

MAMMOTH CAVE AND HOW IT WAS MADE.

By Professor E. D. Eaton, in the *Bulletin* of the College Monthly.

You know how, in the early dawn of the world's history, the shape of our continent was fixed by a long island which raised itself from the waters like a man's arm, with its elbow in the State of Wisconsin and pointing to the northward, east and west. The initial plan was developed by a symmetrical growth in the same shape to the south and to the north, till, before even the medieval time, the southern coast line was where now is the state of Kentucky. The rivers continued cutting into the land and bearing its ruins to the sea. Along the coast, the sweeping currents of the of the tireless ocean were spreading this sand upon the sea bottom, and, as the years crept on, there grew a thicker and a thicker bed of sand over all that region. Should you go there now, you would find it a solid sandstone, hundreds of feet below the surface of the present dry land.

After this great accumulation of rock material, the direction of progress changes. The ocean is now to advance upon its old territory, and the land sinks slowly, inch by inch, and century by century, before the advancing waves. The waters have been too impure with all this sediment, and too shallow and too fresh, for the delicate, cleanly, salt loving corals to make their home. But as the waters grow deeper and purer, they come, migrating slowly from other regions, as the trees spread on our prairies from the knolls, adapting themselves, as they come, to their new *habitat* by various modifications. And, finally, over the land is a garden of sea lilies and corals. These lilies and these corals are of stone and the waves beat them to pieces and grind them to a powder, till the sandstone is covered with their ruins and lies two hundred feet and more below this new bed of limestone.

Then, again, the land rises, and step by step the waters fall away and the inhabitants of the ocean retreat, till in the place of the beauty and the life of the crinoidal sea with its white lily buds, is again a dreary waste of sand, and the limestone lies firmly bound like a book in its covers, between two thick and solid layers of sandstone. As the land continues to rise, the waters continue their retreat to the southward, and today the Kentucky subcarboniferous limestone is five hundred miles from the girdle of the ocean. The cave is in the St. Louis stratum.

Nature's work never lasts. Though the limestone was buried, it was not secured against further change. Through fissures and through the porous sandstone, the fresh water containing carbonic acid finds its way and begins to dissolve it grain by grain. This work may have begun as long ago as the coal time. Very slowly at first the crevices are enlarged, in places distant from each other. During the centuries, they are widened and deepened and opened into each other; and at length there is a subterranean river dissolving the rocks, or more properly there is a river system with its main stream and its tributaries, fed by springs and infiltrating water from the rocks above. There are doubtless hundreds of miles of these caves in the limestones of Kentucky, forming a complete network of ancient river channels.

Our preconceived idea of Mammoth Cave, formed no doubt from the Raphaelitic picture, that used to look at us from the geography of our youthful days, was of immense chambers of rounded proportions, where the glittering stalactites hung from the ceiling in boundless profusion, and were met half way by equally white stalagmites. Put a cover on the Dells of the Wisconsin, remembering that the erosion of sandstone forms a different channel from that solution of limestone, and the result is an enlarged copy of Mammoth Cave.

A few weeks ago, in the early morning, a party of twenty, comprising the State geologists of half a dozen States, from Michigan to Mississippi, and geologists and naturalists from as many more; one who had been with Powell in Colorado, one who had been in the Brazilian jungles with Agassiz, not a few who had climbed the Alps, all stood with their loins girt about, their staves in their hands, and their lamps trimmed and burning, looking down a long slope into a dismal hole in the ground. We had broken through the autocratic rule that is wont to govern cave parties, for, by special permission of the attorney and agent of the owners of the cave, who showed a becoming respect for such an array of science, we formed ourselves into a democracy, and our guide was to obey the expressed will of the majority.

Passing beneath the thin cloud of mist which lay on a level with the external surface, and is caused in summer by the meeting of the cold air of the cave with the warm external air, and noting the juncture of the sandstone above with the limestone, we answered, each one, to our names, and passed the gate, and so left behind us those circumstances of nature which, more than any other, have come to be a part of one's earthly existence. The darkness and the silence are perfect, save, now and then, the falling of a drop of water, or the flickering of a lamp. Here is no morning and no evening, only simple time, undivided. Here is no summer and no winter. The temperature is always fifty-nine degrees. Here is no sound, not even the hum of the insect world. For the few species of insects that live in the cave are not those of the exterior world, but sit, white and voiceless, in the gloomy silence. The fragrance of the flowers and the thousand odors of the world of light and motion are wanting here. In their place is an almost perceptible nothingness. In a word, it is a cosmos. It is like our world, and it is unlike it. The drop of water falls, for the law of attraction is the same as in the world above, and, dropping, it wears away the rock. The animal lives upon the fungus, and, dying, leaves its mineral matter, to which the next link of the unbroken chain comes in the same order as before. But we seemed like visitors from another sphere, to whom all this order of nature was new.

The route chosen was a tortuous channel, which is sometimes of great size, and in other parts its narrowness and lowness are well expressed by such names as Fat Man's Misery and Valley of Humility. Resemblances to various objects have given names to many parts. The Giant's Coffin is a huge rock forty feet in length and eight in depth, with most perfect proportions when seen from a certain point, while a band of black mus symmetrically around it. The chamber where this unknown giant lies is some fifty feet high and a little wider. On the ceiling, somewhat incongruously, is the perfect figure of an immense ant eater, formed by some coloring matter in the limestone. Side passages explored and unexplored lead off in all directions into new mysteries, or perhaps terminate in deep chasms. Through one such crevice in the side came quite a breath of air, indicating an unknown opening.

One might almost think he had descended into the world of an ancient mythology, for after crossing the river Styx, not by the orthodox ferry, but by a natural bridge with a span of one hundred and fifty yards, he comes to an expansion of the cave where, ninety feet below the roof, are gathered the clear waters of Lake Letha. As we were stepping from the boats upon the further shore, the shades,—they were a band of negro minstrels—that the Lethan waters might not bring forgetfulness of our earthly existence, struck up a variety of very non elysian airs. Wading waist deep in the cold water, dragging it with a seine for blind fish, was an additional reminder that we were still in the flesh. And so the mythologies are dissipated.

Beyond is Echo River. It traverses the length of the cave more than half a mile; above, the solid arch of rock; below, the waters lapping the boat; around, visible darkness. But by kindling, upon the stern of the boat, red and green fires, with an abundance of magnesium ribbon, the dark tunnel became brilliant with its illumination, and, as we floated

"As idle as a painted ship  
Upon a painted ocean,"

the musical voice of the guide, now on high notes, now in a deep bass, was answered by echos which grew slowly fainter as they seemed retreating from us into the recesses of the cave.

The bodies of water within are connected with each other and with Green River outside. A large freshet in this river causes a rise of water in the cave of more than twenty feet, flooding the lower parts, and cutting off all communication beyond Echo River. As Green River gradually wears into its bed and finds a lower level, the waters of the cave sink equally. They are simply the remainders of the river that at some former time traversed the cave. The direction in which the waters ran can be seen from the arrangement of the gravel and finer material on the bottom of the portions now dry. Wherever the waters were in more rapid motion, from an inclination or previous damming by obstructions or narrowness of passage, the gravel comes first, then the finer sand, and last the impalpable sediment. This gravel consists of foreign quartzose pebbles, which were brought in from the surface when the large streams from the melting glaciers rolled the drift material before them.

It was in this part of the trip that the power of scientific enthusiasm over mere emotion was strikingly illustrated. All along the party kept quite scattered, for, in the interests of the naturalists, all were diligently engaged in searching for every trace of animal life. Every promising cranny was peered into with the dim light of a small lamp, and the bright light of a scientific expectation of finding something; every stone which gave the prospect of discovery was turned over, and the cry, which more than any other rang through the cave that day, was this: "Quick! Come here! Here is a new bug!" And the cork of the alcohol bottle would be speedily taken out, and in would go another contribution to science. Thus, by straggling, those in the rear were often obliged to make good speed in order not to lose the party. Such an event is said to be a very serious thing. Lost in the perfect silence, with only a faint light, and that soon extinguished in the anxiety, anxiety grows to terror, and, even before the guide can find the lost one, reason is already gone. When some distance beyond the river, it was apparent that some one was missing—only eighteen could be counted. The roll had been given to the porter at the gate, and no one could tell who it was. An inquiry after the man with a seal-skin coat proved his absence, and there was still another. We demurred about going back for them, for another party was behind us, who would find them, and, besides, we thought, naturalists are generally considered insane, even when in their normal state of mind; there can be no danger of their minds being effected. But, even in a democracy, some one always seizes the scepter, and the guide, soberly shaking his head, said they *must* be found. So, while we turned the more diligently to our work, he retraced his steps, and, in a little less than an hour, returned with the truants and with a non-plussed comical look in the corner of his eyes, as if he had discovered a new genus *homo*. He had found them the other side the river, gazing intently into the waters of Lake Letha. They had seen a crawfish, and, in attempting to catch it, had muddied the water. So, with a true scientific patience, they had taken their position on the banks, waiting for the waters to become clear; and as they held up to our view the dejected articulate, they cried, "We didn't know but that we should get lost, but we've got the crawfish."

The only undescribed animals discovered were a new centipede and the probable food of the blind fish, an active little blind crustacean, which two of the party brought up from a clear pool they found in a cavernous recess a hundred feet down a fissure.

The following is the list of animals secured, according to Cope, fourteen species:

ARTICULATA.

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| <p><i>a. Insects.</i></p> <ol style="list-style-type: none"> <li>1. Anophthalmus Telecaudati.</li> <li>2. Beetle, No. 2.</li> <li>3. Beetle, No. 3.</li> <li>4. Phalangopsis, No. 1. (Crickets.)</li> <li>5. Phalangopsis, No. 2.</li> <li>6. Fly, No. 1.</li> <li>7. Fly, No. 2.</li> <li>8. Ephemera—larva-like.</li> </ol> | <p><i>b. Arachnide, (Spiders).</i></p> <ol style="list-style-type: none"> <li>9. Opilio-like.</li> <li>10. Aranea-like.</li> </ol> <p><i>c. Myriapoda.</i></p> <ol style="list-style-type: none"> <li>11. Pseudotremia-like.</li> </ol> <p><i>d. Crustacea.</i></p> <ol style="list-style-type: none"> <li>12. Astacus (blind crawfish).</li> <li>13. Astacus with eyes.</li> <li>14. Grammarus-like (food of the blind fish).</li> </ol> |
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The zoological facts of the cave, in their bearing upon the succession of life, are perhaps the most interesting of all. By the connection with the exterior river, various animals in limited numbers find their way in. But what becomes of them? They gradually lose their color, and, in the course of a few generations, even their eyes. For a zealous evolutionist, looking for an actual development of a new species from an old one in living animals, effected by the sum of its material surroundings, here is the fact in all its transitional steps. First, a little membrane grows over the eye. But there is still a slight opening. In the next generation this may be entirely closed, but the organ is still there. Let the fish out into the sunlight, and their descendants would have the veil drawn aside from the perfect eye. But on the other hand, examine its descendants whose home is the cave. The eye itself is gone, only a little black pigment is in its place, but the optic nerve is there. Is there doubt even that, if these fishes were brought under the circumstance of light, this rudimentary organ would be developed into a perfect seeing eye in the course of a few generations by direct descent? These are the facts of the anatomy of these fishes in all their stages.

In the last mile or two, appear the gypsum stalactite formations. From the presence of oxidizing iron pyrites, sulphuric acid is formed, which changes the limestone into gypsum. This sweats slowly out of the rock, and, taking the moisture from the cave for its water of crystallization, makes it in this part dry and dusty. The fibers, being fastened around the edges of elevations, are rolled outwards by their growth. This efflorescence, in the form of satin spar, lines the ceiling and walls with alabaster flowers of indescribable beauty. "The Last Rose of Summer" is eight inches across, with curling petals of snowy satin whiteness. All along, the walls are covered with sheets of the glittering lining, with flower like forms of various kinds.

A few minutes further and we are at the end, nine miles from the mouth,—the guide says. Here is one place where the water found a lower exit. It is a well of very generous diameter, sinking vertically into the rock, called the Maelstrom. The guide lights a piece of paper and drops it in. It goes circling down and down till the darkness almost closes over it above, and it is still burning there at the bottom one hundred and seventy below. From the bottom radiate other passages. It goes down through all the limestone layers to the sandstone below, and the roof of the dome above is a layer of the upper sandstone. What a magnificent geological section! We make such everywhere in imagination, but here is one already in the rock itself. A phenomenon the reverse of this, but produced by a similar cause, was visited on the way back. It was Mammoth Dome, where the dripping waters have come in from a small crevice above and made an excavation which is roofed over, and in whose bottom we stood, after climbing down some forty feet. With a floor nearly one hundred feet in diameter, it arched above us two hundred and fifty feet, with fluted columns on the side, tier after tier. The remnant of our colored light and magnesium wire was offered as incense in this temple, and as it was filled with the rosy light, drops of water hung from the roof and fell like liquid diamonds, followers of millions that had dropped before, workers in the darkness.

So, after an absence of thirteen hours, without a thought of weariness, so invigorating had been the cave air, we climbed the slope at the entrance, and came once more into the world of odors. It was nine o'clock in the evening, and light enough to see the trees. It had been raining, and everything was covered with drops of water. "It is like the Brazilian forests," said one, An indescribable aroma was in all the air. It was simply the odor of the leaves and of the grass, and of all the vegetation. Doubtless it is always there; but it soon faded away.

Is it always so, that we only appreciate the beautiful, as we come up into it from below?

Manufacture of Sulphuric Acid.

The manufacture of sulphuric acid is based on the oxidation of the sulphurous anhydride by the oxygen of the air, and the oxidation is obtained by the aid of nitric acid. According to the theory generally admitted, it should be possible to prepare any quantity of sulphuric acid by means of the same quantity of nitric acid. But the results obtained in practice do not always realise the promises of theory, and in some cases the loss of nitric acid is much greater than calculated, for large operations. Mr. P. W. Hoffman, director of a manufactory at Dieuze, has been making experiments to discover the cause of this abnormal result, and has found that by the action of the sulphurous anhydride on the sulphuric acid, containing nitric acid diluted with the necessary quantity of water, so as to mark 50° by the aerometer of Baumé, azote, or what comes to the same thing for the manufacturer, protoxide of azote, is produced. But with a compound of the two acids, marking 58° to 60°, this reaction does not take place. Mr. Hoffman has utilized these observations in his manufacture, and by regulating the entrance of steam in the first leaden chamber (drum), in such a way as to produce acid at 60°, he succeeds in economising 2 lbs. of nitric acid for each 200 lbs. of sulphur consumed.

EACH one is the son of his own works.