LEPRA REACTION AND METEOROTROPISM[1, 2]

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INTRODUCTION

It is well known that the chronic course of leprosy is often interrupted by the so-called exacerbations of lepra reaction. From the clinical viewpoint these exacerbations appear as more or less acute manifestations, which have been dealt with in a separate publication (22). In the present report are discussed some of my observations concerning one of the causes of this condition.

Lepra reactions result from various causes. According to Klingmüller they do not depend upon race, sex, climate, season of the year or stage of the disease. Conditions to which they are ascribed include psychic stress, excessive use of alcohol, moist weather, cold baths, the development of puberty, and especially among young people sexual indulgence. Foods are often blamed, as acid fruits, or certain meats such as duck or pork, or other foods to which the patient is not accustomed. According to Braul the occurrence of complicating infections may cause them, and Lowe speaks particularly of malaria in this connection.

In observing this condition I have noticed that patients who have come to us here in the north from the southern regions of the Union (Aiserbaidjan and Armenia) as a rule suffer from these exacerbations after their arrival. Moreover, the condition appears principally in spring and autumn—in the periods of variable weather. In summer, and to some extent in winter, when the weather is stable, it is considerably less frequent. These circumstances caused me to inquire whether atmospheric conditions exert any influence in this connection.

That the state of health is influenced by weather and climate has been known since olden times. Hypocrates himself pointed out

[1] Presented at the Leprosy Conference in Moskau, May 4, 1933.
[2] From a translation from the German by Dr. Alfredo C. Santos.

this relation, and belief in it persisted through the Middle Ages to the last century. At the beginning of the 19th century we find new factors and hypotheses introduced by von Humboldt, but only recently has this question been subjected to a thorough review as a result of newer meteorological investigations.

It is an established experience in medicine that most men must undergo an acclimatization when they remove to a new climate; the human organism, adjusted to certain conditions, needs time to re-adjust itself to new climatic factors. However, we have similar climatic fluctuations in a given place when, for example, after a long predominance of polar air which is cold, dry and pure, there suddenly sets in a warm period with moist, suspension-rich tropical air. Under such conditions we by necessity also undergo an acclimatization of the body, which is hardly perceived by those of strong, healthy nature whereas physically and psychically unstable persons suffer therefrom. A change in the air bodies, which may also be called a sudden change of weather, involves a burden to the sick organism (Linke).

Modern meteorology is devoted to the study of air masses of different origins. One understands by "climate" the relative frequency of certain weather conditions, i.e., frequency of the presence of air from a certain origin (Linke). Climatology has occupied itself with the measurement of the variations of temperature, pressure, moisture, etc.; meteorology investigates the presence in given regions of air coming from polar, continental, maritime and subtropical parts of the world. It determines when an air mass will pass a given place and calculates its velocity.

As long ago as 1856 Loeschner pointed out that the relation between the outbreak and aggravation of diseases on the one hand, and the changes of air and weather on the other hand, must be established on the basis of continued observations in large sanatoria. Many experiments have been made with this in view but as yet they have given no positive results. A whole series of authors who tried to find relations between a disease and data on temperature and pressure had no success. The evaluation of weather by the masses is so uncertain and incomplete that it is useless for investigations (de Rudder). Exact investigations like those of Brezine and Schmidt, or more recent ones employing the correlation calculations of Gafafer, gave no definite results. "Agreement of the diverse meteorological processes as they are summarized in the complex idea of 'weather' and 'climate' would be of importance'' (Linke).

Only the modern science of meteorology can fix the limits of the intricate complex, which is characterized by certain meteoric factors, and establish its origin as well as the changes in its physical condition. One should not think of the relation of disease and weather to each other in a mechanical sense, as of coldness or warmth. This relation has been closely observed for a relatively long time (Altschul, 1891; Blumenfeld, 1909). Jacob pointed out that meteorological measurements can serve only as ''foot prints leading to far-reaching pictures of a higher kind.'' A whole series of investigators of the previous century, like Seibert, Senfft, Goldberg, and Hammerschlag, point to the necessity of a control of the daily atmospheric changes. The task of modern investigations is to determine whether there exists a dependence of disease on the effects of certain air masses and their displacement.

It is clear that the atmospheric changes are only perceived by sensitive individuals inclined to reaction. Change of weather is not the only cause of disease; if that were the case all men in a disturbed region would become sick. The number of cases depends not only upon the intensity of the change but also upon the number of sensitive persons present. For example, in 1876, in St. Petersburg, after a strong frost, mild weather set in during the course of a night; in the morning 40,000 people became sick with influenza (Geigel).

In this region we have as yet very many unexplained conditions, but the number of observations which point to a definite relation between atmospheric changes and morbidity increases daily. A definite effect of the weather on croup has been established by de Rudder; on pneumonia by Post, Bein, Senfft and Seibert; on eclampsia in pregnant women by Linsemeier, Jacob, von Heuss, Oppenheimer, Hoenhorat, Schichting and Hammerschlag; on tetanus by Moro, Gyory, Baar, and Behrend——Moro has even introduced the term ''tetanic weather.'' J. Loeffler has established a relation between weather and glaucoma, etc. (See the monograph of de Rudder.) A relation between skin diseases and weather has been established by Bettmann and Jaquet, among others. The influence of weather has also been established in rheumatic and neuralgic disturbances in the extremities, joints, etc. (Feige and Freund, Turkas, Miller, Bauer, Flach,[3] Schmidt.)

[3] Flach has found that weather changes have a biological influence only when there occurs a rearrangement of the atmosphere into a vertically erected layer, which as a rule is observed in unstable or variable layers.

The same has also been observed by Miller, Erb and Löwenfeld with regard to lancenating pains in pulmonary tuberculosis. The number of deaths in tuberculosis from pulmonary hemorrhage varies with atmospheric changes (Pirquet, Isserlin, Kollisko, Kisch, Jansen). With regard to the skin, the development of efflorescences in cutaneous tuberculosis in relation to meteorologic changes has been shown by Herxheimer and Martin.

After observing that the appearance of exacerbations of leprous processes seemed to be dependent upon weather changes, I started to study this question closely. This condition is a favorable subject for such a study, for it has clearly marked symptoms, and since it appears suddenly the time of its occurrence can be established exactly, which is important for comparison with the meteorological conditions. The appearance at the same time of more than the usual number of cases is a very valuable circumstance, since here is excluded the possible objection of an epidemic infection as is the case of the analysis of group sickness in acute infectious diseases.

METEOROLOGICAL FACTORS

From modern meteorology we know that air masses possess different physical properties. They differ according to their origin—e.g., whether they are polar or tropical—and upon their age, since air masses change when they stay for a more or less long period of time in the same region. Of interest to us are the so-called "variable layers," the boundary layers of two masses that meet, for at the boundary there is no uniform mixing of the colliding air particles. With the shifting of the masses these variable layers also change their position. In our region the cyclone fronts are of the greatest importance; there are variable layers at the anterior front of the cyclone (the warm front) and posteriorly (the cold front); and there are also variable layers at the traverse of the Siberian maximum. According to the reports of the Main Geophysic Observatory one may, in certain infrequent cases, also observe an equatorial front—the Azores maximum. The variable layers which are between air masses that remain in one place for a long time slowly change in their physical properties and give rise to newly-appearing air bodies. But from the quantitive viewpoint the cyclones which often pass in our regions are of greater importance to us.

In our Northern latitude the atmospheric conditions are influenced by phenomena which arise at the border of two streams of air in the troposphere. The troposphere is the lower air layer which covers the earth's surface and is under the influence of the radiation from the surface; its thickness depends upon the place and varies between 8 and 11 kilometers. In the northern regions the polar air moves from east to west; in the intermediate zone and at the northern border of the subtropical zone the tropical air stream is from west to east. These two air masses are different both in their direction and in their physical properties.

TABLE 1.—*Characteristics of air bodies* (de Rudder).

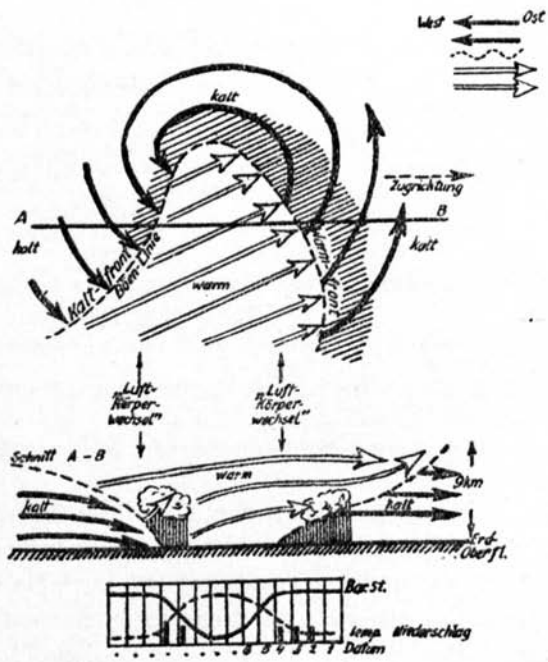
POLAR AIR	TROPICAL AIR
Colder than the substratum.	Cooled by the earth, otherwise warm.
Strata unstable.	Strata stable.
Sparse content of small nuclei.[a]	Richer content of bigger nuclei.
Transparent.	Strongly opaque.
Relatively dry.	Relatively moist.
Diathermic.[b]	Poorly diathermic.
Strongly permeable to short-wave rays.	Weakly permeable to short-wave rays.
Low ionic content.	Higher ionic content.
Weakly charged electrically.	Strongly charged electrically.

[a] Nuclei are small non-gaseous particles which are mixed with the air and play a great role in visibility and electrical properties.

[b] Permeable in a high degree to heat radiation, without appreciable absorption.

Formation of a cyclone.—As a result of these differences there is no fusion of the two air masses at the border, but instead the polar front is formed. Like an elastic membrane this variable layer allows invaginations and protrusions, and from these fluctuations of the polar front arise the cyclonic centers—depressions, low pressure regions (Bjerknäs, Solberg, Bergeron). The accompanying schema (Text-fig. 1) shows such a low pressure area, caused by entrance of tropical air into the polar air.

At the center we have the warm air mass ("warm front," right) which pushes into the polar mass, the displacement setting up a rotation of the latter in the anti-clockwise direction. As a result of this rotation there occurs separation or detachment of the protruding mass of tropical air to form a cyclonic nucleus surrounded by polar air. This cyclone moves from west to east—for us in Russia the principal depressions come from Iceland. When the warm front of a cyclone passes over a region the polar air of the place is suddenly displaced by the warm tropical air of the nucleus, wherefore the temperature rises and the barometer sinks. The change of the air masses, which are absolutely different in their physical properties, affects all kinds of life in the regions crossed. When the cold posterior edge of the depression (i.e., the cold front) passes over a region, replacing the tropical air with polar, the temperature again sinks and the barometer rises.



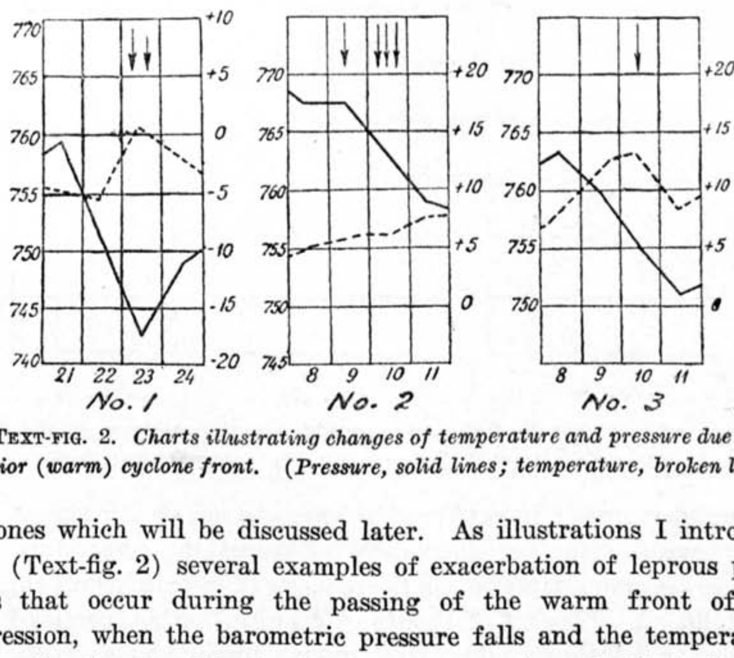
TEXT-FIG. 1. *Schema showing the effect of entrance of a wave of tropical air into the border of the polar air mass.*

Besides the phenomena described, the tropical air tends to rise at the anterior front of the depression, as can be seen from the vertical section (Text-fig. 1, Schnitt A-B). Because of the low pressure and the high content of water vapor in the tropical air there is cloud formation (stratus clouds) which leads to rain. At the back of the cyclone the polar air pushes the tropical air upward, whereby cumulus clouds are formed that cause rain or snow-fall.

OBSERVATIONS MADE ON LEPROSY

The phenomena which accompany changes of air bodies as described can also be followed in my material. Thanks to the kindness of Mr. K. Turigin, director of Weather Bureau at the Main Geophysical Observatory, I have obtained the essential data that characterize atmospheric changes. It has also been possible for me to analyze the synoptetic charts of the atmospheric conditions together with Fr. T. Duletowa, co-worker in the Weather Bureau, to whom I express my deepest thanks.

Effect of the warm front.—As has been said, our region is exposed to most of the passing cyclones, principally the occluded



TEXT-FIG. 2. *Charts illustrating changes of temperature and pressure due to the anterior (warm) cyclone front. (Pressure, solid lines; temperature, broken lines.)*

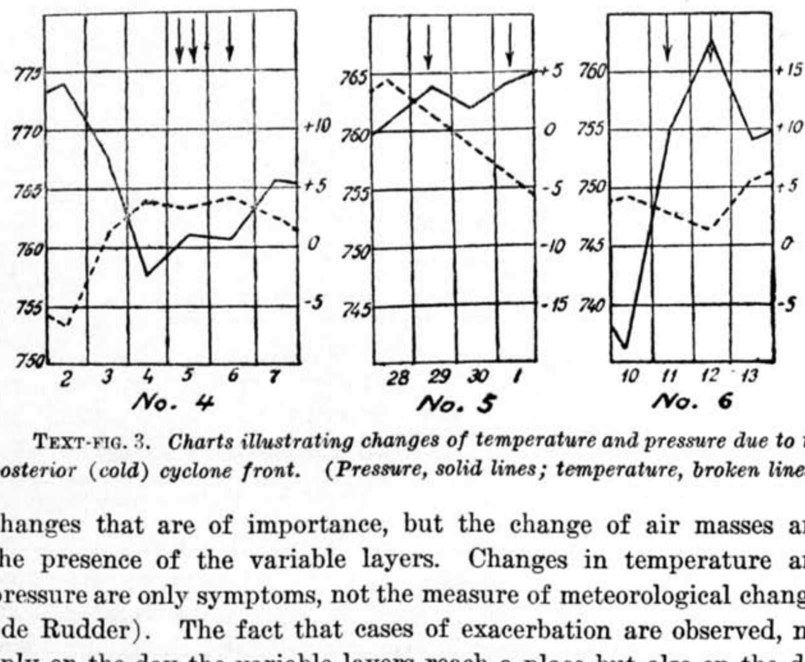
cyclones which will be discussed later. As illustrations I introduce here (Text-fig. 2) several examples of exacerbation of leprous processes that occur during the passing of the warm front of the depression, when the barometric pressure falls and the temperature rises. On the day this front passes over, or immediately before it, we observe the appearance of one or more cases of exacerbation in this institution.

Illustration No. 1 (January, 1930).—From the rise of temperature shown in Graph No. 1 of the text-figure one may note on the 22nd the approach of the warm front, which according to the synoptetic charts set in on the 23rd in this region. The atmospheric pressure went down markedly, whereas the air temperature rose. On the 23rd, the day the warm phase set in, two cases of lepra reaction occurred.

Illustration No. 2 (April, 1930).—Beginning on the 8th there was a gradual rise of temperature (Graph No. 2) indicating the nearing of the warm front, which set in on the 10th. Barometric pressure decreased and temperature increased considerably. One case of lepra reaction occurred on the 10th.

Illustration No. 3 (May, 1930).—Passing of a typical warm front (Graph No. 3). Pressure quite markedly fallen, temperature definitely increased. On the 10th one case of lepra reaction.

Besides these examples I have many other cases of exacerbation which developed either on the day a warm front sets in, or on the previous day. As can be seen from the figures the temperature and pressure may undergo relatively insignificant changes. It is not these



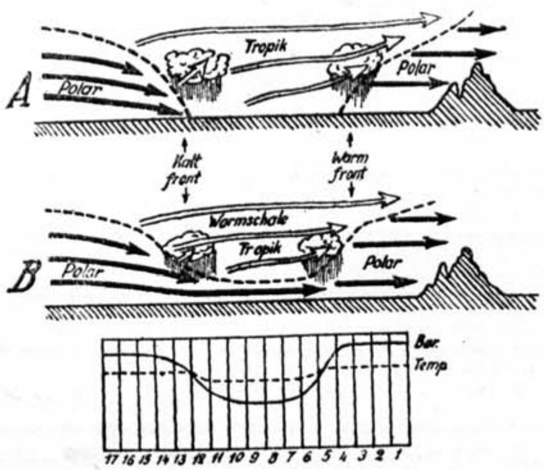
TEXT-FIG. 3. ***Charts illustrating changes of temperature and pressure due to the posterior (cold) cyclone front. (Pressure, solid lines; temperature, broken lines.)***

changes that are of importance, but the change of air masses and the presence of the variable layers. Changes in temperature and pressure are only symptoms, not the measure of meteorological changes (de Rudder). The fact that cases of exacerbation are observed, not only on the day the variable layers reach a place but also on the day previous, is comprehensible since the variable layers do not represent a plane in the mathematical sense but a layer frequently of considerable thickness, up to 300 to 400 km.

Effect of the cold front.—As the cyclone progresses, cases of exacerbation are also observed when the cold front passes. During its passage the pressure rises and the temperature falls, frequently quite heavily. As can be seen from the following examples (Text-fig. 3) the passing of the cold front also causes lepra reactions. The three illustrations here given, like the preceding ones, are selected from a larger number available.

Illustration No. 4 (December, 1930).—From the 2nd the temperature rose and on the 4th there was a typical passing of a warm front (Graph No. 4). No case of exacerbations occurred; apparently there were no susceptible patients at this time. However, on the 5th the pressure began to rise and the temperature to fall, indicating the approach of the cold front, which passed on the 6th. On this day we had one case of exacerbation and on the previous day two cases.

Illustration No. 5 (November, 1930).—The cold front approached on the 28th and passed on the 29th, the temperature falling and the pressure rising (Graph No. 5). On the 29th there was one case of exacerbation. Then followed

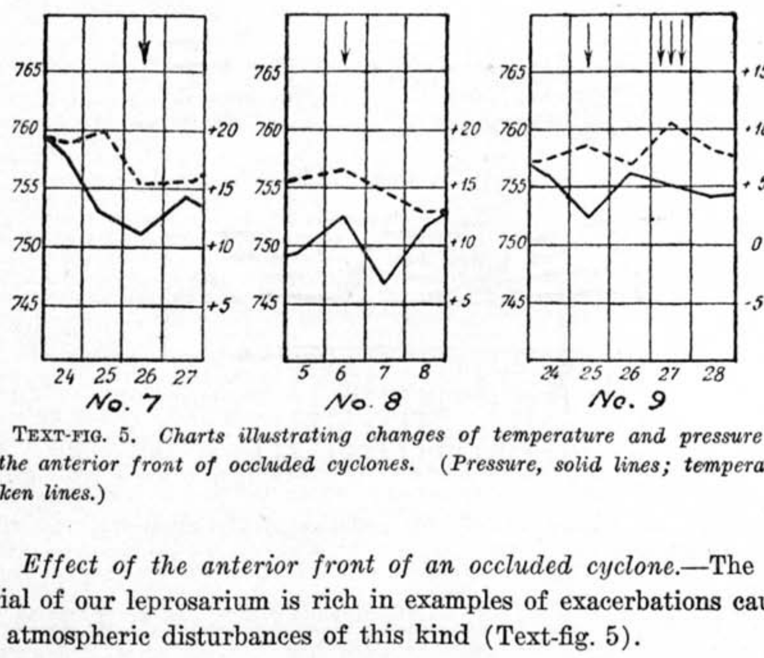


TEXT-FIG. 4. *Schema showing the occlusion of the warm air mass of a cyclone by the posterior (cold) front.*

another increase of pressure and a fall of temperature, and according to the synoptetic charts there was a new cold front on December 1st. This caused a case of exacerbation.

Illustration No. 6 (October, 1930).—On the 10th the air pressure began to rise (Graph No. 6), indicating the approach of a cold front. On the 12th this passed, according to the synoptetic chart. One case of exacerbation appeared on the 11th and one on the 12th.

The occluded cyclone.—As has been said, in most instances in our region we have the so-called occlusion of cyclones. In this case the polar mass at the rear pushes up the tropical mass (Text-fig. 4-A, left) so that the former joins up with the polar air at the front, displacing the warm portion upwards (Text-fig. 4, B). In such cases there is no immediate change in the layer of air at the surface as the cyclone passes, though this can be observed at mountain observatories. There being no change of the air at the surface there is no change in temperature, or if there is a change it is in the opposite direction to that usually observed with the passing of the front of the ordinary cyclone. In this case when the anterior side of the cyclone arrives—the warm front, which is light because of the warm air in it—the layers beneath it are cooled, and when the cold front sets in these layers become warmer because of the presence of the heavy cold air masses (adiabatic temperature changes).



TEXT-FIG. 5. *Charts illustrating changes of temperature and pressure due to the anterior front of occluded cyclones. (Pressure, solid lines; temperature, broken lines.)*

Effect of the anterior front of an occluded cyclone.—The material of our leprosarium is rich in examples of exacerbations caused by atmospheric disturbances of this kind (Text-fig. 5).

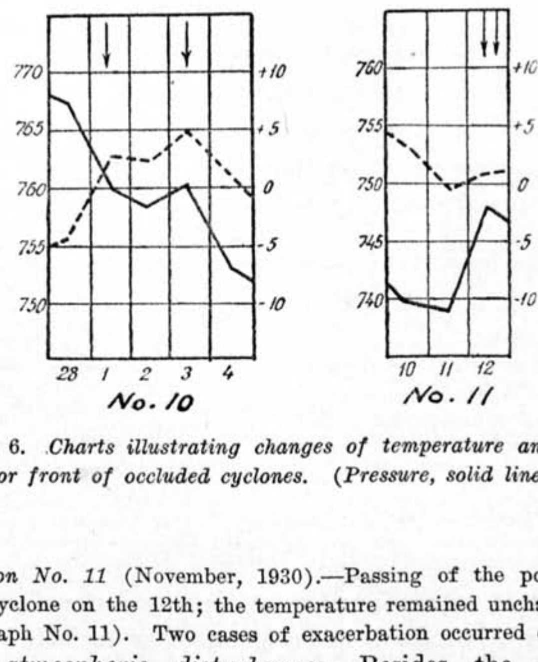
Illustration No. 7 (June, 1930).—On the 23rd the fall of pressure and increase of temperature began, but this disappeared on the 26th (Graph No. 7). According to the synoptetic charts the warm front of the occluded cyclone passed on that day. A case of exacerbation occurred then.

Illustration No. 8 (August, 1930).—On the 7th the front of the occluded cyclone passed, pressure and temperature falling (Graph No. 8). On the 6th one case of exacerbation occurred.

Illustration No. 9 (October, 1930).—On the 25th the warm front passed, pressure falling, the temperature remaining unchanged (Graph No. 9). On the 23rd there was one case of exacerbation. On the 27th another warm front passed, with an insignificant fall of pressure but quite definite deviations of temperature, the daily average increasing slightly. On this day three cases of exacerbation occurred.

Effect of the posterior front of an occluded cyclone.—Finally, as the cold front of the occluded cyclone passes through, exacerbations of leprous processes are also observed (Text-fig. 6).

Illustration No. 10. (March, 1930).—On the 1st there was a typical warm front, accompanied by fall of pressure and increase of temperature (Graph No. 10). One case of exacerbation occurred. On the 3rd the posterior front of the cyclone passed in occlusion; pressure rose and also temperature. On the 3rd there was one case of exacerbation.



TEXT-FIG. 6. *Charts illustrating changes of temperature and pressure due to the posterior front of occluded cyclones. (Pressure, solid lines; temperature, broken lines.)*

Illustration No. 11 (November, 1930).—Passing of the posterior side of an occluded cyclone on the 12th; the temperature remained unchanged, the pressure rose (Graph No. 11). Two cases of exacerbation occurred on that day.

Other atmospheric disturbances.—Besides the circumstances discussed in which cases of exacerbation occur, my data show that such reactions are also seen under other conditions. They occur in instances when the place is reached by the variable layer bordering cyclone and anticyclone, and in complicated conditions—such as the encounter of several depressions—that are difficult to analyze. The same is observed with the "Siberian maximum," which is composed of polar-continental air. A variable layer is formed at the border of these air masses, since they differ essentially from each other.

The Siberian maximum occurs less frequently than the ordinary cyclones.

Stable weather.—From the foregoing it is seen that changes in the weather involving the formation of variable layers cause lepra reaction independently of the system to which the changes belong—cyclone fronts, the borders of cyclones, or the borders of anticyclones. It is now of interest to ascertain whether cases occur when the weather is stable. From my material it appears that out of a total of 86 cases only 6 occurred when, according to the synoptetic charts, no variable layers were passing; 93 per cent of the cases coincided with such changes. However, though the weather was stable when these 6 cases occurred, there were quite considerable deviations of both temperature and pressure on several of the days. During really constant weather only one case was observed.

From my material one may establish the quantitative relations between the occurrence of reactions and the different atmospheric changes; these are shown in Table 2.

TABLE 2.—*Relation of weather conditions to the occurrence of cases of lepra reaction.*

CONDITION	CASES	PER CENT
Passing of the warm front	38	44.2
Passing of the cold front	25	29.1
Variable layers of other systems	4	4.7
Complex conditions (multiple cyclones)	13	15.1
Stable weather	6	6.9
Total	86	100.0

With respect to the number of lepra reactions produced the warm front, which predominates over the other variable layers, holds first place; the other types of atmospheric changes give relatively low figures. Comparing our results with those of analogous investigations we find that, according to the data of de Rudder, the relation is different with, for example, croup. The largest number of cases of that condition is caused by the cold front, the second largest by the warm front. Studies of this kind are regrettably few, so it is impossible at present to determine whether the relations given are really characteristic for the illness mentioned, or whether they could be explained by the relative frequency of the one or the other atmospheric change in other regions. Since some cases of croup arise principally with the cold front and others with the warm, and a third group when there is a rapid change of weather conditions, de Rudder speaks of "weather-susceptible" men. Some are susceptible to the weather of the anterior front of the cyclone, others to that of the posterior side.

This question is further complicated by the occurrence of different kinds of variable layers at the borders of the air masses, as well as by their different velocities. We distinguish main air bodies, polar, tropical, maritime and continental. However, because of a series of relations they naturally change in physical properties, as for example the "aging" which occurs with prolonged stay over a given region. Furthermore, there are intermediate phases; for example, a maritime mass may be polar maritime or tropical maritime depending upon the region of the ocean from which it derived. When these different air masses meet they form variable layers which have different physical properties.

At present it is quite impossible to determine which atmospheric process exerts the greatest effect in leprosy. It may be of interest to note here the following unexplainable cases in my material. Though as has been shown cases of exacerbation arise mostly when the warm front passes, we obtain quite a different picture when we chart the cases by months. In the autumn and winter months (mainly October to January) there is a predominance of cases which arise during the passing of the warm front, but in the warm season—in summer (May, June and July) and partly also in autumn—the greatest number of cases coincide with the cold front. Apparently the front which causes the greatest change of weather is borne with most difficulty by the organism.

It is impossible to determine whether this conclusion is correct, because of the small number of our cases. It must also be pointed out that the number of lepra reactions in the course of the year is disproportionately divided. The number of persons falling ill really depends, on the one hand, upon the number of susceptible persons present, and on the other hand upon the degree of influence of the given meteorologic processes. With regard to the changes of susceptibility as related to the season, this will be reported on later. However, it may be said here that according to my material the groups of cases of lepra reaction are larger in winter than in summer, probably because of the more frequent changes of air bodies in the winter months in this region.

At present we know of many different kinds of illness which are affected by changes of atmospheric conditions, but we cannot as yet determine with certainty the cause of these phenomena. One should not, of course, consider the effect of the so-called atmospheric variable layers as the only cause that determines illness. As de Rudder points out, their influence constitutes only the last loosening tie, the spark that encounters an organism that has already been predisposed by a series of processes conducive to illness, after which it becomes visibly sick. There can occur cases of illness when there is no change either in temperature or pressure. Besides, there are in our region, as in the examples I have given, frequent cases of occluded cyclones, changes of air bodies which proceed at a height and not at the surface of the earth, and cases of sickness are also observed with the passage of the fronts of these disturbances. Their "nearness," in this case, is a relative idea, since this is measured in meteorologic scale.[4]

As can be seen from the illustrations here given, the cases of lepra reaction do not always appear at the time of the passage of the variable layers, but often on the day they occur, or even on the previous day. Thus it appears that atmospheric changes can exert an influence even when no changes have yet been detected by meteorologic measurements. These atmospheric changes often exert an effect at great distances.

One and the same atmospheric change may have very different effects; for example, in one individual it causes pain in the joints, in another an attack of eclampsia, in a third tetanus, in a fourth exacerbations of leprous processes, etc. All these indicate a general phenomenon. According to de Rudder we may consider this the electrical processes which are manifested in the variable layers. The occurrence of sudden changes in the magnetic field when the cyclonic fronts pass is of common knowledge.

The medium—i.e., the affected individual—plays a rôle in cases of lepra reaction in the presence of the exciting agent, as is the case

[4] In such cases there is a marked change of air bodies in the particular region, or a passage of the variable layers.

in other infectious diseases. The opinion of Ruhamann that it is not the condition of the human organism that is modified by meteorological conditions but the virulence of the bacteria hardly applies in my cases. One cannot conceive of a change of virulence of the leprosy bacilli caused by such conditions, since they are to a certain extent protected from external influences. The opposite view of Löwenthal is more correct, in my opinion. In this connection one may cite an analogous example in reference to malaria. Kisskalt observed in war prisoners living in a malaria-free region that typical cases of malaria occurred in the spring, but only in prisoners that came from infected regions; the others remained healthy. From this it follows that the presence of the infecting organism was not enough to cause the disease, but that it appeared only under provocation—in this case the onset of spring. In leprosy there are evidently changes of the immune-biological condition of the human organism under the influence of atmospheric conditions.

CONCLUSIONS

1. The occurrence of exacerbation of leprous processes depends upon changes in the atmospheric conditions.

2. There is no relation between exacerbation and the annual or monthly temperatures, the barometric pressure, rainfall or winds.

3. Exacerbations occur in a region with the passage of "variable layers" of different systems (cyclones, anticyclones, etc.).

4. The greatest number of exacerbations (73 per cent of my cases) occurred during the passage of cyclones and occluded cyclones.

5. The greatest number of exacerbations were observed during the passage of the warm front of cyclones (44 per cent), and next the cold front (29 per cent).

6. In cold seasons exacerbations prevail when the warm front sets in, and to the contrary in the warm season when the cold front passes.

7. Multiple cases of exacerbation are more numerous and appear more frequently in winter.

8. In stable weather only a small number of cases of exacerbation was observed (7 per cent); they appeared only as isolated cases.

9. The exacerbations of leprous processes appear not only on the day the variable layer passes, but also on the previous day.

REFERENCES

(1) BARERA AND CHAVARRIA. Rev. Med. Latin America (1927) 773.
(2) BARERA AND CHAVARRIA. Bull. Johns Hopkins Hosp. **35** (1924) 147.
(3) BAUER. Klin. Wochenschr. (1923) 1917.
(4) BETTMANN. Münch. Med. Wochenschr. (1920) 659; (1929) 591.
(5) BRAUL. Vratsch. delo. (1929) No. 10.
(6) ERNST. Med. Klin. (1929) 1820.
(7) FERMI. Arch. f. Hyg. **43** (1904) 321.
(8) GREEN. Trans. Roy. Soc. Trop. Med. **22** (1929) 367.
(9) HEERUP. Beitr. z. Klin. d. Tuberk. **68** (1928) 739.
(10) HERSHEIMER AND MARTIN. Derm. Zeitschr. **43** (1925) 127.
(11) HUTTER. Deutsche Zeitschr. f. klin. Chir. (1928) 211.
(12) KESTNER. Die physiologischen Wirkungen des Klimas. Handb. d. norm. u. path. Physiol. Bethe, Bergmann, Emden, 1926, XVII, Correlationen III, 498.
(13) KLINGMÜLLER, V. Lepra. Berlin, 1930, J. Springer. (Numerous references.)
(14) LINKE. Die physikalischen Faktoren des Klimas. Handb. d. norm. u. path. Physiol. Bethe, Bergmann, Emden, 1926, XVII, Correlationen III, 463.
(15) LINKE. Mediz. Welt (1931) 14.
(16) LINKE. Zeitschr. f. ges. Physik. Therap. **37** (1930) 217; **39** (1930) 287; **41** (1931) 197.
(17) MARTINI. Zentralbl. f. Bakt., etc. **10** (1929) 245.
(18) MAYER AND SALZBERGER. Arch. f. Dermat. **163** (1931) 245.
(19) DE RUDDER. Ergebn. d. inn. Med. **36** (1926) 272.
(20) DE RUDDER. Wetter und. Jahreszeiten als Krankheitsfactoren. Berlin, 1931, J. Springer. (Numerous references.)
(21) RUSZNYK. Wien. Arch. inn. Med. **3** (1922) 379.
(22) STEIN, A. A. Acta Dermato-Venereol. **15** (1934) 314.
(23) STICKER. Erkältungskrankheiten. Berlin, 1916, J. Springer.
(24) WELTSTEIN. Beitr. z. klin. Chir. **49** (1906) 354.
(25) ZWECKER. Arch. f. Derm. **163** (1931) 366.