

WILEY



The Burial of Olympia: A Study in Climate and History

Author(s): Ellsworth Huntington

Source: *The Geographical Journal*, Vol. 36, No. 6 (Dec., 1910), pp. 657-675

Published by: geographicalj

Stable URL: <http://www.jstor.org/stable/1776838>

Accessed: 11-05-2016 00:25 UTC

Your use of the JSTOR archive indicates your acceptance of the Terms & Conditions of Use, available at
<http://about.jstor.org/terms>

JSTOR is a not-for-profit service that helps scholars, researchers, and students discover, use, and build upon a wide range of content in a trusted digital archive. We use information technology and tools to increase productivity and facilitate new forms of scholarship. For more information about JSTOR, please contact support@jstor.org.



Wiley, The Royal Geographical Society (with the Institute of British Geographers) are collaborating with JSTOR to digitize, preserve and extend access to The Geographical Journal

themselves. Of course, one can never believe what they say without confirmation, but the folk-lore also seemed to point to this fact. Idiong, the practice of divination, struck me as being quite subsidiary to the other forms of religion, but it is very difficult to find out much about their exact relations. As regards Colonel Close's remarks about the spelling of names, for instance, Ekkonnanakku, perhaps I may be allowed to say that I took very great trouble to spell every word according to the rules of the Geographical Society, but it is quite possible that the natives have put on an extra syllable lately, as they are accustomed to do that sort of thing.

THE BURIAL OF OLYMPIA.*

A STUDY IN CLIMATE AND HISTORY.

By ELLSWORTH HUNTINGTON.

CAN this be Greece? we asked ourselves. Can it be that Attica is so utterly barren? The waves of a sparkling sea lapped against a beachless shore of pale grey limestone, as treeless and bare as the Pyramids. At the top of the cliffs there stood out, white and clear against the cloudless sky, an exquisite group of marble columns, a ruined shrine of the God of the Sea. It was Sunium, the outpost of Attica eastward. Near it we passed bare islands, and a bay where a full-winged sail-boat had left the cliffs astern and was coasting along a pebbly beach backed by a slope of brown fields, darkly dotted with olives up to the foot of inhospitable naked hills. This, we told ourselves, is more typical than Sunium, for here we have the tree of Minerva, and one of the bays which made the old Greeks masters of the sea. A few hours later we came within sight of Athens. When we had picked out Mount Lycabettus, and below it the Acropolis with its wealth of columns, we knew that this was the real Greece of the gods and heroes. Yet we were not satisfied, either then or later. The modern Piræus is ugly; the drive to the capital, past little wine-shops, big factories, and discouraged, dusty gardens, is tiresome; and the Athens of to-day does not differ notably from a hundred other modern European cities.

Only the Acropolis and its environs are satisfying. Among the crooked streets at the northern base of the famous hill the uninspiring vistas of the modern city are relieved by bits of real antiquity preserved in stone, or are varied by tantalizing hints of the real life of the people. There in mid-September almost every block was enlivened by women in wrappers bickering with pedlars, whose droop-eared donkeys bore paniers full of green things from the country, or of beautiful grapes, some big and blue, some round and green, and others small, plump, rosy, like the fingers of a child. The Acropolis itself is as fascinating as one's dreams. The scenery seaward is charming, in its mixture of smooth water and irregular islands and mountains; but landward the view is

* Research Department, May 26, 1910.

disappointing in its dreary sameness, and its lack of a dress of living verdure. If Parnes were merely some unheard-of place in Turkey called Boz Dagh, and Pentelicus were only Kara Tepeh, the scene would be far less enticing than a thousand similar views in the Balkans and Asia Minor.

Can it be that Attica was always thus? In the days of Pericles were its hills so barren, its soil so thin, and its population, outside the city, so scanty as now? In those days was the bed of the Ilissos river dry most of the year? Would the old Greek writers have spoken as they did of the famous grove of the Akademe, where the greatest of philosophers walked and talked beside the Kephissos river, if then, as now, the stream had been exhausted by irrigation before reaching the sea, "a mere sandy channel most of the year"? In the days of the glory of Greece, did Athens find it as hard as at present to supply her children with water, and was the amount available for domestic purposes sometimes so unpleasantly restricted as to-day?

Such questions occur to every thoughtful traveller in Greece. They came to the writer with peculiar force when he arrived in Greece in September, 1909, after finishing the six months' work of the Yale Expedition in Palestine, Syria, and Asia Minor. There we had been investigating the cause of the sad transformation which has come over the lands most famous in ancient history. We had reached the conclusion that one great factor has been changes of climate. We had discovered, too, that, in date and nature, the changes which have taken place in Western Asia have agreed closely with those 2000 or 3000 miles farther east in Central Asia and Northern India. Naturally we speculated upon the possibility of similar changes in Greece. Realizing, however, the danger of being carried away by enthusiasm for a mere theory, we endeavoured to refrain from coming to any positive conclusion unless it were positively forced upon us.

Greece is full of phenomena which suggest that a change of some sort has come over the country. This is especially noticeable on the dry east side of the country. Argolis, for instance, like Attica, abounds in mountains of bare limestone. For the most part they are absolutely treeless, with at best a few evergreens near the summits, and a little oak scrub in the damper valleys or on the moister slopes. Often, indeed, the mountains are so devoid of soil that trees could not grow in large quantities, even with sufficient rainfall. There can be little doubt that formerly many of the now barren slopes were wooded. In some cases, such as eastern Arcadia, actual records prove the existence of forests in places where now there are none, and where it seems impossible for them to grow, partly for lack of soil, and still more because of the scarcity of summer rainfall. This condition is especially impressive near Mycenæ at the Heræum, the chief shrine of ancient Argolis. On every side the landscape is of the most barren description.

To be sure, the distant plain—where Argos lies and Nauplia—is green much of the year, and the sloping land which rises to the Heræum is also green for a short time in spring. The general view, however, presents no hint of trees; the land is parched and brown much of the year; and the limestone mountains are wearisomely barren. Perhaps the old Greeks cared nothing for natural beauty. They certainly say little about it. Perhaps, too, their shrines were located without reference to natural scenery even though they cared for it; but this is not the case at Olympia and Delphi, where the scenery is in the one case charming and in the other magnificent. To attempt to draw any conclusion from the Heræum is useless. Yet the almost universal feeling of visitors is a sentiment of wonder that so sane a people as the Greeks should have located the chief sanctuary of an important province in so barren a location. This sentiment is enhanced by a visit to Mycenæ, where the Acropolis is utterly dry and even the neighbouring valley is practically waterless. Yet Mycenæ was once an important town, a leader among Greek cities in the days when Agamemnon ruled with Clytæmnestra. Strange, indeed, that so thirsty a spot could have been the site of so renowned a city. Scores of facts indicative of a great and possibly irreparable change in the physical conditions of Greece might easily be cited. Little would be gained thereby, however, for no one denies that there has been a change. The only question is, whether the change is due solely to human causes, or to a change in nature itself?

The change in Greece is often attributed to deforestation. Recent investigations seem to the writer to prove definitely that this process cannot have played any important part in the decline of the natural resources of Greece. The loss of the forests is undeniably a most serious injury to the country, but it is an effect and not a cause. Prof. Moore, Chief of the United States Weather Bureau, has recently submitted to the Congress of the United States a report which shows plainly that forests do not appreciably affect rainfall. He actually goes so far as to doubt whether the cutting off of forests in itself has any important effect upon floods. It is not our purpose to enter into the discussion of this problem. Greece itself offers a strong argument in favour of the conclusion that, so far as climate is concerned, the disappearance of forests is an effect, and not a cause. Even a cursory examination of the present distribution of woodland in that country shows that upon the mountains which have sufficient rainfall during the warmer half of the year trees still grow in fair abundance. Greece lies on the southern border of the zone of prevailing westerly winds. Accordingly most of its rainfall comes in winter, and is derived from the west, while the summer is characterized by a long sub-tropical dry season. The western portion of the country receives fully twice as much rain as many portions of the east, and the rains in the west continue later in the

season than those of the east. Accordingly the west side of the Peloponnesus supports a fairly large number of trees. In many places, such as the vicinity of Olympia, the mountains are covered with extensive but not dense pine forests. The east coast, on the contrary, is utterly devoid of forests except in a few specialized areas. One of these is the vicinity of Megara, near the head of the Gulf of Corinth, and between the cities of Corinth and Athens. Here, in what was formerly the heart of Greece, and within twenty or thirty miles of the chief city, the hillsides are well covered with an open pine forest. If the cutting of forests were responsible for their disappearance, there surely would be none here. The reason for their persistence is clear. The Gulf of Corinth offers an easy line of access whereby the prevailing west winds, with their freight of moisture, blow through to the east side of Greece without being caused to rise and give up rain. Thus the water of the Adriatic is borne as far as the borders of the Aegæan. Other places where forests occur in the midst of dry, deforested districts are not uncommon. Such, for instance, are Parnes and certain other mountains near Athens. In many cases it can be seen plainly that the occurrence of the trees is directly correlated with an exposure to winds which come in from the sea and are compelled to rise. As yet almost no detailed studies of the matter have been made, but enough is known to show that local variations are much greater than is commonly realized. The rainfall of places only a few miles apart may vary sufficiently to cause marked differences in forests and other vegetation. Therefore we may conclude that, on the whole, forests, or at least evidences of the possibility of forests, occur in practically all areas where they could grow under present conditions of rainfall. Their presence or absence does not affect the actual amount of rain, and so for our present purpose they may be left out of consideration.

In comparing the conditions of ancient and modern Greece, the significance of one important generalization seems to have been largely overlooked. At present the centre of population and culture, if Athens be left out of account, lies distinctly farther westward than in classic times. Athens, of course, still retains its pre-eminence, partly as the capital, partly as the chief commercial centre, and partly because of its traditions, which make the Greeks exult, and bring Barbarians by thousands to admire its remnants of bygone glory. How great is the preponderance of the west over the east may be judged from the fact that, according to the last census, the four provinces of Achaia, Elis, Tryphilia, and Messenia, bordering the western coast, have a population of 472,000 in an area of 3250 square miles. That is, they have 145 inhabitants to the square mile. The five provinces of Boeotia, Attica, Corinth, Argolis, and Lacedæmon, on the eastern coast, have 647,000 inhabitants in 5670 square miles, or 114 to the square mile, in spite of the 250,000 people crowded together in Athens and the Piræus. If

Boeotia and Attica be omitted, and we confine our attention to the Peloponnesian provinces, the density of population on the dry eastern side of the peninsula, the side where most of the famous cities of antiquity were located, is only 74, or a trifle more than half as much as on the west side. The difference is due entirely to the more abundant rainfall of the western coast. The west can scarcely have been so much more populous than the east in classic days. It seems as if the east coast in those days must have been at least as fertile as the west now is. In that case it could support a much larger population per square mile than the west now does, for its plains are relatively extensive, and, if properly watered, highly fertile. Possibly it was formerly still more fertile than the west now is, for, compared to western Europe and eastern America, even the best parts of Greece are dry and barren. A population of 145 to the square mile is far from dense, according to European standards. The west, like the east, has suffered terrible devastation, which is nowhere more striking than in the ruin and burial of Olympia.

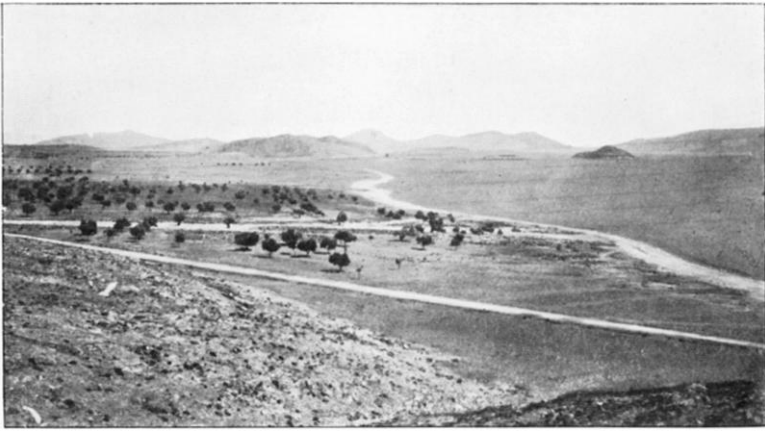
In the preceding pages various phenomena have been mentioned which suggest a decided change in the climate of Greece since classic times. The history of the country can be much more readily understood on the assumption of such a change. Nevertheless, the evidence thus far presented lacks the convincing quality which compels belief. The facts, to be sure, all fit the theory of climatic change, but in any individual case they can be explained upon other theories. Olympia, however, furnishes evidence which, to the writer at least, seems conclusive.

A dozen miles east of the point where the river Alpheios, according to the old Greek myth, plunges beneath the Adriatic sea in mad pursuit of the fleet nymph Arethusa, the river has made for itself a plain. On either side rise the gracious foothills of the Arcadian mountains, dark green where scrub of oak or bay prevails, light yellowish green where tracts of piney woodland have been left, pure bright green among the vineyards, brown where the fields have been reaped, and pale ashy grey where the soil is so thin that vegetation languishes. At the base of the hills the plain, clothed with fine vineyards and dotted gracefully with trees, is cut in halves by a broad depression, whose floor is the grey flood plain of the narrow, dull blue river. On the northern side of the plain, east of the perpendicular cliffs of yellow clay which border the trough of the little Kladeios stream, the ruins of Olympia lie at the foot of the pine-clad Kronian hill. They are a mass of scattered grey slabs and circular rock drums, with here and there a standing column, a prone pedestal, the base of a flight of steps, or the smooth face of a wall. Thirty years ago the Germans, under Curtius, dug out the ruins from under 15 feet of silt. Ruins they were, yet parts were found of every one of the edifices which old Pausanias described with

such exasperating minuteness a century and a half after Christ, in the first painstaking 'Baedeker.'

Every one knows the story of the rise and greatness of Olympia. Pelops played a shabby trick on Hippodamia's father when he bribed the charioteer to pull the linch-pins from the royal chariot in the first great Olympian race; but like other fond lovers, Pelops thought only of his princess, and had no idea that in winning her he should kill her father. For over a thousand years the Olympic games went on, training the Greeks in manhood and nobility at first, but later degenerating into debasing professional bouts. The later games were so demoralizing that in 394 A.D. the Emperor Theodosius put an end to them. In the century preceding the suppression of the games, the Greeks were so severely harassed by barbarian invaders from the north, that they converted the central part of the Olympian sanctuary into a fortress, using for the purpose stones derived from the surrounding structures. After 400 A.D. Olympia practically disappears from history. In the first half of the sixth century, the temple of Zeus, chief of the holy places, was thrown down by two earthquakes. At about the same period, probably, a destructive landslide took place from the Kronion, as the Greeks called the northern hill, and after this an extensive inundation from the Kladeios. The site still appears to have been occupied by a poor village, which, to judge from the coins found in the ruins, existed down to the seventh century. Then the Kladeios again overflowed on the north-west of the ruins, while the Alpheios flooded them from the south-west. How long the floods continued cannot be determined, but, before they came to an end, some 15 feet of silt had been deposited not only among the ruins, but over the whole width of the plain for many miles both mountainward and seaward. When at length the rivers ceased to build up their flood-plains, they once more took up the interrupted task of cutting down their channels. In time they would probably have laid bare the ruins and demolished them, but centuries before that stage could be reached, the Germans appeared upon the scene.

The cause of the burial of Olympia has been much discussed. Two theories, and only two, so far as the writer is aware, have received serious consideration. The earliest and most obvious is that Olympia was buried by a landslide from the hill of Kronion. There appears to be an historic record of such a landslide, and there are known to have been earthquakes which might have given rise to such a phenomenon. To the student of physical geography it is at once evident that this theory is impossible. In the first place, the materials covering the ruins of Olympia are manifestly the result of deposition by running water and not by landslides. In the second place, they form part of a great mass of alluvium extending for miles up and down the Alpheios and its tributaries, and having a volume thousands of times as great as that of the whole Kronion. Finally, a landslide



THE PLAIN OF ÆGINA, LOOKING EAST TOWARDS ATHENS.



THE SKIRONIAN CLIFFS, IN MEGARA.



THE TEMPLE OF HERA AT OLYMPIA.



THE HERÆUM, OR CHIEF SHRINE OF ARGOLIS.



GENERAL VIEW OF MODERN VILLAGE OF OLYMPIA.

from a hill so low and gently sloping as the Kronion could never have travelled hundreds of yards across a level plain studded with massive ruins, as it must have done in order to bury Olympia; and if it had done so, the surface would be rough instead of smooth.

A second theory appears more plausible at first sight. Inasmuch as floods are known to have had a share in burying Olympia, it has been surmised that they arose from the sudden outburst of Lake Pheneos. This lake is a small body of water located among the mountains of Arcadia. It has no outlet above ground, but discharges to the Alpheios river through an underground passage, such as is common in limestone mountains of the sort prevalent in Greece. The lake is subject to pronounced variations in size. Sometimes it has had a length of several miles, and again has been reduced to less than a mile. In a single season the change may be enough to flood 2 or 3 square miles in the spring when the snow is melting on the mountains, and to leave them dry at the end of the long, rainless summer. To explain the floods of the Alpheios, it has been surmised that in the seventh century the underground outlet was suddenly enlarged so that the entire lake was emptied into the river in a short time. The gradual discharge of the lake in the fashion which now occurs is quite insufficient to occasion a flood; but if the outlet should be suddenly enlarged to many times its present size, the water might escape in such volume as to cause much havoc. There is small probability, however, that Olympia was buried in any such fashion. In the first place, while a sudden enlargement of the underground outlet of a lake might possibly occur, it is an event so rare that the writer has been able to find no record of it, either in Greece or any other country. Commonly such outlets enlarge gradually. In the next place, it would be practically impossible for such an event to occur time after time in the same lake within a period of a few centuries. Nevertheless, the burial of Olympia demands that such shall have been the case. The deposition of silt amounted to not less than 20 feet in the immediate neighbourhood of the ruins, and perhaps to more in other places; for the river first filled its channel, and then deposited 15 feet of silt on the ruins. The deposits show by their structure that they were laid down in thin sheets of mud by one flood after another. They extend up and down the valley for scores of miles, and in the lower portion of the river's course expand to a width of a mile or two. No single flood from Lake Alpheios or any other source could possibly have laid down silt throughout the entire valley. Therefore the number of floods must have been more than the number of layers of silt in any one place. We may safely infer that the deposition of the alluvium of the Alpheios valley represents a series of floods, perhaps annual, or more probably occurring every few years, and extending through a period of scores or hundreds of years.

There is, finally, a third reason for believing that Lake Pheneos had

nothing to do with the burial of Olympia. The deposits which enclose the ruins take the form of a broad terrace. Since the deposition of the alluvium which overspread the ruins, the river has changed its method of work from deposition to erosion, and has cut a new valley some 30 feet deep, thus leaving a broad terrace on either side. Similar terraces are found far up the Alpheios: for instance, at Leonhardi in the plain of Western Arcadia. This place lies many miles above the point where the waters of Lake Pheneos join the river, and floods from that body of water could not possibly have had any effect on the terraces of the Arcadian plain. Evidently, then, the terrace-making process had no relation to the lake, and was due to some cause which acted not merely locally, but over a large part of the Peloponnesus.

In any attempt to explain the burial of Olympia the theory of deforestation cannot safely be ignored. We have already spoken of the matter in connection with the country as a whole, but it seems wise to apply it specifically to Olympia. According to the theory, the forests of Greece were cut off, and the mountains were thereby left naked. Hence great quantities of soil were washed down. According to the report mentioned above, the carefully kept records of the United States Weather Bureau seem to indicate that, contrary to almost universal belief, the cutting off of forests does not produce this result. Floods appear to result from deforestation only when the undergrowth is burned off or eaten by flocks. However this may be, let us grant that the old idea as to the effect of deforestation upon floods is true, and let us see how this affects Greece. We are sometimes told that the entrance of barbarian invaders into Greece and other countries caused the reckless cutting of large tracts of forest. This belief finds its warrant in the undoubted fact that in many cases the forests of lands which were conquered by barbarian invaders did rapidly disappear. If the barbarians did not cause deforestation, what did?

In the days when the burial of Olympia was in progress the population of Greece had fallen off enormously, both in actual numbers and in civilization. It needs no proof that, other things being equal, many people use more wood than a few. It is almost equally evident that the more highly civilized a nation is, the more lumber it uses. The ancient Greeks were wise in their day, but we have no reason to believe that they had ever so much as thought of applying the modern policy of conservation of natural resources. In view, then, of the very scanty population of Greece five or six centuries after Christ, and the low state of civilization both among the barbarian invaders and the Greeks themselves, it seems scarcely credible that the cutting off of trees went on more rapidly than in the days when Greece was great and populous. The barbarians certainly were not Gladstones who cut trees for exercise. Nevertheless the trees disappeared at the time when the barbarians came in. Something else was evidently at work.

Let us now turn to the theory which seems to the writer to explain the phenomena discussed above. A scientific theory, to use an old simile, is a master key. Any rational theory opens some doors in its particular field, but only the true theory opens all doors. As the result of seven years' study of the drier portions of Asia, the writer, as has been set forth in this *Journal*, has been led to adopt the theory that the climate of Western and Central Asia has changed in historic times, and that the changes have been of a pulsatory nature. At certain periods the climate appears to have become rapidly drier. At others it became moister, but, on the whole, the general tendency has been from moist to dry, and possibly from cool to warm. Thus it appears that the climate of the present time is distinctly drier than that of two thousand years ago. Nevertheless, at certain times during the two thousand years conditions appear to have been even drier than at present. When used as a key in Greece, this theory is found to fit a great number of facts. For instance, it explains the scanty population and relative poverty of the country to-day, the inadequate water-supply and diminished rivers of Athens, the barrenness of Attica, the location of Mycenæ and other towns in situations where it would now apparently be impossible to obtain a sufficient water-supply, the disappearance of forests from many parts of the Peloponnesus, and the change of the centre of population from the dry east side to the more rainy west. More complex than any of the preceding subjects is the burial of Olympia. Hence the great significance of the fact that our climatic key, as shaped far away in Asia, fits the phenomena of the Greek sanctuary with absolute precision.

The remarkable agreement between the phenomena at Olympia and those of distant Asiatic regions can best be made clear by setting forth two minor theories which form part of our main climatic theory. One of these deals with the mode of origin of terraces, and the other with the date of the driest period within historic times. The two are based on absolutely diverse lines of evidence. When first formulated it was not perceived that they bore any special relation to one another.

The dry mountains of Central Asia are full of alluvial terraces. To the number of five, or even six, they extend for scores of miles along the valleys at heights of from 10 to 1000 feet. They were first carefully studied by Prof. Davis of Harvard University, and the writer, during the course of the Pumpelly Expedition sent by the Carnegie Institution of Washington to Turkestan. Elsewhere such terraces had been ascribed to glaciation, uplift of portions of the Earth's crust, changes in the level or discharge of lakes, or other minor causes. The terraces in Asia were found to lie in such positions with reference to each other and to lakes, glaciers, and lines of earth-movements, that none of the old explanations could possibly fit them. We were finally driven to the conclusion that they must be due to important climatic fluctuations since the glacial period. Apparently during moist epochs

the mountains were covered with forests and other vegetation, whose roots held the soil in place even on steep slopes, and caused it to accumulate to a considerable thickness. Each such epoch was followed by a time of comparative aridity, during which the forests died. The *death* of the trees naturally produced results very different from those due to mere cutting off. Since the country was now drier than formerly, bushes and new trees were not able to spring up abundantly. Little by little the ground became bare, and the roots decayed and disappeared. Finally, nothing was left either to prevent the rain from running off in floods, or to retain the soil and half-decomposed rock upon the slopes. Such a quantity of *débris* was swept down the mountain-sides that the main streams could not carry it all away, and accordingly deposited alluvium in their valleys for scores of miles and to a great depth. When the mountain-sides were largely denuded, or else when the climate once more became moist, and plants increased in number, the deposition ceased. Then the streams began to cut channels in the alluvium, thus forming terraces.

Let us turn now to the theory which deals with the date of the period of most pronounced aridity during historic times. The Caspian sea, like all enclosed lakes without outlets, fluctuates in response to changes in the amount of precipitation. In the past it has generally stood higher than now, indicating a relatively moist climate; but once at least during historic times it has stood so low as to indicate a climate drier than of to-day. From Aboskun, at the south-east corner of the sea, a wall runs 150 miles eastward into the mountains of Eastern Persia. It was built by a Persian king to keep out hordes of barbarian invaders, who again and again swarmed into Persia from the north, impelled, perhaps, by hunger due to increasing aridity in their deserts. The most reliable tradition, according to Rawlinson, assigns its date to some time between 459 and 484 A.D., but it may have been later. When it was built the climate was presumably drier than now, for the wall runs out some miles in shallow water. On the opposite side of the sea, at Derbent, a similar wall for the same purpose was built a century or two later, and elsewhere ancient buildings lie under water. In Chinese Turkestan at this time many towns appear to have been abandoned for lack of water. In Kashmir, among the Himalayas, the Jhelum river was obstructed by deposits of gravel brought down by mountain streams, apparently because of relative aridity. In Arabia, according to Mr. Douglas Carruthers, the members of one of the chief Arab tribes in the region east of Southern Palestine relate that their tribe was once many times as large as now. Shortly before the days of Mohammed—that is, about 600 A.D.—a terrible and prolonged drought caused untold havoc. Finally, such distress ensued that emissaries were sent to spy out a new land. On their report most of the tribe moved to Tunis, forerunners of the tremendous migrations which a few

years later, under the combined stimulus of hunger and of a new faith, overwhelmed Northern Africa and Western Asia. From all these facts, and others, it appears that during the thousand years preceding 600 A.D. there was rapid desiccation of much of Asia. It did not progress regularly, however, for certain periods, such as the third century, were unusually dry, while the fourth and fifth apparently had a climate better than that of the present.

If the theory of the climatic origin of terraces, and the theory of a period of exceptional aridity, culminating about 600 A.D., are both true so far as Central and Western Asia are concerned, and if the climatic history of Greece agrees with that of Asia, it is evident that in Greece we ought to find evidence of the rapid deposition of alluvium in some of the river-valleys during the sixth and seventh centuries of our era. Now this, it will be recalled, is exactly what we find at Olympia. The terraces there are plainly of the same kind as those of Central Asia. They were formed at precisely the time demanded by the theory of pulsatory climatic changes. So striking an agreement between the phenomena of Greece on the one hand, and two independent theories based on diverse phenomena in widely separated parts of Asia on the other hand, can scarcely be the result of chance. If either theory were essentially wrong, or if the climatic changes of Greece did not agree with those of Asia, the law of chances would make it in the highest degree improbable that so close an agreement should exist. When we find that all manner of other phenomena, such as those cited in the earlier part of this paper, point to the same conclusion, the degree of probability of the main theory becomes still greater. Therefore it seems safe to conclude that Greece, as well as all the countries from China to Turkey, has passed through a series of pulsatory climatic changes, and that its climate in the days of its prime was distinctly moister and possibly cooler than at present. Undoubtedly the theory will require much modification in details, but the work of the Yale expedition of 1909 seems to confirm its main outlines so conclusively that we are perhaps justified in using it as the basis of further excursions into the realm of theory.

Assuming, then, the truth of the theory of climatic changes of a pulsatory nature, let us see how far the theory fits and, in some degree, explains the history of Greece. The great outstanding fact in the history of the country is the sad decay in the moral fibre of the Greeks and in their civilization as a whole, which set in about three hundred years before the beginning of our era, and reached its lowest ebb five or six centuries after Christ. Luxury, harmful foreign customs, internal dissensions, external invasions, religious decadence, and a host of other factors played a part in this decay; in some cases as causes, in others as results, and probably in most cases as both causes and results. In the present brief discussion it is impossible to consider the individual

factors separately. We are able merely to take cognizance of the broad general fact that the decay of Greek civilization was due largely to a weakening of the moral fibre of the people. The virile, indomitable Greeks of the classic age, who exulted in their moral uprightness, mental alertness, and bodily vigour, gave place to a weak, effeminate race, who substituted casuistry for honesty, curiosity for true thought, and professional athletics for high physical culture.

Hand-in-hand with the decay of Greek civilization there took place a great decline in population. It, too, began about three centuries before Christ, and culminated nine centuries later. At first the signs of this decline were slight, scarcely more than mild premonitions of what was to follow. The first serious notice of the matter is found in the works of Polybius, a century and a half before the Christian era. For two centuries or more Greece deteriorated, until conditions were such that Plutarch, writing toward 100 A.D., estimates that all Greece could scarcely furnish 3000 hoplites, or heavy-armed soldiers, whereas in the fifth century B.C. Athens alone supplied 35,000, and even little Megara sent 3000 to face the Persians at Platea. Dio Chrysostom, who died in 117 A.D., relates that in his day the greater part of the city of Thebes lay desolate, and only a single statue stood erect among the ruins of the ancient market-place. "The same picturesque writer," to quote the account given by Frazer in his admirable essay on Pausanias, "has sketched for us a provincial town in Eubœa, where most of the space within the walls was a pasture, or rig and furrow, where the gymnasium was a fruitful field in which the images of Hercules and the rest rose above the waving corn, and where sheep grazed peacefully about the public offices in the grass-grown market-place. In one of the 'Dialogues of the Dead,' Lucian (writing after 150 A.D.) represents the soul of a rich man bitterly reproaching himself for his rashness in having dared to cross Cithæron with only a couple of man-servants, for he had been set upon and murdered by robbers at the point where the grey ruins of Eleutheræ still look down on the pass; in the time of Lucian, the district laid waste, he tells us, by the old wars, seems to have been even more lonely and deserted than it is now. Of this state of things Pausanias (143-176 A.D.) is the best witness. Again and again he notices shrunken or ruined cities, deserted villages, roofless temples, shrines without statues, faint vestiges of places that once had a name and played a part in history. To the site of one famous city he came and found it a vineyard. In one neglected fane he saw a great ivy tree clinging to the ruined walls, and rending the walls asunder. In others nothing but the tall columns standing up against the sky marked the site of a temple."

Sad as was the state of Greece in the second century of our era, it was slightly better than that of the preceding century, and far better than that of the years which followed. Already in the time of Pausanias

the Goths from Southern Russia were beginning to make inroads upon the border provinces of the Roman Empire, and in 250 A.D. they began the great advance which carried fire and sword to the very heart of Greece, and shook the Roman world to its foundations. After this terrible devastation, Greece recovered somewhat under the Byzantine emperors, Constantine, Julian, and Theodosius, whose reigns extended from 314 to 395 A.D.; but it was sorely harassed by the invasions of Alaric, which began in 393, and by those of the Huns and Vandals, which began a little later. Then, under the Emperor Justinian, 527-565 A.D., conditions once more improved a little, but not for long. Before Justinian's death the Slavs had begun to come down in hordes from the north. By the end of the century Greek civilization was almost extinct, and Attica and the Peloponnesus had entered upon a period of torpor from which they did not emerge for six centuries.

An analysis of any great historic movement shows it to be composed of a most complex series of factors. For the sake of simplicity, we may divide the factors into five groups: psychological, political, economic, pathological, and geographic. The psychological group is very comprehensive, including religious, moral, and intellectual factors. The degree of importance to be attached to each of the groups must vary greatly according to the tastes and training of the individual. This, however, need not concern us, for no one would deny that all are highly important. The essential matter, not only for the historian, but for any man interested in the betterment of the human race, is to determine how far each set of factors is dependent upon or exerts control over the others. For instance, can any possible height of psychological development overcome the pathological conditions of certain tropical regions? Or, to illustrate the matter concretely, Is it possible for European experts to overcome the sleeping sickness in Africa? The majority of mankind would promptly answer, "Yes," without stopping to consider the steps which lead to such a reply. A fuller answer, however, would require qualifications. The political historian would say, "Yes, provided the nations of the world retain the present political status. The advent of a great war might put off the matter indefinitely, first by its immediate results, and then by the prolonged after effects. Or, if the parts of Africa where sleeping sickness prevails were to pass from the rule of European Governments to that of native chiefs, again the highest mental abilities of Europe would be powerless to eradicate the disease." In like fashion the economist would say that the accomplishment of the task depends upon the preservation of the present favourable economic conditions. Let all Europe and America fall into prolonged industrial depression, and then all attempts to overcome disease in Africa will come promptly to a standstill. And, finally, the geographer would support the economist by saying that a prolonged deficiency of rainfall, such as that which characterized the sixth and seventh centuries of our

era, would cause such economic and political disasters that the world might not recover for centuries. He would add that the eradication of sleeping sickness also depends upon the possibility of permitting the investigators to live in a temperate climate. If they and their descendants were forced to live permanently in the tropical climate of Africa, only the most meagre results could be expected, because of the weakening of mental and physical activity which seems to be inseparable from a tropical climate.

In a case such as that discussed in the preceding paragraph, the importance of all five groups of factors is patent to all. In studying a great event such as the decline and fall of Greece, it is equally manifest that the five groups must each have played a vital part. Nevertheless, even the best histories do not make this evident, largely because the economic, and still less the geographic and pathologic, conditions of ancient Greece are most imperfectly known. The most interesting of all studies to mankind is his own psychological condition as manifested in his religion, his moral code and his intellectual development. These have found expression in the institutions of the home, the Church, law and education—institutions so important that in many minds they fill a large part of the horizon; and rightly, perhaps, for they are the flower and fruit of human progress. Closely associated with them, and surrounding them, as leaves surround the flowers, we find political conditions, and the institution of the State. The history of wars and dynasties and princes is not the history of a people, but it is so fascinating and so relatively easy to record that it occupies a large share of the remainder of the historic horizon. In saying that the psychological and political aspects of history have been cultivated to the exclusion of the other aspects, we do not mean to criticize the historians. We rather mean to criticize the economists, pathologists, and geographers. These men, who ought to have been showing the intimate relation of the branches, trunk, and roots to the flowers and fruit of history, have only begun to realize the importance of their own subjects. Already the economists have gone so far that the importance of the economic element in history is widely recognized. They have done their work so well that the thoughtful historian now, as a matter of course, looks to them for aid, and incorporates their results in his histories. It behoves the pathologists and geographers to do likewise.

The decline of Greece, as commonly studied in these days, includes a threefold decay—namely, psychological, political, and economic. We have seen above that at the same time with this threefold decay there appears to have been in progress a geographic, or more strictly, a climatic decline which was not due to any action of man, but to some great external change in nature itself. This geographic change cannot possibly have been a result of the psychological, political, and economic changes, but it may well have been one of their causes. It is manifest

that in a dry country like Greece a decrease in the amount of rainfall would cause scarcity of crops and great economic distress. This in turn would lead to political unrest, especially through the agency of taxation. The peasants would become so poor that they could not pay the taxes which previously had seemed relatively light, and thus great discontent would arise. More than one revolt is known to have arisen from such causes, and, doubtless, careful study would show that hunger underlies scores of great wars. An equally potent disturbing element would be the vast movements of population which scarcity of rain would cause. Elsewhere the writer has elaborated the idea that many of the World's greatest movements of population, such as the barbarian invasions of Europe in the early centuries of the Christian era, the vast outpouring of the Mohammedans from Arabia, and the sudden outbursts from Central Asia under Genghis Khan and Tamerlane, took place at times of exceptional aridity. We seem to be almost forced to believe that it was hunger, due to lack of rain, which played the compelling part in these epoch-making migrations. Religion and human personality guided and fostered the movements, but it is doubtful whether they caused them.

Economic effects of quite the opposite kind may be produced by changes of climate. The sudden rise of Palmyra to a position as one of the world's great cities in the third century after Christ appears to have been due, strangely enough, to the fact that the Syrian desert which surrounds the city was at that time growing rapidly drier. In earlier days at least three caravan routes led across the Syrian desert and the northern part of the Arabian desert. One ran from Egypt through Petra to Jauf and the Persian gulf. The second, along which the Romans constructed one of their solid stone highways, passed Bosra and Sulkad, which lie east of the Sea of Galilee, and then traversed the desert to Jauf, where it joined the Petra route. A third went straight eastward from Damascus to Mesopotamia. All these roads are known to have been frequented by numerous caravans in the time of Christ, and probably earlier. In the third century they were abandoned. To-day all three roads are absolutely impassable for commercial caravans, not merely because the Arabs who live in the few habitable spots plunder wherever possible, but because water and forage along the routes are so scarce that laden animals cannot possibly subsist. In the third century a rapid decrease in the supply of water and grass along these routes seems to have resulted from a diminution of rainfall. This fact and the consequent greater plundering propensities of the impoverished Arabs apparently caused all three to be abandoned. The trade which had poured along them was concentrated at Palmyra, far to the north. Hence that city suddenly grew rich and powerful; but it soon fell, partly because its trade from distant points sought other routes, and partly because increasing aridity finally impoverished the neighbouring lands, and

they no longer were able to carry on much commerce. Other examples of the effect of changing physical conditions might easily be given, but enough has been said to show their potency. In themselves they seem to be competent to produce the profoundest changes in economic and political conditions. Coupled with other geographic factors, they hold mankind in such a grip that his emancipation is as yet scarcely more than begun.

We have seen the close connection between geography and the economic and political aspects of history. In the remainder of this paper we shall point out a possible way in which changes of climate may act through pathological channels to influence man's psychological conditions, just as they act through economic channels to influence his political conditions. What follows, even more than what precedes, is avowedly theoretical. It rests, however, on a firm basis of fact. Whether the theory here set forth be right or wrong, it may at least serve a useful purpose in suggesting an important but untilled field of study.

Sir Ronald Ross was the first to indicate the importance of malaria from the historic standpoint. In 1907, Mr. W. H. S. Jones, of Cambridge, published a modest little volume entitled, 'Malaria: A Neglected Factor in the History of Greece and Rome.' The book contains only a hundred pages, but it possesses an idea which may lead to important results. In brief, Mr. Jones shows first that the ravages of malaria in countries such as Greece, Italy, and Turkey, where it is endemic, are much more serious than is generally recognized. In such countries a majority of the children are subject to malarial attacks every year up to the age of puberty. After that age the great majority become immune. The disease is looked upon much as we look upon measles, or scarlet fever, that is, as something which every child is likely to have, but which is not usually harmful. Measles and scarlet fever, however, attack a given individual only once in a lifetime, as a rule, and do not leave permanent effects. Malaria, on the contrary, come year after year as regularly as the seasons, and leaves results which never are eradicated. The poor children grow sallow and weak, their spleens are permanently enlarged, and their vitality is lowered for life. No one who has suffered from malaria will question the severity of its results and the length of time that they last after the disease itself has disappeared. Even in these modern days, when quinine has come to our aid, it is one of the most insidious diseases. Every traveller who has seen much of the Orient knows how the sufferers from malaria lie and groan for days, and later have no energy for months, but go languidly to the necessary tasks, and as soon as possible sit down to rest and wait with open, stupid mouths. Physicians agree that it is impossible to expect much initiative or energy from a nation in which the majority of every generation is permanently devitalized by this baneful disease.

The preceding conclusions are those of Sir Ronald Ross and other physicians rather than of our authority. Mr. Jones's chief contribution to the subject is a study of the occurrence of malaria in ancient Greece and Rome. From a painstaking study of classic authors he concludes that up to about 400 B.C. in Greece, and 200 B.C. in Rome, malaria was practically unknown. Then it appeared, and during the succeeding century or two became common. At first it attacked adults, which shows that it was a relatively new disease which had not yet become endemic, or else, we would add, that Greece was on the very border of its habitat. Later it became permanently located in the respective countries, and attacked chiefly the children. It is noticeable that the introduction of malaria coincides with the beginning of the weakening of Greece and Rome, and the time when it became endemic is synchronous with the epoch when the lustre of the ancient names began to become seriously dimmed. Many other important forces were doubtless tending to weaken the Greeks and Romans, and their final overthrow was largely the work of barbarian invaders. Nevertheless the coming in of malaria must have played no small part. The growing effeminacy and lightness of the Greeks, and the brutality of the Romans, are just the effects which would have been produced by malaria upon people of the temperaments of the two races. The case is so strong that one can scarcely resist the conclusion that this pathological factor of malaria must have had an important place in the psychological changes which accompanied the decline of civilization and population in both Greece and Rome.

The reason for the introduction of malaria into Greece and Rome at the specified times offers important food for thought. Jones is inclined to think that these countries were always fit homes for the *Anopheles* mosquito, which, as all the world now knows, is an essential agent in the dissemination of the disease. He therefore concludes that while the mosquito existed from the remotest times, the germ of the disease was not introduced until the highest pitch of civilization had been reached. Then, by reason of great intercourse with Africa or the East, through war and commerce, it was brought in. Such a supposition is possible, but improbable. If Greece was then as fit a habitat for the mosquito as now, and if malaria prevailed in Asia Minor, Syria, and North Africa, as it does at present, it seems scarcely possible that the constant intercourse of all the centuries previous to 400 B.C. should not have caused its introduction. And, again, if it was introduced into Greece in 400 B.C., and had become endemic before 200 B.C., it seems scarcely credible that it should not have been carried to Italy before 200 B.C., for at that time the two countries were in closest intercourse.

I am indebted to Prof. Joseph Barrell of Yale University for the suggestion that the introduction of malaria into both countries was the result of the changes of climate which form the chief subject of this

paper. It is well known that malaria is pre-eminently a disease of tropical and sub-tropical countries. It prevails in regions whose climate is characterized by an alternation of rainy and dry seasons. In such places the streams are subject to floods which spread over wide areas for a brief period. Then, as the dry season comes on, the amount of running water diminishes, and innumerable stagnant pools and swamps are left, ideal breeding places for *Anopheles*. If the pools are permanent and contain fish, the mosquito larvæ have a poor chance, and the insects cannot be very abundant. If the climatic conditions, however, are such that the pools or swamps last a few months and then disappear, ideal conditions are offered for the mosquito. In deserts the supply of water is so scarce that malaria is not common. In temperate regions the rainfall occurs at all seasons of the year. Consequently the streams are perennial, there are relatively few isolated pools and swamps, and in most of these minnows and other small fish abound. Hence in such regions malaria is scarce. In mountains, likewise, malaria is uncommon, even in subtropical regions; for, outside of the main valleys, the water runs off rapidly, leaving little opportunity for the formation of pools. It is noticeable that the inhabitants of deserts, temperate regions, and mountainous sub-tropical regions, are all apt to be endued with a larger share of energy than the people of regions where malaria prevails. Of course temperature, race, religion, and a host of other factors play an important part, and ought to be considered in any complete discussion. Here, however, we are concerned only to point out the possible relation of climate to pathological, and hence to psychological conditions.

If our theory of climate is correct, the historic change which has taken place during the last two thousand years is merely the continuation of the irregular change from the conditions of the last glacial epoch to those of an inter-glacial or post-glacial epoch. In the course of that change any country lying near the northern border of the sub-tropical zone must, at some time, have suffered a change equivalent to a transference from the zone where westerly winds prevail throughout the year to the zone where they prevail somewhat less than all the year, and where their rain-bringing cyclonic storms cease during a period of summer drought, which lasts from one to six months, according to latitude. When the length of the dry period becomes sufficient, the country becomes a fit habitat for the *Anopheles* mosquito. It seems as if Greece must have reached that stage about four hundred years before Christ, and Italy two hundred years later. Under such circumstances the introduction of malaria would depend largely upon climatic conditions. Once introduced, the disease would at first be epidemic and attack adults, but in course of time would become endemic. It would increase in severity with the increasing aridity up to a certain point. The deposition of silt by rivers in their valleys, because of the dying of vegetation,

would help the mosquitoes, for under such circumstances streams spread in many channels. Then, when they diminish in the summer, numerous stagnant pools are left in the beds of the many branches. It is worth noting that at Olympia special mention is made of the great prevalence of malaria in the later days, after the decay of Greece had become pronounced.

A theory may easily be carried too far. Important factors are almost inevitably overlooked. The writer realizes that he is dealing with great matters about which little is known. His purpose is not to advocate the theories here presented, but to set them forth that others may criticize and improve them. Geography is a root from which spring innumerable and, as yet, unsuspected branches in the form of economic and pathological results. These in turn bear leaves and fruit in the form of political and psychological phenomena of varied sorts. Other similar fruits may spring from other roots. With them the geographer is not concerned. It is his province to study faithfully his own subject and learn the nature of the connection between the parts from root to fruit. Only by knowing the whole of a plant can the fruit be improved.

MR. HOGARTH: On the whole I do not feel convinced that so large a cause is by any means necessary to account for the particular phenomena with which Mr. Huntington is dealing. I will not attempt to go into the wider question of general desiccation over the whole, or certain parts, of the world. There is no doubt that the most important questions that this paper raises are the meteorological question, and the semi-geological question about the deposit of alluvia in terraces. About these I have nothing which would be of any importance or any value to say. Having seen something of the country, and having studied Greek history, I will only advance a few questions about the arguments which Mr. Huntington derives from history. It is obvious that the period with which he is dealing is rather short. As geological periods go, it is nothing at all. He supposes that the dry period in Greece began about 300 B.C. But so far as I know, such scanty evidence as we have in Greek authors for the climate of Greece before that period tends to show that it was a dried-up country even in the fifth century, at any rate upon the eastern side. There is a well-known allusion by Aristophanes to the extreme clearness of the air of Attica, and another by Thucydides to the dryness and poverty of the soil. Mr. Huntington, in his paper, has made a great point of the fact that the eastern side is much drier than the western, and has stated his belief that the former could not have been so dry when it was the most populous and most historically important, as it was in the ancient times. Well, I should like to point out that the reason why the eastern side was the most important and the most populous in the ancient times had apparently no reference to its climate, but to the fact that the only land route up the peninsula goes up the east side. Those eastern cities lay in relation to a great trade route, which was of course extremely important when Greece was important, but which ceased to be important when Greece collapsed from various causes into a little provincial place. The transference of population, therefore, was not necessarily due to any climatic change, but to the fact that the routes by land and sea ceased to be important up the east coast, and population took the natural course of going over to the west