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THE COLORADO DESERT.

CROSSING by the San Gorgonio Pass, the continuation of the Sierra Nevada range back of San Bernardino, the traveler leaves the fertile coast valleys, and enters upon what appears to his astonished eyes the parched and death-stricken remains of some ancient world. As he came through the broad, rolling pass, upon his right towered San Gorgonio Peak, a huge unbroken mass, 10,500 feet in height, the great trees up its rugged sides dwindling to mere shrubs. Upon the left, forming the other wall of the pass, pine-clad San Bernardino, more broken and irregular in outline, reaches an altitude of 11,500 feet. But leaving now the mountains behind, he descends into what seems the scorched, blasted bed of some old cyclopean furnace, a wreck of the days when "there were giants in the land." San Gorgonio and San Bernardino on this side have lost their pines, and brown, barren and desolate, frown down upon yet greater desolation. Upon the west, as far as the eye can reach, stretch the Sierras in an unending line—a forbidding, rugged wall. At the north, a spur from this main chain turns off eastward, and then curving around bears to the south, parallel to the Sierras, making another abrupt wall, which at last drops down and is lost near Fort Yuma. Inclosed by these mountains, open only toward the south, where 200 miles away it faces out upon the waters of the Gulf of California, is the Colorado Desert. From its upper end, the eye lifts mile after mile toward the southeast over the broad expanse—no trees, no hills, no water, no life. Only the glare of the never-ending sand, the deceptive mirage, and the silence of death. Here and there a lone

whirlwind rears its stately column of sand hundreds of feet in the heated air, and travels slowly on for hours. At times fierce blasts of scorching wind rage for days, carrying the fine sand in clouds that obscure the sun, and give to the sky a dull red glare. These are the dreaded sand-storms of the desert.

What is the Colorado Desert? In the spring of 1867, I crossed its upper end with troops, on the road to La Paz. I found the sand white with innumerable sea-shells, some minute, some fragile, such as are only found in sheltered arms of the sea. For miles and miles I traced with the eye a strange, well-defined line along the mountain sides, always at the same level. It was as undeviating as the chalk-line of a carpenter's marking-twine. Riding out to it, I found it to be the old beach of a sea.

The rocks were worn and rounded up to that level, as by the constant washing of water, with coarse coral formations in their crevices and upon their under sides. Above that line the rocks were sharp and jagged. The worn rocks showed that for ages the water had stood at that level. No other beach could be discovered. The water consequently, when it abandoned that level, must steadily have diminished, until it disappeared. The surveying party of the Southern Pacific Railroad, in running the line to Fort Yuma, struck the present sea-level the moment their instruments reached this ancient beach. Further south they gradually descended, until a depression of 215 feet below the sea was found. The great basin of the desert, the chief engineer, Mr. Phelps, estimated to be at least 350 feet below the level of the sea. The whole area now below the sea-

level is supposed to be about 3,900 square miles—130 miles in length by thirty miles average width.

The inquiry naturally arises, "At what point has this desert been connected with the sea, and how has it been shut off?" Surrounded upon every side by mountains, except in one direction, and there opening out upon the head of the Gulf of California, the answer is plain. The desert is a portion of the old gulf, which then extended 200 miles above its present limit. Its head-waters then were immediately back of San Bernardino, with only the mountains intervening. The cause of the separation of the upper end of that gulf, making what is now the Colorado Desert, is so apparent, that a moment's examination reveals it. The same agency is still at work, constantly widening the space between the gulf and the desert. Here, nearly 150 miles from the head of the ancient gulf, came in from the east side the Colorado River, bearing in its thick floods quicksand, and the red mud from the great plateaus of Northern Arizona, which gives the river its color and its name.

The contour of the country shows the gulf to have been narrow here. The filling in of this alluvial deposit went on unceasingly, as at the mouth of every great river which enters the sea at a sheltered point. The water grew constantly shoaler, until at length the separation was complete. The upper end of the gulf thus isolated from the sea, and not having rain-fall sufficient to keep up its supply, finally dried up and became a desert basin. The alluvial deposit has steadily increased the distance between the gulf and the low bed of the desert, until now the division is marked by a narrow neck of thirty or forty miles of land but little raised above the sea-level.

The length of time which has elapsed since this great change took place is also another interesting question; the more

so because the change is plainly a recent one, and the data exist for at least a comparatively accurate estimate. Among the many shells which whiten the sand of the desert, I found numbers of a thin, fragile bivalve, about one and one-half inches in length by an inch in width, the shell scarcely thicker than half-a-dozen sheets of ordinary note-paper, closely pressed.

These shells are drifted about in the restless winds, beaten upon by raging sand-storms, scoured and worn by the constant attrition of the sharp grains—and yet to-day they may be gathered in great numbers, unbroken, perfect in outline, only scratched and scored, and evidently rapidly crumbling. How long could these shells withstand this constant wear? Not possibly more than a very few centuries; probably not more than two or three. The rate of formation of the alluvial deposit at the mouth of the Colorado might also be readily computed, although the data here are not sufficient for accurate computation. That it is now very rapid, the mud-laden current of the river and the rolling quicksand of its bed sufficiently testify. That the deposit has been equally as rapid in the past, one thing would seem to indicate. The proof can be taken for what it is worth.

In the possession of General Stone-man, of the U. S. Army, is a map which he obtained in the city of Mexico. This map shows the results of the early explorations of the Spanish navigators at the head of the Gulf of California. That the accuracy of the map is sufficient to entitle it to some credence, one feature renders probable. While the eastern shore of the gulf up to the mouth of the river is clearly and sharply defined, and as at present found, the western shore is left in doubt. This shows a regard for exactness hard to be reconciled with the supposition that the whole map is to an extent guesswork. In that map the Gila

river is laid down as entering the head of the gulf, while now it empties into the Colorado, about ninety miles above its mouth. Granting that the observation was taken at a time when the conjunction of a flood of the Colorado and high tides in the gulf caused an unusual overflow of the lowlands, and thus apparently extended the sea limits, still the great distance now intervening would show a remarkable change. That the Gila could then have entered the gulf by a separate channel, the contour of the country hardly admits as a possibility. The constant drift of sand from the desert, carried by the prevailing west wind, has still further helped to widen the belt of low country. Within the last twenty years, the sand is said to have encroached upon the river bottom more than a mile.

Two other facts, remains of former vegetation and relics of dead races, incidentally bear testimony upon the same question, of time elapsed, and point to the same conclusion. These will be discussed under another heading, viz., the climatic changes which would naturally result in the surrounding territory, as a consequence of the drying-up of this portion of the gulf. That such a change has taken place in the climate of western Arizona and southern California, and within a comparatively recent period, seems positive. It is a transformation within a historical rather than a geological era.

In western Arizona are traces of an ancient population, much more dense, much more highly civilized, than that now inhabiting the country—a people patiently tilling the soil and living upon its fruits. Among these remains are the ruins of cities, once large and populous; canals for extensive systems of irrigation; fragments of pottery so numerous that in places the ground seems almost paved with them. It would hardly have been possible for that population to sub-

sist with the present arid state of the country. These remains are many of them perishable, and can scarcely date back more than a few centuries. The records of the Spanish explorations in the sixteenth century show that even then the population was much more dense than now.

Take another curious fact. Men who have rambled much in these now desert mountains and plains, report that they have found the remains of old forests, still in a passable state of preservation, where all is now parched and dry; perished evidently through lack of moisture. How long a time could elapse after the death of the forests before all traces of them would be obliterated? Even in that dry climate, not more than a very few centuries. It is a natural inquiry, whether there is evidence of any great alteration in the general contour of the country to account for this recent climatic transformation. The shores of the gulf show that for thousands of years there has been no extensive upheaval. The mountain chains of Arizona bear no appearance of recent convulsions. Living and scouting among them for months, the one deep impress which they gave was of age—drear old age. Brown and bare, washed and gullied by the storms of centuries, parched with fierce heats and beaten upon by burning winds, they seemed the skeleton-frame of a world long worn-out and forgotten—borne down with the burden of years, wearily waiting the end. It is a land of wrecks. I have traversed cañons where the solid mountain had by a mighty power been cleft asunder, and the rocky walls lifted bodily back, until upon either side they stood dizzy with their own height—a world-shudder, frozen in the moment of fright—a cold, stony horror. That was ages and ages ago. Since then the water has filled in the bottom of these cañons with the wash and *debris* of centuries; worn channels in the solid rock, that tell

of long quiet and rest. One thing shows the great length of time which must have elapsed since these wide-spread convulsions. I frequently saw, while scouting in the mountains, huge boulders balanced upon slight pinnacles of rock, in such positions that the least shock would have displaced them. They had evidently been so left by the gradual decomposition and disintegration of the softer stone around.

Do not forget these two facts: the still existing traces of a dense population—traces which the lapse of a very few centuries would obliterate entirely; and the remains of old forests, perished evidently through lack of moisture—remains which would also have been undistinguishable in a very limited time. Recall that other fact already given, the existence in a good state of preservation of countless numbers of the thin, perishable shells of the Colorado Desert; shells which the scouring of the ever-shifting sands and the bleaching of the sun would necessarily destroy within a like limited time. Weigh also the evidence of rapid change at the head of the gulf within an even more recent period, as shown by that old Spanish map. Take also for what it is worth a tradition which exists among the Indians upon the lower Colorado, that formerly the river ran much more to the west, and that they had villages and cultivated fields, where now is only barren sand.

The drying-up of the desert and the apparently contemporaneous change of climate is a very remarkable coincidence. Was it more? In the light of the foregoing facts, in the absence of any other apparent cause for that change—nay, with positive proof from the geological formation and topographical features of the country, that no other cause could have existed—shall it be called more than a coincidence? Cause and effect?

What would be the logical result of the transformation of so large a portion

of the ancient gulf? An area 180 miles in length, by an average of at least thirty miles in width, has ceased to be covered by water, and has become a parched, heated desert. The yearly evaporation in the Bay of Bengal, as shown by the published proceedings of the "Bombay Geographical Society," is more than sixteen feet. This portion of the gulf, which is surrounded by high mountains, reflecting the sun from their bare sides, shut off from the cool winds of the ocean, its waters shallow and easily heated, must have been a steaming caldron, keeping the air-currents above constantly saturated with moisture. This evaporation, however, estimated at the rate before given, would be enough, if all recondensed and precipitated, to supply twelve inches of rain to 86,400 square miles—more than double the area of the State of Ohio. Again, that evaporation involves the rendering of a vast amount of active heat latent. This would lower the temperature of all the adjacent territory. Fort Yuma, at the south end of the desert, upon the Colorado River, has for days at a time a temperature of 120°. When the desert was covered by the sea, the heat must have been lower by a number of degrees. This lowering of temperature alone, apart from any increase of moisture in the air, would add to the rain-fall, by increasing the condensation of vapor already brought by the rain-currents from further south. The augmented dampness of the atmosphere and the consequent fall of temperature would have another effect. Such rain as had fallen over the adjacent country would be less quickly dried up, by giving a moister soil and more numerous springs and streams of water. It is not probable that western Arizona, the Mojave Desert, and the mountains surrounding the Colorado Desert, were ever sufficiently well watered for any general system of agriculture, but it is probable that there was enough moist-

ure to supply forests where none now exist, to feed innumerable streams for irrigation where now the channels are dry except after an occasional storm, and to support an annual growth of grass for grazing where now are barren wastes.

Could the Colorado Desert be again filled with water? It is an interesting question. From the Gulf of California, it is probably an impossibility. The gradual silting up of the old gulf-bed at the mouth of the river, and the drift of sand by the wind, have interposed a barrier too extensive to be easily removed. By turning the Colorado River into the desert it might be accomplished. The project has for years been discussed, of taking enough water from the river to irrigate a stretch of fertile land, alluvial deposit, found at the southern end of the desert; but the idea of going further than this, of diverting the river into the desert and forming a large fresh-water lake, seems never to have been broached. Nature, unassisted, is now attempting this. The drift of sand, through the prevailing western wind, is from the desert toward the east. This drift has kept the river walled in upon the east side of the valley, and has apparently constantly forced it further in that direction. The river, however, with its immense alluvial deposit, is unceasingly at work filling up its bed and rising higher above the level of the desert, which a few miles away forms an inclined plane with a rapid descent from the river.

Within the past twenty years, the water, owing, no doubt, to the fact that the rise in the bed of the river is becoming more rapid than the rise of its western bank, has commenced during each flood season to escape over the brim and run back into the desert. The larger portion of the overflow leaves the main river, it is supposed, about forty miles above its mouth. At first it has no definite channel, but, after a few miles, follows a well-marked river-bed. In the summer

of 1868, I crossed this stream, some sixty miles from the point where it leaves the Colorado. It was there a stream one hundred yards wide, with a depth that would average four feet, and a strong flood-current. The stream is said to be yearly growing larger. If left to itself, probably a large portion of the flood of the Colorado would eventually be diverted from the gulf to the desert. The descent is much more rapid than down the present course of the river to its mouth. The reason why the diversion is not more rapid is, no doubt, the fact, before given, that "New River," as the stream is called, has for the first few miles of its course, after leaving the main river, no definite channel. If a channel were cleared out for that short distance, the current would soon enlarge it and make it permanent. The difference between high and low water-mark in the lower Colorado is not more than fifteen feet. The fact that this small rise is sufficient to turn its water into the desert, shows how slight would be the difficulty in diverting the current permanently. The difficulty is even less than this would indicate, for "New River" commences to run long before, and continues long after, the high water-mark has been reached. The evaporation from the surface of the lake thus made would be so great that the Colorado would hardly refill the old basin; yet even now at the flood season a shallow lake is formed many miles in extent, but quickly dries up.

The climatic effect of thus even partly refilling this portion of the ancient gulf with water, becomes an interesting problem. The Colorado Desert is now a serious disturbing element in the climate of southern California. It is a huge furnace, from which withering blasts make forays upon more favored territories around. One personal reminiscence will show the intensity of its heat. When accompanying troops from Wilmington, California, to northern Arizo-

na, in the spring of 1867, I had two men sun-struck, the tenth of March, in traveling a distance of only seven miles, across the upper end of the desert. These occasional hot winds are but the smallest of the evils to which it gives birth. Any one who has resided a few years in the Los Angeles and San Bernardino valleys, can not have failed to notice and execrate the baffling west wind that so often breaks up the storm-current from which refreshing rain is hoped. A south-easter sets in, blows for several days, clouds gather loweringly upon the mountains, and the parched earth waits for the cooling shower. But suddenly the storm-drift checks, the west wind comes rushing in, there is an angry commotion in the upper air, and the clouds, baffled and beaten, are driven back, carrying with them their precious moisture, through the mountain-passes to the interior. This especially happens in the evening, the time for the full strength of the daily sea-breeze, and so repeatedly that the plaintive remark is often heard, "If only our rain-current will continue until the turn of the evening, we shall escape the west wind, and then we are certain of another day's rain." What is the cause of this interruption? Simply this: back of those mountains is the desert. All day it is heating up with the sun. When afternoon comes, it is probably 40° hotter than the ocean, on the west. Then the cold sea-air rushes in through every break in the mountain-chain, to take the place of this rarified atmosphere, forcing back with it the clouds, whose moisture is quickly dissipated by the scorching breath of the sands. So constant and powerful is this wind-current that the trees in the San Gorgonio Pass are all blown from the perpendicular, and slant toward the east.

The same warring of winds is seen again in the months of July and August. Los Angeles, San Bernardino, and San

Diego counties are really within the circuit of the Sonora summer rains. Again comes the south-east wind, but more gently than in winter. Now it seems to follow rather up the course of the gulf, and from there passes over westward. Again the clouds gather upon the mountain-tops. Light showers fall, even heavy rains, in the San Bernardino mountains. Thunder and lightning are frequent. But the disturbing influence of the Colorado Desert again makes itself felt. In winter it was hot. Now it is a fiery furnace. It glows and wavers with ever-increasing heat; without water, without life. Day knows no respite; night brings no freshness—120°, even 130° are recorded. The rains have traveled up the gulf. They have refreshed Sonora and Lower California. Arizona has grown green. They have followed the Colorado River far to the north. They have even turned the upper end of the Colorado Desert, and sent occasional floods upon the higher and cooler Mojave Desert and in the mountains about Tehachapi. They have gone to the south of the great, fertile plains of Los Angeles and San Bernardino; they have skirted the western edge of Arizona, back of them; they have doubled around and spent their strength upon the mountains, north of them. Why have these rains thus gone all around the only extensive fertile portion of southern California, and yet avoided it as a forbidden land? Because, to reach it, they must cross the Colorado Desert, and its fiery breath is to them the blast of death. Should they cross it, should other rain-currents follow up the coast from the south, the cold wind of the ocean, rushing in to displace the overheated air of the desert, beats them back, and so the land has no rain.

Could that desert be refilled with water—converted from dry, hot sand to an inland lake—the very heat which is reflected from the barren mountain-sides around would be a power of good instead

of evil. The constant evaporation would render heat latent which is now active, thus lowering the annual temperature very perceptibly. This lowering of temperature alone, even if unaccompanied by an increase of moisture in the air, would give a greater rain-fall by the more perfect condensation which it would cause. But the evaporation from the surface of the lake would materially augment the supply of vapor in the rain-currents, thus acting in a double manner—a decrease of temperature and an increase of moisture for precipitation. These rain-currents would also meet with less difficulty in making their way against the ocean winds—as these winds, caused largely by the heat of the desert, would be less violent—and would, therefore, with more certainty and regularity deposit their supply of moisture over the plains of Los Angeles, San Bernardino, and San Diego. When it is considered that every additional inch of rain is worth millions of dollars to these southern counties, the value of such a change in quantity and certainty of fall may be appreciated.

The difference in the summer climate would be especially marked. The flood season of the Colorado River is from April to September. The flood is caused by the melting of the snows in the Rocky Mountains, where the river has its source. The water still retains much of its coolness when it reaches the gulf. The lake in the desert would be at its highest, filled with cold snow-water, just in the hottest portion of the year. All the influences at work to modify the winter-rain would now act with double power, and the summer-rains would prob-

ably become as reliable in the mountains of southern California as they now are in the mountains of Arizona. Streams which are used for irrigation would have their flow augmented; other streams, which now only furnish water in the winter, would become permanent during the year. The grazing lands in the mountains and among the foot-hills would furnish a much more abundant and certain pasturage. The hot, dry winds which now come, at times, from the desert, scorching vegetation, would be cool and laden with vapor.

There is satisfactory evidence that such a difference did once exist in the climate of the territory surrounding the Colorado Desert, at a time when it was still a portion of the Gulf of California. The evidence further shows that this difference must have been caused by the presence of such a body of water where now none exists. If the old bed could be filled from the river, is it unreasonable to suppose that the same cause would again work the same result? It might be a rash assertion to say that the work of refilling the desert is a possibility. It might be equally rash to assert that the water of the Colorado would be sufficient for the purpose. Yet men who have traveled much and seen much upon the desert think the project feasible. If it were done, enough land could probably be reclaimed, by irrigation, from the alluvial deposit at the south end of the desert, to amply repay all the expense of the undertaking. Would it be money wasted if the government were to send a commission of scientific men, of engineers, carefully to examine the subject, to run levels, and report the result?