Notes, Short Comments, and Answers to Correspondents.

INDUSTRIAL HYGIENE: ITS RISE, PROGRESS, AND OPPORTUNITIES.¹

BY SIR THOMAS OLIVER, M.D. GLASG., F.R.C.P.

It is just over a century ago since the British Parliament turned its attention to the fate of children employed in the mines and factories of this country, and little more than half a century ago since diseases due to occupation received similar recognition. Great Britain was the pioneer of industrial legislation. The utilisation of water power and steam led to the rise of the factory system and to the growth of large towns. The "Industrial Revolution," which began about 1740, and the inventions which preceded and followed it, not only placed us as a nation in a high position in the world of commerce and made us wealthy, but it created new methods of employment associated with the subdivision of labour, as well as a new class of workers to meet the requirements. It also initiated problems towards the solution of which, as the statesmen of the time had no experience to guide them, the laws which they framed could at the best be but only tentative and a makeshift. While the introduction of machinery made labour in the factories in one sense less irksome, it led to the employment of women and children, many of whom, owing to the long hours and low wages, rapidly broke down in health, with no financial assistance from the State or from the industry to fall back upon, so that to ill-health were added the distressing circumstances of poverty and starvation with only the workhouse to look forward to. In order to prevent physical degeneration of the working classes it became necessary to improve the conditions under which labour was carried on in mine and factory by shortening the hours of labour for women and children, and by raising the age of child workers. The employment of children of seven years of age in our coal-mines and factories, and the harsh treatment extended by overseers to them, since they were frequently beaten or handled roughly when they were found asleep at work, form unpleasant reading in the pages of the industrial legislation of this country.

Industrial Legislation.

From the first decade of last century onwards to the Victorian period Parliament time and again shortened the hours of labour, restricted the employment of children, and improved conditions within the factories, but even as late as 60 years ago little had been done to instil into the mind of the people the association of certain diseases with particular occupations, and how these diseases might be prevented. Thackrah, in 1831, had written upon the subject, and J. T. Arlidge, in 1892, had published his monumental work, but occupational diseases as a class had not yet caught on with the medical profession, and so matters drifted. Sir John Simon, at the dawn of the public health movement in this country, recognised how closely identical was the health of workers with the object sought to be secured by a public health service, and that in the prevention of disease lay one of the most important duties of the medical profession. To-day the preventive side of industrial medicine is regarded as even more important than the curative. Industrial hygiene may be said to have merged out of, or to have been a continuation of, Parliamentary interference with the claims of employers to utilise labour almost to its breaking point. Occupation was never meant to cripple workmen, cause ill-health, or induce early death. It was thus that medicine was drawn into the social movement in which it plays an honoured part to-day. In few fields of human activity has the call for preventive medicine been greater than the various industries of this country, with their former high mortality and sickness rates. Society, in the past, kept itself too far aloof from knowledge of the conditions under which certain trades were carried on, and even the workers themselves were not always aware of the dangers to which their employment exposed them. Ignorance is responsible for many of the calamities which overtake us. It became necessary to instruct workers and employers in regard to occupation and health, for to have knowledge is to be forearmed. Regulations drawn up by the Home Office, and meant for the welfare of workers, have from time to time been challenged by both employers and employed, and there is no objection to this, since at a conference of the parties concerned conflicting opinions may be modified, or,

failing this, a compromise is effected, and work allowed to continue, during which fresh regulations can be given a trial.

The Widened Scope of Industrial Hygiene.

Within the last few years the scope of industrial hygiene has widened. It includes not only consideration of the conditions under which work is carried on, the hours of labour and diseases incidental to occupation, but it deals with the physical effects of work as seen in fatigue and how hours of work and rest may be correlated so that there may be obtained the maximum of production with the minimum of effort, also that the hours of respite from labour may be made sufficiently long for recovery from exhaustion to take place. The tendency has been to remove from labour any serfage element which may have clung to it as a remnant of bygone days, and to recognise that men and women are not mere machines, but that they are entitled to the opportunities of improving themselves mentally and physically. To-day industrial hygiene is no longer the affair of one nation but of all the advanced nations. The creation of the International Labour Bureau under the aegis of the League of Nations has raised industrial medicine to a higher platform, so that while the health of the workers is one of the main objects, and production is regulated by the physical fitness of the worker and by the hygienic conditions under which labour is carried on, the fact that industrial medicine has become international will incite backward nations to aim at securing a higher standard of health for their workpeople, as well as more efficient means of increasing production. Arising out of legislation passed for improving conditions of labour and shortening of the hours of work, and proceeding through medical supervision of workers and the elimination of the unfit as well as the substitution of comparatively harmless for harmful methods of production, of industrial medicine it may be said that although it has made such rapid strides that many of the results obtained have become fresh energising influences in the life of nations, yet many opportunities for good still lie in front of it.

Medical examination of workers before commencing their industrial career would no doubt create hardships, but the ultimate gain would transcend all these. Even with the ordinary precautions taken there would still be found a certain number of persons who would break down in health earlier than others, either as the result of diminished vital resistance or of idiosyncrasy.

Sir Thomas Oliver then gave an account of the transformation from dangerous into comparatively safe industries those of lead-mining and match-making, and discussed briefly the pathology and prevention of carbon-monoxide poisoning, adding a short survey of the preventable hazards to which coal-miners were formerly subjected. He continued:—

Fatigue.

There is one side issue of industrial hygiene which has recently attracted attention—the subject of fatigue. A hundred years ago the world moved, as the saying is, more slowly than it does to-day. Men took things more quietly; there was neither the strain nor the competition characteristic of modern times. Hard work was followed by fatigue then as now, but it affected principally the muscular system; to-day it falls more upon the nervous system. Collective work is carried on in over-heated factories amid the din of machinery and it demands close attention. The reality of fatigue was brought home to us by the large number of men and women who broke down in munition work during and after the war. There is a limit beyond which the human machine cannot produce satisfactorily. Fatigue as subjectively experienced is a series of ill-defined sensations not always localisable, attended by disinclination for work and by a desire to rest. Professor Drever² thinks that the word "weariness" pretty accurately describes the subjective state in the individual, and that objectively fatigue can best be defined in terms of output, as shown by a lowered efficiency in the organism, and revealed by impairment of the quality, and diminution of the quantity, of work done. The delicate nerve cells and nerve endings of the human body become readily fatigued, but if we take fatigue to mean an inability to carry on as previously, then fatigue is not confined to living tissue alone, for a similar event occurs in the inorganic world. Steel wires when over-strained play out and behave as tired nerves. It would be of the greatest assistance if we could with a certain degree of definiteness ascertain just to what number of hours a man can work before his energy begins to fail, for once this takes place, if work is continued, it is unprofitable. Clearly the number of hours of work cannot be the same for all individuals or for all trades. As regards fatigue, much will depend upon the previous health and upbringing of the worker, how he is fed and housed, and how he spends his leisure hours.

The recent war has been followed by disastrous consequences in the case of many of the discharged soldiers.

¹ Abridged from a Special Address delivered at the Eighty-Ninth Annual Meeting of the British Medical Association.

² Drever: *The Psychology of Industry*, p. 61. Methuen.

The long weary vigil in the first line of trenches and the hardships endured, also the comparatively idle months spent away from the firing-line, have made many of the men unwilling or unable physically to return to their previous employment. Some of them have lost their taste for work, and they clamour, like those who remained at home, for shorter hours of labour. Shortening of the shifts and a change in the hours of work are notable facts of the times. Men no longer go fasting to work at 6 o'clock in the morning and breakfast in the factory at 8 o'clock. They leave home, or ought to, after a comfortable breakfast in time to reach the factory by 7.30 A.M., and this has been to the advantage of employer and employed. Better time-keeping has been the result and there has been less sickness. Shortening of the hours has, in most industries, been followed not by diminished but by increased production and by a rise in wages, but as there is a limit to which hours can be shortened and productive efficiency retained, it is a question whether, in some trades, this limit has not now been reached. It is unwise to work men and women to the last unit of their energy, for not only is work under these circumstances never so good, but fatigue—although the contention is not supported by Dr. Vernon—may become a cause of accident. It is now generally admitted that fatigue is the result of the action upon the tissues of such poisonous substances as carbon dioxide and lactic acid formed by the chemical dissolution of the glycogen of overworked muscles. These bodies act, not only upon the muscular tissue itself and the nerve endings in the muscles, but since they find their way into the blood stream they poison the higher nerve centres in the brain, thus converting fatigue, the outcome primarily of localised changes in the neuro-muscular apparatus, into a general state of the organism, and of these two forms of fatigue, central and local, the central or general fatigue is the more important.

Sir Thomas Oliver then alluded briefly to the effect of fatigue on the blood, demonstrated by Dr. Otto Burkard, of Graz, and after commenting on the problems arising out of compensation for industrial disease, concluded with a few words on

The Industrial Medicine of the Future.

Since industrial medicine has come to stay, facilities will in the future have to be provided to medical students and young graduates to become familiar in a practical manner with its objects. Never were the times more opportune than to-day. The prosperity of a nation is intimately bound up with the health of the people who compose it. Preventive medicine has, practically speaking, swept these islands clear of typhoid fever and considerably reduced the mortality of diphtheria. What it has accomplished on the side of public health it can also accomplish in regard to occupational disease. The die has been cast. There is a psychology of industry just as there is a physiology. Psychology is no longer simply "the science of mind or soul," but "the science of the facts of human nature and behaviour," and there is no department of human activity which offers greater scope for its study and application than industry. Employers no longer regard "industrial hygiene" as something to be turned down on the ground of its interference with labour and the conditions under which it is carried on. They recognise that it introduces into industry just that something with a touch of humanity in it which softens the asperities of labour, makes occupation more healthful, and tends to bring employers and employed into closer touch with each other. Had it not been for "welfare work" carried on during the years 1914 to 1918 the enormous productions of munitions could hardly have taken place, and without it we would have lost the war. Industrial medicine and welfare work go hand in hand. Invention and chemical research tend to make industrial processes, if not more complicated, sometimes more dangerous, as was the case in the early days of the war with the handling of certain high explosives, but the same inventive skill which created temporary dangers showed itself equal to supplying an antidote to them or of finding a substitute. In the ever-enlarging sphere of industrial enterprise, to which the various sciences are contributing, and the needs of the world are calling for, lies the opportunity of Industrial Hygiene.

A MINE MEDICAL OFFICERS' ASSOCIATION ON THE RAND.

MEDICAL service to white workers in most of the gold mines on the Rand is secured by the appointment of one, two, or more whole-time or part-time medical officers by a Mine Benefit Society, to which each worker contributes, and the funds of which are administered by a committee elected by the men themselves. Recreation rooms, library, billiard rooms and facilities for outdoor games are also provided by the Benefit Society, and a hospital is run for the employees of one mine alone or for those of two or three neighbouring mines. The native employees as a rule are under the care

of doctors appointed by the proprietors of the mine, and besides staffing the native hospitals these doctors are responsible for supervising the sanitation of the compounds and the hygienic conditions of the native worker. In order to stimulate discussion on the important problems involved in the care of the native, a Mine Medical Officers' Association has recently been formed, its objects being: (1) To study and discuss all problems of special interest appertaining to the work of mine medical officers. (2) To promote and foster friendly intercourse and consequent exchange of views among mine medical officers. (3) To bring to the attention of members matters of interest to them in their special work, by means of periodical publications, &c., as may from time to time seem most advisable. (4) To coöperate in solving administrative and other problems confronting members. Those eligible for membership are medical officers holding whole or part-time appointments in connexion with mine native hospitals in the Transvaal, and such other medical practitioners as the Executive Committee may from time to time invite. The special liability to pneumonia of certain tribes of natives, their protection from scurvy, and the management of epidemics such as that of tropical ulcer which has recently attacked the native workers at one of the mines, are a few of the problems to which the new Association may be expected to give attention.

In the *Medical Journal of South Africa* of March and April 1921, an account of the first meeting of the new Association is given. Dr. A. J. Orenstein reviewed the theories as to the aetiology of scurvy, and spoke of its special interest to medical officers of mines dealing with native employees. In the early days of large scale mining operations scurvy, he states, was prevalent, and though in recent years it had decreased enormously, there had occurred in 1920 in one of the important groups of mines over half the number of cases recorded in that group during the last six years. The figures he gave were as follows:—

	Cases.	Repatriated.	Deaths.
1915	69	51	2
1916	116	55	1
1917	52	56	2
1918	51	69	3
1919	106	38	5
1920	403	102	16
Total ..	797	371	29

Dr. Orenstein said that the vitamin theory was substantiated by the experiences of medical officers in the Rand. In every instance which had come under his own observation in the last six years an outbreak of scurvy was associated with a diminution of the vegetable ration, or gross overcooking of the same, and in every instance an increase in the vegetable ration, or an improvement in the cooking of same, resulted in the prompt checking of the outbreak. Dr. Marion Delf was continuing work started at the Lister Institute on the effect of cooking on the anti-scorbutic vitamin at the South African Institute for Medical Research.

At the same meeting Dr. S. Donaldson read a paper on the Clinical Side of Scurvy in the Mine Native Labourers; he described two types of case, one of which was much more amenable to treatment by anti-scorbutic remedies than the other. In the course of the discussion Dr. Orenstein expressed his conviction that the condition found in mine natives was not scurvy alone, but was due to a deficiency in all three vitamins. Certain cases had improved rapidly after receiving vitamin B., and others after fat soluble A. had been increased in their diet.

FACTORY GIRLS' COUNTRY HOLIDAY FUND.

To the Editor of THE LANCET.

SIR,—Will you allow us to make a very urgent appeal for funds to send working girls and women away for a short holiday? Many of those who are hoping to go during the next few weeks have never slept out of London for a single night. We are almost at the end of our resources, and the need for our help is probably more urgent than ever before. Trade depression has resulted in the girls being the main support of thousands of families, which but for their earnings would be on the verge of starvation. The general standard of comfort in the average home is lower than it has been for many years, and the health of the community in the crowded and airless factory districts of London has deteriorated considerably. Nor has it been possible for the girls to save for a holiday as they have done in former years. Good food, rest, and fresh air for a short time will make it possible for many to continue their work through the winter, who would otherwise break down under the strain and privation they have had to bear for so many months, and the short holiday will give them fresh hope and courage. We earnestly ask for subscriptions and donations to be sent to the Chairman of the Executive Committee, Mr. J. F.

Green, M.P. 75, Lamb's Conduit-street, W.C.1, or to the London County Westminster and Parr's Bank, Hatton Garden, E.C.1. We are, Sir, yours faithfully,

JOHN KENSINGTON, J. H. HERTZ (Chief Rabbi),
ALBERTA SANDWICH, ROBERT F. HORTON,
LOUISE CREIGHTON, FRANK LLOYD,
MARY ST. HELIER, J. F. GREEN (Chairman).

July 19th, 1921.

TRIFOLIUM STELLATUM AT SHOREHAM.

To the Editor of THE LANCET.

SIR,—In the obituary notice of the late Sir George Savage, appearing in your issue of July 16th, a personal friend mentions an unsuccessful search for the star clover at Shoreham, and adds that it is still there. I should be glad to hear if this is really so. Over 30 years ago I can remember Mr. G. C. Druce showing me a pocket-case full of the stellate fruits he had gathered on the beach. During the decade 1902–11 I searched every year for the plant, but only found it (and then very sparingly) on two or three occasions. The erection of bungalows, formation of roads, and other human activities resulted in its practical extinction, so far as my limited observation went. As Shoreham beach is the only British habitat for a rather striking plant, I should be very glad indeed to hear that it was still holding its own. Perhaps some of your South Coast readers have some recent information on the point? I may add that from seeds obtained at Shoreham I have grown specimens of the plant in my garden for many years past.

I am, Sir, yours faithfully, J. E. SAUL.

Analytical and Bacteriological Department, Savory and Moore, Ltd., 143, New Bond-street, London, W.,
July 19th, 1921.

PUBLIC HEALTH AT COLOMBO, 1919.

IN his report on the conditions of public health at Colombo during 1919, Dr. W. Marshall Philip, the medical officer of health, commences by stating that the birth-rate, 21.7 per 1000, was the lowest recorded for 15 years, whilst the death-rate, after falling from 39.8 in 1906 to 24.3 in 1917, had risen to 28.0 in 1918 and 28.8 in 1919; the infant mortality, having fallen from 410 per 1000 births in 1903 to 234 in 1916, had risen to 251, 266, and 271 per 1000 in the three years 1917–1919 respectively. The population is estimated to have been 271,616 in the middle of 1919, but the correctness of this is open to doubt, especially in certain wards, where a large number of new buildings have been erected. Among the various races included in this total, the native Sinhalese naturally form the majority (121,848), after whom come Tamils from Southern India (65,797), Moors (47,854), Burghers (Dutch or Portuguese, 17,812), and Europeans (3795), the remainder consisting of Malays and others. The birth-rate varied from 12.1 amongst Tamils to 32.0 amongst Malays; for Europeans it was 17.1, for Moors 17.6, and for Sinhalese 27.9. The general crude death-rate of 28.8 is to be compared with the decennial average (1909–18) of 28.2; if corrected for deaths in hospital of non-residents, and for age and sex constitution, the ratio becomes 29.7, "which is the nearest approach to the true death-rate of Colombo which can at present be obtained." The corresponding ratio for 1918 was 29.4 per 1000. As regards the different races making up the total (crude) ratio of 28.8, for Sinhalese the ratio was 34.3, for Moors 24.2, for Tamils 23.1, and for Europeans 17.1 per 1000; if corrected for deaths in institutions, this last figure becomes 9.8, practically the same as in 1918, when it was 9.5 per 1000. The infantile mortality ratio (271 per 1000 births) was higher than in any year since 1913, when it had been 286. Dr. Philip discusses this matter and "is forced to the conclusion that one of the principal causes, if not the chief cause, is lack of proper nourishment for the pregnant women and their infants," probably owing to increased cost of living since the war broke out. Owing to failure of the monsoon in 1918, the Indian Government restricted the export of rice. The normal monthly import into Ceylon of 30,000 tons fell to less than half in May, and less than a quarter in June; food control was initiated on May 9th, and rationing of rice on June 10th. The cost of living has been increased in Ceylon, as elsewhere, but Dr. Philip clearly shows that there was no "starvation," though there was a good deal of "privation" and anxiety. The daily crowding together of the people entailed by the introduction of the rice depot system was apparently responsible for an increase in enteric fever and measles; and the storage of grain in buildings not rat-proof resulted in a number of cases of plague in the last three months of the year. The proportion of septicæmic cases (57.4 per cent.), and the very high case-mortality (94.3 per cent.) showed that there had been no material reduction in virulence. No cases of cholera occurred in Colombo, but ten were admitted to hospital from the port, and one from outside the town. There were only three cases of small-pox, two having acquired infection in India. Primary vaccination was performed in 6637 children,

the number of births in Colombo during the year having been 5907. This is very satisfactory, and should be an example to that unfortunately large number of persons in the United Kingdom, who are either unable or unwilling to realise their responsibilities in regard to this matter. Dr. Philip's is a most comprehensive report, fully illustrated with plans and diagrams, and contains much other matter of interest.

ACTION OF THE HEART AFTER DEATH.

SOME interest has been evinced in our correspondence columns by Sir Dyce Duckworth (July 2nd), Sir William Milligan (July 9th), and Surgeon Commander D. H. C. Given (July 23rd) in the circumstances of the death of a man at Willesden whose heart continued beating long after respiration had ceased. At the inquest on June 20th a verdict of "Death from natural causes" was given, the circumstances of the case being as follows. The man became drowsy about Whitsuntide with severe pains in the head, but continued to work until a fortnight before his death, when he became worse. On admission to the hospital he was suffering from drowsiness, stiffness of the muscles of the back, and headache. It was considered advisable to obtain a sample of his cerebro-spinal fluid, and to this end he was anaesthetised with a mixture of ether and chloroform at 11.20 A.M. on June 16th. Some fluid was drawn off—the whole operation took only half a minute, but the man ceased to breathe, though his heart continued to beat well. Artificial respiration was continued up to 7.30 P.M., when the heart ceased beating. The post mortem revealed a tumour on the right side of the brain, which proved to be a sarcoma. A tracing of the heart was taken at 5.30 P.M.

As is well known, in chloroform anaesthesia the respiratory movements may suddenly cease, and after a time be resumed. The heart beats, however, unlike the respiratory movements, do not essentially depend on the integrity of a nerve centre in the medulla oblongata. In fact the heart contains in its own walls and perhaps in its own muscular fibres the secret of its own rhythm. The fact that an excised heart in some animals will beat for days proves this. Those who are not acquainted with the marvellous powers of endurance of the heart muscle regard the heart itself as a singularly vulnerable organ. The very opposite is the case, and it will go on beating for quite a long time, even under seemingly very unfavourable conditions. Its demands are small but specific. In the present case artificial respiration, it appears, was kept up for about seven hours, the heart only ceasing to beat at the close. With the artificial movements of the chest wall the blood would be aerated to a certain extent, and as the heart still retained its automatic rhythmical movements, this partly aerated blood was sufficient to maintain the heart beat, but would not appear to have had the properties necessary for the excitation of the respiratory centre on the one hand, and the maintenance of consciousness on the other. We know how sensitive cerebral tissue is to the lack of oxygen and other conditions.

Prof. C. Richet some years ago obtained a film of the beating of a dog's heart with the chest opened, artificial respiration being kept up or arrested at the will of the operator. With cessation of the artificial respiratory movements, after a time the heart—engorged with blood—ceased to beat. On resumption of the artificial respiration, after a time the congested condition of the heart was relieved, and it slowly but surely resumed its beat. This could be done time after time. In the case recorded above the steady artificial maintenance of the respiratory movements, no doubt, kept the blood sufficiently aerated to ensure the long-continued beating of the heart. At what hour did "death" in the eye of the law take place? With the cessation of normal unaided respiration and loss of consciousness, while the heart still continued to beat; or only when normal respiratory movements and consciousness had long ceased; or when the heart itself ceased to beat?

The law presumably would regard the question as one of fact, depending upon the evidence of the medical witnesses. It would probably ask that the time should be fixed when all symptoms of life ceased, and suggest that this should be treated as the time of "death." It would be difficult to maintain otherwise. In the above case artificial respiration was kept up in the not unreasonable hope that natural respiration and consciousness might eventually be restored, and a medical witness could hardly say that a person was beyond doubt "dead" at a time when he himself, guided by the experience of his profession in other cases and by the observed action of the heart, was treating him as though he were, or might be alive. The question of the exact moment at which life ceases is not often of importance, but it may affect the devolution of property. In the case of the subject of the inquest referred to, if someone had died at 1 P.M. on June 16th leaving to him a sum of money or land in fee simple, the hour of his death might become of extreme interest to his children and to others affected by the same will.