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BRITISH CAVES AND SPELEOLOGY.

By E. A. MARTEL.

At the last meeting of the Sixth International Geographical Congress held in London, in July and August, 1895, I had the honour, as delegate of the Society of Speleology, of communicating a memorandum on the encouragement which ought to be given to researches of all kinds in caves. I explained how the new means of action employed since 1883, above all in Austria by different scientists and travellers, and in France by myself and my fellow-labourers, had resulted in unexpected discoveries. The principal aim of my communication was to attract the attention of English scientific men and tourists to all that still remains to be done and to be found in the natural caves of Great Britain. Alluding to the two works that I had already published,* I tried to prove how speleology, or the science of caves, if it received the attention which it deserves, will help to solve a great number of problems, not only in physical geography, but also in palæontology, zoology, meteorology, agriculture, public works, general hygiene, etc. In order to join example to precept, I had obtained from the French Government, as I did in 1893 for the Austrian Karst, a scientific mission in the name of the Minister of Public Instruction to make a comparison between the grottoes and subterranean waters of Great Britain and those which I had already examined in France, Belgium, Austria, and Greece.

The results of this mission, very fortunately accomplished in July and August, 1895, were abundant enough to furnish matter for a special new work, which was issued in January 1897†; but, wishing to make known to the readers of the *Geographical Journal* at least the principal observations and discoveries which I have made in Ireland, Derbyshire, and Yorkshire, I will devote these few pages to a summary relation of my underground journey in the British Isles, adding afterwards a few words on my researches of 1896 in Spain. I hope thus to succeed in arousing in England a favourable extension of all kinds of subterranean researches, as I have already had the pleasure of succeeding in doing in France.

I.—GENERAL REMARKS ON BRITISH CAVES.

At the beginning of the present century, the caves of England were the object of learned and methodical researches. In 1821 Dr. Buckland undertook the famous excavations of Kirkdale cave, described in his classical work ‘*Reliquiæ Diluvianæ.*’‡ One knows what splendid palæontological discoveries have been furnished by the beds of Hutton, Oreston, Wookey, Victoria, Brixham caves, of Kent’s hole, Dream mine, Goat hole (Paviland), etc. The summary of all this has been described by Prof. Boyd Dawkins in his excellent work ‘*Cave Hunting,*’ published in 1874.§ The mere reading of this valuable volume will suffice to show that palæontology and archæology have been until now the principal objects of English speleologists. One may say that in general they have not thoroughly examined all that concerns the topography, the hydrology, the meteorology, and

* ‘*Les Cévennes.*’ In 8vo. Paris: Delagrave. 1890. ‘*Les Abîmes.*’ In 4to. Paris: Delagrave. 1894.

† ‘*Irlande et Cavernes anglaises.*’ In 8vo. Paris: Delagrave. 1897.

‡ In 4to. London: Murray. 1823.

§ ‘*Cave Hunting: Researches on the Evidence of Caves, respecting the Early Inhabitants of Europe.*’ In 8vo; xxiv., 455 pp.; one plate in colours and fig. London: MacMillan. 1874.

the zoology of their underground caves. On this last point they are very much behind their scientific brethren of Austria, America, and France, as, up to 1895, there was only one grotto in the British Isles—that of Mitchelstown, in Ireland—in which specimens of the fauna special to caverns had been met with. We cannot doubt that this is for want of sufficient researches. The opinion held by Prof. Boyd Dawkins in 1874, that the temperature of caves is in general (like that of springs) invariable, and equal “to the annual mean temperature of the place,” was only really recognized as inexact since my own researches. I proved that it was also without foundation in England.* It is all the more singular to see the British caves thus incompletely studied, as every circumstance seems to favour a careful investigation; in effect, great stretches of tableland and hills are perforated with fissures into which the rainwater is engulfed, with caves which receive them, and sources which distribute them. These regions are very easy of access; they are neither lost in the heart of high mountains, nor far from roads and great centres, as those into which the swallow-holes of the French *causses* open. The 1: 10,560 county map, or 6-inch map, facilitates in a very great measure, and better than in any other country, the knowledge of the land. And the nation which has created the dangerous sport of alpine climbing and founded the first alpine club is far from wanting in initiative and fearlessness. Also we can hardly understand why the courageous Messrs. Lloyd, Birkbeck, and Metcalfe, who, as far back as 1770 and 1847, did not fear to descend into Eldon hole and Allum pot—two abysses of 300 feet deep (of which 180 are perpendicular), have not had more imitators.

In short, the underground of the calcareous regions of the British Isles may be considered as being, topographically, very little known; this is the conviction which was impressed on my mind by my own researches in 1895.

II.—MARBLE ARCH (IRELAND).

Dr. Scharff, of the Irish Museum of Science and Art at Dublin, procured me the co-operation of Mr. Jameson for the exploration of some of the Irish grottoes. His help has been most valuable to me in exploring the caves near Enniskillen (Fermanagh). Marble Arch, which is certainly the most important of all these cavities, is situated 10 miles (as the crow flies) south-west of Enniskillen, at the entrance to the park of the Earl of Enniskillen. The Cladagh (219 feet), a foaming torrent rushing out of a charming woody ravine, narrow and walled in between abrupt slopes for a height of 150 to 250 feet. After a mile's walk up the ravine, we come to a natural arcade of stone, a calcareous layer which has remained stationary, and under which the entire torrent leaps, raging through the stones with which the bed is strewn. The map (sheet 56, Swanlinbar) indicates, at half a mile, two-thirds of a mile, and a mile, south and south-east of Marble Arch, three rivers (Sruh Croppa, Monastir or Owenbreen; the third has no name), which here, running under the rocks, drain the northern turf slopes of Cuilcagh (2188 feet), and disappear suddenly into three holes, Cat's hole, Pollawaddy, Pollasumera.

On July 16, 1895, I undertook, with Mr. Jameson, to find out the quite unknown underground relations between the three rivers and the source. It is difficult to imagine a subterranean arrangement more complicated than at Marble Arch. Three storeys are here superposed: (1) the channels of the subterranean

* *Comptes Rendus* of the Academy of Sciences, Paris, March 12, 1894; January 13, 1896; May 24 and June 14, 1897.

river; (2) three galleries, perforated at about 16 feet above the water which circulated there formerly, and which perhaps passes there still when there are inundations; (3) four openings caused by the falling in of the tableland between 30 and 80 feet higher up. But it is impossible to meet with a more striking example of the destructive powers of subterranean waters. Erosion, corrosion, and hydrostatic pressure have, by widening the natural fissures of the ground, formed a real sponge of stone, about 500 feet long by 200 feet wide. Under the continual action of the internal current, the rock has become, in some way, more and more carious, like a bad tooth. At the points the most attacked, the hollowing out has reached such a development that the overweighing mass fell in, thus producing the four funnels. In short, the formation by the falling in of ground, due to the sapping of a subterranean river, is nowhere, not even at St. Canzian-in-Wald, near Adelsberg,* more evident and more eloquent than here; and the partisans of the theory which attributes the origin of natural wells principally to this cause, will find at Marble Arch one of the best arguments in favour of their thesis. They ought to note, nevertheless, that the want of thickness in the tableland over the cavern (45 to 125 feet at most) is a circumstance particularly favourable to this giving way of the earth, and that, conformably to the distinction that I established already in 1889,† and that is here confirmed, the conditions are no longer the same when the thickness is more than 300 feet. In this case, the narrow vertical abysses from 300 to 1000 feet deep, due, above all, to the external action of the streams which are, or were, engulfed into them (Karst, Causses, Vaucluse, etc.), are much more frequently met with than the gulfs really formed by the giving way of land; the latter are then only exceptions, of which the Dolinas of Recca at St. Canzian am Karst (Istria),‡ Padirac (Lot),§ and perhaps Mazocha, in Moravia, are without doubt the finest examples.

Behind the boulders, the subterranean stream occupies the entire section of a huge gallery. To the extent of 1000 feet we followed, in my folding boat, a great tunnel, previously unknown to man, elbowed in two places with sharp angles. The height and width of this tunnel vary from 25 to 45 feet; it is as imposing as the finest sections of the subterranean Piuka of Adelsberg (see engraving, "Underground river at Marble Arch, Ireland"). At the second elbow there is a cross-way, from whence a dry gallery is prolonged towards the north-east, the principal gallery coming from the south-west. At 650 feet from the cross-way we are stopped by the rocks approaching within 10 inches of the level of the water and not allowing our boat to pass. There are 15 feet difference of level between the source of Marble Arch and the water-surface of the large gallery, where the river has a temperature of 53° Fahr.

In short, it seems that the underground river here has utilized and enlarged the natural fissures of the rocks and formed them into magnificent galleries. Such is probably the origin of the curious labyrinth of the caves of Marble Arch, of which the total development attains nearly half a mile in length.

At a quarter of a mile as the crow flies, south-south-west of Marble Arch, there is another external giving way of the earth. The 6-inch map names it Cradle hole. Five or six times more vast than any of the other four funnels of Marble Arch, it was, like them, produced by the falling in of a subterranean vault. In the north-east_inferior angle there is a cave, less complex and

* See 'Les Abîmes,' p. 459.

† *Comptes Rendus Acad. des Sciences*, October 14, 1889.

‡ 'Les Abîmes,' p. 459.

§ *Ibid.*, p. 263; and 'Tour du Monde,' December, 1890.

less extended than those of Marble Arch, and of which every hole and corner was known for a long while. The whole ends in a wide gallery 300 feet long,



UNDERGROUND RIVER AT MARBLE ARCH, IRELAND.
(Lent by the French Alpine Club.)

similar in form, cut, and dimensions to the one we discovered at Marble Arch. There is also a river in it. The barometer marks 450 feet of altitude—that is to say, 15 feet more than at the end of the large gallery of 650 feet in Marble Arch.

A communication in form of a siphon exists between the two currents. The ramifications of the cave of Cradle hole have about from 800 to 1000 feet of development.

At 220 yards from Cradle hole there is a yawning chasm, the sides of which have been but lately disclosed ; it is, without doubt, quite a recent giving way of the ground (altitude 600 feet), which is not marked on the county map. It is smaller than Cradle hole, and no cave opens at the bottom ; it has unhappily obliterated the subterranean passage, over which the sinking of the earth has taken place. Barely a quarter of a mile farther on, or at about one-third of a mile from Cradle hole, and about half a mile from Marble Arch, there is a real pit (*aven*), that is to say, a narrow natural well (altitude 620 feet). The fathom-line descends 72 feet, that is to say, to the altitude of 550 feet, or about that. Unhappily, we had not time to descend into it, as we wished to examine, at 50 yards from there, the spot where the river Monastir (or Owenbrean) loses itself under the rocks at Pollawaddy. This river descends from the very summit of Cuilcagh. Its disappearance is very picturesque. At 612 feet of altitude (map) the ground comes suddenly to an abrupt termination, and a cliff from 60 to 80 feet high forms a precipice at our feet, barring a hollow ravine at least 320 feet wide, into which the river descends in small cascades. A little byway leads us to its banks, at the very foot of the cliff, into which the water (58° Fahr.) disappears. In the very course of the stream, which is 20 inches deep, we enter under a gallery, 3 feet wide and from 10 to 25 feet high. At 130 feet from the entrance we were stopped by a large stem of a tree, which we could not remove. Thus we were compelled not to know if the stream would have led us to the foot of the pit.

It now remains to descend into the pit (*aven*), and to finish the exploration of the disappearance of the river at Pollawaddy, as well as of Cat's hole (quarter of a mile north-west of Pollawaddy), where the stream Srub Croppah disappears ; and of Pollasumera (two-thirds of a mile east from Pollawaddy), where a third nameless river is also swallowed.

III.—ARCH CAVE OR WATERFALL CAVE, IRELAND.

Opposite to Cuilcagh, the mountains of Belmore (1312 feet) include also between lakes Macnean, Melvin, and upper Erne, some calcareous ground, the subterranean hydrology of which deserves to be studied. On July 14 and 15, 1895, with the very obliging indications of Mr. Plunkett, of Enniskillen, who had himself made some pre-historic excavations in different little caves of Belmore, Mr. Jameson and I examined the basin that serves to feed the source of Arch cave, or Waterfall cave, situated at about 8 miles west of Enniskillen. It is one of the most curious springs that I have ever observed, and was opened by the force of underground waters between the clefts and joints of carboniferous limestone. The origin of the powerful source of Arch cave, whose volume announces the drainage of a rather considerable surface of ground, must be as follows :—

This surface is that of a tableland with three shelves or terraces, which extends towards the west of the cave, and constitutes, in a gentle slope, the eastern declivity of the hills of Tullybrack (1223-1249 feet).

On this tableland a quantity of swallow-holes are the points of absorption of the atmospheric waters. The greatest part of these swallow-holes, or pipes, are impenetrable, being full of pebbles and lumps of earth, like the *betoires* of France, and the *Sauglöcher* of Austria ; but at least two are open and penetrable, like the abysses, or pits, and we descended into them. The first, Sumera, or Noon's hole, is the deeper and the more curious ; the plumb-line marked 154 feet, that is, 216 feet above the outlet of Arch cave, as the hole opens at 747 feet of altitude. It is a real

swallow-hole, but it is not finished; the stream that has already widened it continues its work of enlarging—it still falls into it, and so strongly that we were obliged to limit our descent to 60 feet. At the depth of 80 feet the cavity gets narrower; it has then only 3 feet diameter instead of from 16 to 25, as at the orifice, and the waterfall occupies all the section.

To examine the bottom of it, and to seek the prolongation of Noon's hole, it would be necessary to re-descend into it in a drier season. At least, I have had the satisfaction of verifying that most of those long and narrow vertical abysses of the Causses and of the Karst, which are to-day so dry, are in reality the work of superficial waters formerly absorbed there and now dried up; that they have been formed from top to bottom at the expense of the fissures of the ground, which have been enlarged by erosion and corrosion; and that the opposition that I made, in insisting on this new theory, to the excessive generalization of the hypothesis of the sinking vaults is absolutely justified. Ingleborough hill, in Yorkshire, will furnish us with still more magnificent examples of abysses having kept, until now, their character of absorbing wells.

The other penetrable swallow-hole is Pollanafrin, at half a mile south of Noon's hole, and at 690 feet altitude, only 32 feet deep on one side, and 46 feet on the other. This hole is really the production of a sinking-in of ground; the stream which crosses it has disappeared, a few yards upwards, on the third terrace, into small crevices of its bed. It is sure that all these waters reappear at Arch cave, which is half a mile distant.

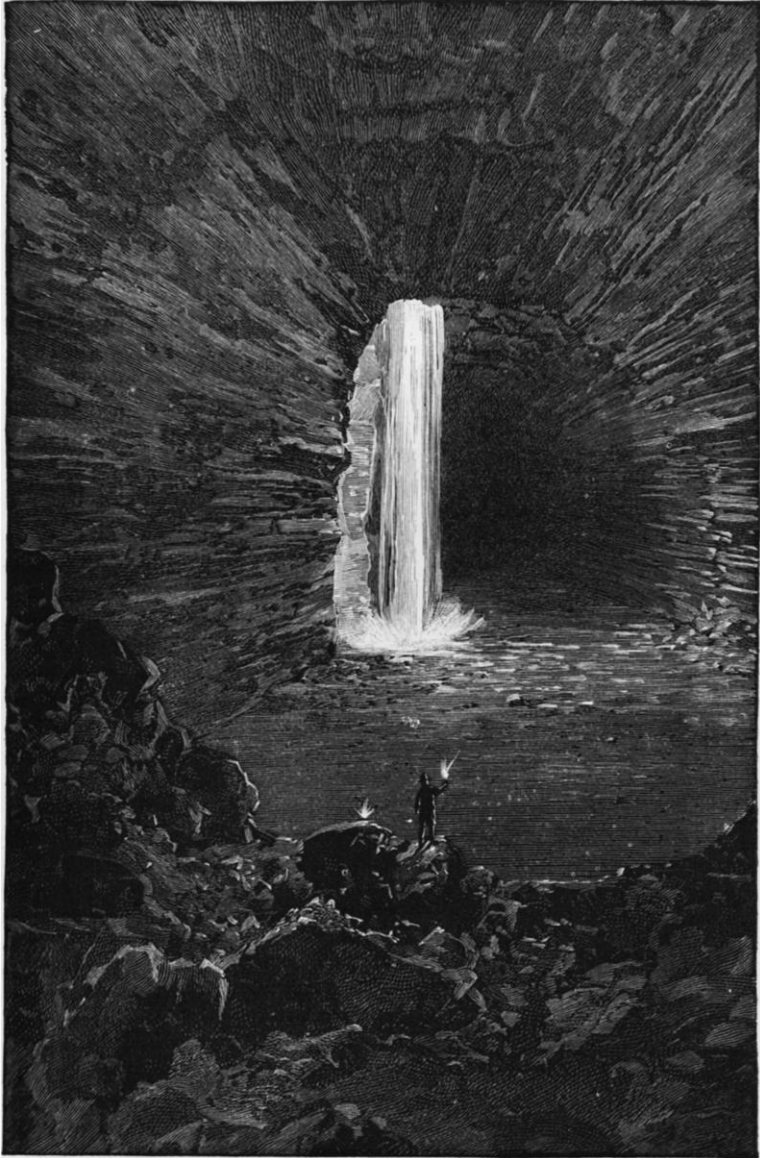
IV.—OTHER RESEARCHES IN IRELAND.

My other underground explorations in Ireland were only interesting from a geological point of view, and were fully reported in my last book. At Cong I found the celebrated Pigeon's hole was not worth its reputation, and I could not discover the subterranean river between Lough Mask and Lough Corrib, though descending in a few not very deep, reputed unfathomable, abysses. The underground rivers of Galway and Clare (at Gort, the Tomeens near Tulla, etc.) did not prove so magnificent as Marble Arch and Arch cave. Theoretically, however, I gathered there much useful information, especially in the existence of really unfinished valleys, where subterranean rivers have not yet wholly destroyed their cavernous prisons. I think I must notice that, quite near the little town of Gort, at $1\frac{1}{2}$ mile east of Kiltartan, a phenomenon is to be seen which is perhaps unique in the physical geography of the Earth; at least, I have never seen its equivalent. In its downward course from the hamlet and the mill of Ballylee (a ruined castle), the river, which bears the six successive names of Boleynneendorish, Ballycahan, Annagh, Turra, Streamstown, and Ballylee, forks suddenly in two arms; opposite each other, at an angle of 180° , these two arms run towards the two opposite extremities of the valley, and sink both—that of the north-east (Pollaleen, altitude 40 feet) after 800 feet of course, that of the south-west (Pollanoween, double, altitude 32 feet) after 1550 feet. The two holes into which these rivers disappear are impenetrable, as are all those of Gort. But the maps do not indicate at all this double current going in contrary directions; I have not seen it mentioned in any work, and I was quite surprised to discover, on the spot itself, this unusual division of waters, nearly on the threshold of two subterranean disappearances, which go no one knows where.

Here I find opportunity to say a word about the *turloughs* (or blind loughs) and the *sluggas* or *sluggys*.

The *sluggas* are simply the light-holes of a sinking in of the ground. These holes must not be mistaken for swallow-holes, like those into which the river

Beagh disappears near Gort, nor for real abysses (pot-holes or pipes) like Noon's hole (see above).



THE INTERIOR OF GAPING GHYLL, IN YORKSHIRE.
(Lent by the French Alpine Club.)

The *turloughs*, or lakes with changeable water-level, alternatively fill and empty themselves by the bottom, according to the oscillations of the swelling or

the decrease of the waters; they are simply the overflowing of the subterranean channels which drain the calcareous ground through its fissures. They repeat here exactly what takes place in the famous lake of Zirknitz, in Carniole (see 'Les Abîmes,' p. 458), of which the irregular ebbing and flowing were so long unexplained.

The chief causes of the multiplicity of these lakes, and the frequency of the phenomena in Ireland, are the slight altitude of the ground and the feeble slope of the subterranean waters which ensues. If the island rose only 300 feet, the drainage would be considerably accelerated, and by degrees would be formed, thanks to the recrudescence of the erosion, more important caverns and more uninterrupted valleys. The flatness of the country has not permitted the trickling down and the infiltration of the waters to do their work as deeply and as completely as, for instance, in the regions of the Causses, the Jura, and the Karst. That is why there are in Ireland so many lakes without any apparent overflow channel, and of which the subterranean issues are unknown, going out, probably, into the sea; this is certain, at least, for some of them which are rather near the coasts, and on the level of which the tide has a visible influence (see Kinahan, 'Valleys, Fissures,' etc., p. 151; 'Les Abîmes,' p. 530).

I have found that the famous Mitchelstown cave (county Tipperary), though one of the largest of great Britain ($1\frac{1}{4}$ mile extent), is certainly much inferior in beauty to the best Austrian and French caves, such as Adelsberg and Dargilan.

To conclude, for Ireland, very much speleological work of all kind remains to be done in the "Green Isle."

V.—THE CAVES OF THE PEAK DISTRICT, DERBYSHIRE.

Peak cavern, just behind the village of Castleton (Derbyshire), is perhaps the most popular in England, and numerous tourists visit it daily. The entrance part alone is worthy of admiration. It is a subterranean river which has made this monumental porch; but it no longer utilizes it, except for the surplus waters in moments of inundation, for its former strength has much decreased, and it bursts out to-day at three points, towards the descent of the river and on an inferior level. The interior of Peak cavern does not possess one single fine concretion. But behind the larger rooms, which are occupied by water only after floods, the subterranean river can be followed side by side in a gallery of 1000 feet; the stream runs noisily along between clay banks. In the vault are transverse diaclasses widening out into spindles, as in Marble Arch, Arch cave, etc.; three of them are large fissures of infiltration. The last of these vertical crevices is an enormous abyss (swallow-hole), one of those upward fissures that the miners of the country call "rakes;" it is from 18 to 30 feet wide, and inclines from 75° to 80° towards the horizon. It is an unfinished abyss; that is to say, it is a crack that erosion has not enlarged up to the surface of the earth, for its orifice has not been found above. It is very elevated, although it has not, probably, the 300 feet in height that is attributed to it; if it had, it would pierce the surface of the earth, which, according to the superposition of the 6-inch map and of my own subterranean mapping, must be in this spot about 100 yards above the level of the interior river. This gulf closed above, called Victoria cave, discovered in 1842, enters into the category of swallow-holes grafted laterally on subterranean rivers, such as Rabanel, the Combettes, the Mas Raynal,* and the larger dome of Padirac,† in France.

* See 'Les Abîmes,' pp. 143, 172, 325.

† See *Comptes Rendus Acad. des Sci.*, October 21, 1895, and *La Nature*, October 16, 1895.

As with all the vertical clefts in the vaults of caverns, it would be well to ascend the interior of this one, in order to find out if it be not an issue to one or several storeys of other grottoes.

Just at the foot of Victoria cave, a small streamlet comes out of a very short gallery (see plan); its course is stopped above, after a few yards, by a pond of water. The temperature of this affluent I found to be 46.5° Fahr. It is very probable that it comes from the second grotto of Castleton, the so-called Speedwell mine. Afterwards the gallery of the principal stream in Peak cavern turns abruptly at right angle towards the south-east; at the end of 90 feet the path is cut off by water 3 feet deep. Wading through it 20 yards, I ascertained that the stream came from under a siphon, and that there is no prolongation, *free for man*, towards the Perryfoot swallow-hole. But it is, nevertheless, quite certain that all the swallow-holes in the great fault of Derbyshire, in the tableland north-west from Castleton, duly run their waters through these caves.

The Speedwell and Blue John mines are particularly curious for their relations with lead ore; but on this specially geological subject I have given a fuller account in my book. Here I will only say that they led to huge interior abysses, similar to Victoria cave in Peak cavern, and draining also the infiltration waters.

Another famous grotto in the district, Bagshaw cave, at Bradwell, was discovered accidentally in 1806 by four miners, who were searching for lead. In it there exists no great hall, and the width and height nowhere exceed 18 feet. The passage through it is difficult; but it must be admitted that, from a hydrological point of view, the cave of Bagshaw is also most interesting. It is composed of three parallel galleries, hollowed out on three different levels, but not on the same vertical plan, and, nevertheless, communicating with each other. The third is at this very time traversed by a subterranean river, and does not appear to be accessible to man. The middle gallery, or principal one, is the characteristic bed of an ancient subterranean river, now dried up. There it is necessary to drag one's self along flat on the ground, and to cross over a pond of water to reach a bifurcation, from whence can be heard the roaring of a torrent, which is very painfully reached. The subterranean river (altitude 606 feet) comes out of a vault nearly on a level with the water; it runs from south to north for the length of 15 or 18 feet, occupying all the width of the gallery, and is then engulfed, after rushing through the stones under another vault 2½ feet high and 3 feet wide. A boat could not pass there on account of the stones, and the strength of the current prevented my risking to go on foot. The direction is that of Bradwell, towards the north-east. There is no notice of the waterfall in guide-books. Unless the river were dried up, I consider it impossible to go farther than I have been myself. The extent of the cave of Bagshaw must, then, be limited to the half-mile that I went over myself, and to the gallery of the Dungeon; that is to say, from three-quarters to one mile in all. Such as it is, Bagshaw cave is one of the longest in England. In a straight line, the point where I met the subterranean river is half a mile from the entrance, and half a mile* from a powerful and impenetrable spring, which rushes out in the village of Bradwell itself, between 580 and 590 feet of altitude, and from 15 to 30 feet lower than the ground of the cave. It is really the torrent of Bagshaw cave that feeds the source of Bradwell, and if ever the latter dries up, they will know where to go to look for it. As for its origin, I

* It is only in adding to the accessible length the unknown and impracticable passages, and even in supposing windings that would double its length, that we arrive at the number 2 miles, which until now has been considered as the extent of the cave of Bagshaw (Baddeley, 'Guide for the Peak District').

can conjecture nothing about it, except that it surely comes from the draining of the limestone tableland towards Tideswell.

VI.—CAVES OF YORKSHIRE. GAPING GHYLL.

Long ago, Prof. Phillips, Prof. Boyd-Dawkins, Messrs. Marr, Dakyns, Tidde-
mann, etc., have drawn attention to the caves and pot-holes of Ingleborough and
surrounding mountains of Yorkshire. The two principal pot-holes of Ingleborough
are Allum Pot and Gaping Ghyll; the last one engulfs the large stream of Fell Beck.
Allum Pot, 300 feet deep (198 feet of which are perpendicular), was first visited in
1847 by Messrs. Birkbeck and Metcalfe, afterwards by Prof. Boyd-Dawkins and
other parties.* Of the second (altitude 1310 feet), nobody, until 1896, had been
able to reach the bottom. Prof. Hughes had only measured it with a plumb-line
in 1872, and had found a depth of 300 perpendicular feet. On August 1, 1895,
thanks to the obliging help of Mr. Farrer, who had got Fell Beck partly turned
aside, I was able to accomplish the first descent of Gaping Ghyll, and to find out
that this hole is, above all, an abyss of erosion formed from top to bottom by the
widening out of a diacalse. The vertical cascade of 300 feet, which falls into it in a
single jet, and the volume of which is enormous after storms or the melting of the
snow, proves that the natural chimneys of the same form must have had an identical
origin, even when we find them dried up and much deeper, as those of Rabanel in
the Hérault, and of Jean-Nouveau in Vaucluse.† Gaping Ghyll is a swallow-hole
which has not ceased to work as a perennial swallow-hole.

At a depth of 210 feet, its large pipe, from 13 to 29 feet in diameter, opens in
the vault of an immense subterranean hall, 480 feet long, from 70 to 110 feet
wide, and from 80 to 100 feet high. The ground (altitude, 300 metres), formed
of gravel and round pebbles, is remarkably flat. The surface is about 4500 square
yards. It is the work of the waters, which, stopped in their descent by the
impermeable sub-stratum of the silurian slates, have, by widening the joints of
stratification and the diacalases, excavated this great reservoir of more than 100,000
cubic yards of capacity. At its two extremities, I found the cave obstructed by
such heaps of stone that I was not able, having gone down quite alone, to remove
them. But in 1896 the large party of MM. Calvert, Gray, Booth, Green, Cuttriss,
Slingsby, etc., made several descents in Gaping Ghyll, and succeeded in discovering
more than half a mile of galleries behind the heaps of stones. Their researches are
not finished, and will be continued. But it is now ascertained that the stream comes
out 140 feet lower down, and about three-quarters of a mile farther on (as the crow
flies), through the grotto of Ingleborough (altitude 825 feet). Since 1839 they have
penetrated for 2000 feet into the turning gallery which this grotto forms, and they
have been stopped by the lowering of the vaulting to the level of the water. In
1896 Messrs. Calvert, Gray, etc., found a new gallery in Ingleborough cave, and
now but a little part of the subterranean river remains unknown.‡

I was also much interested, in the north-west of Ingleton, with the stream of
Doe or Dale Beck, whose capricious course I carefully studied, marking many new
observations, especially on the famous Weathercote cave, which I have accurately
mapped and explained in my book (chap. xxv.).

Lots of caves, abysses, and swallow-holes are still to be scientifically explored
round Ingleborough, as well as in Ireland, Derbyshire, and Mendip hills. Many

* See Boyd-Dawkins, 'Cave Hunting,' in 8vo, p. 41. London. 1874.

† See *Comptes Rendus de l'Académie des Sciences*, October 14, 1889; and 'Les Abîmes.'

‡ For a more detailed account of my descent in Gaping Ghyll, see *Alpine Journal*,
May, 1896, and chaps. xxiii. and xxiv. of 'Irlande et caverns anglaises.'

months, or even years, and many men must be employed for this work. I could only, almost alone and with limited time, disclose very few of the remaining mysteries of British caves, but I trust that my too short investigations, specially those in Marble Arch and Gaping Ghyll, have succeeded in proving that speleology is quite likely to effect future discoveries in Great Britain, just as it has done in Austria and France during ten years.

This was my principal aim in the above very rapidly described journey, and I wish that cave-hunting may be now energetically resumed there by English investigators, to the great benefit of human knowledge and curiosity.

VII.—THE CUEVA DEL DRACH, IN MAJORCA (SPAIN).

In 1896 I turned my attention to another part of Europe, the Spanish Majorca, in the Balearic islands, where a natural marvel was said to be incompletely known



LAGO MIRAMAR, MAJORCA.

—I mean the Cueva del Drach, that is, the Dragon's cave, on the eastern shore of the island, about 8 miles east from the town of Manacor. Since the year 1878 only this cave had been visited, after two gentlemen of Barcelona, with an inefficient guide, had tried to thoroughly explore the cueva—had, in fact, discovered some new rooms, but succeeded principally in losing themselves during a whole day, and in getting half dead from hunger and fright. Actually about half a mile of galleries were known in this cave, adorned with the most beautiful stalactites and stalagmites, and with wonderful little lakes, which had stopped any further investigation (see Vuillier, 'Les îles oubliées').

Several years ago I was invited by His Imperial Highness, the Archduke Louis Salvator of Austria, the learned and generous owner of the Miramar estates near Palma, to work out the exploration of Dragon's cave. It was only in September, 1896, that I at length was able to carry this scheme into execution. But, thanks

to the facilities granted by his Highness and with my folding canvas boats, I was pleased and happy in carrying out at Cueva del Drach one of my most satisfactory subterranean investigations.

I found one of the largest underground lakes known in the world, which I named Lago Miramar, 570 feet long, 100 to 125 feet wide, 15 to 30 feet deep. The accompanying photographic illustration (taken with magnesium light in ten minutes) represents a corner of this lake, and shows better than any long description what a marvel is this mysterious and so long unknown pond, black as night, but sparkling under magnesium wire with all the splendours of the diamond. The vaults and walls are covered with millions of sharp and thin stalactite needles; the roof is supported at intervals by stalagmitic columns resembling the Egyptian or Indian pillars of Karnac or Kailaça. All these concretions are pure white like ermine, without any spot of clay. It presents the greatest contrast to Gaping Ghyll, being a masterpiece of beauty, just as the Yorkshire abyss is of frightful magnitude, both stupefying to human eyes.

And Dragon's cave ($1\frac{1}{4}$ mile long) is not only a picturesque curiosity; all its large and small lakes are on the same level as the sea, with which they communicate through narrow clefts; they are half salt and fresh water, and a hydrological marvel, of which I will give elsewhere a fuller scientific account.* For geographers I only say here that this cavern is a mere sea-cave formed by the Mediterranean waves, and not by an underground river, but a sea-cave of unusual size, unparalleled elsewhere, at least on European shores. It is said that California, Cuba, and Jamaica possess also grand caves of the same kind. When and by whom will they be scientifically explored?

ON THE DISTRIBUTION OF TOWNS AND VILLAGES IN ENGLAND.

By GEO. G. CHISHOLM, M.A., B.Sc.

II. HISTORICAL ASPECTS OF THE QUESTION.†

IN examining this subject from the historical point of view, we begin, of course, with the Roman towns. In pre-Roman times there were no towns. In the state of civilization reached by the Britons, there could be no use for them. So far as Cæsar had the opportunity of observing, there was little cultivation in Britain in his time

* *Comptes Rendus de l'Académie des Sciences* 14 Juin 1897, et *Annuaire du club alpine français*, 1896 (in press).

† Owing to a misunderstanding about the proof in the first of these papers (January, 1897), several misprints were left uncorrected, and should be corrected as follows:—

- Page 79, line 3. For Barstone read Carstone.
 „ 80, „ 3. For deepened read cheapened.
 „ 80, „ 17. For Buckmere read Cuckmere.
 „ 80, „ 25. For Steywing read Steyning.
 „ 81, note. For Gonglis read Gough's.
 „ 82, line 2. For Whilton read Whitton.
 „ 82, „ 9. For South read North.
 „ 86, „ 1. For billock read bullock.