# Past Climates.[1]

By Dr. G. C. SIMPSON, C.B., F.R.S.

THERE is undoubted evidence that at some period or periods in the earth's history the climate in polar regions was much less severe than it is at present. In the Arctic there are indications of a climate when vegetation similar to that which is now found in subtropical regions flourished in Greenland and Spitsbergen. Geologists have generally supposed that during these periods the temperature over the whole earth was much more uniform than at present, so that the temperature difference between the equator and the poles was very small, if it existed at all. These conditions are explained as the consequence of vast oceanic currents carrying warm water to polar regions. The Gulf Stream Drift now maintains a mean annual temperature off the coast of Norway in latitude 70° N., which is 10° C. higher than the mean temperature of the latitude, and it is supposed that if its volume, velocity, or both were increased, and other streams introduced, even higher temperatures could be maintained over the whole of the north polar regions. This supposition is based on an entirely wrong conception of the physical causes which maintain the existing climatic zones.

The primary cause of the difference of temperature between the equator and the poles is the shape of the earth, which results in higher latitudes receiving less solar energy per square kilometre of surface than lower latitudes. But the distribution of solar energy alone does not determine the temperature at the surface; if it did the temperature near the poles would fall to near the absolute zero during the long polar winter. During the whole year, especially during the winter, the temperature in high latitudes is governed mainly by the heat conveyed from low to high latitudes by the general circulation of the atmosphere. On the other hand, the general circulation of the atmosphere is caused and maintained by the temperature gradient along the meridians. Reduce this temperature gradient and the general circulation decreases; increase it and the general circulation becomes more active. No one has yet estimated with any certainty the relative amount of heat transported by oceanic currents and by the atmosphere; but whatever the relative amounts, they both depend on the general circulation of the atmosphere, for the heat-carrying oceanic currents are all wind-driven surface currents. Thus, if we reduce the temperature difference between high and low latitudes, we reduce the amount of heat transported by both vehicles.

If a second Gulf Stream were introduced into the northern hemisphere by, say, cutting a wide channel across the middle of Asia similar to the Atlantic Ocean, heat would be carried into the polar basin, where the temperature would rise. But this rise in temperature would diminish the temperature difference between the equatorial and polar air on which the cyclones of the North Atlantic depend. The winds associated with these cyclones are, however, the chief vehicle for transporting warm air into, and cold air out of, the polar basin; in addition they are the chief factors in driving the present Gulf Stream Drift along its path. Thus the opening of a new supply of heat to the polar region would be accompanied by a reduction of the old supply and the final result would be little or no change in temperature.

This reasoning is admittedly qualitative and alone would carry no great weight; but the existing temperature conditions are conclusive evidence of its correctness. It would be difficult to imagine any distribution of land and sea more different, from the present point of view, than that which exists to-day in the two hemispheres. In the northern hemisphere the land and sea masses are arranged parallel to the meridians, and one ocean extends in an uninterrupted sweep from the equator to the pole; in the southern hemisphere the land and sea masses are arranged parallel to the circles of latitude. Two-thirds of the whole land of the earth is concentrated in the northern hemisphere, mainly about middle latitudes; while the southern hemisphere is mainly occupied by a great ocean which extends almost unbrokenly around the earth between latitudes 40° S. and 70° S. In spite of these extremes of land and sea distribution the average mean annual temperature along every circle of latitude, as determined by Meinardus, is practically the same in the two hemispheres, as will be seen from Table I.

TABLE I.—MEAN ANNUAL TEMPERATURES AT SEA-LEVEL.

| Latitude. | Average Mean Annual Temperature. | | | | Percentage of Land. | | |
|---|---|---|---|---|---|---|---|
| | North. | South. | Difference. | Mean. | North. | South. | Difference. |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| | °C. | °C. | °C. | °C. | % | % | % |
| 0 | 26·2 | 26·2 | .. | 26·2 | 22 | 22 | .. |
| 10 | 26·7 | 25·3 | 1·4 | 26·0 | 24 | 20 | 4 |
| 20 | 25·3 | 22·9 | 2·4 | 24·1 | 31 | 24 | 7 |
| 30 | 20·4 | 18·4 | 2·0 | 19·4 | 43 | 20 | 23 |
| 40 | 14·1 | 11·9 | 2·2 | 13·0 | 45 | 4 | 41 |
| 50 | 5·8 | 5·5 | 0·3 | 5·6 | 58 | 2 | 56 |
| 60 | − 1·1 | − 4·1 | 3·0 | − 2·6 | 61 | 0 | 61 |
| 70 | −10·7 | −13·3 | 2·8 | −12·0 | 53 | 71 | − 18 |
| 80 | −18·1 | .. | .. | (−18·1) | 20 | 100 | − 80 |
| 90 | −22·7 | .. | .. | (−22·7) | 0 | 100 | −100 |
| 0–90 | 15·2 | 13·3 | 1·9 | 14·2 | 39 | 17 | 22 |

Space does not allow of one examining this table in detail, but attention may be directed to latitude 70° as being representative of polar regions where one would expect any difference to be especially marked. Within the Arctic Circle there is a great sea; within the Antarctic Circle there is a great

[1] Abridged from a paper read before the Royal Meteorological Society on June 15.

continent. Outside the Arctic Circle the continents of North America and Asia form together the largest mass of land in any part of the earth; outside the Antarctic Circle a continuous ocean extends completely around the earth for many degrees of latitude. The Gulf Stream Drift, the greatest heat-carrying ocean current which exists, conveys warm water right into the heart of the Arctic Ocean; in the south no current carries warm water within 40° of the pole. Yet there is only a difference of 2°·8 C. between the average temperature along latitude 70° in the north and in the south. In the face of the evidence of Table I. there can be little doubt that the distribution of land and sea plays little part in determining the average temperature along a circle of latitude and that no redistribution of land and water could possibly have raised the temperature in polar regions by the 25° C. required to give Spitsbergen the climate which exists to-day in the Mediterranean.

Although from the above discussion it would appear that the distribution of land and water plays a very small part in determining the average temperature of a zone, there is no doubt that it does play a very large part in determining the actual temperature in various parts of a zone.

Fig. 1 has been reproduced from Hann's "Lehrbuch der Meteorologie" to show the existing variations of mean annual temperature. We see at once that the temperature may be very different at different places along the same circle of latitude. The greatest differences occur along latitude 70° N., the mean temperature off the coast of Norway being more than 20° C. higher than the mean temperature in the west of Siberia.

In the zone between 40° N. and 60° N., the temperature is highest over the east of the oceans and lowest over the east of the continents. This is due almost entirely to the fact that over the east of the oceans the prevailing winds have a southerly component and over the east of the continents a northerly component. This means that the chief transport of warm air from equatorial regions is over the east of the oceans, and as the winds control the movements of the surface waters the effect of the ocean currents is simply an addition to the effect of the winds. On the other hand, the return flow of air from polar regions is mainly over the east of the continents, bringing with it low temperatures from higher latitudes. Whatever the distribution of land and sea within the zone we may expect the same effect, the transport of warm air will be over the east of the waters and the transport of cold air over the east of the land masses. The only question that arises is whether there are any limits to the difference of temperature that may be induced in this way. A glance at Fig. 1 will show that there appear to be such limits. The areas of the continents and of the oceans in the zone we are considering are very different, the extent of Asia being more than twice that of North America and the extent of the North Pacific Ocean being more than twice the extent of the North Atlantic. In spite of this difference of extent the lowest temperature

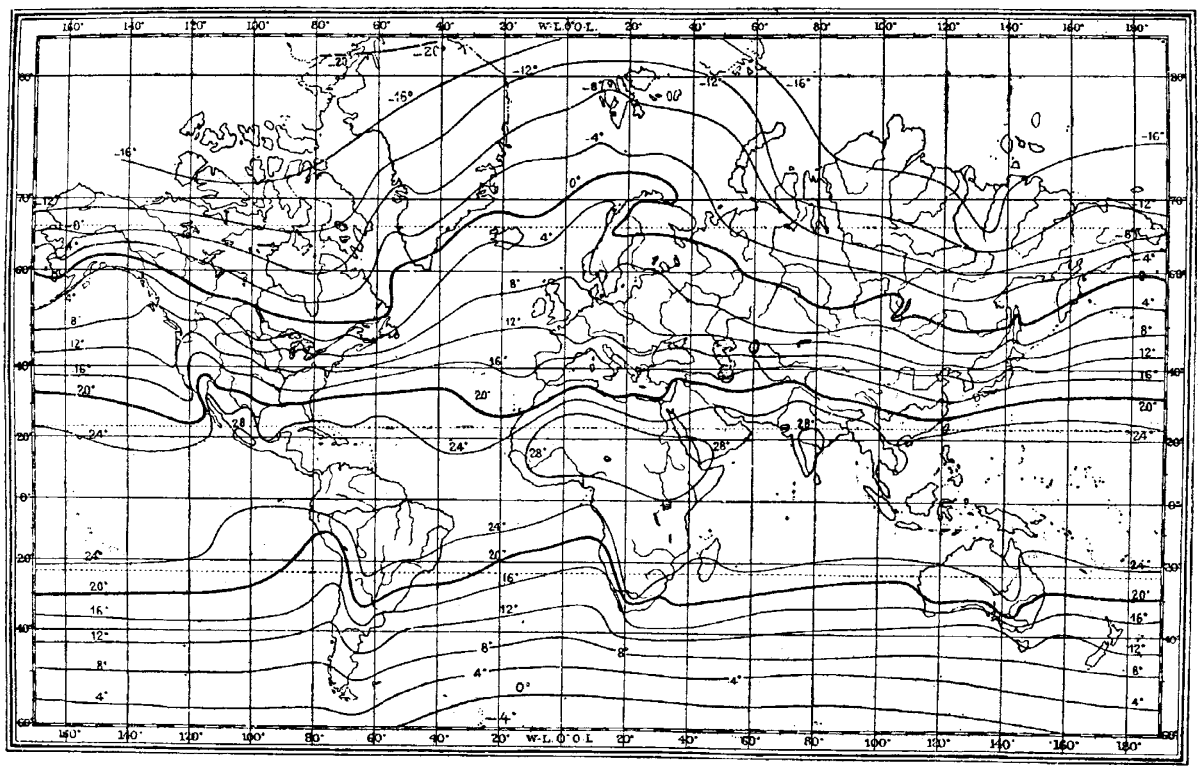

FIG. 1.—Yearly isotherms.

on any latitude over North America is practically the same as the lowest temperature on the same latitudes over Asia. In the same way, in spite of the Gulf Stream Drift the highest temperatures over the North Pacific are very similar to those over the North Atlantic.

The figures are the most striking in the case of the low temperatures in the east of the continents. From latitude 40° N. to 60° N. the great Asiatic land mass produces the same lowering of the temperature within one or two degrees as is produced by the much smaller North American continent. From this we may conclude that North America is already sufficiently extensive to produce the maximum cooling and that no readjustment of the land masses within this zone would produce lower mean annual temperatures than exist to-day in the east of North America and in the east of Asia.

TABLE II.

| Latitude. | Lowest Mean Annual Temperature. | | | Highest Mean Annual Temperature. | | |
|---|---|---|---|---|---|---|
| | America. | Asia. | Difference. | Atlantic. | Pacific. | Difference. |
| °N. | °C. | °C. | °C. | °C. | °C. | °C. |
| 40 | 10 | 8 | 2 | 17 | 14 | 3 |
| 45 | 6 | 4 | 2 | 14 | 12 | 2 |
| 50 | 1 | 0 | 1 | 12 | 9 | 3 |
| 55 | − 5 | − 4 | − 1 | 9 | 7 | 2 |
| 60 | − 8 | − 8 | 0 | 8 | 5 | 3 |

Similarly over the sea; when we find that the highest temperatures over the broad North Pacific Ocean are within three degrees of the corresponding temperatures in the narrow North Atlantic with its active Gulf Stream Drift, we may legitimately draw the conclusion that no redistribution of land and water would materially raise the temperature over the sea.

We thus see that in the north temperate zone there are quite definite maximum variations from the mean temperature of the circles of latitude, and that these exist to-day over both North America and Asia. The conclusion is irresistible that at no time in the past could mean annual temperatures exist locally in the north temperate zone which do not occur on the same latitude to-day.

Similar considerations applied to the polar and equatorial zones lead to the same conclusion, and there seems little doubt that not only have there always existed climatic zones similar to those which exist to-day (assuming no change in solar radiation), but also at no time in the past is a limited region of the earth's surface likely to have had a higher or lower mean annual temperature than can be found somewhere on the same latitude in the northern hemisphere to-day.

## Historical Aspects of Disease.[1]

INFORMATION regarding disease in the past may be derived from three sources—from human and animal remains in ancient times (a considerably limited field), from a study of old sculptures, models, and pictures, which give more especially evidences of abnormalities in growth, and finally from a study of the medical and other writings of the past. Achondroplasia has been shown to exist in Egypt so early as the Sixth Dynasty (2900 B.C.), and achondroplasic dwarfs are often to be observed in Egyptian mural paintings. Pott's disease of the spine has also been noted in a bronze statuette of ancient Egypt. In a bust of Alexander the Great in his fatal illness, Sir Berkley Moynihan recognised evidences of cerebro-spinal fever. Achondroplasia and rickets are portrayed in the mural paintings of Pompeii and Herculaneum. The portrait of Ferdinand I., Emperor of Germany, painted in 1521 by Lucas van Leyden, shows the adenoid facies, although it was only in 1868 that Wilhelm Meyer of Copenhagen made adenoids known to the medical profession. Hystero-epilepsy has been identified in Raphael's pictures, and Charcot and Richer identified hysteria major and hystero-epilepsy in the engravings of the famous epidemic dancing mania which was prevalent in the Rhine provinces from the fourteenth to the sixteenth centuries. Similarly, these authors figured a number of old pictures showing plague victims with buboes, and among them Saint Roch, the patron saint of the disease.

Paintings may also show diseases which were much more common than at present (leprosy), or conditions which have disappeared from Great Britain as the result of efficient preventive legislation (hydrophobia). Although written records of acute disease are far more numerous than pictures and statues showing pathological conditions, their satisfactory interpretation is much more difficult owing to differences in the methods of description and nomenclature and the possibility of the existence of more than one disease raging at the same time, as was probably the case during the Antonine plague in Rome.

Now disease is not in itself a fixed entity, but the reaction of a complex organism to varying degrees of injurious influences; therefore a change in the organism or a change in the injurious factor may lead to widely different pictures. Changes in the organisms responsible for infective disease occur with far greater rapidity than do changes in the higher mammals. Some authors consider that changes in the former are much more important than changes in the host. Wars and famine readily determine changes in the type of disease by setting up conditions favourable to the spread of disease and unfavourable to the victim of the epidemic spread. Such changes are most liable to occur in the acute diseases, but it is very difficult to decide whether a real change in type has occurred.

[1] Abstract of the opening paper in the discussion on "Clinical Variations in Disease from the Historical Point of View," delivered by Sir Humphry Rolleston to the History of Medicine Section of the British Medical Association at Edinburgh on July 22.