SCIENCE IN EDUCATION AND INDUSTRY.

LORD CREWE announced at a meeting of the governing body of the Imperial College of Science and Technology on June 30 that it is the intention of the Government to appoint a Special Committee to inquire into the question of the position of science in national education. It is proposed that the Committee, working in close concert with the President of the Board of Education, shall include representatives of pure science, of applications of science to commerce and industry, and also those who are able from general experience to correlate scientific teaching with education as a whole. The Committee will have a close connection with Government, and Lord Crewe himself will be the chairman. The general objects of the Committee will be, broadly speaking, to inquire into the position of science in our educational system, especially in universities and secondary schools. Its duty will be to advise the authorities how to promote the advancement of pure science and also the interest of trades, industries, and professions dependent on the application of science, not neglecting the needs of a liberal education.

These objects are almost identical with those which the British Science Guild and its various important committees have been urging upon public attention for the past ten years, without much practical support from the scientific societies and educational associations, which only awakened to their importance after the war had been upon us for some months. The new Committee is to be connected with the Reconstruction Committee appointed by the Prime Minister in March last to consider and advise upon the problems that will arise on the conclusion of peace, and to co-ordinate the work which has already been done by the Departments in this direction. Lord Crewe said on June 30 that it had been thought wise that the Prime Minister's Reconstruction Committee should undertake the general supervision and review of the changes which might be required in our national system of education, rather than that this inquiry should, as had been recommended, be entrusted to a Royal Commission. The possibility of immediate action by any Department on any point on which necessity for action was proved was a most distinct and substantial gain over what would be possible if the procedure had been by Royal Commission. It was clear that a review of our education generally could not be regarded as strictly one of the subjects of reconstruction after the war, but, on the other hand, the two things could not be disconnected.

Any suggestions or other communications from individuals or organisations bearing upon the inquiries now being undertaken should be addressed to Mr. Vaughan Nash, C.V.O., C.B., Secretary of the Reconstruction Committee, 6A Dean's Yard, Westminster. They will be considered and referred in suitable cases to the Department concerned or to one of the Sub-committees to which particular subjects or groups of subjects have been referred by the Reconstruction Committee.

SCIENCE AND THE BREWING INDUSTRY [1]

AT the commencement of the period under review, when the author first became definitely associated with the brewing industry, at Burton-on-Trent in 1866, brewing operations were conducted on purely empirical lines, the real nature of the processes involved being unknown. The rational scientific control of these operations which is possible to-day is the outcome of a vast amount of experimental study of brewing problems, and this study has not only extended the bounds of natural science beyond all expectations, but has indirectly conferred incalculable benefits on the human race by its influence on the development of medicine, surgery, and sanitation. The views of Berzelius and Liebig on fermentation were still widely accepted fifty years ago, and the maladies to which beer was subject were attributed to some indefinable transformations of its albuminoid constituents. The true nature of alcoholic fermentation as a normal function of the living yeast cell was elucidated by Pasteur, who rendered immense services to the fermentation industries by his studies on the technology of vinegar, wine (1863–66), and beer (1871–76), bringing to light for the first time the action of bacteria in producing disorders of these beverages. What is not generally recognised is that his later work on infectious diseases and immunisation, which laid the foundation of the subsequent wonderful developments of preventive medicine and hygiene, was the direct outcome of these researches on the fermentation industries, and was in large measure rendered possible by a technique which he acquired therein.

The reactions which take place in the brewer's mash-tun were investigated by O'Sullivan at one of the Burton breweries, from about 1870 onwards, in a series of researches of the first importance, not only to brewing, but to the chemistry of enzyme action. Applying the polarimeter, an instrument rarely used in this country at that time, he studied the action of malt-diastase on starch, demonstrated that the crystallisable sugar formed is not dextrose, but maltose, and studied the quantitative relation of the maltose and dextrin under varying conditions of temperature.

The study of malting processes was stimulated by the transference of the excise tax from malt to beer, in 1881, when certain restrictions on malting operations imposed by the authorities were removed. In a long series of researches the author, in collaboration with G. H. Morris and others, succeeded in bringing to light the principal chemical and morphological changes which go on in the barley grain during the early stages of germination, and laid the foundation of a scientific control of malting processes. He demonstrated that the embryo of the grain is related to the endosperm as a vegetable parasite to its host, that there is no structural connection between the two, and that if the surrounding integuments common to both are removed the embryo can be readily separated from the endosperm and reared into a perfect plant by the application of suitable nutriment. In the germinating barley grain the food reserve in the endosperm is made available for the embryo by means of diastatic, cytatic, and proteolytic enzymes secreted by the epithelial cells of the scutellum of the embryo; these enzymes, projected into the endosperm, dissolve the cell walls and corrode and dissolve the starch granules.

The study of the micro-organisms of fermentation received a fresh impulse, some years after the conclusion of Pasteur's studies on beer, from the work of Emil Chr. Hansen at Copenhagen. He introduced new methods of investigation, distinguished the primary brewers' yeast, *Saccaromyces cerevisiae*, from other types capable of producing secondary changes in beer, and introduced the practice, common on the Continent, of using pure-culture yeasts, produced from a single cell, for brewing.

Many of the problems which arise in connection with the fermentation industries deserve the closest attention of physiologists and pathologists, inasmuch

[1] Abstract of a paper read before the Institute of Brewing, May 8, on "Some Reminiscences of Fifty Years' Experience of the Application of Scientific Method to Brewing Practice," by Dr. Horace T. Brown, F.R.S.

as they present aspects of biochemistry and cell-functioning in a relatively simple form free from many of the complications encountered with higher organisms. One such problem is the activation of enzymes which is sometimes produced by the presence of living cells. The author observed, for instance, that certain kinds of starch granules, capable of resisting indefinitely the action of a highly diastatic liquid in which they were immersed, were readily attacked by the diastase after a trace of yeast had been added. Possibly the explanation is to be sought in the reversible nature of enzyme action and the continuous removal of certain products by the yeast. The subject may perhaps throw some light on the influence of "vitamines" on animal nutrition. The allied problem of symbiosis is exemplified in a relatively simple form by the "amylo-process" employed in certain distilleries at Seclin, in France. In this process the sterilised amylaceous material is saccharified and converted into alcohol and carbon dioxide in one operation by the joint action of a mould fungus which produces diastase, and a yeast which effects fermentation. Another subject which should be of interest to the physiologist relates to the quantitative relation between the reproduction of yeast cells and the supply of oxygen available. The author found that when cells are sparsely distributed through a nutrient liquid the oxygen initially dissolved in the liquid is rapidly absorbed by the cells, and the "oxygen-charge" per cell thus taken up determines the reproductive capacity of the yeast, provided no further oxygen is available. The author gives further examples of the extension of scientific knowledge resulting from the study of brewing problems, and discusses at length some of the more technical matters which still await solution.

THE PLAINS OF NORTHERN INDIA AND THEIR RELATIONSHIP TO THE HIMALAYA MOUNTAINS.[1]

A HUNDRED years ago the accepted idea was that mountain ranges were due to the upward pressure of liquid lava, and that their elevation had been caused by volcanic forces. But when geologists began to study the structure of rocks, they found that mountains had suffered from horizontal compression, which was evident from the folding of strata. This discovery led to the idea that mountains had been elevated, not by vertical forces, but by horizontal forces, which squeezed the rock upward. The wrinkling of the earth's crust into mountains by horizontal forces was explained by the cooling of the earth; this is the well-known contraction theory; the earth's interior is held to cool and to contract, and the outer crust is supposed to get too large for the shrinking core and to wrinkle.

About 1860 the observations of the plumb-line brought to light a most important and totally unexpected fact, namely, that the Himalaya were not exercising an attraction at all commensurate with their bulk.

The plumb-line was observed at Kaliana, 60 miles from the foot of the mountains; the observers found that the Himalaya were exercising no appreciable attraction. By the theory of gravitation the plumb-line ought to be deflected at Kaliana 58 seconds towards the hills. It is not deflected at all; it hangs vertically. This discovery was the first contribution made by geodesy to the study of mountains. The discovery was this, that the Himalaya behaved as if they had no mass, as if they were an empty eggshell; they seemed to be made of rock, and yet they exercised no more attraction than air. From the Kaliana observations Pratt deduced his famous theory of mountain compensation; he explained the Kaliana mystery by assuming that the rocks underlying the mountains must be lighter and less dense than those underlying plains and oceans. The visible mountain masses, he said, are compensated by deficiencies of rock underneath them. This is the theory of mountain compensation. The compensation of the Himalaya is not believed now to be exactly complete and perfect; they seem to be compensated to the extent of about 80 per cent.; their total resultant mass is thus about one-fifth only of their visible mass standing above sea-level. The discovery of mountain compensation struck a blow at all theories which attributed the elevation of mountains to any additional masses that had been pushed in from the sides. The elevation of mountains by subterranean lava squeezed in from the side had to be rejected because it gave to mountains additional mass; the wrinkling of the earth's surface by lateral horizontal forces had to be rejected because it gave to mountains additional mass pushed in from the sides. As the Himalaya possess only one-fifth of their apparent visible mass, I am led to suggest that the principal cause of their elevation has been the vertical expansion of the rocks underlying them, vertical expansion due to physical or chemical change.

Mountains Originate at Great Depths.

A very important work has been that of Mr. Hayford, who has recently discussed the results of the plumb-line at a large number of stations in America. He has confirmed Pratt. Hayford has investigated the depth to which the deficiency of density underlying mountains goes down, and he has found that that depth is between 60 and 90 miles. That is to say, he has shown that the depth of subterranean compensation is very great compared with the height of mountains. The discovery that mountains originate from the great depth of 60 to 90 miles is the second important contribution of geodesy to this study. The first was compensation, the second is great depth.

Southerly Deflections Prevail over the Ganges Plains.

Now let me tell you of the third discovery due to this plumb-line. The survey found that at 60 miles from the hills this plumb-line hung vertically, and Pratt deduced the theory of mountain compensation. But when the survey began to extend their operations, a new phenomenon came to light, which caused great surprise. All over northern India at distances exceeding 70 miles from the hills, this plumb-line was found to hang decisively away from the mountains; here at Lucknow it is deflected 9 seconds to the south. If the Himalaya were simply compensated, this plumb-line should be hanging at Lucknow exactly vertical; if the mountains were not compensated, it should be deflected here about 50 seconds towards the north. But it is deflected 9 seconds towards the south. The observers were astonished to find that at places in sight of Himalayan peaks the plumb-line turned away from the mountain mass; that at Amritsar, in sight of the Dhauladhar snows, it was deflected towards the low Punjab plains; at Bombay it was deflected seawards away from the Western Ghats; on the east coast of India it was deflected seawards away from the Eastern Ghats.

The new lesson to be learnt from the plumb-line is this: a hidden subterranean channel of deficient density must be skirting the mountains of India. Here in North India is a wide zone of deficient density, of crustal attenuation; it is the presence of this zone of deficiency that accounts for the southerly deflection

[1] Abridged from an address to the Indian Science Congress at Lucknow on January 13 by the president, Sir Sidney Burrard, F.R.S.