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THE MARBLE CAVE OF MISSOURI.

BY E. O. HOVEY, PH.D.

A very large portion of the State of Missouri is honeycombed by caverns to such an extent that the underground drainage in many places deprives the surface of small streams. For many years, the existence of a large cave in the extreme southeastern portion of Stone County, Mo., has been known, but the inaccessibility of the locality has kept travelers, with but few exceptions, from attempting to visit it. Within the past year, however, such remarkable accounts of the wonders and extent of the cavern have appeared in the local and metropolitan newspapers that the Missouri World's Fair Commission and the State Geological Survey determined to investigate the cave thoroughly and see what there was of truth in the stories which had been so widely circulated. Consequently, our party of three, representing both organizations, besides our photographer, Mr. C. E. DeGroff, of Warrensburg, Mo., left Aurora, a live mining city of Lawrence County, about 270 miles southwest of St. Louis, on the "Frisco" road, one charming day last fall, to explore the new wonder of the world. The 40 mile drive over cultivated prairies and through fine open but almost uninhabited forests might be dilated upon, but the limits of our space compel us to hasten on to the description of the object of our journey.

Stone County lies for the most part on the southern slope of the so-called Ozark Mountains. These mountains, however, are merely hills and ridges which have been formed by the erosion of the plateau which is known to geologists as the "Ozark Uplift," and would

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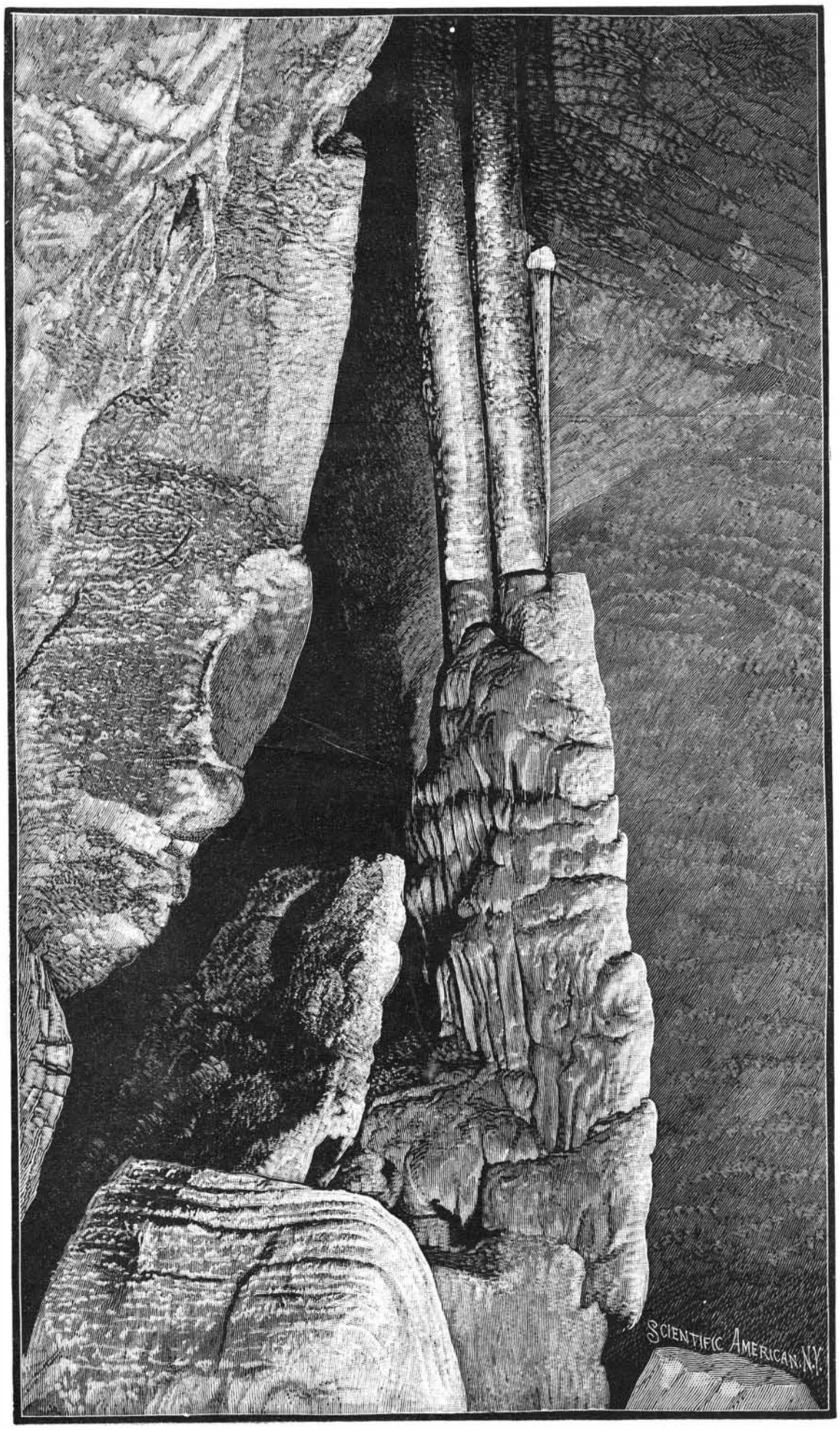
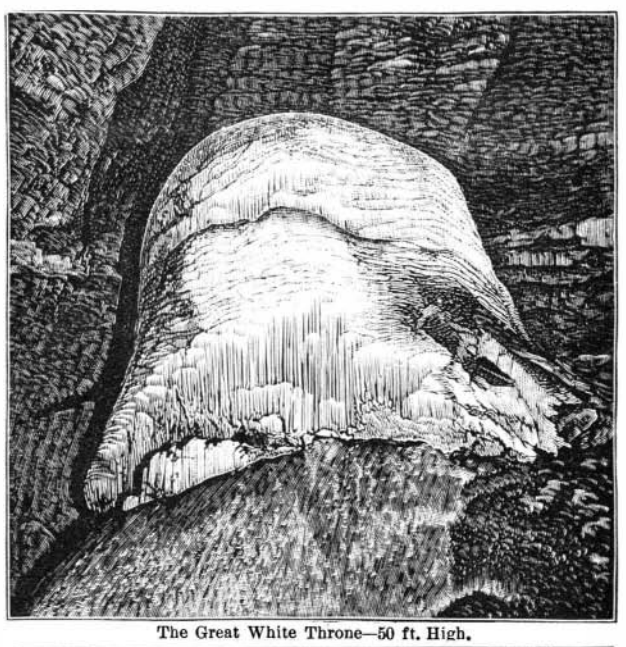
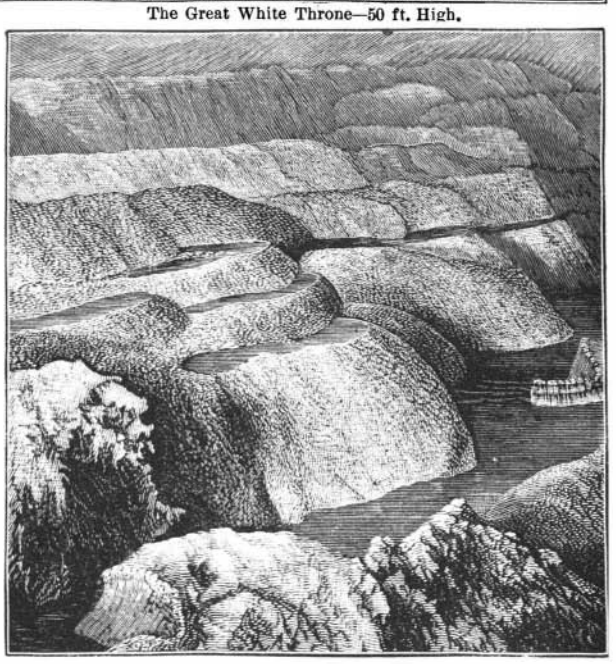


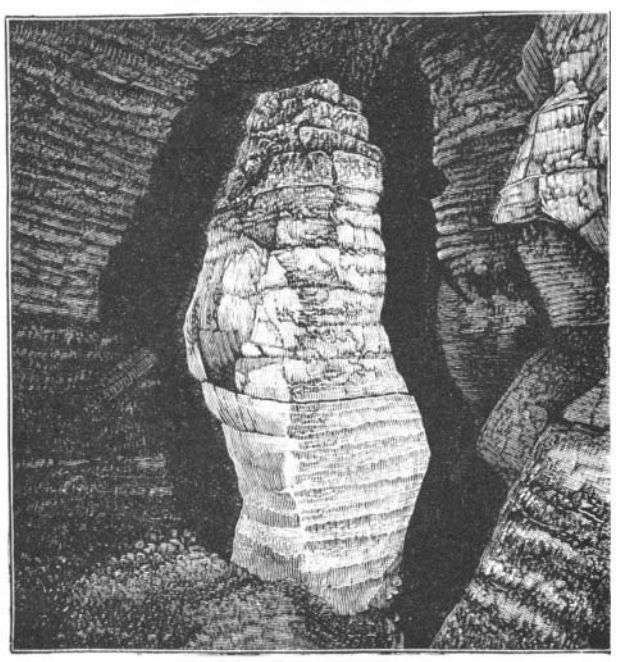
The Spring Room Sentinel.



The Great White Throne—50 ft. High.



The Waterfall—20 ft. Across.



"She," in Mother Hubbard Room.

THE MARBLE CAVE OF MISSOURI.—ILLUSTRATIONS FROM PHOTOGRAPHS.

THE MARBLE CAVE OF MISSOURI.

(*Continued from first page.*)

not be called such by one familiar with the Alleghanies, the White Mountains, or even the Catskills. No railroad has yet touched the county, the forests of oak, with sycamore, elm and walnut in the valleys, are for the most part in their primeval condition, and thousands of acres of fertile land may still be taken up under the U. S. homestead laws. The forests are free from underbrush and much grass grows under the trees, giving the scenery a park-like aspect.

Mr. Truman S. Powell's claim occupies Echo Glade and the neighboring hills about a mile and a half from the mouth of the cave and about 300 feet below it, and is the best headquarters from which to visit the cavern. Mr. Powell is the editor of the *Stone County Oracle*, published at the county seat, Galena, 18 miles from his farm. He says that he has explored fifty caves in Stone County. He is a firm believer in the future of the county and is an ardent admirer of Marble Cave. His eldest son, William T. Powell, is the good-natured, efficient guide to the cave. He is strong and active and a keen observer whose judgment is very reliable.

Climbing this hill, which is known as Roark Mountain, we saw in its top a large sink hole about 200 feet long by 150 feet wide and 55 feet deep, the bottom of which had dropped out, leaving a yawning chasm opening into the chamber below. Descending a series of log steps in the side of the pit, we came to two short ladders which led through the opening to a platform, from which we descended a large, strong wooden ladder into what seems to be a bottomless pit. This part of the journey is fraught with many imaginary dangers to those unaccustomed to ladders, but our party had received considerable training in entering mines in different parts of the State, and consequently we hastened down without fear, anxious to see what was in store for us. The bottom of the ladder rests upon the top of a mound of debris, about 45 or 50 feet below the platform above mentioned. Climbing down this cone of earth and slabs of limestone, we reached the bottom of the vast room which is called the "Grand Amphitheater,"

Some light comes through the great rift in the roof, which is the bottom of the sink hole, and as soon as our eyes became accustomed to the semi-darkness we could see something of the really grand dimensions of the immense dome in which we stood; but when the room was illuminated by red fire, its full grandeur was revealed. The dimensions as given in the newspaper accounts are greatly exaggerated, but the truth is sufficiently grand. The room is about 150 feet wide by 200 feet long, and the roof rises in a magnificent arch to a height of 165 feet from the floor. Some stalactites were seen on this broad expanse of roof, but the beauty of the scene lay chiefly in the symmetry of the arch and the variations produced by the differences in the limestone strata.

Two beautiful examples of drip formations occur in this great amphitheater. One is the "Great White Throne," a magnificent stalagmitic mass of pure white onyx about 50 feet high, 50 feet in extreme width and 12 or 15 feet in thickness, showing all the beautiful forms which one might imagine to be caused by the freezing of a fountain. It is hollow and one can climb more than half way to the top inside.

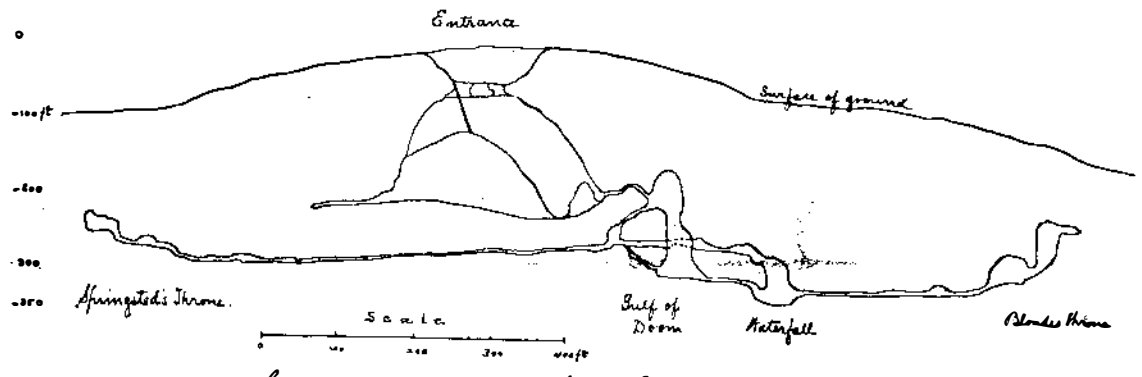
A few yards from the Great White Throne rises the "Spring Room Sentinel," a beautiful fluted column of combined stalactite and stalagmite about 20 feet high and from 2 to 3 feet in diameter with swelled base which stands near the opening leading from the Grand Amphitheater to the Spring Room and to the Animal Room. This passage is a long, straight, gradually converging one following a "joint" in the limestone, which leads to a large low room of unknown dimensions which contains the mummified remains of hundreds, even thousands, of animals, mainly, if not entirely, of carnivorous species. Admittance to this room is positively forbidden by the owner of the cave, but the assistants in the Smithsonian Institution at Washington have had access to material from it and are now at work upon their identifications. A specimen from this room which was shown to me consisted of the skull and jaw bones of a cat-like animal to which portions of dried skin and fur still clung. It had a very ancient appearance. The continuation beyond the Animal Room of the joint leading to it seems to emerge in the side of a ravine outside the cave. What was once apparently an opening here is now filled with earth and debris.

Mr. Will Powell thinks that this is the place where the much desired horizontal entrance to the cave can be made with comparatively little trouble and expense.

Opening out from the passageway to the Animal Room is the Spring Room and beyond this lies the "Shower Bath Room," the latter being a perfect example of a conical dome some 30 feet high, down the roof of which the water trickles and flows over a low precipice into the Spring Room. This water showed the remarkably low temperature of 48° F.

Behind the Great White Throne, in the Grand Amphitheater, is a passageway which leads to the waterfall and to other portions of the cave, which will be described as we go on. The first room to which this passage leads is called "The Registry Room," because the walls are covered in places with firm, damp, red clay, in which numerous visitors have inscribed their names with finger or staff—an unstable method of gaining celebrity. Here our guide called our attention to the fact that the atmosphere had become much warmer than it was in the first great chamber. There is, in fact, a difference of six or eight degrees. Then pointing to a great black hole in the floor of the room, he said, "Listen!" and taking a huge rock cast it into the abyss. After some seconds we heard the sound of the rock as it fell into water below us. The abyss is called the "Gulf of Doom." Actual measurement proved this precipice to be 88 feet in height!

Turning to the left and descending a slippery clay bank and a narrow ladder, we reached a point at which the cave divides, one arm going past a great slab of limestone standing on end, known as "The Lost River Sentinel," in a direction S. 30° W. to "The Lost River Canyon," a journey which we reserved for another day. Taking the other arm, leading in a directly opposite direction, and clambering through two passages like the "Corkscrew" in Mammoth Cave, we soon reached the top of the waterfall. The edge of this fall is about 20 feet across, and the water passes through a series of beautiful little pools with projecting rims of calcite crystals before it takes its final plunge of 50 feet into the darkness. The top of this waterfall is about 285 feet below the top of the hill at the entrance of the cave.



Cross section of Marble Cave, Stone Co., Mo.

MAP OF THE MARBLE CAVE, MISSOURI.

Retracing our steps for some distance from the top of the waterfall and turning on our track again at a lower level, we reached the bottom of the pit (8) into which we had cast the stone from the Registry Room above, and then passed on down a narrow defile by the aid of ladders and over slippery clay banks until we stood at the foot of the beautiful waterfall. Half way down the precipice a projection has caught the spray from the water, and the deposits of ages have formed there a beautiful bowl of carbonate of lime. Pointing to a 25 foot slope of miry clay and water, which lay just beyond us, Mr. Powell said: "That's the way to 'Blonde's Throne,' the prettiest thing in the cave." We looked at the prospect in dismay, and anxiously inquired whether there were no other way to get there; being answered in the negative, we left him behind, as he said there was no need of a guide, and plowed our way through that miry mass, which came to our knees. After toiling up this slope and through a narrow cleft in the rock, we reached the beginning of what they called "The Dry Crawl." We wondered what the *wet* one was going to be. Down we went on our hands and knees and began the toilsome journey. One hundred and fifty feet of this, most of which was too low even for this method of locomotion, brought us to the "Midway Rest," a small room, out of which a passage leads upward to several small chambers, in which were phantastically carved shapes in the limestone. We suggest the name of "The Temple" for one of these chambers, which contains fine Doric capitals. But Blonde's Throne did not lie in that direction. As soon as we had gotten our breath and adjusted our surveying instruments we started on the "Wet Crawl," and *wet* it surely was! We were pretty careful about the first pool, and tried to keep out of the water as much as possible, but when we reached the second pool we saw there was nothing to do but to plunge in and work our way across. After thirty or forty yards of this kind of travel on hands and knees in the water, or worming our way through comparatively dry holes in the rocks, we reached a room at the base of the ascent to our destination. Further progress on the level on which we had come was stopped by a pool of water of unknown extent, known as "Mystic River," spanned at the beginning by a low symmetrical arch of limestone.

A short, steep ascent led us to a great narrow cleft in the rocks about 100 feet high. Following this a short distance, we came to a steep incline of wet, slippery limestone, up which we climbed 25 or 30 feet, then pushing our way through a hole in the wall, barely large enough for our bodies, we were in Blonde's Throne. This is a small room, only about 15 feet in diameter, but it is a gem. It is almost completely filled with beautiful and curious stalactites and stalagmites. Some of the stalactites were in sheet-like folds, and a sufficient number of them give forth musical sounds when struck to enable a skillful musician to play simple tunes. The stalactites here are in all stages of growth, from narrow, hollow tubes, like pipestems, to solid pillars several inches in thickness. A small opening in the side of the room revealed the existence of a room which has never been explored. Rockets fired into it show that it must be a room of large dimensions.

Returning from Blonde's Throne, and slipping and sliding down by the aid of the slimy rope which had helped us up the steep ascent, we reached the bottom of the incline all too soon for some of our party. Lighting up the cleft by magnesium ribbon, we could see weird drip formations filling the crevices and projecting from the walls far above our heads. The return journey to the bottom of the waterfall was made much more expeditiously than the advance, because, being thoroughly wet, muddy, and cold, we did not stop for scenery or surveyor's measurements.

Another day was spent in exploring the windings of the "Lost River Canyon," which, as stated above, lies out to the southwest from the Registry Room. Climbing over huge blocks of limestone which had fallen from the roof, or threading our way between slabs standing on edge, we soon came to the beginning of a much longer but drier crawl than the one just described. After worming our way along for some 200 yards, we came to a beautiful stream of water flowing swiftly through the underground channel which it had carved for itself in the limestone. This was the "Lost River." In several places tortuous passages led out from this canyon, which are barren of interest, and serve merely to confuse the traveler and add to the length of the cavern. Somewhat less than a quarter of a mile from the Registry Room we ascended a steep slope and arrived at "Springsted's Throne." This is a room about as large as Blonde's Throne, but with a smaller amount of drip formation in it. The special feature of the room is a small recess, which is separated from the main portion by a lattice of stalactites. The cave has been explored for about a fourth of a mile beyond this room, but nothing of interest has been discovered in that direction.

The explorations thus far described have been along galleries opening out from only two places in the grand entrance dome. On the north side of the Grand Amphitheater another series of chambers opens out, most of which are comparatively small and devoid of drip formations. The first of these is the Mother Hubbard Room, in which an isolated waterworn pillar of limestone stands which has received the name "She" from its suggestion of Rider Haggard's weird descriptions. A dry crawl of 70 feet from this room takes one to the "Battery," a dome which is 60 feet in greatest diameter and 50 or 60 feet high. Here the bats congregate in vast numbers, whence its name. From one side of the battery a series of rooms, one of which is known as the Dungeon, and low dangerous passages extend to the Grand Amphitheater again.

A low narrow passage leads from the Mother Hubbard Room to the northwest to a series of barren rooms two of which are said to rival the Grand Amphitheater in size. This part of the cave is dry. The second room reached contains considerable amounts of epsomite, $MgSO_4+7H_2O$, and therefore is called the Epsom Salts Room. The passage to these rooms is called the Windy Passage on account of the strong current of air which sweeps through it.

As there were no means at hand of exploring this passage and the dangerous route beyond, we did not undertake to visit it.

In addition to bats the living animals to be found in the cave consist of crickets, newts, and eyeless fish. Plant life is represented by a peculiar white fungus which grows on the rocks in the Grand Amphitheater. Vast numbers of bats make their home in the cave, especially during the winter season, and the floor is covered to a depth of many inches with bat guano. Mr.

Powell has distinguished five kinds of bats here, none of which, however, are of unusual size or appearance.

That the cave was known to the early settlers and explorers of this region is shown by the notched poles which were found in the cave when it was first rediscovered, and which evidently served as ladders for entrance into the cave. Two of these are now to be seen in the Mother Hubbard Room. Local supposition is that these notched trees were used by the Spaniards, as it is known that they occupied the land in this region before the English settlers took possession of it.

The cave as thus described is of considerable extent and possesses variety in scenery and interest. It is well worth a visit, and when the projected railroads from Aurora and Springfield pass near it, it will undoubtedly become a summer resort; but the estimates of the distances, heights and depths which have appeared in certain usually responsible papers and magazines are very wide of the truth. Its unexaggerated beauties are enough to recommend it to the popular favor. The accompanying map represents, as accurately as the circumstances would permit, almost all of the cave that has been explored. It is certain, however, that the cave is by no means fully explored and that further investigation will add largely to this map. At present even Blonde's Throne and Springsted's Throne are practically inaccessible to the average visitor, but a not excessive amount of work would materially lessen the most serious difficulties in the routes.

My special thanks are due Mr. J. D. Robertson, assistant on the Missouri State Geological Survey, and Mr. H. D. Card, draughtsman for the Missouri World's Fair Commission, for their painstaking assistance in making the accompanying map and measurements and the thermometric determinations that are given herewith. To Mr. Powell and his family is due the credit for almost all the exploration that the cave has received.

An exceptionally low temperature, 48° F., was observed at the lowest point of the Grand Amphitheater and in the air and water of the Spring Room. Throughout the rest of the cavern the temperature seemed to be about that usually found in caves, 54° F.

In considering the scientific value of this cave, the fact should not be overlooked that this is the first cavern reported in this country containing mummified animal remains in large quantities.

North Greenland.

Professor Angelo Heilprin recently gave a very interesting address on "The Scientific Results of the Peary Expedition," illustrated by photographs projected by the lantern, before the Engineers' Club of Philadelphia.

The expedition under Lieutenant Peary did not have for its object, as many erroneously supposed, a nearer approach to the North Pole than had yet been reached, but was planned with a definite object, the determination of the northern boundaries of Greenland, which was carried out with unusual fidelity. The basis of operation was not, as usual, the steamship, but the mainland, and the trip extended from McCormick Bay northeastwardly across the ice cap. The entire return distance—1,300 miles—was accomplished on foot, sledges being used only to carry supplies, etc.

The country was found to be bounded by a chain of mountains on both the eastern and western shores, and the trip started at the western shore at an elevation of from 2,500 to 3,000 feet, and continued rising to the apex of the Humboldt Glacier. The ice cap terminated at about 82° north latitude, and open country followed it northward. The northeastern coast was reached in latitude 81° 37′, about 4½° further north than had yet been discovered. From this point the directions and general character of the coast in both directions were established for a considerable distance, although it could not be closely explored, on account of the rugged basaltic bowlders with which it was everywhere covered. The physical features were found to be quite uniform throughout the country. The mountain ranges averaged about 5,000 feet in height, occasionally reaching 10,000 feet or higher. The basaltic bluffs and bowlders on the coast, and the numerous fiords, made it very similar to that of Norway. Inland, between the mountain ranges, there is an apparently endless sea of ice, entirely covering and hiding the true topography.

The expedition solved the problem of the northern termination of Greenland, by showing that it does not extend to near the pole, or northeastwardly, as has been generally supposed. It was also found that glaciers were projected northward toward the pole, and therefore Greenland could hardly have had any connection with the American ice of the great Ice Age, as has often been supposed by geologists.

A narrow border country, having a good vegetable growth and an animal life identical on the east and west sides, extends all around Greenland. The summer temperature there is about the same as that of a mild winter here; the winters are much colder than in this locality, but not more so than in some of our Western States.

There is a very perfect, but very diminutive, forest growth of birch and willow. Poppies, anemones, buttercups, and other bright colored flowers bloom in favored localities, and butterflies and mosquitoes are abundant.

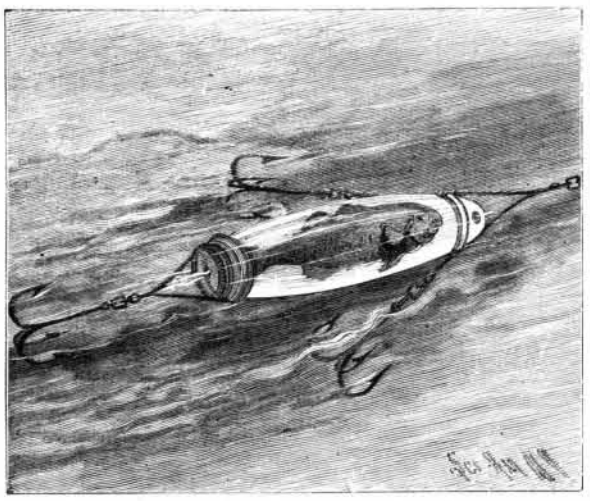
The country, up to the 73°, belongs to Denmark; north of that is No Man's Land, probably because its resources have not made it worth an official claim and protection.

The true Esquimaux are found north of Melville Bay, and now number approximately 250. They seemingly observe no religious forms whatever; they live largely upon uncooked food, are quick of perception and in adapting means to ends, and are absolutely honest.

The expedition to be undertaken next season will attempt to completely locate the northern boundary of the country and to study the open sea beyond.

TROLLING WITH LIVE FISH BAIT.

The improved fishing device shown in the accompanying illustration, and which has been patented by Mr. Henry J. Welch, is designed to keep the bait used alive for an indefinite period. The hooks, instead of being attached to the line in the usual way, are white, and are secured by a swivel and white wire leaders to an annealed, flanged, flint glass tube, through which the water circulates, and in which is held a live minnow, or other living bait, the glass magnifying the size of the fish in the tube, and its effect being such that, at a distance of a foot, only the bait fish in the tube is seen by the fish in the water outside, the hooks escaping observation. An opening in the front of the tube and one in the cap closing its rear provides for a free circulation of water through it, so that one small bait fish may last for a day, the fish being inserted in the tube by unscrewing the rear cap. It is said that this



AN IMPROVED TROLLING DEVICE.

device has been successfully employed in catching muskallonge, pickerel, pike, and bass, being equally adapted for taking either salt or fresh water game fish, whose natural bait consists of small fish.

The tubes are preferably made of different sizes, from 3½ to 5½ inches long, and proportionately trimmed with hooks, according to the kind of fish it is proposed to catch. Further information relative to this improvement may be obtained of Mr. Calvin V. Graves, Natural Bridge, N. Y.

Plaster of Paris Floors.

The French, who have carried the art of hardening plaster to where it is utilized for flooring, either in place of wood or tile, use six parts of good quality of plaster intimately mixed with one part of freshly slaked white lime finely sifted. The mixture is then laid down as quickly as possible, care being taken that the trowel is not used on it for too long a time. The floor, adds the *National Builder*, should then be allowed to become very dry, and afterward be thoroughly saturated with sulphate of iron or zinc, the iron giving the strongest surface, the resistance to breaking being twenty times the strength of ordinary plaster. With sulphate of zinc the floor remains white, but when iron is used it becomes the color of rusted iron; but if linseed oil, boiled with litharge, be applied to the surface, it becomes of a beautiful mahogany color. Especially is this the case if a coat of opal varnish is added.

Paste for Attaching Paper to Glass.

Flour	2 teaspoonfuls.
Water	4 ounces.
Bichromate of potash	5 grains.

The flour must be rubbed to a smooth paste with the water, then placed in a saucepan over the fire and kept stirred until it boils. Add the bichromate slowly, stirring all the time; then stand to cool. The paste must be kept in the dark, and used as soon as possible. Soak the paper in it, and attach to the glass, then place in direct sunlight for a day. This sets up a chemical change in the bichromate, and renders the paste insoluble.

Correspondence.

Nitro-Glycerine Should be Kept from Freezing.

To the Editor of the Scientific American:

How long will the community be startled and appalled by such terrible calamities as occurred recently in a Brooklyn suburb? I answer, just as long as workmen are allowed *to thaw out dynamite.* "But it can't be used in its frozen state." No; but it can be *kept from freezing*, just as easily as ink, or vegetables, or anything else. Dynamite, in cold weather, should be kept in a chest impervious to frost; and any box or chest can easily be made impervious by packing. The legislature of every State where the mercury is liable to fall below freezing should enact a law making it a criminal offense on the part of any one storing or using dynamite *to allow it to freeze.* J. T. PETTEE.

Meriden, Conn., January 2, 1893.

American vs. Foreign Files.

To the Editor of the Scientific American:

I have read Mr. J. D. Foot's answer, in the SCIENTIFIC AMERICAN of January 14, to my note on files. I desire to say that my experience with file *manufacture* is quite small and unimportant; but my experience in the use of files is one of thirty years. This experience teaches me that the files made by Mr. Foot's company are inferior to those of the Stubb's make in at least the degree stated in the note referred to.

It is fair also to assume that Mr. Foot has incorporated his whole file knowledge into his product, and those who are familiar with that product may judge said experience and expertness with little room for doubt, and they may thus gauge his criticism of my note so as to do justice to both of us.

A general expression of the opinions of American users of files on the values of Mr. Foot's files, when compared with the Stubb's files, will teach your readers how these tools generally are considered.

Brooklyn, Jan. 16, 1893. ALBERT D. PENTZ.

The Importance of Auxiliary Water Jet Propulsion for Steamers.

To the Editor of the Scientific American:

Your valuable article on "Safety Suggestions on Ocean Steamers," of January 7, 1893, is very timely and to the point. It should be well pondered and carefully considered by the engineering profession and by the public.

When it is considered that thousands of human lives and millions of dollars of property are risked on the ocean every year, thousands of miles from land, it is a wonder to me that not more precautions are taken to protect life and property, and that not more progress has been made by marine engineers to make steamships superior to wind and water. It seems to me man will master the sea when he will perfect his steamship. He has not done it yet; but if an auxiliary propelling force like water jets were introduced, it would go a long way to make safe and perfected steamships, by giving the vessels a steering and propelling power independent of the screw and shafts. If jets were used with the screw, they would produce increased speed to the vessel; but as a ready protection to a vessel disabled on account of loss of screw or fractured screw shaft, the water jet offers the least expensive and most effectual of any means taken to provide safety for a vessel in such an emergency. With a water jet propeller the vessel is reasonably sure of steering and propelling itself to port, and need not depend on the "hawser" and pay heavy salvage. Then collisions will be less frequent, because bow jets enable the vessel to stop much quicker, and if the government put jets on war vessels, it would find it could maneuver war vessels with jets to a much greater degree than is now the case.

The government should carefully consider the merits of the auxiliary water jet, and if it finds it will protect life and prove valuable in case of loss of the screw or broken screw shafts, then it is the duty of government to enact a law that all steamers and war vessels be provided with the auxiliary method of hydraulic propulsion.

There is no question that water jets will propel a vessel; and as the SCIENTIFIC AMERICAN suggested—by use of the pumps in the ship—an inexpensive means would be at hand to provide a propelling force in case of necessity. Then, no doubt, if the system were adopted it could be greatly improved, and obstacles that now appear could be surmounted. I hope the matter will be taken up, now that you have called attention to the importance of auxiliary water jet propulsion. J. W. H.

Newton, Mass., January 9, 1893.

NICKEL is a modern metal. It was not in use nor known of till 1715. It has now largely taken the place of silver in plated ware, and as an alloy with steel it is superior to any other metal, for it is not only non-corrodible itself, but it transfers the same quality to steel; even when combined as low as 5 per cent it prevents oxidation.