The Coolagh River Cave

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INTRODUCTION

The Coolagh River Cave is one of the many active cave systems that occur on the sides of Slieve Elva and Knockaunsmountain, two hills in north-west Clare, Ireland. It has been formed by four streams that drain the southern slopes of the hills and which ultimately unite underground after sinking at separate swallets. The principal swallet, which engulfs the Coolagh River, was examined by members of the Yorkshire Ramblers' Club in 1936 and 1937. They succeeded in following the river to a point where a flooded bedding cave makes further progress impossible but they did not carry out any survey work. An account of this visit, given by Bartlett in the Journal of the Yorkshire Ramblers' Club,[1] is the only recorded examination of the cave prior to the systematic exploration and survey by the authors and other members of this society in 1949, 1950 and 1951.

LOCATION AND ENVIRONMENT (3, 7, 8)*

The northern part of Co. Clare is composed almost entirely, in ascending order, of the Upper Limestone, the Shale series and the Flagstone series of the Carboniferous system, the strata having an average dip of about three degrees in a direction approximately south-west by west. No faulting of any magnitude has occurred so the successive rocks of the system appear at the surface along the direction of the dip. The junction between the Shale series and the Upper Limestone runs from Fisherstreet, on the west coast, across the county in a south-easterly direction with the extensive area of Limestone " clints " known as the Burren lying to the north. At Lisdoonvarna, four miles east of Fisherstreet, a tongue of shale, two miles wide, protrudes northwards for four miles over the Limestone and carries at its extremity two small outliers of Flagstone which form the summits of Slieve Elva (1109 ft.) and Knockaunsmountain (976 ft.). It is around these two hills that most of the known caves in Co. Clare are found.

The surface drainage on the tongue of Shale is of two types. On the east, north and west sides the junction with the Limestone occurs so far up the hillsides that the many small streams have no time to join together and form larger ones before they reach the Limestone and disappear underground.

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* Reference 3 contains a brief account of the geology and topography of the area which is illustrated by a simplified geological map. This paper also contains references to several other relevant books and papers.

To the south, however, the continuation of the tongue of Shale allows this integration to occur, and nearly all the water that falls on this side of the hills is carried away by two large streams, the Coolagh River and the Owenealikeen River. The two rivers flow into the head of a consequent valley which runs across the Shale in a south-westerly direction from the foot of the hills and continues as a wide, shallow gorge in the Limestone. The Shale is thin, however, and the streams sink in two of the many Limestone inliers which are exposed in the floor of the valley. The Coolagh River sinks in the Polldonough Swallet and the Owenealikeen River in the Polldonough South Swallet.

About 600 yards upstream from Polldonough Swallet the Coolagh River runs for several hundred yards over another Limestone inlier. For most of this distance the stream runs wholly or partly underground following low, bedding plane conduits. At the downstream end of the inlier, however, it reappears at the surface with little apparent diminution in volume.

The map (*Fig.* 43) shows the surface details in the vicinity of the swallets with the plan of the cave superimposed.* In addition to the main streams a number of smaller ones sink near the cave. One of these, the stream that sinks at Polldonough North Swallet, has been identified positively in the cave and several others which appear underground can be attributed confidently to particular swallets. Most of these streams are small, deriving their water from the soil in the immediate neighbourhood of the swallets.

Shakeholes† are also numerous in this region and many of them can be correlated with rockfalls inside the cave. The most convincing instance occurs 100 yards west of Poll Clabber. There are several shakeholes here into which Flagstone boulders are frequently placed to prevent further subsidence. The survey shows that the Main Drain has collapsed in this region and some of the boulders have been found in the cave.

There is no known point of resurgence of the cave waters and it is assumed that they emerge at the coast below sea level, a distance of at least three miles from the sinkings. During wet weather, when the cave is completely flooded, water emerges from many of the shakeholes and flows down the valley floor.

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* There are two inaccuracies in the map in Reference 3. The Lower Owenealikeen River is not shown at all and the Owenealikeen River is shown as sinking at the Schoolhouse Sink. These errors do not occur on the 6-in. and 25-in. sheets (Reference 8).

† In this paper the term "shakehole" is used to denote a surface depression which has been caused by the collapsing of an underground cavity and the term "swallet" to denote a depression or an orifice which engulfs, or at some time in the past has engulfed, a stream.

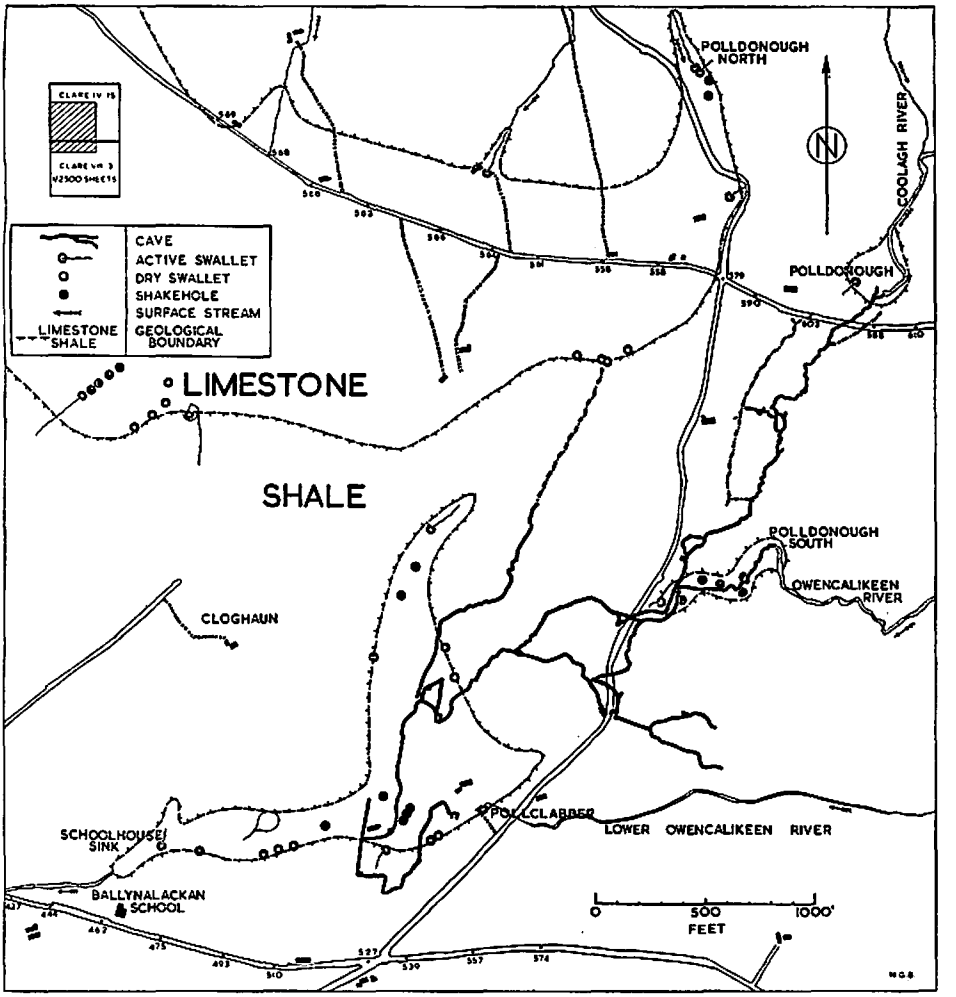

Fig. 43.—Based on the Ordnance Survey by permission of the Minister for Finance, Republic of Ireland. The small diagram, top left, shows the relation of the area to the Ordnance Survey sheets on a scale of 1/2500.

Erratum. For " Owencalikeen " *read* " Owenealikeen ".

THE CAVE

In this section the passages are described under separate headings and two further sub-sections are devoted to descriptions of the hydrology of the cave and to the mud and dripstone deposits. A plan of the passages with sections is given in Plate 31.

The Coolagh River Passage

The Coolagh River Passage is the name given to the system of channels that leads from the Polldonough Swallet to the head of the Main Drain. It was the first route into the cave to be explored and it is the most convenient one to follow when visiting the upper parts of the cave. Although it is a continuous passageway several different streams flow in it for varying distances, and for 500 ft. in the central portion it normally carries no water at all.

The Polldonough Swallet is one of three small swallets in the floor of a large horseshoe-shaped depression which forms the downstream end of the Coolagh River Valley. In the bottom of the swallet is an opening, 5 ft. high and 2 ft. wide, which forms the principal entrance to the Coolagh River Passage and into which the Coolagh River flows. A second swallet, 40 ft. to the north-west, leads into a small passage which joins the Coolagh River Passage after 20 ft.

From the Polldonough Swallet to the First Bedding Cave the passage is a canyon of from 2 ft. to 4 ft. in width. It increases in height from 5 ft. at the entrance to 20 ft. just before the bedding cave as it cuts down through beds A, B and C and into bed D. A small tributary stream enters from a low winding canyon passage about 350 ft. below the swallet. This water comes from a bedding plane on the southern side of the wet entrance. Below this point the upper section of the passage in bed A becomes markedly smaller than the lower section (cross-section 5) and winds over it, sometimes crossing it at an angle of as much as 90°. (This division of a canyon passage into separate sections at a bedding plane occurs frequently in this cave, and in this description the higher sections are referred to as the "upper rifts".) Bed D is first exposed in the floor near cross-section 5 and 200 ft. further on the passage splits into three sections; one in bed A, one in beds B and C, and one in bed D (cross-section 7). The section in bed D, which carries the stream, is not negotiable and when the sections combine again the stream is much reduced in volume. At cross-section 8 the upper rift in bed A disappears to the south, and at cross-section 9 that in bed B disappears to the west. The section in beds C and D forms a low narrow passage, partly blocked by flood debris, which leads into the First Bedding Cave.

This bedding cave is about 15 in. high and quite small in area. At several places in it bulbous protuberances of rock project a few inches below the level of the roof. These protuberances have flat bottoms of irregular outline; their diameters are several times greater than their depth and the distances between neighbouring protuberances are of the same order as their diameters. They occur mainly near the edges of the bedding cave, away from the stream. The roof near the middle of the cave is crossed by

a number of shallow grooves which give it an irregularly corrugated appearance. Both of these features are considered to be the remnants of a network of half-tubes that existed in the bedding cave before the present cavity was formed.

The stream enters the bedding cave partly from the Coolagh River Passage but mostly from a small passage on the east side which carries the water from the main passage near cross-section 7. A third inlet passage enters from the west. This comes from the Mud Chamber (cross-section B), a dome-shaped chamber, elliptical in plan, that extends upwards to the top of bed A. It decreases in width from 10 ft. at the base to less than 1 ft. at the top. The major axis lies along a strong joint. A low arched passage in bedding plane BC leads off from the top of a large mound of mud banked steeply against the western wall. It leads to the West Series which is described below under a separate sub-heading. The passage which connects the Mud Chamber with the First Bedding Cave is joined from the north by a high, narrow canyon (cross-section A). This is composed of the upper rifts in beds A and B which left the Coolagh River Passage at cross-sections 8 and 9.

Three passages lead out of the bedding cave and join after a short distance. Two of them are low and narrow with boulder-strewn floors and the third, which carries the stream, is too small to follow. Below the junction the passage deepens until one can walk upright in a canyon 6 ft. high and 2 ft. wide (cross-sections 14 and 15). After about 400 ft. a low but extensive bedding cave develops in the roof (cross-section 16). At one point in this bedding cave the roof displays many remnants of a half-tube network through which runs a relatively large tubular passage (*Plate* 28, *B*). This crosses over the stream passage at right angles and can be followed for considerable distances in both directions; to the east it ends in a tight bedding cave and to the west it is blocked by a dripstone flow. A small canyon passage from the West Series enters the Coolagh River Passage beside this tube.

Just beyond the tube the roof of the stream passage drops from bedding plane CD to bedding plane DE by a transition that is not abrupt, like most of the others in the cave, but only involves a gradual lowering of the roof. The water deepens after this point and the passage divides. The stream flows away to the south through a wide bedding cave in bedding plane EF while the main passage continues with decreasing width to the Four Foot Pot. The stream can be followed into a T-section passage which is silted up with gravel and partly flooded (cross-sections 19a and 22a). It has not been followed to the limit of possible exploration. There are two semi-tubular passages in the roof bedding plane of this passage and one of them leads under the Oxbow to an impenetrable fissure in the side of the Four Foot Pot. The Oxbow is entered by climbing into the roof bedding

cave of the main passage and crawling along a shallow channel in the floor. This emerges on the lip of a 6 ft. drop into a joint-determined passage where a calcite vein is clearly visible in both floor and roof. A narrow canyon in bed F joins the main passage after about 50 ft.

Below the Oxbow the passage is at first in the form of a narrow canyon (cross-section 23), but between cross-sections 23 and 24 the roof drops by a gradual transition to bedding plane FG. From here to the point of debouchure into the Main Drain the passage is largely of T-section form. Two streams from the Polldonough South Swallet enter the passage near cross-section 24. The first, a small trickle, enters from the east side near the roof; the second, a large stream, enters through a narrow rift in the western wall. Near cross-section 25 two more streams enter. These both consist of mixtures of water from the Polldonough and the Polldonough South Swallets and emerge from bedding passages on the eastern side of the main passage. Neither of these bedding passages has been explored. Many other side passages occur in the roof bedding plane in this area and several of them lead to the Bedding Chamber. A few hundred feet upstream from the Second Bedding Cave the passage has, for a short distance, the complex form shown in cross-sections 27 and 28 where the upper part of the passage is formed on a strong joint in bed F.

At the beginning of the Second Bedding Cave the channel of the T-section passage has become blocked with mud and boulders, the passage has filled with water and the stream has flowed out of the channel into the roof bedding cave. The bedding cave extends for 150 ft. and emerges in the roof of the Main Drain which is here 9 ft. high and 4 ft. wide.

The West Series

This series has not been surveyed but it is estimated to be about 1200 ft. in length, and to originate from the third swallet in the depression in which the Polldonough Swallet is situated.

The low, arched passage that leads from the Mud Chamber emerges in the roof of a narrow canyon similar to but smaller than the first section of the Coolagh River Passage. This passage carries a small stream that flows out of a choke of earth and boulders about 500 ft. upstream from the junction with the entrance passage. Downstream the passage divides. A tubular passage in the roof bedding plane leads off to the south-west and degenerates into a choked bedding cave while a low canyon carries the stream to the south. This joins the Coolagh River Passage near cross-section 16.

The Double Passage and the Gour Passage

The Double Passage and the Gour Passage lead, via the Bedding Chamber, from the Polldonough South Swallet to the Main Drain just

below Balcombe's Pot and thus provide the most convenient route for reaching the lower parts of the cave.

The Polldonough South Swallet is a shallow depression 400 yards to the south of Polldonough Swallet and is separated from the latter by a low ridge of Shale. The Owenealikeen River flows into a wide bedding cave in the bottom of the depression. The cave extends for 300 ft., and the route through it follows the stream for most of the way. The initial and final sections are quite restricted though in the former a shallow channel in the roof that winds above the stream makes progress easier in places. The central section, the Canal (cross-section 3 ; *Plate* 28, *A*), is an arched passage about 4 ft. high in which one can crawl comfortably. The stream in this section, unfortunately, is 2 ft. deep. Just before the beginning of the Canal the right-hand wall of the bedding cave consists of an extensive half-tube spongework (cross-section 2 ; *Plate* 27, *B*).

The Double Passage develops out of the bedding cave as a channel in the floor which quickly deepens into a canyon 8 ft. high. This canyon is, superficially, very different from the other canyon passages in the cave. It is wide at the top and at the bottom and has the two sections connected by a narrow rift, in section rather resembling a wineglass (cross-section 8). The lower section carries the stream and soon becomes so small that progress along it is impossible, but the upper section gets progressively higher until one can walk along resting one's elbows in the roof bedding plane. It is a tedious passage to negotiate, however, as the two sides of the floor slope steeply into the narrow rift beneath. The stream leaves the lower section of the passage through an open bedding plane in the floor after about 300 ft. (cross-section 9) and an intricate system of bedding channels, which has not been fully explored, exists between this bedding plane (EF) and the one beneath (FG). In the last 150 ft. of the passage a number of chockstones that have fallen from the walls are wedged in the rift.

The passage ends in the Column Chamber (cross-section 13), a dome-shaped chamber similar in form to the Mud Chamber. The walls and roof are covered with dripstone and a large column of this material extends from the roof down into the conical pile of mud that covers the floor. The two exits from the chamber, one behind the column and the other through the bottom of the Double Passage, both lead into the Bedding Chamber beneath. This is about 2 ft. high and covers a wide area in bedding plane FG. Many stalactites hang from two joints that cross the roof near the bottom of the Column Chamber and the floor is covered with deposits of dripstone and mud. The Bedding Chamber has not been thoroughly explored but three passages are known to lead out of it. To the south a wide passage, which is really a continuation of the chamber, passes under the end of the Double Passage and develops into a series of low crawls all of which

ultimately enter the roof of the Coolagh River Passage: to the east a very tight crawl with a stalagmite floor leads to the Coolagh River Passage: to the west is the Gour Passage.

The Gour Passage begins as a channel in the floor and quickly develops into a flat-roofed passage about 7 ft. high and 4 ft. wide with several oxbows of similar form but smaller size along the right-hand wall (cross-section 4). The floor has on it the remains of what once must have been a complete false floor of stalagmite. Near the head of the passage it is covered in places by a thick, hollow layer of this material, and further downstream these relics occur as a series of narrow dams, each holding up a pool of water (*Plate* 29, *B*). In the lower parts of the passage the only trace of the layer is an occasional patch of dripstone in the middle of the floor. The passage ends in the roof of the Main Drain 20 ft. above the stream. This short pitch can be climbed easily on a rope.

The Main Drain

The Main Drain is, as its name implies, the principal watercourse of the cave. The Coolagh and Owenealikeen Rivers combine near its head and flow down together to join two other streams which enter lower down. For most of its 2500 ft. of length it is over 20 ft. high and about 6 ft. wide. The stream, which covers the whole floor of the passage, is fast flowing and occasionally interrupted by rapids and waterfalls.

The passage begins in a low, wide bedding cave whose roof contains the remnants of several large half-tubes and whose walls are composed of mud. A number of little tunnels occur in the walls and from one of them a small stream emerges and flows down a channel in the floor (cross-section 1; *Plate* 27, *A*). The passage rapidly acquires a T-section form and the stream is joined by the water from the Coolagh River Passage on the right and from the Flooded Bedding Cave on the left. The gradient of the Upper Main Drain is slight, due to the presence of a thick bed of chert which forms the floor of the passage for several hundred feet and has restricted the downcutting of the stream. The chert floor ends at the Chert Waterfall where the stream drops 4 ft. Immediately below it the water races down a narrow, steeply inclined sluice and plunges over a 2-ft. drop into Balcombe's Pot. This is a V-shaped hole 15 ft. across and over 6 ft. deep which was first crossed by Mr. G. Balcombe in 1937. It is formed on a joint and appears to have been the plunge pool under the chert waterfall before it cut back to its present position. Although in very dry weather it is possible to climb out of it without a rope, under normal conditions crossing it in the upstream direction is an extremely difficult operation even with one. There is an oxbow route round this, which is not shown in plate 31.

From the pot to the Cascade Oxbow the passage is a high, winding canyon whose flat roof is often hidden by the curvature of the walls. Cascades and deep pools occur frequently where joints cross the passage, and just before reaching the Oxbow the stream plunges over two waterfalls. Both of these can be negotiated without tackle. The High Oxbow is reached by climbing 15 ft. up the wall of the Main Drain at the head of the second waterfall.

Below the second waterfall the stream flows through a wide bedding cave while the canyon passage continues to the north as a stream-deserted oxbow. This is composed of two arms, formed on parallel joints, connected by a narrow canyon which is partly blocked by boulders embedded in thick mud. The western arm of the oxbow has on its floor a chert bed, remains of which also appear on the floor of the bedding cave at its upstream end. The stream from the Cascade Branch enters this arm through a window in the wall, flows over the chert and drops 6 ft. into the Main Drain. A small trickle of water also enters this arm from a circular aven in the roof that extends upwards as far as one can see.

Below the oxbow the canyon form of the passage continues (*Plate* 30, *B*). At several points large boulders that have fallen off the walls lie on the floor. After about 400 ft. the floor becomes covered with gravel and the water steadily deepens until it reaches a depth of 5 ft. at the Gravel Pool. At the downstream end of the pool the upper part of the passage becomes very narrow and after 100 ft. it is blocked by the Choke. This has been formed by the collapse of the right-hand wall along a joint plane parallel to the passage and can be passed by climbing along this joint plane and scrambling over some boulders. At the beginning of the Choke one can see the Flagstone boulders that were mentioned above as having been placed in a shakehole on the surface to prevent further subsidence. At several places in the roof one can see the bottoms of small, elliptical, joint-determined avens. The top of a similar one has been located on the surface above but unfortunately it is blocked with earth.

The stream flows through the bottom of the boulder choke and on emerging it enters the Terminal Passage, a high, straight passage about 350 ft. long. It has been formed on two parallel joints about 8 ft. apart. In the section to the south of the Main Drain the rock between the joint planes has been left in the form of a partition pierced with several windows, but in the northern section the only remnants are V-shaped flakes which project from the roof and from the wall at the far end (cross-section 15). The floor at the northern end of the passage is covered with a thick layer of gravel and the stream, which is about 18 in. deep, flows away into a low bedding cave at the foot of the western wall. In very dry weather a bank of gravel is exposed at the left-hand side of this bedding cave and one can crawl into

it for 50 or 60 ft., but the water appears to reach the roof after about 100 ft. This is the furthest point in the stream passage that has so far been reached.

The Mud Branch

The Mud Branch is a narrow passage which enters the southern section of the Terminal Passage at a high dome-shaped chamber. It carries a small stream and has been followed as far as a tight bedding cave choked with Flagstone boulders. At two places the stream leaves the passage and follows a course parallel to it through a bedding cave at floor level. Where this occurs the passage is partly blocked by large accumulations of mud, the walls being covered with a layer sometimes as much as 9 in. thick.

The bedding cave at the head of the passage is crossed by several joints which give rise to a passage of the form shown in cross-section 1. A T-section passage with a lower bedding plane open in the floor (cross-section 2) quickly develops. Although this passage is largely filled with mud, occasional slump pits which expose the floor suggest that a stream in the lower bedding plane is removing the mud during wet weather. At cross-section 3 a high canyon enters from the north. A few feet further down the stream emerges from the east side of the passage and flows down it for 80 ft. before disappearing to the west. The high canyon continues for another 120 ft. (cross-sections 5 and 6) until a small, vertical aven is reached where the upper rift goes off to the west. The lower section continues as a T-section passage (cross-section 7) and is soon rejoined by the stream. Fifty feet further on the upper rift returns (cross-section 9) and from here to the Terminal Passage there is a high, narrow canyon with the stream descending rapidly over a series of cascades and potholes.

The Cascade Branch

The Cascade Branch is the bigger of the two tributaries that flow into the Lower Main Drain. Fluorescein tests show that the stream in it is the one that sinks at Polldonough North Swallet. A stream passage can be entered from the bottom of a shakehole a short distance below the swallet but it is blocked by a roof fall after a few feet. The Cascade Branch has been surveyed for 1200 ft. and has been explored for a further distance estimated at 800 ft. when progress was stopped by a choke of earth and dripstone. The choke could probably be passed by crawling at full length in the water under the stalactites, but in view of the blockage below the swallet, it was not considered worth the effort or the discomfort to do so.

The further part of the passage is a canyon 2 ft. to 3 ft. wide and 10 ft. high with the familiar division, at a bedding plane, into two rifts meandering one above the other. The gradient of the floor is slight and there are few rapids or pools. At the point where the survey ends several large boulders that have fallen from the walls lie wedged in the passage.

Twenty feet upstream from the Chert Waterfall the stream enters a small bedding cave and the upper rift goes off to the right. From here onwards the upper rift is largely blocked with mud but wherever it crosses the stream passage the stream has washed out the mud from beneath leaving the rift looking like a large chamber in the roof. At one or two places collapse of the walls has added to the size of these cavities. The gradient of the passage changes abruptly after the Chert Waterfall and from there onwards the stream descends by a series of waterfalls and cascades. The lower section of the passage has many joint-determined depressions in the floor and for the last 300 ft. it runs parallel to the direction of the jointing. There is a lot of clean, white dripstone in this passage so that, despite its size, it is one of the most attractive passages in the cave.

The Flooded Bedding Cave and the Upper Bedding Cave

Two systems of bedding plane channels occur at the head of the Main Drain; the Flooded Bedding Cave, formed in bedding plane FG and the Upper Bedding Cave, formed in bedding plane EF. The latter is mainly dry and has been explored for 1200 ft. but the former is flooded and can only be explored for a short distance where a large stream of Coolagh River water emerges from it.

The stream in the Flooded Bedding Cave emerges from a network of half-tubes and flows down a channel in the floor of a bedding passage (cross-sections 8 and 9). The channel quickly develops into a T-section passage and after 100 ft. it joins the Main Drain. The remnants of the half-tubes persist in the roof as shallow corrugations right down to the junction with the main passage.

The Upper Bedding Cave is entered by a passage, formed on two parallel joints, which leads south from the head of the Main Drain. At cross-section 7 a low crawl in the roof bedding cave (bedding plane EF) leads to a small chamber. This is flooded, but below the surface of the water can be seen the ends of a number of half-tubes. These are in the FG bedding plane and are therefore, presumably, part of the same network that is exposed at the Flooded Cave. The joint passage ends abruptly and the bedding cave is entered by crawling out of it to the east.

The passages in the bedding cave are wide with mud walls and many half-tube remnants in the roof. For considerable distances they are floored with gravel, and in all the branches the limit of exploration is reached through these deposits becoming too deep. The passages are never more than 2 ft. 6 in. high and are usually much less. In the southern branch a small stream of Coolagh River water flows into a pool at the end. The water, however, must leave through some hidden channel in the floor for none flows down the passage.

The Hydrology of the Cave

Although the drainage pattern in the lower parts of the cave is simple the streams in the entrance passages follow routes which are complex and often impossible to traverse. These routes were investigated by putting fluorescein into the sinkings and observing which of the underground streams were coloured. The conclusions that have been drawn from these tests are given below.

Nearly all the water from Polldonough South Swallet, which leaves the Double Passage before cross-section 9, flows into the Coolagh River Passage between cross-sections 23 and 26 while the remainder enters the bedding cave at the head of the Main Drain. The flow through the unknown conduits must be very direct for little time elapsed between the dye being put in the swallet and the streams inside appearing coloured.

Nearly all the water from Polldonough Swallet, which leaves the Coolagh River Passage near cross-section 18, reappears at the Flooded Bedding Cave. Some of the remainder mixes with the water from Polldonough South Swallet which emerges in the Coolagh River Passage near cross-sections 25 and 26, while the rest, a very small amount, flows into the end of the southern arm of the Upper Bedding Cave. In all cases except the last the dye took from seven to nine times as long to appear inside the cave as did that in the Polldonough South Swallet.

The stream in the Cascade Branch is the one that sinks at Polldonough North Swallet.

A test was also carried out at Poll Clabber to find out if this was the source of the stream in the Mud Branch, but owing to faulty timing between the party underground and the one on the surface it was inconclusive. It is almost certain that the two streams are the same.

The above tests were carried out when the streams were at their normal levels but there is evidence to show that the normally active passages are capable, even after heavy rain, of carrying most of the additional flood water. For instance, during the heaviest flooding no water succeeds in flowing down the Double Passage as far as the Column Chamber, and the water in the Coolagh River Passage is never deep enough to flow over into the Bedding Chamber. The Main Drain is, however, an exception. Either the Choke or the blockage that has been responsible for the aggradation at the Final Bedding Cave has so constricted the passage that the cave at times completely fills with water.*

* The danger from flooding in the cave is very great. The bedding cave at the entrance to the Double Passage remains negotiable long after the Coolagh River Passage and the Main Drain have become impassable torrents. Heavy rain can, however, fill it to the roof in under two hours. A party in the lower parts of the cave would have little chance of escape under these conditions.

Mud and Dripstone Deposits

Deposits of mud occur throughout the cave in the form of thin layers blocking the edges of bedding plane cavities. These can be observed in the roofs of nearly all the passages and are particularly marked in the Upper Bedding Cave; the walls of the passages being covered entirely with mud. In addition to these small deposits large accumulations of mud occur where passages or chambers are no longer traversed by streams. The principal examples of these are the Mud, Column and Bedding Chambers, the Cascade Oxbow and parts of the Mud and Cascade Branches. All these deposits are in process of removal and not deposition. They therefore represent the remains of an accumulation of mud which at one time filled the cave.

Dripstone deposits in the cave are rare. They usually consist of isolated flows on the walls as in the Coolagh River Passage although in the FG bedding plane near the Bedding Chamber the floors of several passages are covered with layers of spongy stalagmite. The most prolific deposition has occurred in regions, such as the Bedding Chamber and the Cascade Branch, where open joints have been exposed, and the general paucity of decoration in the cave seems to be due to the fact that most of the joints are either tight or filled with calcite. Several open joints are exposed, however, in two regions where no dripstone has been deposited, the Cascade Oxbow and the Choke. This absence of dripstone cannot be due solely to the periodic flooding to which they are subjected for the small chamber at the lower end of the Mud Branch is well adorned with stalactites and is at the same level as the Choke. A possible explanation is that while the Mud Branch is only flooded by slowly moving backwater from the Main Drain the other two places are subjected to the full current.

Much of the dripstone is being re-dissolved by the streams in times of flooding but some of the deposits are being removed by an increase in the flow of water that formed them. On the other hand a number of formations are now dry, for instance, the ones in the Column Chamber.

FORMATION OF THE CAVE

The majority of the passages in the cave are in the form of channels incised in the floors of bedding-plane caves. The floors of these channels descend continuously while the roofs, which are determined by the bedding, remain nearly horizontal for considerable distances and then drop abruptly to lower bedding planes. The passages thus tend to be divided up into a number of sections, each consisting of a bedding plane cave out of which develops a T-section passage that gradually deepens into a high, narrow canyon. These are passages of a type whose origin is usually ascribed to the action of vadose streams and all the other evidence in the cave, the

dendritic pattern of the system and the present harmonious occupancy of many of the passages by such streams, suggests that this conclusion is justified.

In the roofs of the bedding caves and also of many of the passages occur the remains of extensive networks of half-tubes. (These are particularly well preserved, though rather inaccessible, in the Polldonough South Bedding Cave.) Half-tube networks of this form have been described and discussed by Bretz[2] (p. 706) and Glennie[6] (p. 8). Both authors consider that they are formed in the bedding planes when all the interstices of the rock are filled with water that has little movement so that the insoluble matter in the rock settles on the floor and forms a protective layer. Enlargement of the cavity thus proceeds upwards. Both authors consider that these tubes are the earliest cavern features to appear in bedding planes through the action of water.

The formation of the cave therefore began when, on the exposure of the limestone at the surface following the removal of the overlying impermeable rock, water penetrated the fissures in the limestone and formed by solution a network of channels in the bedding planes and perhaps also in the open joint planes. It is probable that when the inlier in which the present active swallets occur was first exposed the streams were being engulfed by one or more of the blocked swallets lower down the valley and that this inlier developed in a similar way to the one which the Coolagh River now traverses 600 yards above Polldonough. When a continuous route had been established between two points on the surface at different levels a steady flow commenced which enlarged the conduits until, in dry weather, the streams became free-surface streams and the direction of flow became dependent upon the dip of the strata. Under these conditions the streams descended through the limestone by a series of steps—flowing horizontally along the bedding planes and then dropping vertically down joints. Their erosive power was greatest where their velocity was highest and they rapidly incised deep channels at the heads of the vertical descents. The development of the cave since then has consisted in the steady retreat upstream of these channels, and the tortuous courses of the initial water routes have given them a close resemblance to the intrenched meanders produced in meandering surface streams subsequent to uplift. Where great distances existed between successive open joints the intervening bedding plane formed a local base level of erosion for the streams above it and extensive lateral erosion took place. This is most marked in the region between the Column Chamber and the Cascade Oxbow. Here a complex network of bedding channels has been formed in the EF and FG bedding planes and the water of the streams that now enter it is divided and intermingled. Many of the passages in the network are flooded, but it is being drained by the retreat through it of the Main Drain and of the passage

that leads to the Flooded Bedding Cave. The Gour Passage, when it was active, also contributed to the draining.

The development of the cave was interrupted on at least one occasion when the deposits of mud were laid down. This event must have occurred at a relatively recent date in the cave's history for no passages have been discovered which were obviously formed since. It is interesting to note that remains of a similar deposit have recently been discovered in Pollnagollum.[4]

SPECIAL FEATURES OF THE CAVE

Large Half-tubes

At several places in the cave relatively straight passages with low, arched roofs pass through half-tube networks in bedding caves. Typical examples of these are the Canal (*Plate* 28, *A*) and the passage that joins the Mud Chamber to the West Series. These passages appear to have been formed by strong streams flowing through the bedding planes causing those tubes in the direction of flow to enlarge and coalesce. It does not seem that this process necessarily took place under phreatic conditions; in fact the conditions that prevail in the Polldonough South Bedding Cave to-day would seem to be the best ones under which such a passage could be excavated. This bedding cave normally carries a free-surface stream of fairly low gradient, but on many occasions during the year flooding occurs and the stream fills it to the roof at the same time as the streams' corrading power increases markedly.

The half-tube that crosses the Coolagh River Passage above the Four Foot Pot is possibly a passage of this form but it is not associated with any known system of vadose passages.

Domepits

The points at which the roofs of canyon passages descend abruptly to lower bedding planes are marked at several places in the cave by high dome-shaped chambers. They are all formed on joints and are elliptical in plan with their major axes less than twice the length of their minor axes. Typical examples are the Mud and Column Chambers. They mark the points at which the initial streams in the bedding planes descended down open joints to lower bedding planes and are thus chambers of the type that Bretz[2] (pp. 682-5 and 722-31) has termed "domepits".

From the features of such chambers that Bretz has examined he deduces that they were formed by leakage of water down the joint plane from a number of points in a half-tube network in the upper bedding plane. He also deduces that the main instrument of erosion, both in the initial stages and during the subsequent enlargement of the chamber, was a thin film of water

trickling down the wall and it is implicit in his account that the wall down which this film trickles is dissolved away more rapidly than is the bed of the stream at the top of the descent. He describes and figures one domepit in which a waterfall face 85 ft. high has retreated upstream for 150 ft. during which time the floor of the stream passage at the head of the drop has not been lowered by more than, at most, 1 ft.[2] (pp. 682-5)

The domepits in the Coolagh River Cave are so obscured by mud and dripstone that it is not possible to determine what the initial water channels were like, but their later development does not seem to have been like that described by Bretz. None of them has suffered very much elongation, all are entered by narrow canyon passages that extend from the floor to the ceiling, and the passages upstream of the domepits have gently graded floors right back to the bedding plane caves. It therefore seems that the streams that incised the canyons at the heads of the waterfalls were of much greater erosive power than were the thin films of water that trickled down the walls behind the streams. This inference is given added force by the fact that at places where streams have utilized existing vertical descents, such as the points of debouchure of the Second Bedding Cave and the Cascade Branch into the Main Drain, they have incised deep channels in their floors much more rapidly than the waterfall faces have retreated upstream. The domepits must thus have been formed under very different conditions from those that prevailed when the canyons were being incised. A possible explanation is that the domepits were formed, as Bretz suggests, by solution when, as a consequence of the small flow through the bedding planes, the current load of the streams was very small. The incision of the canyons did not start until the conduits had been enlarged sufficiently for the streams to carry appreciable quantities of silt and their erosive power to become predominantly corrasive.*

CONCLUSION

The Coolagh River Cave is of interest mainly by virtue of its simplicity. It is a cave that has been formed largely by the action of vadose streams in limestone that is fairly homogeneous, almost horizontally bedded and has suffered very little tectonic disturbance. Few of its passages are blocked with mud or dripstone and in only one place has the passage form been badly obscured by rockfalls. Although the cave is fairly mature, in so far as the streams have attained to gently graded courses with few waterfalls, many of the youthful passage forms have been preserved. It is thus an

* A very fine domepit, little obscured by mud and dripstone, that might repay a detailed examination occurs near the beginning of Poll Cullaun. This is a cave on the western side of Poulacapple about two miles east of Pollnagollum. It was discovered in 1951 by the Society.

ideal cave in which to study the action of vadose streams in an environment of almost fundamental simplicity. Although there are opportunities for further exploration a study of the known passages will probably prove of more value than a search for new ones.

NOTES ON THE SURVEY

Over two miles of the important passages were surveyed and the remainder were drawn from memory. In the time available it was impracticable to attempt a high degree of accuracy and the method used was very rough and rapid. A hand bearing compass and metallic linen tape were used. The stations were not positioned accurately and the sights were taken on to head lamps. Since the gradient of the passages is slight no form of levelling was attempted. Instead the beds were carefully followed and have been drawn in with the passage cross-sections. Even this was not attempted in the passages below Balcombe's Pot but the general trend of the passage development has been indicated.

The survey was computed and drawn up at a scale of 50 ft. to 1 in. *Plate* 31 has been drawn from a photographic reduction of this and the passage widths have been exaggerated slightly for the purpose of publication. The value of the magnetic deviation was obtained from direct measurement on the surface.

The survey was also plotted at a scale of 1/2500 and superimposed on the Ordnance Survey map of that scale. *Fig.* 43 shows the correlation of the surface and the underground detail. The positions of the swallets and the shakeholes have been plotted from measurements from well-defined surface features. No levelling on the surface was attempted but the Ordnance Survey spot heights have been included. The approximate position of the junction between the Shale and the Limestone is also indicated.

There were two major loops on the survey which could be closed. The first, from Polldonough to Polldonough South, was 3500 ft. long and misclosed by 62 ft. This indicates an accuracy of 1/56. The second, closing on Balcombe's Pot, was 1500 ft. long and misclosed by 20 ft. This indicates an accuracy of 1/75. These figures give an approximate indication only but if we assume an accuracy of 1/50 the probable errors in the positions of various points are:

The Column Chamber	35 ft.
Balcombe's Pot	40 ft.
The Terminal Passage	55 ft.
The head of the Mud Branch	60 ft.
The end of the survey of the Cascade Branch	60 ft.

These estimates are confirmed by the position of the Choke. The survey shows this to be within 60 ft. of the shakeholes where the Flagstone boulders have been dumped.

The Cave Research Group classification of the survey is Grade 5. It will be noticed that the accuracy is somewhat better than that obtained for similar traverses in the G.B. Cave survey[5] (pp. 179 and 185) but in the Coolagh River Cave we are dealing with long traverses in horizontal passages and consequently the possible sources of error are fewer and there is a greater tendency for errors to compensate for one another.

ACKNOWLEDGEMENTS

The work described in this paper was only made possible by the assistance of a number of people. We would like to express our gratitude to all those who have assisted us and in particular to Miss J. Light, who took part in all the expeditions and assisted in the exploration and survey; to Mr. N. G. Blackwell, who took part in the surveying and also drew the map and plan which illustrates this paper; to Mr. K. Dixon, who took part in the photography of the cave; and to Mr. J. H. Crickmay, who computed the survey readings. We should also like to thank Mr. and Mrs. D. O'Callaghan of the Castle Hotel, Ballynalacken for their great kindness and hospitality on the three occasions that we stayed with them.

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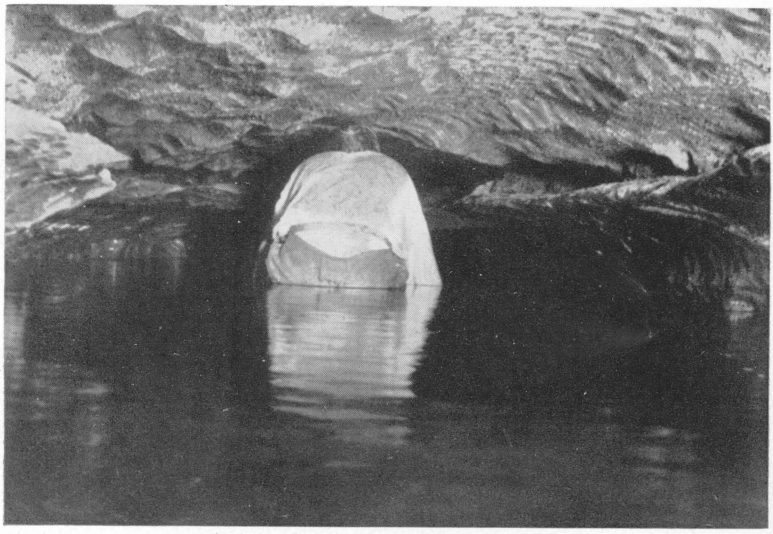
[8] Ordnance Survey of Ireland: 1/10,560, Sheets Clare 4 and 8; 1/2,500, Sheets Clare 4 (15) and 8 (3).

PLATE 27

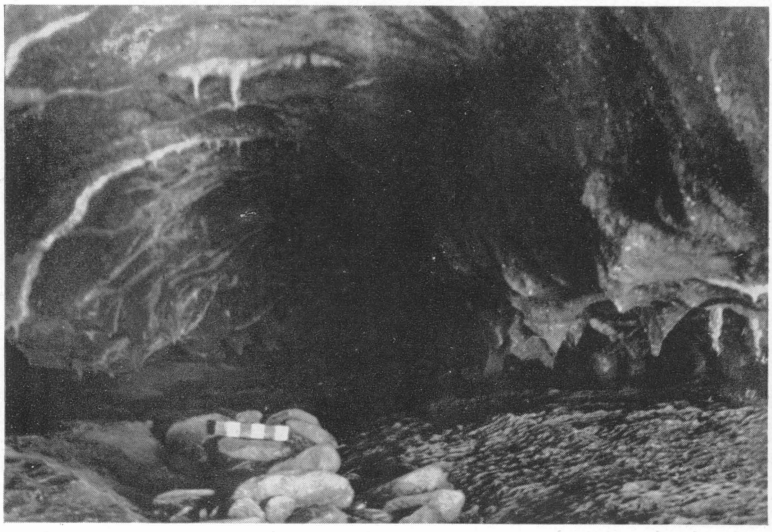
A.—The bedding cave at the head of the Main Drain. Photograph taken near cross-section 1, looking upstream.

B.—Network of half-tubes exposed at the north-west side of the Polldonough South bedding cave. (Scale in inches.)

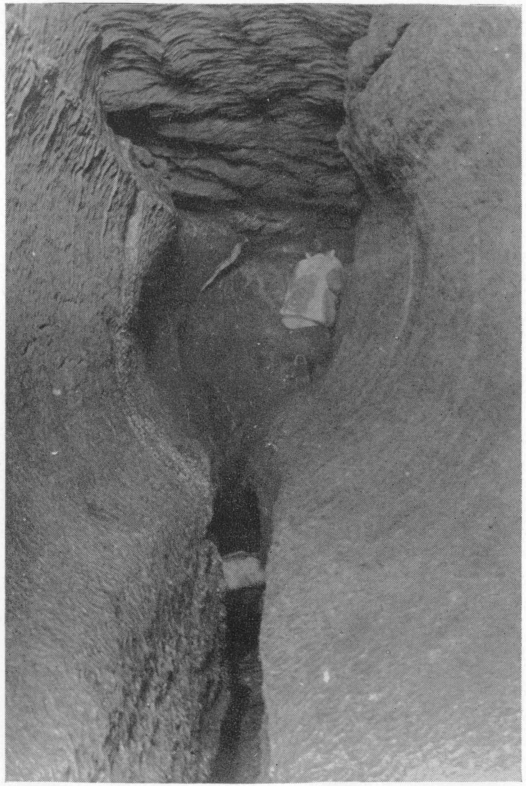
PLATE 28



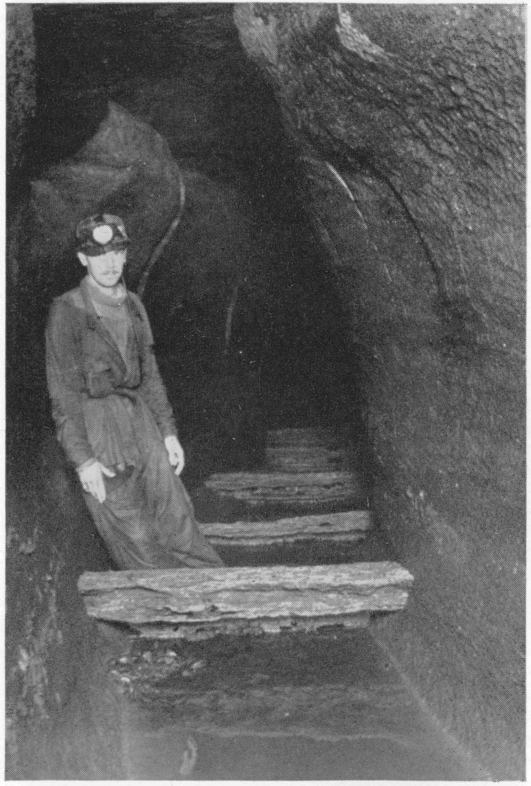
A.—The Canal. Photograph taken near cross-section 3, looking upstream.



B.—The large half-tube that crosses the Coolagh River Passage near cross-section 16. The remnants of the anastomosing half-tubes can be seen in the bedding plane at the side of the tube. (Scale in inches.)

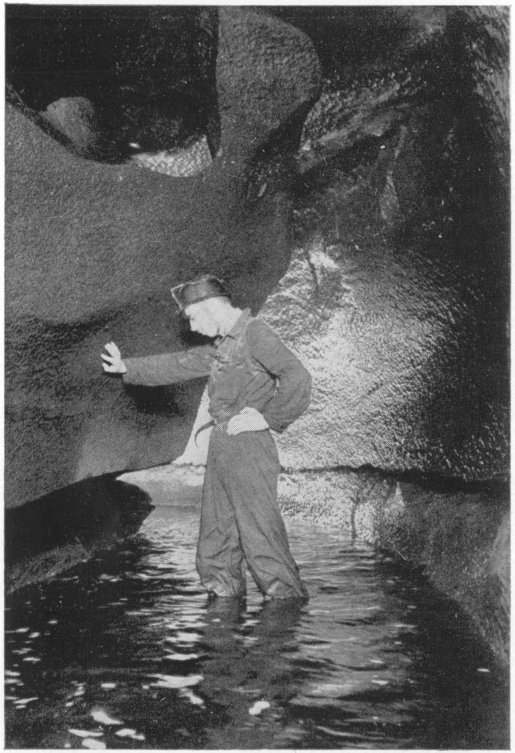


A.—The Double Passage. Photograph taken near cross-section 8, looking upstream.

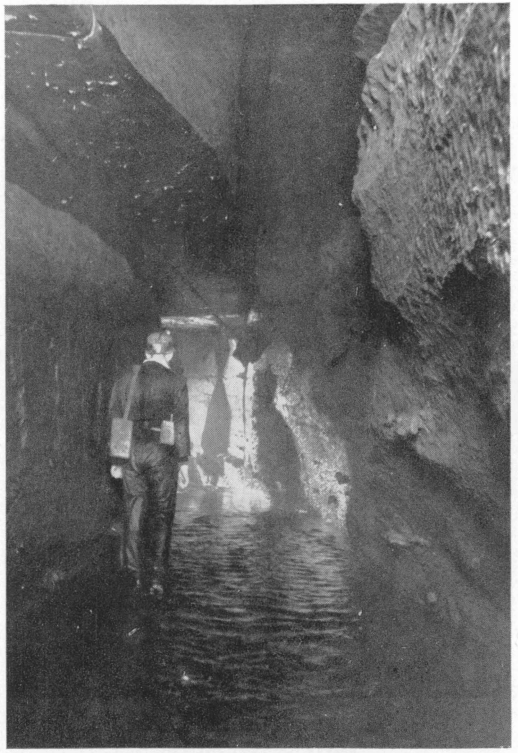


B.—The Gour Passage. Photograph taken near cross-section 3, looking downstream.

PLATE 29



A.—The Upper Main Drain. Photograph taken near cross-section 3, looking downstream.



B.—The Lower Main Drain. Photograph taken near cross-section 13, looking upstream.

PLATE 30

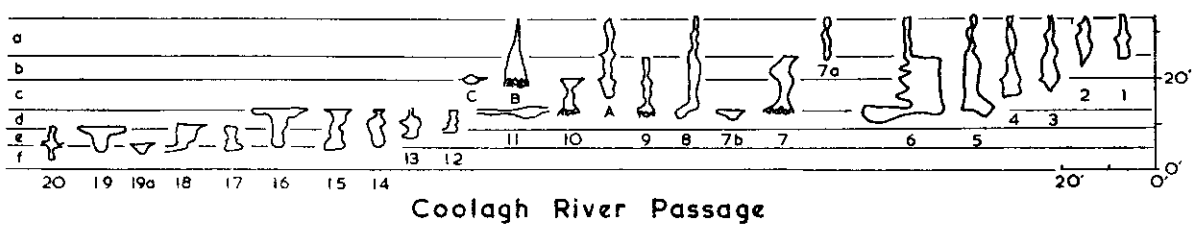
COOLAGH RIVER CAVE

Co. Clare, Ireland.

U.B.S.S. SURVEY

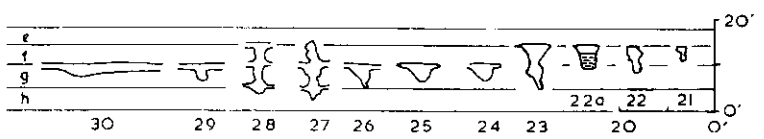
SURVEYED BY R.A.BENDALL N.G.BLACKWELL & J.I.LIGHT. AUGUST 1949 & AUGUST 1950.

DRAWN BY N.G.BLACKWELL

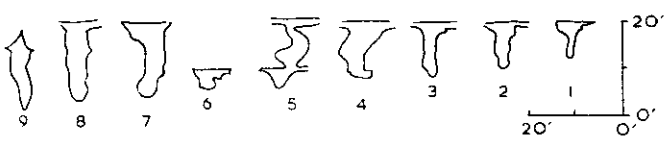


Coolagh River Passage

[ALL CROSS SECTIONS LOOKING DOWNSTREAM]



Coolagh River Passage



Cascade Branch

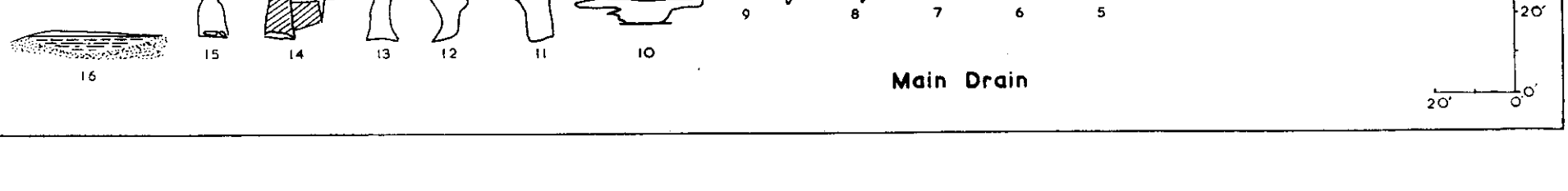
Double Passage

Gour Passage

Flooded Bedding Cave

Upper Bedding Cave

Mud Branch



Main Drain