

Dr. Voûte then presented to Sir Francis Younghusband the Gold Medal of the Royal Netherlands Geographical Society, and Diplomas conferring Honorary and Corresponding Membership of that Society were handed to Sir Charles Close and Mr. Hinks respectively.

M. MAURY, speaking on behalf of the Société Royale Belge de Géographie; said: La Société de Géographie de Bruxelles, désirant, à l'occasion des fêtes du Centenaire, exprimer toute sa sympathie pour les dirigeants de la Royal Geographical Society, et honorer en même temps deux géographes éminents, m'a chargé de remettre en son nom le diplôme de membre d'honneur à Sir Charles Close, Président, et celui de membre correspondant à M. Hinks, Secrétaire. Elle m'a prié également de leur exprimer toutes ses félicitations.

M. Maury then handed to Sir Charles Close and to Mr. Hinks Diplomas conferring respectively Honorary and Corresponding Membership of the Société Royale Belge de Géographie.

The PRESIDENT: We now commence a series of papers on the Habitable Globe, and are very fortunate in having persuaded some eminent geographers to come and speak to us. We have three papers on a subject which perhaps is the most important of any which can be graced with the term "human geography." Amongst those geographers there is a very distinguished man of science, Professor Penck, who has promised to give us a paper on the alleged desiccation of Central Asia, and I will first call upon him, and then upon Professor Gregory and Mr. Leakey.

CENTRAL ASIA

PROF. DR. ALBRECHT PENCK

FOR centuries Central Asia has been the centre of unknown Asia; since the last fifty years it has been the object of so many explorations and researches that even the geographer who stands outside can venture to discuss some questions of importance which were in the foreground of exploration. If he will express his opinion on Central Asia as a part of the habitable globe, he must say at first to whom he owes his knowledge. Many men who have staked their lives and have crossed with indefatigable courage and sharp eyes the high mountains and the deserts, ought to be enumerated. If I mention only two it is to show to whom I am indebted most: Sven Hedin and Şir Aurel Stein are my great masters on the geography of Central Asia.

Whoever speaks on Central Asia must confess what is his conception of this region of the world. There is a diversity of opinions in regard to what Central Asia is. Humboldt laid much stress on its central position in the continent, but indicated no sharp borders; Richthofen followed physiographic reasoning which allows a sharper definition. He observed that all products of the degradation of the land remain in Central Asia and are not transported into the sea. But this is true for all regions which have no outlet to the ocean, whatever their geographical position may be. Richthofen excludes indeed those regions from

Central Asia which in recent geological times were drained into that interior sea which stretched during the later Tertiary Period in the east of the Mediterranean; he does not include therefore Turan in his Central Asia. But there are besides this vast tracts of Persia and Asia Minor which since long time have had no oceanic drainage and continue to have none, and in which all the waste of the land remains, though they have a true peripheral situation in the continent and are neighboured by the sea. These countries also are not included by Richthofen in his Central Asia.

His distinction between central and peripheral regions in a continent is based essentially on climatic facts. The waste of a land remains on that land, where aridity consumes the water. Therefore, an arid climate is the cause of all central regions in the sense of Richthofen. An arid climate however is not always characteristic of the central parts of a continent. Most of the arid regions of the globe lie excentrically; in lower latitudes they stretch to the west coasts of the continents and directly border the ocean. I hesitate to identify the central regions of a continent with arid climate; there are as well peripheral parts which since long geological times are under the influence of a climate of extreme dryness. The definition of a central region in the sense of Richthofen fits excellently for the Sahara, but nobody would apply the designation of Central Africa to that desert. Therefore, when looking for a definition of the central part of a continent I lay stress in the first place on its central position and make use of physiographic or other facts only in order to recognize reasonable boundary lines. For different continents different ways of reasoning can be followed. The purpose must always be to recognize the entity of a larger region.

The climate plays a principal rôle. Central Asia rises out of the arid parts of Inner Asia, but it is not a dry region in its whole extent. It gives origin to large rivers; most of them run into the surrounding deserts or desert-like countries. The Amu Darya and Sir Darya end in Lake Aral; the seven rivers of the Northern Tien Shan evaporate with the waters of Lake Balkhash; Lop Nor or its substitute is the terminal lake of the Tarim. Other rivers of Central Asia, the Hwang Ho and Yangtze Kiang, the Mekong and the Salween, the Brahmaputra and Indus, indeed reach the sea; this is due to the fact that they are not totally absorbed in those arid regions through which they pass. They may be compared with the Nile. Large rivers can never originate in an arid climate. Here all precipitation is consumed on the spot by evaporation. This does not always happen immediately. The water of violent rain-showers runs a certain length on the surface before it disappears. Thus we have in nearly all regions of the world with an arid climate ephemeral watercourses, which in Turkistan are called "sai," while its rivers are called "darya." The sais display in their short course the same actions as all running water: they erode and accumulate according to the same laws as the big rivers. They create in arid tracts the same surface forms as are met with in humid regions. But these forms do not unite systematically into larger ones and the land has not that harmony of slopes which is so characteristic of all humid climates. There is no uninterrupted inclination towards the sea or towards an interior basin. Besides this, wind-action becomes effective; sand and dust are easily blown away and redeposited in other localities. Aeolian erosion and aeolian deposition however are in arid

regions subordinate to erosion and deposition by water, as long as sandy and dusty soils do not predominate. Where this is the case, wind-action also becomes visible even in humid regions; it is not restricted at all to the arid one.

From the morphological standpoint the tracing of a boundary around the arid regions is not easy. The desert of Helwan in Egypt is as water-worn as any limestone region in Europe. The action of wind here seems to be insignificant, if it is not recognized in the absence of fine-grained products of decomposition on some surfaces of the limestone. On the other hand, sandy tracts in moist climates often have a desert-like appearance. Easier it is to judge from the vegetation. Forests are always absent from arid regions; the vegetation here is always scarce, more or less uncovered by it are open spaces. Plantless deserts are a climax of aridity. But deserts are not only the products of an arid climate; they occur also in cold regions. It can become difficult to distinguish dry deserts from cold deserts. This concerns especially Central Asia. One fact gives much help here, that is the existence of terminal lakes with salty water. Here not only that water evaporates which falls as rain or snow on the surface of the lake, but also that water which runs into the lake from the humid or nival neighbourhood. In mountainous regions these salty terminal lakes afford good means of drawing the *arid line* which separates the arid climate from the adjoining climate. They lie in the arid region, their feeding grounds beyond. The arid line is not identical with the border line of interior basins, the rivers of which disappear in their dry interior; it lies always within that border line; arid regions occupy only a part of those regions which have no outlet to the sea.

It is not surprising that our knowledge about the arid line in the continents is still very limited. There is an essay on it in North America, a good investigation on it in South America, and it has been traced through Africa. Dr. Lotte Möller is studying the extension of the arid regions of Asia both in the horizontal as well as in the vertical direction; it is to be hoped that the results of her research will appear next year. My observations on the arid parts of Central Asia have only a provisional character.

In Western Tibet there are salty terminal lakes at elevations of more than 17,000 feet. Here the arid line can be expected at a height of more than 20,000 feet. In the neighbourhood is the desert Aksai Chin, which has the character of a dry desert at 16,000 feet. Similar evidence is found in Central Tibet. The country is sprinkled over with salty terminal lakes at heights of 15,000 feet which receive their water from the neighbouring higher mountain chains. The arid line is here everywhere to be looked for at elevations of about 18,000 feet. Towards the east its height diminishes and the arid line may be at less than 13,000 feet; the salty Koko Nor has an elevation of only 10,000 feet. At the frontier of China proper it sinks down rapidly; the old empire lies everywhere above it. Also in the western direction there is a decrease of the height of the arid region, it embraces still the plateau of the Pamirs (13,000 feet) as indicated by the saltiness of the Qara Köl. But on the western side of the plateau below the snow-line we meet with humid conditions which extend nearly down to the foothill region. Here at elevations of about 4000 feet the arid line makes its appearance. In the interior of the Western Tien Shan the salty Chatir Köl indicates a height of the arid line of about 13,000 feet. Farther north, the brackish water of the Issik Köl demonstrates that this lake is still in

the arid region which must reach here higher than 5500 feet; but at the northern foothills of the mighty mountain chain it extends only up to 4000 feet. Very high it is however on the southern foothills of the Tien Shan on the Muzduk. Judging from the researches of Dr. Groeber it seems to be here on the south side at more than 10,000 feet. Only in a shaded part there are trees at 9000 feet. In the Eastern Tien Shan the arid line is far lower. There are forests on the north side which extend down to 3300 feet, where the dry appearance of the Dzungaria begins. In the south side however the arid character extends up to heights of 7000 feet or more. Very high also is the arid limit on the opposite side of the Tarim basin on the Kunlun and Altin Tagh. The land is dry here even at elevations of more than 13,000 feet. The arid line does not sink much from the highland of Tibet to the southern rim of the Tarim basin, it does not sink much over the basin and makes its rapid descent to the north in the Tien Shan mountains. Thus the basin of the Tarim has no considerable effect upon the situation of the arid line. The arid country between the Himalaya and the Tien Shan forms a vault with reaches highest in Western Tibet, especially in the rain shadow of the Karakoram, and which bends down on the west side of the Pamirs, on the north side of the Tien Shan, and eastward slowly to Mongolia and steeply to China proper.

This grandiose arch of the arid region is surmounted by mountain ridges covered with eternal snow. The snow-line makes a similar arch over Central Asia which culminates at more than 22,000 feet in that region, where the arid line reaches highest, in Western Tibet north of the Karakoram. From here it dips down gently in all directions. In Eastern Tibet and on the Pamirs it is met with at 18,000 feet; this is also its height on the southern border of the Tarim basin on the Kunlun. It is still over 14,000 feet on the northern border of the ridges of the Tien Shan, but in that mountain chain it sinks down rapidly to the north, as shown by a map of Machatschek. The same occurs west of the Pamirs on a smaller scale, along the Nan Shan in the east, and in the Himalaya on the south. Here the snow-line lies about 7000 feet lower than in the adjoining parts of Tibet. But the bending down of the arid line is far more considerable. It sinks below the Himalayas, and where it reappears on the south-western foothills of that mountain chain in the Salt range it has no greater height than 2000 feet. It curves down 16,000 feet, more than twice as much as the snow-line does.

The arches of the arid line and the snow-line in Central Asia are due to the high elevation of the continent just where the arid belt of the old world ends, the beginning of which is at the shores of the Sahara, from whence it extends through Arabia and Persia. Central Asia is dry on account of the arrangement of the climatic belts and its aridity is enforced by the arrangement of the surface features. The high mountains of the Himalayas, of the Pamirs, of the Tien Shan, and of the Nan Shan keep off the atmospheric moisture from the interior plateau of Tibet and from the basin of the Tarim which is surrounded on three sides by high mountains, and which is only partially open on that side from which no sea breezes can come, that is, towards the north-east. The insignificant moisture that can be brought to Central Asia is precipitated on the outer sides of its mountainous border, and only a very small part can enter the interior. Therefore both the arid and the snow-line lie here very high, and

bend down everywhere on the circumference. By this, Central Asia is a unique part of the world, and it is unique also by the fact that the arid-line comes here very near to the snow-line (3000 feet), so near that it may be questioned what is intercalated between them. It is not a well-watered humid region which extends here. There is a country covered with snow during the winter and pretty dry during the summer. It may be called seminival and can be compared to a certain degree with the arctic Tundra region. The distance between the two limits increases if we approach the circumference. Here it becomes everywhere 7000–10,000 feet, and it is only here that we find a true humid climate between the two lines with forests and the possibility to practise agriculture without irrigation. That zone is absent from the interior of Central Asia.

There is still another region of the world where we meet with similar features, that is the Puna de Atacama, where we have the sea coast in a desert country and where we ascend through arid regions until we reach heights which during the winter are snow covered and are dry during the summer. Here, too, the arid region touches the seminival one, but only a few mountain tops merge into the region of eternal snow, while in Central Asia extended mountain chains are covered with nevé and feed glaciers. This causes the difference between the Puna and Central Asia. There are no rivers arising from the Puna, while Central Asia gives rise to an important number.

Central Asia owes its daryas to the nival and subnival climate of its roof; all derive their water from the melting of snow or glaciers. Their feeding by rain or springs is insignificant. In spring or in summer they are fullest, during the winter feeble. They bring water into the arid region and carry with themselves from the high regions enormous quantities of debris which they deposit in the form of alluvial fans at the foot of the mountains. They have a freight of sand and mud which accompanies them until they disappear. This freight is then seized by the wind which blows the sand into dunes and carries away the mud in the form of dust. This is the origin of the vast deserts of sand which extend in the north of Central Asia, of the kums of Turan, and of the dunes in the desert Taklamakan in the basin of the Tarim. Here and there the sands are accompanied by loess, whilst along those rivers of Central Asia which reach the sea there are neither sand-fields nor loess, with the exception of the Hwang Ho.

Richthofen has the great merit of having recognized loess as an aeolian deposit. But it has not its origin in the decomposition of the rocks of deserts or steppes; it comes like the sand of many dunes from river deposits which are rearranged by the wind. The mud is transported farther by the wind until it was redeposited. This happens even on the barren ridge of the Kunlun up to 14,000 feet, as observed by Sir Aurel Stein; this is the rule in corners at the foot of the mountains which in Central Asia are surrounded by a belt of loess. In the Lop Nor region older river or lake deposits are strongly eroded by the wind, and many loess deposits may come from here, but others are derived directly from the mud which annual floods have left behind, and which was not fixed by vegetation. Rivers which are very broad during the summer and narrow in the winter are the birthplaces of many loess deposits. Thus it is nowadays in Central Asia, thus it was in South-Eastern Europe during the

Ice Age. Then the Danube was swollen during the summer months by the waters coming from the alpine glaciation, and very low in the winter which was dry in the east of the ice caps of Northern Europe and of the alpine glaciation. The mud left by the Danube in the low plains of Hungary and near the Black Sea was whirled up by continental winds and spread over the neighbouring land.

This is also the origin of the loess of China. During the Ice Age the Hwang Ho brought thither in the summer months the waters and the mud derived from the Central Asiatic glaciation, which in winter was swept farther and deposited as loess in great thickness on the hills and mountains of Shansi, Shensi, Kapsu, and Honan. From here it is eroded nowadays by rivers in innumerable gorges and brought to the great plains where it becomes again the prey of the wind so that the air is often full of dust. Thus it was during the Ice Age in the basin of the Mississippi. This mighty river was then during the summer full of the muddy melting water of the North American inland ice, whilst it was low in winter. Then the mud left behind by the flood was carried by the wind into the neighbourhood. Along the Mississippi are the loess deposits of North America, and not in the neighbourhood of the salt-steppes of the Great Basin. There is no loess in the steppes and deserts of Africa, and if storms bring dust from the interior of the Sahara, the deposit in Tripoli is not true loess. The origin of the loess is a very complex one; different causes—glaciers, rivers, and wind, nival and arid conditions—must work together. This happened during the Ice Age in the northern hemisphere, but at present it occurs only in Central Asia.

Central Asia is only a part of that belt of arid climate which extends from the Atlantic through the Sahara, through Arabia and Persia, into the interior of Asia. The plains of Turan are arid too, partly desert; but they have no rivers of their own, and on account of their low altitudes they do not touch the nival or subnival climate. Mongolia belongs also to the dry regions of Asia, its Gobi is in part a true desert, but except in its western basins it does not receive rivers from the neighbourhood. Its arid climate is always separated from the nival and subnival one of those mountains by a humid belt with forests. Only in Central Asia the arid zone comes so near to the region of perpetual snow that the humid climate which elsewhere is intercalated between both plays a rôle only on the circumference. That is the consequence of the meeting together of a climate originally arid with very high and continuous elevations. Such conditions do not occur in Turan and Mongolia; in both regions very extensive peneplanations have taken place; the mountains which once existed in the neighbourhood of their sandy deserts are perfectly worn down and the sands of the Gobi areas it seems to be derived from sandstones. Northern Turan and the Gobi represent a state of evolution which Central Asia will reach only after millions of years, and being very far from that terminal state, it differs essentially from its desert neighbourhood. It belongs to that belt of recent elevations which we trace from the Alps through Southern Asia, but from a tectonic standpoint it is no unit. The thrust structure of the Himalayas meets with regions of recent uplift of different kind which on the plateau of Tibet was accompanied by volcanic action.

The snow-line and the arid line are the most important border lines for

human life on the land. The snow-line is nearly impassable for human habitations; only in Europe are a few houses to be found above it: cabins for mountaineers and meteorological observatories. The arid line acts not so sharply. Man can penetrate into the region of arid climate and abide there if water can enter it, either in the form of rivers or in a subterranean way, as ground-water appearing in springs. Springs allow grazing and hunting in extensive arid regions, but they do not afford water enough for the settlement of a great number of men. Only where rivers flow into arid lands and bring much water into them are the conditions given for a large population even in an arid region.

In Central Asia extensive tracts in the arid region are quite uninhabitable. Nearly everywhere a broad belt below the snow-line is devoid of men; where in Tibet the arid line is only 3000 feet below the snow-line, the country is totally deserted. On a surface of 230,000 square miles there is not a single human abode, there are no herds, only now and then hunters or gold-diggers enter that vast tract, and caravans cross it from India to the basin of the Tarim. Another extensive region of Central Asia is as empty of men: the sand desert of Taklamakan is uninhabited and uninhabitable; the same holds good for the rocky deserts east of Lop Nor. At least 150,000 square miles in the basin of the Tarim are totally devoid of men. On 380,000 square miles of Central Asia there is no inhabitant, and on 1,000,000 other square miles there are nearly none. It is difficult to say anything on their number. If we take the data of the anökumene which Machatschek gives for Russian Turkistan, it can be assumed that we may have here two inhabitants to a square mile. This would give two millions in the arid regions of Central Asia, besides those large deserts we have already mentioned, and which are not the only deserts of our region: there are still many others sprinkled over the arid ground. They are included in our 1,000,000 square miles, which may have a somewhat denser population now and then where springs rise or little rivers disappear.

Narrow is that peripheral belt of Central Asia where agriculture is possible without irrigation, and its narrowness is strengthened by its mountainous character. Only on the bottom of valleys and on gentle slopes are fields possible, as in parts of South-Eastern Tibet, in Tajikistan, and in the valleys of the Northern Tien Shan. But nearly everywhere agriculture is helped here by irrigation. Near to that belt of agriculture the arid conditions are less severe than usual, and the population can become larger than elsewhere in the arid regions; there may be altogether 300,000–350,000 square miles within the circumference of Central Asia which on account of their semi-arid to humid conditions could nourish ten to twelve inhabitants to the square mile; they may contain three to four million inhabitants.

The essential scenes of human life in Central Asia are its oases. Most of them lie in lower altitudes, many near to the sandy desert. In general they extend over the alluvial fans which are accumulated by the rivers at the foot of those mountains from whence they come. Here the rivers can be easily divided into the branches necessary for irrigation, or their water trickles down into the loose soil of the fan and reappears farther down in moist places which allow cultivation. Widespread is the method of catching these waters subterraneously by galleries. In Russian Turkistan the cultivated area of the oases is estimated

at 70,000 square miles; it is far less in Chinese Turkistan in the province Sinkiang. Sir Aurel Stein has indicated its extent on a map of the Tarim basin. A rough evaluation gives less than 5000 square miles. If we assume the same figure for the oases north of the Tien Shan, especially in the valley of the Ili, we get for the area of all the oases in the Chinese part of Central Asia approximately 10,000 square miles: a seventh part of the surface of the oases in Russian Turkistan. If the density of the population is assumed to be the same here and there, we have a population of six millions on 80,000 square miles of the oases. More than half the population (11·5 millions) of Central Asia lives in the oases which occupy less than one-twentieth part of its whole surface (1,790,000 square miles).

The following table shows what we believe that the distribution of the population of Central Asia may be in comparison with its actual political divisions and their assumed population.

Deserts	380,000 square miles	—	inhabitants
Other arid land	1,000,000 " "	2,000,000	" "
Semi-desert and humid	330,000 " "	3,500,000	" "
Oases	80,000 " "	6,000,000	" "
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	1,790,000 " "	11,500,000	" "
Russian Turkistan*	400,000 square miles	7,000,000	inhabitants
Sinkiang	580,000 " "	2,500,000	" "
Tibet	810,000 " "	2,000,000	" "
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	1,790,000 " "	11,500,000	" "

All life in the oases depends on the quantity of water which the rivers bring down from the nival and seminival regions. The most important daryas are fed by glaciers. The rivers of Central Asia can be compared with thermometers in which the variations of the expansion of the quicksilver in the bulb are expressed by ample oscillations in the tube. Little variations in the nourishment of the rivers greatly affect their length. These variations may be due to variations in the snowy precipitation of the higher regions or to variations of the temperature there, which increase or diminish the melting of the glaciers. They can be large in wet years or in dry ones. A decision as to which will be the case is impossible on account of the want of observations. Let us imagine that a river of a width of 50 metres which terminates in the sands gains 100 kilometers length, then its surface increases by 5,000,000 square metres. If we assume that the evaporation is the same as on Lake Aral, that is, 1 metre in the year, then evaporation has to take away 5,000,000 cubic metres more than before during the year. That corresponds to $\frac{1}{6}$ cubic metre in the second. Such a little amount of the quantity of water in a river would increase its length for 100 kilometres.

It must be borne in mind however that when entering the Tarim basin the rivers are not only consumed by evaporation but also by the soaking of their

*The former General Government of Turkistan excluded the Transcaspien province and the greater part of the province Sir Darya, excluded Khiva, but included Bokhara. Intentionally only round figures are given.

water into the sand. A lengthening of a river for 100 kilometres will therefore be accompanied by a far greater loss of water than $\frac{1}{6}$ cubic metre per second by evaporation. Let us assume that loss to be ten times as great, then a prolongation of 100 kilometres of a river will be due to an augmentation of its discharge of 2 cubic metres per second. That is a quantity which in a large river cannot be recognized without exact measurement. Therefore, if there are ruined places in the desert of Taklamakan even more than 100 kilometres below the actual settlements it is not necessary to assume a considerable change of climate: a slight diminution of the river discharge can be the cause. This diminution may be due as much to a temporary lowering of the precipitation in higher regions as to the disappearance of some glacier tongues which had extended in a preceding time. I do not believe these quantities of ice to be the relics of the Ice Age; it is not probable that any of them have survived the seven thousand years which we know to be the length of post-glacial time. I think it will be the case of one of those post-glacial extensions of glaciers which now become also known in the Alps.

The question is however a rather complex one. The over-salting of the soil may be the cause of the migration of a settlement. If in an oasis all water is consumed by irrigation, the soil becomes finally too salt and infertile; the oasis must be left and new irrigation will only be possible at a place upstream. This new irrigation will consume the water which was formerly used in the old oasis, and the latter will become deserted. We make these reflections, which could be easily extended, in order to show that it is not at all well founded to conclude, from the shifting of the oases in the Taklamakan desert, that there have been climatic changes in historical time. Sir Aurel Stein has accumulated such an amount of evidence by his finds in the Lop Nor region and in other oases that there can be no doubt of the persistence of desert conditions in the basin of Tarim for more than two thousand years, and Leo Berg has shown how insufficiently founded is the belief in the desiccation of Russian Central Asia. Minor oscillations in the heights of the snow-line and of the arid line cannot be doubted; these minor oscillations become very effective here on account of the plateau conditions of the high ground and they affect the life in the low regions by means of the rivers.

With its $11\frac{1}{2}$ millions of inhabitants Central Asia has no great weight in the population of Asia and of the whole Earth. In the future too it cannot be otherwise. A region which over more than three-quarters of its surface suffers from a pronounced arid climate can never become rich in men. But it may become more populated than it is now. It may be that by the construction of wells in suitable places the grazing-ground in the arid regions could be extended so that there would be more inhabitants to the square mile—let us say four instead of two; this would mean that we had to reckon in that region with 4,000,000 souls instead of 2,000,000. It is probable that in the semi-arid and humid regions the population could be far denser than nowadays—there are whole valleys in the Northern Tien Shan which have been abandoned by their inhabitants. It seems to be possible that those regions could nourish 10,000,000 instead of 3,500,000—a density of thirty to a square mile is met with in the high valleys of the Alps—but more is not probable. As to the oases, not all the water is used for irrigation. Amu Darya and Sir Darya bring into Lake Aral every second 2000 cubic

metres, that means that on its surface evaporation takes off 1 metre of water from its surface. An area equal to that of the lake could be covered annually with 1 metre of water which is not used for irrigation. That is more than the precipitation would yield, but irrigation in Turkistan uses one litre per second on a hectare, that means in the year 3 metres of water on the irrigated surface. Therefore only the third part of the area of Lake Aral could become irrigated by the water which evaporates useless on its surface. The same reasoning is good for Lake Balkhash. An area of about 11,000 square miles more than at present could be irrigated in Russian Turkistan if all available water was used. But it is a question if this can be possible, for only that water can be used for irrigation which can be brought to a place which can be cultivated. If the surface features do not allow the construction of irrigation canals, water will run away without being used. Therefore an augmentation of the cultivated ground in Western Turkistan by 11,000 square metres, that is by 16 per cent. of its present area, will be the uttermost limit which could be imagined.

The situation in Eastern Turkistan is a different one. Here, too, not all the water is consumed by irrigation. For a distance of 750 miles the Tarim flows through a perfectly dry country before it disappears, but there is no longer a permanent terminal lake, and at the first glance it seems that all running water is evaporated directly from the rivers, which in the whole basin may have a length of 1600 miles. If we assume that each has a width of one-thirty-second of a mile they represent a surface of evaporation of 50 square miles on which only 4 cubic metres could evaporate in the second. The discharge of the Tarim observed by Sven Hedin is far greater. There must be therefore still other surfaces of evaporation besides the rivers. We recognize them partly in those thirty-five ground-water lakes which accompany the lower Tarim, and besides these there are many swampy regions along the river which become inundated during its high-water stage. These evaporation surfaces are far greater than that of the rivers; they do not seem to extend over more than 800 square miles. The mean discharge of the Tarim consumed by evaporation does not surpass 60 to 70 cubic metres in the second, which is in accordance with Sven Hedin's measurements. If it was used totally by irrigation, the cultivated surface could be increased along the Tarim only by 270 square miles. If we take into a similar account those rivers of its basin which do not reach it or lose much water in swamps or "köls" the whole surface which could be added to the cultivated ground of the Tarim basin can be estimated at 1000 square miles, the eleventh part of what can be imagined for Western Turkistan.

There are only limited possibilities of extending the oases of Central Asia. An increase of the cultivated surface of the Earth by 12,000 square miles is not much, and if it were populated at the same density as the existing oases it would afford only room for 900,000 men. But I do not believe that only seventy-five inhabitants to 1 square mile are an adequate number for a well-cultivated oasis. This figure may be doubled or raised threefold, but it does not seem to me possible that the Central Asian existing and future oases could support more than 25,000,000 inhabitants. The maximum capacity of Central Asia for mankind will be less than 40,000,000 inhabitants under the present best methods of irrigation and cultivation and the present standard of life, which is very low in Central Asia.

Also in the future Central Asia will not, by the number of its inhabitants, play an important rôle on the Earth. Its inhabitants will always be divided into nomads, whose herds will graze in arid regions, and farmers, who live in the oases. The number of the nomads will always be low. That of the farmers can become pretty high, but both are limited. The proportion of both parts of the population changes according to the state of civilization. It is now 2:6 and may become 4:25; in former times it may have been 1:2 and more. The sedentary population can easily be subdued by foreign rulers and change their national character. The nomads will never lose all their freedom. Though always migrating, they are the more stable part of the population. The more prosperous the oases are, the less influence however will they exercise. Lying on the highway between the occident and the far orient, Central Asia has been influenced from both sides and its dry soil has perfectly conserved the relics of old civilizations, religions, and peoples. But it did not much influence its neighbourhood. In this respect it is inferior to Mongolia, from which nomadic tribes, not numerous but very active, have conquered vast parts of Asia and have extended their rule even to Europe. In Mongolia the oases do not play the same rôle as in Central Asia; the nomadic population is not controlled in the country itself by the sedentary one in the oases, it is attracted by neighbouring lands which are conquered but not subdued as to the race of their inhabitants. The latter absorb the conquerors and they disappear.

In more than two thousand years of historical times and probably also in those prehistoric ones which extend over the seven thousand years of the post-glacial period, the surroundings of men have undergone no important changes in Central Asia. But in the glacial period the state of things was different from what we see now. There is convincing evidence that the snow-line in the Tien Shan and in the Pamirs lay much lower than nowadays, and there are reasons to believe that this has been so too on the high plateau of Tibet. It must be assumed that the arid line was depressed too. The low regions of both Turkistans were more habitable, the rivers which allowed irrigation greater. Therefore Central Asia seems to have had in that time a more friendly aspect, and it may have had at that time a more important position in human life. But this remains conjectural as long as we have no convincing evidence. There are still many anthropo-geographical problems to be solved in Central Asia.

PALESTINE AND THE STABILITY OF CLIMATE IN HISTORIC TIMES

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THE evidence of Palestine as to the stability of climate during historic times is of special value as the conditions of life there during the past 3000 years are recorded in what is still the best-known of all early literature. The Bible contains contemporary records, and traditions that may be accepted as reliable, for two millenniums and a nearly continuous record from about 1200 B.C. to the beginning of the Christian era. The conditions in mediaeval times are revealed by the experiences of the Crusaders and early travellers.