jenkins and Winton at the Connecticut Agricultural Experiment Station had compiled analyses of American feeding stuffs and showed that the corn kernel ranged from 8.2 to 17.0 per cent in protein content. Variations in fat content were also apparent. These wide variations, considered in connection with the notable success which had been attained in Europe in selecting beets for higher sugar content, suggested strongly that the chemical composition of corn might be considerably improved by breeding. Experiments to accomplish this, to alter the protein and fat content of corn, were begun at the Illinois Agricultural Experiment Station by C. G. Hopkins about 1900.

East's first scientific position was that of assistant chemist in Hopkins's laboratory. It was his job to make chemical analyses of the samples of corn involved in the selection experiment. This task he performed with accuracy and efficiency, but with little satisfaction to himself. He realized that the analyses, as such, served an important end; but that they were only tools in an experiment of considerable significance, and he was eager to understand the meaning of the results which were being obtained. Fortunately for him and for the infant science of genetics, his curiosity was kindled at a propitious time.

Long before the rediscovery of Mendel's laws of heredity Balzac had written that "heredity is a sort of maze in which science loses itself", but in 1865 an unknown Austrian monk published in an obscure journal the results of his classical experiments on heredity in peas. Overlooked by the majority of

scientists of the period, completely overshadowed by Darwin's epoch-making "Origin of Species", and as East himself later pointed out, presented to the scientific world before it was prepared to grasp its significance, Mendel's work lay dormant for thirty-five years. Its rediscovery came at a time when interest in heredity, as an evolutionary mechanism on the one hand, as the basis of plant and animal improvement on the other, was at a high pitch. An "International Conference on Hybridisation and on the Cross-breeding of Varieties" had been held in England in 1899. The American Breeders' Association was founded at a meeting held in St. Louis in 1903 in connection with the American Association for the Advancement of Science. Its second meeting was held at the University of Illinois in February, 1905. Among the list of members appears the name of E. M. East.

The Illinois experiments on altering the chemical composition of corn attracted widespread attention. And nowhere, perhaps, were they followed with greater interest than at New Haven, where much of the pioneer American research in nutrition had been conducted by the Connecticut Agricultural Experiment Station in close collaboration with Yale University. It was only natural that E. H. Jenkins, a chemist, when he became Director of the station and decided to expand the work in plant breeding should have thought in terms of improving chemical composition. It was only natural, too, that he should have asked Hopkins to recommend a young man to undertake the new work. East was recommended, accepted the appointment, and came to New Haven in the fall of 1905.

Although East spent only four years in residence at the Connecticut station, these years were, from the standpoint of research, the most productive in his life. He carried on intensive studies on three economic plants, the tobacco, potato, and maize.

His work with potatoes was largely devoted to a study of variation in a vegetatively propagated plant. Part of the results were incorporated in a thesis submitted to the University of Illinois in completion of the requirements for the Doctorate and later published as a bulletin of the Illinois station. Other papers

on inheritance in potatoes appeared in an annual report of the Connecticut station and in the American Naturalist.

His early work on tobacco, although largely of a practical plant breeding nature, laid the foundation for his later genetic research on species of Nicotiana in which he made numerous important contributions.

His most far-reaching experiments of this period were those on maize. It was during this period that he began the study of mendelian characters in maize, the results of which were published with H. K. Hayes in 1911 as a bulletin of the Connecticut station entitled "Inheritance in Maize", one of the classics in the early literature of genetics. It was in maize, too, that he discovered independently of Nilsson-Ehle, the phenomenon now known as multiple factors which, as East recognized almost immediately, provide an orthodox mendelian interpretation for quantitative or "blending" inheritance, then still regarded by many biologists as a separate category of inheritance.

From the standpoint of both theoretical interest and subsequent significance to plant improvement, perhaps East's most important work during his brief stay in New Haven was that upon the effects of inbreeding and cross-breeding. Even before he left Illinois, East had become interested in this subject, for it had become apparent in the Illinois selection experiments that increases in protein and oil content, resulting from selection, were being accompanied by decreases in yield. East suspected that this might be the result of inbreeding for although the plants were not being self-pollinated, intensive selection was constantly narrowing the network of descent. He urged Hopkins to undertake an experiment on the effects of inbreeding in corn. Unsuccessful in this, he, characteristically, initiated some experiments of his own. The records of the dates at which these early experiments on self-fertilization were started are conflicting. A statement in one of his papers in the American Naturalist would indicate that the first selfings were made in 1904. A report in one of the Connecticut Station Bulletins would suggest that they were made in 1905. In any case, the experiments were begun in Illinois and were continued in Connecticut. The first crosses between inbred strains were grown in 1908, and his

first paper on the subject was published in 1908, a second in 1909, and a third with H. K. Hayes in 1912. The experiments were continued by H. K. Hayes and later by D. F. Jones. East never lost his interest in the subject of inbreeding and cross-breeding. His first book "Inbreeding and Outbreeding" published in 1919 with D. F. Jones was on this subject. One of his last papers "Heterosis" published in 1936, was on the same general subject.

The experiments of G. H. Shull at the Carnegie Institution, Cold Spring Harbor, those of E. M. East at the Connecticut station, and other investigators were destined to lead eventually to the development of a radically new method of corn breeding which has had revolutionary effects upon American agriculture. In 1943 more than 50 million acres, approximately half of the corn acreage in the United States, was planted to hybrid corn produced by combining inbred strains.

East's part in the development of hybrid corn is an important one. His investigations with self-fertilized maize were begun on his own initiative to study the effects of inbreeding. He was familiar with the work of Darwin in England and the early corn hybridizers at the Illinois Experiment Station. He was interested primarily in the theoretical interpretation of the reduction following inbreeding and the increased growth resulting from crossing. In his first publications on this subject: "Inbreeding in Corn" (1908) and "The distinction between development and heredity in inbreeding" (1909) he outlined clearly the problem and proposed the stimulation hypothesis to account for hybrid vigor. According to this idea the injurious effects of inbreeding did not keep on accumulating but merely accompanied the isolation of individuals with different genetic constitution and ceased with the attainment of complete homozygosity. This conception he developed more fully with H. K. Hayes in "Heterozygosis in evolution and in plant breeding" (1912) and with D. F. Jones in "Inbreeding and Outbreeding'" (1919). Later his ideas on this subject were developed further in a conception of an interaction between alleles and were published in 1936 under the general title of "Heterosis". His vigorous writings and clear presentation of experimental evidence from both corn

and tobacco did much to stimulate interest in the subject and its application to practical plant breeding.

The idea of crossing inbred strains of corn, first proposed by G. H. Shull, did not appear to him to be a practicable method for corn improvement. In a footnote to the American Naturalist paper (1909, p. 180) East says: "his method is more correct theoretically, but less practical than that of the writer." East proposed the crossing of selected strains or varieties that had not been reduced to uniformity. This was a slight modification of the method of crossing varieties previously suggested and tried by several investigators many years before, but which had not led to any important commercial utilization.

Correspondence between East and Shull shows clearly the part that both have had in developing the theoretical basis for hybrid corn. Shull's paper on "The composition of a field of maize" was read at the meeting of the American Breeders' Association held at Washington, D. C., January 28-30, 1908. East attended that meeting and wrote Shull as follows:

New Haven, Connecticut,
February 5, 1908.

Dr. George H. Shull,
Station for Experimental Evolution,
Cold Spring Harbor, Long Island, New York.

MY DEAR DR. SHULL:

Would it be possible for you to let me read a copy of your interesting paper on maize, if you have a duplicate of it? The published report of the American Breeders' Association will probably not be issued before next fall. I should like to study your results before spring planting, if possible.

Thanking you in advance for this favor, I am,

Very truly yours,

(Signed) E. M. EAST.

February 12, 1908.

DEAR DR. SHULL:

I am returning under separate cover, the copy of paper on corn breeding, which you so kindly let me have. I have had a copy made which I shall keep. Since studying your paper, I agree entirely with your conclusion, and wonder why I have

been so stupid as not to see the fact myself. . . . I expect to quote from your paper and add some data of my own in a forthcoming report from this station, also to obtain more data upon the subject this summer in connection with some corn crossing experiments.

Very sincerely yours,

(Signed) E. M. EAST.

To this letter Shull replied:

Santa Rosa, California,
March 3, 1908.

DEAR DR. EAST:

Your favor of Feb. 12, enclosing the copy of my paper on corn breeding was received before I left Cold Spring Harbor. I am glad to find that your extensive experiments in corn breeding might have led you to the same conclusion as that at which I have arrived, and that you are going to base your experimentation to some extent upon this view. I am convinced that there is a wide open field here which has not been touched heretofore. There is little doubt in my mind that if I had held on to my idea of the composition of a field of corn until I could have worked out some of the subsidiary problems, I could have raised a monument to myself which would be worthy to stand with the best biological work of recent times. But the matter seemed to me of too great importance in view of the value of our maize crop to selfishly keep it to myself longer than was necessary to assure myself of its correctness.

Very sincerely yours,

(Signed) GEO. H. SHULL.

In June, 1908, East visited Shull at the Station for Experimental Evolution at Cold Spring Harbor and they went over together the evidence Shull had obtained that self-fertilization merely separated out pure lines which were inferior because they lacked the stimulating effect of a heterozygous condition. As a result of his 1908 experiments Shull prepared a paper on "A pure-line method in corn breeding," which was read at the meeting of the American Breeders' Association at Columbia, Missouri, early in January, 1909 and published in volume 5 of the proceedings.

Under date of February 4, 1909, East wrote to Shull as follows:

Dr. George H. Shull
Station for Experimental Evolution
Cold Spring Harbor, Long Island, N. Y.

DEAR DR. SHULL:

I hasten to answer your letter which I received yesterday enclosing the article which you read at the January meeting of the American Breeders' Association. I did not know that you were continuing this work as you told me in the summer that you did not have land enough to carry on things as you wished and should be glad if the work was taken up in other places. You know that I have had work going on since 1902 studying crosses and self-fertilized maize, but your article of last year gave me the idea which I was not bright enough to see for myself, namely, that self-fertilization was bringing out the homozygous characters.

The receipt of your article rather surprises me, as early in January I had sent an article to the American Naturalist coming to somewhat the same conclusions as you have. I enclose a carbon copy of this article, but I should be glad to have it returned, if this is not asking too much. In this article I thought that my idea of the distinction between deterioration due to the recombination of hereditary characters, and that due to the depriving of the homozygote of the stimulation due to the cross was a new idea. I rather believe from reading your second paper that you have something of the same idea, but you did not express it in your first paper, and do not make the statement clear in your second paper, which rather surprised me, for if you have this idea it seems to me it is the most important part of the whole matter. From the experience that I have had in pedigree breeding, I feel that the method I have outlined will be much more practical than the one you have outlined in your paper, for this reason, that no matter how the line breeders of the Middle West are selecting, they are in reality inbreeding. I have followed a number of varieties, and pedigrees invariably trace back to a single ear, in from four to six years from the start. The very methods of the so-called corn judge, with the great stress that he gives to uniformity, tend to inbreeding. The method I have outlined is the method for the corn grower,—not the corn breeder.

I wish you could have a little experience trying to get the farmers to take up anything in the least complex, and I know you would agree with me that only the very simplest things can be done by the corn grower. I should be glad to know whether

your idea of the theory in this matter is the same as I have expressed in this article. . . .

Very truly yours,

(Signed) E. M. EAST.

Shull's reply to this letter was in part:

". . . I care very little for the question of priority. What we are most concerned in is the *triumph* of the *truth* and especially of *useful* truth, and it is very gratifying to me that you should find in your extensive and careful experimentation the evidence which has led you to the conclusions so well presented in this paper. . . . You must have misunderstood me in the summer, if you thought I was expecting to abandon my corn experiments. I am going on with them and each year that they are continued makes them more valuable. But just as I told you, I am so limited by considerations of space and my own strength that I must continue them on the relatively small scale I have been using in the past, and cannot branch out onto the questions having purely practical bearings. These seemed to call for larger experiments than I can conduct here, and I hoped for this reason to be able to interest the Agricultural stations in the matter."

And finally on February 9, East sent this note:

". . . I freely admit that your paper of 1908 [The Composition of a field of maize] gave me the first idea of inbreeding separating the biotypes and that on this hinged the whole matter. The later paper is its logical conclusion. . . [Dr. Jenkins] came into my office on the day I received your first paper and I was happy as a lark and told him Dr. Shull had just sent me a paper that gave us the "hunch" we had been wanting about our inbred corn plants. . . ."

About this time, or soon after, East received the offer to go to Harvard University, which he did in the autumn of 1909. There his interests centered on his Nicotiana investigations. After an early attempt to interest some of the western seed corn producers in the production of first generation hybrid seed he gave less attention to the applied phases of this problem, turning this over to Dr. H. K. Hayes who succeeded him at the Connecticut Experiment Station, working under his direction and studying at Harvard University. At this time investigations dealing with selection in self-fertilized lines were begun using both maize and tobacco. The book on inbreeding and outbreed-

ing, published many years later, was outlined as early as 1912.

East was appointed Assistant Professor of Plant Morphology at the Bussey Institution of Harvard University. This institution, originally established in 1871 as an undergraduate school of agriculture, was reorganized in 1908 for research and advanced instruction in subjects related to agriculture and horticulture, and in 1915 became the Graduate School of Applied Biology. Its faculty comprised a small but distinguished group of biologists including William Morton Wheeler, William E. Castle, I. W. Bailey and others. East's appointment to the Bussey faculty came largely as a result of a recommendation by Professor William Bateson of the University of Cambridge, England's pioneer geneticist, who had become acquainted with East and his work while giving the Silliman Lectures at Yale University. East was promoted to Professor in 1914, and his title was changed to Professor of Genetics in 1926. In the interval he was offered appointments in a similar field at Cornell University and Princeton University, as well as the presidency of one of the state agricultural colleges.

During the years 1908 to 1918 he collaborated in tobacco breeding investigations with the Bureau of Plant Industry of the United States Department of Agriculture, and continued for a number of years to act in an advisory capacity to the Connecticut Agricultural Experiment Station and followed the investigations there with keen interest. He had the greatest admiration and respect for Dr. E. H. Jenkins, director of the Connecticut Experiment Station, who was always ready with encouragement and advice during those first years when East was working to establish a name for himself in the scientific field.

At the Bussey Institution, East's interest in research continued unabated. He amplified the studies, initiated at New Haven, on inheritance of quantitative characters and published several papers which are still widely cited in genetic text-books, and which have served as models for much of the subsequent work in this field of genetics. His interpretation, together with that of Nilsson-Ehle, of the inheritance of quantitative characters on the basis of multiple, cumulative factors brought all heredity under the consistent principle outlined by Mendel.

He began the studies, to which he was to devote many years, on the genetics of self-sterility in plants and its evolutionary and physiological significance. These studies resulted finally in the concept of oppositional alleles. The idea was first proposed by A. J. Mangelsdorf who was at that time a graduate student and assistant. This was firmly established by East's extensive investigations and brought order in a chaotic and conflicting mass of observations upon many different plants and animals. His last paper, published posthumously, was devoted to a survey of the distribution of self-sterility in flowering plants. He made a series of studies on the genetics and other biological aspects of species hybrids in Nicotiana and Fragaria. The versatility of his interests included microscopic studies of cell morphology, immunological reactions in plants, and studies at the Harvard Botanical Gardens in Cuba in collaboration with Dr. W. H. Weston, on virus diseases.

But although his investigations during nearly 30 years at Harvard were extensive, versatile in scope, and productive, they appear, in perspective, to have been overshadowed by his influence as a teacher. As a class-room teacher he was not an unqualified success. His course in genetics at Harvard was never especially popular with undergraduate students, although he devoted much time and effort to it and capable students often got more from his lectures than from those of others at the time more popular. But with graduate students the story was quite different. His methods, if indeed he consciously utilized definite methods, were unconventional. Certainly there was no uniformity about them. With all of his students he tried to be helpful, sometimes in ways they did not recognize or appreciate. As for most students, the purchase of clothing was to the writer a problem of great financial magnitude. Arriving in Boston from New Haven one time with a pair of well worn and badly faded rubbers he asked if I had walked all the way. Quite appropriately he mentioned on another occasion that a haircut sometimes might be worth at least a thousand dollars to any man. For himself he set an example of productive work and attention to important details that was difficult to equal. With some of his students he was brusque, stern and apparently unduly critical, with

others he was extremely kind, fatherly and affable, but when necessary he could be brutally frank. Whether he made these distinctions consciously, is not known. The fact remains that his methods were effective. To the great majority of his students he imparted not only a firm grasp of the principle of genetics, but usually also something of his own critical attitude, his passion for accuracy, his recognition of the relativity of scientific truths and not infrequently an interest in literature, history and the arts. He was an educator in the true sense of the word. A list of his former students is a roster of distinguished and successful geneticists in all parts of the world.

Beginning with World War I, during which he served as a chairman of the Botanical Raw Products Committee of the National Research Council, and also as Acting Chief of the Statistical Division of the United States Food Administration, East's interests turned increasingly to the implications of biology to world problems and human affairs. His work in the Food Administration had shown him how narrow is the margin between the world's food supply and its ever increasing needs. His experience in agricultural research had convinced him that the usual estimates of increased production which could be expected from improved agricultural practices were far too optimistic. At about this time he also read for the first time Malthus' "Essays on Population," the treatise which had given Darwin the key to his theory of natural selection as a consequence of a perpetual "struggle for existence." East realized that the fulfilment of Malthus' dire predictions had been merely delayed by industrial developments and advances in agriculture; that the Malthusian Law was still valid and that the world faced poverty, misery, and widespread starvation unless the growth of populations were restricted. These conclusions were lucidly expounded in his "Mankind at the Crossroads" published in 1923, and later translated into German and Italian. Published at a time when the United States was beginning to suffer from a plague of crop surpluses and low agricultural prices, as a consequence of war-time expansion and wide-spread adoption of improved agricultural machinery, the book, though widely read, was severely criticized and even ridiculed in some quarters. It

has required another World War and the adoption of an international view-point on world population problems and food supplies to show that his conclusions are essentially sound. This book was followed by "Heredity and Human Affairs" (1927) an exposition of the principles of heredity and their bearing on social problems, and "Biology in Human Affairs" (1931, with other scientists) which was selected by the American Library Association as one of the 50 outstanding books of the year.

East's writing combined to an exceptional degree complete scientific accuracy with a lucid and effective prose. This was also true of his lectures which were numerous. He was lecturer at the University of Chicago (1911) at the Graduate School of Agriculture, University of Missouri (1914), at Ohio State University (1927) and at the University of Michigan (1931). He was De Lamar Lecturer at Johns Hopkins University (1920), Larwill lecturer at Kenyon College (1927), Harvey lecturer at the New York Academy of Medicine (1931) and held the Harvard lectureship at Yale University (1924-25). The honorary degree of LL.D. was conferred on him by Kenyon College in 1926. He conducted a round table on population problems in 1925 at the Institute of Politics at Williamstown, Massachusetts, in which he invited Henry A. Wallace to take part. This was the beginning of Mr. Wallace's active participation in national affairs.

East was a member of and took an active part in many scientific societies. Apparently his earliest affiliation was with the American Breeders' Association, now the American Genetic Association. He held membership in the American Association for the Advancement of Science, the Botanical Society of America, and the Genetics Society of America (Chairman of Genetics Section 1923, President 1937). He was elected a member in the American Society of Naturalists (President 1919), Fellow in the American Academy of Arts and Sciences, corresponding member of the Philadelphia Academy of Natural Sciences and member of the American Philosophical Society and the National Academy of Sciences. He was one of the founders of the journal, Genetics, and served on its editorial board for many years, taking an active interest in the publication, passing

on many of the manuscripts submitted, and assisting succcessive managing editors in numerous ways. He took an active part in the Sixth International Congress of Genetics held at Ithaca, N. Y., 1932, serving as a member of the committees on organization and publication, and as chairman of the program committee. He attended the fifth congress which was held in Berlin in 1927, and was looking forward with eagerness to attending the seventh which was held in Scotland in 1939. He was a member of the committee of fifteen which organized the International Union for the scientific investigation of population problems in Paris in 1928 and was elected chairman of its commission on food supplies in relation to population.

All his life he was an inveterate reader. All evening, every evening, whenever possible, he read as his father had before him. For years his reading interests were in scientific works and literature, then art, particularly etchings and prints. As he grew older and was too tired at night to do heavy reading he read detective stories, one book an evening. He spent much time in second-hand book stores and built up an excellent library. He had a collection of prints and etchings that gave him a great deal of pleasure. Although an extensive reader he always enjoyed being with others and was an entertaining and instructive conversationalist.

In all of his activities, research, teaching, writing, lecturing and participation in the affairs of scientific organizations, East was a perfectionist. This trait he exhibited even in his hobbies, indeed it was in his recreation that it was perhaps most clearly revealed, for here he was free to abandon activities in which he could not excel. He gave up golf when he found that he could not bring his score below 80, a figure which would have delighted many golfers. Billiards, however, furnished an adequate recreational outlet and he became an accomplished billiardist, playing a game equal in some respects to that of professionals. Perfection, in his eyes, was something to be desired and to be striven for yet it was neither a fetish nor a blind passion. He made a clear distinction between the essential and the non-essential. His experiments were carefully planned and the data were critically analyzed, but field and greenhouse notes

were frequently taken on the margins of letters which he happened to have in his pocket. He was always concerned with the problem of obtaining fair and adequate samples, but his measurements were never more accurate than required because of the limitations of the experimental error. Having a remarkable memory he sometimes leaned upon it too strongly for some of his facts and figures. He abhorred deceit, sham and dishonesty, and yet he recognized more clearly than most scientists that scientific truth is relative and not absolute; that the "truths" of today are no more than stepping stones toward the greater, but still relative truths of tomorrow.

Perfectionists are by their very nature frequently lacking in close friends. This was not true of East. He had many warm friends during his lifetime. In college he was a member of the Delta Kappa Epsilon fraternity. In Boston he enjoyed his association with the Harvard Club. True, he was regarded by many whose acquaintance with him was no more than casual, as cold and austere, but to those who knew him well, he was a man of strong friendships and intense loyalties. Scientific objectivity did not penetrate deeply into this sphere of his life, for it was difficult for him to recognize faults in his friends. His own loyalties were strong and he engendered strong loyalties. One of the deepest satisfactions of his last years, when he was frequently afflicted with illness, stemmed from the expressions of respect and friendship which he received from many of his former students.

Dr. East was married, September 2, 1903, to Mary Lawrence Boggs, daughter of Lieutenant William Brenton Boggs, U. S. N., and granddaughter of Pay Director W. B. Boggs, U. S. N. There are two daughters, Elizabeth Woodruff (Mrs. Ralph L. Drapeau) and Margaret Lawrence (Mrs. Donald L. Gillum).

Shortly after his 59th birthday, Edward Murray East died at Boston, Massachusetts, November 9, 1938. Genetics lost one of its best known pioneers and leaders. A man of rich and versatile talents, a careful worker, a keen thinker, a scholarly writer and able lecturer, he will be remembered by his students and colleagues also as a wise counselor and friend.

BIBLIOGRAPHY OF EDWARD MURRAY EAST

KEY TO ABBREVIATIONS

Amer. Breed. Assn. Rpt.=American Breeders Association Report
Amer. Jour. Bot.=American Journal of Botany
Amer. Nat.=American Naturalist
Arch. Néer. Sci. Exact. et Nat.=Archives Néerlandaises des Sciences Exactes et Naturelles
Biol. Centr.=Biologisches Zentralblatt
Birth Control Rev.=Birth Control Review
Bot. Gaz.=Botanical Gazette
Breed. Gaz.=Breeders Gazette
Brooklyn Bot. Gard. Mem.=Brooklyn Botanical Garden Memoirs
Bussey Contr.=Bussey Contributions
Conn. Agr. Exp. Sta. Bull.=Connecticut Agricultural Experiment Station Bulletin
Conn. Bd. Agr. Rpt.=Connecticut Board of Agriculture, Report
Cont. Lab. Gen. Bus. Inst.=Contributions, Laboratory of Genetics, Bussey Institution
Ill. Agriculturist=Illinois Agriculturist
Ill. Agr. Exp. Sta. Bull.=Illinois Agricultural Experiment Station Bulletin
Ill. Agr. Exp. Sta. Cir.=Illinois Agricultural Experiment Station Circular
Jour. Agr. Res.=Journal of Agricultural Research
Jour. Amer. Chem. Soc.=Journal, American Chemical Society
Jour. Gen. Physiol.=Journal of General Physiology
Jour. Hered.=Journal of Heredity
Mem. Hort. Soc., N. Y.=Memoirs, Horticultural Society of New York
Neb. Agr. Exp. Sta. Res. Bull.=Nebraska Agricultural Experiment Station Research Bulletin
Pop. Sci. Mon.=Popular Science Monthly
Proc. Amer. Acad. Arts & Sci.=Proceedings, American Academy of Arts and Sciences
Proc. Amer. Phil. Soc.=Proceedings, American Philosophical Society
Proc. Nat. Acad. Sci.=Proceedings, National Academy of Sciences
Rpt. Conn. Agr. Exp. Sta.=Report, Connecticut Agricultural Experiment Station
Rpt. Conn. State Bd. Agr.=Report, Connecticut State Board of Agriculture
Rpt. Soc. Prom. Hort. Sci.=Report, Society for the Promotion of Horticultural Science
Sat. Rev. Lit.=Saturday Review of Literature
Sci. Mon.=Scientific Monthly
Scribner's Mag.=Scribner's Magazine

U. S. Dept. Agri., Bur. Plant Ind. Bull.=United States Department of Agriculture, Bureau of Plant Industry, Bulletin

Ztschr. ind. Abst. u. Vererb.=Zeitschrift für induktive Abstammungs-und Vererbungslehre

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