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## OF KENTUCKY. THE MAMMOTH CAVE

BY JOHN R. PROCTER, Formerly State Geologist of Kentucky.

WITH PICTURES BY ANDRÉ CASTAIGNE.

I the Louisville and Nashville Railway, the observant traveler will notice that about forty miles from Louisville the road climbs Muldrow's Hill, which is the northern escarpment of an elevated limestone plateau sloping gently to the south and west. The road traverses this plateau for about one hundred miles, and descends a southern escarpment into the basin of central Tennessee. In this distance only three streams are crossed—Nolin, Green, and Barren rivers; and between these rivers the entire surfacedrainage passes away through subterranean channels, giving rise to a curious «sink-hole» topography which is peculiar to this region. These circular and oval-shaped depressions are so numerous that in places the rims almost touch one another, and one can sometimes count several hundred to the square mile. Through vents at the bottom of these sinks the surface-water passes downward into caverns and underground streams, emptying into the above-named rivers through arched ways near water-level, and in places beneath the surface of the rivers.

The surface-rock of this plateau is the

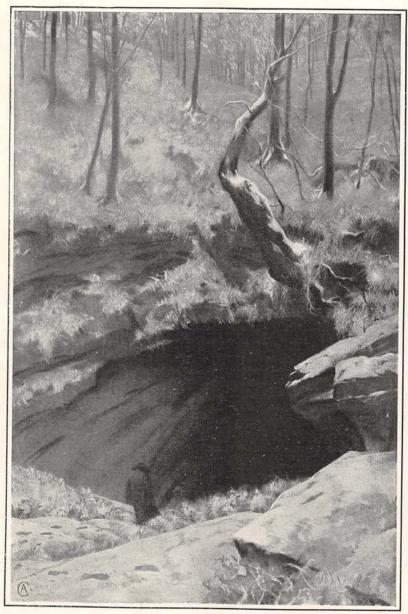
DASSING southward through Kentucky on tervening strata of shale or sandstone conditions most favorable for the formation of caverns; consequently this region contains more and larger caves, in a given area, than any other region in the world. In Edmonson County, where the celebrated Mammoth Cave is located, it is claimed that there are as many as five hundred known caverns.

A range of hills of uniform height, running parallel with the railway and several miles distant, will be observed to the north. On nearer inspection this will be seen to be a level plateau rising out of the limestone plain, and held up by a capping of massive sandstone. It is beneath the protection of this sandstone-capped plateau that the larger caves are found. Green River has cut through this plateau to a depth of about 320 feet; and as the sandstone cap is about 70 feet thick, we find about 250 feet of massive limestone exposed above the drainage-level. As some of the domes and upper avenues of the caves extend up to the base of the sandstone, and some down to the drainage-level, we thus have 250 feet as the present limit of the vertical extension of these caves. The evidence is conclusive that these caves have Subcarboniferous limestone, which is here been cut down to correspond with the deepseveral hundred feet thick, a massive, re- ening of the channel cut by Green River. In markably homogeneous rock, with no in- the region immediately along the line of the

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railway, where the sandstone capping and streams in this region. Every one of the the upper limestone have been removed by innumerable depressions or sink-holes—save erosion, the caverns have less vertical extension, and correspond to the lower avenues ing ponds-communicates with an under-

of the Mammoth and other caves to the north. ground channel or cave, and the aggregate



ENTRANCE (WINTER).

Doubtless large caverns, corresponding to length of such channels has been estimated

those now remaining beneath the sandstone at many thousands of miles. Nor can we plateau, existed here before the upper mem- form any estimate of the number and extent ber of the limestone was eroded from this of large caverns yet undiscovered. But for area. There is no means of estimating the the erosion caused by a small stream cutting extent of the caverns and subterranean through the roof of Mammoth Cave the pres-

ent entrance would not have been broken open, and this, the greatest of caves, might have remained unknown. Several other of the largest and most beautiful caves in this region have been found by accident. Hidden grandeurs doubtless yet remain entombed beneath the extensive uplands reaching out on both sides of Green River. In crossing the southern upland we come upon oval-shaped limestone valleys, surrounded on all sides by a sandstone rim, with no outlet save through vents in the bottom. These valleys are sometimes hundreds of acres in extent, and are probably formed by the falling in of extensive caverns, the debris, disintegrated by the elements, being carried away through the subterranean channels. The fact that existing caves under the hills surrounding these valleys have been found through entrances in the sides of some of the valleys is an indication that this may have been the condition.

So great is the volume of water entering Green River through underground channels, having a uniform temperature of about 54°, that this stream rarely freezes. I have seen Green River, forty miles below this region, entirely free from ice at a time when loaded teams were crossing the Ohio River on the ice. The outlines of the cavernous members of the Subcarboniferous limestone coincide with the outlines of the original «Barrens» in this part of Kentucky. When the whites first came to this region, what is known as the Barrens was destitute of timber, and was covered with a rank growth of grass called «barren grass.» The burning of this grass kept down the growth of timber. The roots of certain species, surviving the fires, would spread out on all sides, and send up shoots, which would be burned off before attaining any size. When the country was settled and farms were opened the annual burning of the grass ceased, and the land was quickly reforested from the roots yet surviving in the ground. It is told of the first settlers that they obtained their fire-wood by grubbing it out of the ground. This is a fertile region, and pleasing to the eye. When clothed in waving grain and meadows, it is a smiling, dimpled land.

The dynamic forces by which these caves have been formed are yet in operation, and the processes are easily understood. The Subcarboniferous limestone, though homogeneous and massive, has cracks and fissures. The surface water, taking on carbonic acid and percolating through these fissures, disintegrates the soluble limestone, and enlarges

the cracks into channels for streams. Into these channels the sands and gravels are carried, adding to the erosive power of the streams. The acidulated water oozing through the limestone disintegrates the surface, so that there is a constant dropping off of particles, thus slowly but constantly widening the channels into broad and lofty avenues. Much of this limestone is oölitic, and an almost pure carbonate of lime, and in places in Mammoth Cave we find what is mistaken for sand to be a mass of tiny grains of oölite that have been detached by the disintegration of the cementing material.

The avenues of Mammoth Cave form a bewildering labyrinth, crossing over and under one another, and winding about in every direction, the main ones having a general direction toward Green River. In places the waters have cut through the several levels of avenues down to the water-level, forming immense domes. Gorin's Dome, for instance, has a vertical range of about 225 feet. We have in the caves a building up through the agency of water as well as the eroding action. In passing through the limestone the water becomes charged with lime, and this is redeposited, forming stalactites and stalagmites. The upper member of the limestone contains iron pyrites, and through the agency of moisture and air upon these and the limestone, sulphate of lime, or gypsum, is formed, and the gypsum crystals incrust the walls and ceilings in the upper and drier portions of the cave with beautiful and fantastic forms of sparkling white. These gypsum formations grow out of the rock as hoar-frost grows out of the ground.

The stalactite formations in Mammoth Cave, while beautiful, especially in some of the great domes, are surpassed by the wonderful pendants, alabaster and onyx columns, and translucent curtains in several of the caves in other parts of Edmonson County; but no cave approaches this in the size and sublimity of its avenues, its awe-inspiring domes, its mysterious rivers, and in the rare beauty of the festoons of flowers and sparkling crystals ornamenting miles of avenues.

The entrance to Mammoth Cave is reached by descending a picturesque pathway leading from the hotel down the hillside over jutting moss and fern-covered limestone cliffs into a beautiful glen extending from the top of the hill down to Green River, which is 194 feet below the mouth of the cave, and about half a mile distant. If the weather is warm, as we near the entrance we step into a



ENTRANCE TO THE CAVE (FROM THE INSIDE).

bracing, cool pure air, welling up from the cave and flowing down the glen beneath the stratum of lighter and warmer air. I have stood near the entrance, and extended one hand into a temperature of 90°, while the other hand was extended into a cool flowing river of air with a temperature of about 60°. The air within the cave has a uniform temperature, summer and winter, of 54°. The cave may be said to breathe twice a yearinhaling during the winter, and exhaling during the summer. This breathing of the cave, and the purity of the air and its freedom from germs, are among the most interesting problems to be studied. By what process the air in the cave becomes sterilized remains to be determined.

But our faithful negro guide has counted the party, selected the requisite number of lamps, and given the word, and we follow him in single file down the rude stone steps into the vestibule of the cave. Turning, we look up at the beautiful effect of daylight which we are leaving, and admire the delicate cascade falling from the overhanging arch at the entrance. The grand dimensions of the opening can best be appreciated from Mr. Castaigne's drawing of the entrance as seen from the inside.

Here our lamps are lighted, and we enter this silent, mysterious, changeless abode of eternal night, where the heat of summer and the cold of winter, the storms and thunders of the outer world, never penetrate. A few hundred yards, and we feel the peculiar sensation of emerging into expanding space. We catch only glimpses of white limestone projecting out of black shadows of the faraway walls and ceiling of an immense, almost guide proclaims the Rotunda.

human voice. Years ago it was my good sing here, and who in the Star Chamber heard

circular room about 70 feet high, which our lofty corridors in majestic waves of melody. I could then appreciate the inestimable We note the peculiar musical effect of the privilege of the few who heard Jenny Lind



THE STAR CHAMBER.

cal society sing in this Rotunda. I went far the prayer from "Der Freischütz." away in one of the great avenues leading from here, blew out my light, and sat alone the perfect clearness of the atmosphere, the in the darkness, and listened while the grand freedom from dust particles of any kind; and anthems rolled and reverberated through the we soon learn that nowhere in the cave will

fortune to hear a celebrated German musi- a member of her party render on his violin

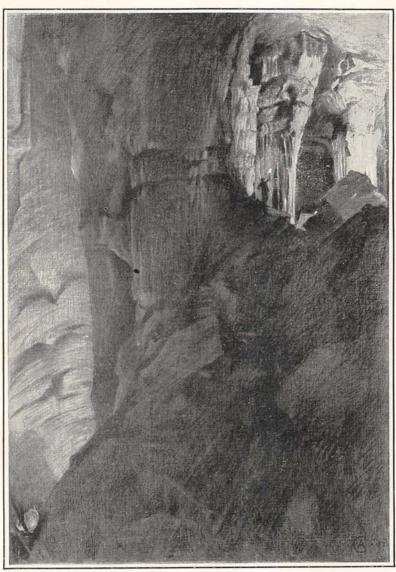
When the Rotunda is illuminated we note



CHIEF CITY.

even dust rise upon our shoes. We note also nues, and used for the manufacture of gunpow-

the exhilarating effect of the air upon the der. The war of 1812 was fought, on the Ammembers of our party. It is believed that erican side, with gunpowder made from saltthe air has become oxygenated by chemical peter taken from caves, and Mammoth Cave process; certainly, from its purity and dry- supplied the greater part. One wonders how, in ness, it enables one to undergo exercise for the absence of germs and of decay, the earth



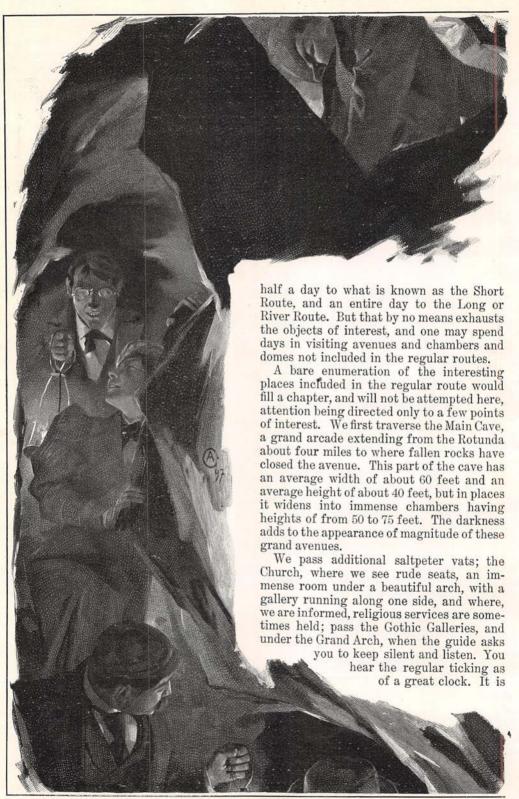
MAMMOTH DOME.

fore us is evidence of the wonderful dry- claimed that nitric acid in the atmosphere, ness of the air. The saltpeter vats erected in 1812, and the timbers which have remained in their present position since then, show no evidences of decay. In these vats the saltpeter was leached from the nitrous earth abounding in the upper and middle dry ave- regulation journeys through the cave: one

hours without a sense of fatigue. Here be- becomes charged with nitrogen. It has been combining with the limestone, forms nitrate of calcium, and the disintegrated waste from the walls and ceiling yields the great supply of nitrogen abounding in the cave.

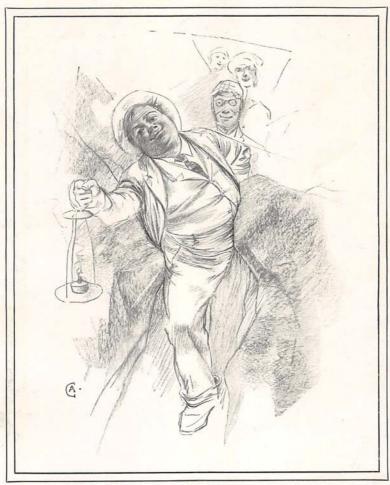
It requires a day and a half to make the

Vol. LV.-82.



THE CORKSCREW.

caused by a single drop of water falling into a up their abode here, and remained for five pool about every second. To get the full value months without going outside. It is said that of this you should be alone, and should blow when they did go out three died before they out your lamp, and then you can hear only could reach the hotel. Something more than this musical ticking, sounding afar through purity is required—sunlight. It is said that the great silent hall. And then one should the saltpeter-miners had remarkable health go alone, where there is no sound of dropping while working in the cave, and persons with water, and, extinguishing the light, learn for the first time what absolute silence and abwalks in this atmosphere. I believe, in time,



FAT MAN'S MISERY.

solute darkness are - profound blackness that that these immense reservoirs of dry, pure, you can feel, no sound save the beating of antiseptic air will be utilized for the cure of your own heart, which after a while you can consumption and asthma, not by sending the plainly hear.

that were built in the cave, in 1843, for the because the timber carried in in 1812 has not abode of consumptive patients. It was bedecayed, and iron hinges have been here effect a cure, and fifteen consumptives took know the air is pure, because here animal

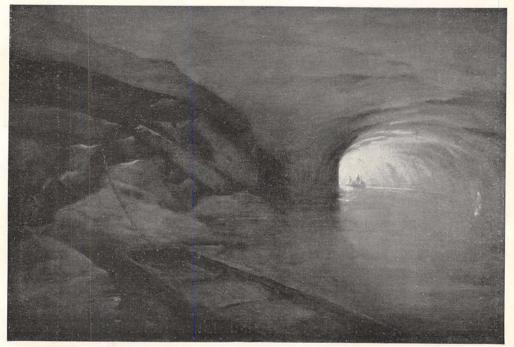
patient into the cave, but by bringing the Some distance on we come upon two stone air into sunlighted sanitariums on the dry, cottages built against one of the walls of the well-drained elevated sandstone plateaus avenue. These are the remains of a number above the caves. We know the air is dry, lieved that the pure air of the cave would since 1843, and show no sign of rust. We



THE BOTTOMLESS PIT.

matter does not decay, but simply dries up. The mummies found in the caves were not prepared mummies, but simply desiccated bodies. The uniform temperature of from 53° to 54° the year round has been demonstrated. Consumptives take long sea-voyages and visit high altitudes to get the benefit of aseptic atmosphere; but they suffer from variations of temperature, from storms, and at high altitudes exercise cannot be taken, while the cave air predisposes one to take exercise with little fatigue. I have known sanitariums supplied with cave air, by letting

pressiveness of the outer air. We dreaded to inhale it into our lungs, and returned again and again into the pure air flowing from the cave. Air freed from bacteria is one of the main reasons for success in modern surgery, and a sanitarium into which this air could be pumped would doubtless be resorted to for difficult surgical operations. Consumptives in high altitudes are compelled to remain indoors in winter weather and breathe the vitiated air of closed rooms; while in delicate women to walk for nine hours in the the air in at the upper part of the rooms and



ENTRANCE OF PURGATORY AND ECHO RIVER.

cave, clambering up steep ascents and over rocks, and come out of the cave feeling no sense of fatigue until they reached the warm, impure air outside, charged with the odors of decayed vegetation, when they would almost faint, and would require assistance in ascending the path to the hotel. We think the atmosphere in the glen at the entrance remarkable for purity before we have become sensitive by hours in the pure atmosphere of the cave. I once went with a friend and a guide to Roaring River and several other remote places, which required remaining in the cave overnight. It was night when we came out, and we had become so sensitive by our stay of thirty-six hours in the pure air of the cave that we were almost overcome by the suffocating mephitic odors and opout at the lower part, all exhalations would pass out, and pure air would be constantly rushing in at a uniform temperature, winter and summer. Then, it would be a boon if we could escape the oppressive heat of summer into hotels kept cool and pure by the air from these great dry caves.

We pass on from these desolate stone cottages with their sad memories. Some of our party have good voices, and all try to get the musical, resounding effect from the lofty vaulting. Then we learn that in places the rocks have a chord of their own, and when the right key is struck the most wonderful musical effects are produced. The guide understands the secret, and commands the rocks to give forth sweet musical responses.

We now enter an immense hall about sev-



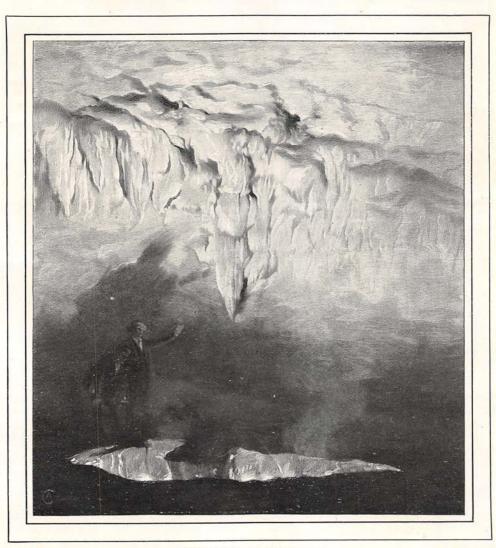
THE DEAD SEA.

enty feet wide, but how high and long we cannot tell; for above the towering cliffs on each side is blackness, and ahead of us the receding walls vanish in utter darkness. By direction of the guide, we seat ourselves on a log, and lean back against the right-hand wall. He removes our lamps so that they will not shine in our eyes, and placing them so the light will be thrown upward, he bids us look aloft. Exclamations of wonder break forth. We seem to be looking out from the bottom of a deep canon into black midnight heavens studded with innumerable stars. The longer we gaze, the more perfect does the illusion become. The guide, by skilful manipulation of the lights, causes clouds to overcast the sky; then black clouds hide the stars from view; a wind sweeps them away, and the stars come out plainer than before; and then the lights disappear down under the farther wall to our right, and we hear the footsteps of our guide resounding fainter and fainter; and then utter blackness and stillness, and we remain in silence in the famed Star Chamber. After a while we hear, far away on our left, the

crowing of a cock; then the deep baying of a house dog. Nearer the barking comes. A faint streak of light steals along the projecting buttresses of the overhanging cañon, and gradually spreads down its sides. We look to the left, and see the light slowly rise above the black horizon, and our guide comes forward with the lights, and receives the applause which he well deserves. The ceiling of the Star Chamber is flat, and is coated with the black oxid of manganese. This is pierced with sparkling crystals of gypsum. The blackness is so intense, and the ceiling so high, that we seem to look up into unfathomed space, in which the tiny stars float. Emerson was evidently more impressed with the Star Chamber than with any other portion of the cave, as will be seen from his essay on «Illusions.» Mr. Castaigne's drawing is the only satisfactory representation of this wonderful place that I have ever seen.

Star Chamber is the end of the Short Route, and visitors retrace their steps from here; but there are some miles beyond, which we will visit in order to see the largest underground dome in the world. This is called feet long, are found here. The ends of these have been charred, and it is evident that were used for torches to illuminate this magnificent temple.

Chief City. This stupendous dome is 500 feet and nodules of flint projecting from the ciracross in one direction, and 280 feet in an- cular walls, and the evidences are abundant other, and the height is estimated at from that the Indians gathered flint from here. 90 to 125 feet. Over this great area extends The moist flint from the cave would flake a solid arch of limestone. The awful sublimegasier than the dry flint outside, and for that ity of this place can be appreciated better reason must have been in great demand by from the illustration than from any attempt these manufacturers of flint implements. at description. This dome was frequented by There is not space to describe here the inthe Indians before the coming of the whites. teresting mummies that have been found Great numbers of reeds, from one to three from time to time in these Edmonson County caverns, nor of the woven fabrics and ornaments found with these mummies. These these were filled with the fat of animals, and fabrics were woven from the inner bark of trees. In Salt Cave and in Short Cave several interesting sandals were discovered a few The Indians procured flint from the cave. years since. They were braided in an artis-Flint Dome, which is rarely visited, has bands tic manner, and were of pleasing shape. They



CROGHAN HALL AND MAELSTROM.

destroyed.

Route we visit some of the wonderful domes. to the beauty of the place.

were like shoes rather than sandals, were a great height. Six enormous columns, eighty of different sizes, and of slightly varied defeet high and about twenty-five feet in disigns, but all shapely and carefully braided. ameter, support one of the circular sides The saltpeter-miners and the early visitors to of the roof. These columns are fluted, and the cave did not appreciate the value of the have well-marked capitals, and look like the remains of the aborigines found, and much ruins of some immense Egyptian temple. valuable material was evidently lost and The white limestone is here incrusted with an amber-colored stalagmitic coating, and Before crossing the river for the Long curtains of the same material add greatly



"THE SPIRIT OF ETERNAL, CHANGELESS SILENCE REIGNS SUPREME."

These are in the portion of the cave nearest by the visitor after wandering through avenues turning in all directions. The most interesting are Gorin's Dome, Bottomless Pit, and Mammoth Dome.

Gorin's Dome has the greatest height and depth, but Mammoth Dome is the largest of the three. It is about 400 feet in length and 150 feet in height. It has two levels—the

Gorin's Dome is viewed through a circular Green River, but this would not be known window in the side of an avenue about midway between the top and the bottom of the dome. The stalactites, hanging curtains, and incrustations are more beautiful here than elsewhere in the cave, which, added to the great height, gives to this dome a peculiar charm. The water in the bottom of the dome connects with Echo River by an unknown passage. There is a winding passageway leadupper containing the large columns shown in ing to the bottom, and as the view from this the upper part of the illustration, and the point is one of the most impressive in the enlower part, into which a cascade falls from tire cave, it is unfortunate that the tourist cannot have the benefit of it. The circling walls reach from the river-level up past all the various levels of the cave, and are carved and fluted by the descending water, and curtains and pendants of alabaster add to their

marvelous beauty.

The Bottomless Pit, though much smaller and less grand, has some of the characteristics of Gorin's Dome. It is a fearful pit to look down into from the bridge spanning one of its bays. I once went with a companion through a tortuous passage to the bottom of this pit, and while there we heard the shouting and laughter of an approaching party overhead. Extinguishing our lights, we waited until they had collected on the bridge overhead; and as they looked down, trying to penetrate the unfathomable darkness of the deep pit, we gave an unearthly, sepulchral wail. Exclamations of fear and horror resounded through the cave from the frightened crowd upon the bridge; but the guide, knowing that we had gone into the cave in advance of his party, quieted their fears by the assurance that the sounds did not come from evil spirits of the vasty deep.

Throughout the portions of the cave visited by tourists, all are impressed by the sense of vastness of the avenues and chambers; and many of the larger avenues are not visited. The main cave on the Short Route is from 35 feet to 300 feet wide and from 40 feet to 125 feet high for a distance of several miles; and on the Long or River Route this sense of roominess prevails throughout, with the exception of a pleasing diversion through the short cut to the river by the intricate windings of the Corkscrew, or through the winding, narrow, water-worn passage known as Fat Man's Misery, which is not over eighteen inches wide for some hundreds of feet. Emerging from this latter winding way into Great Relief, we enter one of the grandest avenues in the cave, called River Hall, extending for several miles, and leading, with its ramifications, to the wonderful subterranean lakes and rivers. We pass along the narrow pathway on the edge of the dark cliffs overhanging the Dead Sea. The lights, skilfully thrown on projecting ledges on the farther side, are inadequate to dispel the darkness surrounding the clear pool of water below. We stop to listen to the musical splashing of a small cascade. We cross a stone archway forming for several hundred feet a natural bridge over the River Styx. We stamp upon the hollow stone to hear the drum-like sounds reverberating through the avenues. We pass

in single file along the side of Lake Lethe, and enter the Great Walk, a lofty, spacious avenue about 90 feet high, extending for about 1200 feet to the shore of Echo River. The floor of this lofty avenue is a clean vellow sand. When the river is high this walk is submerged, thus adding to the width of the river. For a long time Echo River barred the way to the extensive system of avenues beyond. The celebrated colored guide Stephen Bishop was the first to cross it. New avenues have been discovered and opened up, so that it is now possible to reach the trans-river portions of the cave without crossing the river. But these are used only when the river is too high to cross, as a sail on this underground water is one of the most delightful experiences of the cave. Flat-bottomed boats, each with a capacity to carry about twenty persons, have been provided. Our lamps are arranged at each end: we take seats along the sides of the boats, which are pushed off; and we silently float out under the dark archway into an unknown world such as we have never before conceived of. The river is about 20 feet deep, of the purest water, so clear that pebbles can be seen on the bottom. In places it widens out to 200 feet, and branches reach away into darkness on each side. It is a sail of about three fourths of a mile to reach the farther shore, and it is an experience ever to be remembered.

Our guide asks us to keep silent; then, lifting the heavy, broad paddle with which he has been propelling our boat, he strikes with all his strength the flat side on the surface of the water. Instantly the subterranean thunders of this under-world are let loose. From all directions come rolling waves of sound multiplied a thousandfold, receding, and again returning with increasing volume, lingering for many seconds, and finally dying away in sweet, far-away melodies. Then, when the last faint sounds have ceased, he agitates the water with his paddle, and asks us to listen. The receding waves, reaching cavities in the sides of the overhanging arches, break the stillness with sweet bell-like sounds. Some notes, striking the key-note of the rocks, multiply the musical melody; some notes are soft and low; others are loud, almost with an alarm-bell clangor. This music, such as cannot be heard elsewhere on earth, gradually dies away in receding echoes, coming over the waters from far-away hidden chambers. The echo is not such as we hear above ground or in buildings, but a succession of receding waves of sound, lasting for

about thirty seconds, and adding an indescribable melody to all sounds, whether from shouting or from instrumental or vocal music.

The interest in this underground river is enhanced by the knowledge that in it are found the blind or eyeless fish. There are several species of these. They are colorless, and well demonstrate how life is adapted to its environments. There are no visible eyes, but the rudiments of eyes are found under the skin. Instead of eyes, the head is covered with small ridges of cup-shaped papillæ, each papilla containing in the center a delicate, projecting, highly sensitive nerve-filament, which, by its delicate sense of touch, compensates for the absence of sight. So sensitive are these blind fish that it is impossible to touch one of them while they are free in the water. Blind, colorless crawfish are also found in these waters. The cave cricket, or wingless grasshopper, is found throughout the cave. It has eyes, but as they are useless in the dark, it is provided with very long and very sensitive antennæ, which it sways about, and thus manages to get along without light. It is known that Echo River empties into Green River. When the latter river rises, even when there have been no rains in the neighborhood of Mammoth Cave, the rise in Echo River will correspond.

It is a long walk beyond the river to the

end of the regular journey, and many objects of interest and beauty are encountered on the way. The crowning glory of this part of the cave is Cleveland's Cabinet, a lofty archway two miles in length, the walls and ceiling covered with incrustations of sparkling crystals of gypsum. In places the fibrous gypsum has taken on the form of rosettes, and covers the rock as with a mass of snowy flowers. For the entire two miles of this wonderful arcade of gems and crystal flowers we hear nothing but exclamations of surprise and admiration. We leave behind us this fairyland for the more somber avenues, climb up a rough ascent in a wide dome called Rocky Mountains, and enter Croghan's Hall, in which is a deep pit called the Maelstrom. Above this pit hang large translucent stalactites. We are told that this is the end of the cave: but it is only one of the many ends, and some of the avenues have been closed by fallen rocks or by the stalactite growth, and the real end is yet unknown. We retrace our steps, and after a wandering of nine hours emerge from the cave into the oppressive air of the upper world. We have seen nothing more beautiful than the rosy light of the setting sun as we look out from the dark chasm. We turn for a last lingering look into the wonderful, mysterious under-world, where the spirit of eternal, changeless Silence reigns supreme.



## ANDRÉE.

BY WILLIAM PRESCOTT FOSTER.

HERE is a thing must of our time be told:
One heart among us, wilder than the rest,
Took ship of air and sailed away in quest
Of one more thought of God, hid from of old
Behind the eternal barriers of the cold.
Of late we saw him with undaunted breast
Scale heaven and steer to be the white North's guest,
And Winter's ancient fastness to behold.
And now the great winds waken, and the snow
Drives southward, and the red auroras dance.
He doth not come. Will he return? Perchance
The Hyperboreans, rapt with his face,
Detain him in the land of berg and floe,
Or Arctos shines upon his burial-place.