in this account of a man who possessed a personality of rare charm, and, without any commanding intellectual equipment, lived a life of high accomplishment.

E. H. H.

TECHNOLOGICAL SCIENCE IN GERMANY.

WHAT are the chief causes to which the remarkable industrial progress made by Germany in recent years is attributable? This is the question M. E. Leduc sets himself to answer in a paper[1] which, though written primarily for his compatriots, is also of much interest to others.

On the morrow of Jena the outlook in Prussia was sorry indeed. The country was poor, the population sparse; there were no manufactures, and not much commerce. Few roads, and those bad; an ill-equipped postal service; little money, and the kingdom ringed around with tax-offices: such is the picture drawn of the land which lay there bleeding after Napoleon's victory in 1806. Yet now, little more than a century after, the vanquished of Jena have not only ousted their conquerors from the position of military predominance, but are steadily forcing them, and others, from their coigns of vantage on the fields of industry and commerce.

M. Leduc first outlines the earlier steps which led to this industrial advance—the revival of national sentiment, the removal of class barriers and other mediæval restrictions upon freedom—and then deals at length with the two causes which he holds to be the principal factors in the great modern expansion of German commerce, namely, education and cooperation.

By "education" here is meant education in applied science. First, as regards the teacher; the ideal is a man possessing a thorough knowledge of his subject, a teaching aptitude, and a certain quality of industrial practicality. This last is the touchstone. In technological training the aim should be to impart the scientific spirit rather than to let the student lose himself in "pure" science. Otherwise his intellect is apt to become somewhat mummified; and so far as industrial fertility is concerned he presently, college days being over, comes to resemble the fig-tree of scripture, which bore nothing but leaves.

This leaven of practicality is traceable in all the German technical science training. The professors at Charlottenburg are not merely college dons; some, for example, are chiefs of factories, others are the proprietors of commercial laboratories. The students in the technical institutes brew beer, distil spirits, and bake bread, all on a manufacturing scale, and all for sale in the ordinary way of trade.

From the description given it appears that the German instruction in technological science may be broadly classified into four divisions. First, there is the comprehensive training which is to turn out the future captains and leaders of industry. Next, provision is made for putting trustworthy information on technological matters at the disposal of the trading community. Thirdly, central institutions are established where certain industries—*e.g.* brewing, sugar-production—are studied scientifically and practically. Fourthly, there are local technical schools adapted to the special needs of particular localities.

Under the first category comes the famous High School of Technology at Charlottenburg. Here a complete course of instruction in any of the leading branches of technology is obtainable. The scale upon which the institution is equipped may be best shown, perhaps, by the following summary of the professorial staff:—

Section	Professors	Privats-docent
Architecture	21	12
Civil Engineering	13	8
Mechanical Engineering	20	14
Maritime Engineering and Naval Construction	6	1
Chemistry and Metallurgy	15	20
Mathematics and Natural Science	18	15
Foreign Languages	4	—
	97	70

In M. Leduc's opinion, specialisation and the more definitely practical character of the instruction are the points on which the German system shows itself superior to the French. It was all very well a century ago to say "Technical science is one subject; every manufacturer must know it in all its branches or be dubbed incompetent"; but this, like other formulas, has become antiquated, and the world has outgrown it.

Supplementing the tuition in technological science indicated above comes the work of the laboratory at Gross-Lichterfeld. This is a large establishment, covering an area of 10,360 square metres. Its duties are (*a*) to carry out researches, and to make examinations and analyses of materials both for public departments and for the trading community, issuing certificates and valuations based upon the results obtained; and (*b*) to arbitrate, on request of both parties, in matters of litigation concerning the composition and properties of commercial products. In addition, practical instruction in the testing of materials is given to certain students from Charlottenburg; and, as far as circumstances permit, assistance is rendered to persons pursuing special researches. Fixed fees are payable for the services of the laboratory; and the certificates issued are commonly used in commercial transactions as proof of the composition and properties of the articles described upon them. There are six sections, dealing respectively with metals, building materials, paper and textile fabrics, oils, general analytical chemistry, and metallography.

In the third class come the special institutes devoted to various agricultural industries; for example, sugar production, brewing, distilling, milling, and baking. Each of these has its institute, splendidly—nay, lavishly—equipped, not only for the training of students, but for research into any special problem of the industry. One feels, says M. Leduc, speaking of the sugar institute, that money without stint has been given to assemble here everything required for the study of beet-sugar production, and everything is the most perfect of its kind.

Now, in its origin and development this industry is notably a French one, yet Germany has outstripped France in its exploitation, and produces nearly three times as much sugar. Why? Because in Germany the production is organised and unified. "Germany is the land of cartels; jealousy of one's neighbour is unknown. The sugar factories all accept one and the same guidance, namely, that given them by the Institute at Berlin, which is richly endowed by the manufacturers. Prof. Herzfeld, to whom neither money nor help is begrudged, studies for all, and everybody profits thereby."

Similarly in the milling and baking industry,

[1] "L'Organisation syndicale et technique en Allemagne." By M. E. Leduc. (Bulletin de la Société d'Encouragement pour l'Industrie nationale, Octobre, 1909.)

important problems have arisen which could not be authoritatively solved by practical experience only. It was recognised that, as in other industries, the one condition of progress was the founding of an institution devoted solely to the study of cereals, and in which every detail of the questions at issue could be submitted to rigid experimental investigation. Accordingly the required institute was established. It was erected at the expense of the State, but receives subventions from the Chamber of Agriculture, the Society of Millers, and others.

Finally, for the specific assistance of certain local industries, technical schools exist, the particular instances quoted being the professional college of ceramics at Buntzlau and a similar but more restricted institution at Lauban. The instruction here is less generalised than at Charlottenburg, the aim being to impart an artistic and technical education suited to the special requirements of the locality.

As regards cooperation, a good deal is said, but we are only concerned here with its bearing upon technological progress, not with its purely trade aspects. Associations of manufacturers are formed, and if, for example, it is required to carry out some special research, they may give subventions for the purpose to technical colleges or to individual experts; or a commission may be nominated to make experiments; or chemists and engineers may be dispatched abroad to study new processes and new apparatus. Thus even a small manufacturer can keep himself abreast of progress in his department, and researches altogether too costly for single firms can be carried out by spreading the cost over the whole association. As concrete examples may be mentioned (1) the makers of explosives, who maintain an experimental laboratory with firing ground and testing station at an annual cost of 200,000 marks; and (2) the association of Portland cement manufacturers, who, for the reputation of German cement, make stipulations as to quality, and support a laboratory where each member's product is examined to ensure that it conforms to the requirements.

Lack of space forbids us to follow M. Leduc further in his study of this most interesting question, but the keynote of the whole matter is organisation. There is first an intelligent appreciation of the benefits which science can render to industry; next a liberal but carefully-bestowed provision for instruction of her sons in the applications of science; and then, by her organised system of trade syndicates, Germany pushes home the advantage gained through her equally well-organised system of technological education.

C. SIMMONDS.

PLAGUES OF LOCUSTS IN SOUTH AFRICA.

FOR the past three years an organised effort has been made by the Governments of the South African colonies to destroy the swarms of locusts that from time to time invade the cultivated districts and ravage the crops. The third annual report of the Central Locust Bureau has lately been issued under the editorship of Mr. C. P. Lounsbury, the entomologist for the Cape.[1] Together with the two previous reports it furnishes a very instructive demonstration of what can be done by enlightened executives working harmoniously on scientific principles. The Central Bureau comprises representatives of the Cape, Natal, Transvaal, Orange River Colony, Southern Rhodesia, Bechuanaland, Basutoland, Swaziland, Mozambique, and German South-west Africa, its influence thus overstepping political boundaries. It acts by collecting and spreading information about locusts and their migrations throughout the district of its operations, the actual work of repression or extermination being undertaken by the local governments separately.

Two species of locust periodically become serious plagues in South Africa. The red-winged locust (*Cyrtocanthacris septemfasciata*) infests, in various seasons, the east coast districts, migrating in spring and summer, and retiring to the forests in winter. The young locusts are active and most destructive during January and February. No serious invasion of this species was observed in Natal and the neighbouring districts between 1846 and 1893. Whence the migrating swarms come has not been certainly determined, but the Zambezi region is regarded as their probable home. Since 1893 there have been several plagues of this locust in the British colonies, notably in 1907–8, when more than 33,000 swarms were destroyed in Natal. During 1908–9 the insects were by far less numerous; nevertheless, it is computed that a loss of 250,000*l.* from damage to crops was prevented by the exertions of the locust officers.

The brown locust (*Pachytylus sulcicollis*) has its headquarters in the Kalahari Desert, whence swarms migrate into the settled central regions of the South African colonies. The eggs of this species are laid in winter, and are incited to hatch by the influence of the summer rains. Dry conditions lead to postponement of hatching, possibly for a term of more than three years, and such "suspension of animation" is obviously of advantage to a desert-haunting species. Like the red-winged, the brown locust was less numerous and destructive in 1908–9 than in 1907–8, which seems to have been a year of exceptionally severe attack. In March of last year, however, enormous swarms of this species invaded Cape Colony from the north, overspreading an area of 125,000 square miles, so that during the summer of 1909–10 great care and energy will be needed to keep the pests in check.

According to Mr. Lounsbury, no preventive measures can be taken in the "uninhabited and practically waterless wastes" whence the great swarms migrate into the colonies. Attention must be directed to the destruction of the young locusts hatched from the eggs laid by these winged swarms. The young insects during their preparatory stages, while the wings are still undeveloped, are known as "hoppers" or "voetgangers" by the English or Dutch farmers. It is these young locusts that ravage the crops to so terrible an extent, and if the insects be left alone, successive generations may follow each other in the settled districts that are invaded. The farmers, therefore, assisted by the Government, are urged to make war on the "hoppers." Burning grass lands, and poisoning with a sweetened solution of soda arsenite, are the means of combat now in general use. During the locust-campaign of 1907–8, forty-three tons of soda arsenite, ninety-eight tons of sugar, forty tons of treacle, 150 water-tanks, and 5000 pumps were provided, and nearly 12,000*l.* was expended.

In his warfare against the locusts, man finds valuable allies in several species of birds, which pursue the locust swarms, and sometimes well-nigh exterminate them. Kestrels, the "locust bird" (*Glareola melanoptera*), and the white stork are especially active as locust-eaters. It is of great interest to find that two white storks observed devouring locusts in Basutoland in January, 1909, bore leg-rings with inscriptions showing that the birds had migrated from northern Germany in the preceding autumn.

G. H. C.

[1] Third Annual Report of the Committee of Control of the South African Central Locust Bureau. Edited by Charles P. Lounsbury, Government Entomologist, Cape of Good Hope. (Cape Town, 1909.)