THE SUN, HEALTH AND HELIOTHERAPY

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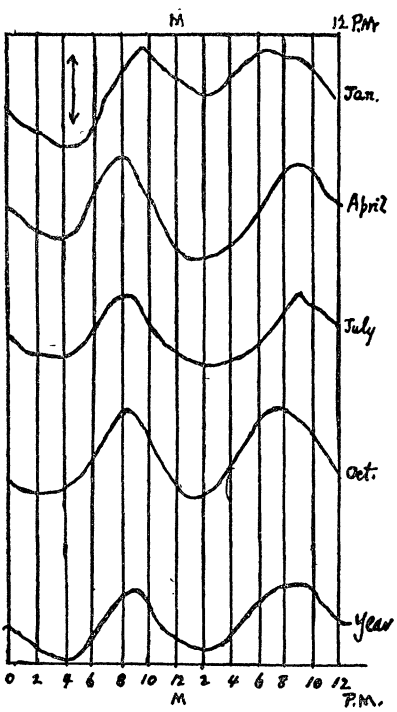
THE relation of the sun to human health and the vital functions is of such great importance that any phase of this subject is deserving of serious consideration. We are accustomed to accept, without question, the beneficent influence of solar light and heat, knowing as we do that actinic and chemical solar rays are necessary for the maintenance of animal and vegetable life upon our globe. These influences reveal themselves in greater or less degree according to the seasons and in the various zones into which we are accustomed to divide time and place in our planetary existence.

But meteorologists and astronomers and students of geophysics are constantly dealing with problems of more subtle type and have devised instruments, the very names of which are scarcely known beyond the physical laboratories and observatories now maintained for research in these hidden realms of the solar and terrestrial forces. Among them we may mention as preeminent in this field the Carnegie Institution of Washington, with its department of research in terrestrial magnetism; the geophysical and physico-chemical laboratories; and the solar observatories on Mount Wilson, in California, and at Calama, Chile, belonging to the Smithsonian Institution. We have also the United States Weather Bureau with its trained experts and well-equipped research laboratories and observing stations; and the Smithsonian Institution with its astrophysical observatory at Washington. The British Empire has its Royal Meteorological Society, with observatories at Kew, Greenwich and Stonyhurst; France, its Société Astronomique under the direction of the distinguished M. Flammarion and, in addition, the Bureau Central Météorologique.

Some have supposed that the sun's electric energy has an influence upon human health and vital functions at the earth's surface, so the author made inquiry of the directors of these institutions and laboratories which have been enumerated. It would appear, however, that the value generally assigned to this phase of the sun's energy at our distance from it, approximately 93,000,000 miles, is small.

In conversation with the late Professor Cleveland Abbe, of the Weather Bureau, he told the writer that we have very little knowledge of the sun as a source of electric energy except as it affects our magnets. It is an immense source of energy; but the gravitational or potential, thermal, optical, actinic and magnetic effects are the only ones that have as yet been measured. The electromagnetic influences of the sun and moon on the magnetic needle at the earth's surface have been observed for many years and a magnetic influence may also be attributed to the same forces that produce the sun spots. This is a manifestation of electric energy transformed into magnetism.



SUMMARY OF OBSERVATIONS AT THE KEW OBSERVATORY, ENGLAND. Dr. Chree. Diurnal Variation in Terrestrial Magnetism. The scale is indicated by the line showing the length equivalent to 50 volts. (Volts per meter.)

Whenever so-called magnetic storms are manifested either by the auroral light, or by disturbance on our telegraph wires or ocean cables, these are explicable in general as the transformation of waves of electric influence or energy, analogous to those that are used in our aerial or wireless telegraphy; but measurements of their intensity have as yet been confined to the Department of Terrestrial Magnetism.

On applying to the Bureau of Standards, Washington, Dr. S. W. Stratton, the director, said that there appears to be no doubt that the magnetic field at the earth's surface is affected by disturbances upon the sun; the electrical field in the earth's atmosphere is also affected, at least indirectly, by the radiation from the sun. Those effects are revealed by the observational study of terrestrial magnetism and of atmospheric electricity. As the action of any of these fields or of their changes upon health is independent of the source of the fields or of their changes, a simple problem would involve ignoring the source, whether the sun or something else, and seeking merely the relation between health and the magnitude and variation of these fields as observed on the earth.

According to George Mahomed, of Bournemouth, who has summarized the daily and monthly observations made by Dr. Chree, the director of the Kew Observatory, the fluctuations in days and months are very considerable. They show a diurnal variation. The maximum of potential occurs in the summer months at about 8 A.M., and between 8 and 10 P.M. In the winter the maximum is about 10 A.M. and the evening maximum at between 6 and 8 P.M. The readings are always higher in winter than in the summer. The morning minimum is about 4 A.M., throughout the year; the afternoon minimum is usually about 2 P.M. In the winter the weather conditions which accompany a high barometer favor the existence of high values and big diurnal changes in the potential. But in summer the barometric readings and the mean, the range, of daily variations of potential maximum seem to have no relation. A high potential occurs indifferently with a high or low barometer.[1]

It is admitted that the earth is negatively electrified and the atmosphere positively. This negative electrification of the earth is probably not uniform and we know that currents of greater or less intensity exist. The states of atmosphere vary considerably in the amounts of positive electricity they hold; but owing to the proximity of these differently electrified bodies there is a strain between them to establish an equipoise or, in other words, the tension may at times be broken by the earth giving up negative electricity and the atmosphere giving up positive electricity in order to form an equilibrium. The intensity with which this seeks to be established is called potential. The electroscope shows this by the behavior, the divergence, of the gold leaf. Mahomed illustrates very well this matter of potential by depicting a pointed, towering rock that tends to get rid of negative and attract thereby positive elecricity, when the potential in the neighborhood will be relatively high. Air currents condensed into a cloud in the higher strata would carry a positive charge; while those formed on the ground or the side of a mountain would probably carry a negative charge. If clouds of these two types should meet a sudden alteration of potential would result. The author has frequently witnessed such an interchange in the mountains of Virginia. In the western portion of the state there are numerous parallel ridges with deep and narrow intervening valleys. It occasionally happens that an electric discharge takes place from the summits of these ridges into the atmosphere. There is nothing audible, but merely a sudden glow of the higher clouds

[1] *Proceedings, Royal Society of Medicine,* December 8, 1909.

in the dark night, and it is possible that the presence of iron-bearing strata may have something to do with determining the electric tension thus manifested.

"Andes lightning" is the name given to a very striking luminous discharge of electricity seen over the crest of the Andes, in Chile, in a region where ordinary thunderstorms are almost unknown. The mountains appear to act as gigantic lightning rods, between which and the clouds silent discharges take place on a vast scale. Whether these phenomena have any solar connection, that is whether they are induced by previous exposure to solar radiation, we do not know. Such phenomena are observed elsewhere, but whether they may be related to vital functions or influence health in any way it is also difficult to say. We know, however, that the sun is positively electrified and the earth negatively and we would expect the potential to be highest near the surface of the latter. Mohamed has suggested that the heating of the earth's surface gives rise to a better ionization of adjacent portions of the atmosphere; it is a fact, probably, that no discharge of electricity takes place in the absence of electrons. These minutest particles of negative electricity have a velocity comparable to that of light. It is further known that the magnetic currents have a daily motion from west to east, that this motion is most marked in the tropics, while other currents go from the tropics to the poles; these latter through their property of deflecting the electrons into their course give rise to the *aurora borealis*. Sun spots, which are probably attended with high ionization hence give rise to disturbances of the magnetic fields of the earth's surface. It is probable that in these magnetic disturbances at the earth, very indirectly of solar origin, there may be some subtle influence on the human nervous system.

It was shown by Hale that there are magnetic fields in the sun spots. He was aided by the work of Zeeman, who discovered that powerful magnetic fields may split an ordinary single spectrum into several components.

All solar rays, whether visible or photographically active, or not, produce heat when absorbed upon a blackened surface. Sometimes the infra-red rays are called heat rays, the light rays, visible rays; and the blue, violet and ultra-violet, "active" or "photographic rays"; but there is no distinction of kind between these things. All are regarded as transverse vibrations of the luminiferous ether, differing only in the wave length.

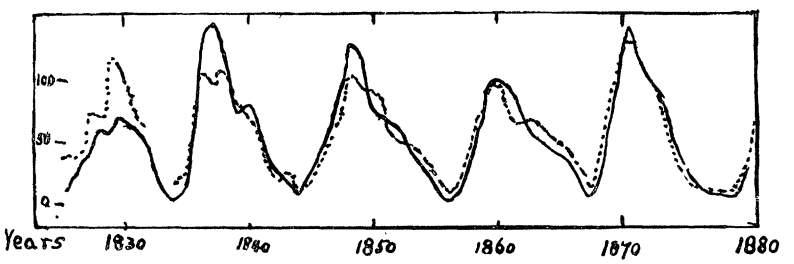
Waves of all wave-lengths produce their just effect when transformed into heat. Though both are forms of energy, radiation is not heat, but may be transformed completely into heat. We regard radiation as wave motion in the ether, heat as irregular motion of the molecules of material substances.

Sunlight has the power of ionizing the air, but there is a marked difference in the degree of ionization between that of the air at sea-level and at higher stations. Even in strong sunshine the surface air is only slightly ionized, but at the height of a few miles, as in balloon ascensions, the ionization may be twenty times as great as at the surface. Sunlight has also been

found to have the power of discharging the antennæ of wireless stations. It has also been found that rays received vertically have far more ionizing power than those received tangentially. Electric rays travel best by day in the narrow shell of dielectric between some stratum in the middle atmosphere and the surface of the earth.

It is a well-known fact that terrestrial auroras, northern lights and southern lights follow the sun spot periodicity and with this periodicity there is also a noteworthy change in the earth's magnetic field. This latter connection is very close as seen by the magnetic curves plotted by Dr. C. G. Abbot in his work on "The Sun."[2]

Abbot says that great sun spots often seem to be the direct



THE FULL CURVE SHOWS SUN SPOT RELATIVE NUMBERS. Dotted Curve, Diurnal Range Magnetic Declination. Data of Wolf and Young.

promoters of great magnetic disturbances and auroral displays, and that the earth's surface air temperature is, on the whole, lower at sun spot maximum than at sun spot minimum. It is only within the last ten years that we have had any direct measurement of solar radiation sufficiently accurate and complete to show these changes. Hale by his discovery of the existence of magnetic fields in sun spots has added to our knowledge of these very remarkable phenomena. Even the form in which matter exists in the sun has only lately been found to be gaseous. At least that is Abbot's and Schmidt's conclusion.

But are the sun spots, after all, potent for good or evil as far as we are concerned? Very few, aside from professional astronomers, have ever seen them, but nevertheless they appeal strongly to the popular imagination. There is undeniably much mystery about them. These fascinating phenomena are huge uplifts of metallic vapors in which vanadium, titanium and iron are evident, while at the top of these immense vortices there is an inflow of hydrogen and vapor of calcium. As they

[2] Page 187.

expand, lose heat and absorb solar light, they appear dark by contrast; so that, instead of 6,000 degrees Cent., which is the estimated temperature of the sun's surface, their temperature drops to approximately 3,500 degrees Cent. The magnetic field which has been detected in sun spots is believed to be due to the friction of the various vapors and gases and chemical compounds in the stupendous whirling motion that characterizes them.

Among those who have lately thrown light on this question is Dr. A. L. Cortie, the distinguished astro-physicist of Stonyhurst College Observatory. He does not believe that there is any basis for the impression that these spots in their immensity act directly to cause magnetic storms on the earth, although it is admitted that these do accompany the appearance of large active spots on the sun. His explanation is of great interest and may be correct. He says:

> The fields are much too weak, at the enormous distance of the sun, to allow of any such direct action. But great solar outbursts must be accompanied by a copious outflow into surrounding space of electrified particles called electrons. The earth is a great magnet, and its lines of force cut the surrounding atmosphere, which, as the barometer shows, has a diurnal oscillation. Hence we have matter moving across lines of force. If one takes a magnet and thrusts it into a coil of wire which is connected to a delicate galvanometer which can show the existence of electric currents, the needle will be deflected, indicating the flow of an induced electromagnetic momentary current. But it is obvious that the wire must be a conductor. A non-conducting material would not have an induced current produced in it. Substitute for the magnet and its lines of force the earth and its lines of force, moving relatively to the atmosphere. Evidently if the atmosphere, which is ordinarily a non-conductor, can be made a conductor electromagnetic currents will be produced in it. Now, when the copious streams of electrons from a disturbed area strike the upper atmosphere of the earth it does become a conductor, or, as it is termed, is ionized. Hence electromagnetic currents are set up, as indicated by the aurora borealis; the earth currents are induced, which upset by their fields the normal magnetic field of the earth, and our instruments record magnetic storms. The source of the energy, therefore, which causes magnetic storms is the rotation of the earth; the electrification of the upper atmosphere simply pulls the trigger and enables the forces to be operative.[3]

All this has a very important commercial and military bearing when we consider that the sun itself can take a hand in the conduct of a great war. Not that the sun should stand still as in the days of Joshua in the battle of Ajalon, but that it should tie up the great wireless plants on which modern warfare relies for daily aid.

With the cutting of the German-owned Atlantic cable at the

[3] *Current Opinion*, November, 1917.

beginning of the war, Germany had to fall back upon her wireless plants in order to transmit news and official or diplomatic messages through a channel not controlled by her enemies. For this the Sayville station on Long Island for a time became the distributing center, the wireless messages being thence transmitted by neutral cable or telegraph to all parts of the world. But when the aurora borealis appeared in May, 1915, the service was suddenly severely handicapped and for several weeks the messages received were for the most part fragmentary or often impossible to decipher. The same situation existed in Tuckerton, New Jersey, much to the dismay of the German owners.

We think it a very significant fact that electric waves, as, for example, those used in the wireless telegraphy, travel with the velocity of light, or at the rate of 186,330 miles per second and it suggests a very close relationship,—more than a mere analogy,—between light and what we designate as electricity. Radiant energy, therefore, proceeding from the sun may be held to include light, heat and electricity and it might be unjustifiable to differentiate too closely between them as we have been wont to do in the past. As we have intimated, our knowledge of some of these attributes of the sun is of very recent date.

As Dr. Abbot, the director of the Astrophysical Observatory of the Smithsonian Institution, says in his work, which we have freely quoted:

> That which the sun sends to the earth in such abundance used to be considered as three distinct things, namely,—actinic or chemical rays; light, or visible rays; heat, or invisible rays. These distinctions are known to be misleading. . . . All rays may be totally transformed to produce heat, however they may differ in their effects upon the eye, or in different chemical substances. All these rays travel with equal velocity in free space.

We are thus compelled to take a very broad view of solar radiation and to give to the electric energy of the sun a wider scope than at first thought would seem appropriate. Thus it is that heliotherapy, the principles of which we shall outline, may owe some measure of its efficacy to the electric energy of the sun. We are very far yet from a complete understanding of X-rays, the Finsen light, heliotherapy and other forms of radiant energy, not to speak of Marconi waves as applied to man's needs in other fields.

We all know that the disturbances of the mental and nervous equipoise are often traceable not only to social environment, but to climatic conditions and, in the belief of the ancients, and

even of some of the present day, to lunar influences. That solar irradiation has a considerable influence is undoubtedly true. It is constant; clouds may intervene, but cannot wholly check its power.

There is at the present time a remarkable interest in what is known as heliotherapy. This branch of physical therapy is winning an established place in the treatment of tuberculosis both of the bones and joints and of the pulmonary organs. During the last ten years heliotherapy has been systematically applied in these affections at suitable stations in the Swiss Alps, and on the French Coast, both on the Mediterranean and Atlantic shores and in Alton, in Hampshire, England. It has also been carried out to some extent in America, but not with the thorough and painstaking methods adopted in Europe.

One of the most ardent exponents of heliotherapy is Dr. A. Rollier who, during the last sixteen years, has treated upwards of 1,500 patients, both children and adults, by gradual exposure to solar irradiation at his institutions in Leysin, near St. Moritz, Switzerland.

At the French marine stations, notably Berck-Plage, Hyères and Cannes, the same method of treatment is adopted and the same good results obtained. The proportion of cures in advanced and apparently hopeless cases of surgical tuberculosis seems incredible. Rollier's clinical records, fortified with photographs taken on admission and discharge, fully corroborate his reports and dispel what might be a pardonable incredulity.

The author has recently brought to the attention of American physicians this remarkable development of tuberculotherapy and begs to refer to his essay on "The Atmospheric Air and Tuberculosis," Smithsonian Institution, Washington, 1914.

Rollier has succeeded in training his patients, both children and adults, by systematic and strict methods adapted always to the individual case so that they live in the free air of the Alps almost wholly naked, but apparently in perfect comfort; the training begins with exposure to the air and, afterwards, exposure to the sunlight, solar radiation, constituting heliotherapy. Under no circumstances does Rollier allow the patient to be exposed to the sun on the same day or even on the day following his arrival in the mountains. According to the gravity of the case or the general resistance of the patient, from three to ten days are allowed for acclimatization to the altitude and training for the air cure. Children seem to display an especial tolerance for exposure to sunshine.

There is one remarkable feature of the higher Alpine re-

sorts such as Leysin, Davos and St. Moritz, and that is that there is a vast difference between the temperature of the air in the sunshine and in the shade. Although snow may be lying on the ground, temperatures of 95 to 100 degrees Fahr. or even higher in the sun are not uncommon.

Sunlight has considerably more actinic force at these mountain stations than at the seashore, and hence the time required for the deep pigmentation essential to the solar cure is probably less than elsewhere. But even Rollier and others in the Swiss Alps have strongly urged the adoption of heliotherapy at the seashore sanatoria, and this is now quite as successfully accomplished. Rollier's record of over 1,500 patients and over 1,200 cures is one of the greatest contributions to modern surgical progress and especially to the fight against tuberculosis.

Heliotherapy in America.—In this country there is every opportunity for practising heliotherapy for tuberculosis and in the wider field which includes many chronic medical and surgical conditions not necessarily tubercular. There are now in military hospitals many cases of tuberculous disease of the bones and joints; and in addition, there are the inevitable torpid wounds, fistulas, and the gangrene, frost bite, and trench foot and the effects of caustic gases lately a part of military practise. Many of the sufferers are sent to Vichy and Aix-les-Bains for the baths; others are sent to Berck-Plage and to Cannes and other marine stations for the additional help of heliotherapy.

Dr. Albert Robin, in his work on tuberculosis, cites the well-known facts that the luminosity of the sea air and the power of the solar radiation at the seaside are very intense. The refraction of light by the sea water gives special properties with luminosity. The sea water absorbs the ultra-red rays that are calorific; it reflects the yellows (luminous) and the blue and violet rays that are chemical rays, the bactericidal action of which is recognized. Light is one of the best health-giving agents; it stimulates all the acts of animal life, particularly oxidation.

The luminosity of the sea air helps, then, to give it a more stimulating action than does the air of inland regions.[4]

Dr. Robin believes that the sodium chloride, iodine and silica (which he showed to be present at Berck-Plage) must exist in sea air in a state of ionization, or perhaps in a physical form which develops their radioactive properties. They in-

[4] Albert Robin, "Treatment of Tuberculosis" (English translation), J. & A. Churchill, London, 1913, p. 380.

crease the phenomena of oxide reducing hydrolysis which occupy the first rank in the acts of disassimilation in organic life. This makes us suspect, if not state precisely, the important part that must be taken by the chemical elements contained in sea air. All of them stimulate the exchanges, this in itself being one of the conditions of remineralization.

The author would strongly urge the establishment in the Rocky Mountain region, preferably in southern California, Colorado or New Mexico, perhaps in connection with some existing institution, of a true sun cure for tuberculosis. Such a locality is eminently suitable for heliotherapy, now for years most successfully carried out in the Swiss Alps by Rollier, and it should not be forgotten that his methods with their brilliant results are applicable not only in the class of cases commonly termed "surgical" tuberculosis, *i. e.*, bone and joint tuberculosis, but in pulmonary disease as well.

The time has come to give this method a thorough trial in the elevated, sunny and dry air of the Rocky Mountain region and Southern California, the climatic features of which justly hold first place in the climato-therapy of tuberculosis. Among the places in America where heliotherapy has been attempted there is a great difference in the amount and quality of sunshine, the *sine qua non* of successful treatment. Nevertheless it has been carried out in such variable climates as at Sea Breeze Hospital on Long Island, in Narragansett Bay, at Perrysburg (forty miles from Buffalo), and at the Children's Seashore House, Atlantic City. But it is in Colorado, New Mexico and southern California where the hours of sunshine are most uniform and least liable to interrupt the cure. Physicians in these states have already reported most encouraging results.