

#### 4 THE ALLEGED DESICCATION OF EAST AFRICA

was a deposit of fine mud particles, so susceptible to the slightest movement of the water, caused by inserting the hand, or even a reed, that it became turbid and prevented further observation. The most remarkable features of the constructions were the outer rings of mud. These were raised about an inch above the water level, and were about four to five inches in width, and had more the appearance of being the work of man than a fish. The mud did not appear to have been pushed up from below, but to have been deposited from above and then smoothed down, the surface being firm and shiny. It is, I believe, not impossible that the mud was brought to the surface in the mouths of the fishes, and then smoothed down by their flattened, slimy, eel-like tails.

ENTEBBE, *May* 1914.

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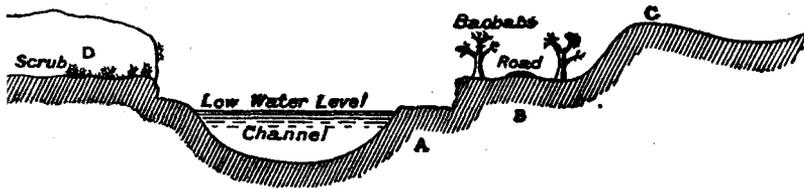
BY C. W. HOBLEY, C.M.G.

This question has been the subject of considerable verbal discussion in the country itself, but very little has been written on it. The evidence for the alleged desiccation of the globe was, however, the subject of a recent learned paper by Prof. J. W. Gregory in the *Geographical Journal* for March 1914, and it has occurred to me that it would be useful to record the evidence on the subject which has come to my notice in British East Africa and other places on the east side of the continent.

Generally speaking, it is believed that very marked evidence is available that considerable desiccation of this part of the continent has taken place from late Tertiary times down to the present day. To commence at the coast, it is undoubtedly the fact that the whole of the coast-line from the German border to, say, Kismayu shows undoubted signs of elevation in recent times. Take Mombasa island, for instance; one there finds the recent coral reefs raised to a height of 70 feet

above sea-level, but at the entrance to Kilindini harbour (Mombasa) there is more than that : on the island, some 200 feet back from the edge of the present coral cliff, there is another cliff which evidently marked the width of the channel in, say, Pleistocene times ; in the opposite direction a third cliff is just emerging from low water level.

Now, I believe that it can be safely asserted that the width of a channel through a coral barrier usually depends on the amount of fresh or semi-fresh water discharged through it, the mixture of fresh water with the salt checking the growth of the reef. I therefore believe that when the cliff marked C was the boundary of the tidal channel, the volume of fresh water discharged into the upper waters of the harbour was



Section of entrance to Kilindini Harbour

much greater than it is to-day ; similarly, when the cliff B bounded the water-channel, the volume of fresh water was greater than at present, when a new cliff A is being formed which can be clearly seen at low tide. The greater volume of fresh water would also bring down mud which is generally recognised as being a factor that checks the growth of coral. This theory is borne out by the large amount of erosion which is visible in the cañons of the Mwachi and Manolo rivers, which even now in flood-time discharge a considerable amount of fresh water into the head of Port Reitz. The amount of fresh water, however, at any season bears a very small proportion to the enormous volume of salt water which flows into and out of Port Reitz and Kilindini harbour. The Andromache reef and the reef to the north of the port correspond in age to the semi-submerged cliff A, which is just showing above sea-level.

At the time when cliff C formed the north boundary of

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the channel, the reef marked D was awash and in the same position as the Andromache reef to-day, the south wall of the sea channel being further back. At Shimoni station, opposite Wasin, there are large underground caves in the coral rock, the ramifications of which extend a considerable distance; in one of the caves there is still a tiny brackish spring, and this gives a clue to their formation, for, as far as I can judge, they can only have been formed by the presence of springs of fresh water which bubbled out at sea-level, and wherever they occurred prevented the coral insect from working in the vicinity; the volume of these springs gradually decreased, and the coral insect built over the top, leaving these winding galleries through the heart of the reef. The springs have now almost disappeared.

As we proceed north up the coast we obtain evidence of another character and of more recent times. The coast-line from Wasin to Kismayu is studded with ruined towns. South of Mombasa they do not appear to be so common as to the north, although there are quite a number to be found in the dense bush along the coast-line at Shirazi and immediately south of Mombasa island. Immediately north of Mombasa there are ruins at various places between Mombasa and Malindi, notably at Kilifi, Gedi, and Mida; near Malindi itself there are traces of large settlements, and again at Shesheli, Ngomeni, and on towards Lamu. Between Kismayu and Port Durnford there are said to be sixty miles of coast full of ruins, and again north of Port Durnford and on the islands of the north portion of what is called the Lamu archipelago there are innumerable ruins of stone buildings, absolute evidence of a dense population. No record remains of these people, but they are commonly supposed to have been early Persian settlers, and the settlements seem to have been formed since the establishment of the Mohammedan religion, for there are numerous remains of well-built stone mosques with the typical Moslem Kiblah (or shrine) on the north side towards Mecca, ruined arches, myriads of stone graves of the Moslem type, and so forth.

Only careful excavation can, however, settle who these people originally were; we have no record of the foundation



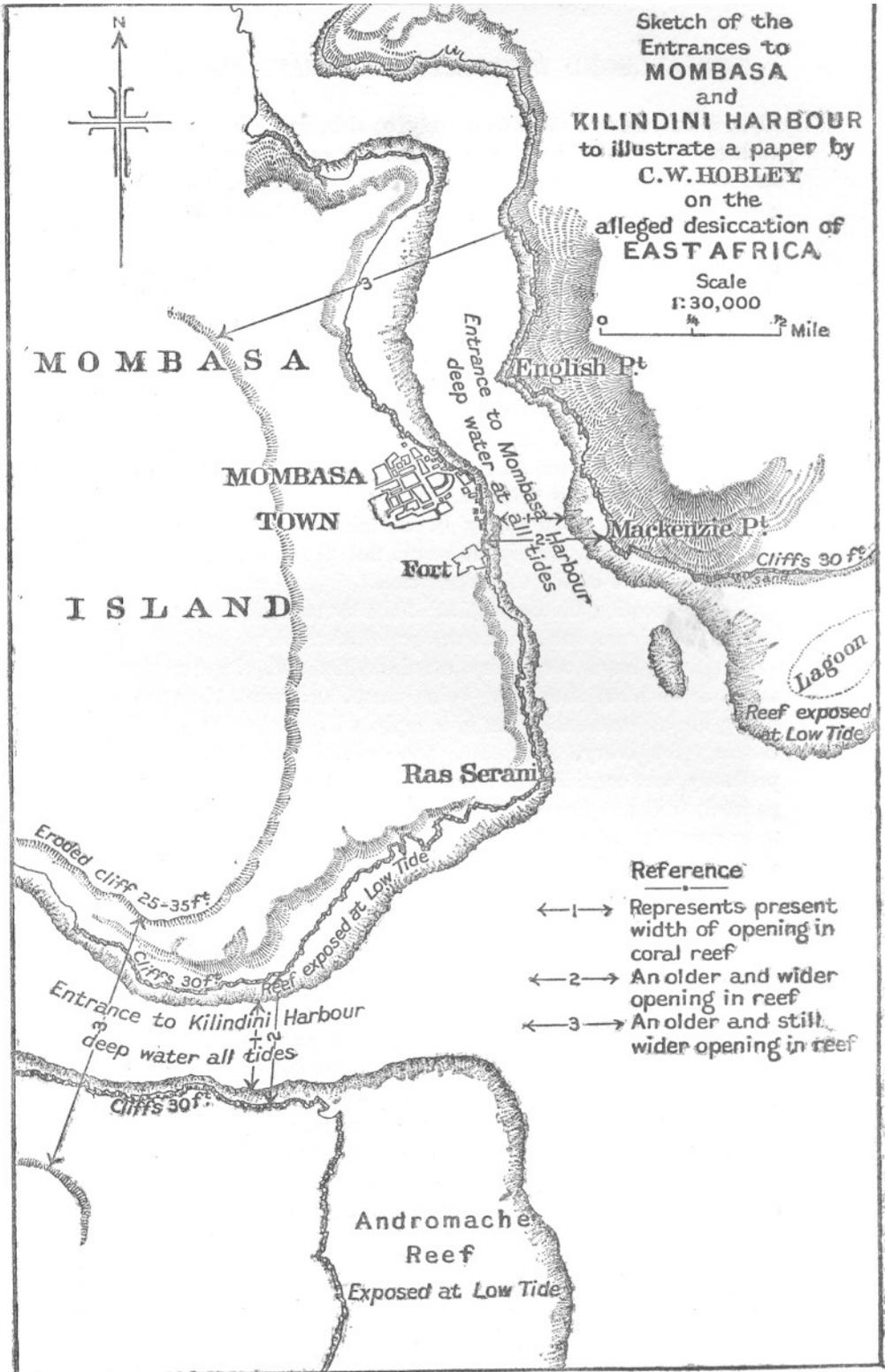
STONE CAIRN ON TANA RIVER, BETWEEN THAKA COUNTRY AND KOROKORO;  
THE TOP OF THE CAIRN IS CONCAVE.

*(E. Battiscombe, photo, 1909.)*

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of such extensive Arab settlements as this, and I am inclined to believe that they may date back as far as Himyaritic times, and be an offshoot of that great civilisation which built the huge dam at Mareb in South Arabia and excavated the Aden tanks. There is some reason for the belief that the tribes of the interior were influenced at a remote period by Semitic beliefs, pre-Mohammedan in point of time, and this influence may have emanated from these settlements ; the Mohammedan mosques and graves being products of the culture superimposed by Arab conquerors. In some places, if we examine the maritime plain in the vicinity, the limits of their cultivated fields can be seen, for land which has been cultivated for a considerable period and then abandoned carries a different flora from land covered by primeval bush or forest ; but wherever I have had the opportunity of examining the area of the previously cultivated strip, it would not prove a *raison d'être* for the presence of the old population.

Now, knowing the congestion of the average Eastern settlement, there is no doubt that the population which built these towns must have been very considerable, and the question arises as to what they were doing there, and what they were living on. Presumably the glib reply will be that they were trading for ivory, apes, and peacocks. The ivory trade probably was considerable ; but I imagine that the apes and peacocks did not figure very largely in their Customs returns, to say nothing of the fact that the peacock is an Asiatic bird, although some ingenious commentator has suggested that the term ' peacock ' really referred to the African guinea-fowl. I am inclined to believe that these settlements really thrived on the cattle and live-stock trade with the tribes of the interior, and for the following reason. In the Somali hinterland there are also evidences of a much greater population, and it is highly probable that they were great pastoral people, for the country is naturally not an agricultural area, but pre-eminently a stock country. Around Wajheir, in Jubaland, to-day, large numbers of artificial mounds are to be found, many of them as much as thirty feet in height, and these are, it is believed, the funeral mounds of an extinct race. The Hon. K. Dundas opened one of the smaller ones. He found a few fragmentary



bones, unfortunately no human ones, but he discovered what appears to be a rude copper bracelet ; as there is no copper found naturally in that country, this betokens trade and intercourse with the coast, and with people who had copper to sell.

These mounds are so numerous, and in addition the large number of well-excavated wells, often over forty feet deep, and the traces of artificial dams, all go to prove that this area, which is now practically a desert, once carried a large and organised population. It is now only inhabited by a limited population of nomad Somalis, who move about from waterhole to waterhole and graze their stock as long as the water lasts. Similar mounds are found throughout the Nyika belt as far south as Taru, on the Uganda railway, but south of Wajheir they become much smaller, and rarely average more than a few feet in height.

The Somalis say that the wells and the mounds were made by the Maanthinle people. This name in the Somali language means the tall people ; possibly they consider that people who carried out such works must have been of superhuman stature.

In the evidences of the population of the hinterland we have, it appears to me, an explanation of the settlements on the coast ; and as to their disappearance, I put this down to the desiccation of the country. There is no record of these settlements having been systematically destroyed by invasion, and even if the coast dwellers were annihilated, it is difficult to see how the tribes of the interior could have been exposed to similar attack.

We know that in about the year 1589 a terrible horde of savages, called the Mazimba, swept up the east coast and destroyed Kilwa and nearly destroyed Mombasa ; this force swept on up the coast, but were, according to the records, finally defeated at Malindi by Mattheus Mendes de Vasconcellos with a number of Portuguese soldiers, the Arabs, and some 3000 Bantu tribesmen recruited in the vicinity and said to be Wa Segeju. This invasion may account for the comparative scarcity of ruins south of Mombasa, but it cannot account for the abandonment of the settlements between Lamu and Kismayu. The trade of these coast settlements was, I believe, the supply of domestic animals for meat during the south-west

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monsoon, to the, at that time, comparatively dense population in South Arabia.

In connection with the presumed desiccation of the country west of Lamu and Kismayu I may mention the drying up of Lake Stefanie. When Count Teleki and Höhnel visited it in 1888 it was a definite lake of large dimensions; when Donaldson Smith visited it in 1884 it was rather larger than in Teleki's day; but of recent years it has become little more than a big puddle holding a certain amount of water during the rains. I do not, however, attach great importance to this evidence, as it extends over too short a period of time. Never having visited Lake Rudolf, I cannot adduce any direct evidence as to whether it exhibits traces of desiccation, but one fact strikes one, and that is that the Teleki volcano at the south end of the lake, which was very active in 1888, is now quite extinct, and this, I am inclined to think, may be due to the recession of waters of the lake, as the steam generated by the infiltration of lake water may have afforded motive power for its eruptions.

To change the scene of our inquiry, let us proceed up country for a little. There are undoubted evidences of the greater extent of Lake Naivasha within geologically recent times; Prof. Gregory, too, gives evidence as to the existence of a great lake he names after Prof. Suess, in the Rift valley, south of Naivasha; Lake Magadi is, I believe, the attenuated relic of a sheet of water of much greater extent. Mr. J. Parkinson, in his paper in the *Geographical Journal* (July 1914), has shown that in post-Pliocene times Lake Magadi was once a sheet of water of much greater extent than the area covered by the soda deposits at the present day, and he further states as follows: 'Evidence is afforded by this district, *i.e.* the Rift Valley, of a general desiccation: the periodical floods of the Turoka river are not adequate for the formation of such a gorge as that now seen, and we have in addition the disappearance of Lake Suess. The old alluvial fans of Lorgosalich, now overgrown by vegetation, point to torrential rains being more frequent at an earlier period.'

Lake Nakuru probably once also extended much further to the south than it does to-day. There is little doubt that

the Lakdera river, which is the dry watercourse which emerges from the east end of Lorian swamp, and which can be traced down to the Deshek Wama lake and so to the Juba river, was once a real river and a tributary of the Juba ; nowadays it can hardly be called a river except for the fact that water can be found in wells at certain places along its course, and thus there is an underground seepage of water which is fed from the Uaso Nyiro after every rainy season. The Lorian swamp, too, turns out to be much smaller than was originally reported, but of course the original reports were very vague. Deshek Wama lake only carries water once in every few years, and that is almost certain to be either surface water from the surrounding country or flood water from the Juba.

If, as is believed in times past, the Lakdera was a considerable river with a belt of thick forest on its banks, this might have exercised some small effect on the climate of the surrounding area. Jilore lake, near the Sabaki river, which was quite a considerable sheet of water up to recent years, has been steadily diminishing, and is now quite dry, and the site is covered with scrub. This may, however, be due to the Sabaki river, which fed the lake to a great extent, having cut its channel below the level of the inlet to the lake. Baratumo lake, on the south of the Sabaki river between Jilore and Malindi, is also said to be now dry.

Proceeding west over the Mau escarpment we descend to Lake Victoria, and there we find definite evidences that that lake once extended eastwards as far as Muhoroni, roughly 400 feet above the present lake-level, and it was probably the waters of the lake which, converted into steam, afforded the motive power that broke down the crater wall of the great volcano now called Tinderet. I doubt if this fall of the level of Lake Victoria is entirely due to the wearing away of the sill of the natural dam formed by the granite dyke at Jinja, known as the Ripon Falls ; I am inclined to believe that the decrease in rainfall has had a greater effect.

The German authorities inform me that Lake Rukwa at the south-east corner of Lake Tanganyika has much decreased in size during the last fifty years, and that the western portion of it has practically disappeared and become swamp ; they also

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state that the marks of the old water-levels on Lake Nyasa are now many feet above the present water-level. This may, of course, be due to the wearing away of the sill where the Shiré river leaves the lake. To go further afield, we know that in Livingstone's day Lake Ngami was an open sheet of water, and is now nothing more than a swamp; but these examples may be considered too remote from the area under consideration to be of any weight. According to the Duke of Mecklenburg, the salt lake of Katwe in South Toro is drying up, and the salt deposits may be seen several yards above the present lake-level. This is probably due to desiccation in historic times, as sodium chloride is such a soluble salt.

One must exercise great caution in an inquiry of this kind to separate evidence of a geological character from evidence of what may be termed an historical character, because in dealing with the two classes of evidence one is thinking in different terms. It must be borne in mind that our accurate meteorological records in these parts of Africa only go back some twenty-five years, and in that period no great decrease of rainfall is marked. The evidence of the coast settlements above quoted goes back probably some six hundred years, and may go back much farther, for, as has been mentioned, it is possible that they date back to the zenith of the Himyaritic civilisation in South Arabia; the fact that there are ruined mosques may not prove that these erections were coincident with the foundation of the settlements. For all this, however, there is a great jump from historic times to the later Tertiary age, when the Rift valley was in an unstable condition owing to volcanic disturbance, but there is nothing to show that the conditions which set in then have not continued up to the present era.

After having stated a problem it is always considered advisable to propound a plausible solution, and it is here that I fear I shall fail to satisfy the critic. There are, however, a few points in this connection which should be set forth. One is the great decrease of the area under forest in the higher parts of East Africa, particularly in the Kikuyu region, *i.e.*, the south-south-west slopes of Kenya and on the Aberdare ridge, during historic times. Owing to the increase of population

and the consequent greater demand for agricultural land during the last hundred to two hundred years or so, it is estimated that the area of forest has artificially been decreased by some 3000 square miles. The rain-borne clouds sweep westward over the continent, and when chilled by the belt of forest on the higher ridges deposit their rain on the western slopes; this would afford a reasonable explanation of a decrease in rainfall in a certain portion of the Rift valley during that period. It would, however, afford little explanation of the desiccation of the hinterland of Jubaland between Kismayu and Lake Rudolf.

Another point which has been suggested is that the rate of elevation of the interior of British East Africa has been in excess of the rate of denudation, so that in effect the rainfall has run off so quickly that it has not had time to permeate the soil of the area on which it falls; this point is, however, I consider, without any support. There is definite evidence that the glaciation over Mount Kenya extended in Pleistocene times to a much lower level than it does at present, and there is little doubt that this state of affairs had a considerable effect on the climate of a great portion of this part of Africa; or, to express it more logically, that the conditions which produced a more extensive glaciation on Kenya also considerably affected the climate of the country generally, and the lower general temperature of this part of the continent would probably cause greater precipitation of rain. As Professor Gregory, however, points out with great acumen, the coastal raised beaches and reefs give no palæontological evidence of contemporary reduction in the temperature of the adjacent ocean.

Prof. Gregory found traces of former glaciation on Kenya over 5000 feet below the present lowest terminal level of the ice, and he goes on to argue that this was due to a much greater elevation of the Kenya area. The present peak of Kenya is the denuded core of a volcano which probably at one time presented a dome-like shape somewhat on the same lines as the Kibo peak of Kilimanjaro; the sister peak of Kilimanjaro, Mawenzi, may be said to be in the same stage of decay as Kenya. Mawenzi is about 2000 feet lower than Kibo, and so we can, for the purpose of argument, add 2000 feet to the height

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of Kenya and obtain a rough estimate of its original altitude ; the extra area of the ice-fields under these conditions would doubtless partially account for the traces of glaciation at a lower level.

Dr. Rocatti, the geologist to the Abruzzi expedition, observed traces of glacial action on that mountain on the east side, at 4870 feet above sea-level ; the lowest level of the existing ice is now about 13,680 feet, an astounding recession of 8780 feet. The climate at the time this vast area of snow-field existed on mountains like Kenya and Ruwenzori must have been extraordinarily unlike present-day conditions.

The botanical evidence available, however, shows that a more or less common alpine flora is to be found on all the high mountains from Abyssinia to Kilimanjaro, and this flora is quite unlike anything to be found in the intervening country. This fact tends to show that at one time, and, speaking geologically, at a not very distant period, there was a continuous connection of land at a high level between these points so remote. Gregory estimates that at that time the mean temperature must have been at least  $17^{\circ}$  lower than at present. Now the prevailing winds on the coast are the north-east and south-west monsoons, which blow periodically parallel to the coast in one direction or the other according to the seasons. Up country, at an elevation of a few thousand feet, the changes in the monsoon are not felt, but over the bulk of the year a strong wind, generally easterly and a little south of east, blows during the greater part of the day, and it is believed that these are the trade winds blowing high over the monsoon winds which keep near coast-level. It is very marked on the big mountains in the interior, such as Kenya, Kilimanjaro, and Elgon ; in the early morning they are generally quite clear, but about 10 A.M. the clouds sweep up from the south-south-east and collect on the mountains and blot them out from view for the rest of the day. These are believed to be clouds borne inland by the trade winds, and the moisture they carry is precipitated mainly on the south and south-east slopes ; the proof of this precipitation exists in the much greater growth of forest on the south and south-east sides of the mountains referred to. Now, when there was a continuous ridge of high land between

Abyssinia and Kilimanjaro this precipitation must have been enormous, and an enormous amount of water must have flowed eastwards towards the Indian Ocean.

Prof. Gregory also produces arguments with regard to the effect of the variation of lines of atmospheric pressure which would be caused by the greater elevation of a large area, and which he claims would greatly increase the rainfall and widen its distribution. I am, however, inclined to doubt whether the information as to the position of the isobaric lines, *i.e.* lines of equal barometric pressure, is sufficiently accurate to build upon, although this would of course not necessarily affect the principle of the argument.

Several other explanations have been adduced by geologists to account for periodic variations in climate, and variations in rainfall would follow. One of these, which has from time to time attracted considerable attention, is that the main contributory cause is the variation in the carbonic acid contents of the atmosphere. There is little doubt that in earlier geological times the proportion of free carbonic acid gas was much greater in the atmosphere than at present; all the great coal deposits of the world are built up of carbon from the atmosphere, and it is alleged that the enormous deposits of limestone in the Earth's crust, which contain many times more carbon than all the coal deposits put together, although primarily they obtained their carbon from the sea, absorbed a great portion from the air. The evidence, as far as it goes, appears to prove that the oceans are the greatest governors of the proportions of carbonic acid gas in the atmosphere, and it is calculated that an increase of 0.06 of carbonic acid gas in the atmosphere would cause a rise in the average temperature in the Polar Regions of some 14° Fahr., the idea being that a reduction in the carbonic acid gas contents cools the climate and an increase causes the reverse.

Now, extensive volcanic action is known to produce vast amounts of carbonic acid gas, but the great volcanic activity of Pleistocene times does not seem to fit in altogether with the greater extent of the Kenya glaciers about that period. I believe, however, that extensive volcanic activity is usually attended by temporary torrential rainfall, partly due to the

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condensation of great masses of steam, and this would probably dissolve the greater portion of the extra free carbonic acid gas. Thus taking every factor into consideration, the most hopeful course would appear to be to search for some cause to account for a gradual change in the routes of atmospheric circulation. The usual cause for such variation is a different distribution of land and water ; in this case, however, there appears to have been no change that can count.

I am not enough of a meteorologist to say whether there are any other theories as to why the monsoons or trade winds should have carried less moisture over the continent during historic or recent geological times, but the evidence remains as I have stated it, and my only hope is that someone may be able to pursue the question a stage further and produce some logical explanation of the problem I have endeavoured to expound.

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### EXPERIMENTS IN HAWKING

By W. F. B. BRYANT, C.E.

Some eighteen months ago, on the Magadi Railway, finding myself amongst many different species of hawks and being very much interested in these birds, I resolved to try to train them, to see what use, if any, could be made of them.

Having spent some time in watching their habits, I found that all of them invariably fed on rats and mice, and took little or no notice of small birds. This was not encouraging, as they spent their time sitting idly on trees and falling on their food in a clumsy sort of way that would in time spoil them for any clever quarry.

However, since they were so keen on rats, I used these for bait. The hawks came down and took them without any hesitation, but, do what I would, I could not catch them in the horse-hair nooses I set round the bait. They seemed to see them and alight on the ground about two feet away, and creep in without danger and carry off the prize.