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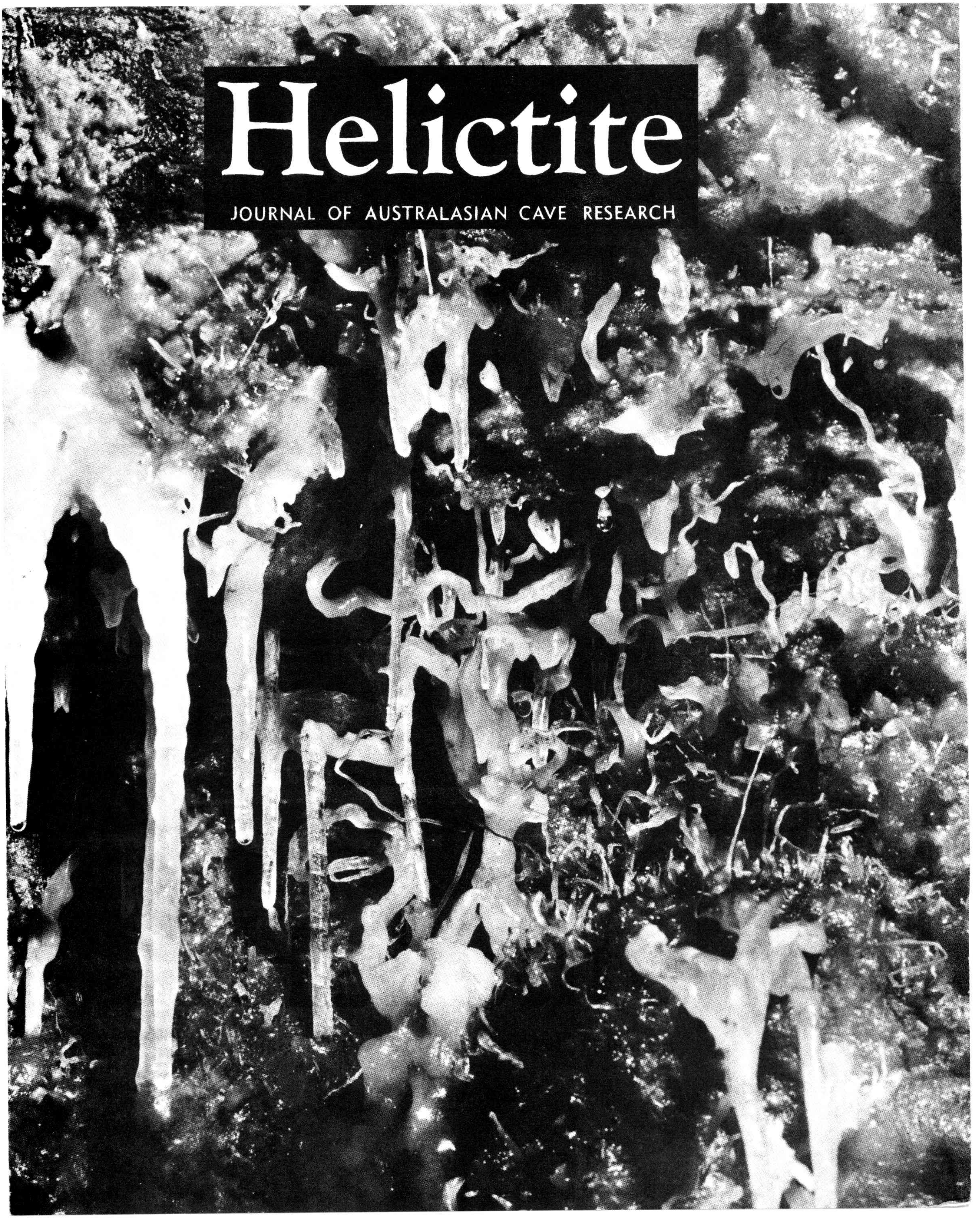

"H E L I C T I T E"

Journal of Australasian Cave Research

Edited by Edward A. Lane and Aola M. Richards

VOLUME 1, NUMBER 2 Published Quarterly JANUARY, 1963

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WATER SAMPLING AT YARRANGOBILLY, NEW SOUTH WALES

By J. N. Jennings, M.A.

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Introduction

Various geomorphologists such as Bögli, Corbel and Lehmann have in recent years demonstrated the interest that certain simple chemical analyses of natural waters can have for the comparison of rates of limestone solution in different climatic conditions. They can also have their relevance for the tracing of underground water connections as Oertli (1953) has shown in the example of the Slovenian part of the classical Yugoslavian karst. Since 1957, the writer has therefore been making such analyses of waters from Australian limestone areas. The chief significance of these measurements comes when one caving area is compared with another. M.M. Sweeting (1960) has already commented briefly on observations from Mole Creek, Tasmania, Buchan, Victoria, and the Fitzroy Basin, Western Australia, made in 1958-9 by herself and the writer; further discussion will appear in a forthcoming publication of ours on the Limestone Ranges of the Fitzroy Basin. Nevertheless measurements of this kind can have a certain intrinsic interest as it is hoped to show in the following notes on the few observations I have made at Yarrangobilly.

These observations are set out in tabular and Trombe graph form; the locations of the collecting points are shown on a map.

Methods

The pH was determined in the field with a Lovibond Comparator, not a very accurate instrument. However, a really portable potentiometric pH meter was not available at the time and it is important that the pH and temperature be determined in the field.

Calcium and magnesium were determined later in the laboratory by the E.D.T.A. method because of the excellent endpoints in these titrations. If the samples are kept for a long time before analysis, a simple precaution is to bubble carbon dioxide through the sample to ensure that all the carbonate is in solution. The calcium and magnesium are expressed as carbonate equivalents on the assumption that other anions such as sulphate and chloride are present in small proportion only. Test analyses show that this was valid in the semi-arid Fitzroy Basin though not so in the even drier Nullarbor Plain. Generally it is a safe assumption to make in S. E. Australia. The presence of appreciable amounts of certain other cations such as iron and manganese can upset the determinations themselves occasionally and this source of error must always be borne in mind.

When the magnesium content is low with respect to the calcium, it is possible by plotting the samples according to the parameters of temperature, pH and calcium carbonate on Trombe's graph of saturation curves for calcium carbonate (Trombe, 1952) to see whether the waters are saturated or not with regard to limestone, in other words, whether they are liable to be precipitating calcite or dissolving further limestone. This method is preferred to the determination of "free carbon dioxide." "Free carbon dioxide" is difficult to determine reliably in the field at the point of collection and in any case it appears it is of doubtful value as a measure of the remaining corrosive power of water when the pH is above 7.2 ; then the amount of free carbon dioxide surplus to the free carbon dioxide generated by the bicarbonate present ("the equilibrium free carbon dioxide") is at best extremely small.

Results

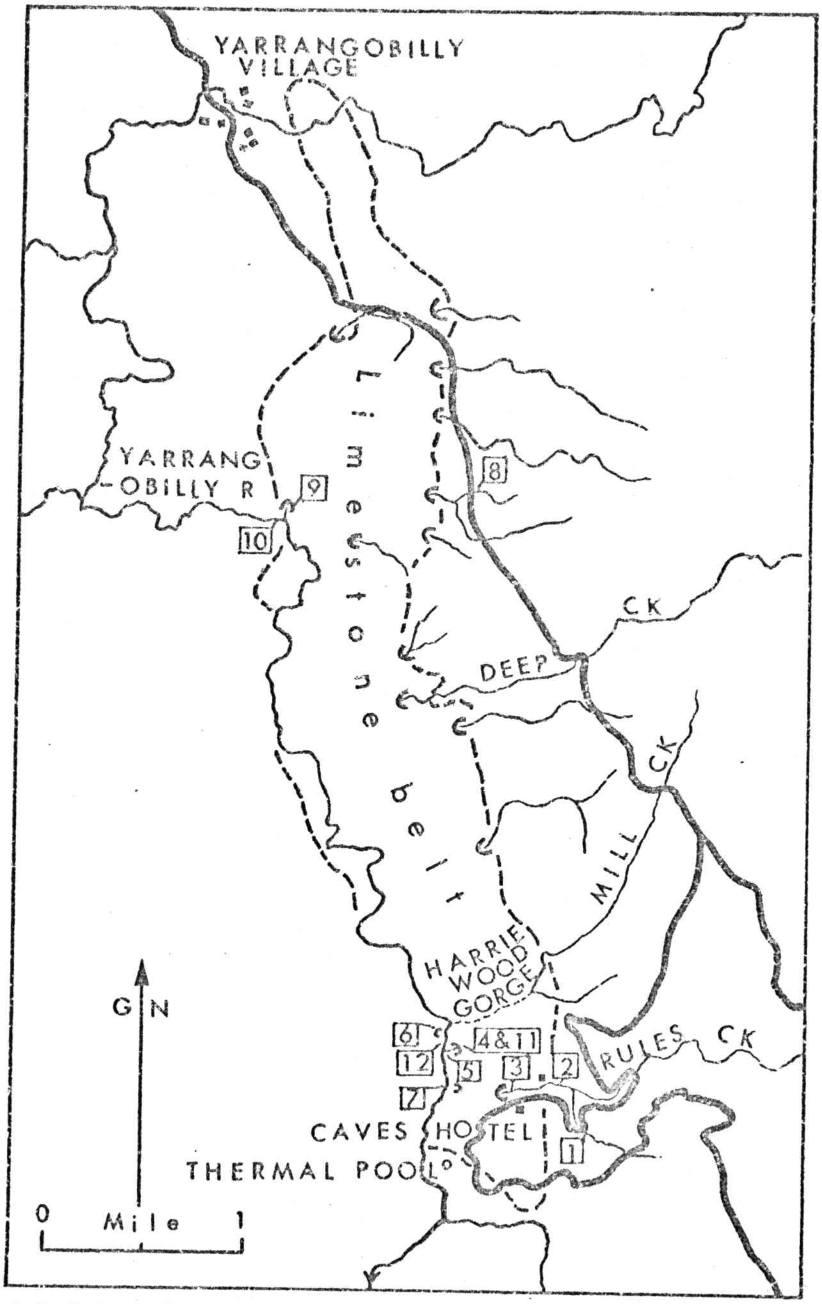
Nearly all the samples listed (1-10) were collected on February 27 - 28, 1960, after a spell of dry summer weather. The river had a normal low summer flow when the limestone underground contributes substantially towards the discharge. Samples 11 and 12 were also collected in summer (15 January, 1962) but after heavy rains.

In all the samples of Yarrangobilly water, which have had a substantial contact with the limestone, the values for magnesium carbonate are low compared with those for calcium carbonate. This is an indication that there is little dolomite in the limestone sequence. Water testing can provide a useful pointer to the presence or absence of dolomite. Thus water sampling at Cliefden has shown the likelihood of a good deal of dolomite in the geological formation there, which is unrecorded in the literature.

Sample 8 can be taken as typical of the runoff before it passes into the limestone outcrop; this is from the creek running into Bath House Cave (Y8), a possible source of Coppermine Cave water. With very low, practically equal calcium and magnesium values, it is very aggressive, i.e. in term of its pH temperature and calcium carbonate content it is capable of considerable solution of limestone.

From Yarrangobilly R. on shales above Coppermine Cave, sample 10 has also very low values and is very aggressive. Although the river has previously crossed a quarter of a mile wide limestone outcrop near Yarrangobilly Village, this has had little effect on the carbonate content since the catchment above this point of collection is overwhelmingly on rocks other than limestone.

Rules Creek was not sampled above the limestone belt unfortunately though a left bank tributory was. This sample (1) is very aggressive but



LOCATION OF WATER SAMPLES

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WATER SAMPLES FROM YARRANGOBILLY

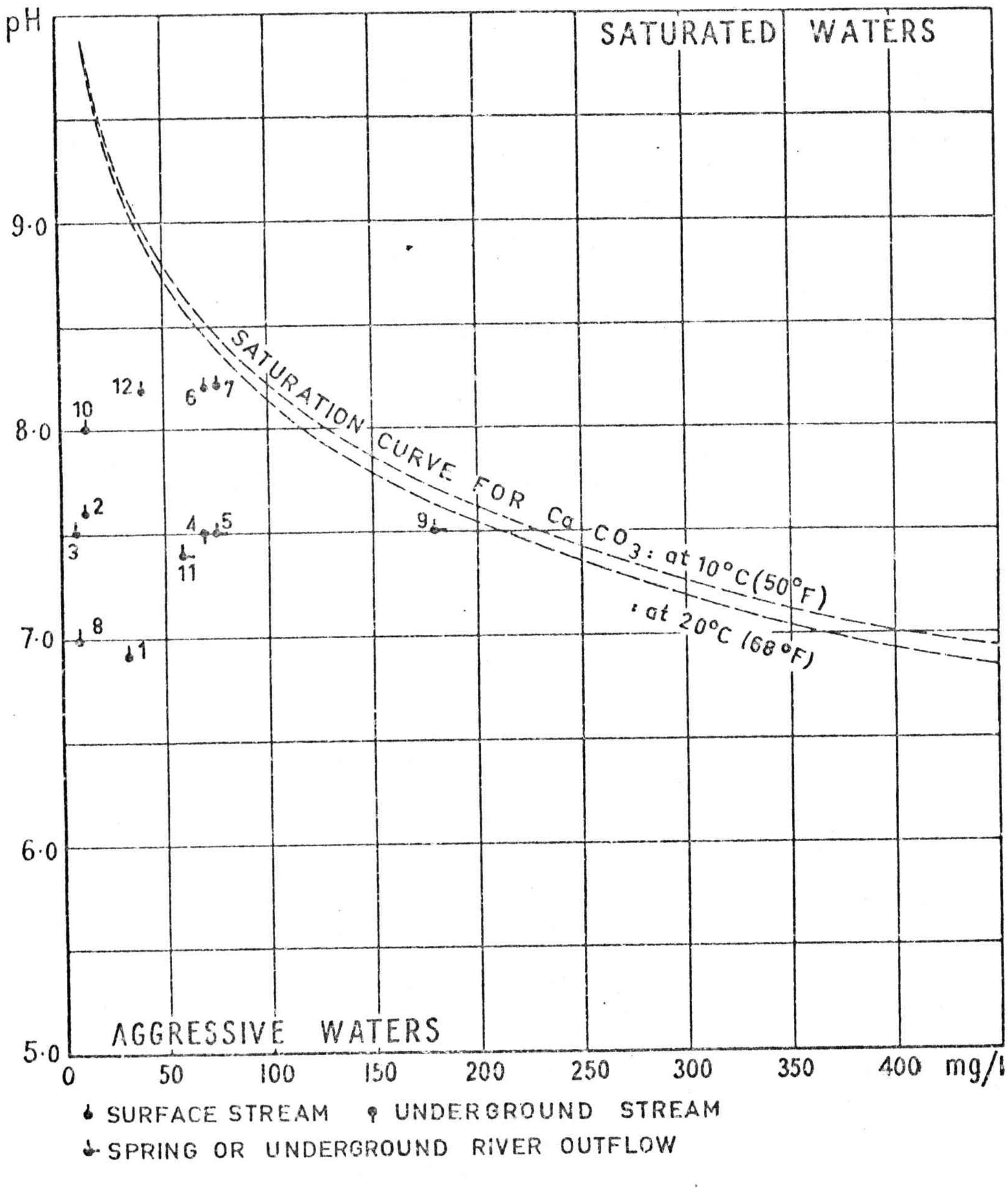

TABLE 1 WATER SAMPLES FROM YARRANGOBILLY

Sample Location	Date	Temp. °F	pH	$CaCO_3$ (mg/l)	$MgCO_3$ (mg/l)
1. Left bank tributory of Rules Creek above limestone (trickle only)	27.2.60	60	6.9	32	15
2. Rules Creek by bridge in camping ground	27.2.60	60	7.6	14	10
3. Rules Creek just above water-sink below hotel (effluent included)	27.2.60	61.5	7.5	10	10
4. River Cave (Y27). Upstream end of cave stream by watertrap	27.2.60	53	7.5	73	13
5. Outflow from River Cave (Y27) near Yarrangobilly River	27.2.60	53.5	7.5	72	8
6. Outflow from cave downstream of Harrie Wood Gorge and up-stream of Y27	27.2.60	60	8.2	71	6
7. Yarrangobilly R. below Glory Arch	27.2.60	63	8.2	73	10
8. Creek above limestone flowing into Bath House Cave (Y8)	28.2.60	56.5	7.0	10	8
9. Coppermine Cave (Y12) outflow	28.2.60	50	7.5	178	12
10. Yarrangobilly R. on shales 50 yards upstream from Copper-mine Cave	28.2.60	68.5	8.0	16	8
11. Outflow from River Cave (Y27) near Yarrangobilly R.	15.1.62	52.5	7.4	61	10
12. Yarrangobilly R. just above River Cave outflow	15.1.62	70	8.2	42	14
13. Glory Hole. Ice stalactite in entrance	14.6.59	32	N.D.	72	3
14. Glory Hole. Drip in entrance	14.6.59	32	N.D.	77.5	7.5
15. Glory Hole. Ice stalagmite in entrance	14.6.59	32	N.D.	112	8

has higher values for its carbonates than is usual for streams off limestone. It was however only a trickle at the time of collection and there has probably been some concentration by evaporation. Experience has shown that tiny surface flows, both on and off limestone, do not give typical results.

The two samples (2 and 3) from Rules Creek itself have low carbonate values and are very aggressive. Little carbonate has been picked up by the creek before it disappears underground near Yarrangobilly Caves Hotel, even though there are limestone fragments in the alluvium over which it flows through the camping ground and alongside the tennis courts. Comparable results have been obtained from McEwans Creek at Jenolan at a time when this creek was sinking at a point below the cricket pitch and despite much contact with limestone in the alluvial gravel and at the base of meander cliffs. The close similarity of samples 2 and 3 make it clear that effluent from the hotel septic tank was having little effect on the pH and carbonate content at this time.

River Cave (Y27) is generally regarded as the outflow of Rules Creek although this has not been subject to any water-tracing test to my knowledge. If it is the true underground connection, it will be seen from samples 4 and 5 that some 60 mg/l of calcium carbonate has been taken up in the underground flow. This is only a moderate amount and the water remains markedly under-saturated at its pH and temperature.

Since the Yarrangobilly R. above and below the efflux of River Cave (samples 6 and 7) has almost the same content as the River Cave water at this time of low summer flow, it can be taken that this efflux is typical of much of the underground water of the Yarrangobilly limestone belt. The river water is much nearer saturation than the cave water but even where it is nearly passing out of the limestone area (sample 7), it is still capable of dissolving a little more limestone.

Samples 11 and 12, taken after heavy rains, form an interesting comparison. Yarrangobilly R. (12) is carrying considerably less calcium carbonate per unit volume as a result of a greater proportion of runoff coming from the non-limestone part of the catchment, the limestone releasing the storm water more slowly. Even the River Cave water (11) has a somewhat reduced calcium carbonate content through more rapid transit of a larger volume of water.

The outflow from Coppermine Cave (Y12) has a much higher calcium carbonate content (sample 10) than that from River Cave though it isn't quite saturated. In this high content it compares favourably with most of the substantial effluxes tested in the south-east of the mainland and in Tasmania. The difference between Coppermine Cave and River Cave can be explained in terms of the longer underground flow of the resurging water in the case of the former and also the slightly lower temperatures at both inflow and outflow with the consequent greater capacity for limestone solution.

Samples 13-15 were collected in wintertime from the Glory Hole by Miss E. Smith and analysed by me. They show a significant increase in carbonate content from an ice stalactite and accompanying drip to an associated ice stalagmite. More elaborate observations, including pH determinations would be necessary to explain the difference. It is not impossible, of course, that the stalagmite formed at a different time when the percolating water was richer in carbonate.

In the course of collecting the 1960 samples, it was noted that some small springs at river level in the cliff-foot slightly downstream from the Glory Arch had temperatures of 75-77°F. As the river was at 60-63° and the other underground waters at 50° and 53°, it is evident that these warmer springs are thermal and related to the Thermal Pool activity. They do not seem to have been noted previously.

References

JENNINGS, J.N. & SWEETING, M.M. (In press) The Limestone Ranges of the Fitzroy Basin Western Australia. A Tropical Semi-arid Karst. Bonner Geographische Abhandlungen No. 32.

OERTLI, H. Karbonathärte von Karstgewässern. Stalactite 4 (1953) 8-18.

TROMBE, F. Traité de Spéléologie, Paris, 1952.

SWEETING, M.M. Zur Frage der absoluten Geschwindigkeit der Kalkerosion in verschiedenen Klimaten 1. Zeit. Geomorphologie, Supp. Bnd. 2 (1960) 66-70.

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POSSIBLE EXTENSION TO WEEBUBBIE CAVE, WESTERN AUSTRALIA

An aqualung dive was made recently in Weebubbie Cave, Nullarbor Plain, by a party from the Western Australian Speleological Society. Weebubbie is one of the largest caves on the Nullarbor and ends in a lake about 500 ft. long and up to 100 ft. wide. The diver, David Cook, penetrated about 200 ft. beyond the terminal wall of the cave. He said he descended about 30 ft. to pass through a siphon, and that he could see the roof of the siphon rising into a further cavern. Unfortunately, he ran out of lifeline and was forced to return without being able to surface in the new section.

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THE ORIGIN OF LIMESTONE CAVES

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In 1930, W.M. Davis published his two-cycle theory of cave formation, and this was really the start of a widespread investigation into problems of limestone cave development. Only after Davis' paper appeared did people realize how indefinite were their commonly accepted views. Solution obviously had something to do with it, but the actual mechanism of cave formation was very vague. Davis suggested that caves were created by solution far below the water table in a zone which was saturated with slowly moving water. This water was called phreatic, in contrast to vadose water which is in contact with the air (either in a cave or on the surface) and flows fairly rapidly. According to the two-cycle theory, most cavern formation takes place in a phreatic zone at some depth (cycle one); in a later period there is erosion and the caves are drained, exposed to the surface, and possibly occupied by streams which flow through them, but were not responsible for their original formation (cycle two). Davis presented a large amount of evidence in support of this theory, and Bretz in 1942, found that two-cycle caves were widespread in the United States of America.

Alternative theories of cave formation were not well expressed, but Davis himself had some idea of the features that might be expected in a hypothetical one-cycle cave. If it is supposed that a vadose stream gradually works its way underground by solution or abrasion, then the resulting cave should have distinctive features to distinguish it from a two-cycle cave. A one-cycle cave would presumably have a branching pattern of passages like a surface stream, whereas a phreatic origin would result in a maze of passages following joints and cracks, giving a boxwork pattern quite unlike stream patterns. A stream-formed cave would also have a gradient from top to bottom, like a stream, but a phreatic cave could change level repeatedly and have no regular gradient. Minor features, too, proved to be indicative of cave origins, and such things as spongework, scalloping and fluting have been observed in considerable detail.

Increased observations led to the postulation of further hypotheses of cave genesis, and more precise questions were asked. How far below the surface are phreatic caves formed? How is slowly moving phreatic water able to dissolve large volumes of limestone? At what period were the caves formed? And so on. From the many newer ideas the shallow phreatic theory (often associated with Swinnerton and Sweeting) has emerged as the current favourite, and this is reflected in the contents of a symposium held recently in the U.S.A. on the Origin of Limestone Caves.

The essence of this theory is that caves are formed just below the water table. This means that they will be completely saturated, and so will have many phreatic features in detail, but since the water table is flat, or has a gentle gradient, so will the caves in section have a tendency to follow horizontal or gently sloping planes. The distinctive marks of such caves, in fact, are a combination of small-scale phreatic features together with a general horizontal disposition of passages. One of the advantages of this theory is that by forming caves fairly close to the surface instead of at great depths it is possible to invoke organic acids, weathering products, and so on, to dissolve the limestone, and being close to the water table, the water can presumably flow at reasonable rates to transfer solutions.

Publication of Symposium

Volume 22 (Part 1) of the Bulletin of the National Speleological Society (U.S.A.) is devoted to the Symposium on the Origin of Limestone Caves, held in January, 1960. The result is presumably a cross-section of present-day opinion in the United States, and the most striking feature is the dominance of the shallow phreatic theory, although the United States was the home of the deep phreatic idea. Most of the papers provide clear evidence for the points made, and it is clear that there is a high degree of scientific competence amongst American cavers.

G.W. Moore provides an introduction to the Symposium and outlines the main features of the meeting. The network pattern of many caves suggests that caves are formed in a zone of saturation. Most caves also have a horizontal pattern and so are not formed at random depth. It appears that a "piezometric surface" (what we would probably call the water table) provides the horizontal control, and the caves have been formed directly below it. Just why solution should be greater here is uncertain, but it may be related to a greater volume of running water, to greater widening of joints, or to chemical effects.

The general introduction is followed by an excellent, detailed study of caves in folded limestone in the Appalachian region by W.E. Davies. Despite the dip of the rocks the caves have gentle gradients, and passages can develop across the dip. Caves are found at several levels, and it is assumed that they were formed successively, the higher being the older. Within any region the separation between the multiple levels is uniform, and the intervals between cave passages correspond to the intervals between gravel benches (river terraces?) in the major valleys. Large caves occur near large valleys, and in upland areas there are only small caves. The stages of cavern development are considered in detail, but the major part of cave formation was accomplished during a period when the water table was uniform in altitude and flow was constant for a long period of time.

Bedding and Joint Control

A more complex situation from Virginia is described by G.H. Deike. Here caves are formed in a syncline of limestone between two sandstone bands. This gives rise to artesian conditions, but the water finds outlets on the edge of the syncline. The caves are markedly joint-controlled, and are also controlled by the bedding. Those far removed from outlets show evidence of deep phreatic development, but near the outlets there is a tendency for caves to be horizontal and shallow, regardless of bedding. There is also indication of several changes of level, causing multiple levels of caves. Thus we have water table control at the outlets (believed to be formed just below the water table), but at depth in artesian conditions there are pure phreatic caves. In late stage development some caves were occupied periodically by streams which deposited alluvium. This paper then, lends some support to the dominant water table theory, but clearly indicates that more complex situations can occur. If Deike had adopted an over-simplified theory he would not have produced such a complete and satisfactory explanation of cave origin.

A further account of Appalachian caves comes from W.B. White. According to his account the caves occur in steeply dipping limestone, but although the passages tend to follow the most soluble beds, the caves remain horizontal and do not extend much up dip or down dip. Water table control is again the dominant factor, and structure and lithology affect only the ground plan and cross section of the caves. He classifies caves on pattern as linear, rectangular, branchwork (his example is clearly structurally controlled and the branching is not genetically significant), network and irregular. Once again it is thought that the shallow phreatic rather than the deep phreatic theory provides the best explanation of cave origin, and it is suggested in discussion that the shallow zone is perhaps up to 100 feet thick. This paper is called "Terminations of passages in Appalachian caves as evidence for a shallow phreatic origin," but nothing diagnostic is said about passage terminations.

A paper by J.V. Thrailkill describes the origin and development of Fulford Cave, Colorado. This is a complex cave in dipping limestone; some passages follow the beds and some remain horizontal, but the latter are strike passages. The evidence here is not as clear as that from the Appalachian caves, and although it is discussed at length, the conclusions are not so positive as those of, say, Deike. It is suggested that the caves formed in three stages: (1) deep phreatic, (2) shallow phreatic and, finally, (3) vadose conditions, and on the whole this seems a reasonable interpretation. Development of cavities apparently began in late Palaeozoic time, but the main cavern development probably occurred during Wisconsin time (the last ice age).

Ghyben-Herzberg Hypothesis

J.H. Bretz gives a brief account of some very unusual caves which occur in Bermuda. At present there is no fresh ground water in the islands and most of the caves contain salt water. Bermuda's fresh water supply is from rain on roofs and other catchments, and from tankers. Despite this the caves are of phreatic origin, and undoubtedly the result of fresh water. To account for this paradox, the Ghyben-Herzberg hypothesis is invoked. This maintains that an island of adequate size can maintain a lens of fresh water, but that a too-small island cannot. In glacial times there was a lowering of sea level, so Bermuda was much bigger than now and maintained a lens of fresh water, enabling phreatic development of caves to take place. With a rise of sea level the phreatic conditions were destroyed, and the caves became partly filled with water, which is the present state.

Changing Concepts

A more general paper entitled "Changing concepts of Speleogenesis" is offered by W.R. Halliday. He dislikes the current emphasis on "one-cycle" "two-cycle" theories, etc., and believes that caves are all so different that an over-simplified idea of their formation is dangerous. Structure, processes and stage are all relevant factors in cave formation and emphasis should be placed on the specific nature of features of individual caves derived from processes in all phreatic and vadose zones. Study of a cave then results in description of individual speleogenetic sequences, and this is much better than a simple "one-cycle" or "two-cycle" label. Nevertheless, it is necessary in discussion to have a verbal shorthand, and so long as it is realised that this is so, the brief terms may be used. Apart from this main theme, the paper is also a good review of the history of ideas on cave genesis, and there is a useful discussion of several concepts such as "phreatic" and "cycle."

The discussion after Halliday's paper is of some interest. C.R. Warren suggests that speleologists drop the terms "vadose" or "phreatic", or use them in his allegedly geological senses (he says "accepted" senses). This suggestion receives little support from other speakers. W.E. Davies still feels that "there is one way in which most caves have formed, and we must find that way. If not we will have chaos; there will be 5,000 different ways to form caves." This seems to the reviewer to be a very unscientific attitude. If there are 5,000 ways to form a cave they must all be studied, and there is nothing to be gained from saying there is only one way, and ostrich-like ignoring the rest. The papers by Deike and Bretz, already referred to, seem to support Halliday rather than Davies.

There is a tendency in much of present day geomorphology to try to use mathematical methods in place of the older observational or "phenomenological" methods, and the symposium contains an example. The paper by

R.L. Curl is called, "Stochastic models of cavern development." It uses examples from West Virginia and the proportion of the total number of caves is plotted against cave length to produce a curve. Another curve is obtained by plotting those caves with only one entrance. The shape of these curves is then accounted for by adopting formulae and assumptions that seem suitable. There are so many factors and possible assumptions that might be used that at the end we have no ideas that were not built-in, and, in fact, a two-cycle geomorphic history is assumed! The conclusions reached deal not with caves so much as stochastic models, although numerical values are attached to two of the possible factors. Curl's claim that "the alternative to a stochastic model is to maintain that every cave is unique and that no process may be identified as acting in common upon all caves" is nonsense; many scientists who recognise features common to several caves do not feel obliged to accept a stochastic model.

Another slightly mathematical paper is "Geometrical basis for cave interpretation" by A.L. Lange. Sharp projecting corners remain sharp while dissolving, but round off when encrusting; inside corners round under solution and remain sharp during deposition. This statement, expressed more elaborately, is the crux of the paper, but it only deals with mathematical aspects. Physical chemistry and crystallography can cause complications, and exceptions to the general statement are pointed out in discussion and can doubtless be thought up by the reader.

Apart from the last two rather pointless papers, the standard of the symposium was very high, and the publication must have been stimulating to cave researchers in the United States, who are, no doubt, looking over their caves again in the light of numerous new ideas. We can benefit from the ideas in Australia and New Zealand, too. Perhaps, one day, we will be able to hold our own symposium and get a concensus of Australasian opinion.

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HISTOPLASMA CAPSULATUM RECOVERED FROM BAT TISSUES. By Martha H. Shacklette, Fred H. Diercks, Nathan B. Gale. Science, March 30, 1962, 1135.

Histoplasma capsulatum was recovered from the liver and spleen tissues of a species of predominantly insectivorous bats as well as from soil collected at Madden Air Field in the Republic of Panama. This is the first report of the recovery of this fungus from bat tissues. The role of bats in the dissemination of H. capsulatum in nature remains to be determined. Whether they are able to disseminate the organism in their excreta or whether they experience overt disease cannot yet be stated. However, the association of the organism with bat guano suggests this animal may eventually be implicated as one of the reservoirs of nature. - E.L.

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ORIENTATION OF BATS AND MEN BY ULTRASONIC ECHO LOCATION

Abstracted from a paper by L. Kay, Electrical Engineering Department, University of Birmingham. University Publication 61/21, and British Communications and Electronics, 1961.

Griffin, in 1938, first detected ultrasonic transmissions from bats and suggested that they used ultrasonic waves as a means of orientation. Several theories have been offered since to explain the high degree of acoustic acuity enjoyed by these animals, but none satisfactorily explains performance under difficult conditions. In this paper a new theory is discussed, together with a possible application as a guidance aid for blind humans.

Kay states that there are two forms of ultrasonic transmission made by bats. Vespertilionidae are characterised by rapid change of frequency from about 80 kc/s to 40 kc/s in a period of a few milliseconds. Whilst the highest frequency may vary, the change of frequency during the sweep was usually of the order of one octave. The sound was made by the larynx (in a different manner from that of a human larynx) and the bats flew with their mouths open. The sound field of emissions covered an angle of more than 90°. There was no beaming of sound and the conclusion is reached, by observation and experimentally, that directional information is derived from signals received by the two ears which are held rigid during flight. Flight without bumping objects is interferred with if one ear is plugged or displaced.

The transmissions of Rhinolophidae is different in that the amplitude and frequency of the emitted ultrasound is almost constant for anything up to 100 milliseconds and the average duration of the order of 60 millisecs. There is a similarity with the emission of Vespertilionidae at the end of the constant frequency transmission - the frequency falls rapidly by 10 to 20 kc/s depending upon the frequency of the tone, and the fall is almost linear. A narrower frequency sweep is made, but duration is comparable with Vespertilionidae.

Rhinolophidae make their emissions through the two nostrils. One theory suggests that the nostril spacing might help control the frequency. A feature of Rhinolophidae is also the rapid and independent movement of the ears backwards and forwards in addition to the scanning movement. Blocking of one of the ears has little effect on the bat's ability to orientate itself. Without ear movement, however, the bat blunders about and is reluctant to fly.

Experiments have shown that bats can easily avoid wires of 1 mm diameter and only seem to be bothered by wires of less than 0.3 mm diameter (about 1/20th. of a wavelength). The animals's echo-location process is remarkable as compared with human efforts using radar and sonar.

Kay states that a background of noise did not cause any interference to the bats. He continues that the high degree of echo-location acuity could hardly be explained by reference to simple principles of sonar. With Vespertilionidae the emission resembled that of the transmission for a pulsed frequency-modulation echo-location system, and the returning echoes would also be pulses of varying frequency, and a difference frequency could exist which was a function of the distance to the object. The duration of this difference frequency was also a function of the distance. Echoes received during transmission could be detected by the beat-note produced in the ears (as when we sing out of tune to a musical instrument). In this manner, a bat could detect objects from three to four feet to zero distance. Kay says the behaviour of the bat makes it appear that resolution beyond the range covered by the beat-note is comparable to that during the time a beat-note is possible. He gives two possible solutions: (a) that memory is used to give a neural beat-note, or (b) a very low transmission is made to set up vibrations in the head when an echo beyond the range of a few feet is received.

He adds that each reflecting surface of object within the first few feet would give a beat-note whose frequency was directly related to the distance so that several objects could be resolved by the cochlea. A simple pulse system would not provide this information. With the beat-note giving distance, an object to the left or right would give a frequency difference at the two ears. Such a system would be expected to give a better performance against a noise background.

The use of long-tone transmission by Rhinolophidae suggested the use of a system relying upon Doppler Effect. This would not be a very effective system for the bat if it relied only on its own flight movement to produce a beat-note between the transmission and the echo from a stationary object. When roosting it would know nothing of its surroundings and would probably miss slowly moving objects. The rapid movement of the pinnae, however, might be the way the bat has overcome this difficulty. A beat-note would be produced in synchronism with the ear movement, even though the bat was not flying and the surroundings were stationary. Several objects, however, could not be resolved by this movement.

Kay adds that a very interesting fact was that two so very dissimilar forms of sound transmission might require the same mechanism of reception and that the same principle might be used for location of objects at short range.

He then discusses the possible application of a system of frequency-modulated transmission to give a beat-note, to the possibility of providing blind humans with information about their surroundings. He concludes that these theories are controversial, but says there is no doubt that the frequency-modulation system was very much superior to all the pulse and frequency sweep arrangements which relied only upon a time interval to be measured by the neural system to give distance information.- E.A.L.

AUSTRALIAN CAVE FAUNA - NOTES ON COLLECTING

Australian Cave Fauna - Notes on Collecting. By Elery Hamilton-Smith. Published by the author. 19 pp., 3 figs., October, 1962. Price 5/.

This booklet opens with an introductory indication of the importance of collecting animals in caves and continues with definitions of a few terms used in discussing cave fauna and with mention of some of the principles involved in the use of scientific names. A brief mention is also made of the significance of certain environmental factors peculiar to caves which have important consequences as far as the cave fauna is concerned. The bulk of the booklet contains descriptions of simple equipment which can be used for collecting specimens in caves, and a list of the groups of animals likely to be encountered there, together with indications of the appropriate method for the preservation of each. Two pages are devoted to line drawings illustrating the typical forms of animals likely to be encountered and one page to similar illustrations of equipment.

The booklet is roneoed, stapled, and has a soft, printed cover. Apart from a few points mentioned below, the book is adequately presented.

This work is not written for the specialist zoologist but for the speleologist who is interested in collecting, for identification, the animals which he meets in the normal course of his caving activities. In these days of specialised study it is important that animals be collected and preserved in the correct way if they are to be of use to the specialist who is to identify them. This booklet provides a concise account of the best way in which this can be done without the use of too much equipment.

It is a pity that some spelling mistakes have been allowed to creep in and it would have been preferable had the figures been referred to in the text. Also, it is stated that cave-dwellers fall into three major groups, but four groups are defined. These points do not, however, detract from the usefulness of the booklet and many speleologists will undoubtedly be encouraged by it to collect specimens for study; in that way it should fulfil its purpose in making the Australian cave fauna better known and help speleologists to take their opportunity to assist in this.

- C.N. Smithers, M.Sc.,
Curator of Entomology,
The Australian Museum.

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RIDGE MINE POT, WYANBENE, NEW SOUTH WALES

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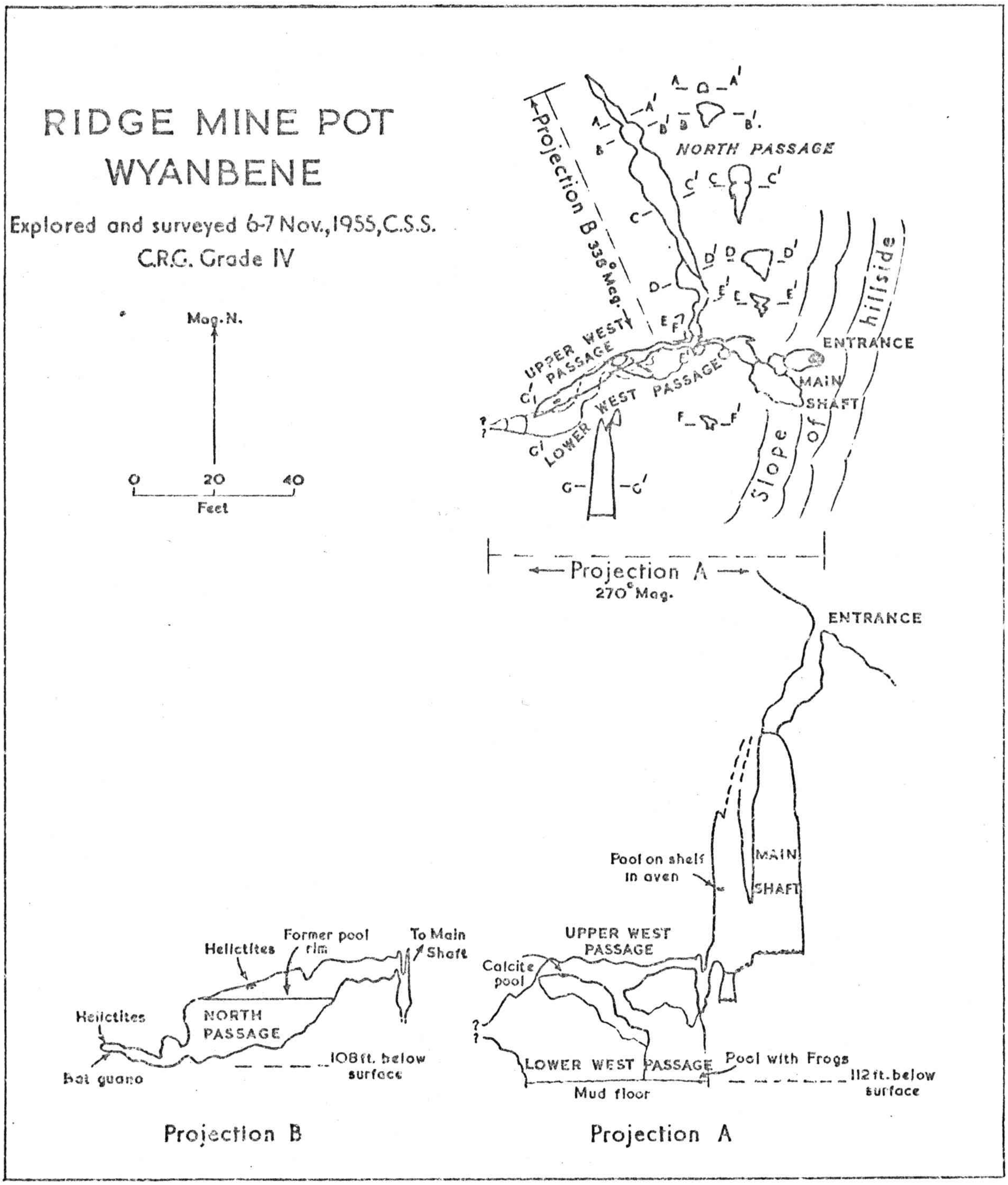
Few Australian caves have been designated as "pots" or "potholes", terms from the North of England implying shaft-like development from the surface. Nevertheless caves which would qualify as pots are by no means rare in this country, for instance in the Nullarbor Plain where N32 Cave is an excellent example and where many of them are "blowholes" as well. That Ridge Mine Pot at Wyanbene has been given this name is perhaps to be linked to the presence of two Yorkshiremen in the original exploring party. However, surveys of Australian pots seem to be as rare as the name and this is the reason for the inclusion of the present note and accompanying figure in this journal.

J. Webb found the pothole in November, 1953, and a Canberra Speleological Society party descended about 25 feet in February, 1955. A full descent had to wait on the construction of more ladders and it was not until 5-6 November, 1955, that a large party under the leadership of Webb explored the cave to its present known limits. A survey using prismatic compass, Abney level and metallic tape was made for which the writer and D. Moore were chiefly responsible.

A low, but sharp divide, between Shoalhaven and Deua drainage rises steeply from the head of the flat running from Mr. R. Watt's homestead to Wyanbene Cave and right on the saddle is an old mine shaft. To get to the pothole one traverses some 200 yards from this shaft along the right bank valleyside of the steeply incised Deua tributary. Thus the pot lies near the southeastern end of the limestone outcrop. Not far above it the Silurian limestone is overlain by Devonian conglomerate and sandstone; indeed the small Clark's Cave nearby is actually developed in the unconformity between the two geological formations.

Ridge Mine Pot does not lie in a gully but breaks abruptly a fairly uniform, if steeply inclined, slope. So, little gathering of surface water occurs to feed the pot. The pothole characteristically consists in the main of two shafts merging below but tapering independently upwards. The smaller shaft appears to be blind, i.e. it is an aven in the British terminology. The main shaft leads to the entrance which is, however, not directly above it but to a flank at a steep angle. Downward-seeping water seems to have fashioned the shafts by solution along the very steeply dipping bedding planes, giving the shafts an elongation in plan along the strike. Much of the walls of the shaft is now coated with secondary calcite, suggesting that there is little active excavation today. The floors of the shafts consist of broken rockfall; at the side of the smaller shaft



RIDGE MINE POT
WYANBENE
Explored and surveyed 6-7 Nov., 1955, C.S.S.
C.R.G. Grade IV
Mag. N.
0 20 40
Feet
Projection B 338° Mag.
NORTH PASSAGE
UPPER WEST PASSAGE
LOWER WEST PASSAGE
ENTRANCE
MAIN SHAFT
Slope of hillside
Projection A
270° Mag.
ENTRANCE
Pool on shelf in oven
MAIN SHAFT
UPPER WEST PASSAGE
Calcite pool
LOWER WEST PASSAGE
Pool with Frogs
Mud floor
112 ft. below surface
Helictites
Former pool rim
To Main Shaft
Helictites
NORTH PASSAGE
Bat guano
108 ft. below surface
Projection B
Projection A

X61-176

floor there is a six foot hole in which are wallaby bones.

From the smaller shaft a constricted entry, which had to be enlarged with the hammer, leads into two short, narrow, horizontally developed passages at right angles to one another in general trend. The North Passage lies along the strike whereas dip joints control the direction of the West Passage. The total length of these passages is only about equal to the total depth of the cave, which thus deserves the name of "pot" quite fully.

The North Passage is the more interesting because of some rather attractive decoration. This consists chiefly of former pool rims, which in parts have been overgrown by dripstone fringes subsequently to the drainage of the pool. This passage is nowadays quite dry. Also there are some helictites. A small amount of bat guano occurs at the low extremity of this passage though no bats were seen at the time of this exploration.

The West Passage consists of two levels, the upper one being rather tight whereas the lower one is of tall fissure type. The latter has a mud floor, which is the lowest part of the cave. At one end a thin film of standing water was present at the time of exploration and here four frogs were found. During a subsequent visit of the Sydney Speleological Society (September 29, 1955), Miss Barbara Dew collected specimens and identified them as belonging to two species, *Mixophyes fasciolatus* and *Hyla lesueurii*. She reports often finding such frogs in caves. In this case one wonders whether they managed to survive a fall down the 54 feet overhang in the main shaft or whether they had some other ingress. Miss Dew also reports collecting an opilionid (harvestman), *Holonuncia cavernicola* Forster, and several species of spiders, including *Cycloctenus abysinnus* Urquhart.

The tendency to horizontal development at the bottom of the pot is not related to the level of the valley bottom outside, which lies far below. It would be interesting to compare the altitude of the bottom of Ridge Mine Pot with that of Wyanbene Cave stream and of the valley flat to which the latter cave's development is related. Ridge Mine Pot may have developed before the incision of the Deua tributary took place and at a time when this valley was at much the same level as that of Wyanbene Creek.

There is no satisfactory belay point at the pot so it is necessary to lay a piece of timber across its mouth to suspend the ladder. We used a ladder for the final sharp drop from the upper to the lower level of West Passage but it could be done with reasonable safety by rope alone.

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ABSTRACTS

RADIOCARBON DATING, FIFTH INTERNATIONAL CONFERENCE. By Prof. H. Godwin. Nature, 195 (4845):943-5, Sept. 8, 1962.

GEOPHYSICS, HALF-LIFE OF RADIOCARBON. By Prof. H. Godwin. Nature, 195 (4845):984, Sept. 8, 1962.

The first reference is a paper giving a brief description of the Fifth International Conference on Radiocarbon Dating and discussion on new developments in this method of dating. The second reference refers to a resolution concerning new determinations of the half-life of radiocarbon 14.

The newly determined half-life is the mean of three very similar carbon 14 values from three laboratories and is given as 5730 + or - 40 years. The "Libby half-life" used heretofore is 5568 years. The Conference resolution recommended that the Libby half-life still be used for the time being for age results, but anticipated that upon completion of the half-life experiments which might give an even more reliable result, the adopting of a new procedure for reporting would be considered. In the interim, published dates could be converted to the basis of the new half-life by multiplying them by 1.03, without appreciably altering the standard errors as quoted.

The Conference also confirmed the practice of using AD 1950 as the radiocarbon dating reference year for reporting radiocarbon measurements.

- E.A.L.

KARST MORPHOLOGY IN AUSTRALIAN NEW GUINEA. By J.N. Jennings and M.J. Bik. Nature, 194 (4833):1036-8, June 16, 1962.

The authors during 1960-61 made reconnaissance studies of a number of karst areas in Australian New Guinea ranging in height from sea level to about 3700 metres and developed in limestones which vary considerably in age and in lithology.

They discuss the karst features at various zones of altitude and rainfall, the latter ranging from about 80 to 300 inches a year, with the higher rainfall at lower altitudes. They state that there seems to be an altitudinal climatic zonation of karst in New Guinea, though at each level the picture was not a simple one, complicated as it was by the cross-cutting influences of lithology, structure and evolutionary history.

After discussing several questions relating to karst, they add that the possibility needed to be considered whether, at certain levels, high tropical mountains might not provide the optimal conditions for karst evolution, combining as they did lower temperatures, hence higher saturation equilibria for carbon dioxide, with a fairly high and an effective precipitation and with the prolific vegetation growth of mossy montane forest throughout the year. - E.A.L.

HISTORICAL ZOOGEOGRAPHY OF AUSTRALIAN MAMMALS. By George Gaylord Simpson. Evolution, XV (4):431-446, 1961.

In this paper a study is made of the historical zoogeography of the five orders of native Australian mammals. Over half the native orders and families, and nearly half the native genera, are placentals. The placentals are of comparatively recent introduction or of only two broad adaptive types (bats and rats). The great majority of ecological niches for land mammals are filled by marsupials. Simpson considers each order in detail in the following sequence - Carnivora, Rodentia, Chiroptera, Marsupialia, Monotremata. His comments on bats are summarised here.

For bats, specific and generic endemicity is considerable, but is less than for rodents, and none of the seven families is endemic. Only two of the 21 Australian genera and six of the 39 species groups are confined to Australia. All were derived ultimately from Asia, where the basic differentiation occurred, in a long series of migrations, perhaps 30 or even more, from early Tertiary onwards. New Guinea was the major centre for bat differentiation within the Australian region, mainly at lower taxonomic levels. Repeated spread from New Guinea to Australia occurred. There was no extensive radiation in Australia, and new differentiation there was less than in New Guinea. There is a fairly regular gradient of chiropteran faunal similarity from Asia through the East Indies to Australia. Migration was predominantly in the direction Asia - Australia, and the gradient is in part due to progressive evolution along that line, in part to subsequent counter-migration from New Guinea westward, and in part to more local differentiations and movements. - A.M.R.

A NEW CAVE-INHABITING CRANE-FLY (TIPULIDAE, DIPTERA) FROM NEW ZEALAND. By Charles P. Alexander. N.Z.J.Sci. 5 : 137-40, 1962.

A new species of crane-fly (Tipulidae, Diptera) is described from a cave in West Nelson, New Zealand. It belongs to the vast genus Gynoplistia Westwood, one of the most characteristic and distinctive genera of these flies in the Southern Hemisphere. The species has been named Gynoplistia (Gynoplistia) troglophila Alexander. It is described from two male specimens found in a dry upper level of Wet-neck Cave, Paturau, the female being unknown. It is allied to G. (G.) hiemalis (Alexander) and G. (G.) ocellifera Alexander, both of which occur in the North Island of New Zealand. A key is given for the separation of the three species. All species are adult during the winter. It is possible that, in certain cases at least, G. (G.) troglophila is a true cave dweller, although it may be found outside caves. The two specimens taken were found dead, and may have entered the cave by accident. The species Gynoplistia (Gynoplistia) tuberculata Edwards has, however, been found in several caves at Paturau, and appears to be a true troglophile. - A.M.R.

CAVE DEPOSITS OF PHOSPHATE ROCK IN CENTRAL JAVA, INDONESIA. By R.F. Johnson and Rab. Sukamto, Geological Survey Research. Article 367, D-219/221, 1961.

Known deposits of phosphate rock on Java are in limestone terrane and commonly occur in caves. The phosphate rock is formed by chemical reaction between phosphoric acid (derived from the excreta of bats) and the limestone floors of the caves. The report describes caves near Adjibarang and Sukolilo in Central Java.

Steep-floored caves near Adjibarang have developed in limestone beds of late Miocene age. Breccia composed of limestone fragments and soil accumulates in the deepest part of the caves. A vertical section through the cave filling commonly shows a soil layer, then one to two metres of soil containing a skeletal network of phosphate rock veinlets containing up to 15 per cent P_2O_5, below this a breccia of limestone fragments cemented and partially replaced by phosphate rock (as high as 32 per cent P_2O_5). The limestone floor of the cave is also replaced by a thin layer of hard phosphate rock.

Surface deposits of phosphate rock in or adjacent to the limestone beds are believed to mark the sites of former caves that have been destroyed by erosion. Of 21 caves and surface deposits visited near Adjibarang, only six contained possible reserves of 100 tons or more. One cave, Gua Serwiti, possibly contains 20,000 tons of low-grade phosphate rock. Residents report that about 10,000 tons of phosphate rock have already been produced from this cave.

Caves east of Semarang have developed down dip in the limestone, but have gently sloping floors in contrast to those in the Adjibarang area. More than 30 caves were examined (ranging from mere overhangs to caves 200 metres long). The phosphate rock occurs as skeletal networks in soil or as cement in cave breccia. About half of the deposits contained from 70 to 2,000 tons each of phosphate rock having from 7 to 36 per cent P_2O_5.

The authors state that difficulties in utilising the phosphate rock for superphosphate are: (1) The caves are small and widely scattered. (2) Most deposits are low grade. (3) Impurities will require special methods of treatment. (4) Sufficient reserves for sustained production are doubtful. - E.A.L.

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NEXT INTERNATIONAL SPELEOLOGICAL MEETING. The next International Speleological Meeting will be organised by the Greek Speleological Society and will be held in Greece between August 28 and September 16, 1963. Papers will be read and discussed in Athens between September 1 and 5. Excursions will be organised before and after the meeting to Peloponnesus, Cephalonia, and the developed caves of Mani, Epirus, Macedonia, Crete and other islands.