come within either the historical meaning of the term—establishment of religion—or within the reason for the constitutional rule prohibiting the establishment of religion. Realistically, sectarian colleges and universities (I exclude avowed theological seminaries) do not exist to perpetuate a religion but to provide secular education; and neither do they as a general rule restrict admission to members of the sect supporting such institution.

And the preference of colleges and universities as investors in the proposed bonds would not deny equal protection of the laws to those excluded from investing therein. Not every preference in legislation is a denial of equal protection of the laws. If classification is necessary to accomplish the purposes of the legislation and if the classification is reasonably related to the accomplishment of these purposes, then, assuming the validity of the legislative purpose and objective, the legislation will not fail merely because there is such preferential or differential treatment among the body of citizens. Here the very object of the legislation is to provide advantageous investments for private colleges and universities. Conceding that such aid to private institutions sufficiently serves a public purpose to meet the requirement of due process of law, the preference of such private institutions is a necessary device to effectuate the object of the legislation. Indeed, if the requirement of equal protection of the laws were to be given a doctrinaire interpretation, the legislature would find itself in a constitutional straight-jacket, for the very purpose of much legislation is to single out some public need and provide the means to meet it.

The unkind may say that this is altogether too simple a solution devoid of attractive red tape. It would not result in the growth of a large bureau, applicants would not flock to Washington, and our elected representatives there would have no opportunity to display their prowess in the support of the schools and colleges at home. It would simply be the right of all private institutions of higher education listed in the U. S. Office of Education to avail themselves of this federal aid in proportion to the educational service they perform.

The idea of issuing a special series of 5 per cent. non-transferable Government bonds is mentioned because it seems to be workable. But any plan of federal aid unaccompanied by federal control would be welcome. The time for inaction is past. It is up to these great private schools and colleges from Maine to Florida and from Washington to California and in between to get together and tell the public what they really want, for legislation may be passed almost any day, which, by supporting only public institutions, will make their survival even more precarious.

RAINFALL PERIODICITY IN RELATION TO MALARIA AND AGRICULTURE IN THE NEAR EAST

By DR. HELMUT DE TERRA
VISITING PROFESSOR OF GEOGRAPHY, THE OHIO STATE UNIVERSITY

THE literature on the Near East is full of speculative references to climatic changes as having altered the history of its peoples. Depopulation of Palestine and Syria in ancient times, shifting of caravan roads and cities, loss of soil fertility, wars between sedentary and nomadic peoples have at one time and another been related to rainfall and vegetation changes. In a most recent book by W. C. Lowdermilk[1] the problem is posed anew. In opposition to Ellsworth Huntington's[2] claim for climatic changes, its author suggests that soil erosion is chiefly responsible for the vanishing of wealth and power in the Near East. In other sources the evidence in favor of climatic controls frequently referred to vanishing forests, to shrinking croplands and to abandonment of elaborate water works. In the other camp are those who emphasize social factors as degeneration of farm practices, raids of desert nomads, excessive taxation and diseases like malaria. The issues have been under discussion for over two generations, but they are not merely academic. On the contrary, they have eminent practical value. If the planners in the Near and Middle East would know what to guard against and at what time adverse climatic factors might arise, it would mean the saving of many human lives and of large sums of money. Already vast projects of land reclamation are under way in Palestine. Others are scheduled and will be tried out in adjoining regions which stir afresh under the touch of reformist movements. Hence a clarification of the issues is as timely as it is desirable.

It seems to me that a new approach to this complex question can be found in analyzing observable climatic records and in relating these to one of the better-known scourges like malaria and crop failures. Rainfall of course is the most important climatic factor in these lands. Meteorologic recordings go back sufficiently in time to permit of definite conclusions as to the periodicity of rainfall and water supply. Long-range recordings are available from stations like Beirut, Haifa, Jerusalem, Gaza and others. A preliminary study of these records tends to disclose that a very real control has been exercised over the welfare

[1] "Palestine, Land of Promise." New York, 1944.
[2] "The Transformation of Palestine," Boston, 1911, and "Climatic Pulsations," Hyllningskrift Sven Hedin, Stockholm, 1935.

of those lands for the last thirty years by observable minor climatic variations.

The accompanying rainfall graphs (Fig. 1) represent a period of sixty-six years. The data were taken from government sources as well as from H. H. Clayton's "World Weather Records."[3] These graphs disclose the following tendencies. A *rainfall periodicity* making for alternate wet and dry "phases" with rainfall maxima corresponding roughly with sunspot maxima. Years with excessive rainfall tend to recur in phases of 10 to 12 years, namely, 1883 to 1893, 1893 to 1906, 1906 to 1917, 1917 to 1929 to 1938. Wet and dry phases have their own oscillations which run counter to their respective tendencies. This introduces a non-periodic element which is presumably due to local storms. The single phase appears to swing away from the total average rainfall by three and four inches, *e.g.,* a rainy phase shows an aggregate surplus of four inches over and above the general mean (Beirut: 35.2 inches). Years with excessive rainfall within a wet phase show increases of 30 to 50 per cent. of the general rainfall mean and up to 70 per cent. from one rainy season to another. The rainfall curves also indicate a *secular change* as revealed by a slight downward trend toward aridity. Whether this is in the nature of a cyclic process or whether it is a one-way change cannot be determined.

Significant also is that excessively wet years are preceded by one or two dry years. This means that after a drought season streams have to remove unusual quantities of weathered rock with resultant overloading and widespread ponding. In such rainy years lakes and open reservoirs experience a sudden expansion, forming additional breeding grounds for malaria mosquitoes. This is especially true for the dry wadis and for the coastal dune belt, where successive dune ridges accompany the shore through which the streams must cut in order to reach the Mediterranean. On the inland plains such rains lead to flooding of valley floors and the formation of stagnant pools. At such times climatic optimum conditions prevail for a malaria epidemic.

To substantiate and clarify this relationship it should be remembered that it was the late malariologist, Dr. I. J. Kligler,[4] formerly of the Rockefeller Institute, who demonstrated that in Palestine malaria spreads with the seasonal rhythm of rainfall and air temperature. There the rainy seasons last from October to April while the summers are dry and hot. It is in the spring that cisterns, ponds and lakes are filled with water and that stagnant pools occur in the valleys. These are the ideal breeding grounds for the malaria hosts. Since the rainy season generally will come to an end in April and with air temperature rising from then on, larvae of the malaria-carrying mosquitoes will mature quickly. The malaria parasites in their mosquito hosts will complete their regenerative cycle within a month. This means that in May mosquitoes begin to play their deadly role as malaria hosts. From then on the percentage of malaria infections rises steeply until an optimum is reached in June and July. In August begins a waning which lasts until November when rains and lower temperatures cause a "dormant phase." This generally lasts until the following spring. According to Kligler's careful studies this seasonal rhythm is found in the coastal plains where the mosquito hosts become active twice. In the inland plains. however, the malaria optimum is reached in the fall occasioned by a later activity of a different species and at a time of greater humidity. Kligler's observations were carried out over a period of two and a half years (1924–1926) and his graphs indicate a rapid rise of malaria infections at the end of 1926. This epidemic coincides with one of the prominent wet phases in Fig. 1.

This striking relationship between rainfall maximum and malaria epidemic is confirmed by records of previous epidemics in the Near East. The calamitous epidemic of 1917–19 which struck Syria, Transjordan and Palestine is well known. It had been suspected that this outbreak was due to an unusual influx of malaria carriers through Turkish and Allied troop movements from countries further east and southeast. However, this outbreak was not confined to these regions but it also affected areas like Greece and the Balkan countries where relatively fewer malaria carriers of eastern origin were stationed during the war. Hence it would seem more plausible to relate this epidemic to the excessively wet phase that prevailed during these years, especially since those countries have similar rainfall régimes (Fig. 1). Preceding it, in the years 1911–1912, Brünn and Goldberg[5] recorded an unusually high percentage of malaria in the Judean Hills. This also was a time of abnormally high rainfall (Fig. 1). Still earlier Dr. John Cropper (*Journal of Hygiene,* V, 1905) found a high rate of infections for the years 1904–05 in Jerusalem. Again this corresponds with the wet phase recorded in Fig. 1.

That the waning of the great epidemic of 1917–19 could not be attributed solely to anti-malarial measures was plainly admitted by the Malaria Commission of the League of Nations.[6] The question con-

[3] I wish to acknowledge with sincere thanks the assistance of Lloyd Stevens, acting director, Statistics Division, U. S. Weather Bureau, who furnished me with certain data.

[4] "The Epidemiology and Control of Malaria in Palestine," Chicago University Press, 1930.

[5] "Die Malaria Jerusalems und ihre Bekämpfung." *Zeitschrift für Hygiene,* Vol. 75.

[6] "Reports on the Tour of Investigation in Palestine in 1925," League of Nations Health Commission, Geneva, 1925.

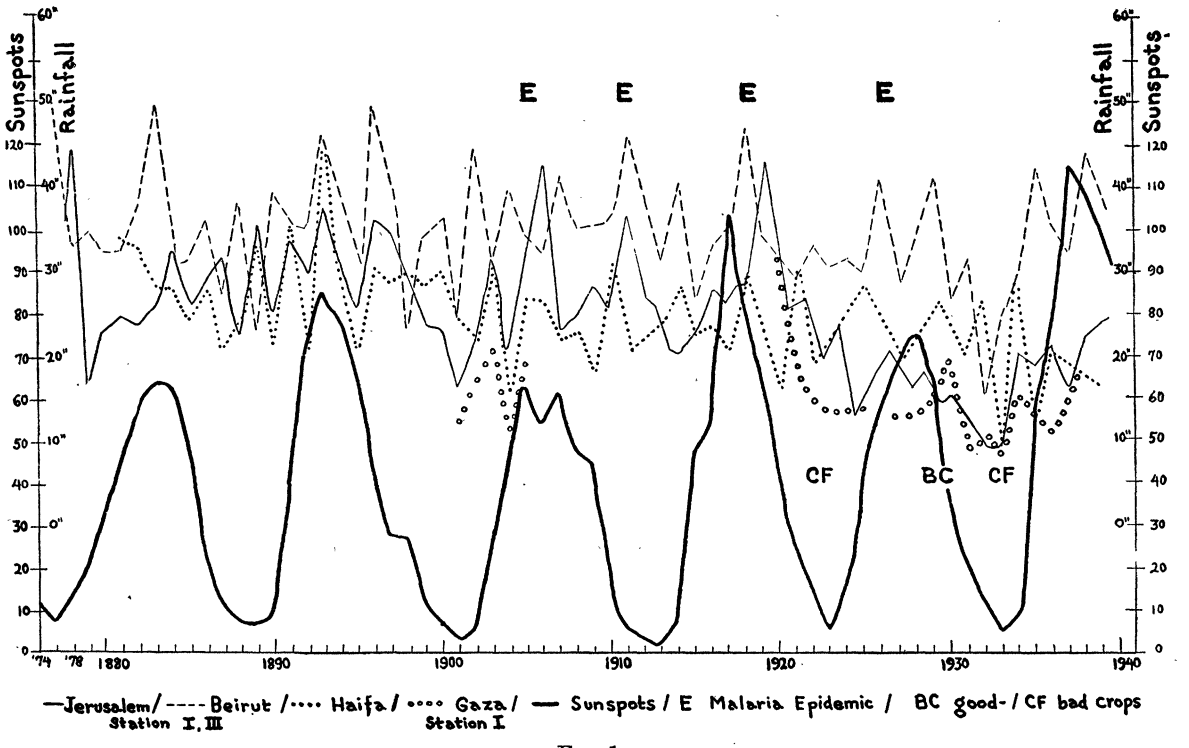

FIG. 1

cerning the controlling factor of malaria epidemics in the Near East was thus left unanswered.

Theoretically speaking, a climatic control of malaria epidemiology in the Near East may work out differently if we admit that any abnormality of rainfall can produce social stress conditions in marginal lands. Excessive drought, for instance, frequently forces desert dwellers to overrun the adjoining farmlands in their search for food resources. If this drought is followed by a rainy phase, a malaria optimum will be reached, by both a sudden influx of malaria carriers and rapid expansion of breeding grounds. No data are available to me to indicate that such an epidemic was caused ever by a drought. In any event such a contributing factor can hardly be called social when it is induced by climatic processes which cause the burning up of croplands or pastures in times of drought.

This latter aspect leads to another relationship concerning the impact of wet and dry climatic phases upon food crops in the Near East. Sufficient data are already at hand to prove that bumper crops of wheat and barley, the chief staple farm products, coincide with wet phases and conversely crop failures with dry phases. The data submitted on the graph are based on statistics from Syria and Palestine. This, as well as other aspects, will be more fully described on another occasion.

The climatic agencies which produce these rainfall changes would seem to be influenced by the sunspot cycle, yet it remains to be seen how exactly this relationship works in terms of atmospheric circulation. It has been suggested to me by H. Bowman Hawkes, of the Department of Geography at Ohio State University, that the alternate phases might be induced by a periodic shifting of the cyclonic storm tracts in the Eastern Mediterranean. This will require a special study which is at present under way.

Once more it becomes apparent that the study of climatic changes and their impact on human society must rely on demonstrable observations rather than on inferences drawn from historic records. Of all other approaches, the geographic method lends itself better to a full elucidation of these inter-related processes because it can synthesize what would otherwise remain unrelated to observable facts. In this case it would seem that rainfall periodicity once recognized and substantiated by more data may actually lead to the prediction of conditions conducive to epidemics and crop failures. In this manner it may be possible not only to undertake preventative measures but to understand more clearly the relationship between climate and human planning. And if, as in this case, the relationship could be fully understood on the basis of observable records, I can see no objection to an acceptance of Huntington's theory whereby the historic fate of Near Eastern nations has at certain times been greatly affected by changes of climate.