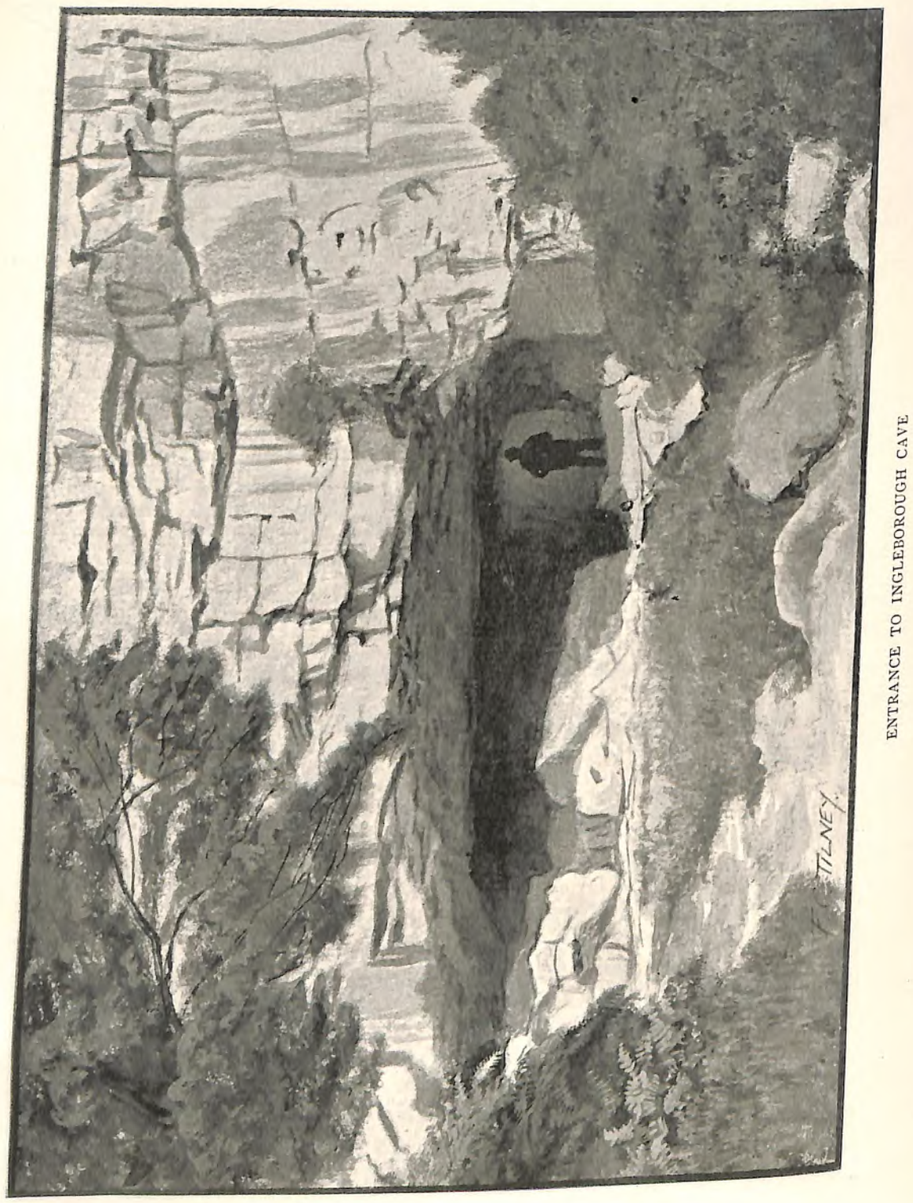


ENTRANCE TO INGLEBOROUGH CAVE

only one that is as Nature has fashioned it. Its iron gates have been its salvation. The spoiler has been barred out, and there is none of man's handiwork in the Cave, except in the footpaths and foot-bridges that make its galleries accessible. "'Tis Nature all, and all delight."

The Formation of the Cave.

And here we may ask the question—How was the Cave formed and fashioned? With some people the prompt answer would be—It has been what it is from the first. Others would say that these passages and galleries are rents and gaps that were made by those mighty upheavals that have given us our lofty hills and scars. But a walk through this Cave, an inspection of its floor and roof, will show us that this cannot have been the case. It was not violent, convulsive forces, but agencies slow and mainly silent, acting through long ages, that formed and furnished this Cave.

The district abounds with swallow-holes, pots, caves and gills. These may be seen in all stages of development. They have all been formed by one agent, and that agent is *water*. Swallow-hole, pot, cave and gill are its work. But its agency is twofold—*dynamic* and *chemical*.

1. When water sinks into the ground it finds the fissures of the rock. If a stream is flowing through some fissure it carries along with it sand, grit, small stones; and thus slowly rubs away the rock-surfaces, and enlarges its own channel.

2. But when the water that flows down our hills and moors finds its way through the limestone-

fissures it has another and more important effect. The rain as it falls through the atmosphere, the surface-water as it flows over heath and bog, takes up carbonic acid. The limestone is composed largely of pure carbonate. Water containing carbonic acid acts as a solvent on the stone. The drip from the roof of every limestone-cave is charged with carbonate of lime. It is limestone in solution. It is this that makes every limestone-spring "hard;" that consumes such quantities of soap when this water is used for washing-purposes; that forms the coating, sometimes half an inch thick, on the inner surface of the household kettle. All this is dissolved limestone. And when we think of the "hardness" of all our limestone-springs, of the quantity of carbonate—dissolved limestone—that is being carried into river and sea, we may form some idea as to how the hills are in this way being tunnelled and honeycombed.

We have, then, only to think of this two-fold agency of water—its dynamic and chemical action—to see how the pots and caves have been formed. On all hands we may find illustrations of this. We have spoken of swallow-holes, pots, caves and gills. These are the several stages in the wonderful process. A swallow-hole is a young pot; a cave, when its roof collapses, becomes a gill.

Swallow-holes. Let us think of some little hollow in which water collects during every fall of rain. This may be over some limestone-fissure into which the water sinks. In course of time this little hollow may be worked out into a swallow-hole, which is usually funnel-shaped. This is a pot in the first

of the trees attain quite stately proportions. The rather backward season will necessitate members restricting their observations to the more fertile beck-courses and the sylvan glades of Trow Gill, ascending towards the chasm of Gaping Gill and the southern and eastern slopes of Ingleborough. The Geologists will visit the Silurian tract in the vicinity of Austwick and the classic group of erratics at Norber. Wharfe, and Feizor, if not too far a-field, will also amply repay botanizing. The limestone abounds with caves, pot-holes, and underground streams containing a variety of life, which will repay investigation. Special facilities have been obtained for the examination of the great Ingleborough Cave, which is traversable for a distance of about half-a-mile. Though originally intended to examine the gritstone tracts of Bolland Knotts, the state of the season will hardly justify members confining themselves to that locality. Those, however, who are passing the week-end at Clapham, will enjoy a ramble over the moors to the summit of the Bolland Road (1,400 ft.), from which there is a wide and interesting panorama.

ROUTES.—All parties will leave Clapham Station at 10-30 a.m.

I.—Mr. Reginald J. Farrer will conduct the general body of naturalists in the immediate vicinity of Clapham.

II.—Geologists will, under the leadership of Mr. Benj. Holgate, F.G.S., arrive at the cave at 11-15 a.m. (Conveyances for those who order); the cave will be left at about 12-40; the stile at head of valley above Trow Ghyll, 1-40; to Gaping Ghyll Hole and back to the stile, 2-40; the party will return towards the foot of Trow Ghyll. These hours will afford plenty of time for the work to be done, and if any time is gained, members wishing to see the Norber Erratics may cross over there, and return to the 'Flying Horse Shoe' by 5 p.m.; 2¾ hours at least are required to proceed from Trow Ghyll to Norber and back to Clapham.

INGLEBOROUGH CAVE.—A reduced charge of 8d. each for admission will be made to Members and Associates showing their cards.

CONVEYANCES.—From Station to village, conveyances will be provided, fare 6d., for members ordering in advance from the Flying Horse Shoe Inn.

GEOLOGY OF CLAPHAM.—Mr. B. Holgate, F.G.S., writes that the objects of interest in the immediate neighbourhood are: To the north and west, the Clapham Beck, with its waterfalls, rapids, and underground stream from Gaping Ghyll Hole, the Cave, Trow Ghyll, the dry valley both below and above it, the remains of Ghylls which were in their time similar to Gaping Ghyll, which now draws off the water that formerly went through them, the valleys along which the streams ran to feed these Ghylls, and the Gaping Ghyll Hole. The cave is of little interest to the archæologist, no remains either of flint implements or bones having been found in it, but it is of surpassing interest to the physical geologist and to those who wish to study the formation of different forms of stalactites and stalagmites, for here we see the pipe stalactite which does not drop and is hollow, the stalactites enlarged from the outside and in length at the same time; the stalagmites, some with the corresponding stalactite above them and some without; here we also clearly see the formation of tufa. Until 1837 the cave was only open for about eighty yards, further access being stopped by two lakes of water at different levels, one behind the other. The way in which they slowly built up their own barrier and raised their edges higher and higher, so making the water deeper, may be clearly seen; also the way in which tufa collected about the pendant stalactites show how this class of lime is formed. The remains of an ancient pebbly conglomerate show the great amount of wear to which the cave has been subjected since that period when this conglomerate formed the pebbly floor. The careful manner in which the cave has been preserved bring out in the best form the above facts, and Mr. H. Harrison, the guide, takes the greatest interest and makes it his study. Leaving the cave and proceeding up Trow Ghyll, we have evidence of the ancient bed of the beck, now no longer in action. At the head of Trow Ghyll Nick the marks still remain of water as it seethed in a turbulent stream from side to side in its rapid and broken course. At the head of this dry valley we have two deep ghylls, now partially filled, probably by huge blocks of stone blocking the upper part of them. These are similar to the Gaping Ghyll Hole, have been fed by the same beck; the dry water-courses are still visible which fed them, and which at that time passed over Gaping Ghyll Hole without falling into it. Care must be taken in approaching Gaping Ghyll, as it is unprotected. To the east of Clapham,

at Norber, we have the well known and splendid example of huge blocks of black silurian rock having been torn by glaciers from their parent bed in the Crummock Valley and distributed in large numbers over the white limestone at the mouth of the valley. Some of these blocks have been borne round to the west of the southern end, at least 250 feet higher than the place from which they were torn.

BOTANY.—In Davis & Lees' 'West Yorkshire,' 1878, pp. 266 and 267, are given two lists, one of 94 plants from near Clapham, Austwick, Feizor, Lawkland, etc., the other of 46 found between Clapham and Bowland Knotts. We are indebted for botanical notes to Mr. Reginald J. Farrer, Mr. Lister Rotheray, Mr. J. Beanland, and Mr. W. West, F.L.S.

Flowering Plants.—There are many very interesting plants to be found, including *Anagallis tenella* (damp field near station), *Trollius and Epipactis latifolia* (woods fringing the Wening), *Ophrys muscifera, Primula farinosa, Gymnadenia, Campanula latifolia, Carduus heterophyllus, Parnassia, Habenaria chlorantha, Viola hirta, Rubus saxatilis, Gentiana amarella, Juniperus, Polemonium* (rare), *Rosa villosa, Antennaria dioica, Convallaria maialis, Saxifraga hypnoides*, various *Droseræ, Chrysosplenium oppositifolium, Pinguicula, Vaccinium oxycoccos, Sedum rhodiola, Arenaria verna, A. gothica, Viola lutea, Sax. aizoides, Rubus chamæmorus, Aquilegia vulgaris*, etc., and various ferns occur.

Mosses and Hepatics.—Mr. Lister Rotheray notes that numerous mosses are on record, including *Sphagnum tenellum, Rhabdoweissia fugax, Campylopus atrovirens, Distichium capillaceum, Barbula recurvifolia, B. tortuosa, Encalypta ciliata, Racomitrium heterostichum, R. sudeticum, Orthotsichum nudum, O. rupestre, O. stramineum, O. crispum, Zygodon mougeotii, Aulacomnium androgynum, Bryum alpinum, B. elongatum, B. julaceum, Cinclidium stygium, Bartramia calcarea, B. halleriana, Anomodon viticulosus, Hypnum plumosum, H. pumilum, H. swartzii, H. filicinum, H. kneiffii, H. scorpioides, Neckera crispa*, etc., and of Hepatics, *Marchantia polymorpha, Preissia commutata, Pegatella conica, Asterella hemispherica, Lunularia vulgaris, Lejeunea echinata, Porella platyphylla, P. rivularis, Lepidozia reptans, Chilosyphus polyanthus, Trichocolea tomentella*, and *Scapania nemorosa*, etc.

Fungi.—No records. **Lichens.**—*Collema ceranoides.* Mr. W. West, F.L.S., notes the following: *Collema furvum, Leptogium lacerum, Cetraria islandica, Peltigera polydactyla, Solorina saccata, Parmelia caperata, P. tiliacea, P. tenella, Umbilicaria polyphylla, Squamaria saxicola, Placodium murorum, P. candicans, Lecanora parella, L. rupestris, L. calcarea, Pertusaria fallax, P. globulifera, Thelotrema lepadinum, Lecidea lurida, L. sanguinaria, L. canescens, L. cupularis, L. grossa, L. vesicularis, L. geographica, Opegrapha varia, Normandina latevirens, Endocarpa rufescens, Verrucaria gemmata, V. calciseda, V. nitida*, etc.

Algæ.—Mr. W. West, F.L.S., has collected many species within easy walking distance of Clapham, including *Lemanea fluviatilis, Spirotænia condensata, Mesotænium macrococcum, M. endlicherianum, Penium navicula, P. polymorphum, Roya obtusa, Closterium cornu, C. costatum, C. directum, C. juncidum, C. kützingii, C. parvulum, C. pseudodianæ, C. subulatum, C. venus, Pleurotænium Ehrenbergii, Tetmemorus brebissonii, Euastrum affine, E. ansatum, E. didelta, E. elegans, E. notabile, E. oblongum, Micrasterias americana, M. rotata, Xanthidium aculeatum, X. antilopæum, Cosmarium blyttii, C. bioculatum, C. brebissonii, C. crenulatum, C. ornatum, C. punctulatum, Spondylosium secedens, S. inflexum*, etc.

VERTEBRATE ZOOLOGY.—Mr. J. Walling Handby, of Austwick, has paid considerable attention to the vertebrates of the neighbourhood, and furnishes much valuable information. We are also indebted for notes to Mr. H. Harrison, Mr. H. B. Booth, Mr. J. Beanland, and Mr. R. B. Cragg.

Mammalia.—The records include the Fox, Otter, Mole, Stoat, Weasel, Hedgehog, Badger, Squirrel, etc., and the Polecat formerly.

Birds.—The moorland and crag species are to be found, and also some woodland forms—The Peregrine, Merlin, Raven, Ring Ouzel, an extensive colony of Sand Martins in sand quarries about a mile from Clapham, Golden Plover, Dunlin, Sandpiper, Dipper, Curlew, Nightjar, Heron, Redstart, Grey and Yellow Wagtail, Twite, Grouse, Land Rail, Moorhen, Snipe, Lapwing, Longeared Owl, Shorteared Owl, Tawny Owl, Great, Blue and Longtailed Tits, Whitethroat, Blackcap, Garden Warbler, Willow-wren, Wood-wren, Chiffchaff, Pipits, Spotted Flycatcher, etc. The Buzzard is now extinct.

FIG 2.

Reptiles.—The date is too early, unless the day be very warm and sunny. The Lizard occurs, the Blindworm is fairly numerous, and no doubt the Viper occurs, though not on record.

Fishes.—The Common Trout, Bullhead, and Eel abound, while the Perch occurs in Low Pond, Clapham, and Tench in a quarry on Newby Moor (H. Harrison).

CONCHOLOGY.—Conchologists will find the neighbourhood of Clapham a rich field for investigation, the characteristic species of the Scar-limestone tract, such as *Balea*, *Clausilia dubia*, *Helix rupestris*, etc., being plentiful. Mr. Hugh Richardson's list of mollusca of the Clapham district (J. of Conch., Ap., 1886, p.p. 60-61) includes 41 species, of which *Helix lamellata*, *Pupa muscorum*, *Azeca*, were found in Mr Farrer's grounds and in Clapham Woods; a number of freshwater species in a fossil state are to be found in the Lake Marl of Crummockdale. Mr. Beanland finds in a field to the right of Clapham Station *Succinea putris* and *Limnæa truncatula*, *Cl. laminata*, and the various species of *Pupa* and *Vertigo* in moss all the way from the village to the cave.

ENTOMOLOGY.—The Insect-fauna of the district seems to be a blank, there being no district records, except the following:—

Lepidoptera.—*Larentia multistrigaria* (J. Beanland).

Coleoptera.—Mr. J. W. Carter notes that the following species have been taken near Clapham and Ingleborough: *Carabus arvensis*, *Notiophilus aquaticus*, *N. palustris*, *Nebria gyllenhalii*, abundant on Ingleborough summit; *Clivina fossor*, *Patrobus assimilis*, abundant on the summit; *Pterostichus æthiops*, *Calathus melanocephalus* and its var. *nubigena*, *Byrrhus fasciatus*, *Silpha atrata*, and other commoner species. The rare *Carabus glabratus*, discovered in England and on Inglehorough by Sir W. J. Hooker, should be looked for, as it has probably not been observed since its discovery a great number of years ago. *Miscodera arctica* and *Pterostichus vitreus*, both of which are alpine and sub-alpine species and occur in some other parts of Yorkshire, should be looked for, the former I have always found under *very small pieces* of stone.

NATURAL HISTORY NEAR BOWLAND KNOTTS.—Mr. J. F. Pickard writes that not many plants found near Bowland Knotts are likely to bloom at this time of the year, though *Meconopsis cambrica* is said to grow in some abundance near the Knotts and Tosside, but he has not found it himself. *Andromeda polifolia* is common in the marshes on the Bowland side of the Knotts, together with *Vaccinium vitis-idæa* and *V. oxycoccos*. Between Dale Head and the Knotts is a large moss, where grows *Menyanthes*, *Drosera rotundifolia*, and probably *D. longifolia*; on the roadside near is a quantity of *Veronica scutellata*. Both oak and beech fern are found in the neighbourhood, and on the Knotts *Lycopodium selago* and *L. clavatum* are said to grow. The **Birds** are Golden Plover, Raven, Merlin, Kestrel, Snipe, Rock Dove, Short-eared Owl, Stonechat, Wheatear, Ring Ousel, Cuckoo, Curlew, etc. The Fox is occasionally shot but is exceedingly rare in Bowland.

GEOLOGY OF BOWLAND KNOTTS.—It had been originally intended to make a special feature of Bowland Knotts, but found somewhat too early in the year for general work. A long and most interesting note by Mr. R. H. Tiddeman, M.A., F.G.S., sent for this circular, has had to be omitted for want of space, but is in type, and copies will be distributed at the excursion.

PHOTOGRAPHERS.—It is hoped that photographers present will consult the Secretary, with a view of taking views that may be reproduced to illustrate the report of the excursion.

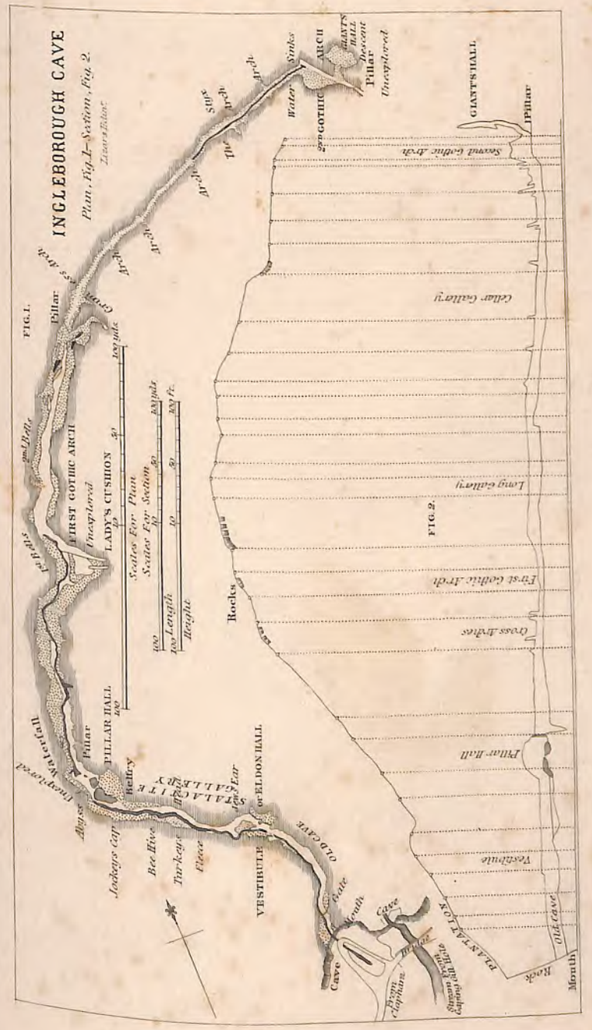
SECTIONAL MINUTE BOOKS FOR 1897 AND PREVIOUS YEARS.—Several are missing; will Sectional Officers or Members assist the Secretary to recover them, so that proper accounts may be published of last year's excursions.

PROGRAMME OF MEETINGS.—

5-0 p.m.—Meat Tea, 2/- each
6-0 p.m.—Sectional Meetings
6-15 p.m.—General Meeting

} All at the Flying Horse Shoe Inn, close to Clapham Station.

Train leaves Clapham for the South at 6-55 p.m.



ON CLAPHAM BECK

stage of its manufacture. It may be small or large, a yard in diameter, or as wide as the mouth of Gaping Gill, which was once a swallow-hole. In many places a *series* of swallow-holes may be seen lying along the course of some occasional stream. These are as surely linked with some underground water-course as is a series of mole-hills with the animal's tunnelled passages in the soil. The action of the water is always widening the throat of the swallow-hole, and also the underground channel. A swallow-hole may be directly over a cavern. The roof is slowly eroded by the acidulated water until it falls in, and the cavern thus becomes a pot. And time only is needed to convert the series of swallow-holes into a series of pots, and the underground channels into caves.

The best illustration of this that we have seen is on Fountains Fell. This lies away from the beaten routes, but the rough slopes of Fountains have much to teach us. In the case we now refer to, a gill runs down the west slope of the Fell. At one point in its path the stream falls into a deep chasm. It has thence an underground course, and re-appears at a considerable distance down the hill. This first chasm is a fully developed pot, and a fine one. A little way from this there is another in a partial state of development. Near its mouth there are two natural drains which in wet seasons discharge their water into the pot; and passing through this pot the water reaches the same underground course. It is evident that this pot was once a cavern, as the *débris* of the roof may be seen at the bottom. There is a third pot in a more elementary state not many yards below. Time will

convert this series of allied pots, with their connective tunnels, into one long gill.

The Furniture of the Cave.

A cave that has been thus formed by the streams may, in course of time, be forsaken by them. The water may work out for itself fresh channels, may find lower levels, and we may then have a "dry" cave. And now the same chemical action of the water that had so much to do in the formation of the cave is also the agency that beautifies and adorns it. A limestone-cave is never really dry. There is always more or less drip. There is also slight evaporation. Professor Boyd Dawkins says that he has found in all the caves that he has examined "a free current of air."* We have only to think of the solution of carbonate as dripping from the roof,—as trickling down the walls,—as bathing with tiny ripples this and that mass of rock,—losing water by evaporation and leaving some of its carbonate behind, to see how Nature garnishes and furnishes these lonely galleries and halls. A little knob of rock is the point on which one drop after another forms and whence it falls; that point becomes the root of a stalactite. The drop strikes the floor, its particles are dispersed over a small area, and the foundation of a stalagmite is laid. The stalactite may be a straight, slight, translucent tube; or of tapering form like an icicle; or may grow long and thick as an elephant's trunk. The stalagmite may be built up into a pillar, or minaret, or dome. Moisture from the upper surface of a rock makes its way in minute rivulets down its face, and here we

*Cave-Hunting, p. 61.

John Birkbeck Jun
with W. Boyd Dawkins. Esqr.

"Observations on the Rate at which Stalagmite is being accumulated in the Ingleborough Cave," by W. Boyd Dawkins, M.A., F.R.S., F.G.S.

The only attempt to measure with accuracy the rate of the accumulation of stalagmite in caverns, in this country, is that made by Mr. James Farrer in the Ingleborough Cave, in the years 1839 and 1845, and published by Professor Phillips in "The Rivers, Mountains, and Sea Coast of Yorkshire," (second edition, 1855, pp, 34-35). The stalagmite of which the measurements were taken is that termed, from its shape, the jockey cap. It rises from a crystalline pavement to a height of about 2½ feet, and is the result of a deposit of carbonate of lime, brought down by a line of drops that fall into a basin at its top, and flow over the general surface. On March 13th, 1872, in company with Mr. John Birkbeck and Mr. Walker, I was enabled by the kindness of Mr. Farrer to take a set of measurements, to be recorded for use in after years.

For the sake of insuring accuracy in future observations, three holes were bored at the base of the stalagmite, and three gauges of brass wire, gilt, inserted, gauge No. 1 in the following table being that on the S.S.E., No. 2 on N.N.E., No. 3 on the W. side. The curvilinear dimensions were taken with fine iron wire, or with a steel measure; and the circumferential around the base along a line marked by the three gauges. The measurements 2, 3, and 4 of the table ware taken on the 15th of March, by Mr. Walker, and their accuracy may be tested by the fact that they coincide exactly with No. 1, which I took two days before.

The lengths of wire, properly labelled, will be deposited in the Manchester Museum, The Owens College, for future observers.

In the following table I have given my own measurements and compared them with those taken by Mr. Farrer.

TABLE OF MEASUREMENTS.

	13th Mar. 1873. Inches.	1839. Inches	30th Oct. 1845. Inches.	Increase since 1839	Increase since 1845	Rate of increase per annum. Inches.
1 Basal circumference at Gauges..	128	118	120	10	8	·2941—·2857
2 Guage No. 1 to Gauge No. 2....	52·625					
3 ,, 2 ,, 3....	35·0					
4 ,, 3 ,, 1....	40·375					
5 Gauge No. 1 to hole in centre of basin at apex....	30					
6 ,, 2 ,, ,, ...	29·5					
7 ,, 3 ,, ,, ...	31·4					
8 Hgt. from Gauge No. 1.....	20·9					
9 ,, ,, 2 minimum	20·4					
10 Maximum.....	29·7					
11 Tape measurement on slope gauge No. 1 to edge of apex..	26·7			5·6		
12 ,, No. 2 ,, ,,	26·6	21·0		4·0	1·0	
13 ,, ,, Maximum ,,	36·0	32·0	35·0		8·25	·2946
14 Roof to apex of Jockey cap	87		95·25			
15 Roof to tip of stalactite			10			
16 Stalactite to apex of Jockey cap.			85·25			

Unfortunately I have been unable to identify the exact spots where the stalagamite was measured by Mr. Farrer, so that the only measurement which affords any trustworthy data for estimating the rate of increase is number 14. With regard to this the only possible ground of error is the erosion of the general surface of the solid limestone, of which the roof is composed, by carbonic acid, since the year 1845, and this is so small as to be practically inappreciable. We have therefore evidence that the jockey's cap is growing at the rate of ·2946 of an inch per annum, and that if the present rate of growth be continued it will finally arrive at the roof in about 295 years. But even this comparatively short lapse of time will probably be diminished by the growth of a pendent stalactite above, that is now being formed in place of that which measured ten inches in 1845, and has since been accidentally destroyed. It is very possible that the jockey cap may be the result not of the continuous but of the intermittent drip of water containing a variable quantity of carbonate of lime, and that, therefore, the present rate of growth is not a measure of its past or future condition. Its possible age in 1845 was estimated by Professor Phillips at 259 years, on the supposition that the grain of carbonate of lime in each pint was deposited. If, however,

it grew at its present rate it may be not more than one hundred years old. All the stalagmites and stalactites in the Ingleborough cave may not date further back than the time of Edward III. if the Jockey cap be taken as a measure of the rate of deposition.

It is evident, from this instance of rapid accumulation, that the value of a layer of stalagmite, in fixing the high antiquity of deposits below it is comparatively little. The layers, for instance, in Kent's Hole, which are generally believed to have demanded a considerable lapse of time, may possibly have been formed at the rate of a quarter of an inch per annum, and the human bones which lie buried under the stalagmite in the cave of Bruniquel are not for that reason to be taken to be of vast antiquity. It may be fairly concluded that the thickness of layers of stalagmite cannot be used as an argument in support of the remote age of the strata below. At the rate of a quarter of an inch per annum 20 feet of stalagmite might be formed in 1000 years.

In Clapham Cave.

INGLEBOROUGH

PECCA TWIN FALLS, INGLETON

Clapham, Yorkshire.

Published by the Skipton Stationery Co.

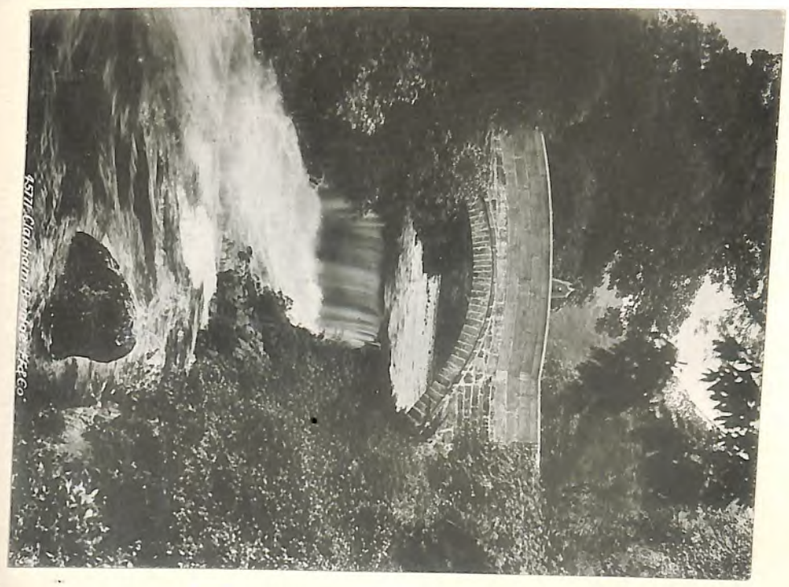
Clapham Village. No. 2.

Published by the Skipton Stationery Co.


INGLEBOROUGH, WITH CRINA BOTTOM.


Clapham, Lower Falls.


Upper Falls, Clapham.



From a photograph by B. E. Ingleby, *Giggleswick School.*

CLAPHAM LAKE.

CAVE ENTRANCE.