freely soluble)[19] yields a dough quite as easy to handle as that produced from pure wheat flour. Such a dough does not, like ordinary doughs containing substitutes, easily become "overproved." The loaves do not fall in the oven, for the serum proteins decrease the leakage of carbon dioxide from the dough.[20] The danger of the loss of a whole batch from excessive fermentation is therefore minimized.

The use of serum proteins in this way materially lessens the very real difficulties which now exist. Moreover the resulting loaf is larger and more elastic, of better color and texture, and in all respects superior to loaves containing equal amounts of wheat substitutes but lacking serum. If it is inferior to bread made of pure wheat flour, it possesses certain important qualities of its own, and its use seems to be in all respects quite unexceptionable.

ROPE

Ropy bread is produced by the action of certain microorganisms whose spores survive the heat of the oven and later, when the conditions are favorable, attack the center of the loaf. At a temperature of about 26° C. (80° F.) their growth is rapid. For this reason epidemics of rope occur in summer. The principle organisms which cause rope belong to the *B. mesentericus* group.

Another condition which is necessary for the development of the rope organism is low acidity.[21] Bread which is sufficiently acid is quite immune. It is therefore possible absolutely to prevent rope by sufficiently increasing the acidity of dough. It has been found that the degree of acidity which is otherwise most favorable in ordinary bread making, at least as practised both in America[14, 16] and in Denmark[15] is sufficient for this purpose. This acidity is indicated by a full red color when a few drops of a solution (0.02 per cent. in 60 per cent. alcohol) of the indicator methyl red are placed upon a slice of bread. Bread should be adjusted to this acidity, especially when there is danger of an epidemic of rope. This is best done by the addition of increasing amounts of acid to the dough of successive batches until the baked loaf gives the desired color. Generally the right amount of lactic acid is between one and two pounds of the commercial product (22 per cent.–25 per cent.) per barrel of flour. (This corresponds to 1.25 c.c. normal lactic acid in 100 g. flour.)

It has been pointed out that wheat substitutes usually combine with more acid than wheat flour itself. In this way they neutralize the acidity of the dough and as a result the greater the amount of substitute the greater is the amount of acid that must be added to bring bread to the acidity indicated by a red color of methyl red. The preference of the baker for "young" doughs and the greater capacity of the substitutes to neutralize acids is the reason why rope has caused so much trouble during war time.

We are indebted to the Carnegie Institution of Washington and to Professor Theodore W. Richards for the use of much valuable and indispensable apparatus, without which our researches could hardly have been carried out. It is a great pleasure to express our thanks for this aid.

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L. J. HENDERSON

[19] Burrows, G. H., and Cohn, E. J., "A Quantitative Study of the Evaporation of Serum Proteins," *Jour. Biological Chemistry*, 1918.

[20] Unpublished observations.

[21] Cohn, E. J., Wolbach, S. B., and Henderson, L. J., "The Control of Rope," *Jour. of General Physiology*, Vol. 1, No. 2, 1918.

INDUSTRIAL RESEARCH AND NATIONAL WELFARE[1]

AT the outbreak of the war the average statesman of the Allied powers was but little concerned with the interest of research. Necessity, however, soon opened his eyes. He began to perceive the enormous advantages derived by Germany from the utilization of sci-

[1] From an address delivered by Dr. George E. Hale under the auspices of Engineering Foundation in the Engineering Societies Building, New York, May 28, 1918.

ence, and sought to offset them by the creation of appropriate agencies. Thus arose throughout the British Empire a group of councils for scientific and industrial research. The first of these was established in England by an order in council issued in 1915. Subsequently, Canada, Australia and South Africa followed the example of the mother country, and New Zealand proposes to do likewise. The world-wide movement swept across the empire, and its benefits will be felt in every country under the British flag. A similar awakening was experienced in France and Italy, but in both of these countries the pressure of the war concentrated attention for the moment upon military problems. At present, the needs of industry are also under consideration, and research organizations are being developed to meet them.

Without entering here into a detailed discussion of these councils, we may mention certain typical illustrations of their activities from the report of the British Advisory Council for Scientific and Industrial Research for the year 1916–17. In this period it devoted itself mainly to the organization of industrial research, partly because of the prime importance of stimulating and fixing the interest of manufacture in the development of industry through research, and partly because the effect of the war has been to render industrial leaders more susceptible than ever before to the growth of new ideas. In pure science, on the contrary, the war has seriously affected the prosecution of research, because so many investigators have been drawn into military and industrial activities. Thus, while the advisory council strongly emphasizes the fundamental importance of pure science, it has been forced to postpone its activities in this field until the arrival of more favorable conditions.

Research for the development of the industries may be conducted in several different ways. In this country a stimulating example has been set by such great corporations as the American Telephone and Telegraph Company, the General Electric Company, the Eastman Kodak Company, the Dupont Companies, and the Westinghouse Electric Company, which have established large research laboratories.

The value of this example has been enhanced by the remarkable success achieved by these laboratories in matters affecting public welfare, such as the reduction in cost of electric lighting caused by the development of the Mazda lamp and the possibility of transcontinental telephony, not to mention the latest advances in the field of wireless telephony.

Self-interest will sooner or later induce many other corporations to adopt similar methods of improving their products, but the heavy expense of establishing independent research laboratories will sometimes prove an insurmountable obstacle. Other means must then be resorted to. A useful example is that afforded by the National Canners' Association, which has established a central research laboratory in Washington, where any member of the association can send his problems for solution and where extensive investigations, the results of which are important to the entire industry, are also conducted.

The British Advisory Council, aided by a government appropriation of one million pounds, is actively promoting the organization of trade research associations for the mutual benefit of the members of the great industries. Thus a provisional committee representative of the British cotton industry has proposed the establishment of a cooperative association for research in cotton, to include in its membership cotton spinning, doubling the thread making firms, cloth, lace and hosiery manufacturers, bleachers, dyers, printers and finishers, which will conduct researches extending from the study of the cotton plant to the "finishing" of the manufactured article. So long ago as 1835 Baine wrote in his "History of the Cotton Manufacture": "The manufactory, the laboratory and the study of the natural philosopher, are in close practical conjunction; without the aid of science, the arts would be contemptible; without practical application, science would consist only of barren theories, which men would have no motive to pursue." This spirit, clearly shown in the early cotton industry, is now to be revived for the common benefit.

The woolen and worsted manufacturers of Great Britain are also drafting the constitution of a research association, and the Irish flax spinners and weavers are about to do likewise. Research associations will be established by the Scottish shale oil industry and the photographic manufacturers, while various other British industries are looking in the same direction. Thus a national movement for research, directly resulting from the war, has already made marked headway. The research councils in various parts of the British Empire, actuated by the same spirit, are rapidly extending the advantages which an appreciation of the national importance of research will afford.

The National Research Council, aided and supported by the Engineering Foundation, is just entering upon an extensive campaign for the promotion of industrial research. In addition to a strong active committee, comprising the heads of leading industrial laboratories and others prominently identified with scientific methods of developing American industries, an advisory committee has been formed to back the movement. This already comprises the following gentlemen: Honorable Elihu Root; Mr. Theodore N. Vail, president of the American Telephone and Telegraph Company; Dr. Henry S. Pritchett, president of the Carnegie Foundation for the Advancement of Teaching; Mr. Edwin Wilbur Rice, Jr., president of the General Electric Company; Mr. George Eastman, president of the Eastman Kodak Company; Mr. Pierre S. duPont, president of the E. I. duPont de Nemours Powder Company; Mr. A. W. Mellon, founder of the Mellon Institute for Industrial Research; Judge E. H. Gary, president of the United States Steel Corporation; Mr. Cleveland H. Dodge, of the Phelps-Dodge Corporation, and Mr. Ambrose Swasey, of The Warner and Swasey Company.

We are indeed fortunate to have the aid of men whose experience and standing are so certain to command public recognition of the claims of scientific and industrial research.

Science is in the air, keen competition is in prospect, and the industries are more favorably inclined than ever before to the widespread use of research methods. Their greatest leaders, moreover, are unanimous in their appreciation of the necessity of promoting research for the sake of advancing knowledge, as well as for immediate commercial advantages. Only thus can the most fundamental and unexpected advances be rendered possible, and continued progress in all directions assured.

GEORGE SCHRADER MATHERS

CAPTAIN GEORGE SCHRADER MATHERS, M.C., U. S. Army, a member of the staff of the McCormick Institute for Infectious Diseases, Chicago, died October 5, 1918, at the age of thirty-one.

Captain Mathers took his college work in the University of Texas and the University of Chicago, and received his medical degree from Rush Medical College in affiliation with the University of Chicago in 1913. Having served one year and one half as interne in the Cook County Hospital he began work in the McCormick Institute under a grant from the Fenger Memorial Fund, but before long he became associated fully with the institute. During the three and one half years of this association he accomplished much fruitful work and published important papers or lobar pneumonia, epidemic poliomyelitis, acute respiratory infections in man and in the horse, and on epidemic meningitis. He demonstrated that a streptococcus-like microorganism occurs apparently constantly in the central nervous system in persons that have died from epidemic poliomyelitis. Early last spring he was commissioned as first lieutenant and placed in charge of the laboratory of the embarkation hospital at Camp Stuart. In May he was promoted to captain, and given charge of the laboratory of the base hospital at Camp Meade. He gave himself completely to his work. In the course of his duties and while intensely