HEALTHY ATMOSPHERES.

PHYSIOLOGICAL research has proved that the cause of discomfort felt in close, ill-ventilated rooms is due to the physical, and not to the chemical, properties of the atmosphere. We exclude gross contamination by products of imperfectly combusted coal gas, *e.g.* from defective gas fires imperfectly flued. These chemical products irritate the nose and throat, and one of them—carbon monoxide—is a poison. We exclude too, those mines and factories wherein certain poisonous products of industry may pollute the atmosphere. We are writing of rooms crowded with human beings, of over-heated, windless rooms. The percentage of oxygen in such crowded rooms is never reduced by more than 1·0 per cent., and at any of the mountain health resorts the concentration of oxygen is reduced considerably more owing to the attenuity of the air. Similarly the percentage of carbonic acid is never raised in crowded rooms to such a level that it has the least toxic effect. Within the lungs a constant concentration of carbonic acid of about 5 per cent. of an atmosphere is maintained. The acidity of the blood regulates the action of the breathing mechanism, so that both it and the concentration of carbonic acid in the lung are kept constant. The only result of breathing an atmosphere containing 0·5–1·0 per cent. of carbonic acid—the most crowded room does not contain more—is a slight deepening of the respiration by which the concentration in the lung is kept at the normal figure. It becomes difficult to maintain the normal concentration in the lung when the concentration in the atmosphere rises above 3·0 per cent.; the breathing of even a resting man then becomes over-laboured. The crew of a submerged submarine feels the need for fresh air when the CO_2 concentration rises above this level.

Exact experiment, made by many competent researchers, wholly fails to confirm the assertion, so confidently made in all popular books of hygiene, that the expired air contains a subtle organic poison. The air of a crowded room smells offensive to one coming in from the fresh ar, and it may, and often does, infect us with the living germs of disease, sprayed out from the mouth, or nose, of those who cough, sneeze, or speak, but it contains no organic chemical poison, and the fatigue and headache felt by the more sensitive occupants is certainly not due to such. These effects are produced by the physical properties of the atmosphere acting upon the nose and skin, on that enormous field of sensory nerves which supplies the surface of the body, contributes so greatly to our feelings of well-being, and regulates the metabolism of our bodies. The cutaneous and nasal sense-organs are influenced by the temperature, movement, and vapour pressure of the air, and the physical qualities of the atmosphere, which control the loss of body heat by convection or evaporation. Out of doors we are ceaselessly stimulated by the play of wind; cloud, and sunshine, cold and heat, wet and dry alternate; monotony, the curse of the nervous system, is repelled. Cool, moving air braces us up; we are made active, eat more, and breathe more to keep up our body furnace. The daily turnover of the body is thus enlarged, the appetite is stimulated, and the food eaten is completely utilised and does not become dross and waste, the generator of bacterial decomposition in the bowel. The blood is refined out of a larger choice of foodstuffs, and the organs receive from it an ampler supply of the more precious and rarer building stones; the muscular exercise which we are compelled to take to keep warm, occasions the blood to circulate in ampler and quicker streams, and deepens the breathing, thus ensuring the proper expansion of the lungs, and the natural massage of the organs of the belly.

We are built to be active, and keep ourselves warm by muscular action. By over-clothing our bodies and over-heating our rooms we weaken our vigour, expose ourselves to nutritive disorders, and debilitate the natural mechanism of defence against infective disease. Moreover, in these heated, stagnant atmospheres we expose ourselves to massive infection by those carriers of disease who have in their respiratory tract some strain of microbe exalted in virulence, and thus spread "colds" or influenza, pneumonia, or phthisis. Mere exposure to cold does not cause these ills. Arctic explorers and shipwrecked people who suffer the extremes of exposure do not suffer in consequence from such illness. Excessive cold may cause local death and gangrene, or kill by cooling the whole body below a viable temperature, but our power to withstand cold is enormous, innate, the result of a million years of an evolution spent in struggling against the forces of nature. The inclement and dark wintry weather impels people to shut up windows, crowd into close, over-heated rooms, and thus expose themselves to massive infection.

The sedentary worker in heated, windless atmospheres runs his metabolism at a low level, and if he over-indulges in the pleasures of the table, easily becomes the sufferer from digestive and metabolic ailments. It is not the bad weather that causes the ill-health prevalent in the winter, but the excessive precautions most of us take to avoid exposure to cold. Only the very old and feeble, in whom the lamp of life burns low, want such protection. The young and the able-bodied require the stimulus of exposure to the weather; the discomfort arising therefrom soon results in vigorous health, and ceases to be felt. The soldiers of our new armies taken from shop, desk, or factory, and exposed in trench or camp, have been singularly free from disease which is supposed to result from chill, in spite of the hardship of cold, wet, and mud. Adequately fed, clothed, and rested, the open-air life has made the clerk, shop, or clubman twice the men they were, given them a healthy hunger, steady nerves, a clear, ruddy complexion, and increased weight, and yet for days together their clothes may have been damp.

The fear of cold and damp instilled in the nursery often checks the physical development of the young, and leads to a lessening of national vigour and health. The open-air school works wonders on the badly nourished, defective children, and should become the school of every child in the community. The camps of to-day placed in the wind-swept open spaces of the land are founded on the emergency of war, but should become the week-end playgrounds of the nation in times of peace. Our cities have been built so as to satisfy regulations based on the chemical theories of ventilation and the nursery-bred fear of cold. They should be re-planned so as to allow the maximum of sunlight and wind, affording baths and exercise grounds for all. The conditions of life at present wage a deadly war against us. We listen for the whirr of the Zeppelins, and take little heed of the silent sowing of the germs of preventible disease.

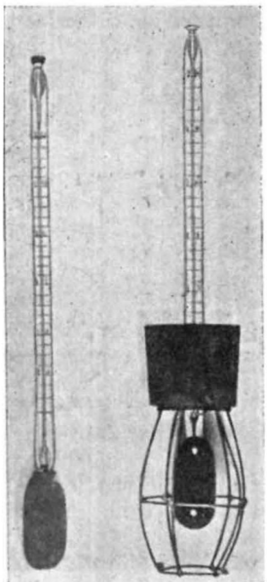

FIG. 1.—The Wet and Dry Katathermometer. The Dry instrument is shown enclosed in a wire cage, which was used for taking observations in investigations on clothing.

To secure these healthier conditions we require instruments which will measure the physical conditions of the atmosphere and make manifest the differences between confined and open air. The thermometer registers the average temperature of the surroundings; it gives us no information as to the rate of heat loss from the surface of the human body. It is the rate of heat loss which matters to us. Out of doors, on ideal spring days, the ground is warm and the wind scarcely moves at foot-level, while our heads are blown upon by a variable cooling breeze; the sun warms one side of us while the other is cool. The clouds chasing each other across the blue sky give us shade alternating with sun. Our feet are kept warm, our heads cooled, and our cutaneous nerves are continually excited by the ever-varying rate of cooling. There is no monotony, but an agreeable energising of our nervous system. When the heating and ventilating engineer gives us a uniform summer temperature of 63° F. by means of steam coil (so called) radiators, he secures us a warm atmosphere above and a cold floor below, cold feet and warm heads, and a deadly monotony of conditions. The right system of heating and ventilation would give us a warm floor and a variable, gentle, cool breeze moving round our heads.

In the House of Commons the engineer forces air, heated to 63° F., through a perforated floor, and thus, cooling the Members' feet, gives them conditions which lead to congestion of the mucous membrane of the nose and its air-sinuses, resulting in obstruction of the nasal airway, feelings of stuffiness in the head, and increased liability to infection by the germs of "colds" and influenza. A system more contrary to the outdoor ideal conditions could not have been invented. To measure the physical conditions outdoors and indoors we require an instrument which will measure the rate of cooling by radiation, convection, and evaporation, and will tell us whether the atmosphere is monotonous or not. The present writer has introduced the katathermometer for making these measurements, and with Mr. O. W. Griffith has introduced an electrical instrument, the caleometer, for the purpose of recording not only rate of cooling, but indicating whether the atmosphere is monotonous or lively.

The katathermometer (Fig. 1) is a large-bulbed spirit thermometer, made (by Mr. J. Hicks, 8 Hatton Garden) as nearly as possible of a standard size. Each instrument is tested against a standard one, and a constant obtained by which the rate of heat loss can be deduced in calories per sq. cm. of surface. The katathermometer is heated in warm water until the spirit just rises into the top bulb, and the column is free from bubbles. The instrument is then wiped dry and suspended in the atmosphere, and the time observed taken by the meniscus in falling from 100° F. to 95° F. This gives the rate of heat loss by convection and radiation, the instrument being approximately at body temperature. A muslin finger-stall is then drawn over the bulb and the operation repeated after heating the instrument and jerking the excess of water off the muslin cover. The time taken in this case gives us the heat loss by radiation, convection, and evaporation. The difference between the dry and wet readings gives us the heat loss by evaporation only, and from this, when the readings are taken in still air, the vapour pressure can be determined.

The value of rate of heat-loss measurements are seen by the following examples:—(1) Inside a cottage room on the East Coast and outside on the cliff edge the summer temperature was the same, but outside the katathermometer cooled much faster. It registers just as the human body feels the bracing effect of the moving air. It acts as an anemometer, sensitive not only to currents in one direction, but to every eddy which the ordinary anemometer fails to register. The instrument shows the vast difference between the conditions of the indoor and outdoor worker. (2) In the debating chamber of the House of Commons the thermometer registers a temperature of 63° at foot and head level, but the katathermometer shows the rate of cooling is 50 to 100 per cent. greater at foot level than at head level. When the conditions were experimentally altered in one part of the House so that all floor inlets were closed, and the air introduced at the gallery level, the rate of cooling became slower at foot level than at head level. Then the congestion of the nose was relieved as the feet became warm and comfort was secured. (3) In a room heated by a gas (so-called) radiator with window open at top a few inches, and three doors, beneath

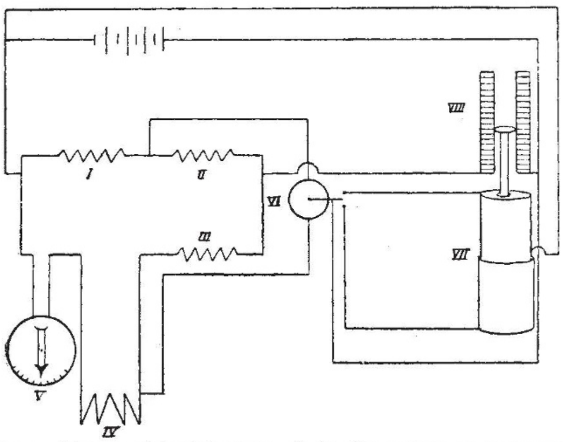

FIG. 2.—Diagram of the Caleometer. I., II., III. and IV. are the arms of a Wheatstone Bridge. When the caleometer coil IV. becomes warmer than 40° C. the index of the galvanometer VI. (used as a relay) goes upwards in the diagram and completes the circuit which includes the upper half of the electro-magnetic coil VII., the soft iron plunger moves then upwards and increases the resistance in VIII., less current then passes and the coil IV. cools. When the caleometer coil IV. cools below 40° C. the index of the relay VI. moves downwards and completes the circuit which includes the lower half of the coil VII. and this pulls down the slider and lessens the resistance in VIII. V indicates the watts or calories required to keep IV. at 40° C.

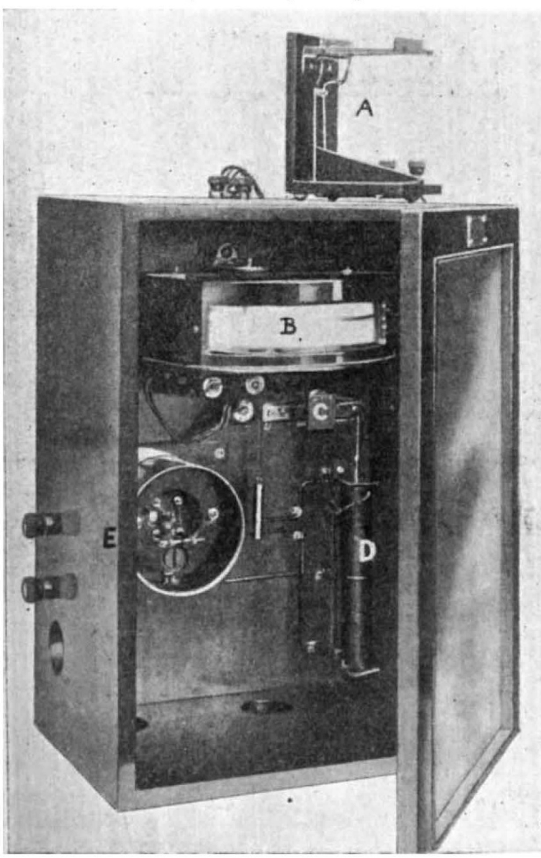

FIG. 3.—The Caleometer. A, caleometer coil. B, watt meter. C, travelling slider. D, magnetic coils surrounding soft iron plunger which moves in oil-bath. A string passes from the plunger over a pulley wheel on the slider to a counter-balancing weight and actuates the slider. E, the galvanometer acting as relay.

which the draught entered, the feet felt very cold and the head felt stuffy, the nose was congested, and the conditions for comfortable mental work at a desk were bad. The katathermometer showed that the rate of cooling at foot level was 40 per cent. greater than at head level. On heating the same room by a properly flued gas fire, and securing warm feet by exposing them to its radiant heat, comfort was at once secured. The katathermometer showed that the rate of cooling at the level where the feet were was 30 per cent. slower than at head level.[1]

The caleometer, by its automatic action, indicates the amount of heat energy required to keep a small coil of wire at body temperature. The oscillations of the indicator show the cooling effect of moving air and the variations of air currents. If the atmosphere is still and monotonous, the oscillations of the indicator will be small and few in number.

Records of any number (up to eight) of caleometer coils, placed in different parts of, say, a factory, can be taken by using a self-recording watt-meter.[2] The instrument is seen in Fig. 3.

LEONARD HILL.

AIDS TO NATURE-STUDY.[3]

(1) THE entomologist's walk in life is in many respects an enviable one, for it is his particular business to study creatures which often exhibit great beauty, amazing variety, and a strange subtlety of behaviour. The current of research as regards molluscs or mammals, let us say, has a strong, quiet flow, but that in entomology recalls a mountain stream with novelties and surprises at every turn. We feel this more than ever as we read Mr. Step's fascinating "Marvels of Insect Life." With the aid of beautiful photographs, many of them from his own camera, he gives us a lively sense of the wonderful intricacy of insect-behaviour, which often seems like a caricature of that of higher animals. But no one knows what its most accurate psychological interpretation may be.

The author writes with clearness and accuracy, and there is no fussiness in his enthusiasm. He is to be congratulated on having secured Mr. Theo. Carreras as a draughtsman, for the full-page plates are exceptionally clever, and most of those in colour are as successful as they are daring. In its whole get-up the book is certainly at high-water mark. Two minor features may be mentioned which show that there has been careful consideration of what an intelligent reader reasonably expects and rarely gets. One is that the technical names of the insects dealt with are

[1] Volunteers who will undertake daily readings with the katathermometer are asked to communicate with the writer (London Hosp tal Med cal College, E.). He is seeking to secure during the next six months records of open-air conditions in representative parts of Britain, and of those conditions which obtain in houses, schools, and factories.

[2] The instrument is made by Mr. Robert W. Paul, Newton Avenue Works, New Southgate, London, N.

[3] (1) "Marvels of Insect Life. A Popular Account of Structure and Habit." Edited by E. Step. Pp. viii+486. (London: Hutchinson and Co., n.d.) Price 10s. 6d. net.

(2) "Nature Notes for Ocean Voyagers." By Capt. A. Carpenter and Capt. D. Wilson-Barker. Pp. xvi+181. (London: C. Griffin and Co., Ltd. 1915.) Price 5s. net.

(3) "The Drama of the Year." By Mary Ritchie. Pp. x+118 (London T. C. and E. C. Jack, 1915.) Price 2s.