G. B. CAVE, CHARTERHOUSE ON MENDIP

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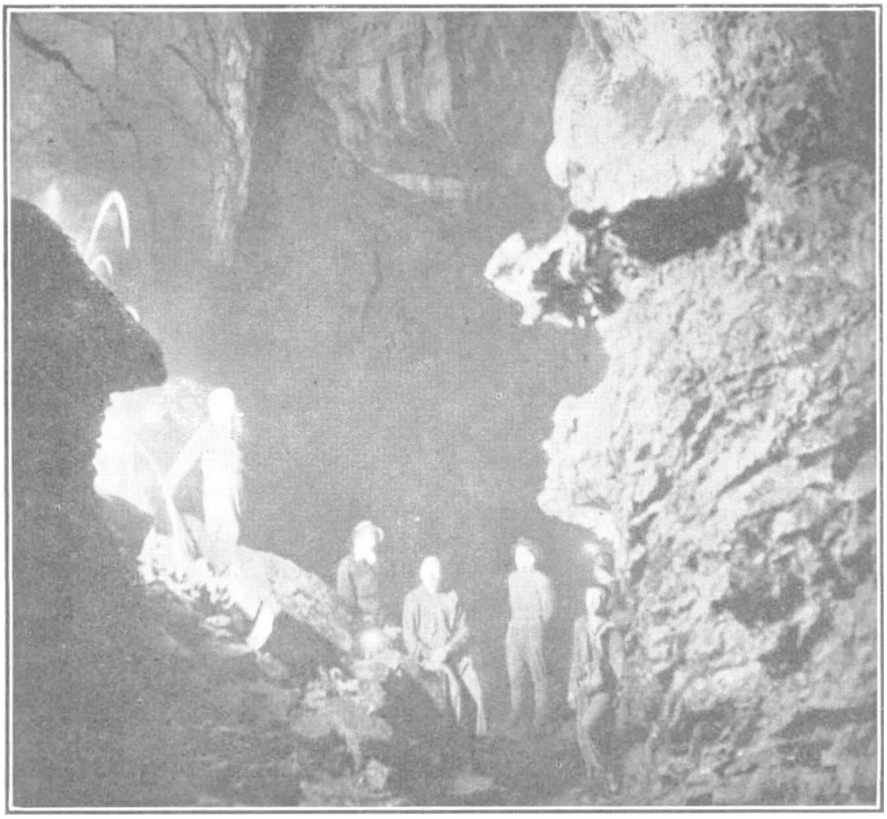
IN these modern times the opportunities for making new geographical discoveries have become very scarce, and for this reason the opening up of a large new cave system, such as G.B. cave, within twelve miles of Bristol, should be of considerable interest to the scientific world.

The range of Mendip Hills in Somersetshire extends from the upper valleys of the Frome and Brue in the east some 23 miles down to the Bristol Channel. It is generally about 6 miles in width, and its south-western face descends to low moors drained by the Axe, and other streams, to Cheddar and Wells. It is with this area that the Spelæological Society of the University of Bristol is concerned.

The Mendips consist principally of carboniferous limestone, but at its highest point, Blackdown, which rises to a height of more than 1,000 ft., the limestone and the limestone shales have been eroded, leaving a cap of Old Red Sandstone. The numerous caves to be found in this district are formed by the action of surface water penetrating the strata at the juncture of the Old Red Sandstone and the limestone.

To the south of Blackdown, the strata dip in the direction of the famous Cheddar Gorge, and on this face there lies a pitted and mine-scarred patch of ground aptly named Gruffy Field. Close by runs the Roman road which once carried Mendip lead to the coast of the Bristol Channel. A small stream runs into this field and disappears at the base of a cliff at the end of a small gorge which it has carved for itself in bygone ages. This stream and neighbouring swallow holes, or swallets, have been investigated by the Society for the past twenty years; most notable of these excavations was that by E. K. Tratman, now professor of dental surgery at King Edward VII College of Medicine, Singapore, who always believed that a large cave system lay beneath the surface at this point.



GENERAL VIEW OF THE MAIN CHAMBER OF G.B. CAVE. THE ROOF OF THIS CAVERN IS 120 FT. ABOVE THE FLOOR-LEVEL AND THE TOTAL LENGTH OF THE GORGE, OF WHICH IT IS THE LARGEST PART, IS 786 FT.

About 100 yards west of the point where the stream now penetrates the rock, there is a dry swallet where it formerly disappeared. At the instigation of F. J. Goddard, who was secretary of the Society at the time, and the co-discoverer of the cave, Dr. C. C. Barker, work was begun in this choked streamway early in 1939. Owing to the small size of the rock fissure, progress in the actual stream bed was found to be very difficult, and another shaft was sunk a few yards away, to a final depth of twenty feet. At the bottom of this hole was revealed a small crack from which

ERRATIC STALACTITES ON ROOF OF 1ST GROTTO, G.B. CAVE

there issued a draught strong enough to extinguish the flame of a candle held in it; this gave us an indication that a cave system lay within reach below. However, it was found impossible to enlarge the crack in the solid rock by normal means, and we resorted to the use of a charge of explosive. This proved most effective, and after the debris had been cleared, it was found just possible to force an entry through it into a small passage.

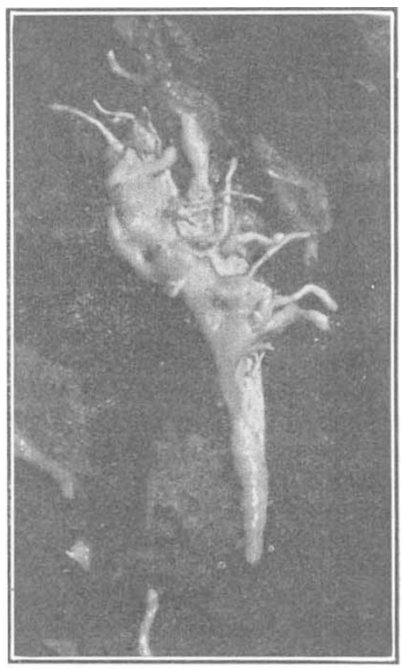
This soon opened up into a gallery leading into a grotto of extraordinary beauty. In this grotto the calcareous formations take on an amazing variety of shapes. Both stalactites and stalagmites branch and twist into fantastic shapes for the formation of which there has as yet been advanced no satisfactory explanation. These erratics have been termed 'helictites', and there are very few caves known where they exist in such profusion as they do in all parts of G.B. Cave. It is interesting to observe that they have not been found elsewhere on Mendip, except for a few examples in a new chamber of East Twin Swallet, in Burrington Coombe, recently opened up by the Society.

The way on from this chamber is up a 10-ft. climb into another grotto rivalling the first in its fairy-like beauty. From this there leads a series of climbs and crawls 300 ft. in length which try the fortitude and tax the agility of even the most hardened caver. They end in an unpleasant water-crawl about 2 ft. high and 18 inches wide, which we have named the Devil's Elbow; emerging from the end of this, one looks down into a large boulder chamber from a height of about 15 ft. The amount of icy water rushing along this passage and over the drop prevented further exploration for some months, but in March 1940 four members were able to fix a rope over the lip and descend into the chamber.

We were delighted to find that a large rift led steeply out of this chamber down over a series of potholes to a narrow slit in the rock. Squeezing through this one by one, we found ourselves in an enormous chamber, so high that the light from our acetylene headlamps would not illuminate the roof. We followed the stream along its floor, over a mass of shattered boulders until we were halted by a drop. The chamber, or, as we have christened it, the 'Gorge', widens out at this point into a cavern about 100 ft. in width and 120 ft. high, and its roof is hung with magnificent formations, which can best be viewed from a gallery which runs high up along one wall. Lining one side of the chamber are hanging tapestries of white stalactite fully 60 ft. high, while large stalagmite bosses, many feet across, are set in the walls; in fact, it is only by using lengths of magnesium ribbon as illumination that the true magnificence of this cave can be appreciated, so huge are its dimensions.

After negotiating the drop, we round that the Gorge gradually narrowed down to end in a small sump chamber, where the stream disappeared underneath the rock in a syphon, or sump. At this point one is 480 ft. below the surface, and the total length of the Gorge is 786 ft., so that as a single continuous chamber it must be one of the largest in Great Britain.

Subsequent exploration revealed a new series of chambers and passages leading from the roof of the main chamber, some of which ascend to within 100 ft. of the surface. These chambers contain



ERRATIC STALACTITE OR HELICTITE FROM 1ST GROTTO, G.B. CAVE

some of the most beautiful formations of all, including some fine erratics four or five feet long, and some curious, slender, apparently windswept stalagmites.

A number of true cave pearls have also been found here, together with a large amount of so-called coral formation, making the cave unrivalled in Mendip both from the point of view of size and beauty.

Owing to its size, and the narrowness and intricacy of its upper passages, the survey and photography of the cave have not been easy. Our work has, in addition, been held up by the salvaging excavation undertaken by members of the Society on the site of our museum, the valuable contents of which were destroyed by fire during an enemy air raid on Bristol.

However, the survey has been completed, and we are now concentrating upon obtaining a comprehensive photographic record of the cave, which offers unlimited possibilities in this direction, and upon an attempt to follow the stream still farther into the heart of Mendip past where we now lose it.

ASPECTS OF MATHEMATICAL LOGIC

By Dr. Harold Jeffreys, F.R.S.

IT is recorded that when a pupil asked Confucius what he would do first if he had absolute power, the Master replied "I should reform language". (The development of the theme in the text of the "Analecta" is scarcely worthy of it, but incorporations are suspected.) The history of mathematical logic since "Principia Mathematica" affords an admirable illustration. Even before that great work, the need for unambiguous definitions and for the explicit statement of even the most harmless hypotheses was a main source of inspiration; but later investigators have found that ambiguities remained. In particular, there was a confusion between a symbol and the thing designated by it, and a propositional function was sometimes a property and sometimes what Prof. Willard Van Orman Quine in his recent book, "Mathematical Logic"*, calls a "statement matrix", that is, an expression that would become a statement if it contained names in place of variables. It was hoped also, especially in Russell's popular works, that the actual existence of numbers could be demonstrated in terms of the theory of classes.

It seems to me that such an approach was bound to be unsatisfactory if the scientific use of mathematics was to be justified. For equality of number between classes has to be defined in terms of an empirical method of comparison, and an empirical hypothesis is used in the statement that two classes defined in terms of some property, found similar in one test, will be found similar in another. This hypothesis is so elementary that it has usually passed unnoticed, but if mathematics is justified only for classes satisfying certain axioms, it follows (1) that we cannot significantly speak of the number of individuals with a certain property if the number is liable to change, (2) if there are in the world no classes at all that satisfy the axioms, the whole system breaks down. The fundamental objection to this approach, from the point of view of an empirical scientist, is that we must be able to query and test any empirical statement whatever, and this cannot be done if some such statements are selected and made part of the method of analysis itself.

Later writers have mostly abandoned Russell's attempt; the best known is probably Carnap. Axioms are now regarded as abstract statements, and a clear distinction is drawn between a thing and its name. Logic reduces to stating the rules of a language and investigating what kind of statements can be made in the language. Actual demonstration of the existence of structures formally similar to those laid down in the abstract rules is left to the empirical sciences. Even where the rules are not satisfied they can still serve as a useful standard of comparison. The chief aim now is to show that the rules themselves do not lead to contradiction; ordinary language, if not supplemented by rules that have been discovered by persons still living, does lead to contradictions—some are sufficiently elementary to be given in "The Week-End Book".

It is easy to show that if two contradictory propositions are demonstrable (in the ordinary sense) in a language, then every proposition in the language is demonstrable. If we have p and $\sim p$, and we consider any other proposition q, then p entails (p or q); but $\sim p$ and (p or q) together entail q; hence p and $\sim p$ entail q. Similarly, of course, they entail $\sim q$. This result in one form or another occurs in all the modern languages of mathematical logic. Now if every proposition capable of being stated in a language could be proved both true and false, the language would be of little scientific use; and this argument shows that a useful language must contain no contra-

* Mathematical Logic. By Prof. Willard Van Orman Quine. Pp. xiii+348. (New York: W. W. Norton and Co. Inc.; London: George Allen and Unwin, Ltd., 1940.) 21s. net.