and February and from the south during all the other months. By months, the relation that the prevailing wind bears to the entire wind movement, expressed in percentages, is as follows: January, 52; February, 70; March, 43; April, 45; May, 70; June, 50; July, 41; August, 39; September, 73; October, 68; November, 43; December, 43. The following statement shows the second most frequent direction, where it is at all close to the prevailing: January, south; March, northwest; June, southwest; July, southwest; November, northwest; December, northwest.

A study of the diagram clearly indicates that the wind from any of the directions from which it usually blows will carry the smoke from the industrial zone out into the country, and that the smoke-bearing winds will blow over the city during but a small part of the time.

In discussing this subject Mr. West made the following statement:

It is obvious that it is greatly to be desired that the residential sections of the city be to the windward rather than to the leeward of a large factory district, especially where the use of soft coal is prevalent. Even though electric energy be used to a large extent in such a factory district, there are always odors and noise emanating from such a factory district, which tend to make homes to the leeward thereof undesirable. A case in point is the large area of Chicago to the leeward of the stock yards. Unquestionably millions of dollars have been lost to property owners whose property has been affected by this condition.

Some years ago we got out a plan for La Salle, Ill. The Illinois Zinc Co. had its plant on the river bank, and directly to the north on the hills lies the major portion of the residential section. The gases and smoke from this plant resulted in killing trees and shrubs along the streets and on private grounds. In another portion of the city trees and shrubs in a cemetery located to the leeward of a large cement plant have been seriously injured by dust and gases. In working out the industrial district in this case, we were careful to place it on plateau land well to the northeast where, fortunately, we were able to secure other requisites, such as belt line connection with railroads, fairly level land and adequate water supply.

In the plan for Shreveport, La., we were compelled on account of local conditions to place the future factory district to the south of the city. We were careful, however, to zone the city in such a way as to force the better residential sections out of the path of the prevailing winds.

Some cities are not so fortunately situated in this respect as is Springfield. It is obvious that where a large body of water lies to the leeward of a city, preferred location for its industrial district can not be arranged. In the case of Chicago the prevailing winds are from the southwest during January, February, July, September, October, and December, and west in November. It will be noted that the winter months, when the smoke is probably the worst, are included in the southwest group of months. The prevailing wind is northeast during March, April, May, June, and August. The best residence sections have the advantage during these months.[1] A table showing the frequency of monthly prevailing wind direction at Chicago gives southwest 35 per cent of the total, and northeast 23 per cent. The large industrial plants at South Chicago and Gary are fortunately located. Because of the curvature of the shore line of Lake Michigan these plants are so situated that the smoke largely blows either to the southwest over open country or to the northeast far out over the lake and away from the city. The smoke from the west side manufacturing districts and railroad yards moves over the business center and north shore suburbs during the greater part of the year. This could only be avoided by locating these districts in what is now the best residence section of the city, the lake preventing the establishment of a manufacturing zone to the northeast of the business and residential sections.

At Milwaukee the prevailing wind is northeast during April, May, June, and August, but west and southwest throughout the remainder of the year. Here again the lake prevents the locating of smoke-producing industries in the most favorable place. The plants south of the business center and near the lake meet the situation fairly well. The trend of the shore line at Cleveland is largely northeast-southwest, and the lake offers no interference to the ideal placing of smoke producing industries. The prevailing winds are from the southwest during January, February, November, and December, west in March and April, and southeast from May to October, inclusive. With plants located in the extreme northeast part of Cleveland, the winds from any of the above mentioned directions would carry the smoke away from the entire city.

As planning and zoning projects are taken up in the various cities of the country consideration must be given to the matter of wind direction, and Weather Bureau officials will no doubt be asked to cooperate with the engineers in furnishing the desired information.

[1] Cox and Armington: The weather and climate of Chicago.

STIMULUS AND CONSERVATION OF ENERGY AS BASES OF MEDICAL CLIMATOLOGY.

By FRANZ BAUR, PH. D.

[Wetter-und Sonnenwarte, St. Blasien, Germany, April, 1923.]

SYNOPSIS.

The effect of stimuli on the natural defensive processes of the human body and conservation of its stock of energy, are the starting points from which medical climatology must develop, and which the latter has to deduce from observations of the physical condition of the atmosphere from clear comparative records. To do this it is necessary that all observations should relate to special physical properties of man, as well as his place of residence and personal habits, and that the description of climate hitherto customary, by giving only mean and extreme values, should give place to a description based on values intensities of stimulating power and of cooling power, and their respective durations.

It has been frequently pointed out, in recent times, both by medical men and meteorologists, that the method hitherto adopted of applying meteorological data to medical purposes is of little practical use. The deficiency is due partly to the different attitudes adopted by the professional meteorologist and the physician towards physical conditions of the atmosphere, and partly to the course of development of medical science during the last century. In both respects we seem to have reached a turning point. Medical climatology is about to give itself an independent position between meteorology and medical science, and to separate from the province of meteorology as a whole, those questions and results of research which are of especial importance to the physician.

A change has already become apparent in medical science, in serology and the therapeutics of proteins. For decades the chief objective of medical science was the complete understanding of the cause of diseases and the healing of the injured part of the body by means of specially adapted remedies, the so-called *specific* therapeutics. With medical science working on these lines, it was naturally only with difficulty that the completely unspecific *Climatotherapeutics* could be brought into line. Since, however, the value of increasing the energy of the cellular tissues through the application of protein therapeutics (injection of albumins), and the therapeutics of stimulus arising from this, has found new and general recognition, the way has also been made clear for a wider and more complete understanding of the nature of climatic influences on both healthy and sick people. Although the different methods of healing adopted in protein, physical, climato-and balneo-therapeutics respectively, appear very different, yet they all have a *common basis: the effect of stimuli by which the natural defensive processes of the body are set in motion.* In this respect casein injections and irradiations are similar, as also are open-air cures and hydropathic treatment. The stimuli called forth by these methods differ, of course, in intensity and kind.

The recognition of the fact that the influences of meteorological phenomena on the human body chiefly consist of stimuli acting on the defensive processes, offers a direct hint as to how the peculiarities of a climate have to be grasped and set down, in order that the doctor may use climatic data for his purposes. It is the business of the physiologist to investigate the nature of the stimulating effects of climatic elements, that is to say, to attribute certain responses of the many and various defensive processes of the human body to different stimuli, which are determined by atmospheric conditions; and further, to decide for each element the downward limit of intensity beyond which no stimulus is perceptible. It is the task of the climatologist to determine the strength of the climatic stimuli for each locality. From this it is clear that the method adopted up to now of recording mean and extreme values of the different meteorological elements, is quite unsuitable for medical purposes. We must rather have a continuous record of measurements of all climatic elements in question, and then from such a record formulate a complete survey in the shape of tables or graphs, showing how often and when, in a given locality, during a certain period, certain intensities of the cilmatic stimuli are either not reached or exceeded. Let us take for example the electric vertical current, which passes from the atmosphere to man in the open, certainly constituting a valuable stimulus and tonic, and let us assume that, on the ground of physiological investigations, the defensive processes of the body are stimulated only at an electrical conductivity of the air equal to a, and that at a conductivity greater than $3a$, still more defensive processes enter into play. In this case it will have to be shown how often, and in what space of time, and for what duration, in each separate case, at a given place, the conductivity falls below a, lies between a and $2a$, between $2a$ and $3a$, and exceeds $3a$. As far as two or more cilmatic elements cause stimulating effects, which may be equal to or dependent on each other, it will not be enough to consider the elements separately, but will be necessary to consider them acting together, and to classify them again according to limits of stimulating power and duration.

By the side of this biological aspect of the influence of climate on man, we can and must place, however, another, purely energic aspect, since not only the nature and intensity of the climatic stimuli are involved, but also the demands made upon the stock of energy in the human body. The source of the total activity of the human body is after all the heat of combustion derived from food supply and from respiration. Part of this heat is consumed in keeping the body at a temperature of about 37° C. by means of various physiological expedients, in spite of the atmosphere which in our latitudes almost always exercises a cooling influence. The greater the total effect of all cooling factors (i. e. the "cooling power"), the greater is the demand on the heat energy of the human body, and the less energy is available for other activities. On this basis extensive experiments have recently been made in Davos by Dorno [1] with the "katathermometer" recommended by Leonard Hill,[2] and he calculated the cooling power for several other localities also, in Europe and North Africa, in accordance with Hill's formulae. The experiments were carried out with both wet and dry bulb katathermometers. Taking into consideration the half-moist epidermis and the moist mucous-membrane of man, it is obviously necessary to determine the cooling power with a wet kata thermometer. It is, however, very doubtful whether the method adopted by Hill of covering the bulb with wet muslin creates the conditions of evaporation corresponding

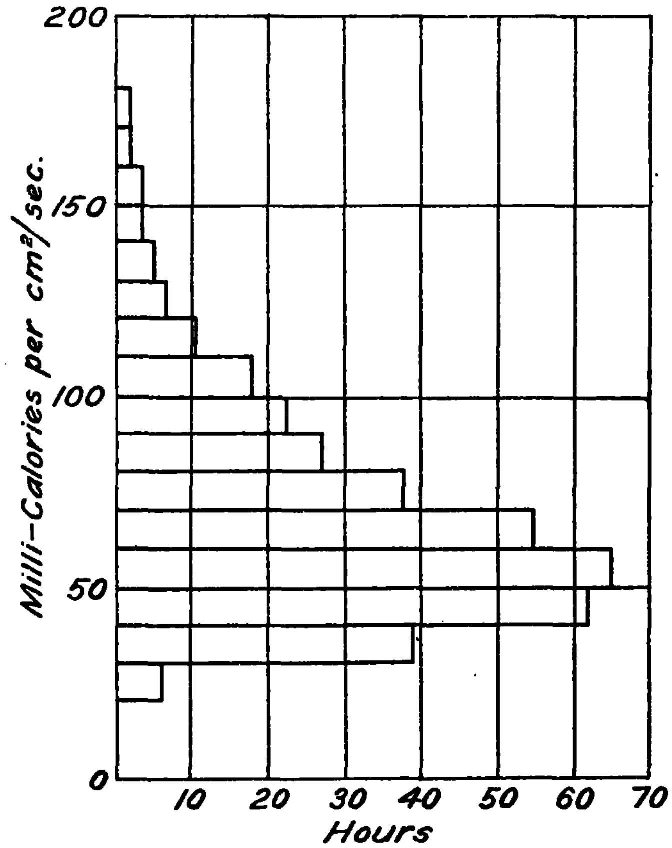

FIG. 1.—Hours of occurrence of certain "wet cooling powers" of various intensities between 7 a. m. and 7 p. m., in January.

exactly to those which prevail in the human body. In connection with this, and considering the great discrepancy between the size of the kata thermometer and the human body, it is still uncertain whether the velocity of wind really deserves the great significance as a cooling factor ascribed to it in Hill's formulae and Dorno's researches. In spite of this, however, the Hill-Dorno method of determining cooling power has meant a remarkable step forward in medical climatology. Thus Dorno's investigations produced the result, so important to the physician, that in the climate of a sheltered *elevated* valley (such as Davos), which acts as a powerful stimulus (too powerful for some patients), the human body provides itself much more easily with sufficient heat than on the North-German Coast (Borkum), and in

[1] Meteorologische Zeitschrift 1922, p. 344.
[2] MO. WEATHER REV. 1920, p. 687.

North-German Lowlands (Potsdam), so that Borkum and Potsdam are much "colder" for man than Davos, although the latter shows on the average a considerably lower atmospheric temperature. The conclusion drawn by Dorno, however, that the climate of Davos as regards heat-production makes a smaller demand on the human body than the most sheltered places north of the Alps, is too general.

It is just as inadequate to take only average values in ascertaining cooling power as a measure of intensity of stimulus, since a number of secondary cooling factors of importance to the physician may be overlooked. In this case also it would be most useful to work out the frequency with which the limits are passed, and to represent this graphically as shown in the accompanying graph. On the axis of X the number of hours is marked off; on the axis of Y the limits of cooling power in $\frac{1}{1000}$ gram-calories per sq. cm. per second. This example taken at random shows for how many hours in any given month the cooling power lies between certain limits in a given locality. Herein it would be advisable to omit the hours of the night when hardly any people, especially patients, remain in the open. In the half-year from October 1 to March 31 one should perhaps make use of observations made between 7 a. m. and 7 p. m.; in the other half-year those between 6 a. m. and 8 p. m. These observations are recorded on the supposition that the meteorological elements composing the cooling power are registered continuously. It is also of special importance to medical men that the observation shall be made where the patients are actually living. This holds good less for measurements of sun-radiation and all those elements which only vary in intensity with considerable change of locality, than for observations of atmospheric temperature, since it is not possible to find an observation-point in every district which could be regarded as representative of atmospheres more remote; yet still more important is it for measurements of the wind, the sphere of influence of which is exceedingly limited. The researches of Hellmann and A. Peppler on wind-measurements carried out from the radio towers at Nauen and Eilvese, have shown that in the lower 16 meters, over level ground, the velocity of the wind increases considerably with the altitude; whereas in higher altitudes the increase in velocity is only very slight. From this, for the purposes of general meteorology and climatology the inference was doubtlessly correctly drawn that the measuring apparatus should be allowed to reach the atmospheric layers above 16 meters, since beyond this any difference in the height of the apparatus is of little consequence. It is, however, obvious that data concerning wind-velocities measured at a height of several meters above the roof level of any locality, and also cooling powers deduced from such measurements, are of no value to the physician. Similarly, Dorno's comparisons of cooling powers for different places lose in value since they are built partly on observations made at places never visited by patients. In health resorts, wind measurements and observations of cooling power should be made on *such* promenades and resting places as are chosen by patients. Of course, in order to fulfill the requirement of obtaining strict comparison between observations for different places, so important for the physician, it will not be possible to avoid making parallel measurements within the same district. It is also necessary to choose localities for observation with especial care, and describe them with minute accuracy.

FATA MORGANA ON THE NAGYHORTOBÁGY.

By DR. ANTONY RÉTHLY.

[Budapest, Hungary, May 31, 1923.]

Upon the occasion of my visit to Nagyhortobágy for the purpose of setting up a meteorological station, while talking with the wife of the meteorological observer, Adalbert Rácz, on June 7, 1922, I mentioned how much I regretted that, up to that time, I had had no opportunity of seeing a fata morgana. She replied that if I had told her so that morning, she could have shown me one, for just that morning had been an exceptionally fine phenomenon of this kind. But I might be assured, she said, that there would be one the following day. Upon asking for more details she told me that this phenomenon can be seen almost every day, if there is no rain. It is a continually moving sight, changing its place every moment, the objects run away, then return, suddenly disappear and reappear larger than before. To my remark "There is too strong a wind to-day", she answered "That's nothing, the better and more interesting it is." My expectation was aroused, I was quite incredulous, and I asked her to relate more particulars about the phenomenon, whereupon the lady invited me to go to the railway and look over the region.

Standing on the railway at 6 o'clock in the afternoon she showed me the whole panarama in order that I might see the region *when there was no fata morgana.* I observed the horizon with the unaided eye from ESE, to W. On the lower part of the annexed sketch (fig. 1) I reproduce what I saw. The view was thoroughly calm without trace of atmospheric unrest or of inverted images.

On the morning of June 8, I was occupied with the installation of the meteorological station. At noon I

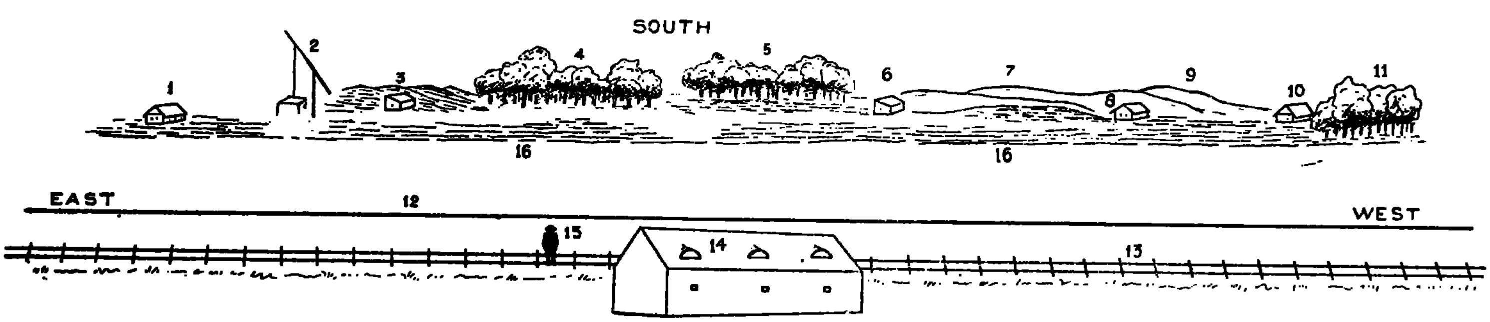

FIG. 1.—Sketch of the fata morgana on the Hortobágy. Explanation: (1), (3), (6), (8), (10) are huts; (2), a well;(4), (5), and (11), woods; (7) and (9), hills; (12), horizon; (13), railway;(14), a granary; (15), point of observation: (16), apparent water surface;.