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A SCIENTIST LOOKS AT HISTORY¹

TO THE LAYMAN, science and history at first glance seem unrelated and far apart. A closer analysis, however, reveals some astonishing similarities between these seemingly separated fields of learning. I do not allude, as you may perhaps infer from this statement, to that long line of historians who have chronicled the achievements of science from early historical times up to the present. History as a narrative of events could not ignore scientific achievements any more than it could ignore the chronicles of political and social events.

I have in mind as I view history, more fundamental and deep-seated similarities to science which have to do with methods and techniques, and especially with objectives and even with outcomes and results, as these affect our human progress in all its manifold branches. History that is merely and only a narrative of events is like a collection of those curios—sometimes called curiosities—found on the what-nots of our Victorian-age parents or grandparents, to wit, perhaps, a vegetable worm from Australia, a clump of native copper from Michigan, an Indian arrowhead from the Great Plains, and the inevitable polished sea shell that still echoed the roar of the ocean waves from which it had been rescued. Such curios and such historical events lack continuity and interrelation. They reveal little of cause and effect. They are incomplete and sometimes even mislead-

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ing as records of human experience. Human experience is merely another term for human experiments. Like all other biological organisms, the human race is constantly experimenting, consciously or unconsciously, in biologic, social, economic, and political relations. The results of these experiments are incompletely recorded unless displayed in their setting of relevant preceding and succeeding events. Such experiments differ not at all from the experiments which the scientist carries on to extend knowledge in his particular science.

The chemist puts two chemicals together—events that, so far as he knows, have never occurred in such a sequence. The substance or substances produced are the resulting historical event. Only when he is a faithful historian of every condition and of every episode occurring in such a controlled experiment and only when he is a wise and sound interpreter of the cause and effect relations—only then is he a truly scientific investigator. It is just so, I take it, with the historian of human history. He too must recognize the experimental significance of human events. He too must stick strictly to the facts, be they contrary to or in accord with common beliefs or be they even explosive of sacred tradition. He too, without prejudice or distortion, must interpret and record the events that reveal the results in terms of human relations.

It must be quite obvious that the historian's job of interpretation of events as significant factors in social, political, and other experiments in human history is a more complex one than that of the scientist. The scientist aims to control every condition of his experiment: as purity of chemicals, temperature, light, humidity, and the like. Only when these conditions are controlled and meticulously recorded can the experiment be accurately repeated. Only thus can he be sure of obtaining the same result. Only then does his scientific history repeat itself.

But the chronicler of human history cannot control the

conditions of the experiments in human progress. He cannot alter in the slightest the events that preceded the signing of Magna Charta. His is the task of correlating the events that most clearly have causal connections and significant interrelations. Perhaps because of the improbable occurrence of strictly identical conditions, history never exactly repeats itself. Even the biologist's planned experiment frequently fails to give consistent results because of unforeseen or uncontrollable factors or conditions. Scientists often have violent disputes among themselves even over the facts involved as well as over interpretations of these facts.

This naturally raises the question, how exact is science? Some scientists maintain that physics and mathematics are the only exact sciences, and there are those who would even exclude physics. An exact science is one in which the historical record is unfailingly accurate.

On the other hand, cause and effect relations are clearly demonstrable in the scientist's experiments and confirmable by frequent repetition. Just so in the history of the human race, out of the complex conditions presented by different times and different lands, by different social and economic conditions, cause and effect are also discernible. And herein lies the value of history. As an accurate record of experiments and experience in human progress, it is the most available and most reliable guide to future experiments offering greatest probability of success. The repetition of probable failures may often be avoided and successful experience repeated. But history cannot be the sole guide for civilization's experiments any more than it can be in the field of science. Scientists are constantly inaugurating totally new and unprecedented experiments with the astounding results familiar to all in the physical world of today. And so is the human race trying radically new experiments in its social, political, and economic growth and evolution.

For instance, to the cold, analytical eye of the scientist—and I am sure to the equally analytical eye of the his-

torian—Communism in Russia, Naziism in Germany, and Fascism in Italy are political experiments in nationalism. We, as critics, may have positive and even violent opinions as to the probabilities of success in the attainment of the defined or undefined objectives of these experiments. We may invoke historical events of the past and attempt to predict the results of such experiments, yet it must be quite obvious to an unprejudiced observer that, even though all three of these political experiments may be classed as totalitarianism, no two of them are exactly alike. And it is improbable, to say the least, that any experiment exactly identical with any one of them has ever been tried in the past or recorded in history. When you change the conditions of an experiment, you change the experiment, and the political, social, and economic conditions of the year 1939 or of any other year are peculiar to that year itself. Totalitarianism is a quest for power through national regimentation. Will power be the deciding factor in the competition for national dominance, or even in the struggle for existence? How will democracy match that power and still retain its liberties, rights, and privileges for the individual? This will become an exceedingly important question if the European experiments in totalitarianism finally demonstrate a consistent and enduring superiority in the development of national power. These are problems that the human race is seeking to solve by new and radical experiments. The historian of the future will read and interpret the answers in events to come.

Let us consider now for a moment the scientist and his methods. To my mind, he is fundamentally a historian. He believes in and uses the historical method. He does not attempt a new experiment until he has searched the literature of the whole world not only to make sure that the experiment has not been previously performed but to learn all that has been done in the field of that experiment. He must know the past before he can safely explore the future. Frequently he finds that his experiment has been tried many times, but in a careful scrutiny of the methods used or conditions surround-

ing such experiments, he finds factors or conditions that may have led to failure and which he can therefore avoid. Accuracy of history is therefore to him of most vital importance. And it follows, therefore, that the history which he writes—he calls it a paper on research—must be faithful, accurate, and complete in every detail. Just as with the historian, the facts, procedures, and observations of events must be faithfully recorded so that others may interpret them for themselves with even radically different conclusions. It is not merely coincidence, but it is a fact of significant interest to the historian that Darwin's famous work was entitled *Origin of Species*.

In another and even more important sense, all science has an ultimate historical goal. Notwithstanding the myriad applications of electricity in power transmission, in light, in radio, and so on, no one knows exactly what electricity is. The head of the great research laboratories of the General Motors corporation has said that no one yet knows just how the spark in a gasoline motor ignites the gas. The final goal of physical science is a knowledge of the constitution of matter. In other terms this means the origin or the beginnings of matter—and that is a historical event. That it will ever be found, no man knows. Human comprehension may not even be able to recognize it.

Of all the scientists, the biologists are most intimately and practically concerned with history. Indeed, biology is founded on biological history. The history of life on this planet is sometimes called evolution—which is merely the record of the events and changes which have taken place in past ages since the origin of living things. The biologist's history goes back millions of years. Thousands of years are as a day. His historical records are not merely books or hieroglyphics. They are fossils and casts and remnants preserved in coal, in limestone, or other earth structures—historical records antedating recorded history by millions of years. And even in the biological facts of the present, the biologist finds valuable historical records of the even distant

past, because biologic organisms in their brief span of life from birth to death repeat in epitome the long history of their species. In that epitome may be found structures that record biological events of ages ago. Through an increasing knowledge of the mechanism of heredity, the plant breeder gleans valuable historical data from a detailed knowledge of the life history of living organisms which throws light on life in the distant past. And, conversely, a knowledge of organisms existing millions of years ago may explain biological processes and structures of living organisms of today. Verily is the biologist a historian.

As I have pointed out above, history is of vital importance to human progress as a record of human experiments, as an interpretation of the results of these experiments, and as a guide to human actions and relations. To profit by that history requires faithfully reported facts and accurate and unbiased judgment in interpretation and use of the results. Science and history are identical in these demands.

And, finally, to every one of us in our everyday life, the methods common to science and history are of paramount practical significance and importance. Intelligence and education are the rocks on which are founded the blessings which democracy, through ages of social and political experiments, has won for the individuals of the human race. To retain those blessings, the people, as their own rulers, must know the facts of history—the whole unbiased truth—not distorted or perverted in any way. And they must learn to interpret these intelligently, which means with historical and scientific accuracy. In the ideal democracy of the future, every citizen must be a historian. Utopia has never been found in the world's past history, but science teaches that such a negative fact can never be finally validated until the end of time. It will never be found except through human experiments carefully planned and accurately interpreted.

E. M. FREEMAN

COLLEGE OF AGRICULTURE, FORESTRY, AND HOME ECONOMICS
UNIVERSITY FARM, ST. PAUL



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