

FOSSIL FORESTS OF THE YELLOWSTONE.

BY PROF. SAMUEL E. TILLMAN.

THE fossil forests of the Yellowstone Park are among its most interesting features, but they are as yet not within ready reach of the tourist, and so little has been published about them that only a few have definite knowledge of them. It is accordingly believed that the accompanying notes in regard to them will be of general interest.

The locality to which the term fossil forest has especial reference is along the west rim wall of the valley of the Lamar River,

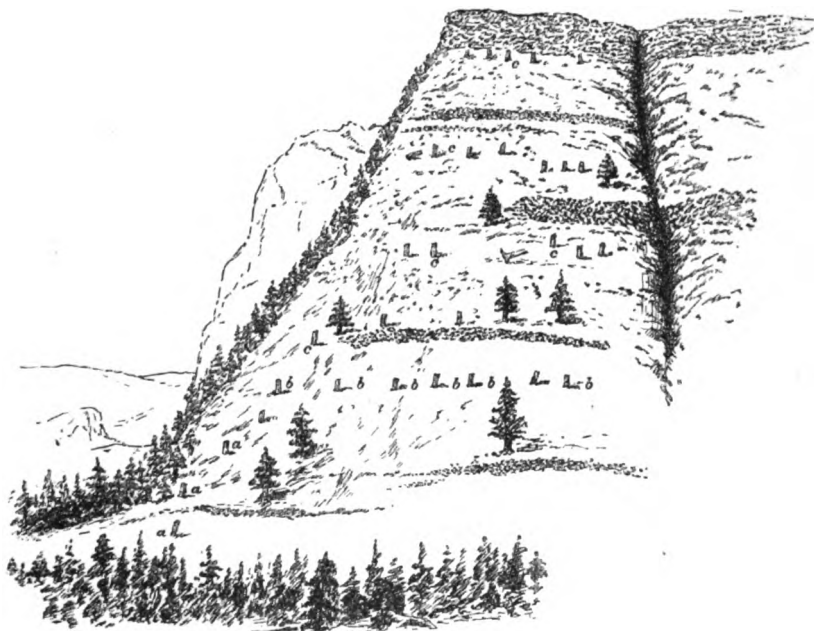


FIG. 1.—POINT OF SPECIMEN RIDGE: *a*, *b*, *c*, PETRIFIED STUMPS.

or East Fork of the Yellowstone, opposite the mouth of Soda Butte Creek. The same arrangement of petrified stumps and trees is, however, found at many other places in this region separated by considerable distances—as much as thirty miles. The general physical conditions that brought about the existing state of affairs is so plainly shown by the present exposures that they can not be mistaken.

The petrifications were visited at several places, but the description appended refers to a part of the ridge designated on the map of the Geological Survey as Specimen Ridge, at a point about six miles east of the junction of the Lamar and Yellowstone Rivers.

The fossil trees exposed at this point are along the upper slope of the southern wall of Lamar Valley. The slope here makes an angle of about thirty-three degrees with the horizon, and is about nine hundred feet long. The petrifications are standing all the way up this slope, interspersed with the living conifers of to-day, represented at Fig. 1. At first sight it appears that either these ancient trees grew upon the slope now exposed, and that there had been no change in the slope from that day to this, or that the present had brought back *exactly the same surface conditions* as existed when the now silicified trees were alive. Such an apparently simple conclusion would, however, involve more remarkable phenomena than are yielded by the true explanation.

A little consideration, taken in connection with the formation of the bluffs that connect Lamar Valley with the higher lands to

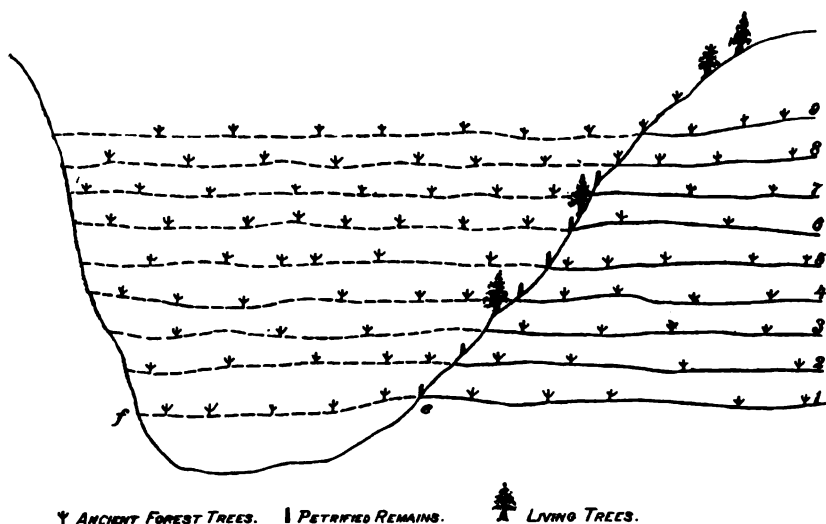


FIG. 2.

the south and west, shows clearly the action that has placed the living and petrified trees upon the same slope at this and at many other points in the region.

A series of forests has grown upon successive levels, each level having been produced by an accumulation of volcanic material which destroyed the then existing forest. This explanation will be readily understood from Fig. 2. The level upon which the first forest grew is indicated by 1. The level of the volcanic accumulation which destroyed this growth of trees is shown at 2. Upon this second level came another growth of trees, which in turn was destroyed by the accumulation extending to the level 3. Still another forest grew upon 3, which in course of time was destroyed. This alternate growth and destruction was repeated

until at this place (Specimen Ridge) there grew and were destroyed certainly *nine* successive forests and very probably twelve. This is all indicated in Fig. 2.

The number of growths was determined in two ways: first, where the roots of the petrified trees are shown at different heights in the same vertical plane the horizons of growth may be counted directly; second, when the roots do not show, a sufficient vertical distance must be allowed between horizons to insure that the projecting body at one level does not have its roots in the horizon next below.

In the second method it was sometimes possible to settle the point by following the volcanic ledges to the right or left until a petrification with roots exposed, decided the question.

In later times, when the volcanic accumulations had ceased and the agents of denudation began their work, the layers of lava and the great sheets of volcanic conglomerate were gradually eaten away, and a valley formed extending in the figure from *e* to *f*. Along the southern slope of this valley are growing the conifers of to-day, and on the same slope also stand the petrified stumps, the relics of many successive forest growths. Thus, though the living and the petrified trees now stand on a common slope, the latter did not, like the former, all grow at the same time, but succeeded each other at intervals of considerable length.

These standing silicified stumps and fallen trees were found varying in diameter from one to seven feet. Two sections of trees were found so perfect that the rings of annual growth throughout could be counted, except a few, perhaps fifteen or twenty, near the heart and bark. One tree, measuring three feet in diameter, had two hundred and twenty-two rings of growth; and another, of three feet five inches diameter, had two hundred and forty-three—this without any allowance for a few missing rings at the center and toward the bark. The larger of these trees was only about half the size of the largest seen. Many were found varying in diameter from five to seven feet, but none of this size were seen exposing the rings throughout the entire section. Judging from the closeness of the rings in certain well-preserved portions of these larger trees, many of them must have been at least five hundred years in attaining their growth, if the rings were truly annual. Taking one half this number, two hundred and fifty years, as the more probable age of the successive forests at this point, it is seen that the earliest of these trees were living more than two thousand years before the latest, during which time there were alternating conditions of growth and accumulation of volcanic material.

This estimate makes no allowance for the time necessary for the formation of a soil upon the volcanic material, which at first

sight would seem necessary for the support of such a vigorous vegetation. It is not probable, however, that any considerable time was necessary for this purpose, for, with rare exceptions, each succeeding forest took root and began to grow very promptly after the destruction of its predecessor. In most cases the destroying flood consisted largely of mud, ashes, conglomerate, and other volcanic material, which formed an excellent base for vegetation, and it was doubtless covered with a luxuriant growth as soon as it was dried or cooled sufficiently, and this would require only a short time.

In some cases the trees grew upon a true lava base; but even then the growth began very promptly after the flow; for the upper surface of the lava soon weathered sufficiently for vegeta-

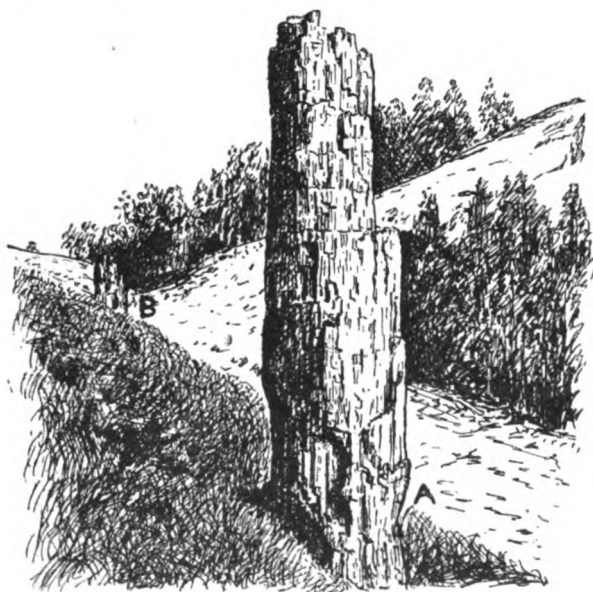


FIG. 3.—A, B, PETRIFIED STUMPS NEAR YANCEY'S, TWENTY MILES EAST OF THE MAMMOTH SPRINGS.

tion to gain a footing. The growing trees then too, as at present, were frequently supported by very shallow and wide-spreading roots. We now often see large trees with such roots standing over rocks barely covered with soil; the petrified trees exhibit the same phenomena.

Besides the standing stumps, the fossil forests contain many specimens lying upon the ground. Some of these were petrified standing and then fell, and others were down before the petrifying action began. It is frequently possible to distinguish between the two by position: the first lie upon the present slope of the ground; the second often show the original surface and consequently pro-

ject at different levels from the bluff and making angles with the present slope.

It is rather remarkable that only one standing stump was seen with a limb in position. This is probably explained by the fact that the living trees were generally covered by the volcanic material to a less height than that of their lowest limb, and consequently the upper portions of the trees were not preserved, but suffered aerial decomposition. In general, the silicified tree would crumble down as rapidly as the rock material surrounding it would wear away, so that only short stumps would now be found, though greater lengths were petrified. The absence of limbs in position is, however, mainly due to the fact first named. In the cases of trees that were petrified after they had fallen, both limbs and roots projecting upward were seen in position.

Specimens of rotten wood far progressed toward complete decomposition were found perfectly preserved in stone. Petrifications of bark were of frequent occurrence, and the channeling and borings of worms or insects were beautifully preserved in some of the specimens, so that we literally have *petrified wormholes*.

In some of the finer water-collected *débris* were found beautifully preserved impressions of leaves, showing two kinds of deciduous trees, of course entirely different from any trees now growing in the region. The impressions of conifer leaves and the petrified part of the same wood were also found.

These fossil tree remains are found over a wide area in the park region. Along Soda Butte Creek they stand up the slope from each bank, but along the Lamar River, below the mouth of this creek, they exist on the left bank only, the imbedding material having been entirely removed from the right bank by erosion. The lowest level at which a petrified tree was seen in position was on the left bank of the Yellowstone, opposite the mouth of Hell-roaring Creek, at an approximate altitude of 6,100 feet. The highest was seen opposite the mouth of Soda Butte Creek at an altitude of about 8,180 feet. These trees are twelve or fifteen miles apart, and the original slope of the ground between them is not known, so that they can not be taken to fix the highest and lowest levels of the original forest growths in this area.

At Specimen Ridge, where the closest examination was made, the lowest stump seen in position was at an altitude of about 7,000 feet, and the highest a little over 7,500 feet. There were here between these limiting growths certainly nine successive forests, and of course an equal or greater number of incursions of imbedding materials.

In what has gone before I have not attempted to designate

definitely the imbedding material which engulfed and destroyed the living trees, and in which the petrifications are now preserved. It is, as a rule, a volcanic conglomerate, or more properly a volcanic agglomerate. Both the matrix and the imbedded particles are truly volcanic, the latter varying from dust particles through all sizes up to those of a ton or more in weight. That the material has been accumulated under the partial influence of water or liquid conditions is evident from the more or less perfect stratification which generally pervades it. But the fragments are too angular, brecciated, to have suffered transportation and deposition as subaqueous or as ordinary river deposits. The attractive and satisfactory explanation of conglomerate formation in the Utah plateau region, as given by Captain Dutton, I do not think is here applicable.

From what is said in regard to the series of forest growths, and also from the evident thinness of the layers of *débris*, it is seen that there have been many successive sheets of the material laid down at the same place. In some cases and at certain places a true lava flow has spread over the surface, but the lava ledges can at points be seen to shade into the brecciated layers. While not believing that the great mass of breccia, covering perhaps hundreds of square miles, has been literally ejected from volcanoes, as has been held in regard to such formations, I am of the opinion that the accumulation of it is the direct and immediate result of such eruption.

Extruded lava from any source, not being perfectly liquid, would cool with an irregular surface, and terminate in precipitous ledges. This unevenness of surface, combined with the original slope that must have existed to permit any flow, would soon cause the whole area involved to be abundantly floored with volcanic fragments of all sizes. During subsequent eruptions these fragments would be swept along by and with the liquid matter, commingled with dense showers of ejected material, amid heavy flows of water from accompanying rains and perhaps melting snows, to be deposited in layers at varying distances from the centers of eruption, the condition in which it is now found. Most of the material of which the agglomerate is composed I believe to have come by the ordinary process of weathering of previously erupted rocks, and then to have been commingled with finer ejected material and distributed by the floods which accompanied some if not all the outflows. The interstratified beds of varying degrees of fineness are the results of less tumultuous periods.

Such explanation involves the necessity for many centers of eruption in the park region, for the agglomerate is of wide extent, and it could not be formed at great distances from these centers.

The above facts and conclusions are from personal observations begun by me in the summer of 1891, and continued in the summer of 1892 in connection with Prof. James Mercur, of the United States Military Academy. Not until we had embodied our conclusions in an official report to the War Department did I become aware that anything had been published in relation to these forests. I then learned that Mr. W. H. Holmes, formerly of the Hayden Survey, had made reference to them in his report on The Geology of the Yellowstone Park; also that Mr. W. H. Weed, of the present Geological Survey, had contributed an article upon the subject to the School of Mines Quarterly for April, 1892. It is believed that nothing else of an explanatory or descriptive nature has been published in regard to these interesting objects.

PRIVATE RELIEF OF THE POOR.*

BY HERBERT SPENCER.

LESS objectionable than administration of poor relief by a law-established and coercive organization, is its administration by privately established and voluntary organizations—benevolent societies, mendicity societies, etc. “Less objectionable” I say, but still, objectionable: in some ways even more objectionable. For though the vitiating influences of coercion are now avoided the vitiating influences of proxy-distribution remain. If we have not a machinery so rigid as that set up by the Poor Law, yet we have a machinery. The beneficiary is not brought in direct relation with the benefactor, but in relation with an agent appointed by a number of benefactors. The transaction, instead of being one which advantageously cultivates the moral nature on both sides, excludes culture of the moral nature as much as is practicable, and introduces a number of bad motives. Note the ill workings of the system.

As with the Poor Law (especially the old Poor Law), those who were distressed but thrifty and well conducted got no help, while help came to the improvident and ill-conducted; so with philanthropic societies in general. The worthy suffer rather than ask assistance; while the worthless press for assistance and get it. The Mansion House Fund of 1885-'86, for instance, was proved to have gone largely for the support of “idlers, spendthrifts, and drunkards.” “They did not see why they should not have some of the money going as well as their neighbors.” In some cases applicants “*demand*ed their share.” Where, as in another case,

* From the author's *Principles of Ethics*, vol. ii, just published by D. Appleton & Co.