

BULLETIN TEN



The Caves of Texas

APRIL 1948

BULLETIN TEN

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To stimulate interest in caves and to record the findings
of explorers and scientists within and outside the Society

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THE NATIONAL SPELEOLOGICAL SOCIETY was organized in 1940. It now has members scattered throughout the United States, and also has many members in foreign countries.

THE SOCIETY is a non-profit organization of men and women interested in the study and exploration of caves and allied phenomena. It is chartered under the law of the District of Columbia. Its energies are devoted to the unlocking of the secrets of the netherworld.

THE SOCIETY serves as a central agency for the collection, preservation, and publishing of scientific, historical, and legendary information relating to Speleology. It arouses interest in the discovery of new caves and encourages the preservation of the natural beauty of all caverns.

THE AFFAIRS of the Society are administered by a Board of Governors elected annually. The Board appoints the national officers. The Board also appoints committee chairmen—who are chosen not only for their proved ability in a particular field, but also for their activity in the work of the Society.

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LIBRARY: An excellent speleological library is owned by the Society and constantly is being enlarged. Items on hand may be borrowed by NSS members. Extensive collections of cave maps, photographs, and slides are being gathered together and are available on a loan basis.

MEMBERSHIP helps to support the publications, special investigations, and the operation of the Society.

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PUBLICATIONS include the BULLETIN published at least once a year, and the NEWS appearing monthly. All members receive the BULLETIN and the NEWS.

Why Texas?

BULLETIN TEN is an experiment. If judged to be a success, it will be followed at intervals by other regional surveys.

It will surprise many persons that Texas was chosen as the first of the projected series. The NSS has relatively few members there, and its caves are probably less numerous than in several eastern areas of equivalent size. But the caves of Texas, and their contents, are so varied and unusual that the choice was a logical one.



Nowhere in the United States is there a more remarkable collection of living cave animals, while the few excavations of fossil animals give promise of further rich finds. The country's largest series of Indian paintings decorate the walls of its caves and rock shelters. It has more great bat caves, rich in history and legend, than possibly any equivalent area in the world. And Texas has so many partially and completely unexplored caverns, some of them dangerously deep, that they offer a tremendous challenge to the growing army of speleologists and spelunkers.

FIVE YEARS AGO the Exploration Committee of the NSS compiled its first list of caves of the Lone Star State. This became the worksheet for the small group of speleologists who for the last year and-a-half have spent almost every spare hour, weekend, and vacation ferreting out new caves, exploring and describing them, collecting their fauna, and searching out printed and unprinted information about them.



An editorial committee, appointed in September, 1946, has coordinated the program of exploration and investigation that is culminated in this Bulletin. It has rounded up photographs, maps, and drawings, secured out-of-print documents from the Library of Congress, and arranged for the inclusion of data from journals and magazines whose ink scarcely was dry when Bulletin Ten went to press.

IN TEXAS not all time was spent cave crawling. Radioman Pat White went on the air repeatedly to locate persons with valuable information. He did not succeed, though, in getting anyone to bring him a blind fish—rarest form of subterranean



life in Texas. He led party after party to the many caves of the Edwards Plateau and finally gave up his job to carry on a furious program of exploration right up to our deadline for going to press.

Sixteen years ago a doctor sent accountant A. T. Jackson to "a high, dry climate" for his health. He became an archeologist and explored hundreds of caves and shelters. This Bulletin could not have been prepared without his extensive knowledge of Texas caves and his untiring efforts in the past 18 months in running down clues in dusty courthouses and in library and newspaper files.

Many others have helped: cave manager Tom Goeller, globe-trotting attorney Vic Craun, scientists too numerous to mention here, as well as college students from Texas to California.



ON FOOT and on muleback, by car, jeep, and truck our spelunkers have travelled in their searches. Most unusual was Peter Koch's raft, built of four century plant logs which he paddled, sometimes carried, down the canyons of the Rio Grande.

From these sources we have fashioned a guidebook. It is an invitation to you to sample the speleological riches of our biggest state. But it is more than that. Throughout the following pages are mentioned specific problems of exploration, promising fields of investigation, and needed observations. Bulletin Ten can be generously supplemented and it is the moral obligation of every person who uses it to see that additional data of interest is forwarded to the NSS for filing and possible publication.

C.E.M.



Tom Cu'verwell

JUST BEFORE MIDNIGHT Ralph Velasco is lowered to join Floyd Potter in the first exploration of the Devil's Sinkhole by NSS members. Floyd, 200 feet below, shouts that he is on top of a huge mountain of rock and travertine. Eddie Raney lies on the ledge overhanging the widening hole, while Pat White operates the auto to which the cable is attached.

The Devil's Sinkhole

By PATRICK J. WHITE

*A*DVENTURE has been defined as the result of inadequate foresight. And we had no way of foreseeing the problems attendant upon the conquest of that isolated, monster of abysses called The Devil's Sinkhole!

Utterly alone on the highest, most remote point of the great windswept prairies of Texas' Edwards Plateau, this 407-foot cauldron has been shunned by man and animal alike through all the generations it has been known. The few attempts to exploit it have met with failure; livestock refuse to venture within a thousand feet of it; and the few men who have passed its formidable barrier have left conflicting legend and little else.

On the bright, moonlit night of January 24, 1947, at 8:15 p.m., Floyd Potter, Eddie Raney, Ralph Velasco and I walked cautiously over the boulder-strewn prairie in search of it. The landscape was incomparably desolate: Miles upon miles of rolling hills clad only in shoulder high mesquite and occasional stunted trees. Too poor to support cattle, too arid for cultivation, a few sheep and goats were the only living creatures we met. Somewhere in all that wasteland lay The Devil's Sinkhole; precisely where, we did not know. The guide we finally found was probably as weird as anyone has ever followed.

We saw it suddenly towering against the starry sky: A waving, undulating plume of blackness 75 feet thick and rearing 150 feet above the prairie! It seemed to pulse from within as though with a life of its own—a massive column resembling some freak tornado inexplicably held fast to a stationary apex.

Intuitively, without consciously identifying it, we linked it to The Devil's Hole. But not until its overpowering odor reached us did we realize that the plume was composed entirely of flying bats!

Without their warning we might have stumbled into the 75-foot mouth of the pit which is unmarked and perfectly flush with the flat ground. For some reason, perhaps because the

air directly above the hole was warmer than that surrounding it, the bats did not fly out, but continued their rotary flight within the column.

Cautiously we approached. The rocky soil underfoot gave way abruptly to great slabs of heavily weathered limestone. And we found ourselves staring into the vortex of that mass of swirling blackness which extended far down below the earth, swallowed by a yawning ebony gulf at our feet!

With great care we lay down flat on our bellies and crawled forward until our heads were out over the shaft. The beating of wings was all about us, punctuated only by the shrill shriek of bats.

Our lights picked up the opposite ledge of the opening 75 feet across from where we lay. And, as we lowered the beams, we saw that the ledges at the surface were deeply undercut and that we were upon an overhang to a shaft far larger than its opening.

About 70 feet down, another ledge sloped precipitously outward only to dive inward and out of sight as it was undercut. Forty feet lower still, the ledging repeated itself. And another 40 feet down our lights picked up three boulders directly in the center of the Hole.

We thought then that these boulders were on the bottom. We still thought so the following day when we viewed them from the top in the full light of the sun. We were wrong. But it is only when inside the Hole that one may perceive that they merely rest upon the peak of a huge conical mountain of tumbledown which pitches downward another 200 feet to a 300-foot-broad base beyond sight beneath the deepest overhang!

For a long time we lay on the edge of the pit watching the bats who made no move to leave their swirling column. Then, alternately silent with awe and talkative with enthusiasm, we trudged back across the prairie to our automobile. We were tired. We had been eight hours late in reaching the Hole due to equipment

difficulties which had beset us since early morning.

With no way of foreseeing the dimensions of the Pit nor the unique problems a descent into it would involve, we had equipped ourselves with 1000 feet of $\frac{3}{8}$ inch cable, cable clamps, a snatch-block pulley and a bosun's chair rigged by Ralph Velasco who, because of several years' experience as a mate in the merchant marine, was put in charge of the tackle.

There was also, of course, the usual 100 feet of safety rope, assorted lights, collecting equipment and other gear. Velasco advised a more complete array of lowering equipment, but capitulated to an argument based upon expenses. Before we were done, all of us wished fervently that we had heeded his advice. What should have been one trip was prolonged into two and each of us went through some nightmarish moments which we are not anxious to repeat.

Had Planned An Early Start

We planned to leave San Antonio at 9 a.m., and reach Rocksprings, about 150 miles away, by noon. Last minute difficulties in securing our equipment delayed our start until 1 p.m. And a broken fan belt on Floyd Potter's car marooned us 20 miles from Rocksprings on the desolate prairie. Two hours more were lost while Eddie Raney flagged a ride into town and returned with a new belt. This time was spent searching for herpetological specimens for Floyd, but rock after rock upturned at considerable effort yielded only nests of ants and dens of writhing scorpions.

We arrived in Rocksprings about an hour before sundown and were sent back 10 miles along the way we had come to The Diamond Bar Ranch where the townspeople said we could get directions to the Hole.

At the ranch house a Mexican foreman greeted us alertly and in passable English. But when we requested directions to the Sinkhole, his manner became abruptly hostile and he lapsed into that nearly unintelligible patois colloquially called "Tex-Mex."

He said that the roads were impassable and that the Hole was so far out on the open range that it could not be found without a guide. He added hastily that there was no one available who could serve in that capacity. Nothing we could say moved him until Ralph Velasco addressed him in Spanish.

Velasco's idiom is authentic and the foreman warmed to him at once. In an excited gush of words the foreman told him that the Sinkhole was evil. That it was a place of ghosts and devils and terrible legends. That it was the Mother Nest of all rattlesnakes. And that nothing in the world could force him to go near it.

Ralph, with a native understanding of these people, did not laugh, but sank to one knee and while scratching with a stick on the ground began to talk seriously, softly with the foreman. The sun sank out of sight beyond the horizon before he gained his information.

Fortunately, the car was equipped with mud-der tires. We turned south from the highway through the first gate west of The Diamond Bar and immediately plunged into a bog. After about a mile of impossible slithering, the bog gave way to a hard, rocky trail as bad as any I have ever seen. The terrible beating it gave the car had nearly disastrous results the following day when we used the car to lower ourselves into the Hole.

Even the walking was difficult that night, so stone strewn was the ground. After about two miles of this rockway, we reached a fork in the road not taken into account by our instructions. There we split the party and continued afoot. Eddie Raney and Floyd Potter took the northern branch, Ralph Velasco and I the southern.

Gradually the trail disappeared entirely and shortly thereafter we saw Eddie's light glimmering in the mesquite to our left. We called and they joined us, having circled up parallel to our course.

We debated again the advisability of abandoning the search until the following day, but the urge to see the fabled abyss was too much upon us. Furthermore, the night was relatively warm and the rattlesnakes were in hibernation. Never have I seen stars more bright.

We moved onward carefully. And then, hanging like swirling smoke in the air, we saw the monster plume of bats above the hole!

The emotional impact of that first sight of The Devil's Sinkhole was out of all proportion to its anticipation. I shall never forget one moment of that night of brilliant stars, whirling, stinking bats and that terrible gulf at our feet.

There was a weird majesty in the moment as elemental as the earth itself. And not one

of the four of us escaped it. It lingered into our dreams and manifested itself in a dozen subconscious delays in the morning. It was 7:30 before we had finished breakfast at the Rock-springs hotel and 9 o'clock before we were back at the Hole. We had planned to be there at dawn.

In the full light of day the Hole lost much of its quality of weirdness, but none of its impressiveness. And as the sun mounted in the sky, the old, familiar passion for exploration replaced our strangely piquant restiveness of the night.

The daylight reached down into the huge crucible all the way to the cone of the interior mountain and by some strange trick of perspective made this point, which towers some 200 feet above the cavern floor, appear to be the floor itself—perfectly level and only about 150 feet below us.

MOSS AND LICHENS ON WALLS

Stalactites so massive as to resemble parts of the ledges themselves drooped downward covered with moss. Water dripped in a fringe from an upper tier, lost itself against the wall after about 30 feet, and could be heard gurgling somewhere near the bottom of the shaft. Gray green moss and lichens grew thickly upon the weathered limestone and some 80 feet from the surface a mass of ivy hung like a giant dark green tassel against the wall. Upon the precipitous slopes of the middle ledge, a tree, long dead, still held its bare branches upward as though in prayer to some heedless god of sun.

The shaft itself, when viewed from above, did not reveal its true dimensions. It seemed to fall sheer from ledge to ledge. Actually, it tapers on all sides continually outward away from its axis.

From a small hole artificially cut in the surface ledge, an ancient ladder, now rotten and crumbling, reaches downward to the first ledge. It is held in place by a rust covered cable and its extension to the second ledge has entirely fallen away. Another small, artificially carved hole adjacent to the ladder entrance, once served as a port through which guano was hauled to the surface some 20 years ago. The mining venture soon ended in failure.

About 50 years ago an enterprising rancher dropped his windmill pipes to the Emerald

Lake in one the caves at the bottom. Nothing is known of the method by which he gained entrance and egress, or the manner in which he performed the heroic feat of laying his pipes to the surface.

Certainly, as we looked into the Hole that morning, there was not one of us who would have attempted such a task without the aid of professional constructionists. Yet, impressed as we were with the pit, we even then underestimated the difficulty—not so much of entering—but of returning from its depths. We set to work assembling our tackle with a lightheartedness not justified by the materials we were using.

We affixed the bosun's chair (a device that looks like a swing suspended from one rather than two lines) to the end of our $\frac{3}{8}$ inch cable, weighted the chair and paid out the cable until the bottom of the Hole had been reached. We then backed the two-door Plymouth sedan as close to the edge as safety permitted and affixed the free end of the cable to the bumper. The clamps were tight and the chair solid. We had no fear of the line.

The pulley has been abandoned in favor of letting the cable run directly against the edge of the limestone ledge which was obviously soft enough to permit a track being cut by the action of the cable. We made two trial runs with the car marking the path with rocks and building rock cairns at the points where the car should be slowed for passage of the ledges, and stopped when the bottom had been reached. It all looked reasonably good even for swinging out that tremendous distance over the jagged rocks below.

We wanted Ralph to remain topside and watch the rigging on the first descent. It was Eddie's first experience with any shaft deeper than 100 feet. So the maiden drop was left for Floyd or me. We flipped a coin; I lost. Floyd crawled into the bosun's chair. And I took the car to the end of the run. Eddie stationed himself midway between the car and the ledge to relay signals and Ralph remained at the ledge to watch the line. He assisted Floyd to back out over the brink until the bosun's chair swung free. Then he signalled, "Lower away!"

At exactly 10:55 a.m., I got the signal. At 11 o'clock Floyd touched the first ledge and while dangling in the swing against its steep face began trying to hack down the dead tree

that was in the path of our descent. At 11:01 he gave up the task. At 11:03 the wheels of the car reached the cairn marked "on the bottom" and Floyd's voice drifted up the shaft, "Everything okay. Pull up the chair!"

I leapt out of the car and went to the lip of the shaft. With Floyd standing ant-like among the boulders at the bottom, I began to perceive for the first time the true depth of the hole. After a moment Ralph turned away from the pit. "Well, let's go," he said. It had been decided that he was to team with Floyd.

I got back into the car and drove forward to the cairn marked "on top." Eddie helped Ralph over the ledge and I began lowering at 11:20. Ralph was on the bottom without mishap at exactly 11:25.

Once again I went to the edge of the Hole and watched the two men below. "We're on top of a hill," one of them shouted up. "This thing is much bigger than we thought. Drop a line. We'll measure it."

Eddie threw them a line and they disappeared under an overhang with the end of it. The illusion was that they had travelled over a perfectly level surface until the overhang cut them from view. Actually their path had been down a 45 degree slope.

After a short while Ralph's figure appeared and called to haul in the line and measure it. Later we would triangulate from this measurement and from others taken in the Hole. The result of this calculation gave up a depth of 407 feet sheer from the surface of the water level—a figure which we believe to be very nearly exact.

We sent down a load of equipment and, leaving the chair on the floor of the cave, Eddie and I prepared to await the return of our friends who had promised not to be gone longer than four hours.

It was past noon and the sun was so hot that we spread a blanket on the flat, limestone ledge at the pit's entrance, stripped off our clothes and lay down for a sun bath—our first since the preceding summer. I do not know the exact temperature, but we fell asleep and rested comfortably until three o'clock with our heads not more than a foot from the top of the shaft. I mention this because of the probability that weather conditions dictated the peculiar activity of the bats that weekend. I had noted the temp-

erature during the bat flight the preceding night and it was 38 degrees inside the car.

Lying there in the sun it did not seem that it could have been so cold. But the temperature dropped rapidly at twilight and the bats came out again that night. Exactly at sundown they began their spiraling in the huge shaft. Slowly as more and more bats joined the flight, the whirling column began to extend upward into the air above the Hole. By 8 o'clock, it seemed about the same height as on the preceding evening. But this was the last night we saw the phenomenal column.

RETURN TO THE SINKHOLE

During the next week, a norther howled down out of the Panhandle. And when we returned to the Hole, the following Saturday, there was not a sign of a flying bat anywhere. Nor did they emerge the following Sunday. Apparently, the marked difference in the temperatures of the two week-ends accounted for the change in their activity for they did not go away. We saw them hanging torpidly in their usual spot under the ledges on both occasions.

M. E. Stone, a member of the Rocksprings Chamber of Commerce, who had observed the bat flight in summer, told us that their customary procedure was an upward spiraling followed by a mass break for the southeast. He said that practically all the bats flew off in this direction and that there were two flights every night. One at about 5:45 p.m., and the other approximately one hour later. He added that each lasted about 45 minutes and was preceded by a few bats which, in his opinion, appeared to be "scouting," because they returned down the Hole before the flights began.

On the one week-end when we observed any bat activity, there was nothing to indicate the direction which the bats would have taken had they broken from their column. Nor did we observe two flights. However, Floyd Potter did secure two distinct species in the Hole: One was the usual little brown bat apparently *Myotis velifer incautus*; the other was the long-eared or lump-nosed bat, *Corynorhinus*. In all probability, neither of these bats made up the flight we saw. It seems certain that the millions of bats here are the free-tailed variety, *Tadarida mexicana*. Actually the Hole is seldom visited by the natives and we were unable

to find anyone who had made other than casual and very occasional observations there.

Potter succeeded in taking from the water at the bottom of the cave a number of isopods which probably will prove to be *Cirolanides texensis*. We saw no other cave fauna although Potter netted zealously through a good many pools. He found a hibernating lizard of the variety *Crotaphytus collaris collaris* under a stone about a thousand yards from the hole. Aside from these, the only fauna observed by us in the vicinity were a number of flies presumably of the genus *Collyphora*, the common Blue Bottle Fly.

These were plentiful around the edge of the pit during the hot afternoon and disturbed our sleep as Eddie and I awaited the return of Velasco and Potter from the depths. When finally their call resounded up the shaft, it was exactly three o'clock.

Eddie and I dressed and manned the rigging. Floyd climbed into the bosun's chair and I brought him up to the highest of the two interior ledges without difficulty. There he tested the lower rungs of the ladder which led down from the manhole at the top. He reported the ladder in very dangerous condition. He had another unsuccessful attempt at getting the tree out of our path. And then he signalled to be hauled out.

UNEXPECTED TROUBLE

There the trouble began. I had proceeded with the car only about 50 or 60 feet when I began to notice an irregularity in the pull of the cable which manifested itself as an almost imperceptible jerking. Just as Eddie called, I stopped the car and ran back to the pit leaving Floyd twirling gently on the end of the cable about 100 feet above the boulder strewn floor and 50 feet below us.

At the edge of the pit I discovered that the friction of the cable had worn a groove in the soft limestone where the cable paid over the rim. This groove on the downward trips had served as a satisfactory guide. But by now it had slotted so deeply that the cable was no longer running smoothly, but was feeding in slight jerks. To make matters worse, the cable was so deeply wedged that we were unable to lift it out of the slot and give it a new seat. Our at-

tempts only served to twirl Floyd even more giddily on his airy perch.

Ralph had warned us that a cable which will pull apart only under great stress, will snap with relative ease. So we were particularly apprehensive of the jerking which we knew would get progressively worse as the slot wore deeper. We decided to drop Floyd onto the ledge and clear the bearing. Very slowly I began to back the car. Eddie's shout stopped me. The cable behind the car had gone slack. Floyd was still dangling where he had been, his weight was insufficient to pull the cable through the slot. There was nothing to do but go forward.

With great care we inched the car ahead and took up the slack. Then, as the cloud of white powder arose from the slot, the chair began to rise. I was driving so slowly that it was necessary to slip the clutch constantly. Suddenly the car began to skid—at least that is what I thought was happening.

I released the clutch fully. The motor apparently engaged. But the car did not move. Not until I smelled burning rubber did I realize that it was the clutch and not the tires which was failing to hold.

In a wave of burning rubber we would proceed a few feet. Stop. Race the engine. Lose a little ground. And then inch forward again. After a seemingly interminable period of this, the car's front wheels reached a spot only a foot from the cairn which marked the final stopping place. That last foot was the most difficult.

The ledge at the top of the Hole was only about three feet thick and the chair had to be brought up as far as possible in order to get the man out and safely over the ledge. At the same time, we could not risk taking the car an inch too far as that would have thrown the cable clamps against the slot and if any appreciable pressure from the car were then applied, the clamps would probably be stripped from the cable—or the cable would snap. Somehow we made that last foot. I set the brakes and gears and ran back to the Hole.

Floyd's blackened sweat-smearred face and the tops of his shoulders only were visible above the ledge. His expression was as close to anxiety as I have ever seen it and his temper, as we worked him upward, as close to being short as it probably ever gets. I certainly did not blame him. After that nightmarish rise out of

the depths, he was stuck at the ledge, unable to get over the final three feet to safety.

It was another problem we had not foreseen. The thickness of the ledge, the depth of the undercut, and the set of the tackle combined to wedge the knees of anyone sitting in the swing under the ledge. And there was no way of getting a straight upward pull: We could not lean out over the edge as there was no purchase afforded by anything. And the cable clamps were too dangerously near the slot to lift with the car.

Floyd was trying to clamber up by sheer exertion, but the angle would not permit it. We handed him a length of half-inch manila safety line and he threw a bowline around himself; we made the other end fast to a mesquite bush. This did little to relieve the tension. Because if we were unable to get him from his position right at the ledge, what possible luck could we have had in hauling him in hand over hand the length of the safety rope?

It took ten agonizing minutes to get him across the ledge and then it was accomplished only when he wriggled free of the lap lacing and stood upright on the bosun's chair.

I was surprised at his resiliency. He shed his tenseness almost immediately upon attaining solid ground. And I asked him to drive his car on the next haul as I thought he might better understand its peculiarities.

We cleared the cable from the slot, inspected it, and sent the chair down for Ralph. During the drop Floyd stopped several times and experimented with forward runs of the car. By the time the swing reached the bottom, he was confident of the car's ability to effect the lift. Ralph climbed into the chair and the car started.

Floyd was driving at full idling speed in order to keep the clutch holding. Ralph came up comparatively fast and began to twirl dizzily after passing the lowest edge. Then he came up fast again, spinning like a top. In short order we had him brought up firmly against the ledge. The last foot of the lift being the only troublesome one.

At this point, however, the situation was exactly the same as before. Ralph hung below the ledge just as Floyd had. We gave him the safety rope and he made it fast around himself. He was quite nervous as we all were; the giddy twirling had made him so dizzy that he had

been forced to shut his eyes and lock his arms around the tackle to keep from falling out of the chair.

Even with three of us topside, it took seven minutes to work him over the ledge. When we did, he lay at full length on the rock regaining his wind and then walked straight away from the Hole for several minutes before returning. I experienced exactly the same feeling later that night.

Both men were enthusiastic in their reports of the grandeur of the pit's interior. It had to be seen, they informed us, to be comprehended. They told of Emerald Lakes and marvelous formations; of sizes breathtakingly great and of sensations not to be experienced elsewhere.

Eddie and I decided to go down at once on the tackle as it stood. Most of the trouble had come on the ascent and Eddie proposed that Floyd and Ralph change the rigging while we were in the cave. He suggested a method which sounded as though it would solve our difficulties on the ascent.

I got into the swing, took the cable in my hands and backed out over the edge, slithering down until the swing hung free. The car started slowly and I saw the entrance fade above me. The nearest wall was 40 feet away and the first ledge was coming up fast. I could see that I was going to land in the tree which Floyd had been unable to dislodge. I called for a slowdown and just as I touched the bare topmost branches, my speed was checked.

I worked through the tree and began to twirl. Fortunately a thick branch fell under my hand just as I went clear of the tree. I used it to stop the twirl. Floyd had speeded up again and I came down on the second ledge fairly fast but in the proper position—facing inward. One kick and I arched outward and clear over the ledge and down. In a moment I was on the bottom and out of the chair. It was on its way aloft again as I got my first breathtaking view of the Hole from within.

I was standing on top of a mountain of talus, strewn with the biggest limestone blocks I have ever seen. Looking upward, along the jug shaped shaft to the entrance which appeared as a tiny window against the sky, it was clear that the mountain had been formed by mammoth cave-ins in the dim geologic past. At my feet this giant hill tumbled downward at about



Francis Wood

THE MAN is standing on the summit of a mountain which continues downward another 200 feet into the lower levels. The ledge which seems close enough for him to touch is actually some 40 feet above him. The sloping effect at the left is due to camera distortion; the hole is as sheer all around as it appears at the right. The ladders are rotten and useless; some of them are washed out of position.

a 45 degree angle for nearly 200 feet, losing itself in the shadows at the base of the walls of the room.

This was my first full view of the tremendous chamber. It undercuts the lowest ledge so deeply that only the immediate center of it can be seen from the surface. I was instantly impressed by the perfectly smooth walls and the perfect cup shape of the room. It must once have housed a great whirlpool which formed the room as much by erosion as by solution. Into this 300-foot-broad cup, probably after the water had drained away, the collapse of ledge after ledge of massive limestone above had formed the mountain and opened the entrance at the surface. Lush green moss grew profusely over all the rocks on the peak of the mountain and provided a fairly comfortable seat as I settled back to watch Eddie come down.

He backed over the edge with fair dispatch, called for a slowdown to scramble through the tree and over the first ledge. It was his first experience of any kind on lowering tackle and as soon as he cleared the first ledge he called, "Okay!" Ralph relayed the call and Floyd speeded up the car.

Eddie began to twirl violently and came down with a rush toward the second ledge! I leapt to my feet in alarm! The lowering crew could not see what was happening! Before I had time to shout, Eddie's spin turned his back toward the ledge and he slammed down on it with a sickening thud! The blow threw the chair outward, clear of the ledge. I saw Eddie's hands fly off the rigging as he arched out over the hole! His body bent far backward! He was still in the seat, but held there only by the lacing across his lap which was not designed to hold a person in the swing!

I thought he surely had broken some bones and perhaps was knocked unconscious and would fall. But immediately, I saw him draw himself up in a sitting position and his hands grasp the rigging again! The speed of the drop suddenly checked and he was lowered gently to the floor!

All of this happened too fast for any calling back and forth between us. I jumped over a boulder toward him and heard him exclaim: "Ohhh, brother!" That was enough. It did not sound like the remark of an injured person. In some manner the crash against the ledge had

done no worse than bruise him. He was quite breathless, but otherwise ready to continue the exploration. The incident had frightened me a good deal more than it had him.

The bosun's chair disappeared upward on its way to the re-rigging. But Eddie and I were too busy surveying the weird netherworld to give much thought to our trip to the surface.

The mountain fell away from us on every side. The degree of precipitousness appeared from where we stood to vary only slightly, with the easterly slope presenting a somewhat less difficult descent. Slowly we made our way downward in this direction over exceptionally rugged terrain.

Soon we were under the overhang and the green moss covering the rocks changed abruptly to deep, soft, brown guano. It blanketed everything, filling up the cracks between the rocks and even adhering to the sides of upright slabs. We directed our headlights against the ledge above us, but saw no bats. The guano was often eight inches deep and of a consistency to provide reasonably secure walking; it gave off practically no odor.

As we approached the cup-like walls of the room it became apparent that the mountain did not end at their base, but continued on down still farther. An investigation revealed that around the entire room the walls came down almost against the sides of the mountain and were there undercut horizontally for varying distances. This undercutting, where not plugged with the talus of the tumbledown, provides the caverns at the bottom of the Hole. In them are the Emerald Pools of water, the strange crustaceans, and the fabulous formations.

The most exciting view which the pit provides is from a point just outside of this final undercut. From there one looks up nearly 200 feet along the rocky slope of the mountain and on upward another 150 feet along the narrowing shaft, and finally outward to the sky. The effect is of looking upward to an open dome in some strange story book cathedral of undreamed proportions. The entrance seemed scarcely larger than a postage stamp and the hanging bosun's chair could not be seen at all.

Methodically, Eddie and I began a circle to the left around the base of the mountain. We were particularly anxious to locate two reported rooms: One is said to be directly beneath the



Francis Wood

STALACTITES DECORATE the sloping ceiling of the rooms at the base of the "mountain." They vary in color from delicate pastels to rich browns. In other chambers are tiny helectites, flowstone, dripstone, canopies, and "bacon rind." Pools of clear, emerald green water occupy the lowest point reached by the explorers.

talus mountain and to be more than a city block in length. The other is said to lead outward under the overhang and to proceed for more than five miles away from the Hole itself.

None of our party found either of these chambers. It is doubtful in my mind that the five-mile passage exists although there may be a continuation of a room which is supposed to be reached only by swimming under water in one of the lake rooms. This we did not attempt because of the lack of time.

The chambers which Eddie and I did enter, however, were many and beautiful. Almost every type of cave formation of which I have ever heard appears somewhere—if not profusely—in this subterranean fastness. Even the

walls of the outer Mountain room show rich and varied canopies of stalactites, flowstones, dripstone, "bacon rind," tiny helectites, and other forms. The coloring is mainly in the iron zone, ranging from delicate pastels to full rich brown. There are also formations of crystal white calcite, strange greens, and an odd form of guano-dappled stalactitic formation that resembles Toll House cookies.

Circling the main room, Eddie and I entered dozens of blind leads, merely wormways beneath the talus, leading nowhere. But always a drop away from the mountain revealed new wonders. Along the far perimeter of the lowest level we could reach, stands the Emerald Lake from which Nicholson is reported to have taken

blind fish. The water is cool and crystal clear, taking its emerald hue from some source unknown to us. The water depth varies, roughly from 5 to 30 feet, and several overhangs were noted well beneath the surface.

The running stream which Nicholson reported in the cave was not observed by our party. It may exist on a lower level than we attained, or in the great room under the mountain, if there is such a room.

It was during our tour by the edge of the Emerald Lake that the impossibility of giving a scientific report on this cave in the time allotted us became apparent. Such an undertaking would require days of exploration followed by days of research by experts intent upon classifying and identifying the specimens brought forth. We decided that the best we could do was to present some account of the grandeur and adventurous lure of the pit as an inducement to further speleological investigations.

Our trip around the base of the mountain was not too difficult. A great amount of climbing and some rockwork was necessary, but the way was safe enough and there appears to be almost no *scree* on the slopes—most of the rocks being firmly wedged.

Under the northwest ledge we came upon a colony of bats. They were the only ones we saw in repose and though there were a great many there, it did not seem to me that they were more than a fraction of the number we had observed flying the night before. (It is also the opinion of the natives that the majority of the bat population does not reside beneath these outer ledges, but hides away in some unfound gallery).

One of the most spectacular phenomena of the cave may be observed from directly beneath this northwesterly bat ledge: It is the westerly face of the mountain which, from this vantage point, is seen to rise as a giant fang, sharp and forbidding, with an enamel of slick, glistening travertine encrusting it. This face of the mountain could not be scaled without ropes from above. It is as slick as ice and as formidable as the Matterhorn. We had to circle halfway back around the base of the mountain before ascending to the summit again. By the time we had attained it, there was only about 30 minutes of daylight remaining. And we were anxious to reach the surface before dark and the bat flight.

On the summit, we sat down to catch our breath from the exertion of the climb. We looked upward and for the first time took pause to consider the skyward journey. The prospect was anything but pleasing.

Across the mouth of the shaft, dimly against the darkening sky, the cable stretched threadlike. There was no sign of activity. We shouted and were told that it would take about ten minutes more to complete the rigging.

Following Eddie's suggestion, they were mooring one end of the cable securely to a peg in the ground on the opposite side of the hole from the automobile. The bosun's chair was suspended from a pulley which rode free on this cable. Thus, the cable would run from the mooring, loop down the shaft, through the pulley, and up to the car. As the car advanced it would pull the loop taut across the top of the Hole, lifting the chair up the center of the shaft instead of along the lower ledges. There would be no twirl. The safety rope was to be knotted loosely around the cable and used by the ground crew to pull the chair from the center to the edge once the cable was made taut and the chair was hanging even with the surface. It sounds good. It probably even looked good—but not from the bottom of the hole!

DELAYED ASCENT

It was getting cold. Eddie and I huddled together as close to the Coleman lantern as we could get. We discussed the cave. We tried not to think of the spiderlike contraption above us.

Ten minutes passed. Then twenty, and thirty. It grew dark. We became progressively more nervous. "The unexpected!" I complained. "It's always the unexpected that causes trouble. Who in the hell expected anybody to re-rig and then test the gear on live subjects in the dark?"

There was some activity at the opening. Then a pebble came down with the zing and the splat of a rifle bullet. We yelled for care topside and were assured that all would be well in a matter of minutes. Then we saw the half inch manila line wagging back and forth at the edge of the hole as they tried to stretch it across. This is a difficult task as it must be thrown clear of bushes and small trees. But from our position on the bottom, their efforts appeared to be the confused fumbling of idiots, accomplishing

nothing. "Why don't they get started?" Eddie muttered. I was too disgusted to reply.

Finally, just as the rope appeared safely across, one end came loose and the hundred foot length of it, held only at one end, fell down the shaft. It seemed to come slowly, straightening itself out leisurely like a giant, overfed snake. Then it popped straight with a sound like a long drawn-out whiplash. There were curses from above and the rope began to be hauled upward.

Eddie and I made no comment. Our confidence in our teammates was evaporating irrationally in the prospects of being drawn up the center of the dark shaft. "What have you got that cable moored to?" I howled up to the surface. Ralph, as urbane a person as I have ever known, lay down and poked his head over the edge to reassure us.

"It's moored to an iron peg in the rock," he called patiently.

"Only *one* peg?" I yelled back.

"It's perfectly secure," Ralph assured me and began to go into a lengthy discussion of the tests to which he had subjected it.

"Never mind," I interrupted. "Let's get going. Only make sure you don't drive the car an inch too far and pull out the peg while we're hanging at the top." With as much calmness as can be commanded by a man shrieking at the top of his lungs, Ralph reassured us further. Then he disappeared from view.

The bats came out. First just a few. Then so thick that a steady rain of guano was hitting our helmets. I quit looking upward after receiving several eye-fulls. The air was beginning to sound like a maelstrom. It was pitch dark.

People react differently in a subconscious effort to protect themselves from the effects of nervousness. I have seen many strange habit patterns which are simply sublimations of the fear instinct. Mine is anger. I cursed blithely away for another twenty minutes before the swing came down.

Then I cursed ten minutes more while hanging 60 feet off the floor; the rigging had gotten fouled with the safety rope. Finally I began going up again. The ascent was perfectly smooth and effortless. The sound of the cable whispering through the pulley was reassuringly



Francis Wood

A DESCENT on the improved rigging used on the trip to the Hole is supervised by Capt. F. M. Johnson. The automobile furnishing the lowering power is out of sight down the trail; it will approach the hole as the bosun's chair swings lower. The car in the foreground serves as mooring for the stationary trolley.

steady. But now I was among the unbelievable vortex of bats. Contrary to custom, several thumped me on the legs.

About ten feet from the top, I began yelling for them to slow the car and take care against pulling up the stationary end of the cable. They were as concerned about this, or almost as concerned, as I. We negotiated the last ten feet at a snail's pace. And I was sweating profusely in spite of the cold.

I refused to look down. I kept looking up in spite of the guano and there, overcast by the bats, were the Seven Sisters of The Pleiades swinging directly overhead.

Ralph let go the safety rope. Its big open knot slid down the cable with a swoosh, and fetched up against the pulley; its free end struck the side of my head with staggering force, but I clung to the bosun's sling. It is an eerie feeling to hold on to something which you know will be the one thing that falls if anything does.

"For God's sake, pull this damned thing in!" I demanded.

They pulled. But I did not move very far. The sag in the cable was still too great. Floyd had to run 800 feet down the road to the car and inch it even further ahead, applying more pressure to the mooring. Then he came back to the edge and they brought me over against the ledge, but there I stuck. All of their work to re-rig had come to naught so far as that last three feet was concerned. The cable sag placed me in exactly the same predicament as Floyd and Ralph had been in that afternoon.

If anything, I was worse off. I was slightly lower and involved with an extra rope in which I nearly hanged myself. All in all, it took 15 minutes to get me over that ledge. At that, I had to repeat Floyd's maneuver of standing upright in the swinging bosun's chair.

I lay on the ground for a moment and then walked away from the Hole. I did not want to look at it or go near it. It was then that I had the most difficult task of that very nerve wearying day. I had promised Eddie as I left the cave floor that I would check the cable mooring before he came up. This was perfectly easy to do, but it meant returning to the edge of the pit, laying down, and sticking my head back out over the side. For some strange psychological reason it was more difficult to return to the edge of the pit than it had been to get into the swing and make the ascent. As soon as I reported to Eddie, I got back away from that Hole again. But by the time the chair had gotten back to the floor for him, the short-lived repugnance for the Hole had vanished and I went back to the edge to aid in getting him up.

It was the same old story. A clear run upward through the bats with a silent prayer for the mooring. The stalled swing over the middle of the hole as the last few feet were inched. The hand-over-handing of the pulley over to

the ledge. And, finally, the last nightmarish moments of trying to struggle onto the flat rock. It took fifteen minutes to get Eddie across the ledge.

The bats were up to the full height of their column by now. And there was much more of the cave we wanted to see. But all of us had had our fill of this particular rigging. We decided to call it quits until the following weekend when we could return with proper equipment.

So it was that on the following Saturday night, after dark but with not a bat in sight, Tom Goeller, Mickey (Capt. Floyd M.) Johnson, Eddie and I threw a one inch cable across the Hole and made it fast at both ends. We had a double pulley riding the cable, another pulley on the chair, and the $\frac{3}{8}$ inch cable for the lowering.

At dawn, Floyd Potter arrived with Mrs. Potter, Francis Wood, a professional photographer from Austin, (who made the accompanying photographs) and his family, M. E. Stone and B. C. King of the Rocksprings Chamber of Commerce, and a large group of women and children who had somehow gotten word of the project also came out to the Hole. We made the drop and ascent this time with no difficulty other than a little at the ledge.

Tom Goeller pronounced the Hole one of the most remarkable phenomena he had seen in his years of spelunking all over the country.

Much of our initial expedition had been a comedy of unpreparedness. But, considering the size of the Hole and the time allowed, we were satisfied with the results as a preliminary survey. And as we drove homeward through the cold, clear night, Comus, low on the horizon, flashed his fiery red, yellow and green starlight, as though in greeting, all the way from the southern hemisphere.

UNIQUE ANIMALS

Inhabit Subterranean Texas

By CHARLES E. MOHR

I HAD COME half way across the country to Ezell's Cave on the outskirts of San Marcos, Texas, to see one of the world's strangest creatures, a blind cave salamander. Now, testing the rope on which I was to lower myself 40 feet to the first level, I felt a tingling thrill of anticipation. In less than an hour I might see *Typhlomolge rathbuni*.

The first salamander had been found in 1896', not in the cave but in the concrete basin of a new artesian well drilled at the U. S. Fish Hatchery in San Marcos. It had come up from a water-filled cave 190 feet below the surface. For several years about 100 were found in the basin annually.

From the beginning this remarkable amphibian intrigued scientists. It was only the third kind of blind salamander to be discovered in all of the caves of the world. It differed strikingly from the other American species, *Typhlotriton spelaeus* of the Ozark Mountains. Young Ozark blind salamanders possess gills but lose them as the creatures develop into the adult stage. But no *Typhlomolge* had ever been found without gills. For 20 years zoologists speculated on what known or unknown salamander *Typhlomolge* might turn into when it matured. Then it was learned that actually it bred in the "larval" state—that it was a "permanent larva"—a condition called neotony.

I knew that the salamanders no longer came from the artesian well but that a few had been collected in Ezell's Cave². Here flowed the same underground stream that fed the well.

Dr. C. S. Smith, zoologist at Southwest State Teachers College, was pessimistic about my chances. One professor hadn't seen a salamander in a whole year despite a dozen descents into the cave; another man had spent the past summer in a vain search for them. And I could stay only a few days.

Doctor Smith's twelve-year old son, Gene, showed us how to lower ourselves on the rope, finding toe-holds most of the way to the floor of the good-sized room 40 feet below the crack we entered. With me was Kenneth N. Dearolf, long-time companion in scouting and spelunking³. We had no sooner reached this first level than Ken found that the place was alive with cave crickets and daddy-long-legs. Scorpions were fairly numerous; we treated them with respect. The chirps of a little cave frog came from nearby but we couldn't take time to track him down now. Where was the underground river?

Down in one corner of the room Gene wriggled into a pile of rocks. I followed, making one of the toughest short crawls in many a cave. I could understand why salamander-expert Dr. Sherman C. Bishop who had been here a year earlier had written to me "it is impossible to reach the underground stream."

But finally after jack-knifing down between two rocks we found ourselves perched at the top of a steep incline. My glasses were so steamed as a result of my exertions that I could see nothing, but when I kicked loose a pebble I heard it roll down the slope and splash into water 20 feet below. We had reached the "river," 94 feet below the surface. A thin calcareous film floated on the water which extended some 15 feet to the left, 50 feet to the right. Ten feet ahead of us the ceiling descended below the surface.

With a dip net we scooped up large quantities of the white "icing," tossing it out on shore. Many other fragments slowly sank to the bottom. Soon we had a clear view of this almost motionless river. We could begin our search for *Typhlomolge* and the other odd inhabitants known to be living in this underground water system. Eagerly we probed into

the increasing depths of the water with our flashlights. We worked carefully along the shore, investigating every little bay, examining under overhanging ledges. Not a sign of life could we find.

Then I became aware of a minute white organism flowing upward along the side of a rock. It was flat, white, and about an inch long, but it kept changing its shape, lengthening, twisting, becoming wide, then slender as it slid over the surface. It was a large planarian, at least twice the size of the cave flatworms we had collected in Pennsylvania and Kentucky. No cave planarian from Texas had ever been described. It was a new species! Standing knee-deep in the pool, I scooped it into my hand, then into a vial.

The blind salamander was forgotten as we left the cave with our prize, photographed it, then carefully pickled it. Early the next morning we were back. Still no salamander could we



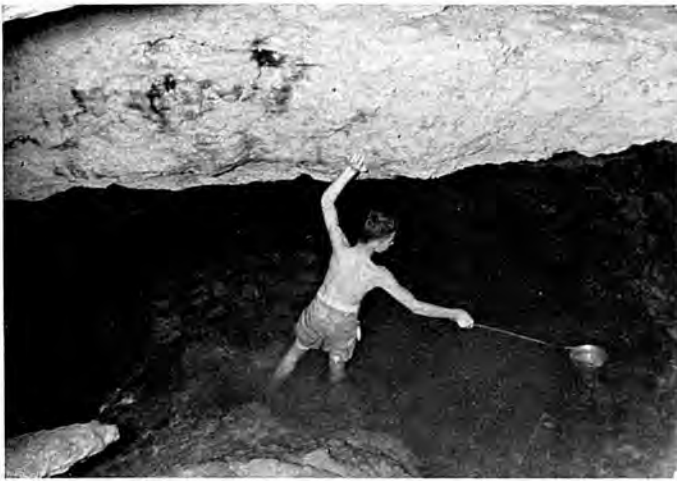
WITH ROPE secured around a convenient rock, Dearolf and Wilks prepare to descend into Ezell's Cave. (left) **PAUSING** on a ledge during the 40-foot descent into the first chamber.

All photos by the Author

find. Dearolf settled down to watch the pool. Scouting around I discovered a low passage paralleling the river but out of sight of it. It didn't look big enough to enter but a mud-caked string, left by some other explorer, led into it. I followed.

I had shed everything but sneakers, shirt and shorts, and it was still a tight squeeze. Sometimes my heels touched the ceiling while my toes scraped the floor. Inching my way forward for several hundred feet, I saw that the passage widened into a room with a pool in it. Eagerly I scrambled forward and found space enough to stand up. Forcing myself to be calm I cautiously pushed the calcite deposit from the water's surface. Surely there must be a salamander here. I searched for half an hour but saw no sign of life. Dejectedly, I wormed my way back to the main room, deciding that I'd have to repeat the tortuous journey the next day.

No, Dearolf hadn't seen a salamander either.



IN THE UNDERGROUND RIVER in Ezell's Cave (left) live some of the world's strangest creatures. The stream is part of the Purgatory Creek System which is tapped by other caves and wells near San Marcos.

but he had captured an isopod, a white, blind, aquatic arthropod that looked like a pillbug. It was a creature totally different from any of the numerous flat-bodied isopods we had found in eastern caves. Its name was *Cirolanides texensis*, its length, about half an inch.

Tired and hungry we left the cave to return again the next day. This time we found life was more abundant. Almost immediately we captured a cave shrimp, *Palaemonetes antrorum*, a creature so transparent that we discovered its presence by noticing its shadow move along the bottom of the shallow pool. Only once before, in Mammoth Cave, had we seen these shrimps. Another isopod rose from the depths and came within reach of my net while Dearolf was catching a second planarian. Still another water creature, a blind white amphipod, *Eucrangonyx flagellatus*, came swimming toward us. It was a humped up, laterally flattened "water flea" whose erratic spurts made it hard to catch.

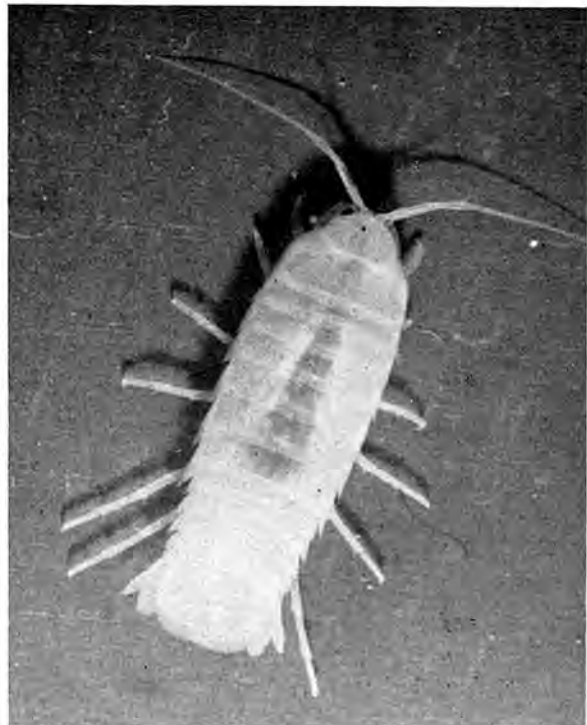
Our headlamps were giving us some trouble, and since we needed more flashbulbs we climbed out again. Later that day we made our fourth descent. We had scarcely reached the river when we spotted another planarian floating on the surface of a shallow pool at one end of the room. I waded out and captured it.

Then, just as I turned toward shore, I saw it—a blind salamander close to my knee in half a foot of water. The sight left me breathless. The creature was beautiful and exotic. It had a pearly white body and brilliant, tufted blood-red gills. Never had I seen anything like



PLANARIANS such as this inch-long specimen (above) alternately shorten and lengthen as they flow along. Blind as well as white, they are closely related to pigmented, eyed flatworms that live in streams above ground.

A RARE ISOPOD (below) from the waters of Ezell's Cave. This type of arthropod is found only in caves in central Texas, in northern Mexico, and Cuba. Length, about half an inch.



this spindly-legged, angular-headed amphibian. I trembled with excitement as I pleaded with Dearolf, across the room, to hurry with the net. Afraid to wait I leaned cautiously toward the salamander, moving an open quart jar toward its head, hoping to drive it into my trap.

In a flash it was away, swimming swiftly toward a deep crevice. Vainly I tried to scoop it out of the water. It was gone and I had stirred a thin film of mud in my pursuit. A moment later I caught sight of it again, its silky white body gliding through the murky water toward the middle of the pool. I scooped again with my hands and missed; again, and the weird beast was flopping in my hands and up onto my close-pressed wrists. I was begging Dearolf to hurry, as he scrambled awkwardly over slippery up-tilted rocks, the net in one hand, a vacuum bottle in the other. Splashing out toward me he held forward the open bottle and a moment later our prize was safely inside. The vacuum jar would keep the salamander at approximately the 71° temperature to which it was accustomed.

Getting a Photo Record

Happily we made our ascent to the surface and hurried on to our tourist court "laboratory" on the other side of town. Here we transferred *Typhlomolge* to an aquarium and sat down to gloat over our living treasure.

Nearly five inches long, it was one of the largest specimens ever captured. The next few hours we spent in photographing our prize, marveling at its queer posture, recording on motion picture film its exotic coloration and its weird movements. At close range we could see that the creature had tiny eyes but that they were beneath the skin, consequently sightless.

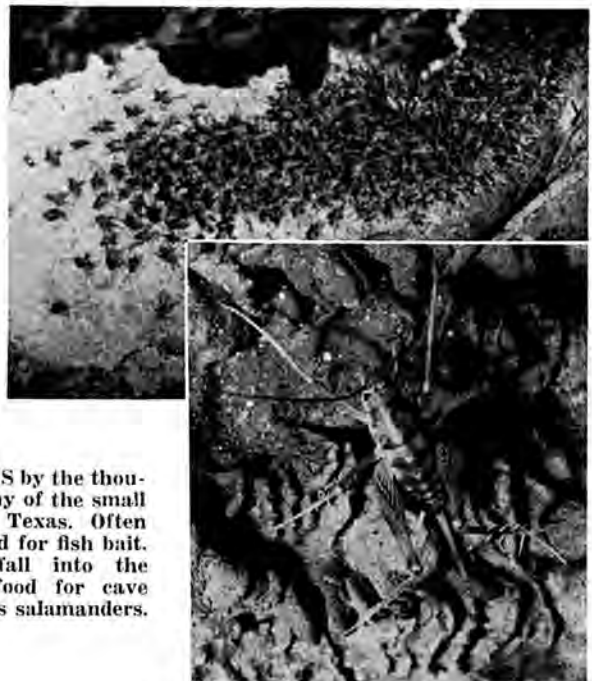
Along with his studies of other blind cave vertebrates, Dr. Carl H. Eigenmann⁷ had examined the eye of *Typhlomolge*. He found it much more degenerate than that of the Ozark salamander, *Typhlotriton*, and somewhat more degenerate than the eye of the famous "olm," the European blind cave salamander, *Proteus anguinus*.

Eigenmann, comparing the Texan and European amphibians, found that:

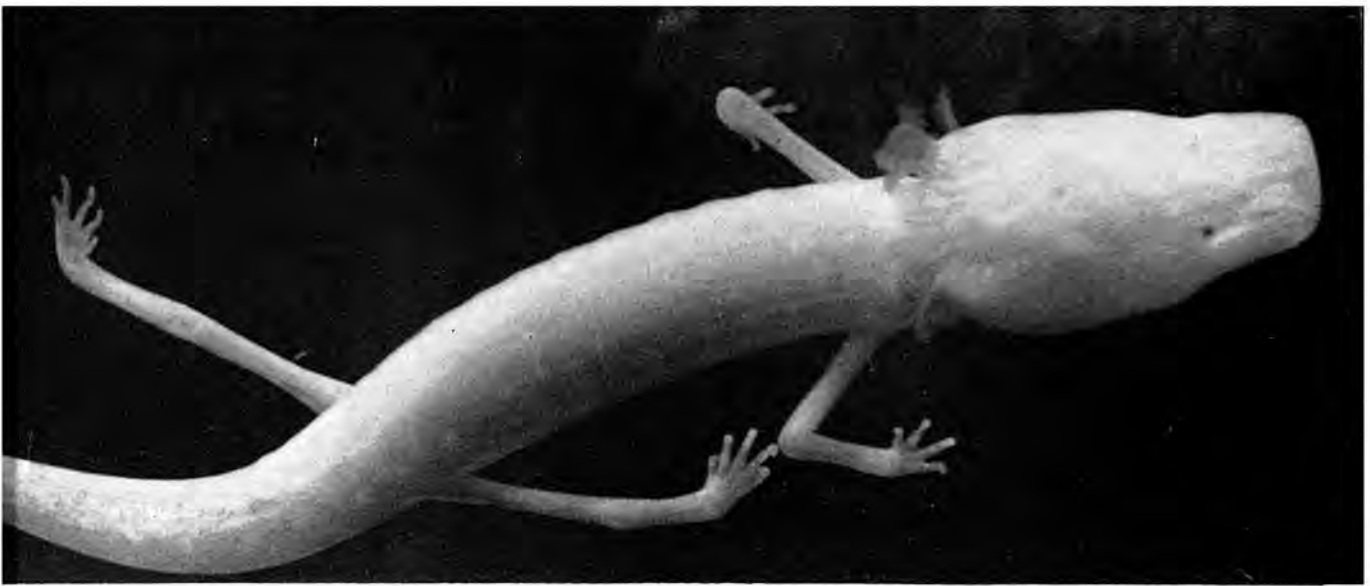
In *Proteus* the six [eye] muscles are all present; in *Typhlomolge* they have entirely disappeared. In the former all the layers normal to the retina are present; in the latter the conditions are much simpler. In *Proteus* the lens is still present and blood-vessels still enter the eye; in *Typhlomolge* no trace of the lens could be found, except in one individual, and blood-vessels no longer enter the eye. . . . the dermis and epidermis are continuous over the eye . . . There are nowhere the slightest evidence of any rods or cones [in the retina].

Lacking sight, which would of course be useless in their subterranean habitat, the salamanders seem to find food by investigating every slight movement in the water about them. They move with great caution, however. Their long, slender legs carry them forward slowly but deliberately, almost with the stealth of a cat stalking a mouse. There is no indication that the creature possesses a sense of smell. Movement of its prey—smaller aquatic organisms such as isopods and amphipods—seems sufficient to enable the salamander to locate potential food. Once it grasps an object, such as a piece of meat waved slowly to and fro with a forceps, it clings securely to it and even struggles to maintain its hold. Evidently the caution is directed solely to approaching its prey without disturbing it.

The slender, weak legs cannot support the creature out of water, but in its only natural



CAVE CRICKETS by the thousand inhabit many of the small caves in central Texas. Often they are gathered for fish bait. Crickets that fall into the water become food for cave creatures such as salamanders.



THE TEXAN blind cave salamander, *Typhlomolge*, has minute, skin-covered eyes. Lungless, it "breathes" with gills which are retained through life. Until 1939 this was only the second known kind of blind salamander in America, the third in the world. A single, new eyeless salamander came out of an artesian well in Georgia in that year, and in 1944 a second species of Ozark blind salamander was named. *Typhlomolge* is now very rare. It averages four inches in length.

environment they enable it to walk rapidly, even break into an awkward run if disturbed. For rapid swimming, however, the legs are laid lengthwise against the body and propulsion is supplied solely by the tail.

The exact distribution of this remarkable salamander is not known. It has become so rare in the San Marcos area that it should no longer be collected there. In fact, some steps have been taken to establish Ezell's Cave as a wildlife sanctuary. There have been reports of *Typhlomolge* from other nearby areas. Bishop⁶ says, "I have seen other living specimens from New Braunfels, Comal County, and from Boerne, Kendall County." Wright and Wright⁷ quote reports from "Burnet Cave in Kendall County, Twin Sister Mt., in Hays County, and from near Ozona in Crockett County." There are no known museum specimens, however, except those from the San Marcos area—where presumably they all come from the Purgatory Creek System. A large gap in our knowledge of their distribution remains to be filled.

We visited other nearby caves. In commercially developed Wonder Cave, earlier known as Beaver Cave, the lowest chamber reaches almost to the same underground river we had seen in Ezell's. In fact, a shallow well dug in it many years ago had produced a few *Typhlomolge*.

Not far away was a well-like depression, 25 feet deep, called Cricket Cave for the hundreds

of pale cave crickets which fishermen gathered there for bait. A few yards from the entrance we were brought up short by a coiled diamond-backed rattler. It was easily snared in the loop of our snake stick and lowered into the big burlap bag we were carrying for the purpose. It was a medium sized rattler, five feet long.

A SLIMY SALAMANDER exudes a sticky, milk-white fluid if roughly handled. It is harmless; five inches long. In caves, it is found under stones, in crevices, and often crawling over the mouse dalls,



What caused us more concern than snakes were the ticks that infested certain of these Texas caves. After we emerged from Cricket Cave, Dearolf and I picked over 200 ticks off each other. Only frequent and thorough examination prevented bites which might have had very serious consequences.

With Dr. S. S. Wilks, professor of physics at Southwest State Teachers College, we visited Heidrich Cave near New Braunfels. A short distance within the cave we came to a place where the thin roof had collapsed. Beneath this opening we found a veritable menagerie: numerous common toads, *Bufo valliceps*, a rarer narrow-mouthed toad, *Gastrophryne texensis*, and in nearby crevices the little cave frog, *Syrrophus marnockii*, whose calls were so puzzling when we tried to locate their source. Under stones on the floor were more toads, and seven slimy salamanders.

These salamanders and the ones we found a few days earlier in Schneider Cave, near Boerne, proved to differ somewhat from the slimy salamanders which occur so commonly in eastern United States. They have since been described⁸ as *Plethodon glutinosus albagula* and appear to be found in a number of the caves of the Edwards Plateau. This central cave region offers rare opportunities to the herpetologist. Caves are the ideal habitat for amphibians in arid, hot areas so it is not surprising that real "finds" are being made here.

Rivers such as the San Marcos rise full blown from great underground streams which abruptly flow to the surface. The underground source of San Marcos River has never been traced. In the great "spring" at its head I dipped my net into the aquatic vegetation. When I dumped the net I found a dozen small, gilled salamanders. Though none of them were more than two inches long, they proved to be adult, sexually mature salamanders, new to science⁹. They have been named the dwarf salamander, *Eurycea nana*. At times they are strangely absent from the spring. It may well be that at intervals they retreat to the subterranean stream. If that is the case they may someday be found in one of the caves of the area.

In Cascade Cave, at Boerne, we went hunting for the white frogs and salamanders which an earlier explorer had reported. We found and captured three salamanders, colorless it seemed, as our flashlight picked them out in the cave stream. On closer examination, however, they proved to have a pale, pinkish brown pattern. And they had eyes. Quite recently Floyd E.



ALIVE (above), the little cave frog has a well developed, pinkish-brown color pattern.

DEAD (left) for 12 hours, this specimen lost its pigment and became a "white" frog. The inch-long frogs were heard chirping in many caves but were hard to locate. Like crickets, they often leave the caves at night.

Potter, Jr., has captured a larger series in the same cave. Study of these specimens shows that they differ somewhat from other salamanders on the surface. They have been named *Eurycea latitans*¹⁰.

The contrast between pale amphibians and the darker surroundings in a cave often makes them look whiter than they actually are. The frogs we found did look white at first glance. Brought outside they proved to be normally colored *Syrrophus*. But during the night one of the little frogs died and when I discovered it the next day it had turned white!

While visiting caves around Kerrville with taxidermist Ira Norris, I had one of my greatest scares. We had driven 15 miles northeastward from town to the edge of the Guadalupe River. There the foreman on the Prassel ranch led us down a gully toward the river and pointed to a small opening from which a shallow stream flowed. "You can wade in there for half a mile, and you'll find fish and crawfish."

As we prepared to enter, he said, "I wouldn't stay in there very long. The river backs up into the cave in high water," and casting a thoughtful look skyward, added "It sure looks like rain."

Taking the warning lightly, we ducked under the low entrance and quickly found ourselves in a tunnel-like channel about ten feet wide; the ceiling was a few feet overhead. We waded slowly along in knee-deep water, trying not to stir up so much mud that fishes would be hidden. We saw several, swimming just ahead of our boots. All of them were dark colored; they were catfish and perch; undoubtedly they had come in from outside.

I pushed on through gradually deepening water while Dearolf paused to pick insects off the smooth walls. The passage curved slightly. The water had become waist deep but was clear enough for me to pick my path along the bottom. Thirty yards ahead the passage curved sharply.

Suddenly I became aware of a distant sound. I stopped to listen. Yes, I could hear it distinctly now, it was coming from somewhere up ahead. It became steadily louder. I had a panicky feeling as I thought of the foreman's warning. I knew enough about flash floods above ground to have an idea what might happen if heavy rains poured into a cave. The

(continued on page eighty-eight)



LITTLE BROWN BATS roost in clusters on the ceiling of a Texas cave. In summer they are alert and fly at the least disturbance. They probably hibernate most of the winter.

CAVE SALAMANDER (below) from Cascade Caverns. Small-eyed and lightly pigmented, it retains its gills in adult life. Recently described as a new species, *Eurycea latitans*.



Nature Discloses More QUEER LIFE



At left, Dr. Frank E. Nicholson building a gray hat which was found in the Cascade Cavern near San Antonio, Tex.



A salamander captured by Dr. Nicholson one-half mile within the Texas cavern. At left, a crawfish with a booklike feeler which protrudes from the nose and connects with nerves of the eyeball. This feeler is sensitive to vibrations, making it possible for the crawfish to find its way and its food.

Explorer Tells of Diving Through Subterranean Lake and Finding a Cave Where Blind Fish, Salamanders, White Crickets and Frogs, Bats and Oak Trees Grow in Black Void Hundreds of Feet Underground

By Frank E. Nicholson

I HAVE pierced a curtain constructed by Nature which, for ages, concealed amazing subterranean secrets.

On the other side of the curtain I wandered into a world that knew no light, that has never known sun, day rain nor wind nor seasons, yet oak and hickberry trees are growing there, little brown crickets (through a forest of stones, spilling into basins of crystallized gypsum—all within a black void in the cool mysterious depths of Texas' earth).

Along the shores of a subterranean stream I found blind white frogs with translucent bodies, pale gray bats and milk-white crickets and beetles. Within the waters gleam blind fish and cave amphibiae darted about. It is truly a rare new subterranean life.

Caves have excited the awe and wonder of mankind from the beginning of time. They have been the centers around which cluster many legends and superstitions. Numerous of the classic Greek myths have built from mental conceptions of that which man knew within Stygian depths.

Clods of red iron, whose no earthly residence would have been possible, were reported to live amid subterranean caverns in the depths underground. And it was from man that Croesus spoke their knowledge and revealed the destiny of man.

In the light of present-day sophisticated wisdom which has brought man to a cave exploration is never without its thrill to young and old. In essence of a million and a half American's annual journey below the surface they are awed by the bewildering works of nature which show last-night commercial covers on the continent.

To a spelunker who spends his time exploring unexplored caves, there is no final greater feat than the one which comes when his flashlight pierces the gloom of a glittering subterranean chamber never before seen by the eyes of men, and before him there opens a veritable underground fairland.

After exploring caves on five continents, including the Cascade Caverns of New Mexico and the best caves of Southern France, this writer has concluded that a cave near Brownsville, Tex., on the Old Spanish Trail, which he recently discovered and explored, is one of the most bewildering labyrinthine he has ever seen, that in the multitude of little things found therein.

The spectacular entrance to a Cocklin high cavern, cut by former waters in the face of a sheer cliff of honeycombed rock, some sixty feet high. The opening has long been known to the residents of Texas' famous "Hill Country" in Kendall County, but the cave was believed to be sealed but 500 feet. At that point a subterranean lake blocked further progress. From the rising above the lake there hung huge stalactites, reaching down and into the water, creating the aspect of a black veil of the cave.

For so one now knew many feet the dark lake with its formidable hangings pressing downward from overhead, with jagged rocks and menacing



To the left center of this subterranean landscape may be seen the figure of a swimming goddess, hands over her eyes, with a booklike and trailing gown—the spirit of Croesus—made of gypsum.

bottom beneath the black surface had stood quiet as an ancient city, to ever tomorrow beyond.

MUCH more to be said, I concluded. I opened first yielding the lake, why? Because evidence of crystals was so strong at the entrance and in the first room as to prove that the currents of mineral waters which carried the gigantic opening must have carved more than 300 feet before ceasing their labor. Furthermore, what appeared to be the base wall was stalactite formation, that hung down from the ceiling, rather than rising from the floor. Doubtlessly it would be possible to duck under the barrier—if one didn't mind getting too wet.

My assistant and I decided to find out. We stripped off our outer clothing and waded into the hot, black water. The floor was irregular and we crawled considerably as each step led us into deeper water. Yet we traveled cautiously and sure-footed, as there was the possibility of a jumpoff.

As we pushed forward the water rose higher and higher on our bodies, until it reached our armpits at the spot where the cave was supposed to end. We fell into the water, and the bottom of the first formation—the lip was perhaps a foot below the surface of the water. The plan was to dive beneath, swimming under water until we had cleared the



An unidentified species of blind white frog which changed its color twenty-four hours after being taken from the Cascade Caverns.

obstruction overhead and reached the lowest shore of the lake. We were using three-ounce flashlights, which we sealed in ball-gallon fruit jars, enabling us to keep them burning under water.

We soon grew somewhat accustomed in the chilly waters and with a deep breath dived down—no without silent imagination as to what might await us farther on.

We progressed foot by foot. With one hand we held our light focused upward. Now and again we found "pockets" between formations into which we could fit our heads, bringing enough above water for a breathing period.

At last, after having traveled approximately 200 feet of this territory, we crawled out on dry land. The smell of rot, musty underground was about us. We shaded our heads ahead, and were held speechless at the spectacular sight which met our eyes.

Ahead, the ceiling rose, the cave opened into a great vaulted tunnel, hung with literally millions of formations of infinite variety, size and shape. Stalactites, which in the distance looked

phantom-like and forbidding, became gleaming columns of rainbows as light were brought down.

The formations on all sides of us, as soon noted, were lined in pastel shades of red, gray and amber. To attempt a description of the natural beauty would be to find the English language wanting in superlatives. We came to spots where the ceiling disappeared behind millions of stalactites: some massive, others no larger in diameter than a wheat straw. Here and there against the walls were frozen cascades of formations. Jutting rocks supported lacy formations, like coral. One could let his imagination feast on the likelihood which these queer shapes suggest: jumps and barriers, beards, towers and tree trunks—all gracefully rounded, delicately etched, built by nature through the slow process of dripping water.

We pushed ahead until we came to a pool of pure water, as clear as glass. It was a subterranean spring, and the water, bubbling over the edge of the basin, flowed merrily on its way down the main tunnel. Following its course we finally stood beside a seemingly bottomless pit into which the stream emptied. The sparkle of the water, lighting itself in the gloom of a black hole—no man knows how deep!

A LONG the edges of the stream we noted living things. There were numerous white crickets, crawling about the naked bottom of the stream. The crickets' antennas were crawfish-like. For some reason or other, which science cannot explain, left a world of promise to live in dark recesses underground. Their eyes became useless in the black shade, but Mother Nature caused a whisker-like growth to sprout from

their nose—a sensitive "feeler" that connects with a nerve to their two colorless eyes. This "feeler" acts as a detector of food, likewise a steering apparatus. The light of our lamps had no effect upon them, but the moment we touched a finger in the water near them, away they darted. Here and there in the water darted spotted minnows.

We also found two rather rare pleurotrochid salamanders, cave amphibiae, which we captured, and which are now on exhibit in the Wente Memorial Museum, in San Antonio, Tex.

Clinging to a shining-glass formation, we found a queer frog that, as yet, no one can identify. In some respects it resembles a tree frog, but other characteristics bear no relation to that species. It, further, have three long tails, and the hind feet long. On either side it is a "vacuum cup" arrangement, which enables the frog to cling to slick surfaces.

Apparently, it was an comfortable clinging on wall or ceiling, horizontal or upside down, as it was on the floor. We found that by placing the specimen on the side of our flashlight that it was translucent, almost transparent. We could see its entire intestinal tract. It was milk-white in color, but a few days after it was brought into daylight pinkish spots appeared on its back. The specimen is now in the Texas University zoology department for further study.

Along the trail we also found white crickets and beetles by the hundreds.

WE FOUND mystery abounding at many a turn of the winding tunnel and passageway. Fascinating, too, was this mystery as we realized we were the first human visitors to this strange country throughout its ages of existence. Each hook and crevice was filled with the laboratory air that came from yawning depths.

Throughout the cavern we found on two rooms similar in description, none did we find the formations alike in symmetry or shape. There was a constantly changing panorama of weird subterranean scenery. Yet, on the whole, traversing the main hallway was somewhat like a childlike walk in some old World, mysterious—willing peace and quiet, with at no time the feeling of being underground—what was it to be compared with when one has never seen nor experienced anything remotely like it!

In one above we found a hollow stalactite, some three feet in diameter and equally high. A subterranean spring oozed over the upper rim. We drank our fill and dubbed it "The Fountain of Youth."

A mile inside we came into a gigantic chamber, the ceiling of which is a particularly interesting example of erosion. Dripping waters long ago ground out deep, inverted bowls overhead, some as deep as ten feet, and from eight to twelve feet in diameter. The ceiling bears striking resemblance to that of the old Alhambra.

We found a lower level to this chamber, with an opening that led on. It was a few feet down this passageway that we found Spanish oak and hickberry trees defying the laws of nature. More than a mile from daylight, in a space of 800 feet below the surface, dandelion and rain, the growth has carried on for years. The trees are the envy of them. We took specimens to William King, well-known Southern botanist, who made an examination of the gnarled roots, the non-transparent trunks and branches and the pale green leaves, and, according to him, in an exposed fifteen years in age—no less than two feet tall.

We are taught that the reason for trees stretching upward is that they are reaching for the life-giving sunlight. These dark trees, which we never known sun, are growing absolutely perpendicular, although they have sprouted from a sloping floor.

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A Celebrated Cave Exploration

By FRANK E. NICHOLSON

INTRODUCTION

The newspaper feature which is pictured on the opposite page, and which is reprinted below, appeared in the PHILADELPHIA PUBLIC LEDGER on Sunday, October 30, 1932. A few weeks later the LITERARY DIGEST (December 10) published the story under the heading, "Weird Inhabitants That Grope in a Newly Discovered Texas Cave," quoting almost the entire story. The DIGEST feature attracted widespread interest and some of the statements gave rise to speculation in an early Bulletin (No. 5, p. 37, 1943).

While enthusiastic accounts of cave exploration often are guilty of some exaggeration, this article makes such amazing claims that it seemed desirable to compare them with the findings of several of the Society's members who have explored this cave—Cascade Cavern.

The fauna was studied by Charles E. Mohr and Kenneth Dearolf in June, 1938. At the editor's request, Patrick J. White recently investigated other phases of the story. Their combined comments on Nicholson's story are presented in italics (W=White, M=Mohr). —Ed.

Nicholson's account follows:

I HAVE PIERCED a curtain constructed by Nature which, for ages, concealed amazing subterranean secrets.

On the other side of the curtain I wandered into a land that knew no light, that has never known sun nor rain nor seasons; yet, oak and hackberry trees are growing there; little brooks trickle through a forest of stone, spilling into basins of crystallized calcide—all within a black void in the cool, mysterious depths of Pluto's realm!

Along the shores of a subterranean stream I

found blind albino frogs with translucent bodies, pale gray bats and milk-white crickets and beetles. Within the waters, queer blind fish and cave amphibians darted about. It is truly a cave where subterranean life abounds.

While the various "finds" will be further described below, with critical comments, it can be said at this point that the "trees" were mere seedlings; that no milk-white, blind creatures have yet been collected in this cave, and that bats do not differ from those in neighboring caves; they have a normal amount of pigmentation. —M.

Caves have excited the awe and wonder of mankind from the beginning of time. They have been the centers around which cluster many legends and superstitions. Numerous of the classic Greek myths were built from mental conjectures of that which may exist with Stygian depths.

Gods of old, for whom no earthly residence would have been suitable, were reputed to live amid unimaginable splendors in the depths underfoot. And it was from caves that Oracles spoke their knowledge and directed the destinies of man.

In the light of present-day sophisticated wisdom such superstitions seem woven of thin and transparent threads, yet a cave exploration is never without its thrills to young and old. In excess of a million and a half Americans annually journey below the surface and are awed by the bewildering works of nature which adorn sixty-eight commercial caves on this continent.

To a speleologist who spends his time exploring undeveloped caves, there is no thrill greater than one which comes when his flashlight pierces the gloom of a glittering subterranean chamber never before seen by the eyes of men, and before him there opens a veritable underground fairyland.

After exploring caves on five continents, including the Carlsbad Caverns of New Mexico and the weird caves of Southern France, this writer has concluded that a cave near Boerne,

Texas, on the Old Spanish Trail, which he recently discovered and explored, is one of the most bewildering labyrinths he has ever seen, due to the multitude of living things found therein.

The spectacular entrance is a Gothic arch carved out by torrential waters in the face of a sheer cliff of honeycomb rock, some sixty feet high. The opening has long been known to the residents of Texas' famous "Hill Country," in Kendall County, but the cave was believed to extend but 500 feet. At that point a subterranean lake blocked further progress. From the ceiling above the lake there hung huge stalactites, reaching down and into the water, creating the aspects of a back wall of the cave.

For no one knows how many ages this dark lake with its formidable fangs of stone pressing downward from overhead, with jagged rocks and menacing bottom beneath its black surface, had stood guard as an ancient dragon over treasures beyond.

Much must lie beyond, I concluded, upon first visiting the lake. Why? Because evidence of erosion was so strong at the entrance and in the first room as to prove that the torrents of meteoric waters which carved the gigantic opening must have carved more than 500 feet before ceasing their labors. Furthermore, what appeared to be the back wall was stalactitic formation that hung down from the ceiling, rather than rising from the floor. Doubtlessly it would be possible to duck under the barrier—if one didn't mind getting too wet.

My assistant and I decided to find out! We stripped off our outer clothing and waded into the icy, black waters. The floor was irregular and we gyrated considerably as each step led us into deeper water. Yet we traveled cautiously and sure-footed, as there was the possibility of a jumpoff.

As we pushed forward the water rose higher and higher on our bodies, until it reached our armpits at the spot where the cave was supposed to end. We felt with our hands the bottom of the first formation—the tip was perhaps a foot below the surface of the water. The plan was to dive beneath, swimming under water until we had cleared the obstruction overhead and reached the inward shore of the lake.

We were using three-cell flashlamps, which

we sealed in half-gallon fruit jars, enabling us to keep them burning under water.

We soon grew somewhat accustomed to the chilly waters and with a deep breath dived down—not without silent misgivings as to what might await us farther on.

We progressed foot by foot. With one hand we held our light focused upward. Now and again we found "pockets" beneath formations into which we could lift our heads, bring mouth above water for a breathing period.

At last, after having traveled approximately 200 feet of like territory, we crawled out on dry land. The smell of cool, musty underground was about us. We flashed our lights ahead, and were held spellbound at the spectacular sight which met our eyes.

The lake is, and was then, about 100 feet wide and the stalactite curtain began about half way across it, thus the party traveled approximately 50 feet of "like territory." Even before the level of the lake was lowered it was possible to make the passage without swimming. (See description in "Commercial Caves of Texas")

—W

Ahead, the ceiling rose, the cave opened into a great vaulted tunnel, hung with literally millions of formations of infinite variety, size and shape. Stalagmites, which in the distance looked phantom-like and forbidding became gleaming columns of calcide as lights were brought nearer.

The tunnel referred to is about eight feet high and six feet wide. "Calcide" is obviously a typographical error. —W.

The formations on all sides of us, we soon noted, were tinted in pastel shades of red, gray and amber. To attempt a description of the natural beauty would be to find the English language wanting in superlatives. We came to spots where the ceiling disappeared behind millions of stalactites; some massive, others no larger in diameter than a wheat straw. Here and there against the walls were frozen cascades of flow-stone. Jutting rocks supported lacy formations, like coral. One could let his imagination feast on the likenesses which these queer shapes suggest; jungle and barnyard beasts, flowers and tree trunks—all gracefully rounded, delicately etched, built by nature through the slow process of dripping water.

We pushed ahead until we came to a pool of pure water, as clear as glass. It was a subterranean spring, and the water, bubbling over the edge of the basin, flowed merrily on its way down the main tunnel. Following its course we finally stood beside a seemingly bottomless pit into which the stream emptied, the sparkle of the water losing itself in the gloom of a black hole—no man knows how deep!

The "bottomless pit" was a hole 18 inches in diameter. As it is now plugged with mud, its actual depth is not known. —W.

Along the edges of the stream we noted living things. There were numerous white crawfish crawling about the sand bottom of the stream. The crawfish's ancestors were crawfish that, for some reason or urge which science cannot explain, left a world of sunshine to live in dark recesses underground. Their eyes became useless in the black abode, but Mother Nature caused a whisker-like growth to sprout from their nose—a sensitive "feeler" that connects with a nerve to their now useless eyeballs. This "feeler" acts as a detector of food, likewise a steering apparatus. The light of our lamps had no effect upon them, but the moment we touched a finger in the water near them, away they darted. Here and there in the water darted eyeless minnows.

The crawfish are colored like surface varieties and there is no reason to believe that they are blind. They have antennae and a pair of smaller "antennules" as do other crawfish. While highly sensitive to touch, those structures are not a steering apparatus nor do they connect with the optic nerve. Blind fish have been collected from artesian wells in Texas but there are no reliable reports of even sight observations in Texas caves. Their discovery and capture would be of very great interest. —M.

We also found two rather rare phlebotomid salamanders, cave amphibians, which we captured, and which are now on exhibit in the Witte Memorial Museum, in San Antonio, Texas.

*The salamander, a Plethodontid is almost identical with ones which live on the surface. It recently has been minutely studied and has been named a new species, *Eurycea latitans*. It is pinkish-brown in color. Its eyes are somewhat reduced in size. —M.*

Clinging on a shining onyx formation, we found a queer frog that, as yet, no one can identify. In some respects it resembles a tree frog, but other characteristics bear no relation to that species. Its forefeet have three toes each, and the hind feet four. On either toe is a "vacuum cup" arrangement, which enables the frog to cling to slick surfaces.

Apparently, it was as comfortable clinging on wall or ceiling, horizontal or upside down, as it was on the floor. We found that by placing the specimen on the lens of our flashlamp that it was translucent, almost transparent. We could see its entire intestinal tract. It was milk-white in color, but a few days after it was brought into daylight pinkish spots appeared on its back. The specimen is now in the Texas University zoology department for further study.

*Nicholson's photograph leaves no doubt that the "white" frog was Marnock's Frog, *Syrrophus marnockii*, which is found in many caves in this region. It was first described in 1878. This frog is not blind, as stated in the caption, and all live specimens which I have seen show a pinkish coloration (See photograph and further description in this Bulletin) The toes number four in front, five on the hind feet. —M.*

Along the trail we also found white crickets and beetles by the hundreds.

Neither the beetles nor the crickets are white; they are numerous. —M.

We found mystery abounding at many a turn of the winding tunnels and passageways. Fascinating, too, was this mystery as we realized we were the first human visitors to this strange country throughout its ages of existence. Each nook and crevice was filled with the uncanny air that comes from yawning depths.

Throughout the cavern we found no two rooms similar in decoration, nor did we find the formations alike in symmetry or shape. There was a constantly changing panorama of weird subterranean scenery. Yet, on the whole, traversing the main hallway was somewhat like a cloister walk in some Old World monastery—inviting peace and quiet; with at no time the feeling of being underground—but what can it be compared with when one has never seen nor experienced anything remotely like it!

In one alcove we found a hollow stalagmite, some three feet in diameter and equally high. A subterranean spring empties into it. Pure sparkling water bubbled over the upper rim. We drank our fill and dubbed it "The Fountain of Youth."

The "fountain" was not a hollow stalagmite, but a fallen stalactite which had impaled itself, base upward, in the mud of the floor. Constant dripping from the ceiling kept it filled and running over. It has since been removed from the cave. —W.

A mile inside we came into a gigantic chamber, the ceiling of which is a particularly interesting example of erosion. Eddying waters long ago ground out deep inverted bowls overhead; some as deep as ten feet, and from eight to twelve feet in diameter. The ceiling bears striking resemblance to that of the old Alhambra.

The length of the entire cave is slightly over a fourth of a mile when following all of its meanderings. The "gigantic chamber" referred to is about 850 feet from the entrance. It is 380 feet long, 60 feet wide, and 68 feet high. The "inverted bowls" in the ceiling do not exceed a depth of five or six feet. —W.

We found a lower level to this chamber, with an opening that led on. It was a few feet down this passageway that we found Spanish Oak and hackberry trees defying the laws of nature. More than a mile from daylight, in excess of 600 feet below the surface, denied sun and rain, this growth has carried on for years. There were perhaps fifty of them. We took specimens to William King, well-known Southern botanist, who made an examination of the gnarled roots, the semitransparent trunks and branches and the pale green leaves, and, according to him, they exceeded fifteen years in age though less than two feet tall.

This deepest point is 120 feet below the surface, and 1000 feet from the entrance. One of the owners of the cave, Al Gray, says there were only *THREE* of the "trees," all apparently

Live Oaks. They sprouted from acorns washed in by flood waters. They grew to be about one foot high and were as thin as a match, with three or four white leaves on top. William King is a business man who disclaims any special botanical knowledge. Mr. King saw the trees in the cave but denies identifying them or giving any estimate of their age. Mr. Gray reports that someone from the electric company experimented with the seedlings in the cave, exposing them to ultra-violet radiation several times a day for three or four months. During this time they grew to 2½ or 3 feet in height and took on a little color. The experiment ended when the lamps were left on too long, killing the seedlings. —W.

We are taught that the reason for trees stretching upward is that they are reaching for the life-giving sunshine. Yet these scrub trees, which have never known sun, are growing absolutely perpendicular, although they have sprouted from a sloping floor.

In the absence of light, erect growth of seedlings is normal. They grow directly upright, away from the center of gravity, exhibiting what is known as "negative geotropism." This type of demonstration is frequently made in biology classes. —M.



Les Colin, Collier's Weekly

Trailing Texas Troglodytes

By A. T. JACKSON

"He's that caveman from Austin."

Thus was I introduced, by a merchant from the town of Comstock, to a ranchman on the Pecos River. For six years or more I had been hunting cave dwellers, a search that led me into hundreds of caves and rockshelters over a vast area extending from El Paso to Waco and from Del Rio to Amarillo. I was looking for Indian paintings and carvings—pictographs and petroglyphs.

Ranchmen led me to some of my best finds. Sometimes they took off half a day or longer to guide me to a site I couldn't have found alone. All they asked in return was that I explain "why in blazes" I wanted photographs of "them old drawings."

Many people visit certain well decorated caves without noticing the paintings on the walls. Of course, they are looking for other things. Some paintings escape even trained eyes because of their positions or elevations. Often they are where you would least expect them.

In a few caves we found pictures partly or completely covered by camp refuse. This means that when they were painted the floor was three to six feet lower than at present. How long, I've been asked, did it take for that depth of debris to accumulate? The answer depends on several variable factors, such as the number of occupants, and whether the cave was occupied temporarily or continuously.

Occasionally paintings appear on cliffs at heights as great as 30 feet. How was the primitive artist able to paint in such places, you may wonder. Since we found no house ruins from which the paintings might have been made, it is logical to believe that they used ladders. There are other cases where pictures were painted on a roof so low that the artist must have lain on his back while painting. Then again we may find one picture superimposed on another. Since these "double exposures" may furnish clues to the comparative age of different types of painting, they warrant careful study.

Sometimes a painting appears very dim because it is covered with dust or dirt. A damp, but not wet, cloth lightly applied to the surface does no harm, and may make the outline of the picture much more distinct. There is little likelihood of using too much water, in an arid region such as this.

Some cave pictures appear humorous, even though they may not have been so intended. Others provoke mirth by their association or manner of execution. A few are grotesque. Many arouse curiosity and wonder. All are challenging.

Most of the paintings are on the walls of overhanging cliffs or shelters. Some of these have an overhang of only a few feet, and are scarcely large enough to shelter two people. One ranchman calls them "honeymoon caves." At the other extreme are a number of shelters of great size. One, in which I did much work, has a length of 515 feet, with an overhang or depth of 98 feet. Its name—Tribal Shelter—resulted from a visitor's exclamation, "It's big enough to shelter a whole tribe!"

Certain sites are a combination shelter and cave, in which the main entrance is a typical overhanging shelter; the rear narrows to a small passage, which leads into subterranean chambers. The darker, deeper rooms evidently were not so popular with the Indians. They doubtless feared the dark. I have explored a few real caves that have paintings on the walls, and deep deposits of camp refuse on the floor. Usually, however, there are neither pictures nor camp refuse in caves with much seepage. Stalactites and stalagmites rarely are present in chambers occupied by the aborigines.

When they occupied a deep cave it usually was in the "front room," where some daylight could penetrate. There are a few notable exceptions. These goaded me on. If paintings had been made back farther in these caves, I wanted to find them; so, at intervals, I succumbed to the temptation to "nose around" in deep caves. On one such occasion, with half a dozen com-

panions, I explored what was then known as Sherrard Cave, in Burnet County, Central Texas. Later it became the Longhorn Cavern State Park. Our little band, armed with flashlights, candles, rope and cord, traversed a distance of more than a mile. Though we searched for six hours we found no evidence of primitive occupation beyond the first 40 feet.

Our guide was a local man, well versed in cave lore and legend. We heard from him about two teen-age boys who became lost in this cave, and wandered for three days, finally emerging on the opposite side of the Colorado River, miles from where they entered. I later heard the story from other sources; but no one was able to furnish the names of the boys.

I've heard my share of tall stories about the great size of caves, but this guide topped them all. He swore that a geologist had told him that the Carlsbad Cavern, with its main entrance in New Mexico near the Texas line, extended southward across Texas, beneath the Rio Grande and far into Mexico.

Another story he related had to do with two horse thieves who hid in Sherrard Cave to escape the law. A panther sprang in on them, killed one man immediately and finished off the other just as his Bowie knife penetrated the beast's heart. The three corpses, he declared, were found in a heap.

Colorful Names

The names of our caves suggest interesting, even exciting, stories. We have Painted Cave, Comanche Cave, Indian Cave, Bee Cave, Wonder Cave, Palace Cave, Panther Cave, Robbers' Cave, and many, many others.

Panther Cave, really a rockshelter, in Somervell County, has been inhabited by both Indians and whites. Back in the fifties, so the story goes, a woman and several small children were in their cave-home one day when attacked by a hungry panther. The mother grabbed a nearby gun and tried to shoot the beast. The gun snapped. With a steady nerve, developed by pioneer privations, she tossed the firearm aside, seized an ax and brained the big cat.

Sam Bass Cave, Williamson County, is reported to have been used as a rendezvous by that notorious outlaw. But so far as I am concerned, a few pictographs on the wall are of much greater interest than a cave full of legends.

Often the caves and rockshelters are nearly inaccessible. The field archeologist must be agile, and cautious. I forgot that rule for a moment down along the Devil's River in Val Verde County, and had a mighty close call. My companion and I were climbing to a pictograph site, high on a cliff overlooking the picturesque river. We had reached a narrow ledge, within 30 paces of the small shelter. Then I saw paintings of huge animals on the wall ahead. I was excited, because the layout was very unusual. I hurried forward, a camera tripod in my left hand, the camera dangling at my side; my eyes were on the paintings.

Suddenly I stepped on a slick rock, lost my balance, and started falling toward the edge of the precipice. Three feet away was a sheer drop of more than 200 feet to the boulder-strewn river channel below. Close to the edge grew a single lechuguilla, *Agave lechuguilla*. Instinctively I grabbed the tall green flower stalk with my free hand. The plant's root system, penetrating deep into rock crevices, held my weight. It stopped my fall.

"Gosh!" I sure would have wrecked my camera if I'd gone over there," I exclaimed.

"Well, you'd have never known it," commented my young companion. Then the perspiration broke out on my forehead. I sat down and pulled off my boots; it was safer to go in my socks.

Generally, though, hightops are essential. The country is very rough, and there is always the chance of stepping on a rattler. I remember once when with a small field crew we were excavating archeological sites.

Taking along one of the men, named Henderson, I went on a short scouting trip to see which of the many nearby caves we ought to work in next. We found a small hole in the side of a hill and crawled in. Yes, it was a cave, all right. Soon we were able to stand erect. We took a dozen steps, then froze in our tracks as the never-to-be-forgotten buzz of a rattlesnake sounded. Where was it? The sound was near but hard to locate.

"Don't move," whispered my companion, who had been a hunter and trapper. He gripped a 22-caliber rifle. Then as our eyes became adjusted to the semi-darkness, I saw him slowly raise his gun. He had spotted the snake, and



CALDWELL CAVE No. 1 in Culberson County, differs from the sink-hole type common in the region. When approached from the rear the entrance cannot be seen until one is practically at its brink.



UPON ENTERING this long-used "home," in Val Verde County, one sees ashes, fragments of burned limestone, animal bones, flint chips, pieces of cordage and other discarded articles.



Peabody Museum of American Archeology and Ethnology

INDIAN BURIAL in a cave in the Hueco Mountains. The skeleton was incomplete and probably had been pulled about by animals. The body had been wrapped in a fur-cloth blanket.



SQUARE-TOED SANDALS made of yucca leaves show hard usage over the rocky terrain. Length, ten inches.



THUNDER BIRD with wings outspread (above). This fine, early Indian painting or pictograph in red is five feet across. It is located in a shallow limestone shelter in Terrell County.

HUMAN FIGURE wearing buffalo horn headdress (right) is in white and is nearly three feet high. It is known locally, in El Paso County, as a vinegaroon or whip scorpion.



Photos, except burial, by the Author

a moment later it was writhing on the floor. He shot it through the head.

The report was still echoing through the cave when two other snakes, one to the right, another to the left, began serenading us. Henderson killed both of them, and we moved on a little farther into the cave. A good-sized rock blocked my path. Just as I stepped up on it, a snake rattled from beneath it. I nearly cracked my skull against the low cave ceiling. While Henderson was attempting to get a shot at this latest disturber of the peace, a fifth one sounded off. In much less time than usual, I decided that this cave was of no archeological importance. We got out fast.

Water Is Precious

Fortunately, not all caves were rattlesnake dens. Occasionally we camped beside the cave entrance. One such we later named Rabbit Cave. We found only traces of pictographs in this cave, but other cultural remains were abundant. It was one of the few caves in which I have found evidence of habitation far back in the dark recesses.

This unusual site is located in a sparsely settled region in the eastern part of Culberson County, at an elevation of about 3,700 feet. It is very dry country, and it was surprising to find evidence of extensive occupation, for this cave is located five miles from a permanent water supply. The Indian occupants may have secured water by scooping out shallow pits in a valley half a mile away, where, it is said, water can be obtained in the sandy soil at a depth of about six feet.

We appreciated the Indians' water supply problems because we had trouble providing water for our own small crew. We hauled it from an open "tank" or man-made pond, after skimming off the green scum that covered the surface. While sitting around the camp each evening, we boiled a five-gallon can of water for use the following day. But we had a truck in which to haul our water; the poor squaws and their numerous small children, had to carry their supply of water in crude containers on top of their heads.

In the cave debris we found evidence of the kind of footwear worn by these women and

children when they trudged across the hot sands. They wore "fish-tail" sandals—so named from a V-shaped protrusion—made from the narrow unsplit leaves of beargrass, *Yucca tenuistyla*, or from the split leaves of Spanish dagger, *Yucca treculeana*. Tie-strings held the sandals on the foot. When worn thin, the sandal sometimes was reinforced or "half-soled" with pads of fiber or yucca leaves.

This was a large cave, its west end measuring 180 feet in length, with a maximum width of 110 feet. The central section had dimensions of 160 x 170 feet; the east end 150 x 110 feet. The over-all area totalled 500 x 160 feet. Though the west end was deeper and darker, its roof showed little evidence of smoke-blackening. The campfires apparently were kept burning on the comparatively level floor of the central section.

Treasure hunters had recently dug out a pit at the west end. In the loose dirt we found a tin can containing a sheet of paper, on which were scrawled the names of the diggers. In their silly search for buried gold they had destroyed an Indian burial. Carelessly they had shoveled out broken human bones, two grass mats, a yucca mat, a rabbit net, two notched rhythm sticks, a bone bead, a pendant made of buffalo horn, and a few flint projectile points. All of these specimens had been burial offerings.

In a pile of debris collected by pack rats, we found a desiccated human right hand. The extremely long finger nails were intact. Another grave, partly disturbed by rats, had a skull on which much of the hair remained; the ears were in a desiccated condition. The body had been wrapped in grass mats and a fur blanket, but the latter was in a bad state of preservation.

The most interesting burial, in a large crevice in the central section of the cave, contained two skeletons, one on top of the other. The lower one was of a child; the one on top was a woman lying face down.

There were funeral offerings in the grave: a piece of yucca flowerstalk decorated with black paintings, a net, about 18 feet long, wrapped around sticks that had one end sharpened and the other notched. The sticks may have been used in stretching the fiber cord net, perhaps to

snare game. The bottom of a basket was beneath the abdomen of the woman.

It was too dark here to take photographs by daylight so we tried several types of illumination: a gasoline lantern, four carbide lamps, and two flash sheets. All three methods worked.

As we began excavating the eastern section we were disappointed to find that fibrous materials, sticks and other debris had been ruined by fire. Loose, feathery ash disclosed that the trash deposit originally was four to five feet deep. In places there had been several fires, with periods of occupation intervening. Large boulders had served to check the flames in spots, and thus saved important materials in small areas. The fires could have been accidental, or may have been lighted for the purpose of disposing of excess debris.

In the debris were several yucca hearth sticks and a hardwood fire drill. Another fire implement was an oak scoop, with one end charred. It may have been used for carrying coals, or for scraping hot ashes. Among the important finds were specimens showing the contemporaneity, in this region, of the atlatl and the bow and arrow.

From a few potsherds, introduced from the Pueblo region in the Southwest, it was determined that this occupation occurred between 1300 and 1600 A.D. For our "calendar" we are indebted to Dr. A. E. Douglass and his capable co-workers, who have developed a remarkable tree-ring chronology for dating archeological sites.

These early cave dwellers left a record of their food supply, almost as complete as if they had prepared and left daily menus. I have published elsewhere¹ the following listing of their food:

Cacti and mesquite beans seem to have been the chief items of food. Next in importance came rabbits and birds. Large game was scarce, but an occasional deer and antelope furnished a feast . . . No corn was found . . . Internodes of the cactus stem, or prickly pear (*Optunia lindheimeri*) were plentiful. From most of them the spines had been removed. Some appeared to have been roasted. Tunas, or fruit of the prickly pear, also were present in the midden

¹ "Exploration of Certain Sites in Culberson County, Texas," Bulletin Texas Archeological and Paleontological Society, Abilene, Sept. 1937, p. 165.



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PRESERVED from the elements, these vegetal remains from southwestern caves give best idea of Indian food plants. Included are corn, black and white beans, squash seeds, pinon nuts, grass seeds, acorns, mesquite beans, quids of agave, tornillo beans, yucca pods and seeds.

deposit . . . A few agarita berries, grass and yucca seeds, and numerous fragments of sotol crowns were found.

Cacti and mesquite beans, jack rabbits and quail, garnished with berries and grass seeds! Not a bad menu! But how would you secure the rabbits?

We learned how the Indians probably got them. In the cave we found a large number of throwing clubs. Made of hardwood, usually 18 to 24 inches long, 1 ¼ to 2 inches wide, and ¼ to ½ inch thick, most of them showed evidence of hard usage. One end often battered, sometimes split, and several bore splashes of blood on the battered end. They are called "rabbit sticks."

There were hundreds of jack rabbit bones in the refuse or midden deposit, and rabbits

abound in the region today. These facts, coupled with the knowledge that historic Indians stage rabbit drives, suggest that the sticks were used by the cave dwellers as weapons, or utility implements for throwing or striking. It may be that the rabbit drives were in the nature of communal sports events.

I never saw so many rabbit sticks. One of my workers called to me, "I've found the granddaddy rabbit stick of 'em all! It's three feet long."

Looking up I saw him turn his head at the proper angle to throw the beam of his carbide lamp onto the object. With a yell he dropped his trowel and grabbed a shovel. He had uncovered a rattler, dormant and dusty. He dispatched it quickly. Later others were unearthed and killed.

Rattlesnakes are not the only pests one must watch for in cave work. Ticks live there too, and in a few caves they are infected with the virus of relapsing fever. I first became acquainted with this tick, *Ornithodoros turicata*, in the spring of 1937. We were excavating a cave in San Saba County which was destined to be flooded by the impounded waters from the Buchanan Dam, on the Colorado River in central Texas. For years I had heard that the bite of ticks in this cave could cause relapsing fever. I had never put any stock in the story, looking on it as a superstition. After all, I had been in the cave on several occasions, without ill effects.

So, while excavating adjacent sites, most of which were in the open, it was decided to permit the crew to work in this cave when it rained. We worked in it several days during February and March. No one saw a tick, and no one took the fever. Then, for more than a month, there were no heavy rains, and we worked outside.

One day in May, Dr. S. W. Bohls of the Texas State Department of Health came looking for infected ticks for a laboratory experiment he was conducting.

"I don't think you will find any ticks," I remarked.

"Oh, yes we will," he replied, "There are plenty of them in the cave."

I told him what we had done. He laughed but shook his head.

"Don't take the men in there again," he cautioned. "The weather was cool when you were working in there. That explains why you found no ticks. Come along with us and you'll see plenty of them today."

I went, but remained outside, as he suggested. He and his assistant wore rubber hip boots, around the legs of which they smeared stripes of grease. Inside they dipped up a small can of dirt, brought it outside, and scattered it on a newspaper. Dozens of small ticks were in the dirt. They made three trips into the cave and easily collected all the specimens they needed. Dr. Bohls' believes that the ticks may have been infected even at the time the cave was occupied by the Indians.

When I examine a deep deposit of cave debris, and wonder how long it must have taken to accumulate, I am reminded of a poem by Edgar A. Guest, in which he says:

"It takes a heap o' livin' in a house t' make it home."

The cave dwellers certainly did "a heap o' livin'" in many of these places.

While working in one large cave, I often spent the noon rest period atop a flat boulder near the entrance. From that vantage point I could view a great number of pictographs on the wall, and scan the debris-strewn floor.

I wished I might have lain there when the cave was throbbing with activity. Then I would know the story of their lives that we are so painstakingly piecing together, bit by bit, from the evidence they left behind. I wanted to catch my archeology alive. Should the occasion require, I wondered, could we go back to the life of these natives and do as well as they? Little did I think that in a few years we might be inspecting such caves with a view to storing supplies, or even living in them in times of emergency.

I'm in favor of playing safe. I've located some caves that sheltered lots of occupants in the past, and if you want to rent one let me know. But I've already put a sign in front of one cozy, secluded little cave, deep below a limestone hill. The sign reads:

"NO VACANCY!"

Commercial Caves of Texas

By VICTOR S. CRAUN

OF THE NINE CAVES which come within the scope of this article, three are currently commercial, one is soon to be reopened, and five are ex-commercial. They are located as follows: *Wonder Cave* is on the outskirts of San Marcos. *Longhorn Cavern* is 10 miles south of Burnet, within a few miles of the geographical heart of Texas, in the Longhorn Cavern State Park. It is the state's largest commercial cave. The *Cave Without-a-Name*, formerly known as the Short Ranch Cave and later as the Horne Ranch Cave, is 11 miles northeast of Boerne and is the most important formation cave in the state. *Cascade Cavern*, formerly Hester Cave, is 5 miles southeast of Boerne. The ex-commercials are: *Richland Springs Cavern*, 5 miles southwest of Richland Springs; *Robber Baron's Cave*, San Antonio; *Austin Caverns*, Austin; *Fairy Cave*, 8 miles east of Boerne; and *Hammett's Cave* or *West Cave*, at Hammett's Crossing, near Cypress Mills. These caves represent distinctive types with many interesting features, some peculiar to these caves.

I am indebted to Patrick J. White and Tom Goeller for many notes on these commercial caves and to A. T. Jackson and Charles E. Mohr for much of the historical data.

WONDER CAVE

Oldest in point of continuous operation is Wonder Cave, originally called Beaver Cave after Mark Beaver who discovered it in 1896. Opened to the public prior to 1915 by its present owner, A. B. Rogers, this small cave is located along the Balcones Escarpment at San Marcos. The entrance is on the southwest slope of San Marcos Hill at an elevation of 652 feet above sea level. The location of the cave indicates that it belongs, like many of the caves in the neighborhood, to the Purgatory Creek System.

This cave is a straight crack in the Edwards limestone, widened, and the walls smoothed by the action of water. Its bottom is made up of huge masses of fallen rocks which form, at some places, high cliffs dividing the entire cave horizontally into a number of rooms connected by narrow tubes, and vertically into several compartments. It has various formations including particularly noteworthy flowers of gypsum.

The deepest depression in the bottom of Wonder Cave is 125 feet below the surface. When the cave was first explored, no water was found but a well drilled at that time from the surface indicated the presence of water only a few feet below the floor of this room. The water stands at the same level (584 feet above sea level) as in several other caves in the Purgatory Creek System, the most interesting being Ezell's Cave.

LONGHORN CAVERN

Prior to its development by the Texas State Park Board in the early 1930's, Longhorn Cavern was known as Sherrard Cave, being named for the owner of the land. An interesting newspaper account of an exploration of Sherrard Cave was written by A. T. Jackson in 1929. It appeared in *The Houston Chronicle*. The explorers found few facilities for tourists:

It is located in the heart of a cedar brake; and is just as nature left it, except that a few cedar logs have been inserted to serve as ladders. The visitor has to provide his own lights.

There are three main openings, two of which may be used as entrances. The third and smallest hole is in the flat surface of the ground and drops straight down for a distance of more than 60 feet. No fence, obstruction or sign warns one of the approach of this "jumping-off place."

The other openings give one the impression of huge wells that have



Bill King, *Collier's Weekly*

caved in on all sides. They are not so steep but that one can negotiate them. Numerous boulders make easier the descent.

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On entering the largest opening one finds a vast room with a domed roof. Inscriptions dating back 20 years show that, despite its inaccessibility and lack of advertising, the cave has many visitors. Judging from the writings on the walls, few penetrate the cave for more than a few hundred feet.

After passing from the first chamber, the cave branches out into several passages. These gradually become narrower and lower until one must stoop, then go on hands and knees. After a time the passage begins to enlarge and presently leads to another chamber or vaulted room.

The formations vary greatly. At first there is ordinary limestone. Then one comes to a so-called "glass room." It is approximately 40 feet square and lined on all sides with quartz-like rock, which glistens in the glow of the candlelight. Small pieces look like diamonds.

On emerging from the glass room, one again enters a narrow channel lined with jagged rocks. A little farther and a dirt floor is encountered, the black soil being dry and fine as powder. Then another glass room, even more beautiful than the first. The narrow channel leading from this room is floored with mud. As the roof becomes lower, the mud seems softer and more like glue. There is a small lake, around the edge of which one must crawl.

Jackson explored other corridors but many tunnels were choked with clay. During the commercial development of the cavern, an estimated 20,000 cubic yards of clay was removed, increasing the size of the corridors by 75 per cent.

Shortly after these excavations had been made, and after electric lighting had been installed, a surveying party from Southern Methodist University, under the direction of H. M. Law, made a thorough examination of Longhorn Cavern. Their report, with maps, appeared in the second number of *Field and Laboratory*, published by the science departments at SMU. Since the report is the most detailed ac-



Field and Laboratory

Fig. 2. Ideal view of Backbone Mountain and the area adjoining the Longhorn Cavern.

count of any Texas cave, and since it is out of print, it is reprinted below:

The Longhorn cavern, located within a residual plateau, a fault block of Ellenberger limestone of Cambro-Ordovician age, is distinguished by the fact that it exhibits a wide variety of cave phenomena. The plateau block with an area of about 16 square miles stands 550 feet above the valley of the Colorado river to the west. The plateau, locally known as Backbone Ridge, has a triangular shape. The entrance to the cavern lies near the center of the triangle. The larger rooms of the cave, grouped about the main entrance 75 feet below the surface, are of sufficient size to be utilized, respectively, as lobby and museum, cafe, ballroom and theatre. This group is connected with the "Crystal Rooms," to the south and the "Lake Room" to the north by narrow passageways that contain a chain of small rooms with ceilings 10 to 15 feet high. The cave has several small springs and standing pools, but no permanent streams. The area above the cave is covered with sinkholes which conduct all meteoric waters directly to the cavern channels.

The Central Mineral region is an area of intense faulting. Backbone Ridge is one of a series of residual plateaus, or fault blocks, which are cut across by pre-Cretaceous denudation. Following the stripping of the Cretaceous cover from this ancient peneplain, the superimposed Colorado River and its tributaries cut lowlands on the softer granite and schist blocks, leaving in relief blocks of Ellenberger and other limestones. The Ellenberger limestone, forming the plateau, exhibits extensive ground water metamorphism, as shown in the development of a sugary crystallization in the limestone and the filling of cavities and fractures with larger multi-colored crystals. In local areas the spreading and mingling of bright colors along the margins of fine fractures

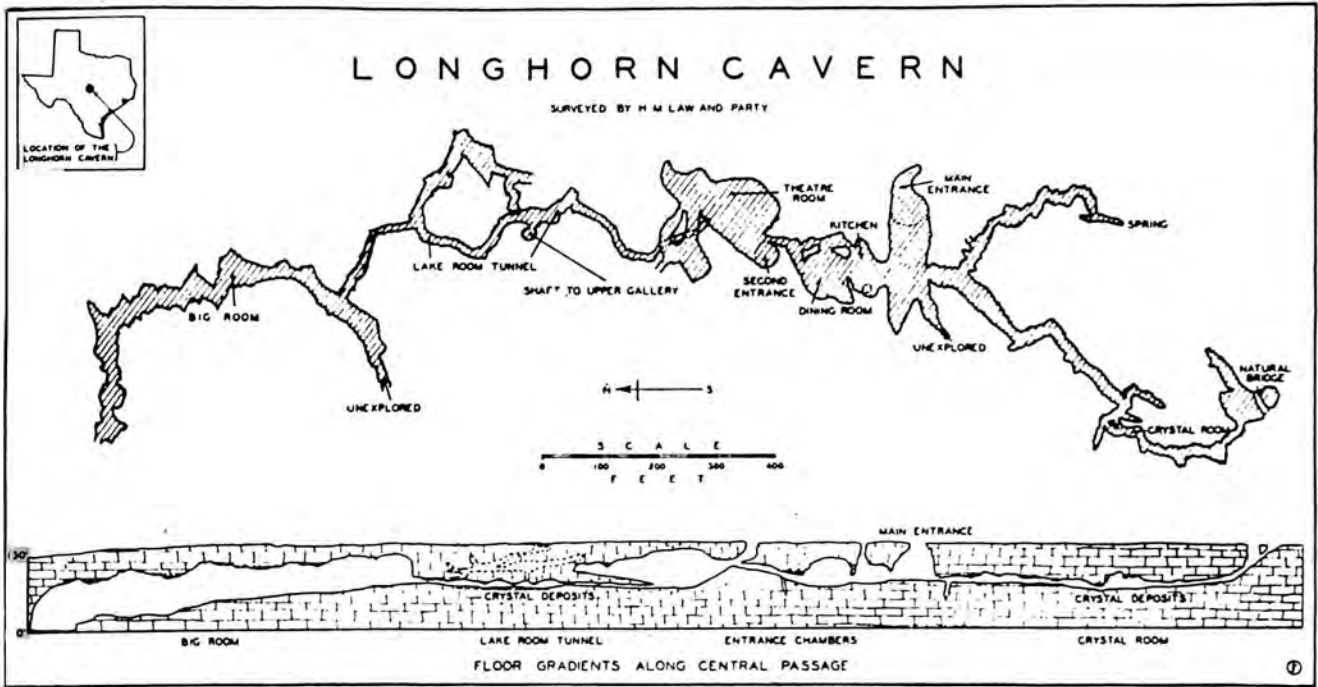


Fig. 1. Map of Longhorn Cavern (above) reproduced by courtesy of Field and Laboratory, Southern Methodist University.

SAM BASS entrance to Longhorn Caverns (below). Here, legend has it, the notorious outlaw hid after his raids on the countryside. This is the main entrance to the cave.

Courtesy of the Houston Chronicle



produce a commercial marble of exceptional beauty, with a fairly high crushing strength. Chert exposed in the cavern walls appears in interbedded layers, varying from a few inches to several feet in thickness, and protrudes along the walls of all the rooms of the upper cave level.

The beds from which the principal channel ways have been dissolved are nodular and finely laminated. Beds of the more soluble and pervious limestone are separated by thick beds of dense, relatively insoluble, dolomitic limestone. The solution of the weaker, more soluble members has produced galleries on three levels. The harder, insoluble strata form the floor. In the entrance room and a few other large rooms solution has included the heavy intervening beds and produced rooms with exceptionally high ceilings.

Many of the rooms have circular domed ceilings so uniform in curvature as to appear artificial. The walls of these rooms are dense, thick beds, while the roofs are shaped from the beds of laminated, incoherent material, incapable of projecting far beyond the supporting medium.

Following the rejuvenation of the Colorado river, which meandered widely over the ancient peneplain uncovered by stripping off the Cretaceous overburden, the river valley became sufficiently incised to furnish drainage for the present cavern territory. The process of drainage was too slow at first to permit the water table to sink far below the surface. Only after a long period of solution did the passageways open sufficiently to allow the lowering of the water table on the low divide of the plateau and the beginning of an appreciable movement of ground water toward its margins. At this early period the waters found egress through springs near the bottoms of the gradually deepening valleys of the Colorado river drainage system. Under hydrostatic pressure of an arching water table the diverging waters may have found little difficulty in reaching outlet springs by advancing through devious channels in the more soluble beds along joints, fractures, and fault planes which may have extended to considerable depths below the surface of the water table.

When adjacent valleys were sufficiently lowered to offer outlet springs at lower levels, the descent of meteoric waters through solution channels to the new and lower water table became too rapid for effective solution. Such vadose water as filtered its way through thick roofs entered the upper cavities laden with dissolved lime carbonate. Upon entrance into the air-filled chambers, it began to deposit dripstone and flowstone. In this cave the process must have been productive of a generous growth of stalactites and stalagmites, as is evidenced by the abundance of decayed fragments found upon the floors of the older upper rooms. In course of time the roofs covering these rooms were thinned so much by surface erosion that descend-

LOOKING UP toward the ceiling of one of the rooms, one can see (right, top) the profile of a human face. The cave guides call it Abraham Lincoln.

THE HALL OF MARBLE (right, bottom) as it is known, is effectively lighted from recesses in the walls. There is much evidence that an active underground stream played a major role in the formation of the cave.

Photographs by courtesy of the Houston Chronicle

ing water reached the cavern ceilings only partially saturated; in fact, being still unsated, it began to devour the formations that had been formerly deposited, with the result that many stalactites were either redissolved or cut loose from the ceiling by solution of their bases of attachment. Many fragments, a foot or more in diameter, found in the debris of the floor, are badly decayed and honeycombed with re-solution. At present only a few pendant forms are to be found in the upper and larger rooms of the cave, but fragments are abundant on the floors.

Work of Running Water

A feature of this cave, not always present on so large a scale, is the work of running water. A large part of the cavern, including the "Big Room," "Lake Room," and the entrance chamber connections, forms a typical dendritic drainage pattern below the surface. "The Big Room" occupies the bed of the main stream, which has been so deepened as to become a winding, subterranean canyon with tributary branches entering as a surface stream. Where there are two galleries connected by shafts and occupying different levels, the connecting shafts show all the phenomena of differential solution, but only slight effects from running water. The bed of the main stream in the "Big Room" is 15 to 20 feet wide, incised in a floor that was at one time about twice as wide. The new stream bed, from three to ten feet below the old one, forms terraces several feet wide on one or both sides of the present channel.

Rounded boulders and gravels indicate that at times the stream has been a torrent. All the attendant phenomena of running water are to be found, including cataracts in shelving strata, falls, pools and potholes. The gradient of the stream increases rapidly as it approaches the lower end of the Big Room, drops over low cataracts, then over a 10-foot fall into a pool, about 30 feet farther drops something like five or six feet into another pool and disappears under the end wall.

If the successive galleries had been developed by respective base levels, the grading of each gallery floor by running water would be expected. The process would have filled all low places with sediments up to the level of the spillway for each segment of the cave. There is no evidence of extensive grading or stream erosion on the floors of any except the lowest gallery level.





Courtesy of the Houston Chronicle

CALCITE CRYSTALS as much as six inches long line the walls of five rooms. In an earlier period the crystals may have covered the ceiling as well. Whole slabs of them have fallen because the softer limestone which supported them has eroded away.

To the average visitor the most spectacular feature of the cave is its crystal rooms. They are veritable jewel caskets. These rooms, five in number, although not large, are lined with a thick coating of calcite crystals in variegated colors, often measuring four to six inches along their rhombic edges. Adjoining crystals may be of brilliant contrasting colors. Dogtooth forms in bright colors are often found, penetrating larger transparent ones.

A study of the profile section (Fig. 1) shows that the crystal rooms lie at the lowest section of a siphon-like tunnel; they are low points below the level of the spillways for the segments. They are in part even today collecting basins. The crystals along the wall are apparently the

result of crystallization from standing pools of saturated waters.

The upper parts of the crystal rooms are mostly free from the crystal coating. The fact, however, that slabs of crystals are found embedded in the floor debris of these areas, indicates that the entire ceiling may have been coated at one time, but since the limestone walls were more soluble the crystals have weathered loose, and have fallen down where the walls are either overhanging or very soluble. In places the limestone has been dissolved away from the crystal sheets, leaving them standing out three or four inches from the present walls.

The Life Content of the Cave

In the pools of the stream in the Big Room numerous yellow-white crayfish dash about as if frightened by the advent of light. They appear to have normal eyes and some are still unblanched. They may be immigrants into the cave from streams into which the cave empties. Other arthropods (white crickets, daddy-long-legs, millipeds, spiders and beetles) and numerous worms are found throughout the cave. Small pools of stagnant water, near the lower ends of shafts connected with surface sinks, were thick with decaying insects; mute caution to all who would drink water issuing from limestone fissures. Bats are so numerous in some parts as to necessitate their removal before the rooms can be opened to the public.

In the drifts and bars of the streams, as well as the debris of the floors at points not affected by running water, are numerous bones of bison, bear, and possibly camel, as well as those of many modern forms.

Numerous flints, arrow and spear heads, crude tools, bits of charcoal, and reported beds of ashes and charcoal indicate that the cave has been at times a temporary harbor for human beings. If it were inhabited for any length of time by a race using fires, the walls have lost all traces of the ancient smoke stains through scaling and weathering.

Two human skeletons have been found. One is said to have been beneath a large boulder in the center of the big entrance chamber and the other on a ledge farther back in the cave.

The cave, which is managed by H. H. Galloway of Burnet, has been elaborately developed for two of its reported eight-mile length. The floors are covered with crushed limestone. At the extreme end of the cave one can descend to a stream of clear water which backs up from the Colorado River. Other levels of the cave are expected to be opened to visitors in the future.

The work of developing the cave was done by the C. C. C. under the direction of the Texas State Park Board. About three-quarters of a



Courtesy of Texas State Park Board

FOOTPRINT-SHAPED depression, ten feet long, in ceiling. Laughingly referred to as "footprint of Sam Bass."

mile back from the entrance a shaft was sunk from the surface. Through it thousands of tons of clay were removed from the cave. Along most passages one can observe the line on the walls showing the depth of the clay before it was removed and at many places also can be seen high water marks left when the cave was flooded. In several corridors and rooms, where the clay was removed, beautiful areas of calcite cover the walls. In the higher areas these crystals are white and clean with a yellowish tint but in the lower areas they were dirty and sometimes blackened by humic acid from flood-deposited vegetable debris. This discoloration led amateur cave developers to hammer off the entire cumulus-like surface in one corridor to give it a glittering effect, totally ruining a fine deposit.

The cave is rich in legend. It was occupied as early as 1860 and powder for the Confederate army was manufactured in the 183-foot-long "main room." The principal entrance is named for Sam Bass, the notorious outlaw. Rusted revolvers and flattened bullets found in the cave indicate its use as a rendezvous where pistol practice, if not actual gun battles, was staged.

LARGEST CHAMBER in Texas' most extensive commercial cave is the Convention or Big Room. Thousands of tons of clay were removed from the cave during its development by the Civilian Conservation Corps. Here Oscar Marx, head guide of Longhorn Caverns, is conducting a group of visitors.

Courtesy of the Houston Chronicle

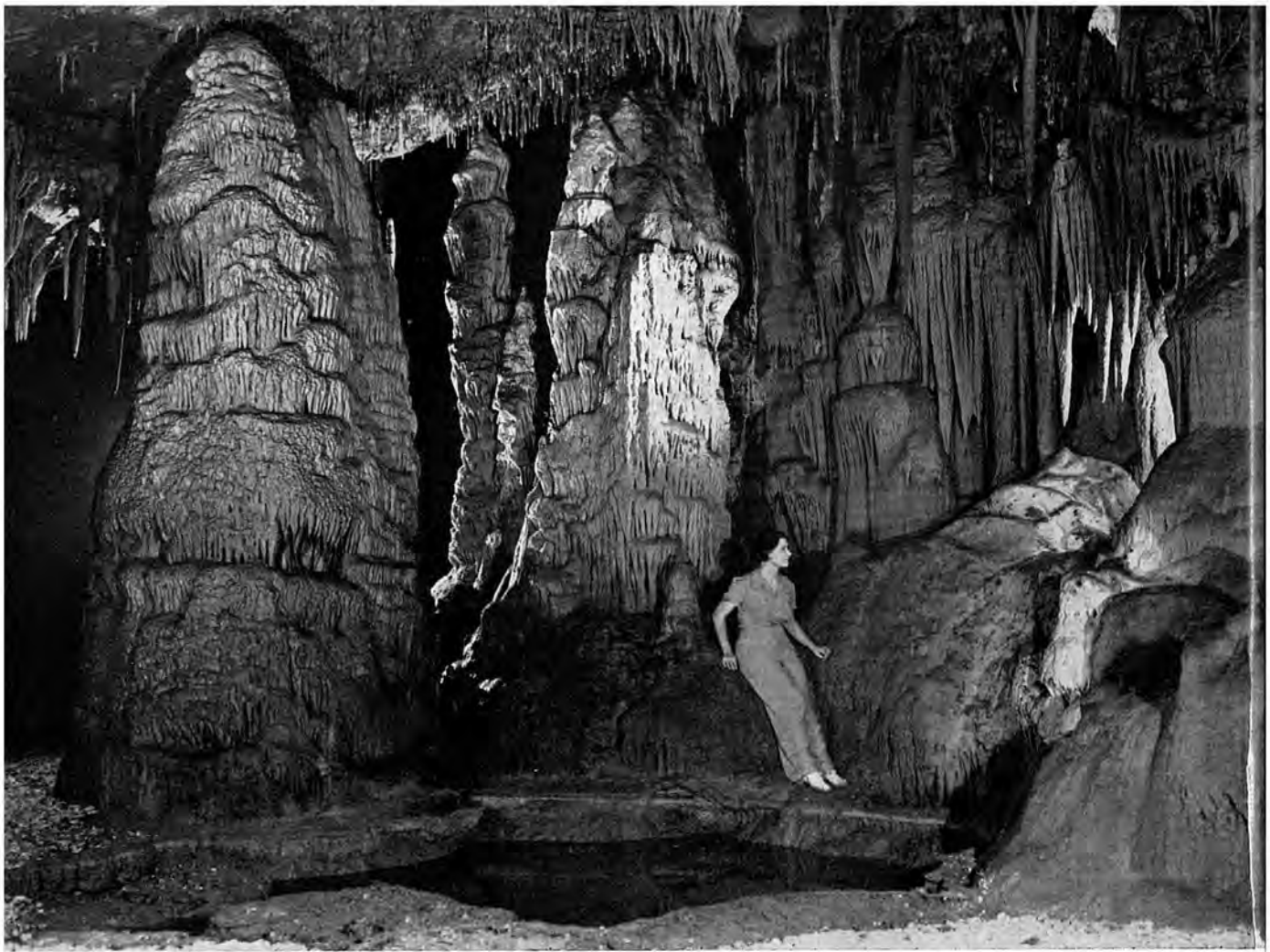
Longhorn Cavern Cleared

In the dry summer of 1947 the waters of Lake Travis became low. The waters of the lake are impounded by the 270-foot Mansfield Dam, erected at a cost of approximately thirty million dollars. The upper reaches of the lake are in the vicinity of Marble Falls, some ten miles southeast of the Longhorn Cavern State Park. The meandering Colorado River, above the lake in places, passes within some 3 miles of the cavern entrance.

These facts became the basis for one of the rumored reasons as to why the lake was shrinking and leaving a mud flat where formerly had been water. Some interested parties declared that the lowering of the lake was due to the waters of Lake Travis running into Longhorn Cavern.

To show the absurdity of this rumor, the Lower Colorado River Authority, managers of the dams and lakes, state that the cavern is 175 feet higher than the lake level. The trouble, they say, was insufficient rainfall.





Zintgraff, Courtesy of the Cave Without-a-Name

OUTSTANDING SHOW CAVE of Texas, the Cave Without-a-Name is relatively small. But throughout the 600 feet it has been developed it shows a profusion of multicolored formations. This travertine-rimmed pool is called "The Wishing Well." A great many sink-holes, many of them unexplored, are located nearby.

THE CAVE WITHOUT-A-NAME

In August 1946, the Cave Without-A-Name, which had been closed for a four-year period preceded by a brief, unsuccessful operation, reopened to a rather expectant public. For this small cave, whose lighted and conditioned section does not exceed 600 feet in length, presents a type of exceptional beauty, and it was well publicized.

Owned by J. L. Horne, the cave is located eleven miles northeast of Boerne, Kendall County, about 40 miles from San Antonio. It lies in a lower Cretaceous outcropping on the southern border of the Edwards Plateau, not far from the Balcones fault. This is a region containing hundreds of shafts and swallow holes, remarkably few of which have been entered.

The main tunnel of the cave lies uniformly

at a depth of 110 feet beneath the surface, and is reached by two vertical shafts in which a flight of 125 steps has been built. These shafts and some 20 others on the property were carved both by abrasion and by the action of acidulated water. The lower entrance shaft is beautifully hung with vivid coral-colored draperies, though partially hidden by a temporary stairway. From the foot of the stairs a 50-foot walk and a short duck-under brings one into the main room.

The first view of the cave is startling for its impression of spaciousness and color; above all, color. Bland, muted color, coral and dull gold, salmon and amber, white and ivory, blended and contrasted seemingly with little regard to the scientific rules governing their creation from prosaic red oxide of iron. Here are the first of the great 30-foot stalagmites for which the cave



STALAGMITES, 18 feet tall, and massive pillars and terraces of flowstone create an underworld fantasy. Where bare rock is exposed fossils are numerous and clearly seen. This is the Queen's Canopy, in the second room of the cave.



Zintgraff, Courtesy of the Cave Without-a-Name

THE RIVER disappears in a low tunnel 100 feet beyond the end of the tourist trail. It is believed to continue in the neighboring Dead Man's Cave. At the other end of the cave also, progress along the stream is blocked.

is notable; and to either side of this initial group of formations the cave stretches, black and shadowy, until each section is illuminated successively, to reveal constant variety of formation and of color.

The cave consists of a single long, lofty corridor, subdivided into rooms by groups of formations. The northern end, to the left of the entrance, is a magnificent hall designated the Gold Room. It is 150 feet long, 35 feet wide, surmounted by a perfectly arched 30-foot ceiling, the walls hung with stalactites and draperies and colored a dull rich gold. This end of the cave is terminated by a small chamber, the Papoose Room, glittering with countless fragile, delicate, translucent stalactites. Beyond this the cave can be followed another 50 feet as a crawlway, before mud chokes the passage.

From the Papoose Room to the far end of the cave two things can be noticed repeatedly: First, that the walls, wherever they are free of

secondary formation, are covered with marine fossils of the lower Cretaceous period. Second, that the secondary formations are remarkably translucent, even in thick masses. As to dimensions, from one end to the other the ceiling maintains, with one exception, an almost unvarying height of 30 feet; the floor, also with one exception, is almost unvaryingly level and flat; and the corridor keeps an average width of 35 feet.

The walls and ceilings are clustered with secondary formations of endless variety and size. Each successive section of the cave differs from the preceding section, from the exquisite fairy-like ceiling of the Papoose Room, the rich grandeur of the Gold Room, past the great columns and oriental ceiling of the King's Canopy, past the 25-foot Christmas Tree, a unique, symmetrical stalagmite, to the Queen's Canopy, where the touring groups usually pause.

The Queen's Canopy Room has an almost iridescent coloring, endlessly reflected in the terraced pools at the bases of the formations. To the right of the canopy rises an 18-foot stalagmite of translucent peach-colored onyx. Beyond, one passes the Wishing Well and a series of travertine-rimmed pools, to the Leaning Tower. It is customary to illuminate this suddenly out of total darkness and the effect is breathtaking. The cave is partially blocked by an ancient rock fall, surmounted by a 55-foot ceiling, up into which rises the highest of the cave's formations. Beyond this the cave continues past walls of marine fossils, past The Room of The Crystal Ceiling, to the stream that terminates the regular tour.

The pathway ends in a high vaulted hall, through which runs a considerable stream, visible for about 100 feet until it disappears in a low tunnel at the left. The stream has been explored as far as is practicable in both directions. Going downstream, the water can be followed easily past a series of drapery-hung pools, for about 200 feet, after which the ceiling descends directly into the water. It is surmised that a cave on the next property known for many years as Dead Man's Cave, is the continuation and outlet of the stream, and perhaps some day a passage will be effected between the upper part of Dead Man's Cave and the lower section of the Cave Without-A-Name.

Roof Sinks Into Stream

Continuing upstream, the stream can be followed for possibly a quarter mile. For about half that distance it is possible to travel by boat, but eventually the ceiling descends to within a few inches of the water. Often it is necessary to dive under low places before reaching sections with high ceilings. Finally the roof sinks into the water and exploration is necessarily ended. There are, leading from the main tunnel, two water-filled side branches that have never been fully explored.

The temperature of the cave is maintained at a constant 66 degrees; and the humidity remains above 95 per cent. The stream maintains its level through the driest seasons, and all but a very few of the formations are continually wet. For several months of the year, electric pumps are kept operating to drain the overflow from the travertine basins.

In the upper entrance shaft where the rock was blasted, may be seen many fossils, pockets of red oxide of iron, geodes, and seams of dog-tooth spar.

Very little life has been found in the cave. Salamanders, *Plethodon glutinosus*, have been reported. The common cave cricket is plentiful, and ants and white millipeds occur.

CASCADE CAVERN

The sensational publicity given this cave in 1932, shortly before its opening evidently was insufficient to make it a commercial success. The original story, by Frank E. Nicholson, is reprinted elsewhere in this Bulletin. The cave is located 4.8 miles south of Boerne and is well marked by highway signs.

The cave was closed as a commercial venture just before the war, but is soon to be reopened under new management. Electric lights, flagstone paths and stairways, installed during the commercial period, have fallen into ruin and the reopening of the cave awaits the necessary reconstruction. The new manager is a Mr. Lindberg of San Antonio.

Cascade Cavern is a combination joint and dip and strike type. Its large, impressive entrance is in the face of a 60-foot cliff at the bottom of a drainage arroyo. Dikes and causeways prevent flood waters from entering. Before the cave was developed in 1932, a large pool of water 500 feet from the mouth deterred further access. This pool was negotiated by explorers swimming partly under water; it was later partially drained to make accessible a long corridor opening into three rooms at varying levels.

Surface water accumulates in a depression over part of the cave and finds its way through the caprock, taking lime into solution and depositing it in the cavities as secondary formation.

The cavern is developed along a crevice about 120 below the surface; it alternately widens into large rooms and narrows to mere paths between adjacent walls. These walls show multi-colored flowstone and from the ceiling hang colorful draperies and delicately tinted stalactites, many of which have been badly vandalized. Small stalagmites dot the floors.

Once past the lake, the rooms are respectively 380 feet long by 60 feet wide and 68 feet high;

50 by 30 feet by 30 feet high and a final room which now appears about 40 feet square, but which is expected to be much larger following the completion of excavations soon to be undertaken. The rooms are 650 feet, 1105 feet, and 1175 feet from the entrance, approximately. The entire length of the cave, following its meander, is nearly one-half mile. The lake room is about 100 feet in length and the entrance room about 100 feet by 40 feet by 60 feet high.

RICHLAND SPRINGS CAVERN

This cavern, also known as Treasure Cave, is four miles south and one and a half miles west of Richland Springs, San Saba County. It occurs in the Upper Ellenberger formation and apparently was formed almost entirely by solution.



A. T. Jackson
ENTRANCE-CLUBHOUSE at Richard Springs Cavern, now closed. Discovered in 1937, this cavern had a very brief existence as a commercial development. The cave has a particularly fine display of stalactites.

The lowering of ground water due to a general decrease in rainfall, and deep trenching of branch streams of the San Saba River, also may have affected its development.

The entrance was discovered in 1937 by Mark Terru when he entered a small crack in the limestone, roped himself down 40 feet to the floor and entered a large room, the first in a series of elliptical chambers conected by small passageways.

The cavern was extensively developed as a commercial venture by its leasor, Lon Piper of San Antonio, who excavated and enlarged the passages and installed an elevator and electric lights; but the project was soon abandoned and the cave is now almost reclaimed by the earth.

A large number of beautiful stalactites adorn



CASCADE CAVERN ENTRANCE (above). This is the cave which was explored by Nicholson in 1932, as described elsewhere in this Bulletin. It has been open to the public at intervals. It is now closed but is expected to reopen soon.

FOSSIL TUSK OF A MASTODON (below), unearthed in Cascade Caverns, probably measured nearly nine feet in length. The mastodon lived at least ten thousand years ago.

Photos by Charles E. Mohr



the ceiling. A dark red clay, not characteristic of cave deposits in this area, covers the floor of the cavern and imparts traces of its color to some of the partially dissolved limestone. The color may be due to small deposits of iron in the limestone which passed on its tint to the subsoil; it also seems possible that some of it might have been washed in by ancient floods.

The bones of a deer and a horse were found partially buried in the red clay flooring. It is reported that the subterranean galleries and passages of the cave extend more than a mile in a southwesterly direction.

AUSTIN CAVERNS

The cave is within 1,000 yards of Lake Austin, in an area of massive limestone ledges. Most of the commercial history of this cavern system has been lost. It was operated for a short period in 1932 but soon was closed and the entrances blasted. The old entrance has reopened itself in the past few years and now permits admittance into the first four chambers of the old cavern.

This is the first Texas cave of which we have printed record. On February 5, 1840, *The Telegraph and Texas Register*, of Austin, published the following account:

An extensive cave has been discovered near the City of Austin. The entrance of this cave is situated in an elevated plain, upon a hill about three miles distance from the city, in a westerly direction and across the Colorado.

This entrance forms an aperture about eight feet long and four or five wide, rendered irregular by projecting angular fragments of rocks; and sinks suddenly, like a well, to the depth of a few feet. From the bottom of this aperture two passages extend into the rocks nearly at a right angle from each other. The smaller of these, which is about six feet wide and three or four high, extends towards the north in a horizontal direction; and at the distance of about 100 feet from the entrance becomes so narrow that a man of ordinary size can with difficulty penetrate farther. Here numerous small passages extend obliquely upwards into the rock.

The other and main passage of the cave is about twice as large as the former, extends in an easterly direction obliquely downwards about 100 feet, where it opens into a chamber about twenty feet wide, thirty feet long and five or six high.

Many narrow passages extend beyond this, and probably communicate with other subter-

anean chambers that have not yet been explored. The walls of this cavern are limestone. Small stalactites have formed upon them and in many places unite with stalagmites from the floors, forming small, irregular columns. These are generally opaque and of a dull, dingy white color. The floor of the cavern is generally covered with a deep bed of dirt, in which are enclosed many bones of bears and other animals. It probably contains large quantities of nitre.

The walls of this cave exhibit in every part the action of a current of water and evince its origin. There are probably in the neighboring hills many similar caverns, which have been worn in the rocks by subterranean torrents.

The original cavern system was reported, doubtless with great exaggeration, as being about seven miles long. At least it must have been much larger than the areas now accessible. A large number of unexplored cracks and fissures in the nearby limestone give rise to the hope that a new entrance may be discovered to the section of the old system which has been cut off by the blast.

These chambers, which still can be entered, appear to have been greatly altered, perhaps by the blasting. The largest is about 50 feet by 30 feet by 6 feet high. Stalagmites throughout this room have been curiously sheered off in such a way as to show clearly that they once were taller than the present height of the room. This apparent phenomenon may have resulted from a sudden lowering of the ceiling.

Although the formations are badly weathered, there are some interesting displays of fresh white calcite crystals and flint outcroppings. The preponderant color throughout results from iron. There are a few small travertine and flowstone deposits. No fauna was observed although there were numerous strands of spider webs in evidence.

ROBBER BARON'S CAVE

An unusually formidable array of legends has grown up around this curious labyrinth since its commercial abandonment in 1933. Up to that time some 300,000 people were said to have visited it; since then, a far greater number has doubtless heard and re-told its preposterous stories.

One account, written by W. A. Ownby and published in the *Dallas Morning News*, June 23, 1929, describes it as follows:

Probably one of the most interesting caves in the State is located about eight miles north of San Antonio and within less than fifty feet of the King's Highway . . . If the walls of this cave could talk they probably could reveal tales of crime which cause the blood and thunder stories of the wild and woolly West to pale into insignificance . . . [it] is known as the Robber Baron's cave, the name having originated from early day stories that it was once the rendezvous of a band of robbers whose depredations extended over a wide area of the Southwest. It is related that the chieftain of the band ruled his men with an iron hand and that when one was sent out on a mission of crime, if he failed, he never returned.

The entrance to Robber Baron's Cave is through a large hole in the surface of the earth. A winding stairway extends from the top to the floor of the first chamber, a distance of about sixty feet. This opening resembles an old well with the walls caved in. The entrance is surrounded by a fence to prevent livestock or persons from falling in. The cave is lighted with electricity for about 3000 feet.

This cave is open to the public [1929] and almost every day little groups of visitors are to be found exploring its winding chambers.

The article states as might be expected, that "the cave has never been explored to its remote limits" and that "to attempt such a feat with only a lantern to guide one's steps would be extremely hazardous." It is rumored, Ownby says, to extend eight miles to San Antonio.

Our member, Patrick J. White, writes, however, that while entrances have been reported in many parts of the city, all of them have proved to be either separate caves or sections of the ancient aqueduct built by the Spanish missionaries who colonized the area.

All the caves in the city are erosion channels in a hard, calcarous clay. Robber Baron's is no exception. It actually is an incredible network of tubes and tunnels on many levels, intersecting, branching, and doubling back upon themselves. None of these passages exceed 20 feet in height and 5 feet in width. There are no rooms. Various cave-ins have blocked off corridors which doubtless led into a still greater maze. At the present time, one may travel for hours in this rabbit warren of a cave, yet never get more than 300 feet from the entrance which has silted in heavily, leaving only a very tight squeezeway striking at a 20 degree pitch southward from the

bottom of a 30-foot deep sinkhole. Even this dubious entrance would now be closed were it not for the efforts of the neighborhood children who dig continually in order to keep it open.

Once the initial squeeze has been negotiated, the remainder of the cave affords plenty of headroom. Some drably colored flowstone and small stalactites can be seen. Cave crickets were the only fauna observed. Much of the cave lies within 10 feet of the surface and crumbling roofs are commonplace, consequently exploration is rather hazardous.

FAIRY CAVE

This small single-chambered cavern was commercially operated for only six months and was closed sometime in 1930. Operated by the Cartwright brothers, it is on the DePuy Ranch eight miles east of Boerne and is reached by a road now very difficult to negotiate; furthermore, all of its commercial equipment has fallen into ruin.

Distinguished by interesting stalactite and stalagmite formations, the cave's single chamber is 250 feet by 30 feet by 30 feet high. It is reached by a 35-foot vertical shaft in the Edwards limestone and seems to be completely barren of cave fauna.

HAMMETT'S CAVE (West Cave)

This tiny, but extremely beautiful cavern on the Pedernales River at Hammett's Crossing, was commercially operated for only a short period. It was closed about ten years ago. It is a striking example of a grotto being converted into a cave by growth of thick stalactite curtains from an overhanging ledge. These curtains form the outer wall of the cave and are translucent to the daylight.

The cave's single chamber is about 150 feet long, in a bluff 200 feet high. It is very wet and much alive, with massive formations of many varieties. The formations also grow from the outside of the cliff in places where they are exposed to the rain. The headroom in the chamber is about eight feet throughout. There are two entrances, one at each end of the stalactite curtain. The cave is unusually beautiful and is in a charming natural setting. A small cascading waterfall plunges from the cliff above to a crystal pool at the cave's entrance.

Caves of Central Texas

By PATRICK J. WHITE

The following list of caves is in no sense complete. It covers all the caves known to the writer over a wide region of varying limestone geology, much of which is heavily pocked with swallow holes and possible cave entrances as yet unexplored. Many of these caves have been visited by, others reported to, the writer. All have been confirmed by reliable sources. No attempt has been made to list rumored, but unconfirmed, caves—chiefly because there are too many of them.

Unfortunately, until there is a greater distribution of speleologists in Texas, most of these rumored caves must go unlisted. Here are many virgin fields for the explorer.

The writer would like to express his appreciation to A. T. Jackson, Edwin C. Vinther, and Charles E. Mohr for their permission to incorporate some of their writings into this article in order that a more comprehensive picture of Edwards Plateau caves might be presented. The sections dealing with Shelter Caves were written by Jackson; Vinther and Jackson collaborated on the Williamson County section and Mohr wrote the Hays County section. The contributions of each are so labeled. Credit too is especially due Tom Goeller, Floyd E. Potter, Jr., and Raymond Medellin for much information and physical assistance in the actual work of exploration.

BELL COUNTY

Salado Cave — This cave, located at left of the highway at the southern edge of the town of Salado, has been proclaimed to be very extensive. Actually it is a single chamber 20 by 30 feet by 8 feet high and about 10 feet below the surface. It contains a beautiful crystal pool which is linked to the Salado creek. Two passages, a northerly and a southerly, lead from the chamber. They both taper to dead ends within 30 feet. (This county is not part of the Edwards Plateau but of the Blackland Prairies of Central Texas.)

North Salado Cave — About 1.5 miles northwest of Salado, at the bottom of a 20-foot limestone swallow hole, a small shaft drops downward into a tiny muddy room. This cave is supposed to be very extensive, but this writer found no exit from the room. Possibly the passageway has become plugged with silt.

South Salado Cave — Following a joint in the limestone, there is an extensive, though low-ceilinged cavern about 20 feet below the surface. The cave is about 400 feet on the right of Levett Road, 2.7 miles from the Road's opening into the Austin Highway south of Salado. To reach the Levett Road, turn west on the Austin highway exactly 2.9 miles north of the Bell county line. A succession of five sprawling rooms filled with beautiful stalactites and stalagmites, some dripstone and flowstone, and one small deposit of helectites comprise the known section of the cave. These large, low chambers are subdivided by heavy stalactite curtains and contain broad, meandering, shallow pools of great beauty. The rooms are separated from each other by difficult squeezes near the ceilings. The floor of these short squeezes is very abrasive and the passages bend at acute angles; the writer's party, moving fairly fast, required 4 hours to make the round trip—a total of about 100 feet. Numerous cave crickets were seen and some guano, but no bats. A half-starved raccoon was surprised in the innermost chamber, but it eluded rescue by retiring up a tiny unexplored squeezeway at the rear of the fifth large chamber.

South Salado Caves No. 2 and No. 3 — About 7 miles southwest of Salado, on the old West place, there are two small swallow holes striking southwest and northwest, respectively, along the line of the joints of the limestone. These holes are directly opposite each other and about 30 feet apart. The northeasterly hole leads into a single large chamber which once contained many formations which

have almost all been vandalized. The cave is now dead. The southeasterly hole leads to a similar, though smaller, room.

Shelter Caves (A.T.J.) — Watt¹ in writing of the *Kell Branch Shelter*, says it is on a small stream "which flows into Stampede Creek a few hundred feet above the latter's confluence with the Leon (River), is located about 9 miles north of the city of Belton.

"In the overhanging cliffs forming the west walls of the south fork are a number of small shelters . . . The largest . . . is somewhat crescent shaped and can be reached either from above, along the rock ledge, or by climbing a steep talus slope from the stream level to a height of about 30 feet. It is in the west wall of the canyon and faces east. The shelter is on land owned by the T. C. Caskey estate.

"The dimensions of the No. 1 shelter are as follows: Length, north-south . . . 109 feet; depth of shelter . . . 5 feet . . . The maximum height of the ceiling was 5 feet."

"At 64 feet from the north end, a stalagmite had formed, completely blocking the entrance for a distance of 20 feet, and building up the floor immediately back of it almost to the level of the ceiling."

Jackson² mentions a "crevice-like entrance to a so-called cave." It is on the C. V. Brown farm, at Kuykendall Spring, 1 mile north of the Leon River, 1.5 miles southeast of Moffat.

BEXAR COUNTY

Robber Baron's Cave — This ex-commercial cave is described in the article on "Texas Commercial Caves" elsewhere in this Bulletin. To reach *Robber Baron's Cave* go out Broadway in San Antonio to the outskirts of Alamo Heights. Turn obliquely right on the old Nacogdoches Road (pronounced (Nak-ah-DO-ches) and proceed about 300 feet past the first intersection. There, on the left, within 10 feet of the road, is a large sinkhole. The entrance is a tiny squeezeway at the bottom.

Helotes Cave — Four miles north of Helotes on the Scenic Loop Road to Leon Springs, the *Helotes Cave* is located on the summit of a very high hill about 100 feet southeast of a roadside park. The entrance is at the bottom of a 12-foot-deep swallow hole. A single chamber 20 by 30 feet and 5 feet high comprises the cave.

Various small sinkholes in the floor indicate a possibly traversible labyrinth below.

Shertz Cave — Sometimes called *Cibolo Cave*, this shallow labyrinth is quite difficult to locate as its entrance is a large sink, sheltered by trees, in the middle of a rolling, brushy pasture. Go to the town of Shertz in Guadalupe County, turn left across the railroad tracks, then right and follow the Cibolo Creek road about 2 miles until you see a 75-foot-bluff across the creek bed. This bluff is highly pocked with shallow shelter caves. Cross the dry creek bed on foot (this brings you back in Bexar County) and look for a narrow, steep arroyo at the south end of the bluff. Go 150 yards up this arroyo, turn sharply left, cross a fence and walk about 200 yards. The cave will be found nearby. Apparently *Shertz Cave* was at one time quite extensive. There are many evidences of caving blocking off passages and partially filling rooms. At present (1948) there is about 1.5 miles of passageways varying from 4 feet in height and 10 feet in width to mere crawlways. No formations were observed and only a small amount of guano in the far left branch. The cave has been "dead" for a long time and the limestone which contains it is now mainly decomposed to a clayey consistency which accounts for the recent cave-ins. The ceilings are treacherous, the air stale and dusty, the walking uncomfortable, and a snake was shot in the entrance. Nothing of interest was seen except at a point about a quarter of a mile along the right branch. There someone had excavated and apparently removed a small chest, or box, the outlines of which are still clearly visible in the hard clay.

Lee Ranch Cave — A considerable cave, by no means fully explored, is reported on the old Lee Ranch about 15 miles west of San Antonio on the Bandera Highway. The writer has not been able to locate it.

BLANCO COUNTY

Blow-out Cave (Bat Cave) — This cave, or grotto, is slightly more than 200 feet long by about 50 feet wide; its entrance is 8 feet high and 40 feet long. To reach it, take the Llano road northeast out of Fredericksburg (Gillespie County), and go 11.1 miles; turn east and drive 8.8 miles on the Willow City



DAVIS BLOW-OUT CAVE is Blanco County's only known cave of any size. It has a large bat population. A fire set in 1856 to drive out a bear caused an explosion giving rise to the cave's name.

DIAGRAM OF BEAVER CREEK CAVERN (right) was drawn by W. B. Phillips in 1901 and published in *Mines and Minerals*.

road to a road fork. Proceed on the north fork 3.2 miles to the Davis Ranch gate; go through it and 3.3 miles farther where you will see a prominent pegmatite dike crossing the road. Two-tenths of a mile east of the dike and one-tenth of a mile south of the highway, you will see a hillside with a conspicuous opening near the top. That is *Blow-out Cave*. Careful inspection will reveal a trail which leads up to it and over which it is reasonably safe to take your car. The cave is excavated in massive ledges of dolomite in the Wilberns formation. And the rough roof, where not encrusted with travertine which stands out one or two inches in miniature, closely packed stalactites, appears to be etched and displays many crevices. Except for a small area near the entrance, the floor, with which the roof slopes about 17 degrees to the southwest, is heavily strewn with huge blocks of dolomite apparently fallen from the ceiling. The cave is quite dry, being protected from rains and slope wash by its position at the top of a well-drained ridge. It must have been formed at a period prior to the cutting of the present valley when more water flowed into the crevices along Blow-out Ridge. In the summer, small brown bats completely blanket the walls and ceiling and pack in thick masses in the crevices and joint fractures. Guano, which emits stifling ammonia fumes, forms a thick cushion over large areas of the floor. And small, gray beetles and silver fish-like insects abound. Bones of a

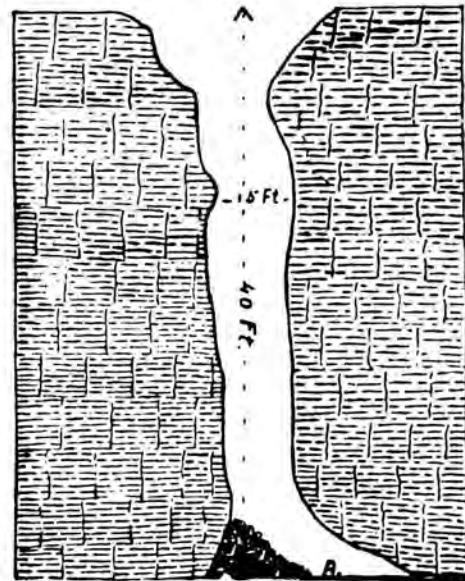
deer were found about 50 feet from the entrance. The cave's name refers to an explosion in the cave in 1856, an event described elsewhere in this Bulletin.

Cypress Mill Cave (A.T.J.) on Cypress Mill Creek near the village of the same name, is a small one-chamber, pillbox-like enclosure with a fairly small opening. Most of the wall space is damp, but there are a few rather recent Indian paintings.

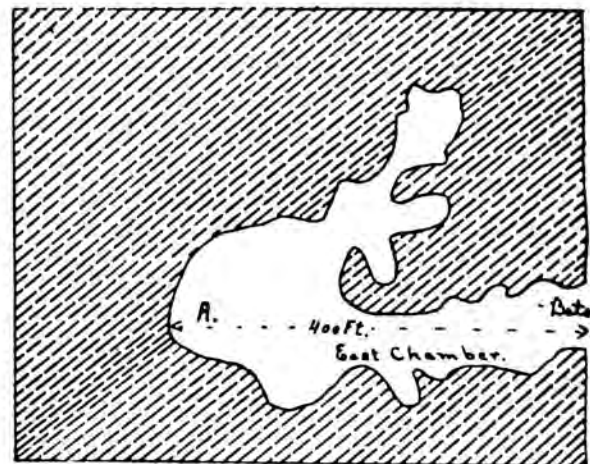
BURNET COUNTY

Longhorn Cavern — A commercial cave. For description see article on Commercial Caves. To reach the cavern take the Longhorn Cavern road, plainly marked from Burnet.

Beaver Creek Cavern — Hewn in massive ledges of the lower Ellenburger dolomite, the



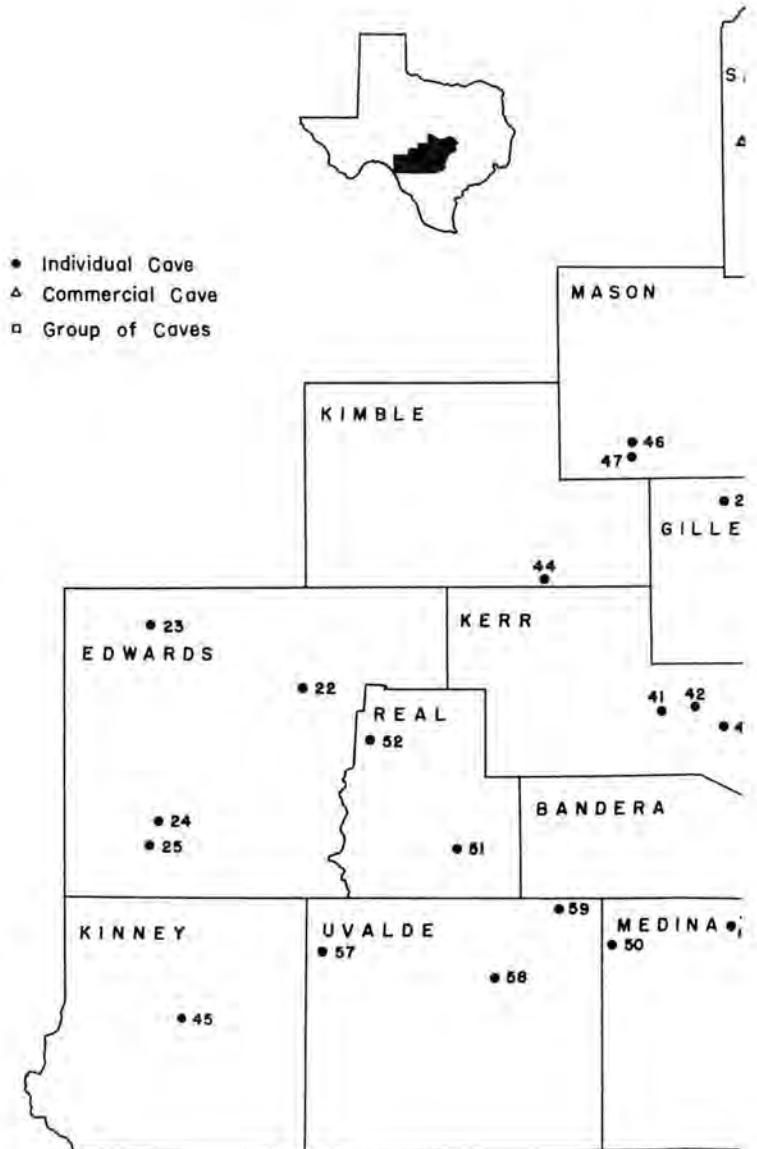
Vertical Section.



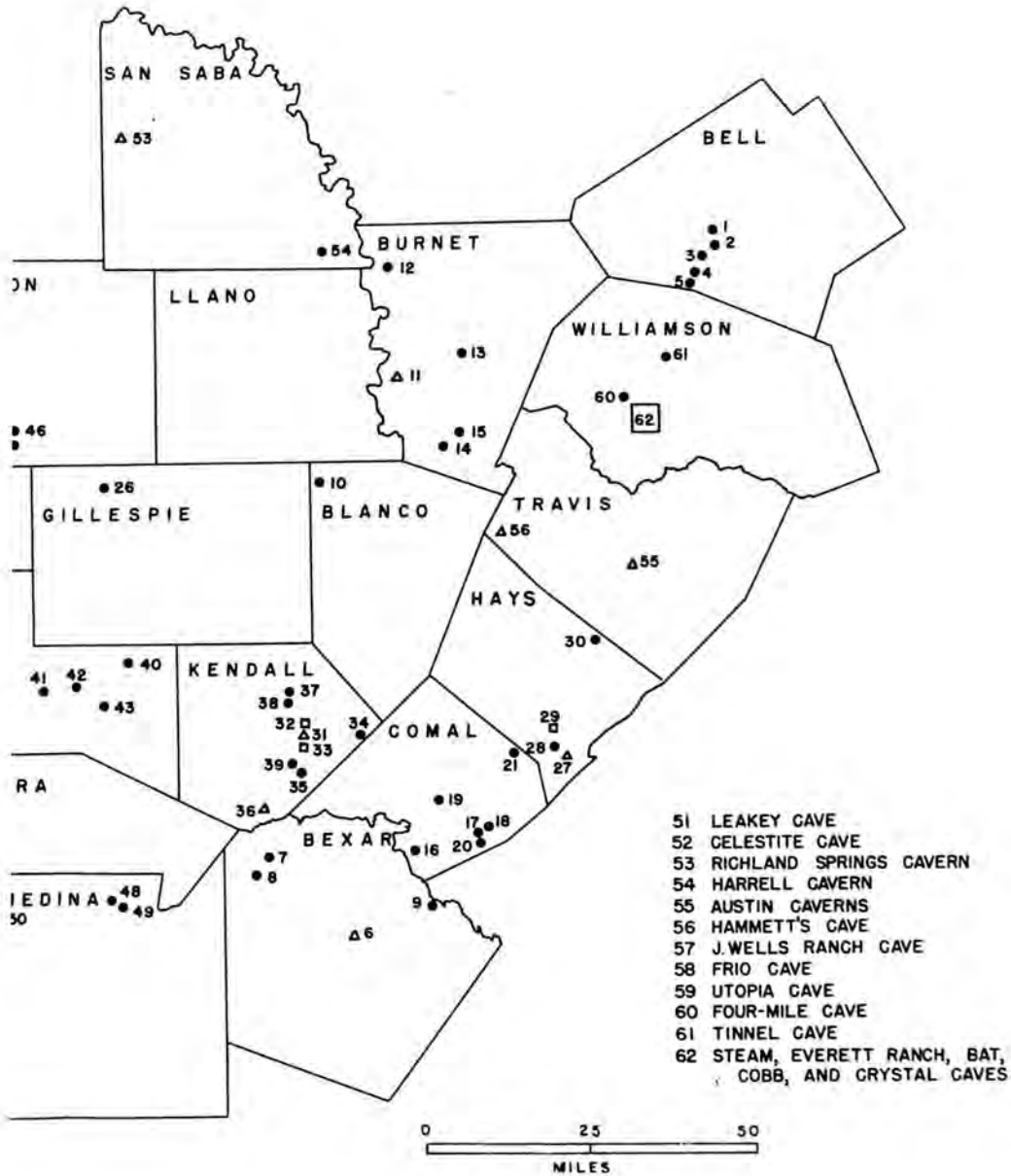
Ground Plan.

- 1 SALADO CAVE
- 2 NORTH SALADO CAVE
- 3 SOUTH SALADO CAVE
- 4 SOUTH SALADO CAVE No.2
- 5 SOUTH SALADO CAVE No.3
- 6 ROBBER BARON'S CAVE
- 7 HELOTES CAVE
- 8 LEE RANCH CAVE
- 9 SHERTZ CAVE
- 10 BLOW-OUT CAVE
- 11 LONGHORN CAVE
- 12 BEAVER CREEK CAVERN
- 13 POST MOUNTAIN (BURNET) CAVE
- 14 DEAD MAN'S HOLE
- 15 MARBLE FALLS CAVE
- 16 BRACKEN BAT CAVE
- 17 BREHMMER CAVE
- 18 LITTLE BREHMMER CAVE
- 19 E.J. HEIDRICH CAVE
- 20 R.R. CORETH CAVES
- 21 BOYETT'S CAVE
- 22 THE DEVIL'S SINKHOLE
- 23 WHISTLING CAVE
- 24 DRAGOOL CAVE
- 25 ASA TOMLINSON CAVES
- 26 INDIAN (FREDERICKSBURG) CAVE
- 27 WONDER CAVE
- 28 EZELL'S CAVE
- 29 CAVES OF SAN MARCOS, INCLUDING
CRICKET CAVE, McCARTY CAVE,
CORRIE SMITH'S CAVES, SWIFT'S
CAVE, JOHNSON'S WELL, ARTESIAN
CAVE
- 30 BARKER'S RANCH CAVE
- 31 THE CAVE WITHOUT-A-NAME
- 32 HORNE RANCH CAVES, INCLUDING
SMOKE HOLE, TIN CAN HOLE,
SCHULTZ HOLE
- 33 KOPECKY RANCH CAVES, INCLUDING
DEADMAN'S CAVE
- 34 SPRING CREEK CAVE
- 35 FAIRY CAVE
- 36 CASCADE CAVERNS
- 37 PRASSEL RANCH CAVE
- 38 SCHNEIDER CAVE
- 39 EDGE FALLS CAVE
- 40 KARGER CAVE
- 41 R.R. MERRITT RANCH CAVES Nos. 1, 2, & 3
- 42 SEINWEBER CAVE
- 43 REAL CAVE
- 44 FLEMING'S CAVE
- 45 WEBB CAVE
- 46 BAT CAVE CAVERN
- 47 CAVE NEAR BAT CAVE CAVERN
- 48 NEY CAVE
- 49 RATTLESNAKE CAVE
- 50 DONAHO CAVE

CAVES OF CENTRAL



CENTRAL TEXAS



entrance to this subterranean chamber of more than 300 feet is a gaping vertical shaft which plummets 45 feet and requires the use of climbing equipment to negotiate. The cave is nearly "dead" now. And, judging from its conspicuous fracturing, with joint lines trending northeast and southwest, and its present water protected position, it was probably formed at an early stage of erosion history, perhaps soon after the removal of the cretaceous cover. The entrance shaft at the surface is 50 feet from north to south and 30 feet from east to west. At the bottom it is somewhat smaller, with the floor striking southeast, in conformity with the dip of the formation, at about a 5 degree pitch, to a 4-foot-high opening which fans rapidly into a large chamber festooned with bats and teeming with insects. Until several years ago guano was mined commercially, but the operation is now abandoned. The cave is not difficult to find, being 11.7 miles west and 9.5 miles north of Burnet. But the directions for reaching it are somewhat complex; From the headquarters of the Goodrich Ranch in the road running southwest out of the village of Natuna, take the Lake Road 2.4 miles to the second gate. Turn sharply southwest 1.6 miles along a little used road to the old Litton Ranch house. Turn southwest again and go 1.4 miles on an almost indefinable road to a sheet iron building near the top of a prominent ridge on a southwest sloping hill. The entrance to the cave is at this building.

Post Mountain Cave — This small, single chamber cave is on Post Mountain just southwest of Burnet. It's semi-circular room is about 20 feet in diameter, doming to a height of about 35 feet.

Deadman's Cave—The only great totally unexplored cavern now known in Texas, this hole poses unique problems of descent. A small sinkhole, about 6 x 10 feet, leads straight down about 15 feet to a small ledge which extends about five feet into a fissure some 30 x 15 feet and oval in shape. From the edge of this ledge, the fissure is seen to fall perfectly sheer for as far as the eye can reach. The writer lowered a gasoline lantern 165 feet from the surface. It came to rest on what may have been the bottom of the cave or, possibly, merely on a ledge. Due to a succession of overhangs and a

slight tilting of the shaft at that depth it was impossible to be sure. Natives believe that the hole is "bottomless" and say that no one has ever been into it. Legend has it that three dead men were thrown into it shortly after the Civil War. It emits a draft of steam in cold weather. Unquestionably it should be the number one project in the future exploration of Texas caves. Directions: One mile south of Marble Falls turn east from the San Antonio highway on the Spicewood Road, ford the creek and take the right hand fork, drive about 2 miles to the first gate on the left, back up about 200 yards until you see a fence on your left going away from the highway at a 90 degree angle. Follow this fence about 200 paces, turn left 20 paces to the hole.

Marble Falls Cave — On the right hand bank 2 to 2.5 miles down the Colorado River from Marble Falls, is a cave said to have two openings, one on the top and one on the bottom of a bluff. There are a few dead formations reported in its three staircased rooms.

Shelter Caves (A.T.J.) — A rock shelter long was known as being on the O. K. Chestnut Ranch, at the junction of North and South forks of Morgan Creek. Paintings on the wall were recorded before the site was inundated by the waters of Lake Buchanan.

COMAL COUNTY

Bracken Bat Cave — This cave, one of the most amazing sights of Texas, is reached by a two-mile drive over an extremely bad road north of the town of Bracken. *Bat Cave* has been a constant source of commercially mined guano for about 60 years, producing approximately 80 tons a year. It can be entered only during the winter months when the bats are hibernating. Even then, the odor is unpleasant and exploration in it is unusually filthy; a change of clothes should be carried. The cave is a single chamber about 1000 feet long, lying generally about 120 feet beneath the surface. The height of the chamber runs from 30 to 50 feet, and the width from 40 to 100 feet. From the innermost point of the cave, a shaft runs to the surface; through it sacks of guano are hoisted. This shaft, artificially carved, pierces the ceiling at a point where there was a very lofty

chimney which had risen almost to the surface. The center of the single room is piled with the debris of an ancient tumbledown which at one point reaches almost to the ceiling. The entire cave is piled several feet deep in guano, usually in a dry, powdery form which rises in clouds about one. Where there is water dripping from the ceiling the guano becomes very difficult to navigate. Leading from the walls of the room are numerous tiny tunnels, too small to allow the passage of a human body for more than a few feet. The workmen in the cave had been working there for about 14 years. Daylight penetrates about half the length of the room but farther back the dimensions are so great that lanterns make little impression. Entrance to the cave is made from the bottom of a large sinkhole, the result of a tumbledown that has blocked the rest of the cave. From this entrance, about 40 feet wide by 20 feet high, one is startled by the immensity of the scene. Very far below, lit by pale daylight, one can see the tiny figures of the workmen. The cave appears as a tremendous cavity far larger than it actually is. This initial and spectacular view alone repays the effort needed to reach the cave.

Brehmmer Cave — This highly interesting, formation-full cave is located in a limestone outcrop under a flat pasture owned by Ed. C. Heidrich, it appears to have been formed almost entirely by solution. Go northwest from New Braunfels on State Highway 46 to the Bulverde Road. Turn west on the Bulverde road and go 1.5 miles to the Heidrich home which is atop a knoll on the north side of the road. Stop at the house and request permission to visit the cave. It is given freely but do not attempt to enter the pasture without first consulting the owner. In front of the house and across the road (south) is the pasture gate which leads to the cave. (*Little Brehmmer-Heidrich Cave*, listed elsewhere in this article, is on a continuation of this road past *Brehmmer Cave*.) From the Bulverde road, it is 1 mile south on the pasture road to *Brehmmer Cave* which is plainly marked with a sign. The entrance strikes southward at a gentle pitch between large limestone boulders. About 50 feet from the entrance, a shaft, excavated during the Civil War when the guano in the cave was being used in the manufacture of nitrates, drops from the surface into the first

cave room. The shaft, however, is a sheer drop, while the other entrance is a gentle gradient requiring no climbing equipment. Although untold damage has been done the rich formations of this cavern by visitors, it remains one of the most interesting in this part of the country. Some easy climbing and a good deal of crouching is required in negotiating the more than 300 yards of known areas, but the effort is highly rewarding: One finds a bewildering multiplicity of formations everywhere. There are delicately



Glen M. Kohls

BREHMMER CAVE entrance. A sign posted by owner Ed. C. Heidrich warns visitors to look out for rattlesnakes.

tinted canopies, flowstone, pure white calcite, a few greens and many shades of browns, yellows and grays. Travertine, stalactite columns, large stalagmites, a few helectites, and ceilings clustered in tiny, white, living stalactites. Filagree work of honeycomb rock, stalagmite forests, dripstone and a tiny, beautiful grotto with a pool spilling over travertine—all conspicuously beautiful. The entrance room is about 20 feet long by 15 feet wide and 6 feet high, striking in a westerly direction. It opens abruptly into the second room which is rimmed on the right side by a deep channel. After 30 feet the roof drops to 4 feet, while 300 feet inside there is a 30-foot climb to the left, down and up again to the 100-foot-long Refrigerator Room, the most beautiful room in the cave. Returning to the bottom of the divide between the Refrigerator Room and the Big Room one turns to the right and after about 40 feet, parallel to, but at a lower level than, the Big Room, comes to the Whale's Mouth Room. From here, from the far end of the Refrigerator Room and also

from the gulch rimming the Big Room, unexplored squeezeways drop downward abruptly. Bats are in abundance as are cave crickets. Black scorpions have been reported in the Big Room by the owner, but were not seen by the writer. Large mounds of guano are in the Big Room and in the Divide. A cushion of guano is over most of the level floor of the Big Room. The cave is still very much alive and is slowly filling with mud and silt brought in from the surface. No water, other than the drippage, occurs except as run-off when it rains. Rattlesnakes are common at the entrance and among the rocks surrounding it.

Little Brehmmer-Heidrich Cave — This small but extremely fascinating cave is about 1 mile past big *Brehmmer Cave* along the same pasture road. Follow the same instructions as given for reaching *Brehmmer Cave* but continue about one mile farther along the pasture road. (It would be advisable to have someone familiar with the terrain show you the entrance to this cave as it is approached over an almost indefinable pasture trail with many side trails and forks.) The entrance is a small passage between limestone rocks. From it, one emerges immediately into an alley between bronze colored stalagmites. The overall height in the alley is about 4 feet. A rugged forest of stalagmites covers the floor to the left as it drops downward. Go among them and down to another chamber; then forward and circle to the left through three other chambers and back to the entrance. Apparently this cave which is 150 feet long by 30 feet wide and about 10 feet below the surface was originally one large room extending about 60 feet, dropping to a lower level—though keeping the same ceiling—and continuing another 90 feet. It is now subdivided into at least five chambers by delicately tinted, translucent stalacite curtains. Holes have been opened in these curtains permitting access to the various rooms. As in *Brehmmer Cave*, this cave is full of handsome formations including flowstone, white calcite and draperies; the ceiling is richly encrusted in tiny, white stalactites very much alive. No bats frequent this cave, but cave crickets were seen in large numbers. Due to warmth, about 65 degrees, and the fact that much of the entrance room is in the twilight zone, raccoons, skunks, and rattlesnakes fre-



Charles E. Mohr

SKUNK HOTEL is the local name for this Heidrich Ranch cave. Dr. S. S. Wilks of Southwestern State Teachers College is the explorer.

quent it. *The owner issues a particular warning regarding the rattlers.* And the writer was even more startled than the surprised skunk which confronted him when he went over to a ring of stalagmites to see why it was called "Skunk Hotel." The animal calmly retreated into a crevice. Incidentally, no odor of skunks was present. There are several unexplored squeezeways in the cave, which is silting up rapidly because of soil carried in by rainwater.

E. J. Heidrich Cave — A hole 4 feet in diameter penetrates the 5-foot-thick rock ceiling 15 feet above the floor of the principal chamber of this small cave. This chamber is about 40 feet in diameter and contains the vestiges of a great many stalactites most of which have been vandalized. A rapidly narrowing fissure leads downward along the western edge of the main chamber and a small crawlway strikes west from the north end of the chamber. Both terminate within 30 feet in fissures too narrow to permit

the passage of a human body. No fauna was observed. The Heidrich Ranch is on the left of State Highway 46 about 8.5 miles northwest from New Braunfels.

R. R. Corith Caves — One of the state's most interesting undeveloped caves, the *R. R. Corith Cavern* probably presents a geologic history quite similar to that of The Devil's Sinkhole—in a much smaller way, of course, and with the final surface breakthrough not yet attained by the *Corith Cavern*. Apparently a succession of cave-ins filled and partially filled a large solution chamber with its floor about 95 feet below the surface. The result is a cavern with a large chamber, about 100 feet by 50 feet by 15 feet high, with its floor about 20 feet below the surface. To the north, a large corridor swings in a half circle around the room gradually diminishing in size from about 8 feet wide and 10 feet high to a small crawlway. To the south, a small passage amid the rubble leads steeply downward to the 90 foot level where a small semi-circular room has escaped being plugged up by the falling debris. The floor drops another 5 feet to a pool of water which extends along the outer perimeter of this lower chamber. The cave is wet and muddy on the lower level but no formations were seen. Vast mounds of soggy guano could not be plumbed with a 13-foot pole, but only a few bats continue to make their residence there.

Boyett's Cave (C. E. M.)—Uhlenhuth (See article elsewhere in this Bulletin) visited this cave 14 miles above San Marcos where the Purgatory Creek Valley starts. The entrance is about 1,100 feet above sea level, and leads to a large main hall about 50 feet below the surface. The former presence of water is indicated by a horizontal line on the walls, with a type of pebbly deposit typical of underwater formation. There are attractive stalactites and a number of shallow drip pools in which amphipods were collected in 1916.

EDWARDS COUNTY

The Devil's Sinkhole — One of the continent's great chasms, it is discussed in a separate article entitled "The Devil's Sinkhole" printed elsewhere in this Bulletin. To reach the Hole go 8.7 miles northeast of Rocksprings on State Highway 41. Turn south through a white gate

on an azimuth bearing of 160 degrees. Continue on this bearing until you see a fence to your left. Follow this fence to the second red gate. Turn left through it and bear to your right at the fork. The cave is about 1000 feet past this fork over a very dim trail and extreme care should be taken lest you drive off into the abyss. It is located on the property of Clarence Whitworth.

Whitling Cave — An unexplored cave on the Sonora Road out of Rocksprings is reported to whistle as air blows from its entrance. Rumbling sounds also are said to issue from this cave.

Dragool Cave — A large, only partially explored cave is reported on the Tom Dragool Ranch 20 miles south of Rocksprings on the Bracket Road.

Asa Tomlinson Caves — Several caves are reported on the Asa Tomlinson ranch (Kickapoo Ranch) 8 miles west of *Dragool Cave* on the Neuces Road.

GILLESPIE COUNTY

Shelter Caves (A.T.J.) — *Lehmann Rock Shelter*, on Onion Creek nears its junction with Threadgill Creek, is located 4 miles south of Doss. The shelter is in a sandstone and shale cliff. From base to summit the cliff measures about 75 feet. The overhanging rock is some 20 feet from the ground. Excavated by University of Texas archeologists in January, 1936.

On the map of Central Texas Caves this site is listed as *Indian Cave*. Also it is sometimes known as *Fredericksburg Cave* although it is some 25 miles from that town.

HAYS COUNTY

BY CHARLES E. MOHR

Wonder Cave (Beaver Cave)—A commercial cave described under that heading. Follow signs on old San Antonio Road (Hopkins Street), 1.2 miles west of Court House in San Marcos.

Ezell's Cave—From the Court House, San Marcos, go west on Hopkins Street 1.5 miles (0.3 miles beyond the overhead *Wonder Cave* sign); turn right on gravel road. Instead of taking next turn to right (back toward town) go straight up hill along old roadway about 100 yards. Park by ruins of house and old street

cars. Cave entrance lies along low escarpment just beyond ruins. Take 70 feet of rope. The cave entrance is part of a 62-foot slit largely blocked by big rocks and runs from NNW to SSE, the axis of the cave. A large fallen rock mass separates the main room, 40 feet below the surface, from the second room which reaches water at a level of 94 feet below the surface. A narrow tube connects the two rooms. A description of this cave and its unique fauna will be found elsewhere in this Bulletin.

Cricket Cave—Near Ezell's Cave; proved to be merely a well 25 feet deep. Reputed to be a snake den, it is the abode of hundreds of crickets, harvestmen, and ticks, as well as many spiders, white millipeds, collembola, slimy salamanders, and hundreds of fungus gnats.

Swift's Cave—This small cave is reported to be about 1 mile west of Ezell's Cave, at an altitude of 700 feet above sea level. Uhlenhuth visited it in 1916 in the hope of reaching the subterranean Purgatory Creek, described in another article in this Bulletin. A tube continuing downward from the one small chamber was not explored but it is doubtful whether it could be followed to a depth of 114 feet below the entrance to where water could be expected to be found.

Other "Caves" at San Marcos—Geologists believe that the San Marcos Springs which give rise to the River, are of the same origin as the artesian wells of this area, such as at the U. S. Fish Hatchery. The water coming from the funnel-like depressions in the floor of the springs has the same temperature as the artesian well and Purgatory Creek Waters. *Frank Johnson's*

Well, mentioned elsewhere, is located about 2 miles west of town and about 0.5 mile south of Ezell's Cave. At a depth of 32 feet a completely water-filled cave was struck, under a pressure sufficiently great to lift it 3 feet in the well. *Artesian Well Cave*, described elsewhere, is located at the U. S. Fish Hatchery in San Marcos.

McCarty Cave—From the San Marcos Court House go west on Hopkins Street for 3.6 miles; turn right on gravel road, cross cattle bar at 0.9 mile, continue 0.2 mile, turning off road to left. Cave entrance is among trees 100 yards to the north. There is a big tree on the gravel trail at top of slope, opposite the cave. Rattlers are common around entrance. Cave consists chiefly of one room, 8 to 15 feet high, 50 by 100 feet wide. A considerable portion of an old guano deposit covers the floor in the right hand end of the cave but no bats were seen. Interesting chert nodules project from one portion of the ceiling (see photograph).

Corrie Smith Caves—Follow Hopkins Street west from San Marcos Court House for 2 miles. Turn right through gates and drive to right around house (0.3 mile from highway). Go through two gates, pass small pond on right and larger one on left (1 mile). Just beyond pond take right fork, turning left 0.2 mile farther on and continue another 0.5 mile. The caves are

CHERT NODULES (left) in irregular masses project from the ceiling of McCarty Cave. Similar formations seen elsewhere in caves of the Edwards Plateau resulted from solution of the surrounding limestone. The chert is virtually insoluble in weakly acid water.

DEEPLY PITTED CEILING (below) in Corrie Smith Cave, being examined by Ernest Ackerly.

Photos by Charles E. Mohr



in tree-lined depressions 50 yards west of the telephone line. A wide room averaging 8 feet in height connects two, possibly three, of the sinks.

Jacob's Well—According to Uhlenhuth a water hole is located along Cypress Fork in Hays County, a tributary branch of the Blanco River, about 1,000 feet above sea level. The water hole (*Jacob's Well*) itself is filled with blue water which has a temperature of 22.5° C. Farther up on one of the slopes of the dry valley is located the entrance to a cave in which the water (probably *Jacob's Well*) could be reached. It has been penetrated to a place where a number of small holes perforate the bottom of the cave; pebbles thrown into the holes evoked the sound of rather deep water. By dislocating a large rock, it might be possible to make one of the holes large enough to gain access to the water.

Barker's Ranch Cave—On Barker's ranch between Buda and Manchaca on the old Austin highway, is a cave, reportedly a very deep, sheer shaft. It is said to be a rattlesnake den.

Posey Cave—In the American Museum of Natural History, New York, is a series of slimy salamanders with the data: Posey Cave, 7 miles west of San Marcos. Nothing else is known about the cave.

KENDALL COUNTY

The Cave Without-a-Name—See article on "Texas Commercial Caves." The road is clearly marked. The cave lies 11 miles northeast of Boerne.

Cascade Caverns—A commercial cave. The road is clearly marked 4.8 miles south of Boerne.

Fairy Cave—An ex-commercial, described elsewhere. It is near Boerne.

Spring Creek Cave—Bearing few formations but many interesting examples of erosion, and fine fossils, this large subterranean watercourse may be entered from the southern bank of Spring Creek, 0.3 miles west of *Dead Man's Cave*. (See below). In wet weather a sizable stream issues from a horizontal shaft 20 feet wide by 15 feet high; during the dry season, however, there is no issue and water is not encountered for several hundred feet inside the entrance. The watercourse is about 3 miles long

and somewhat convoluted, but the size of the passage is fairly uniform (20 feet wide by 15 feet high) throughout and there are no side passages. The trip should only be undertaken in a boat. The writer managed to traverse the entire distance by walking in the stream. This trip was made at the height of a severe mid-summer draught—yet the water was often neck deep and the cold was intense. Furthermore, a bed of gummy mud, often waist deep, overlays the floor of the entire streambed.

Dead Man's Cave—A water cave with a large stream running from the entrance which is located at the base of a cliff on Dr. Kopecky's ranch about 14 miles northeast of Boerne on the road to the *Cave Without-a-Name*. The stream which issues from *Dead Man's Cave* has been determined to be the same stream which flows through the *Cave Without-a-Name*. *Dead Man's Cave* must be negotiated the entire distance by boat or by swimming. Only a few formations occur, but the cave is rich in marine fossils of the lower Cretaceous period.

Horne Ranch Caves.

Cave Without-a-Name Property:

Smoke Hole—(Horne Ranch) This unexplored swallow hole is about 60 feet behind the entrance to *Cave Without-a-Name* and claims interest chiefly as a possible second entrance to the commercial cavern. The hole drops about 20 feet vertically through easily scalable limestone. A small passage then receives the head only and permits an unobstructed view to the left along a roomy passage extending about 5 feet horizontally and then arching downward out of sight. A rock thrown over the arc indicates a very short drop to a mud floor. Smoke was seen issuing from this hole when blasting was being done at the foot of the stairs in the commercial cavern. Very slight effort at the entrance probably would remove the one loose rock barring it.

Tin Can Hole—(Horne Ranch) From the *Cave Without-a-Name* drive toward the highway 0.5 mile and look for this singularly uninteresting fissure enlargement about 30 feet from the right side of the road. A 40-foot crawlway, a 30-foot scale-down, and about 150 feet of slowly lowering ceiling leads to a cul-de-sac. The air at the bottom becomes stale quickly. Nothing of interest was observed.

Schultz Hole—(Horne Ranch) A 75-foot-deep swallow-hole discovered by Richard Schultz near the *Cave Without-a-Name*. A descent had been made with the aid of ropes but the hole tapers out.

Other Horne Ranch Caves—Numerous other swallow holes, unexplored and possibly leading to worthwhile caves are reported on the 150-acre property of the *Cave Without-a-Name*.

Kopeke Ranch Caves—There are two caves on the Kopeke ranch which is located northeast of Boerne on the road to the *Cave Without-a-Name*. One is a vertical shaft 60 feet deep leading to a cul-de-sac. A ledge about halfway down makes rope work difficult. The surface opening is an elongated oval which rapidly converts to a nearly perfect circle as the cave drops downward. Another cave is reported on this property.

Prassel Ranch Cave (C. E. M.)—Situated 15 miles NE of Boerne; is located on a small arm of the Guadalupe River which backs into the cave in flood periods. The entrance in the bank is low and narrow; inside the passage widens into a tunnel-like corridor, about 10 feet in height and width. A shallow stream 2 to 3 feet deep traverses the known part of the cave, explored about one-quarter mile (see article "Unique Animals Inhabit Subterranean Texas").

Schneider Cave (C. E. M.)—About 1 mile south of *Prassel Ranch Cave*, near the Guadalupe River. This small cave is reached by a ladder through a vertical fissure. The passage at the foot of the ladder soon splits into two small corridors, the longer being only about 75 feet. Despite its small size, the cave harbors great numbers of daddy-long-legs (harvestmen), thousands of them forming dense vibrating masses covering pockets in the ceiling, a common scene in these caves. The shorter of the two passages (right) ends in a shallow well where were found beetles, frogs, white millipeds and thysanurans, and silver-flecked black salamanders which were new to science.

Edge Falls Cave—Mr. Bernard Cartwright of Boerne reports a fairly extensive water cave near Edge Falls. However, he says that he and a party of 5 or 6 encountered a heavier-than-air gas which bubbled up through the water each



Charles E. Mohr

SCHNEIDER CAVE entrance is a vertical fissure. Though small, the cave has an abundance of animal life. Ira Norris (left) and the ranch foreman stand by the entrance.

time they stepped into the mud beneath. This gas was of sufficient concentration to cause acute physical symptoms in Mr. Cartwright and to cause several members of his party to abandon their explorations of caves permanently. (See article, "Phosgene In The Dark?" elsewhere in this Bulletin.)

Spring Branch Caves—Two caves are reported on the ranch of a Mr. Bender at Spring Branch, 40 miles above San Marcos and about 1,100 feet above sea level. One is a narrow channel through which the head water of Spring Branch Creek passes out. The channel is filled almost to the top with water but it is possible to penetrate it to a depth of 350 feet. The water flows quite rapidly. The other cave represents a narrow crack in the strata containing water at a depth of 45 feet. It is only a small pool, which, however, is part of a larger body of water covered by overlapping ledges. The temperature of the water is 20.5° C. Besides frogs, some other creatures are said to inhabit the pool.

Other Kendall County Caves—Kendall county, just north of the Balcones Escarpment on the Edwards Plateau, is the most productive known cave-maker in the state. Over 400 shafts and possible cave entrances are reported within a 2-mile radius of the *Cave Without-a-Name*. Tom Goeller, who has located a large number of them, says that relatively few have been entered. He lists as particularly noteworthy the openings on the Brady Ranch, the Kopecke ranch, and the El-Max Ranch.

KERR COUNTY

Karger Cave—This small, one-room cave, or grotto, is located 6 miles northeast of Kerrville on State Highway 16 on Bruno Schultz's "Take-It-Easy Ranch." It was formerly the property of Harry Karger for whom the cave was named. The entrance is under a limestone ledge and is about 3 feet high, with a soil floor; native shrubs and trees grow around the mouth, but do not obstruct it. The entrance opens into a single room 12 feet by 6 feet and 4 feet high, sloping down to less than 1 foot headspace. Small stalactites, 3 or 4 inches in length, cluster and hang in fringe-like formations from the moist ceiling. Crickets and daddy-long-legs have been observed in the cave.

R. R. Merritt Ranch Caves Nos. 1, 2 and 3—Ask directions to the R. R. Merritt ranch at Hunt just west of Kerrville. Take climbing equipment.

Cave No. 1—A vertical shaft, 8 feet in diameter drops about 35 feet to a single room 25 feet in diameter. No side passages have been reported.

Cave No. 2—A vertical drop about 8 feet through limestone, which permits scaling without equipment, leads to a small room about 12 feet in diameter, barren of formation and having 4-foot headroom, tapering out.

Cave No. 3—An 8-foot vertical shaft plunges through a hole 3 feet in diameter to the cave's first floor level which then steps down about 3 feet farther into a fissure in the limestone. The fissure comprises the cave; it is 40 feet long, 8 feet high and 5 feet wide and is distinguished by a large variety of stalactite sizes ranging up to 8 feet in length.

Other Kerr County Caves—*Seinweber Cave* on Indian Creek just outside of Ingram; *Ancient City Cave* on the "We-Like-It Ranch" near Kerrville are both reported as small caves.

KIMBLE COUNTY

Fleming's Cave—A reported series of tunnels and tubes extending some distance down into the side of a limestone hill. Stalactites and stalagmites occur. Go south from Junction 13.1 miles to Lewis Crossing; then 14.1 miles south on Highway U. S. 83.

KINNEY COUNTY

Webb Cave—On Webb ranch about 7 miles north of Brackettville on Rock Springs Road. Cave is about 5 miles from the ranch buildings. Although only small deposits of guano were found, old hoisting gear suggested that considerable amounts were present years ago. Water flows through the cave during heavy rains.

LLANO COUNTY

Shelter Caves (A. T. J.)—*Simpson Shelter*, 4 miles east of Field Creek village, contains a few pictographs.

Submerged Shelters, 21 miles northeast of Llano, were excavated before inundation³.

"*Shelter No. 1* . . . has a length of 27 feet and a maximum overhang of 16 feet. It was long occupied and contained a deep deposit . . . *Shelter No. 2* . . . is some 30 feet up the bluff and very small, measuring 9 x 5½ feet. Its entrance is 4 x 3 feet . . . In it was found what appeared to be a cremated burial. . . *Shelter No. 3*, in the bluff at its base . . . had dimensions of 9 x 5 feet. The midden deposit extended to a maximum depth of 30 inches. In a cleft at the north end of the shelter was found an extended burial.

MASON COUNTY

Bat Cave Cavern—This commercial guano mine is located 16 miles southwest of the town of Mason on the H. O. Shulze James River ranch. One very large chamber is known, but the owner says that the cave, to his knowledge, has never been fully explored. It is thought to contain several other chambers and passageways. There are almost no formations in the main chamber which houses millions of bats.

Other Mason County Caves—A number of caves are said to exist in the immediate vicinity of *Bat Cave Cavern*. One such small cave lies only about 50 yards from *Bat Cave Cavern* and contains quite a display of formations of various types.

MEDINA COUNTY

Ney Cave—A medium-sized bat cave, formerly owned by the Ney brothers, is located 20 miles north of Hondo in Medina County. Take the old Bandera road out of Hondo. About 18 miles north, turn left on a graded farm road, through a cattleguard, to Joe Short's place. Inquire for directions there. The cave is on the Ben Gerdes ranch, 1 mile farther on. You can drive a car right up to its mouth on the side of a small mountain. The cave is peculiarly constructed: A large entrance, 150 by 75 feet, leads down a steep slope into a medium-sized bat chamber. From this room a passage leads about 50 feet to a spring and then rapidly tapers



Glen M. Kohls

NEY CAVE has the country's greatest bat population. It was a center of activity in the bat-warfare project described elsewhere in this Bulletin. It has been visited by many naturalists and several reports appear in these pages.

out. Also from the main bat chamber, a hole in the ceiling leads to a large chamber on a higher level. This chamber is connected to the surface by an artificially bored shaft 6 feet in diameter and 36 feet deep, the walls of which are smooth and offer no foothold. Climbing tackle should be taken as there are two drops of 15 feet as well as the 36-foot shaft. Guano was mined from this cave until recently and equipment is still to be seen around the entrance. Large numbers of bats were captured here during the war for the fantastic "Project X-ray" (See article elsewhere in this Bulletin).

Rattlesnake Cave—A small, single chamber cavern about 200 yards down the hillside from *Ney Cave* is interesting principally for the somewhat lurid legends surrounding it. The cave was, reputedly, an old Spanish mine, probably silver, possibly gold. And several earthen crucibles still to be seen beside a nearby creek are supposed to have played a part in the handling of the ore. Careful inspection on the part of the writer, whose particular interest happens to be prospecting, revealed no signs of anything which appeared to him as having been a mining operation. One boulder, apparently in no danger of falling, has been timbered up and someone has chipped away a rather large quantity of an unusually thick travertine encrustation, but this writer found no evidence of mining or mineralization of economic interest.

Donaho Cave, or *Valdina Farms Sinkhole* as it is known today, is a large bat cavern about 20 miles north of D'Hanis on the Seco Creek. At the Valdina Ranch house inquire for Mr. Lacey, as the cave is in an 18,000-acre ranch and quite difficult to locate. The entrance to the cavern is a spectacular sink falling 100 feet sheer on one side but beautifully terraced like an amphitheater for the first 40 feet on the other side. Of the remaining 60 feet, all but the last 20 are negotiable by hard rope work. The last 20 feet, however, takes the climber over a deep undercut. Take at least two one-hundred foot ropes. The writer visited the cave alone and was unable to negotiate this last 20 feet. The cave was described by Dr. William B. Phillips in 1901 and pictured in the accompanying diagrams:

The opening into the cave is on a slight rise about 30 feet above Secos Creek 200 yards from it. A huge funnel-shaped depression, 100 feet

in diameter at the surface, leads down into the cave proper. The first bench is at a depth of 100 feet from the rim of the funnel, the floor then slopes 6 feet in 25 feet and at this point there is another vertical descent for 54 feet making the total depth from the rim of the funnel to the permanent floor 160 feet. Fig. 1 gives a vertical section from the rim of the funnel to the permanent floor, and shows offset 22 feet from the projection extending over the last descent.

The general shape of the shaft, hewn out of limestone by the action of water and air, is that of an enormous funnel set in the mouth of a bottle of very irregular shape. At its narrowest part, the neck of the bottle, the diameter is 12 feet, and so numerous are the bats in this cave that it requires three hours for them to emerge through it. One of my companions, who attempted to enumerate the number of bats, finally gave it up and threw his paper and pencil down, saying his arithmetic had "gin out." The cave has been entered by several different persons, but no guano has ever been removed from it.

The cave is now difficult of access. The only means of getting down into it is by rope, and when one swings clear of the projecting ledges and begins to spin around like a top, with the blue sky above and the brown rocks beneath, he realizes the uncertainty of life. I made two trips down, first on a rope, to see what arrangements could be made for a comfortable descent, and then on a ladder, which we constructed of $\frac{3}{4}$ -inch manila rope and mesquite rungs. A great poet has said that a certain descent was easy but the return trip was laborious. He referred to an unmentionable place but might have had this cave in his mind. On the first trip I spun around at the end of the rope until I was glad to land even upon a skunk whose defunct body was in perfect harmony with his malodorous life. It was a large place into which he had fallen, but he filled it completely and could have filled several acres. There was an-

other one 60 feet lower, and together they made a pair hard to beat. What they left to be desired in the way of odor was more than supplied by the bats.

Fig. 1 also gives a plan of the bottom of the cave where the guano is found and where the bats most do congregate.

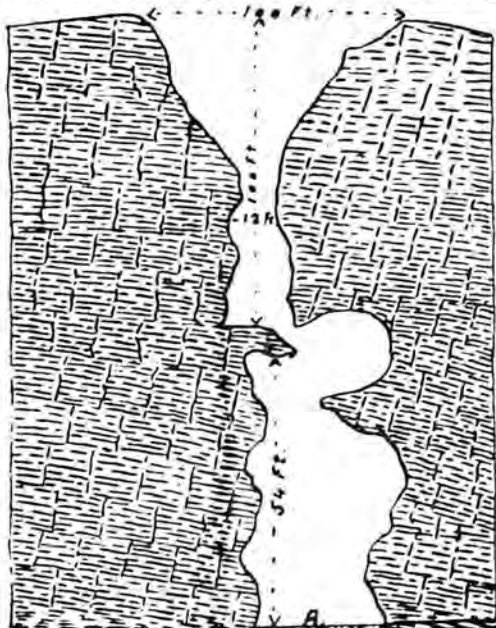
It is difficult to estimate the amount of guano in a place such as this. The floor is of irregular shape, and many large fragments of stone that have dropped from the roof are to be met with, besides smaller pieces that have become imbedded in the mass. What appears to be a bed of guano of considerable thickness is found, on investigation, to be a layer of from 1 to 6 inches in thickness covering the rock. A few feet from this point the guano may be 4 or 5 feet deep, completely filling the depressions in the floor. In some places it is banked up in mounds, or spread out evenly on the floor, where it is comparatively level. One can walk for 1,000 feet without



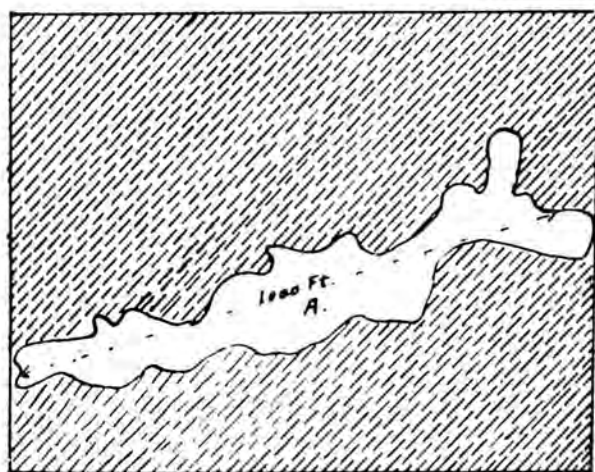
Jack C. Couffer

DONAHU CAVE is entered from a steep-sided, funnel-like opening, 100 feet across. Careful rope work is required.

stepping off the guano, and can wade in it up to his knees. Most of the material in this cave is dry, but towards the northeast end it becomes soft and is evidently of more recent origin.



Vertical Section



Ground Plan Donaho Cave.

DONAHO CAVE plan as sketched by W. B. Phillips in 1901; reproduced from *Mines and Minerals*. Lack of personnel and time has prevented the NSS explorers from mapping any Texas caves. This cave is known today as Valdina Farms Sinkhole.

When the bats become tired of one roosting place they go to another. Some of the smaller chambers opening out from the main cavern do not seem to have been used by the bats at all, for there is no guano in them nor any indication that they were ever used by the bats. It is said that the bats sometimes become tired of a certain cave and desert it entirely, taking up their abode in some adjoining cavern. The odor at times may prove too strong even for a bat and he moves to clearer quarters.

REAL COUNTY

Celestite Cave—A small cavern on the Miller Ranch, 13 miles west and 5 miles south of the junction of U. S. Highway No. 83 and State Highway No. 41. The cave lies from 10 to 15 feet below the present surface. It is about 25 feet long, 14 feet wide, and 5 feet high with a narrow opening extending about 40 feet beyond the main cavity. Bat guano covered the cavern floor to a thickness of several feet. Celestite occurred as a crystalline mass from 1 to 2.5 feet thick on the west and south walls, with singly terminated prismatic crystals from half an inch to 4 inches in diameter extending outward into the cave. Calcareous dripstone forms thin encrustations over parts of the deposit. About 70 tons of the high grade celestite was mined during 1943 and later. In the vicinity of this cavern and in other parts of the southern Edwards Plateau, numerous caverns have formed in the Cretaceous limestone; hence it is possible that other cavern celestite deposits may be found within the region. A note on this cave appears elsewhere in this Bulletin.

Leakey Cave—The manager of Garner State Park reports that he was seriously injured several years ago when he fell from a cliff deep within a large cave near the town of Leakey. The fall was reportedly sustained because of highly friable limestone which makes the cave generally dangerous. No further exploration was attempted after this accident.

SAN SABA COUNTY

Richland Springs Cavern (also called *Treasure Cave*)—An ex-commercial cave mentioned elsewhere. Take the Maxwell Crossing Road 4 miles south from Richland Springs to a fork in the road; take the right hand fork west 1.5 miles.

Harrell Cavern—This small but peculiarly interesting cavern is 200 feet from the north edge of the San Saba-Chappel road, 13 miles from San Saba and 0.5 mile north by 1.5 miles west of Chappel. Take climbing equipment for a 43-foot drop down a nearly circular hole of about 5-foot diameter which occurs at the junction of two nearly vertical joints dissolved and eroded from the evenly bedded, somewhat oolitic, Gray Marble Falls limestone. The large

oval room below is 170 feet from north to south, 150 feet from east to west and 25 feet high. The floor strikes northward at a pitch of 5 degrees, 10 inches, conforming to the dip of the limestone and the direction of the solution channel. There are, in effect, two levels to part of the main cave room, the upper being the tilted top of a gigantic (20 by 20 by 10 feet high) block of limestone which fell from the roof; one may pass it only via a narrow passage around its eastern edge. This passage forms a channel for water entering from the shaft during wet weather, trickling to the northwest edge of the cavern and disappearing into a small passageway. The cave is much alive with stalactites and stalagmites, including an extremely large, conical one about 50 feet from the entrance. Particularly picturesque is the smooth, fairly dense travertine which has built up in three ledges over which a small stream cascades into a small passage. The waterfall is about 4 feet high. It closely resembles a man-made spillway and is at the south end of the cave. Bats are plentiful in the cave as are termites, cave crickets and spiders. The bones of a deer and a bear were found.

Other San Saba County Caves—A number of other shallow caverns are reported from highly reliable sources as existing in the 1000 to 2000-foot-thick dolomite of this region, particularly in the western and southern sections of the county.

Shelter Caves (A. T. J.)—Postoak Falls Cave, on Postoak Creek about 100 yards north of the falls, according to Mansfield and Boardman, "On the top of the bluff a small opening a few yards across leads into a cave estimated to be about 75 feet deep and 50 feet in diameter. There are small side chambers, and the main cave opens out at the bottom on the valley side at about the level of the base of the cliff. There is a steep descent from its mouth to the river (Colorado). The cave had evidently been a refuge for goats and possibly other animals.

"The walls of the main cave and the principal side chambers were carefully examined with a flashlight, and small amounts of incrustations were observed here and there. These incrustations were mostly of calcium carbonate, but some were of other substances, and in one place there was a small accumulation of white crys-

talline salts about half an inch thick . . . These salts were not pure nitrates.

"The cave at Postoak Falls is thus a place where typical cave nitrates might be expected, but where they are more sparsely represented than at many localities in other regions."

Nitrate Caves, about 4 miles southeast of San Saba, in travertine bluff.

Fall Creek Caves and Shelters, at junction of Fall Creek and Colorado River, 21 miles northeast of Llano. Jackson³ reports: Caves and shelters are in "steep bluffs, rising about 100 feet above the high river terrace. The bluffs consist of heavy strata of the hard dark Ellenberger limestone . . . Over the edge of the stratified rocks on the exposed bluff are huge deposits of travertine or calcareous tufa. Under the deposits of tufa there are a number of small rock shelters and two caves. . . .

Cave No. 1—"with maximum dimensions of 61 x 38 feet, has a comparatively small opening, facing north . . . The upper two inches of the floor deposit consisted of dust and animal excrement. Beneath this was a layer 15 inches deep of compact soil apparently consisting of dust from the roof intermixed with camp refuse and red river deposits. In this stratum were found . . . flint artifacts, bone beads, mussel shells and snail shells and split animal bones . . . The bones include those of the deer, buffalo, small mammals, turkey and tortoise.

Cave No. 2—"measuring 36 x 20 feet was more extensively occupied than No. 1. A small Fall Creek shelter, facing northeast, measures 10 x 4 feet. Its room was only 4½ feet above the present floor level. The midden deposit had a depth of 30 inches, showing that a small shelter might be utilized extensively."

These Fall Creek sites have been inundated by the impounded waters of Lake Buchanan, and are here mentioned only for the completion of the record.

Gibbons Shelter, one mile above junction of Big Brady Creek with San Saba River, 12 miles south of Richland Spring. The Shelter is 15 x 6 feet, with stones piled in front, apparently to assist in leveling the floor, and thus affording more usable space. The wall is decorated with historic paintings of horses and white men.

TRAVIS COUNTY

Austin Caverns—This ex-commercial cave is described in the article on "Texas Commercial Caves." To reach the cave's only currently known entrance, go to the 1900 block of Rockmore street in Austin, turn east on a lane which within 100 feet nearly parallels the face of a limestone cliff to the south. Leave car at end of lane about 150 feet from Rockmore Street and continue afoot straight ahead up a small hill about 50 feet farther on. At the top of this hill there is a vertical swallow hole about 50 feet deep. Descend it; the rock is heavily weathered and provides ample hand and footholds. At the bottom a large crack strikes southward, and a tiny hole northward. Follow the small northward crawlway about 30 feet into the cave. (The large southward fissure terminates in a dead-end after about 40 feet.) This was once, reportedly, a very large system, only a small section of which remains accessible.

Unexplored Caves in the Immediate Vicinity of Austin Caverns—There are at least 12 unexplored openings within a few hundred yards of the entrance to *Austin Caverns*. These may lead to new caves or may prove to be heretofore unknown entrances to various sections of the old *Austin Caverns*.

Bee Cave—This so-called cave is simply an overhanging ledge at the town of Bee Cave. Beer was manufactured here in early days and the town took its name from the grotto. It is of no speleological interest.

Shelter Caves (A. T. J.)—*Cedar Shelter*, located about 3 miles east of Marshall Ford Dam, on the north side of the Colorado River. Both Indians and whites have used this medium-sized shelter. The last use was for storing cedar posts.

Trammell Shelter, located about two miles west of Cedar Park, near Williamson County line. This low, cave-like shelter is adjacent to a large Indian campsite and showed evidence of considerable usage.

Handprint Shelter, on Barton Creek about two miles west of Barton Springs and four miles southwest of Austin. There is a dim handprint on the roof of the small shelter.



Walter Barnes

TRAMMELL SHELTER being excavated. Among the Indian remains recovered in the screening of clay removed from the cave, was a piece of obsidian which rarely is found in this region.

Rock Shelters, about six miles southeast of Austin. One is on south side of a small stream, facing north; another is on the north side, facing south.

UVALDE COUNTY

Frio Cave—This tremendous cave is located on the Annendale Ranch just south of Concan on the Sabinal Road. Explicit directions should be obtained from Mr. Fitzgerald at the ranch house as the cave is difficult to find. In spite of the vastness of Frio's huge chambers, the immensity of its few formations, and the strange, unearthly beauty of its gigantic entrance chamber, into which flocks of swallows plunge through 20-foot chimneys to fly about the room and nest in its pitted walls, Frio Cave taken as a whole is an ugly cavern. The cave occupies the whole heart of a small hill. The writer saw a 5-foot-thick column of bats pour unceasingly from the cave for 45 minutes and there had been an earlier flight lasting 15 minutes; later apparently disorganized bats poured out of all entrances for about 2 hours. The entrance chamber proper is some 600 by 300 feet, oval in shape and pierced by three huge arches to the outside and four arches toward the interior. In addition two great chimneys open to the mountain top. A wagon road makes a half-circle around this entrance chamber and terminates beside a wooden "railroad" track which plunges 75 feet down a precipitous slope into a 1000 by 600 foot chamber with ceilings varying from 40 to 100 feet in height. The wooden track continues some 550 feet along



Photos by Glen M. Kohls

VIEW OF COUNTRYSIDE around Frio Cave, Uvalde County. The cave is located seven miles south of Concan.

this chamber atop a 20-foot-high trestle, then swings dizzily to the left and hurtles another 60 feet downward under an overhang, levels out and loses itself in the distance of another immense chamber too infested with mites for safe exploration. Guano is still mined from the cave, but only from the upper levels and the elaborate trackage has fallen into ruin. Tremendous boulders litter the floor, and one chamber, immediately to the left of the entrance is notable for deep pits leading to a labyrinth below. In this room a huge stalagmite stands athwart a hole in the floor large enough to permit the entrance of a man—apparently the floor gave way after the stalagmite had formed. Dense travertine blankets much of the walls but is badly discolored by guano. A fine growth of iron pyrites has occurred among a tumbledown on a lower level and iron stains are everywhere in evidence. It was in this cave that the writer's party was swarmed upon by bats apparently attracted by the light of a Coleman gasoline lantern. (See article titled, "Bat Blitz," else-

FRIO CAVE is one of the four greatest bat caves in this country and has long been worked for guano. Here a lantern within the cave illuminates part of the entrance passage.



where in this issue). The same party was also driven from the cave's lowest level by mites which literally blanketed the legs and arms of the explorers before they could effect a retreat. Summarizing: Frio may be said to have three giant chambers each at a level 60 to 75 feet lower than the preceding one; in addition, it has two smaller chambers on the highest and lowest levels with a small labyrinth between. The cave is now dead. Total darkness is not reached until about 500 feet inside the main chamber and both flora and fauna are fairly abundant in the entrance room.

Utopia Cave—Carl Stephens of Devine, Texas, reports a small cave near the community of Utopia. Stephens gives the dimensions of its single chamber as "about 200 or 300 yards long." He says that the few stalactites measure only about 2 or 3 inches in length and that numerous ledges encircle the room. The floor is well packed at the entrance, he adds, but at the rear is composed of "loose ash soil."

J. Wells Ranch Cave—Reportedly a large solution cavern with several chambers. Go from the town of Montelle Creek to Rogers' Ranch and ask directions. This cave is only partly explored.

Shelter Caves (A. T. J.)—Caves reported on West Prong of Sabinal River. *Herndon Shelter*, 8 miles west of Laguna . . . *Wells Cave and Shelters*, 9 miles west of Montell. Paintings very dim . . . *Mitchner Shelters*, 10 miles north of west of Montell . . . *McGowan Shelter*, 15 miles north of west of Camp Wood . . . *Roberts Shelter*, 5 miles southwest of Reagan Wells . . . *Hobbs Shelter*, 11 miles southeast of Concan. Dim paintings and midden.

WILLIAMSON COUNTY

BY EDWIN C. VINTHER

As told to A. T. Jackson

There are several interesting caves near Georgetown in Williamson County, Texas. Five of them will be described and certain unexplored ones mentioned.

Bat Cave is located about one mile southwest of Georgetown, and $\frac{1}{4}$ mile from the West Fork of Smith Branch—a wet-weather stream. The cave consists of one large open-topped room, with three short side passages.

The passages have entrances leading into them. The main chamber is about 40 x 70 feet, and 9 to 15 feet deep. It is fairly dry, with only a few small stalactites. The center of the cave is grown up in China berry trees.

One can walk upright in some parts of the passages; and in other places must go on hands and knees. The height varies from 2 to 15 feet. One passage ends in a shaft 18 feet deep and 6 feet across, reaching down from ground level. The shaft is about 90 feet from its entrance to the main chamber. Another of the passages slopes to a small opening at the surface. This passage is about 140 feet from its entrance to the main room. The third passage opens into a straight hole about 9 feet across and of the same depth. It is only about 15 feet to the main chamber.

The cave walls are of rather soft limestone, smoked black in places. The smoke resulted from fires caused by burning guano.

There are very few bats occupying the cave at present. But years ago it sheltered thousands of bats. At that time much guano from the cave was sold. The small quantity of guano now in the cave is leached out and of no commercial importance.

"Bobcats" sometimes frequent this cave, as indicated by their tracks. The writer set traps in the cave for the cats, but never caught one.

The cave has its usual quota of crickets.

Steam Cave is about $1\frac{1}{4}$ miles southwest of Georgetown and less than $\frac{1}{2}$ mile from the West Fork of Smith Branch. It is said to have been so named because of "steam" or vapor arising from one entrance on wintry days. This is supposed to have resulted from warm, moist air coming out into contact with the cold air. The writer has never seen "steam" emerging from the cave.

The cave has three openings where one can enter, and another too small for entry. One entrance is a six-foot shaft-like hole, into which the visitor enters—by a ladder—to a depth of about 15 feet. The second shaft is about 8 to 20 feet deep and some 6 feet across. The third entrance is accessible from a slight sink in the surface. One cannot enter standing erect. The passage leads into a large corridor.

The cave has no large chambers, but a series of passages, irregular in size, and varying in

width from 2 to 16 feet. The height of the corridor is 3 to 15 feet. There is a network of these corridors. Parts of the cave contain water in small pools or puddles.

Some of the side passages from the corridors bend downward and may lead into other chambers not yet explored.

Tinnel Cave is on land owned by Joe Tinnel, about $7\frac{1}{2}$ miles southwest of Georgetown. The landowner reports that he enlarged a very small opening sufficiently to enable him to enter. He "saw a long way back" and concluded it is a large cave; but he has not explored it farther.

Cobb Cave is on the Cobb Ranch, about 4 miles north-northeast of Georgetown, approximately $\frac{3}{4}$ mile northwest of Berry School and $\frac{1}{2}$ mile north of Berry Creek. The cave consists of several fair-sized chambers, larger than those in Steam Cave. One entrance is an irregular, crooked shaft, entered hand over hand on a rope. There are medium-sized passages between the large chambers. In places there are outcroppings of red clay-like dirt. There are quite a few water formations, as large as 12 to 15 inches in diameter.

Some bats inhabit the cave, but there is no great quantity of guano. Cave crickets are present.

Four-mile Cave was so named on account of its location about 4 miles west of Georgetown. One entrance is about 10 or 15 feet south of the right-of-way of State Highway No. 104 from Georgetown to Burnet. The cave has two entrances. A fair-sized room was used for storing dynamite when the highway was under construction in the middle 1930's. One passage in the cave has been stopped up.

Crystal Cave, on Fred Vinther Ranch, is located about $1\frac{1}{4}$ miles southwest of Georgetown. Some years ago there were two openings, about 50 feet apart. One was 2 x 3 feet; the other about 3 feet in diameter, at the bottom of a large sink. Heavy rains had washed much dirt into these openings before the landowner filled the mouths with rocks. The cave could be entered by removing the rocks and excavating a quantity of dirt fill.

Other Cave Entrances Filled.—There are other caves that have had their openings closed

by ranchers. This is done to eliminate hiding places for "varmint"—predatory animals.

Unexplored Sink Holes.—Along the fault line are numerous small sink holes that probably lead to underground passages. For hours after a heavy rain one may see water pouring into a sink hole and disappearing. Standing near the hole, one sometimes can hear the water tumbling and falling for what seems to be considerable depths. If the hole were enlarged it probably would provide an entrance to an unexplored cave.

Many more caves could be located in this region, if someone had the time to devote to the task.

Everett Ranch Caves (P. J. W.)—There are at least three unexplored caves on the Everett ranch. Take the Austin highway south exactly 3.5 miles from the Georgetown city limits. Turn west through a cattle guard 0.7 mile to the

Everett ranch house. Inquire of Mr. Everett who is most cooperative. To reach the so-called *Shallow Cave*, only partly explored, continue past the house on the same road, ford a creek, and pass under power lines. 250 yards past the power line, leave your car and bear from the road on an azimuth of 320 degrees to a fence. The entrance is a plainly seen swallow hole about 10 feet beyond the fence. To reach the general area of the other caves, return to the road and follow it to its first crest, near a windmill. A little scouting will reveal the other holes nearby.

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Prospects for Finding Great Caves

By CHARLES LAURENCE BAKER

On the basis of his 30 years of extensive fieldwork in the Southwest and in Mexico, Mr. Baker, formerly Professor and Head of the Department of Geology at Texas A and M College, was asked to comment on the likelihood of important cave discoveries in this region. His reply, drawn from two letters to the Society, follows:

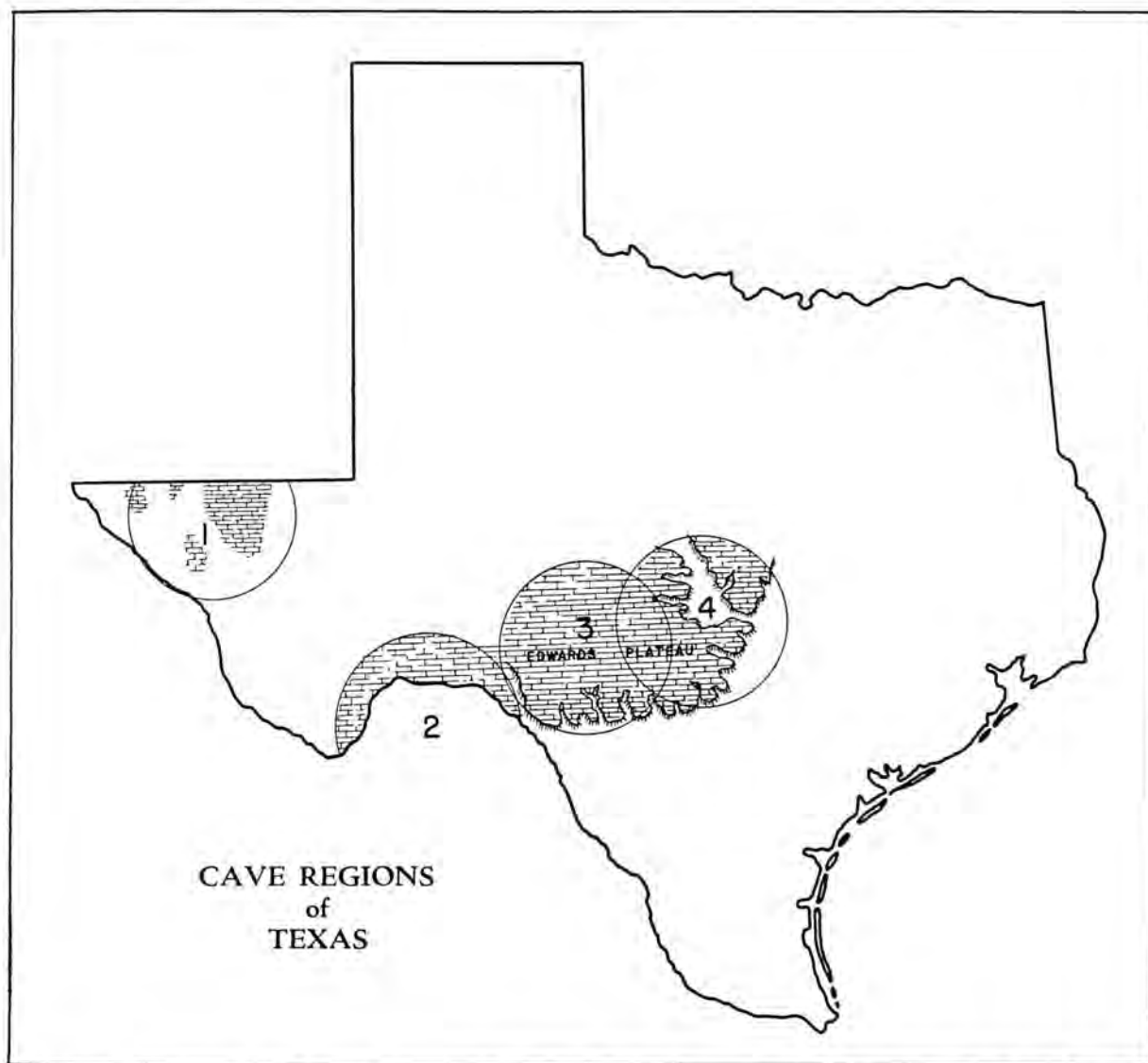
I DO NOT BELIEVE that any very great caverns will be found in Texas east of the Pecos River, for the following reasons: (1) favorable limestones do not have sufficient thickness, and (2) the level of ground water saturation is too close to the surface.

San Marcos is the most eastern point at which limestone is thick enough for important caves. In the Edwards Plateau area north of San Marcos, New Braunfels, and San Antonio, the only extensive cave maker is the Edwards limestone which there lies so deep that the permanent water level is too close to the surface.

This is particularly true 60 miles north and a little west of San Marcos, in southern Burnet County. There the Ellenberger limestone and dolomite (of lower Ordovician or Beekmantown age) ranges from 1000 to 2000 feet in thickness. The largest caves at present known in the State are in this region, in southern and western Burnet County. There are small caves, too, but if any truly great caves have been formed they are still below the water table.

Prospects for finding caves in the Ellenberger limestone of the Llano Uplift of central Texas, in Llano and Burnet Counties, are good but the caves probably will not be large. Longhorn Cavern, for example, is merely an enlarged fissure (though its terminal chamber once had a very beautiful lining of calcite crystals, mainly removed before the cavern was developed).

The Glen Rose limestone which underlies the Edwards, appears to be too clayey to dissolve with large openings. There are, however, two commercial caves—Cave-Without-A-Name and Cascade Caverns—and a large number of small



1. Thick Pennsylvanian and Permian limestone, where great caverns may occur in the Guadalupe, Delaware, Sierra Diablo, and other mountains.

2. Front range of the Cordillera at the lower end of the Big Bend of the Rio Grande eastward for about 100 miles to the Devil's River. The Glen Rose and Edwards limestones are very thick and pure. There are numerous small caves.

3. Western Edwards Plateau, where there is an anticlinal uplift forming the divide between the Llano,

Devil's, Nueces, and Concho rivers. In this area is the deepest sinkhole in the state, and notable cave discoveries may be made.

4. Edwards Plateau area north of San Antonio, New Braunfels, and San Marcos has Edwards limestone, but the water level is close to the surface. In southern Burnet County the Ellenberger limestone and dolomite range from 1000 to 2000 feet in thickness. The largest presently known caves in the state are in the Burnet County region. The Llano Uplift (the gap between the shaded areas) also contains the Ellenberger limestone.

caves, mostly of the enlarged fissure type, but nothing especially noteworthy.

Possibly there are good-sized caves in this same Glen Rose formation in the next county to the west, Bandera, because there the limestone is becoming both purer and thicker. The rainfall, at least at the present time, is too sparse for extensive underground solution.

In the western Edwards Plateau, where also the limestone is purer and thicker, there is an

artificial uplift forming the divide between the Llano, Devil's, Nueces, and Concho rivers. Here the ground water level is low. The Devil's Hole, northeast of Rocksprings, Edwards County, in this divide area, is the deepest sink or swallow hole in the State. Exploration in northern Edwards and Real Counties or in southern or central Sutton County or in western Schleicher County, all in this general uplifted divide region, might lead to one or more notable cave discoveries.

The thick, extensive, pure limestone west of the Pecos River, where the ground water level is far beneath the surface, would have very great caves except, perhaps, that there is little rainfall, necessary for extensive solution. However, there has been ample time, so solution appears extensive though its rate is less than in better watered regions.

Limestone Canyons

With an exception to be noted later, the front range of the Cordillera at the lower end of the Big Bend of the Rio Grande is perhaps the western limit of important possibilities. Thence eastwards for about 100 miles to the Devil's River the Glen Rose and Edwards limestones are very thick and pure. The drainage is mostly underground into the beds of the Rio Grande and Devil's Rivers. The Devil's River has the greatest minimum flow of any Texas river because it is fed by underground cavern streams. No great caverns have ever been reported from this area, though there are numerous small caves.

The Rio Grande flows through a canyon in the limestone all the way from the mouth of Stillwell Canyon (in a syncline just east of the Carmen Range) to the mouth of the Devil's River. Counting the numerous meander bends, the length of that canyon must be about 125 miles. It should be explored by boat *in the winter* (one is apt to be drowned in a cloudburst in the summer rainy season) and perhaps one or more extensive caverns could be found. There are so many side canyons that any other mode of exploration is scarcely practical. The Carmen Range itself has thick limestone and underground drainage. I very nearly died of thirst in my two summer explorations of it. It shouldn't be tackled in summer but can safely be explored in winter if one carried all his water. It is doubtful, however, if the rainfall is great enough for extensive solution, though this is uncertain. Conditions in the thick Pennsylvanian and Permian limestones and dolomites in the high mountains of Trans-Pecos Texas are very favorable. Great caverns must occur in the Guadalupe, Delaware, Baylor, Sierra Diablo, Glass, and lower Chianti mountains and the Diablo Plateau and Hueco Mountains (Permian and Pennsylvanian) and especially in the Sierra del Carmen (east part of the Big Bend National Park) in the Edwards and Glen Rose limestones.

In these mountains soluble limestones and dolomites are very thick and the level of ground water saturation quite deep. In fact, the water table is more than 1000 feet beneath the surface in most of the mountains. In the Diablo Plateau, between the Texas and Pacific Railway and the New Mexico line, west of the Sierra Diablo scarp and east of the Finlay and Hueco mountain scarps, many borings for oil and water have found caverns which the drill was unable to penetrate.

It occurs to me that in these Trans-Pecos areas geophysical methods may discover large caverns, either by sonic (sound reflection), gravimetric, or perhaps even seismographic methods. Even electric resistivity (earth induction) methods would be worth a trial. Perhaps one reason for the failure of geophysics to find structure favorable for oil and gas in the Rocky Mountain Province and in the Dakota Basin is the nature of the underlying Madison (Osage, Mississippian) limestone. I have determined that this limestone was extensively caverned by solution especially during the time it lay exposed under moist, warm seasonal rainfall weathering during Middle and Upper Mississippian times.

Guadalupe Mountains

In my opinion, the best place to find another great cave is in the Guadalupe Mountains on the Texas-New Mexico border. That range is high enough to receive sufficient rainfall and there is a 2000-foot-thick soluble dolomite. There ought to be one or more caves the size of Carlsbad; in fact, I have pretty good evidence that there are. Slaughter Canyon alone has nearly 100 caves, some of them very large. No one, of course, knows how big Carlsbad Cavern really is. It has never been mapped, much less fully explored. Dr. Willis T. Lee went down in it 1100 feet vertically beneath the entrance without reaching its bottom and no one yet knows how deep down the permanent water level will be found.

Another likely place to find some truly great caverns would be in the San Andres limestone of the Sacramento Mountains (summit and eastern slope), central southern New Mexico. All known conditions are favorable for large caverns there.

Go Cave-Hunting in Mexico

The greatest caverns in the world, however, are likely to be found in the high limestone anticlinal ridges forming the easternmost mountains in north-eastern Mexico, the Sierra Madre Oriental. There rainfall on the summit and the eastern slopes is heavy and the Cretaceous soluble limestone on the Nuevo Leon-San Luis Potosi-Tamaulipas border northwest and west of Victoria Ciudad (Capital of the State of Tamaulipas) ranges up to two and a half miles in thickness.

I measured this solid limestone west of Miquihuana and found it 12,675 feet thick, but there and elsewhere it is repeated by overthrusting until it has an accumulated thickness of 20,000 to 30,000 feet. North of Miquihuana, in the axis of a high mountain anticline, I found a solution swallow hole 3,500 feet in depth and 40 to 50 square miles in area. I found others nearly as large considerably farther south on the route from Micos and Tamasopo to Ciudad del Maiz, to the westward of Tampico.

Up north in the Sierra del Carmen, Sierra Hermosa de Santa Rosa, Sierra del Musquiz, etc., region, central northern Coahuila, all the higher intermontane synclinal basins and adjoining anticlines of the mountains drain underground through solution caverns, the water finally reaching the surface and forming headwaters streams of the Rio Sabinas northwest of the Barroteran and Las Esperanzas higher Cretaceous coal synclinal basins.

In fact, *every river between the Rio Grande and the Isthmus of Tehuantepec emerges full fledged from underground caverns* at the east bases of the mountains where the limestone is overlain by east-dipping impermeable upper Cretaceous shales varying in age from Turonian (Benton) to Pierre (Santonian). In other words, drainage from the interior region goes underground and emerges as rivers at the east bases of the easternmost Sierra.

Big Caves in Tamaulipas

I have been in some big caves around Quintero and Gomez Farias in the westernmost part of the State of Tamaulipas. The headwaters rivers in the common boundary area of San Luis Potosi look as if they ran in underground caverns across anticlines and intervening synclines;

in reality, their surface courses appear to have been originally through underground caverns the roofs of which have subsequently collapsed.

The Rio Alamar, for example, flows into the Jaumave synclinal valley from which it escapes through a great limestone canyon in an overthrust block. This river heads at 12,500 feet in the Cerro San Antonio de Pena Nevada. Where I crossed the canyon lower down its course it was 4,500 feet deep. I found a fossil Pleistocene proboscidean tusk in a terrace near the bottom. I could see that the canyon was considerably deeper farther downstream and the Mexicans told me its stream still ran for a considerable distance in an underground course.

Highly Soluble Rocks

Now, the Cretaceous "Sierran" limestone mountain maker is underlain by extensive calcium sulphate deposits in the Upper Jurassic (probably Kimmeridgian), the overlying Portlandian-Tithonian being limestone. The anhydrite, being exceedingly plastic, is thickened greatly by crumpled folding in the hearts (axial areas) of the anticlines, and it being more soluble than the carbonate rocks, you can expect almost anything in the way of caverns. I have seen some big ones in the solution anticlinal and thrust valley between Zaragosa and Aramberri in southeastern Nuevo Leon State.

Many of the great silver-lead bonanzas in east Mexican limestones are cavern fillings. Indeed, some of the stoped-out ore bodies originally filled openings of truly immense extent; quicksilver ores are likewise found in similar caverns in this province.

You may be interested to know that I have seen several fossil bone caverns in Mexico, and that I ran across a lake deposit rich in Pleistocene fossil vertebrates in a swallow hole near Las Virgenes, northeast of Aramberri.

Hence, if you "spelunkers" wish to do something really great, go to the Mexican limestone sierra and while you are hunting caves look out for ore bodies, fossil bones, and human remains in the caverns.

There is a widely persistent legend in Texas of the existence of a tremendous cavern in the Big Bend which reputedly links the United States and Mexico beneath the bed of the Rio Grande. No corroboration of the legend has ever been obtained.

Well-Drilling Reveals Debris-Filled Caves

From many parts of the country have come reports of well-drilling operations in which drillers struck caves far beneath the surface. Generally the presence of such a cavern is revealed when the drill drops into an open space. The existence of a cavern completely filled with sand and clay or other material is much more difficult to establish. Several are known in West Texas.

In 1915, and again in 1921, oil-well drillers in central Culberson County brought up well cores that showed the usual succession of Permian age rocks interrupted by deep beds of mixed gravel, shale, sand, and clay. The Permian rocks were limestone, dolomite, and gypsum, about 175 million years old. But fragments of oyster shells and other fossils in the 120-foot layer of debris were positively identified as being of Cretaceous age, about 100 million years old.

Obviously the drills had passed through a large cave which later had become filled with debris originating in a more recent geologic age. Its discovery was reported by J. A. Udden (1922, *Bull. Geol. Soc. America*, 33:153-155), who wrote that "it seems most likely that the cavern now filled had developed after the elevation of the Permian series to its present height, which probably took place at the end of the Mesozoic age or later, and that the filling represents a time when the Cretaceous sediments were still present over a part of this area."

From the nature of the mixture Udden concluded that the filling actually had occurred recently, relatively speaking. He believed that it occurred during the Pleistocene period, approximately one million years ago.

In one cave the ceiling was struck 380 feet below the surface, the floor, 120 feet below.

—WILLIAM E. DAVIES

There is wide speculation on the existence of a great cavern system extending from *Leon Springs, Texas*, for some 20 miles to the east. The speculation is based upon the belief that a stream resurgence near Shertz is a reappearance of Cibolo Creek which during high water runs into a deep hole just south of Leon Springs.

Celestite Cave-Deposit Found in Real County

Celestite, a strontium mineral of industrial importance, occasionally occurs in cave deposits. Since it produces a brilliant red flame it has been used extensively in signal flares and tracer bullets as well as in civilian fireworks.

Known chemically as strontium sulphate, this mineral commonly occurs in cleavable crystalline masses, usually light blue in color. It may closely resemble some limestones or dolomites, but it can be distinguished from these rocks by its greater weight (specific gravity 3.9 to 4.0) and by brilliant red flame under the blowpipe test.

The discovery and mining of a celestite deposit in a cave in Real County, Texas is described by Glen I. Evans in a recently published volume on "Texas Mineral Resources" (1946, U. Texas Publ. 4301: 113-131).

Cavern Deposits.—Celestite occurs on the walls of a small cavern on the Miller ranch, 13 miles west and 5 miles south of the junction of U. S. highway No. 83 and State highway No. 41 in Real County. The cavern is developed in massive Cretaceous limestone from 10 to 15 feet below the present surface. It is about 25 feet long, 14 feet wide, and 5 feet high with a narrow opening extending about 40 feet beyond the main cavity. Bat guano covers the cavern floor to a thickness of several feet. The celestite occurs as a crystalline mass from 1 to 2.5 feet thick on the west and south walls. Singly terminated prismatic crystals from half an inch to 4 inches in diameter extend outward into the cave from the celestite mass. The crystals are strongly marked by etching channels which have developed along the planes of cleavage. Calcareous dripstone, later than the celestite, forms thin encrustations over parts of the deposit. Although this deposit was obviously quite small, it was opened in 1943 and about 70 tons of the high grade celestite was produced. In the vicinity of this cavern and in other parts of the southern Edwards Plateau, numerous caverns have formed in the Cretaceous limestone; hence it is possible that other cavern celestite deposits may be found within the region.

—WILLIAM E. DAVIES

West Texas Caves and Shelters

Excerpts from Published Notes

Compiled by
A. T. JACKSON

THE AVAILABLE literature in archeology, geology, history, and folklore, contains many descriptions of West Texas caves and rock shelters. The best way to present much of this material seems to be by means of brief excerpts. References are listed at the end of the article.

Not all known sites are included. In fact, many reported sites remain to be visited and studied. Sometimes "cave" is used in referring to a shelter. Again, "cave shelter" is employed. There are many more shelters, however, than solution caves.

BREWSTER COUNTY

Setzler¹ writes: "The Chisos Mountains were first surveyed from the air, and numerous caves were sighted along the precipitous cliffs. The territory we covered by plane in an hour required four days to reach by mulepack.***"

"Our first camp was established near the south tip of *Mule Ear Peaks*, and here two caves were completely excavated." The Chisos Mountain area is some 150 miles south of Alpine.

Cartledge Cave, on Wayne Cartledge Ranch about 7 miles east of Terlingua, was excavated by Setzler.

Coffin² writes: "The rock shelter is located on the ranch of Mr. Lee Schuler, on the north side at the mouth of Bee Cave Canyon,*** a box canyon about 1500 feet deep and 400 feet wide at its mouth and derives its name from the colonies of bees that nest in crevices of the wall of the rock shelter.***"

"The rock shelter, measured by the overhang, is 768 feet long and 106 to 110 feet wide in its central portion from overhang to back wall. A mass of rocks which has fallen from its roof near the center almost divides it into two portions.*** Much filling and leveling had been done during the time of occupancy (by

Indians)*** The mass of stones*** which had fallen from the middle of the arch of the rock shelter roof, formed several small caves.*** The larger*** was 37 feet, 9 inches in extreme length and about 9 feet wide. The smaller was about 9 feet square.***"

Mansfield and Boardman³ describe *Worthington Rock Shelter*, located at Agua Fria Spring, about 70 miles south of Alpine. "The rocks are igneous and have been determined by E. S. Larsen, of the Geological Survey, as soda rhyolite. The bluff is approximately 450 feet high and hangs over enough to protect its lower part from rain and running water. Large blocks have broken down from the sides and have formed recesses or half caves at the sides of the bluff near the base. These recesses have apparently made very desirable dens for animals and may also have been used by Indians. The ground at the foot of the bluff here is black with organic matter made up largely of camp refuse and animal excreta, and the rock wall is ornamented with figures made with red paint.*** The oxidation of organic matter, aided by the action of bacteria, is commonly thought to be the process that has formed the nitrate in many localities.*** With the abundance of organic matter in sight at this locality it does not seem necessary to look elsewhere for a source for the nitrate. This means that the nitrate found here is restricted to the surface, and except in small cracks near the surface the rock itself will be found barren of nitrates.

"Mr. Robinson estimated the amount of incrustated material in sight at this locality at less than 100 pounds. It is evident that the deposit as a whole is without commercial possibilities."

Kokernot Rock Shelter. —Lehmer⁴ describes it thus: "The Kokernot Rock Shelter is located in the Kokernot ranch on the western side of the mile-wide Calamity Creek valley about 3

miles below the ranch house. The site is confined to the area between a small tributary arroyo and the base of the cliff of Cretaceous limestone which forms the western edge of the valley at that point. The cliff is broken occasionally by vegetation-covered valleys, and several small shelter caves and overhangs occur at the base."***

Fletcher⁵ has the following to say about certain cave burials: "Some 40 feet back in a cave, 6 miles southwest of *Santiago Peak*, two burials were found. The bodies were in baskets laid on poles over a natural vertical shaft that descended from the floor of the cave. The bottom of the shaft yielded nothing of interest."

Smith⁹ says: "*Hord Rock Shelter* may be located by reference to the Alpine Quadrangle of the USGS, being approximately 30° 23' north latitude and 103° 47' west longitude.*** The site is*** one of a number which form the Sunny Glen group."***

"*Waldron Cave*, at the quicksilver mining village of the same name, is a large chamber 100 feet long, 75 feet wide and about as high as it is wide. The walls and roof," according to old newspaper accounts, "are a beautiful combination of colors, with red predominating. The cinnabar sparkles in the candlelight of the miners."

"It is thought that this cave is where Indians secured the red paint with which they painted numerous inscriptions on bluffs and walls of caves and shelters in the Big Bend region. The first known white man who entered the cave is said to have found a crude pole ladder, believed to have been used by the Indians in entering the cave for the cinnabar ore."

Old Hookie Cave. —Newspapers of some twenty years ago contained accounts of this cave, but its exact location was not given. "Old Hookie Cave reminds one of the crater of an extinct volcano. In the bottom of the first chamber is a growing tree. Visible from the first chamber is another that resembles a huge vault."

Smith⁷ writes: "*Carved Rock Shelter* is one of a number of similar sites in the Sunny Glen Canyon, near Alpine, where conditions were most favorable for agriculture.*** The owners of the land, Mr. Perry Cartwright and his father, Mr. T. J. Cartwright.*** The general

form of the overhanging ledge is that of a shelter 80 feet long, with an extreme depth of 45 feet."

What might be called *Handprint Shelter*, sometimes called *Byrd Mine Shelter*, located 12 miles east of Alpine, also has been discussed by Smith⁷⁻⁹ who reports there are "thirty-two handprints; two right, thirty left. A few small prints indicate the hands of women and children."

CROCKETT COUNTY

Jackson⁸ reports a medium-sized rock shelter 23½ miles southwest of *Ozona*. Some of the paintings on the wall are "almost covered by smoke, while others have lichens growing over them."

CULBERSON COUNTY

In the northeastern part of the county "The region has an elevation of about 3700 feet above sea level," Jackson⁸ reports. "It is semi-arid, sparsely settled and devoted exclusively to the ranching industry. Numerous caves are found in the low hills. Some are real caves, with small openings that lead into large chambers. Others are called '*sink-hole shelters*,' due to the entrance being a large depression or hole with parts of the wall overhanging.***"

"*Caldwell Cave No. 2*, 40 miles northwest of Toyah, is a typical sink-hole shelter, combined with a real cave. The entrance is circular, with a diameter of 74 to 77 feet. The walls have a sheer drop on all sides of 8½ to 27 feet. Except for the east and southeast, the circular wall has a considerable overhang, under which the Indians lived. Back of the shelter is a low-roofed chamber, leading by a narrow passage to a large cave toward the west. The cave extends several hundred feet, but shows no signs of human habitation."*** It is inhabited by rattlesnakes.

"*Rabbit Cave*," on Shelby Brooks Ranch, 32½ miles northwest of Toyah, is a large cave with several small openings in the side of one of the numerous hills. See a discussion of the cave in another article.

Writing of the same general region, Sayles¹⁰ reports: "Several sites were investigated in the *Rustler Hills* region, about 40 miles northwest of Toyah.*** The site is a typical sink-hole

shelter, formed by water carrying away the gypsum strata which underlie the surface limestone. The latter, being more resistant, forms a dome; the ceiling eventually falls, which leaves a cave with an overhanging encircling rim.

"The principal part of the sink-hole occupied was that directly beneath the opening.*** This was reached from the surface by a slope, where drainage into the cave had built up a talus covering the bedrock which formed the principal living area, and which was about 20 feet below the outside ground level. On each side of this area the overhanging rim provided protection; opposite to the entrance slope was an extension of the sinkhole, semi-dark, ending in a small sink into which the surface water disappeared, after draining along each side of the main part of the shelter.

"This semi-dark extension of the cave was on a general level about 15 feet lower than the living area.***

"The site had a great deal of occupation as evidenced by sotol pits on the outside, round mortar holes in the exposed limestone of the rim adjoining the cave; also by numerous pictographs covering parts of the walls of the shelter, but particularly by the accumulation of the refuse in the cave itself. This extended from beneath the overhanging rim, where it was protected from moisture, a width of about 60 feet, and to a like distance into the darker part of the cave.

"The deepest part of this refuse was where it joined the living area—where it dipped to the lower part of the cave. Here the trash was 7 to 8 feet deep; and from here it sloped, becoming thinner until it joined the guano which covered the floor of the darker part of the cave."***

Double Shelter, located in the Guadalupe Mountains, 1½ miles north of Frijole. The shelter, facing toward the southeast, is "at the bottom of the caprock, and at the top of a half-mile-long talus slope." According to C. L. Baker, who examined a specimen of the rock, it is 'magnesian limestone recrystallized and almost marble in texture.'***

Deer Shelter, so named because of the number of these animals painted on the walls, "is located," Jackson reports, "in a rugged section,"

29 miles north of Van Horn. It is "a very small shelter, 21 x 7 feet.The roof is only 4 feet high.*** The elevation above sea level is about 6,000 feet.*** The rock is Permian limestone."***

EL PASO COUNTY

Hueco Caves.—"The mountains in which the caves are located," Roberts¹¹ reports, "lie between El Paso and the famed Hueco Tanks, in the range bearing the same name.*** There are 28 of these natural recesses in the face of the limestone cliffs. See description elsewhere in this Bulletin.

Ceremonial Cave, in the Hueco Mountains 29 miles northeast of El Paso, has been discussed briefly by Alves^{12,13}. The cave took its name from the discovery in it of many archeological specimens of such nature as to suggest ceremonial use.

Council Chamber Cave is at Hueco Tanks, 30 miles east-northeast of El Paso. "There is a cave," Crimmins writes, "near the mouth of the amphitheatre which has a flat table-like rock that has been worn smooth on top. It is the largest cave thereabouts. ***It has two large white snakes painted on the wall, and each is over 50 feet long and about a foot wide. Bartlett [John Russell Bartlett, the Chief of the American-Mexican Boundary Commission, 1850] reports that the Indians held councils in the great amphitheatre. On one occasion after the Indians had committed depredations and murders around El Paso, they were trailed by the Mexicans to this amphitheatre. They were driven to the far end and then built a wall of rocks from one perpendicular rock to the other. Here they were besieged and being cut off from food and water, they were eventually overcome and 150 were killed."

HUDSPETH COUNTY

Bat Cave, in Diablo Mountains, 18 miles west of north of Van Horn, is called a "dry cave" because there is no nearby water. See illustrations and further description in another article.

Two rock shelters, located 12 miles northeast of Fort Hancock, have 15 round mortar holes in the red sandstone nearby.

Potash Mine Shelter.—Mansfield and Boardman³ report: "The site of the potash mine, a large outcrop of massive sandstone, is reached by traveling 7.2 miles by highway west from Van Horn and thence 1.6 miles northeast by trail through a narrow cut. It is virtually on the Culberson County line. The sandstone outcrop lies N. 20° E. of the exit from the cut, which was formerly used as a dam site.*** The southeast end forms a cliff that has a prominent overhanging ledge, which at some places extends out 5 feet at a height of 8 to 12 feet. The overhang runs approximately 200 feet and has afforded, and still affords, resting places for bats. There is also abundant evidence of the use of the place as a shelter by Indians. ****Prospecting by digging, tunneling and blasting has been carried on for a length of about 150 feet at the base of the cliff, and to a depth of 2 or 3 feet. ***Some shipments are reported to have been made. ***The organic and surficial origin of the nitrate is evident. ***The deposit is obviously not commercial in any but the most limited sense.

Hudspeth County Shaft (P.J.W.)—One of the few known spectacular descents in the state still to be pioneered is a sheer shaft at least 150 feet to a large chamber said to contain massive formations. There is a reasonable probability that a large labyrinth underlays the shaft.

JEFF DAVIS COUNTY

Jones Shelter, 14 miles northwest of Fort Davis, faces west and is 21 x 18 feet. Paintings are damaged by lichens.

Rock Pile Shelters, 30 miles south of Kent, are surrounded by huge piles of syenite boulders. Two of the shelters have been occupied, the third has a sloping stone floor with no midden deposit.

Merrill Shelters, 12 miles south of west of Fort Davis, were briefly described by Peabody¹⁴ in 1909 and subsequently by other writers. Historic Indian paintings are found at the site.

Phillips Shelter, 37 miles southwest of Balmorhea, is of rhyolite lava. The site is very inaccessible, in Little Aguja Canyon.

Jeff Davis County Cave (P.J.W.)—Reportedly one of Texas' greater caves. Only par-

tially explored it is said to contain lakes with blind fish, though no specimens have been taken. A solution and erosion system, large rooms and great formations are reported.

PECOS COUNTY

Sherbino Shelter, 35 miles south of Girvin, contains a number of handprints.

Borilla Shelter, 38 miles west of Fort Stockton, has some pictographs.

Panther Bluff Cave and Shelters.—Holden¹⁵ states: "Approximately 22 miles east of Fort Stockton*** is Tunis Spring. A current of clear water some eight feet wide and a foot deep flows from beneath a stratum of limestone.*** Tunis Canyon in which the spring is located varies from two to four miles in width. ***The sides of the canyon*** rise some 400 feet and are covered with a caprock of limestone about 20 feet thick. This caprock in its perpendicular sides along the edges of the canyon contains a number of caves and rock shelters. ***Panther Bluff, located 3 miles southwest of the spring, has one cave and two shelters. The cave, whose entrance measured 7' 8" wide and 5' 3" high was filled with debris to a depth of 3 feet. ***Of the two shelters in Panther Bluff one measured 21' wide, 6' 6" deep and 6' 3" high. The other was 19' 6" wide, 18' deep, and 8' 6" high. The ceilings of both had smoke incrustations ***and neither contained debris."

McKenzie Cave.—"Approximately 6 miles east and 4 miles south of Tunis Spring is McKenzie Cave, located on the ranch of Mrs. Mary Lea McKenzie. It measured at the entrance 38' 7" wide, 23' 4" deep and 5' high. The ceiling is practically level. However, the floor slopes upward toward the back until it is within 18" of the ceiling. Between 10" and 15" of debris covered the floor."***

PRESIDIO COUNTY

Knight Cave, on the Mollie B. Knight Ranch, 170 miles southeast of El Paso, was reported by Setzler¹⁶ of the U. S. National Museum and Smithsonian Institution; the cave "lies 400 yards from the Knight ranch house and on the west side of a small canyon whose basaltic walls rise 200 feet or more. Although only 100 feet above the valley floor, the cave entrance is well

concealed. ***Huge fallen rocks block its narrow opening, so that it had been unknown until 1923 when a fox which Mr. Knight was chasing conveniently found it.*** The rocks at the entrance*** supported the cave roof, so that it seemed treacherous to remove even the rocks we did in order to make an entrance four feet wide through which to remove the dirt. To reach the main chamber we were at first forced to crawl on our hands and knees over the sharp cactus spines that the pack rats had carried in. Excavations began in the entranceway. Enough dirt was removed to permit entering in a semi-erect posture.***

"Only one who has worked in a cave where the sole means of ventilation was a small opening at the floor level can fully understand the physical difficulties under which our work was carried on. Dry dust, finer than flour, formed thick clouds. There was no escaping it: no movement of air to remove it. Dust masks were indispensable, and even with this protection it was necessary to leave every 15 or 20 minutes to fill our lungs with fresh air and change the filters in the masks. The fine dust even clogged the mantles of our gasoline lanterns, so that pocket flashlights had to suffice for illumination. ***But our lungs soon became adjusted to the ordeal. ***Many tons of rock and earth were removed in hand buckets through the constricted cave entrance to be carefully screened in the open air.***

"After this cave was excavated three smaller caves and one rock shelter in the same canyon were investigated."***

Bogel Shelter, sometimes called a cave, located 12 miles south of Marfa, is a large rock shelter of volcanic ash or rhyolite tuff-breccia.

Nitrate Cave, or Rock Shelter, is located about 3 miles southeast of Candelaria, a little settlement on the Rio Grande, 45 miles south of Valentine.

Glasscock Cave, according to Mansfield and Boardman,¹⁷ "is about 44 miles nearly due south of Marfa*** but the distance by road is about 50 miles.*** The rock in the immediate vicinity*** is igneous, fine grained and dark and is tentatively classed as basalt. The nitrate is found in a cave in this basalt.*** It is probably that this igneous rock represents an old lava flow over 60 feet thick that, while still molten, became

honeycombed with cavities that range from cracks a fraction of an inch in diameter to openings as large as the caves,*** owing to the expansion of gases in the rock. In addition to the cave*** there are*** rough holes or openings in the rock locally known as 'blowholes.' The cave is in the face of a steep bluff of basalt that is fractured along planes at right angles to the face of the bluff. These fracture planes and the cavities made by the expansion of gases afford a route for the circulation of waters carrying salts in solution.

"The nitrate is found as incrustations on the walls of the nitrate prospect cave and in caked masses in the dirt in this cave.***

"Just above the prospect cave is a natural cave that at one time was*** an old Indian camp. On the wall are figures in red paint, and the floor of the cave contains black dirt, presumably the ashes from old camp fires mixed with other camp refuse containing a large percentage of organic matter."***

Panther Peak Cave, at headwaters in Black Hills, 35 miles east of Presidio and ten miles north of the Rio Grande, was reported by Frank Mills, a former Texas Ranger. Accessible only by pack.

Humphris Shelters, 27 1/2 miles south of Casa Piedra and 72 miles south of Marfa, contain historic paintings.

Handprint Shelter, 33 miles west of south of Casa Piedra, has its walls decorated with many prints of the human hand.

Shafter Shelter, about 7 miles east of Shafter, shows a picture of a man on a horse.

Threadgill Cave is located on Segunda Creek, 18 miles northwest of Lajitas and 64 miles south of Marfa.

REEVES COUNTY

Popham Shelters, located 19, 20 and 21 miles east of Balmorhea showing evidence of Indian occupation.

TERRELL COUNTY

Goode Cave, according to Setzler¹⁷, "is located on the south side of Richland Canyon, one mile west of the ranch house, and 4 miles west of the Pecos River, in the extreme northeastern corner of the county. The cave faces approximately 15 degrees north of west, overlooking two small box canyons."

Bendele Shelter, 15 miles east of north of Dryden, is a pictograph site of note. The floor floods periodically, but the wall is covered with pictures of varying ages. In addition to prehistoric pictures there are ones of missions, priests, stage coaches and others. The site bears much evidence of vandalism. What remains undamaged should be protected.

Hill Shelters, about 35 miles east of north of Sanderson, have carvings on the walls.

Black Hand Cave, or Shelter, about 50 miles east of north of Sanderson, has walls and ceiling covered with soot. There are handprints—all of the left hand—with etched outlines, paintings of the atlatl, etc. The dimensions of the shelter are 70 x 18 x 10 feet.

Mitchell Cave, 23 miles north of Sanderson, is 20 feet wide, 20 feet deep and 10 feet high. Ash deposit in cave. Some paintings damaged by the spalling of wall and ceiling.

Cunningham Cave, 35 miles south of Sheffield, Midden deposit in cave.

VAL VERDE COUNTY

Moorehead Cave, on the Pecos River near its confluence with the Rio Grande, according to Setzler¹⁸ is "about 200 feet wide at its mouth and 300 feet deep." Excavated by Frank M. Setzler for U. S. National Museum and the Smithsonian Institution.

Goat Cave opens "on a small canyon just south of Deadman's Canyon, a tributary of the Pecos. It measures about 69 feet in width and 38 feet in depth.

Eagle Cave—Rockshelter—on Ingram Ranch in Mile Canyon, about one mile east of New Langtry. "is roughly semi-circle in shape," reports Davenport¹⁹. "It is 193 feet across the mouth, 83 feet deep and the ceiling is about 50 feet high at the mouth. The usual rock talus extends from the cave to the canyon floor, about 30 feet below." Excavated by Witte Memorial Museum of San Antonio.

Shumla Caves, on the Ross Ranch, "clustered together about a half mile north of the Rio Grande," writes Martin²⁰. "The banks of the Rio Grande in this vicinity form cliffs 300 to 350 feet above the present river bed." Milo Canyon enters that of the Rio Grande from the north. The Cliff walls contain numer-

ous large and small caves.*** The ninth cave is on the south side of the Pecos, about two miles northwest of Shumla."*** Excavated by Witte Memorial Museum.

Murrah Cave, Holden²¹ reports, is located*** on the lower Pecos River, approximately 15 miles from the Rio Grande as the crow flies, and some 25 or 30 miles as the river winds.*** The cave is in the east bank, facing west, of one of those bends whose circular side is to the east. The river in this region has cut several hundred feet through the Comanchean limestone. The east bank, on the outside curve, is practically perpendicular, with overhanging ledges here and there.***

"A number of caves of varying sizes are found in this bank.*** Murrah Cave, the largest of them all*** is located approximately 200 feet above the water level of the river, and 60 feet from the top of the cliff. It extends back into the cliff 124 feet, is 24 feet wide at its mouth*** and 45 feet wide at 100 feet from the entrance. Toward the back it narrows down to a passage-way only a few feet wide, which extends some 24 feet farther.*** The ceiling in the mouth of the cave is 9' 6" from the floor. It is almost level for about 80 feet back, where it begins tilting downward. Toward the rear it is approximately 25 feet from the floor.

"Human occupation was confined largely to the comparatively level stretch of floor in the front 50 feet. Behind this the bats have lived, and the guano is from 2 to 3 feet deep.***

"The cave is well located.*** It is not possible to see the entrance from any direction until one is within 30 feet of it, except from the ridge far across the Pecos valley.*** Out on the ledge in front of the cave, one can look down and see large catfish swimming along the bottom of the greenish waters of the Pecos."

"*Fielder Canyon Cave*," Kirkland²² writes, "is in Fielder Canyon about 3 miles from*** where it empties into the Pecos River on the northeast side about one mile below the Ozona-Langtry highway crossing in the northwest corner of the county. There are numerous caves in the district, usually high up in the sides of the cliffs.*** The cave is under the caprock 30 feet below the top of the canyon. A long, steep talus extends from the mouth of the cave down-

ward to the bottom of the canyon, which is about 200 feet below. The mouth of the cave is about 5 feet square. Its inside width is about 8 feet, its depth 12 feet, and its height 5 feet.***

"The cave was discovered by Walter Babb, a local rancher, 20 years ago when his dogs ran a bobcat into a hole in the top of the cave. In trying to get at the cat, he discovered 4 or 5 arrow foreshafts and a number of small glass beads on a ledge in the cave."***

"*Tribal Shelter*," located 9 miles south of west of Comstock is one of the largest rock shelters in the state, measuring 515 feet in maximum length with a depth or overhang of 98 feet. "The shelter, which is crescent-shaped," Pearce and Jackson²³ report, "can be reached only by climbing a steep talus slope from the bottom of the canyon to a height of about 100 feet."

Eight other rock shelters are located in the bluffs of *Seminole Canyon* in a distance of about three miles immediately above its junction with the Rio Grande, a few miles east of the Pecos River. Two large shelters were long inhabited; four smaller ones show considerable evidence of occupation; but two, due to flooding, contain no camp refuse.

Mosquito Shelter, sometimes called *Panther Cave* from a large animal painting on the wall, is located high in the cliff at the mouth of *Seminole Canyon*, on the north bank of the Rio Grande. The shelter is unusual in several respects. The name *Mosquito Shelter* was applied because of the fact that at noon on a warm fall day the mosquitoes were so numerous and vicious as to force a photographic party to tie cloths about their heads for protection. The wall of the shelter bears the remains of many superimposed paintings—perhaps more on a given area than at any other Texas site.

Rattlesnake Canyon Shelter, about 8 miles southwest of Langtry and $\frac{1}{2}$ to $\frac{3}{4}$ mile north of the Rio Grande, is reached by a "road" so rocky and rough that one is in danger of "swallowing his teeth." The paintings in one shelter appear to be prehistoric; those in the other shelter are historic. A mural painted from the old pictures was placed on exhibit at the University of Texas Centennial Exhibit in 1936.

Ingram Shelter, on east bank of Pecos River, 16 miles northeast of Langtry, has an area



A. T. Jackson

SHELTER CAVE COUNTRY. Within a few miles of this Pecos River bridge, near its junction with the Rio Grande, are many deep rock shelters. Val Verde County.

about 75 x 6 feet on which paintings are present. They are of widely varying ages.

Ingram Shelter, on west bank of Pecos River, 15 miles northeast of Langtry. The shelter measures 100 x 20 feet and has a floor of solid rock.

Slick Rock Cave (Shelter), on east side of Pecos River, 14 miles west of Comstock. There are many positive hand prints, about evenly divided between right and left hands.

Wild Mare Trail Canyon Shelter, on east side of Pecos River, 14 miles west of Comstock.

Habey Shelters—one known as *Wolf Cave*—on west side of Pecos River, about 14 miles west of Comstock. Dimensions are 120 x 70 x 50 feet and 150 x 30 x 50 feet.

Perida Caves No. 1 and 2 (No. 1 sometimes called *Painted Cave*. No. 2 sometimes called *Pecos Cave*) two miles down the Rio Grande from the mouth of the Pecos River, and on the Texas side of the Rio Grande across from the mouth of *Perida Canyon* in Mexico, $1\frac{1}{2}$ miles down river from mouth of the Pecos, about $15\frac{1}{2}$ miles south of west of Comstock. No. 1 measures 195 x 135 x 40 feet; No. 2, 80 x 60 x 40 feet. Located near the back of No. 1 is a spring that furnishes a permanent supply of water. There is a certain amount of seepage over the rock wall, but the paintings have been preserved in places.

Brown Shelter, on west side of Pecos River, 14 miles southeast of Langtry, has some very old and dim paintings. The shelter measures 130 x 30 x 16 feet.

Bell Shelter, on Rio Grande above old railroad tunnel, about 19 miles (by road) southwest of Comstock. The wall of the large shelter is soot-covered, much of the soot having accumulated after many of the paintings were

placed on the wall, thus almost obliterating some of them.

Still Canyon Shelter, at Oliver Springs, 20 miles northwest of Comstock, has a few paintings, among which is a so-called plumed serpent.

Dead Man's Canyon Shelter, 1 1/2 miles above high railroad bridge on Pecos River.

Lewis Canyon Shelter, on east side of Pecos River, 26 miles northwest of Comstock. There is a pool of water in the shelter, and pictographs are almost ruined by dampness. Water drips down the wall.

Devils River Shelter, on east side about 3/4 mile below mouth of Dry Devils River.

Cedar Canyon Cave (Shelter), about 35 miles northeast of Comstock.

Painted Caves, two rock shelters to west of old highway right-of-way on west bank of Castle Canyon, 14 miles west of Del Rio. Many of the pictographs have been ruined by white campers and other vandals. The site was first reported by U. S. Army Engineers in 1849, when surveying a route from San Antonio to El Paso.

Turkey Bluff Shelter, on Devils River about 10 miles below Juno, is reported to have taken its name from a black painting of a turkey.

Rio Grande Shelters, four in number, between mouths of Painted Canyon and Seminole Canyon, 9 to 12 miles southwest of Comstock.

Satan's Canyon Shelter, 1 1/2 miles up from Devils River, about 10 miles below mouth of Dry Devils River.

Adams Shelter, at mouth of Dead Man's Canyon on Devils River.

Cauthorn Cave, on Devils River, said to be about 20 miles northeast of Comstock.



As T. Jackson

APARTMENT SHELTERS, between Camp Wood and Rocksprings, Edwards County, resemble other western Texas caves formerly occupied by Indians. Pictographs decorate the walls of these deep shelters.

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More Notes on Val Verde County

Langtry Gypsum Cave (P. J. W.)—This cave was discovered when workers laying U. S. Highway 90 cut through a small shaley hill just 1.1 miles west of Langtry. Of two small openings in the side of the cut on the south border of the highway, one leads to a cul-de-sac, while the westernmost enters the cave. This passage extends horizontally about 10 feet and then drops sharply at about a 70-degree pitch for about 30 feet to a narrow ledge. From this ledge there is a sheer 40-foot drop to the cave floor. This shaft must be negotiated with a rope as the lowest 15 feet do not permit chimneying or scaling. The cave is an enlarged fissure extending in both directions from the bottom of the shaft: southward for about 100 feet to a dead end. And northward for approximately a quarter of a mile. Throughout the entire area the cave is heavily hung in massive gypsum formations. In many places whole sheets are buckling away from the wall, elsewhere they have fallen leaving large piles of gypsum on the clay floor. Various colorings, salmon, browns, stippled and gleaming white are observed. The cave is very dry. At the southerly end of the cave a tiny passage broken through the floor admits one to a small chamber with many fossilized shells in the ceiling and walls.

Langtry Quarry Cave (P. J. W.)—This most recently discovered of the Langtry caves is located in a quarry on the ranch road which leads northwest from the railroad station. It is about 3 miles from the station on the right side of the road. The entrance is down a large shaft for about 60 feet over a 60° slope of dangerous *scree*, so loose that one may easily *glissade* the entire distance. Here the entrance chamber forks. The left hand fork ends in a blind alley and the right hand fork enters into a narrow, precipitous crawlway with a very dangerous shaley roof which comes away in one's hands. About 30 feet of this crawlway brings one to the edge of a pit which drops 40 feet to a narrow ledge, 35 feet to a small alcove, and 15 feet farther down a slight offshoot to the cave floor—a total drop of 90 feet which cannot be made without a rope although the walls permit some chimneying all the way. The cave proper, lying

about 120 feet below the surface, is in a highly soluble limestone and seems to have been formed by both solution and abrasion. The first chamber is about 40 feet long by 30 feet wide and 8 feet high. This drops to a head clearance of about one foot and holds at this exhausting squeeze for the next 300 feet after which the roof opens up to between 4 and 5 feet and the 30-foot width narrows to a passageway of about 8 feet. This passageway has been followed for at least a mile and shows no signs of diminishing. The cave is now quite dry and contains a large number of shells embedded in the walls. There are almost no formations and no fauna of any kind was observed, although the skeleton of a large bobcat was found.

Old Railroad Tunnel Houses Bats

Some four miles southeast of Shumla, Val Verde County, is an abandoned railroad tunnel inhabited by bats. After penetrating the tunnel for some distance the spelunker has a feeling that he is in a cave.

A brief description of the tunnel is contained in Bulletin 838 of the U. S. Geological Survey¹:

"Several years ago" (in the early 1880's) "the Southern Pacific Railroad instead of spanning the Pecos River Canyon by a very high bridge, as it now does, turned south from Shumla and followed the precipitous north wall of the Rio Grande Canyon until it crossed the Pecos River near its mouth. About four miles southeast of Shumla it was necessary to tunnel out part of this old road bed. When visited by Mr. H. M. Robinson, in September, 1918, the tunnel was about 1,500 feet long, 30 feet from roof to floor, and 15 feet from side to side and was inhabited by bats. An automobile could be driven on top of the high plateau to a place within a hundred feet of the western portal. He estimated the amount of guano in the tunnel roughly as a mass 1,300 feet long, 12 feet wide, and two inches deep."

—A. T. JACKSON

¹ Mansfield, G. R. and Leona Boardman. Nitrate Deposits of the United States. Geological Survey Bulletin 838. United States Department of the Interior, Washington, 1932, p. 95.

Why Are Cave Remains Important?

By A. V. KIDDER

In most parts of the world and for most periods, archaeologists are faced by the difficult task of visualizing the life of prehistoric peoples and of judging their competence as craftsmen on the evidence of the very few sorts of artifacts that are capable of resisting decay. The meagerness of such materials was years ago brought home most forceably to Mr. Cosgrove and me when we made what might be called a survival survey of the Peabody Museum's collection from the dry Basket-maker caves of northern Arizona. We wished to see how much of that remarkably illuminating lot of specimens would have perished in sites unprotected from the weather. We found that of the hundreds of objects, filling five large display cases and many storage drawers, there would have remained no more than a score or so of chipped flints, a handful of bone awls, and a few beads of stone and shell. The whole lot would have gone into a good-sized soup plate. That pitiful residue would have told us nothing of how the Basket-makers cradled and diapered their babies, how they dressed, how they wore their hair, what crops they grew or—what is quite as important—what plants they had not yet learned to cultivate. It would have given us no inkling of their extraordinary skill as weavers and wood-workers. As it is, we have intimate knowledge of all these and of many other details of Basket-maker life, knowledge which in the case of the overwhelming majority of ancient cultures is lost beyond recall.

Such collections as that from the Arizona caves are of enormous value, not only for the light they throw on given cultures, but also in providing bases for estimating the probable total content of those that have suffered more severely at the hand of time. It is therefore most fortunate that Mr. and Mrs. Cosgrove were able to secure, from caves in extreme southern New Mexico and in adjoining parts of Texas,

* Reprinted from the Foreword to "Caves of the Upper Gila and Hueco Areas in New Mexico" by C. B. Cosgrove, Papers of the Peabody Museum of American Archeology and Ethnology, Harvard University, vol. XXIV—No. 2, 1947.

another large collection of excellently preserved materials representing at least two stages of pre-Columbian development in areas previously unexplored and which, because of their position on the southern periphery of the Southwest, athwart one of the most likely routes for early migrations and for transmissions of cultural influences, are bound to become of increasing archaeological significance.

The early remains, evidently from the same general time horizon as those of the Basket-makers of northeastern Arizona and southeastern Utah, further illustrate that pregnant stage in the growth of all higher civilizations during which the cultivation of a cereal was fostering sedentary life, transforming nomadic hunters and gatherers of wild food-plants into settled village dwellers, providing leisure for the perfecting of arts and crafts, and bringing increase and concentration of population, which in turn necessitated the creation of workable social systems.

All civilizations, as I have said, must have passed through such a stage, for all are based on cereal crops. In Egypt, in Mesopotamia, in the Far East, in Mexico, the relentless corrosion of time has almost completely effaced the record. In the Southwest, however, it can still be read, perhaps more clearly than anywhere else in the world; and when our still scattered data are gathered together and have been added to by the further discoveries that are sure to come, we shall have not only a firm substructure for the culture history of the Southwest, but also invaluable material for interpreting the more fragmentary remains from those regions in which similar developments took place.

The first indications that the builders of the pueblos and cliff-dwellings were preceded by humbler folk were found in the 90's by the Wetherill brothers in the caves of southeastern Utah. They named these people Basket-makers, because basketry, rather than pottery, was used for mortuary offerings. Subsequently work by S. J. Guernsey, of the Peabody Museum, E. H.

Morris, F. H. H. Roberts, J. L. Nusbaum, and others, has yielded remarkably complete information as to the way of life of these first farmers of the San Juan country, and we can now follow upward in time the gradual growth of the cultures to which theirs was ancestral and which culminated in that of the Pueblo Indians.

The canyons of the San Juan and other tributaries of the Colorado are rich in the dry caves that have embalmed, so to speak, the culture of the Basket-makers. The great stretch between the San Juan and the country treated in this report contains far fewer shelters. Nevertheless, it has yielded faint but unmistakable traces of early occupancy. Only in the extreme south along the Mexican border do there again occur numerous habitable caves. From the more easterly of these, in the Big Bend region of Texas, F. M. Setzler, V. J. Smith, and others, have unearthed remains in many respects similar to those of the San Juan Basket-makers. West of the Big Bend and on into southern New Mexico, the caves worked by the Cosgroves produced still more remains, evidently akin to what has come from the Big Bend but including a certain number of objects practically identical to ones from the San Juan.

Setzler calls the Big Bend people Cave-dwellers. He considers them to have been a more or less isolated or independent group and suggests that theirs may be part of a larger prehistoric culture centering in northern Mexico, especially in Coahuila.

The racial, cultural, and chronological relationships, not only between the early peoples of the San Juan and those of the Mexican border, but between them and the inhabitants of Lovelock Cave in Nevada, of the Ozark bluff-shelters, and of the Coahuila caves, present problems of the greatest interest and importance for New World prehistory and for the light their solution would throw on the genetics of culture and the mechanics of trait diffusion. Answers can only be had by continuance of field work of the sort done by the Cosgroves and by technological analysis as meticulous and illustration as full as theirs.

Hueco Mt. Caves

By C. B. COSGROVE*

Because of their proximity to El Paso and their conspicuous entrances, these caves have been long and widely known. The Society is fortunate to be able to reprint the following detailed descriptions of the caves and the series of excellent figures and photographs as well as Dr. Kidder's introductory remarks on the preceding pages.

Mr. and Mrs. Cosgrove carried on extensive field work in the Southwest during the late 1920's and early 1930's. The present report (cited below) was prepared shortly before Mr. Cosgrove's death in 1934 but was not completed and published until December, 1947.

Mr. Cosgrove was Research Associate in Anthropology for the American Southwest at the Peabody Museum of American Archaeology and Ethnology, Harvard University. It is through the courtesy of Mr. Donald Scott, Director of the Museum, that these excerpts from the voluminous report are published.

HUECO MT. CAVES

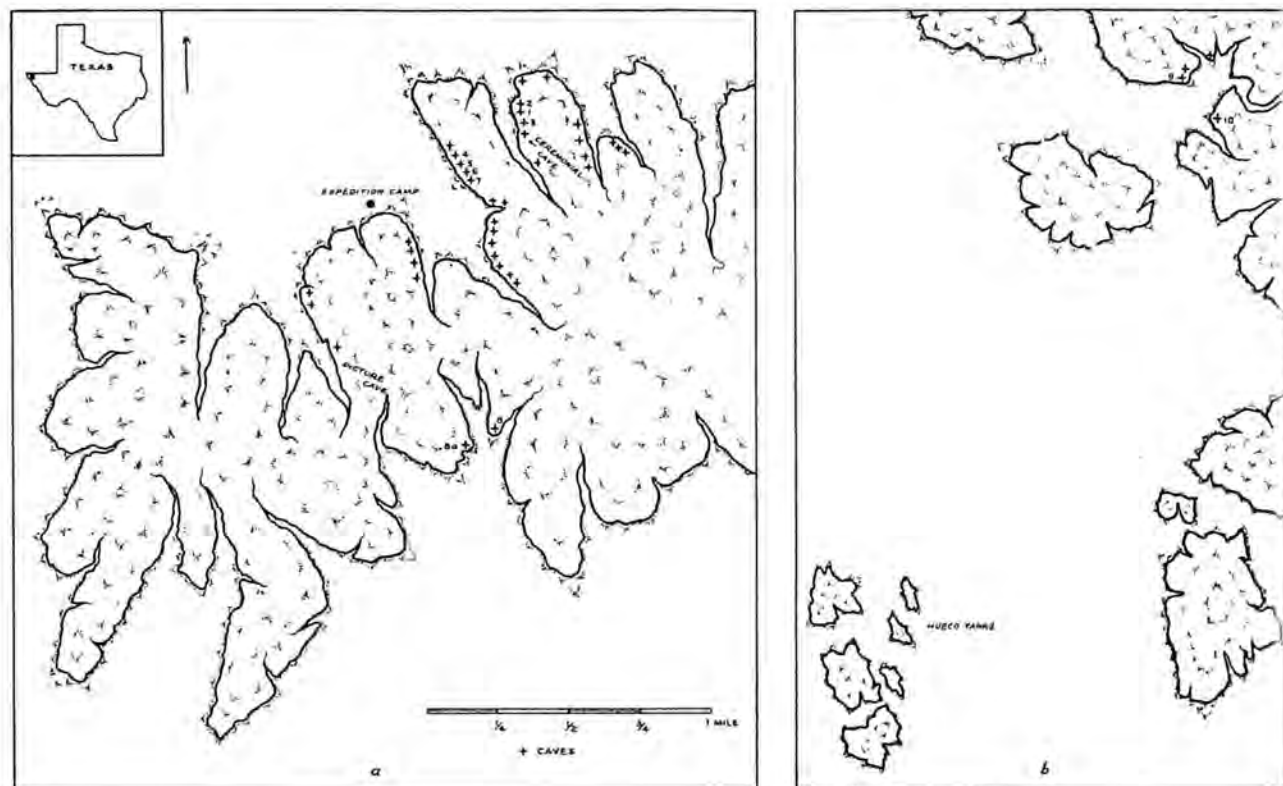
(Twenty-four miles in a direct line northeast of El Paso, Texas, in Town. 27 and 28 S., R. 7, 8, and 9 E., El Paso Co., Texas.) The shelters showing former occupancy generally have a western to southwestern exposure and an unobstructed view across wide, flat plains toward the Franklin and Organ Mountains, above El Paso, Texas. They occur in the faces of bays and cuts in limestone escarpments which consist of a 200-foot talus, surmounted by a 250- to 300-foot cliff. Most of the caves are at the foot of the cliff, just above the talus and along a bedding plane which, as nearly as can be judged without an actual survey, appears

* Reprinted from "Caves of the Upper Gila and Hueco Areas in New Mexico," by C. B. Cosgrove. Papers of the Peabody Museum of American Archaeology and Ethnology, Harvard University, vol. XXIV—No. 2, 1947.

to follow the same general level throughout the section. The overlying strata seem to have been more soluble and easily acted upon by water, since the tunnels and larger caves, some of them with domed roofs, have their floors and entrances on top of the harder stratum. In places, this forms an outer shelf which affords easy passage from one opening to another. No

be seen on the map, two of these (Picture and Ceremonial Caves) had previously been named; the rest were numbered as our excavations were carried on.

PICTURE CAVE (fig. 1). Our camp was established at a point from which a large number of caves were accessible. Picture Cave was



Courtesy of the Peabody Museum of American Archeology and Ethnology, Harvard University

Fig. 1. Hueco Mountain District, Division b of map is 2½ miles north and 4 miles east of division a.

springs were seen along the cliffs; and the only sources of water, aside from modern drilled wells, which at present supply ranches and the city of El Paso, are natural rain-filled tanks or basins in the cliffs.

Twenty-eight of the 41 small and large caves shown in the more detailed map (fig. 1) gave no evidence of having been occupied. Some of them may bear excavating, and undoubtedly there are still more to be found in this locality.

The principal sites here described are on land owned by Charles M. Newman and were drawn to our notice by Mr. and Mrs. R. B. Alves, of El Paso, who with Colonel M. L. Crimmins have discovered many other caves east of this place at what is localised termed "Hueco Tanks," and in the Cornudas Mountains beyond. As can

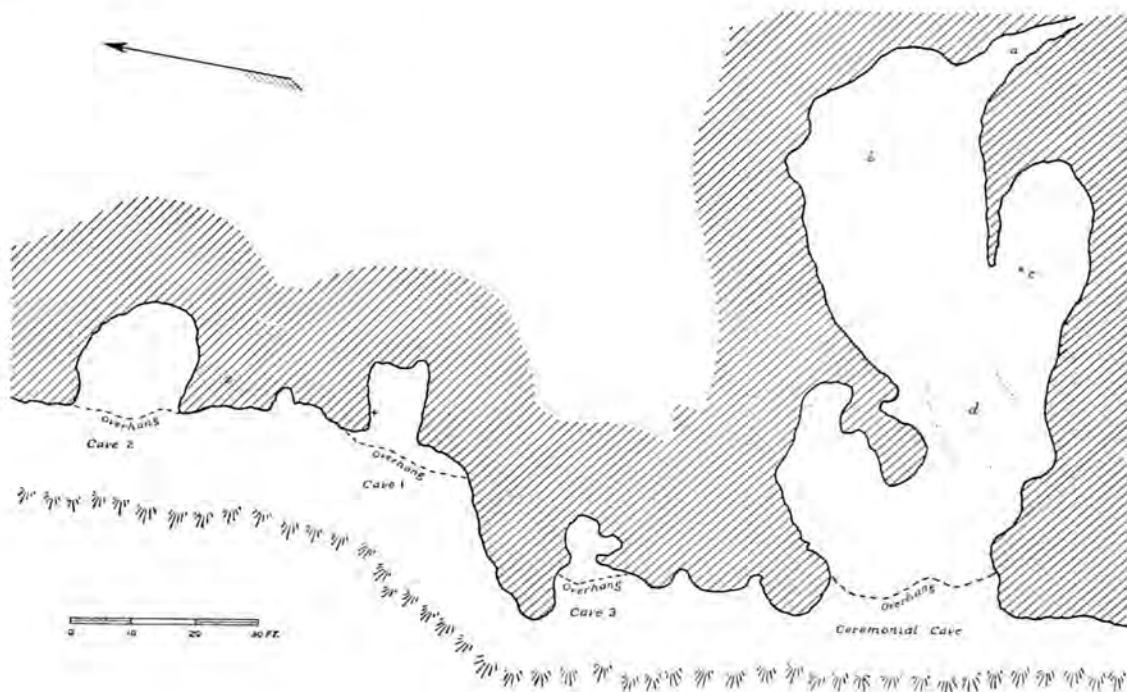
1 mile to the southeast. It is really 2 caves connected by an unsheltered ledge 37 feet long. The southern grotto is 23 feet wide and 33 feet deep to the end of Tunnel 1; the northern part is an open shelter under an overhang 60 feet long, with Tunnel 2, 36 feet deep, at the south side. Throughout the cave are pockets and shallow drifts, in which no refuse was found. On the inner north and back walls of the northern open shelter are numbers of red pictographs of birds, snakes, human figures, and geometric designs (page 84). The drawings of snakes are interesting as four of them are good examples of the plumed serpent, one finely decorated with geometric patterns. The cave had previously been dug.

The material from this site, as in many

others, points to visits of both Basket-maker and Pueblo people.

CEREMONIAL CAVE (fig. 1). Ceremonial Cave is situated at the top of the talus near the mouth of a short rough canyon, 1 mile east of the base camp, facing west. The entrance is 27 feet wide, 15 feet high; depth from overhang of line, 90 feet; maximum width, 41½ feet (fig. 2).

the roof. The only definite stratum found was a layer of packed grass directly above the barren cave floor. The grass layer which had been burned in places, extended over the middle third of the cave floor, and above it grass, dirt, and loose trash became progressively deeper and more compact toward the back, where rats had nested and had literally cemented the surface together with their droppings. Scattered throughout the



Courtesy of the Peabody Museum of American Archaeology and Ethnology, Harvard University

Fig. 2. Plan of Ceremonial Cave and Caves 1-3, Hueco Mountains. For details on the archeological findings consult the volume from which this article has been extracted.

The roof of this cave, as in nearly all in this district, was smooth, showing no recent falls of heavy stone. Below the refuse and lying on a yellow sandy fill were blocks of a friable, crystalline formation that had sloughed from the roof long ago. Only 1 cave out of the many explored had this encrustation still adhering to the ceiling.

The fill of the cave rose gradually and at the back was 8 to 10 feet higher than at the entrance, where previous digging had uncovered so many artifacts. At the rear, because of the great quantity of cactus thorns brought in by rats, this disturbance was not so great. Our excavations varied from 1 to 5 feet in depth, reaching to points below blocks fallen from

fill, and particularly in the deeper parts, were fragmentary and worn fiber sandals to the surprising number of 935. On the surface, and slightly below it, 1 party had previously gathered 100 sandals, and other people had also made collections; so it can safely be stated that a slow accumulation of no less than 1200 to 1300 sandals had been deposited in the cave.

Ceremonial Cave was well named. The entire absence of artifacts for domestic use, of well-established fire hearths or pits, and of any accumulation of food bones was convincing evidence that it had not been a dwelling place. Grass bedding that had been carried in by transient visitors and carelessly fired left a stratum of ash over parts of the cave, but this resi-



CEREMONIAL CAVE was not used as a dwelling place.

due was easily recognized as not being from wood fires used for warmth or cooking. The many articles belonging to the burial of a woman wrapped in a fur-cloth blanket prove the former presence of the Basket-makers. Signs of later visitors, at least up to the end of Pueblo III times, are shown by the Pueblo reed arrows and an El Paso Polychrome sherd. Miniature grooved throwing sticks, darts wrapped and decorated to be converted into pahos, tablitas, and reed cigarettes are a few of the ceremonial objects which indicate that throughout many centuries the place continued to be a shrine of importance. The great accumulation of sandals in association with so many offerings suggests that it was the practice of the people to leave in the cave the footgear worn out in their pilgrimage thither.

North of Ceremonial Cave, and accessible from a ledge at the same level, are the small Caves 1, 2, and 3, all having western exposures (figs. 1, 2).

CAVE 1. This cave is 12 feet deep with a rectangular entrance 6 feet high and 8 feet wide. The floor was nearly level and was covered with about 2 feet of dust and blowsand which contained leaves but no grass bedding. In the gen-

eral fill and from a rat's nest in a pocket at the back, a number of articles were recovered. Near the front of the cave, against the north wall, were the body of an adult male and that of a very young infant wrapped in fur-cloth blankets and accompanied with baskets.

CAVE 2. This is an irregular, low opening 16 feet wide, 6 feet high, and 14 feet deep. The fill consisted of 2 to 3 feet of clean dust and blow-sand, without masses of bedding to indicate occupation; yet apparently the cave had been used at times for shelter. A few specimens were found in the cave fill.

CAVE 3. Cave 3 is a small pocket 7 feet deep. It contained some rubbish which yielded a single worn Type 3a sandal.

Caves 4-7, all with southern exposure, lie along the same ledge, 20-25 feet above a steeply sloping talus. From the expedition camp they could be seen $\frac{1}{4}$ of a mile east, in the limestone cliff, 200 feet above the surrounding country.

CAVE 4. This cave has a rectangular entrance 13 feet wide, 8 to 10 feet high, and 24 feet deep. The roof is horizontal and the floor almost level. It would have made an ideal shelter, yet nothing was found in the clean dust and sand fill lying 1 to 2 feet deep on the floor.

CAVE 5. To the east of Cave 4 is Cave 5, which has an oblong rectangular entrance 20 feet wide and 7 to 8 feet high. Originally it had been 51 feet deep, with a fairly horizontal ceiling; but the back half of the ceiling had fallen, depositing a slide of rock on the middle third of the level entrance and leaving at the back an irregular bench, measuring 20 by 32 feet. Above this fall the maximum ceiling height was 10 feet.

CAVE 1 and burial, Huceo Mountains.



CLOSE-UP VIEW of burial in Cave 1.



CAVE 6. East of Cave 5 is an arched opening 11 feet wide and 8 feet high, which quickly narrows to a horizontal drift or tunnel, averaging 6 to 7 feet in diameter and pinching out to terminate in a crevice 41 feet from the entrance. The floor of the tunnel was level and covered with a shallow deposit of sand, dust, and thin spalls from the roof.

CAVE 7. Cave 7 lies east of Cave 6. It has a triangular entrance 15 feet wide by 7 feet high, opening into an irregularly outlined circular chamber 26 to 27 feet in diameter. The domed roof is 19 to 20 feet above the basin-shaped floor. The fill, 1½ to 2 feet of dry dust, sand, and some stone, had been dug over by others. Leading from this chamber toward the northwest was a tunnel 32 feet long ending in a small circular pocket. The tunnel, 5 feet high, was half filled with dirt upon which was trash brought in by rats. No artifacts were found in this deposit.

CAVES 8 and 8A. These are situated across the mountain, 1 mile southeast of the base camp, at the head of a wide bay in the south side of the western cluster of the Hueco Mountains (fig. 1). Both are 450 feet above the surrounding plains and have an unobstructed view to the south. An old Indian trail passes across from this locality to Picture Cave, previously described.

CAVE 8A. This is a conglomerate rimrock, measures 12 feet wide and 19 feet deep with an opening 6 feet high. A boulder at the front partially screens the southern entrance. The floor is level. The specimens which were found in the small amount of refuse, which contained grass bedding, indicate that this was a Pueblo site.

CAVE 8. On the opposite side of the canyon from Cave 8a. is a cleft in the conglomerate, formed by water tunneling through from the bench above. It faces south and is high above the bed of the canyon and is reached by climbing over a rock slide from a broken white stratum below the conglomerate cap. The site had been disturbed by others, but among the rocks on the trough-like sloping floor some specimens were found. The almost inaccessible location of the site prevented its use as a habitation. From the objects found, and the slightly outlook, it appears to have been a shrine of importance in

Pueblo times and possibly for later nomadic Indians.

CAVES 9 and 10. These are both in Texas, 18¼ miles southeast of Newman, New Mexico, and 3¼ miles south of the New Mexico line. Like the shelters in the vicinity of Ceremonial Cave, 7½ miles to the southwest, which are in outlying groups of the Hueco Mountains, these caves are situated in a short western canyon emerging from the more compact main ridge (fig. 1).

CAVE 9. Cave 9, facing southeast, is at the top of the talus, in the north wall of the canyon, 100 feet above its sandy bed, which in places shows moisture. It is a rough cleft in the rock 35 feet deep, with a dangerous roof and, in the sloping floor, a series of benches or level spaces left when the cliff-side slipped and settled.

Apparently a party of hunters from west of the Rio Grande who had wandered out of their territory was besieged in this cave. This is suggested by the discovery at the front of the cave of 48 arrow foreshafts, 44 of them badly broken and splintered by striking the rocks.

CAVE 10. Near the mouth of a short canyon, southeast of Cave 9. It is 55 feet deep, with a finely arched opening 30 feet wide and 14 feet high. The exposure is to the west. The sandstone floor is somewhat moist, so that most of the perishable objects in a shallow fill of dusty sand and leaves were decayed. This was the only one among the number of caves examined in the district in which a sandstone stratum was encountered below the limestone cap. The site, although an ideal shelter, gave evidence of only temporary occupation by the Pueblo.

FOUR of the 41 Hueco Mountain Caves. These are Caves 4 to 7, and are located 200 feet above the surrounding country.





Courtesy of the Peabody Museum of American Archaeology and Ethnology, Harvard University

PICTOGRAPHS from Picture Cave, Hueco Mountains. For color scheme and other details consult the volume from which the notes on the preceding pages were taken.

Picture-Writing of Texas Indians

By A. T. JACKSON

This is the author's own summary of the magnificent, 490-page bulletin of the same title published by the Department of Anthropology, University of Texas, in 1938, but now out of print. As editor J. E. Pearce explains, "Mr. Jackson has done in this bulletin a careful, accurate and thoroughly dependable piece of fieldwork, which, because of the rapid disappearance of the pictographs under present conditions, was badly in need of being done."*

IN COMMON with other American Indians, and primitive people in general, the Texas aborigines possessed a crude system of picture-writing. The overpowering culture of the European conquerors arrived before the Indians anywhere in the Americas had developed a genuine alphabetic system of writing. At most, as in Mexico and Middle America, it had reached only the ideographic (pictographic) or rebus stage.

There are brief historical references indicating that picture-writing, in one form or another, was practiced rather widely by Texas Indians. All of it in many sections has disappeared, due to having been painted or carved on materials of a perishable nature. In a few cases there remain specimens of paintings on skins and bones; also paintings and carvings on small stones.

Of the 195 pictograph and petroglyph sites reported, 129, or 66 per cent, are in rockshelters. Many of these are locally referred to as caves. Thirteen of the sites, seven per cent, are real caves. Most of these caves are west of the Pecos River. Thirty-two sites, representing sixteen per cent, are on cliff walls. The remaining 21 sites, or eleven per cent, are on exposed rocks in the open—the designs being pecked or carved.

The picture-writings divide themselves into two general classes, paintings and carvings. The

former are known as pictographs, the latter as petroglyphs. The term petrography sometimes is used to include both classes.

Pictographs were painted in a variety of colors. Those most prevalent in Texas are red, black, yellow and white, in the order named. Other colors rarely are met with, and then only in restricted localities. The red paintings appear in various shades. Most of the paint has a mineral source.

Petroglyphs were pecked with a hammer-stone or cut with a sharp stone implement. The technique employed must have depended in large measure on the kind of stone on which the pictures were being executed. Pecking more often was used on hard stones; while carving was employed on less resistant ones, such as sandstone and soft limestone. There are, however, a number of exceptions; and some evidence suggests that the peckings and carvings may have been made by different tribes and at different periods.

The pictographs and some of the petroglyphs are located on the walls and roofs of rockshelters, slightly overhanging canyon bluffs and the walls of real caves. Ninety per cent of the paintings are on the walls, with the remaining ten per cent on the roofs.

The sizes of pictures vary greatly. Certain human figures do not exceed three inches in height; while at the other extreme is one ten feet tall. Animals range in length from two inches to seven feet; insects, from one inch to seven feet.

There is a diversity of design elements. Often one is highly prevalent in a given locality. Others are general in their distribution.

The ages of the pictures constitute an important problem that is at present far from a satisfactory solution. There are, however, a few clues that shed some light on the question. Among these are the superimposition of pictures, the gradual covering of certain old designs by the accumulation of camp refuse, the association in a few sites with datable potsherds and the presence of pictures showing European contact.

* The University of Texas Publication No. 3809. Bureau of Research in the Social Sciences, Study No. 27. Anthropological Papers, J. E. Pearce, Editor, Volume II. Austin, Texas, March 1, 1938.

The 110 sites that have been studied in detail may be divided into the following rough chronological groups:

Age Groups of Pictures		
Period	No. Sites	P.C.
Entirely prehistoric -----	86	78
Prehistoric and historic ---	22	20
Entirely historic -----	2	2
	110	100

It is, of course, possible that some of the sites listed as prehistoric may have some pictures made in historic times. But, if so, the historic pictures are not identifiable as such. On the other hand, there is a possibility that a few of the so-called conventionalized horses and mission buildings were erroneously classed. Barring such possibilities, it is thought that the above percentages are accurate.

The outstanding point of interest in this connection is that 22 per cent of the sites studied show at least some evidence of European contacts; but only two were entirely historic.

Difficult to Interpret

The meanings of a few of the pictures are self-evident; some are suggested in the paintings and carvings; but many will never be known. No interpretation can be accepted finally as scientifically accurate that has not been verified by comparison with the habits, customs and symbolism of the historic Indians of the region.

Since the Texas Indians were driven out of the state more than fifty years ago, and before any scientific interest in ethnology had appeared in Texas, or elsewhere for that matter, the opportunity for such comparative study is gone.

The pictures were made for various purposes. Many, no doubt, had a ceremonial or religious significance. Among such may have been dancing scenes, masked figures, sun and rain symbols, etc. Again, there may have been some designs and symbols involving adolescence ceremonies. Some of the animal and other figures probably were clan totems or signatures of migratory bands, giving brief accounts of clan movements. Other pictures may have been for the purpose of recording personal exploits of bravery in battle or prowess in the chase. It is possible that some animal pictures may have been drawn to

serve as charms, or in the practice of sympathetic or imitative magic, to assure success in the chase.

The study and preservation of the picture-writings are well worth while. They represent in a measure a cross-section of Indian life, and are the first attempts at art in Texas. They reflect the customs, beliefs, superstitions, longings and accomplishments of a primitive early race. Since all races once were primitive, they are an integral part of the general history of civilization. Their very crudity makes them interesting; and their existence throws light on the processes of primitive mentality. By general consensus of scientific opinion, they are held now to be the earliest crude forms of writing, as well as the first forms of painting and sculpture.

A careful study of Texas picture-writing has exploded several popular fallacies. Chief among these is that all were meaningless scrawls, made to while away idle hours. At the other extreme is the fallacy that the prehistoric Texas Indians were on the verge of an alphabetical system of writing; and that a key, such as the Rosetta Stone, might some day be discovered. All picture-writings were not idle scrawls. But there is no "key" by which all may be deciphered.

The conclusions may be summarized as follows:

The oldest pictures probably were made by the first occupants of the regions. The practice of making them persisted well into historic times.

There is some evidence that the oldest petroglyphs in the Trans-Pecos region may be of greater age than the first pictographs. Many of the carved petroglyphs farther east are much more recent than the pecked designs.

Not of Great Age

The ages of the oldest pictographs may not go back further than 1,500 years. Most of them appear to be much more recent. Perhaps the majority are not older than 500 years, with some not more than 100 years.

Certain "styles" of pictures are found in various restricted areas. In the El Paso region are many masked human heads, and mountain sheep. In the Big Bend are pictures showing men armed with crude types of stone implements and clubs. In the lower Pecos section are extra large paintings of human, animal and in-

sect figures, which appear to be among the oldest pictographs in the state.

Farther east are small black paintings of human and animal figures. They do not seem to be so old. In the Texas Panhandle are some unusual square-shouldered human figures, a large plumed serpent, etc.

Among elements common to all the regions are rayed sun discs and various geometric elements. Snake-like elements have a general similarity in a wide occurrence.

Rainfall, seepage, exposure, wind action and the kind of stone have much to do with the preservation of pictographs. Vandalism also ruins many pictures. Unless the present destruction by vandalism is checked, another twenty years will see most of the now decipherable pictures covered with scratched and painted names and dates.

Man-Made Cave of Mystery

Carey Lake Cave, sometimes called Slave Cave, is located about two miles northeast of Todd City, one-half mile east of the Neches River and some ten miles west of Jacksonville in Cherokee County, Texas. This is a man-made cave, with the entrance in the side of a bluff facing the nearby lake to the north.

The cave, said to consist of thirty-two connected rooms, runs beneath a graded country road. No one was found who claims to have entered all the rooms. One explorer, who entered the cave in 1907, reports having gone into sixteen of them.

B. W. Acker, a pupil in the Jacksonville High School, reports that on October 18, 1947, he and his father visited the cave and "went into three rooms and stopped because without a flashlight it was dangerous . . . A lamp or torch will not burn . . . There is a wind blowing through the cave."

Most of the rooms are approximately ten by twelve feet, with a roof five to seven feet high. The rooms are neither round nor square. The walls are approximately squared, but the corners are rounded. The "doors" or entranceways between the rooms are in the nature of tunnels, about three feet in diameter. There is said to be a basin-like cavity, some sixteen inches in diameter, hewed out of the center of the roof in several rooms. Its significance is not known.



A. T. Jackson

IN NORTHEAST TEXAS, halfway between Waco and Shreveport, and not far from U. S. Highway 79, is this strange man-made cave. Said to contain 32 rooms, it was laboriously excavated in hard-packed sandstone.

One report says that water runs through some of the rooms; and that they apparently were dug to different depths, with the floors at varying levels. The depth of the water thus varies in the different rooms.

Other history students of Miss Lois Boles of the Jacksonville High School report on the early-day findings in the cave:

"About fifty years ago there were evidences in some rooms of meat having been packed for storage. Other storage rooms had firewood in them. Two rooms contained piles of hides. There was a spring in another room."

There is a story to the effect that the cave was dug by slave labor, and occupied by refugees from the State of Louisiana from about 1862 to 1864. This story seems to tie in with the accounts of early discoveries in the cave, as mentioned above.

Naturally, there also are a number of legendary stories interwoven with the hazy history of this unusual man-made cave. One is that the Indians dug the cave long before the Civil War. It even is declared that one room contained "horns, tomahawks, bows and arrows and pottery of different kinds."

And, of course, the list would not be complete without a Jean Lafitte legend, telling about this noted pirate having buried valuable treasure in the cave. In the sixteenth room, it is declared, was a chest six by three by two feet. It "was of beautiful shining coins, and all kinds of money. . . . People have tried to find the room since, but get lost on account of the branching rooms leading off in different directions."

If one had the time to do exhaustive research, and winnow fact from fancy, a highly interesting story regarding the digging and occupancy of this cave might be developed.

Other "Civil War Caves"

In addition to the Carey Lake Cave, in Cherokee County, already discussed in detail, there are reports of similar man-made caves in various parts of eastern Texas.

Some years ago William Ford in Jefferson reported that he knew of two caves on the Hagerty place, between Jefferson and Linden, about seven miles north of Jefferson, Cass County—very near the Marion County line.

Another cave is reported on the Jack Jones farm, three miles west of Bivins, on the Linden road near Kaufman place, also in Cass County.

Located about five miles northeast of Cushing, in the southern edge of Rusk County, is said to be a cave in a hillside, entering from a deep ravine, by what appears to be a man-made ditch or tunnel. The cave is declared to be badly caved in.

In 1932 Reverend Chambers, a Baptist preacher, ran a ferry on the Sabine River, twelve or fourteen miles northeast of Patroon in Shelby County. At that time he stated that he knew of a nearby cave, apparently dug by man, that contained several rooms.

—A. T. JACKSON

Unique Animals

(continued from page 21)

rumbling had become a roar and suddenly there burst around the corner a moving wall—of bats.

In a moment they were upon me. The air was thick with them. Waving my arms wildly, I knocked a dozen into the water. Hundreds dodged past me, rumbling on toward the entrance. Afterward it seemed incredible that the faint rustle of their wings should have echoed and re-echoed so loudly.

Reaching for the downed bats I discovered that they moved faster than I could, swimming quickly to the walls, climbing up a short distance, then launching themselves into the air. Some even took off from the water's surface. It was only after going outside, cutting leafy branches and waving them vigorously just inside the entrance that we knocked down and captured the specimens which we needed.

They proved to be little brown bats, *Myotis velifer incautus*, and not the free-tailed bats which populate many of the biggest southwestern caves in such tremendous numbers.

Deciding to tempt the fates no further we left the exploration of the rest of the underground river for another day.

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Texas Bat Caves Served in Three Wars

By CHARLES E. MOHR



Courtesy of Atlantic

THE RECENT DISCLOSURE that bats from Texas and other Southwestern caves were used in a fantastic war project, to carry incendiary bombs,¹ recalls the importance of these caves in two earlier wars: World War I and the War between the States.

"The most effective weapon ever dropped from an airplane," one army officer said of the bat warfare project. LIFE described it as "one of the most extraordinary military operations ever conceived."

The inventor of the fantastic but fascinating plan was Dr. Lytle S. Adams, a surgeon from Irwin, Pennsylvania. In a recent interview Dr. Adams told me many previously undisclosed details of what was long a closely guarded secret. Here is how it started:

"On Sunday afternoon, December 7, 1941," stated Dr. Adams, "I was driving near Washington when the news of the Japanese attack on Pearl Harbor came over my radio. How could we fight back, I wondered. What offensive weapons did we have?"

"I had just been to Carlsbad Caverns, New Mexico, and had been tremendously impressed by the bat flight. Now the thought flashed through my mind—couldn't those millions of bats be fitted with incendiary bombs and dropped from planes? What could be more devastating than such a fire-bomb attack? If dropped over Japanese industrial centers, fleet concentrations, ammunition dumps or underground or other storage depots, the bats would seek shelter in inaccessible cracks and crevices above and below the surface of the ground and set off without warning a multitude of explosions and fires."

Wanting facts to bolster his idea, Dr. Adams left next day for Carlsbad to capture some bats and test them. Within a few weeks he was back in Washington with a container of them and some startling facts. Having literally ransacked the Library of Congress and museum libraries for information on bats and bat caves, he prepared an outline of his proposed bat warfare project and on January 12 sent it to the White House.

The idea appealed not only to President Roosevelt and his advisors, but to high military authorities as well. The project was immediately authorized, with Dr. Adams in complete command. A small

group of field naturalists, chiefly from the Hancock Foundation, University of Southern California, was chosen to make the search for the country's greatest bat concentrations. One of the youngest was NSS member Jack C. Couffer, then only eighteen.

"We visited a thousand caves and three thousand mines. Speed was so imperative," explained Dr. Adams, "that we generally drove all day and night when we weren't exploring caves. We slept in the cars, taking turns at driving. One car in our search team covered 350,000 miles."

The rigors of almost continuous high speed travel were as nothing compared to the exertion



Photos by Jack C. Couffer

NEY CAVE entrance (above). Boxes stacked in front of the entrance were used to transport bats to a refrigerated storage room.

SCREENED ENCLOSURE (right) at Ney Cave during construction, in October 1943.



and hazards of the underground surveys. Untrained in safety techniques now in general use by the NSS for all dangerous descent, the project members, including the middle-aged project leader himself, really took their lives in their hands.

In the Devil's Sinkhole they descended 200 feet on the rickety ladders which a few years later Pat White found crumbled and out of place [See picture page 9]. This descent and every other one was made *without a safety rope*. My hair figuratively stood on end as Dr. Adams told me how they descended 900 feet in an old

mine at Quartzite, Arizona. Since their knotted rope wasn't that long, they dropped it from level to level with a lighter line as they descended.

"We found bats in the deepest section, and watched them fly straight up the shaft, 900 feet to the surface," said Dr. Adams.

The deepest cave, and his choice for the most interesting, is the Devil's Sinkhole. Next to that in depth is Rose Cave, which apparently hadn't been explored before.

"We gathered up hundreds of feet of barbed wire fence, and with short sections of brush for



Jack C. Couffer

BRACKEN BAT CAVE, screened to permit capture of bats as they try to leave the cave.



Airforce Photographic Department

THOUSANDS OF BATS alight on the screens of Ney Cave as the evening flight gets underway.

rungs, improvised a ladder and reached the bottom. I want to go back and explore that one fully."

Maximum Bomb Load

While the bat caves were being surveyed, scientists from California Institute of Technology, University of California at Los Angeles, Southern California, Harvard, and Massachusetts Institute of Technology were working on other phases of the project. It was determined, for instance, that a bat could carry a bomb three times its own weight. The biggest bat found in the United States or northern Mexico is the mastiff bat, *Eumops*. With its wingspread of 20 inches it carried a one-pound stick of dynamite. While the survey proves that mastiff bats existed in much greater numbers than naturalists had suspected, they didn't prove sufficiently abundant for the project.

The more common mule-eared or pallid bat, *Antrozous*, could carry three ounces but wasn't hardy enough for the rigors of bomb-carrying. After dozens of species were tried, the free-tailed or guano bat was selected. Although it averaged only one-third of an ounce in weight, this bat easily navigated with a one-ounce bomb load.

Bats of this species were captured in Carlsbad by Dr. Adams and carried to Washington. Released in the War Department Building, they flew agilely around the room, easily carrying a dummy bomb apiece. They were returned to their cages, and on a trip to western Pennsylvania, survived temperatures of ten degrees below zero.

"They were frozen solid," Dr. Adams declared. "Yet when I reached New Mexico, I opened the cages and the bats flew out, apparently no worse for their experience. I am satisfied that they are hardy enough to ship all over the world in cold storage. We built an artificial cave, a huge refrigerator, and kept hundreds of thousands of the bats in it, at 40 degrees temperature. If allowed to remain long at normal temperature, the bats would speedily oxidize all their food reserves and would have to be fed or they would starve to death."

After considerable experimentation, special bomb-like containers were designed. They held trays or fillers resembling those used in egg crates and carried 1,000 to 5,000 bats. They were



Photos by Naval Photographic Service

DORMANT BATS with bombs attached being placed in "egg-crate" bomb trays by Dr. L. S. Adams, director of the bat warfare project. An ingenious system of safety pegs prevented premature ignition of the incendiaries before release.

BAT-BOMB CONTAINERS (below), dropped by parachute, contained barometric device which released the bats at a predetermined altitude.





Naval Photographic Service

BAT WITH BOMB attached. The one-ounce incendiary weighed three times as much as the bat, burned for eight minutes.

dropped with a parachute to give the bats time to be warmed and awakened by the air as they fell. A simple mechanism opened the container at an altitude of 1,000 feet to allow the bats to fly away to secluded places of their own choice.

The containers were brought into the refrigerator room for packing. The bombs were attached to the dormant bats and each placed in its own little cell where a safety device provided against accidental detonation.

The one-ounce time bomb was slightly larger than the body of the bat and was attached to the loose skin over its chest by a surgical clip and a short length of string. After flying to some hiding place, the bat generally chewed off the

string, then continued its exploration. When the bomb finally exploded it produced a 22-inch flame which burned for eight minutes.

Fortunately for the development of the project, free-tailed bats proved to be incredibly abundant. The year-long survey of bat caves established the fact that four of the biggest bat colonies in the United States are located in Texas. Two of them far surpass Carlsbad Caverns' huge population, calculated in June, 1936; to number 8,700,000.

Greatest Bat Cave in U. S.

"Ney Cave, near Bandera, is our greatest bat cave," declared Dr. Adams. "We have estimated that the colony there numbers between 20 and 30 million. Bracken Cave is a close second, well ahead of Carlsbad. Frio Cave and the Devil's Sinkhole both have many millions. We calculate that in our survey we saw well over 100,000,000 bats."

The U. S. Navy leased these four Texas caves and assigned Marines from Corpus Christi to guard them. In October 1943, Dr. Adams had screened enclosures erected at the entrances of Ney and Bracken so that the bats could be trapped as they attempted to emerge. The enclosures were prefabricated at Hondo Army Air Field and trucked to the cave entrances. These big sections of screens at Ney and seven at the larger Bracken Cave enclosure could be opened, affording the bats unobstructed exit or entrance. With such an arrangement the bat collectors could close the screens and collect a million bats in one night if necessary.

In preliminary tests a dummy village built in the desert was burned to the ground. An even more convincing demonstration of the effectiveness of the "incendiary bats" came when a couple of bomb-equipped bats escaped from a careless handler and set fires that consumed most of an auxiliary air base at Carlsbad, N. M.

Named "Project X-Ray"

This accident may have dampened the Army's enthusiasm. At any rate, the Navy took over the operation in August 1943, designating it "Project X-ray." Navy BuAir continued the experiments until October 1944 when the project which is estimated to have cost \$2,000,000 was abruptly abandoned. "Perhaps," as LIFE suggested, "by that time the top government

officials had reason to believe that another and even more deadly weapon would soon be ready."

Dr. Adams believes that the widespread fires which could have been set by the bat-transported incendiaries would have been more destructive than the atomic bomb.

"We found that bats scattered as much as 20 miles from the point where the bomb opened. Think of thousands of fires breaking out simultaneously over a circle of 40 miles in diameter, for every bomb dropped. Japan could have been devastated, yet with small loss of life."

Some of the bats were used for scientific experiments which aided the war effort in other ways. Studies of bat flight contributed to our knowledge of aerodynamics, while experiments on bats' navigation by "echo-location" aided considerably in so rapidly bringing radar to its high state of development.

Important in Civil War

Eighty years earlier bats played an important role in the production of gunpowder. In 1863, when the Confederate ports were effectively blockaded by the Union fleet, a powder factory was established a few miles below San Antonio, and saltpeter was made from bat guano. While many caves in the southeastern states had been mined for nitre-bearing earths during the War of 1812, it was not until a few years before the Civil War that caves in Texas were worked. According to Dr. William B. Phillips,² writing in 1901:

As early as 1856, perhaps even earlier, it was noticed that the brown deposit in some of the caves would burn, and during the Civil War saltpeter was made from the materials by leaching and subsequent evaporation. A part of the niter thus made was used in the manufacture of gunpowder, and the bats contributed their share toward the strife that raged from the Potomac to the Rio Grande. Even these harmless, timid creatures were brought into service in those dreadful days, for men were busy in searching for material wherewith to kill other men.

Writing in *The Texas Almanac* in 1872, A. R. Roessler³ estimated that he had examined about a dozen caves which had guano deposits in sufficient amount "to warrant the manufacture of saltpeter at their respective sites" and pointed out that, "During the last war, nitre works were in operation two miles south of



Naval Photographic Service

IN TEST DROP over the desert a container holding about 1000 bats is released from plane and floats slowly earthward.



Naval Photographic Service

FLAMES consume buildings at an auxiliary airport after a bomb-equipped bat escaped and tried to hide under the roof.

the mouth of Fall Creek, Burnet County, near one of the largest caves." This was Beaver Creek Cave, whose entrance was described as a vertical shaft which "was entered to the depth of 45 feet." Unlimited supplies of guano were found in numerous caves within 30 to 60 miles of San Antonio, to the north and west. Along streams or at water holes near the caves great hoppers of wood or stone were built. Dr. Charles A. R. Campbell⁴ described the process:

The guano was brought in wagon loads or in sacks to the hopper, in which it was put in layers alternating with wood ashes, the said layers being separated by strata of broom weeds. As the water which was then poured into it gradually filtered through it into a series of large, open, cast-iron boilers, which were fired; and when the liquid was reduced to the proper specific gravity, it was conducted into large shallow pans, where saltpeter crystallized by evaporation, and was sacked and shipped by ox-team to the factory, miles away.

The workers used oxen and burros to haul the guano, making narrow trails in the mountains for the burros when cart trails could not be built. "The favorite cave with these workers," wrote Campbell, "was the Verdi Cave, having a mouth large enough to permit a four-yoke team of oxen to be driven inside and the wagon loaded and turned around, with plenty of room to spare. Many were the vicissitudes endured; and an open eye for marauders and redskins was an essential precaution." Verdi Cave is known today as Frio Cave.

Although few of the Texas caves are believed to have approached the Carlsbad Cavern in the amount of guano removed, the volume excavated in certain caves was considerable. Phillips² found that:

The weight of a cubic foot of air-dried material [guano] varied from 40 to 45 pounds, and that it would be safe to take 40 cubic feet as equivalent to 1 ton of 2000 pounds. How great the accumulation has been in some of the caves may be known from the fact that 1000 tons, or 40,000 cubic feet have been taken from one cave . . .

The guano deposits were worked almost exclusively in the late fall and winter months when the bats left the more exposed portions of the caves. The nature of the guano deposits

BATS BY THE ACRE cover ceiling and walls of Texas bat caves. Adult free-tailed bats (above) hang quietly until late afternoon, then swarm from the cave.

WEEK-OLD naked bats (below), cling to ceiling. Females leave them to fly outside at night; return and nurse them. Bats fly at the age of three to four weeks.

Photos by E. P. Haddon, Courtesy Texas Game, Fish and Oyster Commission.

and the behavior of the bats was vividly described by Phillips, as follows:

In texture the guano varies from a softish mass, into which one sinks readily and disgustingly, to a brown dry material that can hardly be compressed into a ball in the hand. Now and then it appears somewhat moldy, and this may be due to its being very old. In the caves I have visited, containing possibly as much as 1,200 tons in all, the material was quite dry until I approached nearer and nearer the recent deposits. Then it became soft and I mired in it above the knees. As I was quite alone, and as the light decided to go out just then, I followed its example.

During the winter the bats remain in the caves, going as far back as possible and hibernating there. When they are disturbed they begin to twitter, a few fly by, as if on watch, and then the mass begins to stir. At first there is a muffled sound coming out of the profound blackness, but this soon gives way to a roar of many waters, and presently innumerable soft wings and velvety forms brush past, the advance guard. The roar increases, the foul air sweeps by in waves of fetidness, and the main body is on the wing. By the dimmed light one may see shadowy forms hurrying past, thousands and thousands, until the vast caverns seem to throb with the motion . . . If the weather is somewhat chilly, the bats do not leave the cave, but circle around and around until one becomes dizzy in watching the interminable circlings. In the spring and summer, the bats leave the cave in the late afternoon and return early next morning. From one orifice, which is 12 feet in diameter, they have been observed to emerge for three hours, rising 100 feet into the air as a great circling column of black smoke before they begin to separate. They pour out from the opening as smoke from a chimney, and are as the sands by the seashore for multitude.

The bat caves, according to Phillips, are distributed "along a line stretching in a southwest direction from Lampasas County to Uvalde and Edwards Counties, a distance of some 250 miles." The guano deposits were not always used, because some caves were in inaccessible places. In others, colossal boulders and steep



slopes made operating costs prohibitive. In still others with large exposed entrances or holes in the roof, rainwater leached out the valuable nitrogen. Some deposits were ruined by fire. An instance of such destruction in Comanche Creek Cave (Blow-out Cave), "half a mile north of the Fredericksburg road, Blanco County," is described by Roessler³:

No work was done in it, owing to an accident which happened in 1856 to someone while bear-hunting. He set the entrance on fire, in order to smoke out a bear which had taken refuge there; a tremendous explosion followed, and the cave was burning for two years. I did not ascertain what became of the bear or the hunter.

The great piles of ashes resulting from the burning of the bat guano were described by Phillips who declared that "these ashes have been used locally as a fertilizer, as they carry phosphate of lime and potash." While most of the fires probably were set, Campbell claims that fires of spontaneous origin were of common occurrence:

There is no cave inhabited by bats, whether worked for commercial purposes or not, that in some remote time had not been on fire, as evidenced by the entire floor being covered by compacted ashes, sometimes fifteen feet thick. This occurs only in caves that are not worked, in which the guano is allowed to accumulate, and into which rain finds its way. The fires are brought about by chemical combustion from the heat generated by the decomposing guano, which is eventually largely converted into nitrates and nitrites, or saltpeter.

Fire in a cave produces what the ranchmen call "smoke holes" and if witnessed at night must be truly an awesome spectacle. Campbell described one such scene whose location on the side of a mountain, in "stillness and solitude, with the tips of a few trees silhouetted, give it the weird appearance of a cyclopean eye."

During World War I, bat guano was especially in demand as fertilizer. As a patriotic action Campbell organized the "Texas Bat-Cave Owners' Association," with a view to "introducing this Nature's fertilizer into general use."

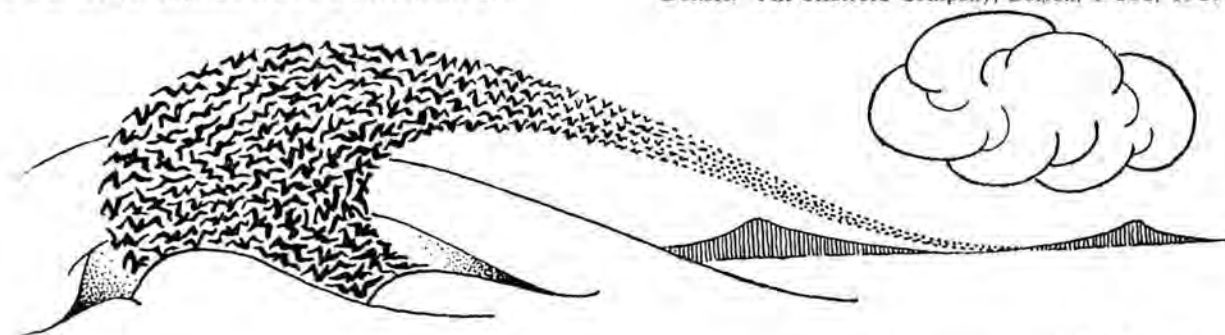
At that time, the officials of the Southern Pacific Railroad Company estimated that the bat guano handled annually over their road out of Texas amounted to 50 carloads of 30,000 pounds per car. From the territory northwest of San Antonio, other roads carried about 15 carloads, making a total of 65 carloads of this valuable fertilizer produced in West and Northwest Texas annually.

Some caves which once supported great bat colonies were later deserted by the guano producers. Campbell mentioned one such cave on the bluffs overlooking the Rio Grande in Brewster County, Texas (and pictured it, facing page 36), from which 400 tons of guano were removed. He attributed the absence of the bats to decreasing rainfall and a resulting scarcity of insects upon which the bats must feed.

And what of the future? Certainly many of these large caves, which already have served in some degree in three wars, would again be utilized if this country should become involved in another war. Their value to the national defense has already been assessed. We all fervently hope, however, that they will never again be needed for wartime uses.

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Falcons Prey on Ney Cave Bats

By KENNETH E. STAGER

ONE OF THE MOST interesting bat caves in the United States is located on the Gerdes ranch among the low, forest-covered hills of the Balcones Escarpment in Medina County, southcentral Texas. The guano deposited by the cave's huge population of Mexican free-tailed bats, *Tadarida mexicana*, has been a source of revenue for the Ney family, of D'Hanis, for many generations. It is from this family that the cave derives its name. It was a desire to see the bat colony that brought me to the cave.

Through the kindness of jovial Ben Gerdes, owner of the ranch, my companion and I pitched camp near the cave on August 5, 1938. We lost no time in beginning our observations.

Bats Blanket the Ceiling

The bat colony is so extensive that every inch of ceiling space is covered with a living, squirming mass of bats. This condition existed to the very tip of the cavern mouth and is discernible as far down into the cavern as the beams of light could penetrate. From the cave mouth the floor drops away at a 45° angle for about 200 feet. The large accumulation of soft, fresh guano makes one's footing uncertain, since beneath it are numerous large, irregular limestone blocks. One sinks into the guano a foot or more with each step.

At the bottom of the large ante-chamber the cavern narrows to a tunnel about five feet in diameter. My companion and I attempted to enter the tunnel. Almost immediately we found our way blocked by countless thousands of bats which had been disturbed by our presence and which were pouring forth from the tunnel.

According to Lester Gerdes, the cavern continues on for a considerable distance with numerous chambers which are all bat-filled except one which contains a fine clear pool of excellent drinking water. It is here that the "guano miners" rest and refresh themselves during the guano removal operations which are necessarily limited to the winter months.

The cavern has been breached from the top of the hill with a deep shaft which penetrates into one of the large inner chambers, thus making the removal of guano much more expeditious.

In addition to the bat colony, the cave harbours a huge insect population. Millions of dermestid beetles are present in the guano and are constantly occupied with devouring the numerous dead bats which have fallen from the colony on the ceiling. Various external parasites of the bats occur in abundance. They include the streblid flies which are present not only among the bats but also on rocky surfaces recently vacated by bats. In addition to these bat flies, large numbers of cimicid bugs which are closely related to bedbugs, were hiding in the cracks in the limestone walls.

As is characteristic of many bat caves, especially those harboring large colonies of *Tadarida*, the ammonia fumes rising from the guano-covered cavern floor were so powerful as almost to prohibit exploration.

After several hours inside the cavern we withdrew, in early afternoon, in order to witness the spectacular bat flight, which, according to Mr. Gerdes, "usually begins late in the afternoon, but several hours before darkness sets in, as the cave contains so many bats that it is necessary for them to come out early, in order that the last ones to depart could leave before the first ones began to return."

Falcons Precede Bats

Accordingly, I stationed myself in the ranch yard below the mouth of the cave, watching for the vanguard of bats which would announce the evening flight. Suddenly three Duck Hawks, *Falco peregrinus* subsp., appeared. Instead of passing on around the hill, however, they began circling and making rapid dives, directly above the mouth of the cavern. The interesting behavior of these swift birds of prey at Ney Cave I have already described in an article,* "A Group of Bat-Eating Duck Hawks," as follows:

* *The Condor*, 43 (3) 137-139, 1941.

This maneuvering continued with an increase in the speed of the aerial acrobatics. The falcons would disappear for a short period and then reappear from around the hill, dashing horizontally through the air, directly above and slightly out from the cavern's mouth. Throughout this performance the falcons kept up a steady cry similar to that given when in combat with a fellow bird over the possession of captured prey.

Daily Performance

At this point, Ben Gerdes noticed my interest in the activities of the falcons and informed me that the performance was a daily affair at the cavern mouth and that the "blue dodgers" were "warming up" to catch their evening meal of bats. According to Mr. Gerdes, the falcons had been making a practice of catching bats at the cavern's mouth for many years. The rancher and his two sons kill the falcons at every opportunity, because of the depredations made upon the young poultry and also because of the number of bats they kill. The Gerdes family hold the bats in high esteem and are careful to see that nothing harmful befalls the colony.

The three falcons had appeared at approximately 3:10 p.m. and by 3:30 their numbers had been reinforced by three more. The six birds continued to cry and dive at the cavern mouth as if they were calling the bats to come out. Suddenly a dark cloud of bats broke from the portal of the cave and poured out in a long stream to the east, flying directly over the ranch house at a height of about 300 feet. The column was approximately fifteen feet in diameter, with the bats flying in as compact a formation as possible. As the stream of bats emerged from the cave, it rose at an angle of almost 45° for approximately fifty feet and then leveled off. The head of the column was soon lost to sight in the east where it disappeared beyond the tree-covered hills. The thousands of bat wings set up a decidedly noticeable roar, which tended to add to the awe-inspiring spectacle.

Falcons Attack

The instant that the bats made their appearance, the band of falcons set to work. Darting from above, or on the flank of the column, the birds would cut into the on-rushing mass of bats with talons set, and they seldom emerged on the opposite side without their prey held fast.

The bats apparently took no notice whatever of the falcons, except at the point at which the diving bird broke into the column. As the falcon flashed into the flying mass, collisions were inevitable and many times the birds would be deflected from their course.

The flight continued for over an hour and then began to dwindle in numbers. The number of falcons had diminished to two birds by this time, with the others presumably having fed to capacity. According to Mr. Gerdes, the flight just witnessed was only the "preliminary flight" and but an example of the main flight which customarily follows the vanguard after the lapse of approximately one hour.

At approximately 5:30 p.m. the main flight began, with the column emerging with the same volume and speed as the preceding flight. A pair of the falcons reappeared and began to harass the outcoming bats in a rather desultory fashion as compared to the gusto with which they had set upon their unfortunate prey earlier in the afternoon. This second flight of bats from the cave continued until approximately 9:30 that night, as attested by the roar made by the countless thousands of wings.

Awakened by Bats' Return

Camp had been established along a pecan-bordered stream which flowed along the base of the hill in which the cavern was situated. The mouth of the cave was not over two hundred yards up the hillside from our camp, so that the noise made by the outgoing and incoming column of bats was clearly audible from this point. I awoke at 3:00 a.m. to the roar of the incoming flight. Shortly after 4:00 a.m. it became light enough to see, and I arose and made my way up the hillside to the mouth of the cavern. The return flight was made in the same manner as the evening flight in that the incoming bats flew to a point several hundred feet directly above the cavern's opening and then volplaned downward and into the yawning mouth of the cave at a terrific rate of speed. By training one's eye to the top of the descending column, bats could be discerned approaching the "diving point" from all points of the compass.

The mouth of Ney Cave opens as an oval doorway, ten feet high and twenty feet wide. This made it necessary for the descending bats to execute a sharp turn as they entered the cave. I found myself within ten feet of the rapidly descending column of bats. They were so close that the ripple of air on their wing membranes was clearly audible and much like the sound produced by air being rippled over rubber sheeting.

Shortly after daylight, the duck hawks put in their appearance and immediately set to work securing their morning meal of bats. The capture of incomers was not as easy a feat as that of the preceding evening, largely because the incoming column was not as com-



E. P. Haddon. Courtesy of Texas Game, Fish and Oyster Commission

BATS POUR OUT OF CAVE. The first flight begins about 3:30 p.m. (in early August) and lasts for an hour. The main flight starts about 5:30 p. m. and continues for four hours. The colony is estimated to contain twenty to thirty million bats.

pact as the outgoing stream and was descending at a much greater speed.

Although the catches of the falcons were less numerous, the birds seemed not the least discouraged and worked with great alacrity. Upon making a capture, a falcon would immediately retire to a point out of sight around the hill, as had been done on the previous evening. I was armed with a shotgun and in one instance fired at a bird as it started to make off with a bat in its talons. The gun was not of a suitable type for stopping duck hawks, however, and the charge of the shot only made the falcon drop its prey. The limp body of the bat dropped on the open hillside and when retrieved it was found to be lifeless, with deep talon punctures in its body.

The spectacle of the Duck Hawks feeding on the colony of *Tadarida mexicana* is one of great interest for many reasons. Aside from the fact birds were securing food of an unusual nature and in a unique manner, it causes one to pause and consider the unusual concentration of duck hawks in the vicinity of the cave. Did the surrounding area have an overabundance of duck hawks or were the birds drawn to the area by the presence of the bat colony and the huge food reserve which it offered? As far as endangering the existence of the bat colony is concerned, the depredations of the falcons would seem insignificant because of the enormous size of the colony.

Great Bat Colonies Attract Predators

That the daily attack on bats at Ney Cave by duck hawks is not an isolated example, is borne out by a letter which I received recently from Jack C. Couffer, of Glendale, California. The attacks on the bats are not limited to hawks, however.

Couffer spent several weeks during November and December, 1943, at Bracken Bat Cave and Ney Cave, and made a number of visits to Frio Cave. Of all three he writes:

These animals prey on the free-tailed or guano bats, *Tadarida mexicana*, which occasionally fell to the ground during their flight to or from the cave. They were knocked down either by striking the walls too hard or by colliding with each other in the congested flight. The predators seemed to hear their prey fall, for as soon as a bat hit the ground it was pounced upon—before it could recover and take off again.

So far as I could tell the bats were eaten on the spot but a most perplexing riddle remains unsolved. Every morning the carcasses of 20 or 30 dead bats could be found about the entrance skinned and decapitated but otherwise whole. Why only the head, skin, and sometimes the wing membranes should be eaten I don't know. Nor do I know by what—probably by some animal that would not venture near while I was stationed at my vantage spot with the light.

Red-tailed hawks, *Buteo borealis calurus*, sparrow hawks, *Falco s. sparverius*, and duck hawks, *Falco peregrinus anatum*, visited Bracken Cave every evening when the bats began to emerge. After dark barn owls, *Tyto alba pratincola*, could be heard screeching nearby.

The large populations of bats at these caves support quite a variety of small carnivores and predatory birds. At Ney Cave a large hog-nosed skunk, *Coneptus mesoleucus mearnsii*, lived in a shallow hole about 40 yards inside the mouth of the cave and could usually be found there during the day. At Frio Cave two striped skunks, *Mephitis*, were occasionally seen together about 75 yards from the entrance. Some of my companions reported seeing a Bobcat in this cave on an earlier visit.

The Devil's Sinkhole offered no opportunity for the carnivores to reach the bats, and we saw none. But in Davis Blow-out Cave I found a raccoon, *Procyon lotor fuscipes*, occupying a crevice inside the cave's entrance.

At Bracken Cave I had many opportunities to observe the predators that visited the cave nearly every night to forage for bats. I spent many nights stationed at the entrance with a powerful flashlight and quickly discovered that carnivores—raccoons and striped skunks—were not bothered by lights. Also, they were quite tolerant of noises and movements.

The sparrow and duck hawks were quite successful at catching bats on the wing, both during the morning and evening flights. As many as three red-tails were seen foraging at the same time but they were not as adept as the falcons. They would soar through the compact stream of emerging bats five or six times before catching one in their talons. They seldom were present during the morning flight when the returning bats were more scattered.

The barn owls were never actually seen to catch a bat but they were usually at the cave entrance in the evening and screeched weirdly all through the night. I did see a great horned owl, *Bubo virginianus*, catch and eat *Tadarida* at Carlsbad Caverns, New Mexico, on the evenings of May 27, 28, and 29, 1943. Only about one out of every eight or ten attempts to catch a bat was successful.

These observations would indicate that predation upon cave bats is more pronounced than has generally been believed. Persons visiting caves should be alert to observe and report further instances of predation. The pellets of owls and the scats or feces of raccoons and other carnivores should be examined. Bat bones, especially skulls, should be carefully preserved. The particularly large bat populations of many of the Texas caves serve as a strong magnet for predators and offer a splendid opportunity for studies of this type.—DENNY G. CONSTANTINE, 4049 Sunset Drive, Los Angeles 27, California.

It is claimed that the great *Balcones Fault* which extends from Del Rio, Texas, west and north to the Red River Valley and forms the southern boundry of the Edwards Plateau can be clearly seen in the largest chamber of *Cascade Caverns*, near Boerne.

BAT BLITZ

By PATRICK J. WHITE

*I*N THE IMMENSITY of silence that was the largest room of Frio Cave, the sounds were beginning. They whispered in the darkness 60 feet above us near the ceiling; and swelled in volume slowly until they became a ceaseless rushing sound as though the ghosts of ancient waters had returned to the old home they had gutted for themselves in the hollow mountain.

On the cavern floor, our single gasoline lantern glowed like a tiny lidless eye in the vastness of the thousand foot chamber and our three flashlights stabbed persistently upward toward the source of the rushing sounds.

The bats fell like great bunches of swollen grapes from the ceiling. First here, then there, they came in clusters and dropped with vegetable immobility some ten or fifteen feet before they took to flight with the whispering, watery sound of membranous wings churning air.

Each cluster as it came away flew clockwise around the room, pyramiding whisper upon whisper until a muffled roar surged through the enormous cavern as it slowly filled, as though by a great expanding whirlpool, with spinning bats.

The perimeter of the swelling mass advanced toward us, Helen Stephen, Raymond Medellin, and me, and we retreated to the wall. But there was neither protection nor escape. The mass expanded. The bats on the fringe of the rotating circle began to fly into us, cling to us where they struck, and crawl upon us demanding to be plucked away.

Then they came too rapidly to be plucked or even brushed away. Many of them abandoned the spinning circle and dove straight at the gasoline lantern which was wedged in a niche from which they could not knock it. They struck us like hail in a high wind.

Medellin had the presence of mind to wrap Miss Stephen's face and his own in coils of the rope we were carrying and they crouched together swathed like partial mummies, blanketed by crawling bats.

I was struggling to extinguish the gasoline lantern. There was no retreat through the density of the swirling bat mass, but their behavior gave increasing evidence that it was the light rather than our presence which motivated them.

The knob which is used to extinguish a Coleman gasoline lantern of the two mantle type that we carried had fallen from this particular lamp and I was in the habit of carrying it free in my pocket, withdrawing it only to ignite or extinguish the lamp. But I had eight zippered and glutted pockets and this time I had misplaced the knob in one of them. By the time I located it, it was necessary to rake bats constantly from my face in order to see how to use it. And when finally the lamp was extinguished, I was both exhausted and bat-blanketed and Miss Stephen and Medellin appeared only as a crawling mound of bats upon the floor.

In the welcome darkness we huddled together fighting the bats and fighting panic. But fortunately the battle was not extended. Almost immediately with the coming of the dark the bats receded toward the ceiling. And as we got rid of those which were already upon us they were not replaced. We waited until their sounds were high above us before venturing to shoot a flashlight beam into the darkness.

Instantly the bats began diving at the light again exactly as strafing airplanes dive upon a target. They made it necessary for us to retreat from the chamber in stages—putting on the lights and moving and then waiting quietly in the dark before moving again.

Later we discovered it possible to move without great trouble if only a single light be used and its beam not cast upward. It was the gasoline lantern which caused the principal activity. Any light, however, in that particular chamber will bring at least a few diving bats.

I have never heard of bats behaving in this manner. I think that their actions should not be construed as an "attack" upon us. Rather, it appeared to be an almost exact parallel to the behavior of moths, even to the extent that many of the bats must have been badly burned as they hurled themselves against our hot lamp and, with disregard of pain and death, tried desperately to cling against its searing sides.

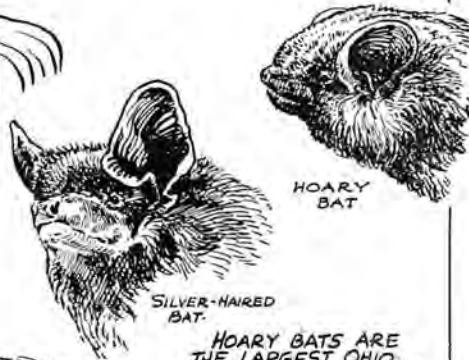
OHIO BATS

...MYSTERY MAMMALS.



THREE SPECIES OF OHIO BATS SLEEP DURING THE DAY IN TREES AND MIGRATE SOUTH FOR THE WINTER.

WHEN RESTING ~ ALL BATS HANG HEAD DOWN. THEY MAY LIVE 11½ YEARS OR LONGER.



HOARY BAT

SILVER-HAIRED BAT

HOARY BATS ARE THE LARGEST OHIO SPECIES AND REMAIN ACTIVE LONGER IN THE FALL THAN OTHERS ~ SILVER-HAIRED BATS HAVE SILVER TIPS ON THEIR DARK BROWN FUR.

RED BATS HAVE REDDISH FUR WITH WHITE SHOULDER PATCHES.



RED BAT



BATS ARE NOT BLIND. THEIR TINY EYES ARE ENTIRELY FUNCTIONAL.

BATS DO NOT GET IN PEOPLE'S HAIR ~ NOR DO THEY CARRY BEDBUGS.

THERE ARE NO BLOOD-SUCKING BATS IN THE UNITED STATES. VAMPIRE BATS ARE FOUND ONLY IN THE TROPICS.



Bob Hines

MOST BATS SLEEP DURING THE DAY IN CAVES AND HOLLOW TREES ~ AND HIBERNATE IN THE WINTER RATHER THAN MIGRATE.

THE FOOD OF OHIO SPECIES IS INSECTS ENTIRELY ~ THE ONLY ENEMY IS A SNAKE ~ OR AN OWL ~

THEIR FLIGHT HAS BEEN MEASURED AT 15 WINGBEATS A SECOND.



BIG BROWN BAT

THESE ARE THE BATS MOST LIKELY TO ENTER A HOUSE OR BUILDING.

THEIR COLOR ~ SIZE AND STRONG FLIGHT HELP TO IDENTIFY THEM.



LEAST BROWN BAT



LITTLE BROWN BAT

LITTLE BROWN BATS RANGE AS FAR NORTH AS ALASKA ~ IS ONE OF THE MOST COMMON SPECIES.

THE LEAST BROWN BAT IS ONE OF THE RAREST FOUND IN THE STATE.



SOCIAL BAT

A MIXTURE OF COLORS BLENDS THE FUR OF SOCIAL BATS INTO A PINKISH CAST.



PIPISTRELLE

PIPISTRELLES ARE SO SMALL THEY HAVE BEEN MISTAKEN FOR MOTHS IN FLIGHT.



LONG-EARED BROWN BAT

THIS BAT LOOKS LIKE THE LITTLE BROWN BAT ~ BUT HIS EARS ARE LONG ENOUGH TO REACH BEYOND HIS NOSE.



Wharton Huber

MULE-EARED OR PALLID BAT, *Antrozous* (above). Though a bigger bat than one at right, its ears are smaller (one inch long).

LUMP-NOSED or long-eared bat, *Corynorhinus* (right), has ears 1.3 inches long. It is found in Southeast as well as Southwest U. S.



Photos by Charles E. Mohr

FREE-TAILED or guano bat, *Tadarida* (below), is most abundant species in Southwest U. S.



Texas Cave Bats

Texas caves offer the best bat-collecting in the United States. Not only do the state's bat caves harbor unnumbered millions of free-tailed bats, but a surprising variety of other species as well.

At least 15 species, possibly as many as 17 or 18, will eventually be found in caves in this state. A list of them appears on the next page. The majority of them have yet to be found in Texas caves, but records from other southwestern states and Mexico indicate that they are cave-dwelling species.

OHIO BATS . . . MYSTERY MAMMALS, reproduced on the opposite page by courtesy of the OHIO CONSERVATION BULLETIN, pictures a number of species which occur in Texas as well as Ohio. Three species, however, the red, silver-haired, and hoary bats are "tree bats"

A LIST OF BATS

Which Should Be Found in Texas Caves

SPECIES	CAVE RECORDS	TEXAS DISTRIBUTION	NOTES
Lappet-chinned or old man bat <i>Aello (=Mormoops) megalophylla senicula</i>	Yes*	Uvalde County	Colonial, rare
Long-tongued or long-nosed bat <i>Leptonycteris nivalis</i>	Yes*	Mt. Emory	Colonial, rare bat tailless
Little brown bat <i>Myotis lucifugus fortidens</i>	Yes	Trans-Pecos	Rare
Cave bat <i>Myotis velifer incautus</i>	Yes*	Widespread	Colonial
Yuma bat <i>Myotis y. yumanensis</i>	Yes	Trans-Pecos	
Long-legged bat <i>Myotis volans interior</i>	Yes	Chinati Peak Trans-Pecos	5 specimens
California little brown bat <i>Myotis c. californicus</i>	Yes	Trans-Pecos	6 specimens
Little-footed or black-nosed bat <i>Myotis subulatus melanorhinus</i>	?	Trans-Pecos	Locally common
Fringe-tailed bat <i>Myotis t. thysanodes</i>	Yes*	Trans-Pecos	Colonial common
Canyon bat <i>Pipistrellus hesperus maximus</i>	Yes	West Texas	Solitary
Pipistrelle <i>Pipistrellus s. subflavus</i>	Yes	East Texas	Solitary
Big brown bat <i>Eptesicus fuscus pallidus</i>	Yes	Whole state	Common
Lump-nosed or long-eared bat <i>Corynorhinus rafinesquii pallescens</i>	Yes*	West Texas	Small clusters
Pallid or mule-eared bat <i>Antrozous pallidus pallidus</i>	Yes	C & W Texas	Locally common
Mexican free-tailed or guano bat <i>Tadarida mexicana</i> and <i>T. texana</i>	Yes*	Widespread	Most abundant
Big free-tailed bat <i>Tadarida macrotis</i>	?	Chisos Mts.	Colonial, rare in crevices
Mastiff bat <i>Eumops perotis californicus</i>	Yes	Langtry	Largest bat, 1 record

* Recorded from a Texas cave

¹ For descriptions and other details see "THE MAMMALS OF TEXAS," by Walter P. Taylor and William B. Davis. Bull. 27, Game, Fish and Oyster Commission, Austin, 1947, pp. 13-21.

rather than cave bats. No live specimens of these "furry tailed" tree bats have ever been found in caves. It still is possible that they may occasionally roost in caves during their migrations, southward in fall, northward in spring. All speleologists are urged to be on the look-

out for them.

Migration is not limited to the "tree bats." Banding experiments in New England indicate that bats will fly as much as 165 miles from their summer roosts to their winter quarters in caves. Some species that are present in caves



Charles E. Mohr

OLD MAN BAT, *Aello*, strangest looking bat in the U. S. Wartime bat cave survey proved this bat to be fairly common in Texas. Many in Frio Cave were banded in the hope of learning something about their movements, longevity, etc.

LONG-TONGUED BAT (right) is believed to feed on nectar of night-blooming flowers. This is *Choeronycteris mexicana*, photographed in California. It closely resembles *Leptonycteris*, found in Mt. Emory Cave.



Clyde Fisher from A.M.N.H.

MASTIFF BAT (below) is country's biggest, with wingspread of 20 inches. Though known from a cave in Coahuila, it prefers steeples and buildings.

Courtesy of L. S. Adams



in summer are absent in winter; with others, the reverse is true. Almost nothing is known about their seasonal movements in this region.

Some of the most unusual bats, like the lappet-chinned bat pictured on this page, and the tail-less, long-nosed bat are Mexican species that have been found in the United States only a few times. Further exploration is certain to reveal more colonies of these and other rare bats.

Dr. Seth N. Benson, University of California mammalogist, points out in a recent letter that certain bats such as *Pipistrellus hesperus* and *Tadarida macrotis* seem to prefer crevices in the rocks to actual caves. Mine tunnels are preferred by *Myotis subulatus*, and apparently, *Antrozous*. He suggests that since the rare spotted bat, *Euderma*, was found near El Paso but in New Mexico, thorough search in Texas may reveal it, possibly in tunnels.

Another form of pallid bat, *Antrozous bunkerii*, has been found in a Kansas cave. It might occur in Texas. Still another possibility, Dr. Benson suggests, is a rare free-tailed bat, *Tadarida femorosacca*, which occurs in Arizona and Nuevo Leon in habitats rather similar to those in western Texas.—C. E. M.

What About Vampire Bats?

By CHARLES E. MOHR

HOW MUCH of a threat to man and livestock are the vampire bats that live in the caves of northern Mexico? At the Annual Meeting of the National Speleological Society, in Washington, D. C., in February, 1947, the author reported the presence of colonies of vampire bats within 250 miles of the Rio Grande, and commented on the species as a disease carrier.

Ensuing magazine¹ and newspaper reports appear to have caused so much concern, particularly in Texas, that a review of the facts seems to be in order.

Vampires were one of the main objects of two speleological expeditions to Mexico during the summer of 1946. The first I made in the company of five other members of the NSS; the second with a writer whose colorful but sometimes inaccurate descriptions of the vampires later appeared in COLLIER'S² and the READERS DIGEST³.

A Carrier of Disease

South America's earliest colonizers noted that many of their horses and cattle died after being bitten by bats. Death, however, was mistakenly attributed to loss of blood. The name "vampire" for the blood-drinking bats was appropriately adopted from the much older Slavonic superstition of supernatural vampires. Only within the last 40 years has the role of the vampire bat in causing death been clearly understood.

In a recent review of the subject Gilyard⁴ recorded an outbreak of rabies among cattle and horses in Brazil in 1908. The rarity of canine rabies in that area led investigators to suspect bats of being vectors of the disease. This proved to be true. The vampire bat, *Desmodus*, transmitted the virus in its saliva.

By 1925 bat-transmitted rabies had spread considerably and had reached Trinidad. There, between 1929 and 1936, the disease was fatal to at least 55 human beings; animals died at the rate of 2,000 a year. The disease was combatted by immunizing livestock and screening houses and stables. In addition, a vigorous

campaign to eradicate the bats in all known roosts was carried on, particularly during the last war. This may account for the virtual disappearance of rabies in Trinidad. In Brazil and Venezuela vaccination of cattle against the disease has been given "precedence over bat suppression as a logical means of control."

Recent Investigation

Recently Tellez Giron⁵ and Johnson⁶ have demonstrated that the bovine disease known as *derriengue* (pronounced derri-en-gay) is identical with paralytic rabies, and is more prevalent in Mexico than had been suspected. In 1944 the virus of derriengue or rabies was found in vampire bats collected in caves in the states of Michoacan and Jalisco, in western Mexico, by scientists from the Rockefeller Foundation's International Health Division.

Also present in Mexico is equine trypanosomiasis or *murrina*, a disease caused by *Trypanosoma hippicum*. This blood parasite is known to be transmitted by *Desmodus*, but biting flies also are thought to be vectors. Serious outbreaks of *murrina* have occurred among cattle and horses, particularly in the State of Guerrero.

How does the presence of these disease-infected bats affect our welfare? Are they likely to reach the United States? The following points seem to be fairly well established:

1. The known centers of infection for both diseases are in the *Pacific Coast States of Mexico*. Outbreaks of derriengue have been reported from Sinaloa and southwestern Chihuahua in the North to Chiapas in the South, but no scientific study has been made north of Michoacan. The Chihuahua locality is 300 miles southwest of the Big Bend.

2. Examination of *Desmodus* from east and northeast of Mexico City has so far failed to show the presence of either disease.

3. While *Desmodus* occurs in considerable numbers (cave colonies numbering up to 500 individuals) near Valles, San Luis Potosi, along the Pan-American Highway about 300 miles from the U. S. border, and in smaller numbers



Photos by Harald N. Johnson

VAMPIRE BAT has few teeth but they are highly modified. Long, canine teeth look dangerous, but it is the two upper incisor teeth which gouge a shallow groove in victim's skin. Vampire then laps up the blood, may transmit rabies through the wound.



TELL-TALE, tar-like excrement proves vampire bats' presence.

in a cave within 250 miles, careful search in half a dozen caves farther north, in Tamaulipas and Nuevo Leon, failed to show any evidence of its presence.

4. With an abundance of wild and domestic animals as sources of food, vampires very rarely attack man. They are *in no sense* a menace to tourists, nor even to spelunkers who visit their cave lairs. *Extreme caution, however, should be exercised in handling these bats*, since they may bite viciously and penetrate any but heavy leather gloves.

5. *Vaccination*, both of animals and man has been used successfully as a preventive measure in combating rabies.

6. *Vampire bats are not known to be migratory*. Since these bats appear to markedly prefer *cave roosts* to hollow trees, vacant buildings, etc., spelunkers visiting Texas' multitudinous caves would be most likely to discover them if they appear in this country. As Ditmars and Greenhall⁷ point out in their splendid account of vampire bats in Panama, *the presence of vampires is immediately evident*. The excreta

is a reddish-black, tar-like liquid which collects in pools beneath the roosting bats. It gives off a strong odor of ammonia.

7. Although vampires probably are not migratory, infected individuals are capable of transmitting rabies to insect- and fruit-eating bats which might themselves be migratory. While this seems no cause for alarm, *periodic collection and examination of bats* from caves in Texas, and to a lesser extent from other border states, would seem to be a wise precaution.

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How Fast Do Bats Fly?

Naturalists in Texas have a rare opportunity to determine the speed of flight of bats as well as other characteristics of their homing powers. The large population of free-tailed bats, *Tadarida mexicana*, in many accessible caves in central Texas offer ideal material for an experiment such as is described in 1925 by Dr. Charles A. R. Campbell of San Antonio (*in Bats, Mosquitoes and Dollars*, Stratford Co., Boston, p. 62-65).

"Further to verify the observations of the remarkable faculty of orientation possessed by bats," wrote Campbell, "the author with a large bag made of mosquito netting, caught, to be exact, 2,004 of these creatures from a very peculiar cave, the surroundings of which furnished splendid environment for study. The cave is on the summit of a low, bald hill, and one of its mouths is a perfectly reamed hole in the solid rock, looking like a doodle-bug's home, the wide end being about 12 feet in diameter, the smaller end, or neck, about a foot and a half, and the depth about 10 feet. Out of this large rock funnel the bats emerge toward evening, but return through an entrance on the south side of the hill." The "doodle-bug" cave is believed to be Ney Cave although the hole described is now larger.

In a high-powered car the bats were taken to an open field about 30 miles from their home. Here the author liberated one bat, and watched its behavior. It took immediately to the air in the accustomed manner, and after describing only one small circle, with a velocity of flight that left no doubt as to its certainty of purpose, made for the direction of its home. Four were then liberated; and without the least confusion or separation from one another in a very short time they got their proper direction and passed out of sight at a speed which would place a carrier pigeon in the pelican class.

The rest of the 2,000 bats were drenched in their cages with a solution of powdered chalk and water to which some gum arabic had been added to give adhesiveness. When the bats were dry they were released. Campbell recorded the time, and raced back to the "doodle-bug" cave in his "high-powered" automobile. He covered the 28 or 30 miles from the field to the cave

"in just fifty minutes" and stationed himself to await the coming of the bats.

"Within eight minutes," he wrote, "the vanguard appeared, then the larger numbers, and began dropping from a great altitude and darting into the side entrance of the cave."

Although Campbell claimed that he saw "all manner of white stains" on the swiftly descending bats, scientists received the story somewhat sceptically, especially since he made no attempt to capture any of the white-washed bats.

If the experiment were to be repeated the bats could be individually marked with numbered aluminum bands (a large team of banders could mark 5000 bats in a short time). Observers stationed at the point of release, at intermediate points, and at the cave entrance could accurately time the flight, and returning bats could be shot for positive identification, or if the structure of the cave made it feasible, they might be caught on gill netting. If a large number of bats were released at one time, it might be possible, though not easy, to keep them in sight from a slow moving plane, or better, from a helicopter.

The long, narrow wing of *Tadarida* closely parallels the shape of the Chimney Swift's wing. It may be the swiftest bat, as the swift is probably the fastest flying bird (the Indian Swift is credited with speeds of 177 and 200 miles per hour).

Marking a large number of bats in a particular colony with phosphorescent paint might make it possible to answer another unsolved question, namely, how far from the cave roosts do bats travel on their nightly forays? — CHARLES E. MOHR.

TEXAS BATS PROTECTED

Through the efforts of Dr. Charles A. R. Campbell, San Antonio physician who advocated and built municipal bat roosts 30 years ago, the Texas Legislature passed the first and only known law protecting bats.

Effective March 10, 1917, the law made it a misdemeanor (with a fine of not less than \$5.00 nor more than \$15.00) "to willfully kill or in any manner injure any winged quadruped known as the common bat."

Tracing An Underground Stream

A Digest of An Article by EDUARD UHLENHUTH*

In August and September, 1916, Dr. Eduard Uhlenhuth, working under a special grant from the Rockefeller Institute for Medical Research made an intensive study of the caves in and around San Marcos, Texas. He hoped to capture enough blind salamanders to carry on physiological experiments upon them.

In the course of the investigations, certain geological and hydrologic peculiarities of the region were noted, and later were described* at considerable length, in an article from which this digest was prepared.

San Marcos is located on the Balcones Scarp line which takes the form of escarpments overlooking the plains to the eastward. Along this line a faulting took place in Eocene time, resulting in many breaks in the rock layers. The caves along this line represent giant cracks.

Since the limestone rock of the area (forming the Edwards Plateau) contains especially soft strata, numerous caves have been formed by the mechanical force of water combined with its dissolving action.

As a result of this double process most of the rivers of the Edwards Plateau have disappeared from the surface, and their former beds are dry. These rivers have sunk beneath the surface where they flow in subterranean channels.

Purgatory Creek is one of these streams. Water ran in it until about 1870. In times of cloudburst water still flows in the creekbed to a depth of 8 feet, but it disappears completely within several hours. The creek has gone underground, and it is this stream that can be reached in Ezell's Cave, the most important biologically of the caves around San Marcos.

That the water in Ezell's Cave is part of a subterranean river is indicated by a scarcely perceptible flow. The distance from the entrance down to the water surface is 94 feet which makes the level of water about 577 feet.

* Uhlenhuth, Eduard. Observations on the Distribution and Habits of the Blind Texan Cave Salamander, *Typhlomolge rathbuni*. BIOLOGICAL BULLETIN, Vol. XL, No. 2, pp. 73-104, February, 1921.

In his search for salamanders, Doctor Uhlenhuth investigated every cave which showed any promise of leading to water. Along the dry, flat valley of Purgatory Creek he found a well, on the Frank Johnson Farm, which apparently tapped the same underground stream.

The altitude of the water surface in this well, when measured by means of a barometer, proved to be 584 feet, or approximately the water level in Ezell's Cave.

In nearby Beaver Cave, opened to the public under the name Wonder Cave, the deepest depression was 590 feet above sea level—not quite deep enough to reach water. But a well drilling made from the surface above this deepest room had indicated the presence of water only a few feet below the floor. Therefore, a hole was dug in the bottom of this "Well Room" and water was reached at 584 feet.

Evidence of Connection

What indications were there that these three bodies of water were part of the same river, and what connection might there be with the original Artesian Well at the U. S. Fish Hatchery in San Marcos? When it was drilled, in 1895, a number of water reservoirs were peoned up. At present only the water which rises from a depth of approximately 190 feet is used. The altitude of this water-filled cave, then, is 360 feet above sea level, or about 125 feet lower than the water level in the other three sites which Uhlenhuth investigated. Could it be connected?

Apparently the possibility of using dyes or other chemicals to trace the underground river did not occur to anyone. From evidence of another nature, however, it is fairly conclusive that a connection exists.

The water in each place has a temperature of 21.5° C. and is of an extreme clearness and of bluish color: it is so-called "sweet-water." More important the same fauna occurs in all four: *Typhlomolge*, the blind salamander, and the shrimp, *Palaemonetes antorum*, neither of which

are positively known from other nearby localities.

Figure 1 shows the relationship between the four places under consideration. Frank John-

It is of great importance to ascertain whether or not such a communication exists, since this would facilitate following the *Typhlomolge* along the course of travel and since it would permit conclusions as to the mode of the dis-

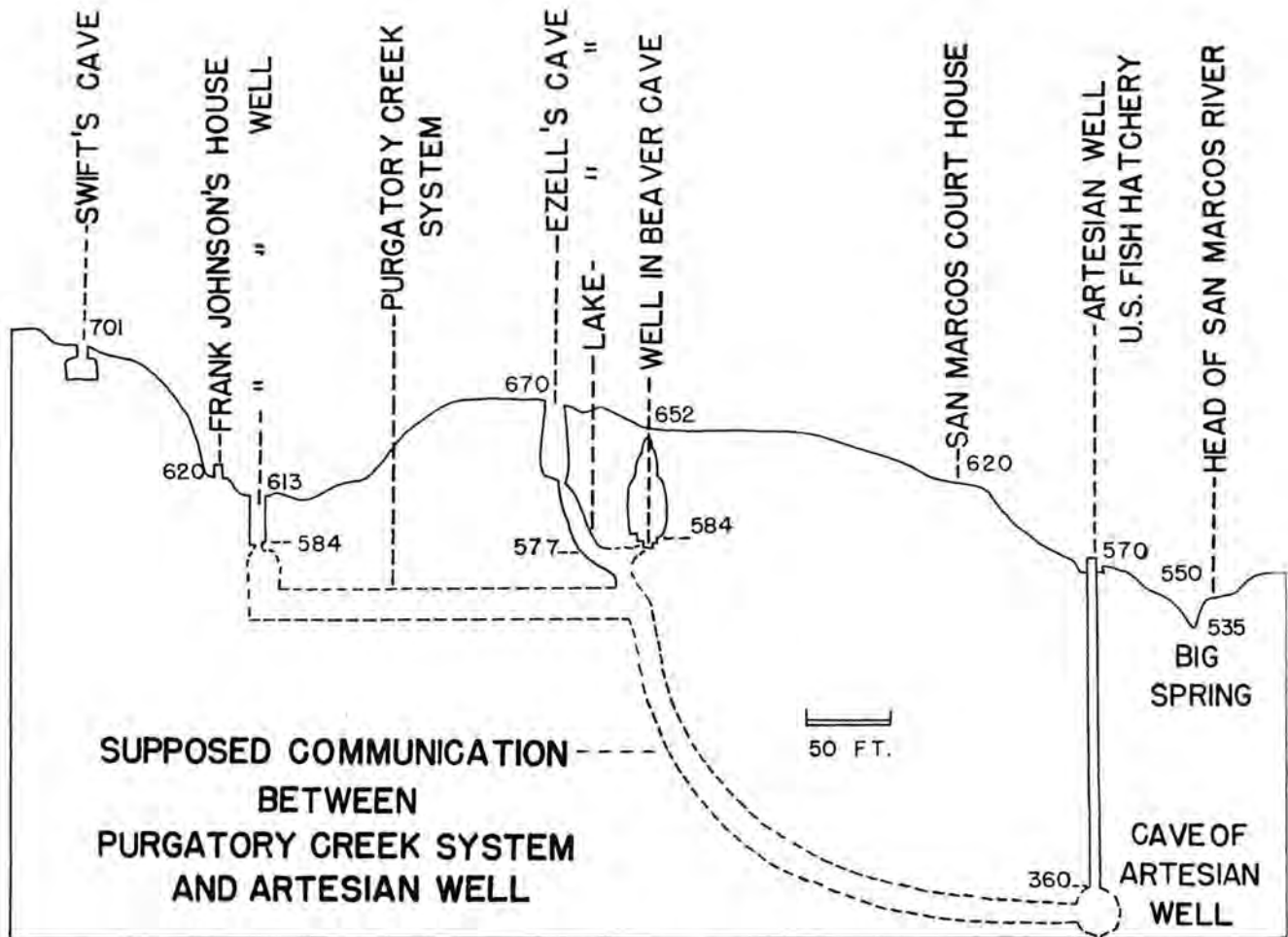


Fig. 1. Caves and wells around San Marcos showing their position relative to the subterranean Purgatory Creek, and indicating a possible connection with the source of the Fish Hatchery artesian water (after Uhlenhuth). Numerals indicate feet above sea level.

son's, and Beaver and Ezell's Cave are located north of, and on top of the Balcones escarpment. The Artesian Well, on the other hand, lies south of, and below, the escarpment. It is not surprising, then, that all these subterranean sites occur in the same geological formation, the Edwards limestone. It is due to faulting, of course, that the Artesian Well lies 125 feet deeper than the Purgatory Creek caves, as is indicated in the diagram. The connection evidently is along the fault line.

Doctor Uhlenhuth makes the following comment:

tribution of the species. Besides the suggestive structure of Ezell's Cave there are a number of facts which are in favor of the existence of a communication. If no connection between the two systems exists it would mean that the *Typhlomolge* lived in the subterranean rivers before the present southern and northern parts of the Edwards limestone were separated from each other, and that after the dislocation in Eocene time part of the species were caught in the caves of the Edwards limestone of the San Marcos area south of the Balcones where it lived completely isolated from the rest of the species. Since the specimens obtained from Ezell's Cave and the Artesian Well are identical, it would mean either that the species remained absolutely

unchanged since Eocene time, or if it changed, underwent exactly similar changes in the open ponds of the subterranean Purgatory Creek and in the completely closed and water-filled subterranean caves of the Artesian Well. It is evident that none of these possibilities is probable.

Not only the Artesian Well at San Marcos but numerous other artesian wells along the Balcones escarpment are supplied from the sweet water horizon; yet from none of them, except the San Marcos Well, *Typhlomolge* has ever been reported. This would be explained if the San Marcos Well contains besides the sweet water also the Purgatory Creek water, since this certainly could not be true for the other wells. Probably the Purgatory Creek is the original habitat of the *Typhlomolge* and later on the animals migrated down to the water channels of the Artesian Well.

Also in none of the fissure springs of the Balcones scarp line, not even in the San Marcos springs though they all come from the sweet water reservoirs, *Typhlomolge* ever has been collected. The same explanation as to the artesian wells could be applied to these springs, if a communication exists between the Purgatory Creek System and San Marcos well.

Finally an incident may be mentioned here which also would speak in favor of the existence of a direct communication between the Artesian Well and the Purgatory Creek System. Mr. Mark Riley, superintendent of the U. S. Fish Hatchery, informed me that in the basin of the Artesian Well a number of catfish were kept at one time, but they disappeared gradually from the basin and it is claimed that they migrated into the tube of the artesian well. The writer is not prepared to form an opinion con-

BASIN OF THE ARTESIAN WELL at the U. S. Fish Hatchery at San Marcos, Texas. Drilled in 1895, its water carried up several hundred blind salamanders in 15 years, none since about 1910.

Charles E. Mohr



cerning the probability of such migration. One day, however, while I was looking for *Typhlomolge* in Ezell's cave, I saw some fishes hiding behind the rocks. Shortly after this we caught two fishes by means of hooks which were placed near the rocks where I had seen the fishes; both were catfish. And they were the only specimens of fish which I ever saw in Ezell's Cave during the 12 days I spent there. If these were identical with the individuals kept in the basin of the Artesian Well, it certainly would be proof of the existence of a communication between the Purgatory Creek System and the San Marcos Artesian Well. It would be of great importance to trace the course of the water in Ezell's Cave and Johnson's Well down to the reservoir of the Artesian Well. As suggested by the possible migration of the catfish, such methods could be easily designed and will be employed as soon as the investigations can be continued.

Unfortunately it was not possible to continue the investigation as planned. This remains as one of the most challenging problems of subterranean hydrology and it is to be hoped that Texas speleologists soon will undertake to solve it. —CHARLES E. MOHR

Blind Fish From Artesian Wells

Two species of blind fish have been found in waters pumped from deep artesian wells in or near San Antonio, Texas. Both are catfish. The first was named *Trogloglanis pattersoni* by Eigermann¹ in 1919; the second was recently described by Hubbs² as a new species, *Satan eurystomus*.

One specimen of each fish is in the Witte Memorial Museum, San Antonio. Each is about 2¾ inches long. The specimen of *Trogloglanis*, the second known, came from a well 2¾ miles east and 1¼ miles north of the Alamo in San Antonio. The only known specimen of *Satan* came from a well 1250 feet deep.

Hubbs considers it "virtually certain that they have been derived from the chief water-bearing stratum of the region"—the Edwards limestone. He believes that the ancestors of the fish entered the waters of this stratum farther west, probably along the Balcones Fault where these waters reach the surface. Since the Edwards limestone dips quite sharply to the eastward (lying 3000 feet below the surface in

(continued on page 124)

Cave-Hunting in the Big Bend

By PETER KOCH

*I*N THE CENTER of the Big Bend National Park located in Brewster County, west Texas, are the Chisos Mountains. It is here that we made headquarters in 1946 during our search for caves. These mountains are a beautifully wild but exceedingly rough escarpment forming the principal scenic attraction west of the Pecos River. Surrounding the mountains is a great flood plain, a semi-arid desert, that isolates the peaks from the eastern spur of the Rockies. This isolation produces a striking "Lost World" atmosphere.

Colorful lava cliffs rise nearly a thousand feet above talus slopes. Sheer walls, pinnacles, and overhanging cliffs may be seen within every one of the numerous canyons that radiate from Mt. Emory, the central peak. This mountain reaches an altitude of 7,835 feet, and is believed by some geologists to be the central core of a massive volcano that erupted and "blew its top."

Overhanging cliffs are so deeply eroded as to form massive "caves" that extend for a considerable distance under the cliffs. Those located conveniently near water were once the homes of cave-dwelling Indians. On the basis of evidence gathered from caves less than 200 miles to the north it appears certain that these shelters were occupied, thousands of years before the coming of the first Indians, by animals now extinct.

Near Signal Peak, the 8,400-foot southern terminus of the Guadalupe Mountains, in Culberson County, Texas, is Williams Cave¹. Here in 1934 and 1935 scientists dug trenches seven feet deep and found remains of 24 kinds of animals, five of them long extinct. Seven still are living but are not now found within hundreds of miles of western Texas.

The grizzly bear lived here and so did the extinct "dire wolf," and the elk or wapiti. The two earliest inhabitants were horses, extinct long before the coming of the Spaniards, and great ground sloths that vanished from North America 10,000 or more years ago.

Indian remains were found only in the top three feet of the excavations in Williams Cave.

Study of their burials, their bone and stone implements and ornaments, and their woven fibre mats and baskets reveals a culture corresponding "to the Hueco Cave Dweller rather than the Pecos River Cliff Dweller of Texas."

Within the Park comprising 700,000 acres, there are doubtless caves and shelters which would produce even richer "finds" of extinct animals and of the first Americans. And even though archeologists have spent considerable time in southwestern Texas, the area is so vast that the surface has barely been scratched.

To be sure, explorers, prospectors, and stockmen have been criss-crossing the Big Bend Country for 400 years, since the coming of the Spaniards in 1535, but the frontier appearance and conditions still exist.

A Succession of Tenants

The caves formerly tenanted by ground sloth and grizzly, and later by Indians, now shelter an interesting array of smaller mammals such as the long-tailed cacomistle or ringtailed cave cat which is known to reach the deepest recesses of these caves, as do the little white-footed cave mice. Another common cave dweller is the white-throated cave rat, or pack rat, *Neotoma*, which penetrates far underground. Other visitors include the skunks, rock squirrels, gophers and prairie dogs. Sometimes bear, deer and panthers use them. And, of course, bats.

Before the National Park Service was established, sheep and goats, horses and cows frequently occupied the caves and drove out the wild animals. With the removal of the domestic animals, the native mammals are returning. It will take years, however, before the traces of the ranching period disappear, for nothing ever rots in this country.

Ground sloth dung, well preserved in this arid climate has been found also in other caves in the Guadalupe Mountains and elsewhere in the Southwest. Besides Williams Cave on the east slope of the Guadalupe, at an elevation of 4,900 feet, there are the so-called Sloth Caves,

on the west side of the mountain. In Upper Sloth Cave, at an elevation of 7,000 feet, female and young long-eared bats, *Corynorhinus*, were found in August 1939².

I was looking for bats as I explored the Big Bend caves and rock shelters. One of the most promising caves, and the largest I had heard about, was high on the slopes of Mt. Emory, the Park's highest peak. Here in July, 1937, ten long-eared bats, *Corynorhinus*, had been seen as well as the little brown bat, *Myotis t. thysanodes*. Far rarer, though, were four Mexican long-tongued bats, *Leptonycteris nivalis*, not previously known from Texas³.

To reach the Mt. Emory Cave I followed the trail from the tourist area in the Basin to the South Rim. Two miles of good trail lead up the ravines. Finally at the crest of the ridge that runs from Ward Mountain to Mt. Emory, the trail branches toward the east.

Looking eastward toward Emory for a landmark one can see two dark stains on the bluff at the base of the cone which is the topmost peak. The stain at the right was my guide as I went forward along the steep slope, covered with oak and tough, scrubby growth. At last I reached a talus slope and a ravine filled with large boulders. Crossing it I climbed upward toward the base of the cliff—and the stain. There I came upon the cave entrance, at an elevation of 7,100 feet.

Fourth Trip to the Cave

The floor of the entrance chamber was strewn with boulders which continue on into the rooms of the cave. Our visits to the cave in March, June, and October had resulted in finding groups of *Myotis*, never more than a dozen. Now, in December, we hoped to find larger, hibernating colonies. But the weather was so mild that bats were still outside the cave. They were seen nightly flying around the Burnham Ranch, a few miles away and 2,500 feet lower. In the cave there were none.

The great boulders on the floor conceal buried silver, according to local legend. This is the celebrated "Treasure Cave" of the Big Bend Country. A bar of silver was found here some years ago and is now in the possession of a Mexican in Presidio, I was informed.

Bandits made this cave their headquarters,



Glen M. Kohls

7,000 FEET above sea level, this Hudspeth County cave resembles several other Trans-Pecos caves. This is McAadoo or Bat Cave, 18 miles north of Allamore (on U. S. Highway 80).



A. T. Jackson

INTERIOR of the cave is a chamber 265 feet long, 55 feet wide at entrance, and 17 feet wide at rear. Pictographs, sandals, basketry, etc., were left by Indian occupants.

the story goes, and hoarded their loot, captured in the lush days when silver and gold were carried from western mines and Old Mexico to San Antonio over the Comanche Trail and the Old Spanish Trail.

One cave the pioneers didn't know about is located at the western edge of the park, along the gravel highway six miles east of the quaint town of Terlingua. The cave was uncapped by a road crew levelling off the top of a ridge a few years ago. The opening is only a few feet from the top of the crest, on the La Jitas side. From my car I looked into the dark opening, about five feet across and only a few feet from

the edge of the road. Bill Dunnington, of Terlingua, who broke into the cave while road grading reported it to be very deep. Subsequently exploration is said to have revealed a cavern 93 feet deep but so narrow that it is hardly more than a deeply eroded fault in the limestone bedrock. A trace of cinnabar was found, but of life there was none. The theory was advanced that this cavern might connect with a mine shaft nearby, but this was proven false.

The southernmost caves in the Big Bend are in the southeastern slope of Mariscal Mountain, where the eastward progress of the Rio Grande almost ends as it turns practically due north and then northeast. At an elevation of 2800 feet (the mountain rises to 3940 feet) is one of three Guano Caves. It consists of a tunnel 150 feet long, with two small connecting chambers. Here long-eared bats and a few fringe-tailed or little brown bats were found. The main feature, however, is a colony of about 3000 free-tailed bats, *Tadarida mexicana*. It was the guano from this aggregation which gave the cave its name and which was the object of an abort-



Peter Koch

COW CAVE has an imposing entrance. It is seen here from the far side of the Rio Grande, in Santa Elena Canyon, at the western end of the Big Bend National Park. Hermit Cave, as it is also known, is a deep rock shelter.

ive attempt at removal for commercial purposes. Two other small caves are said to be nearby. They may be mines since abandoned cinnabar mines are known farther north on the mountain.

Other caves along the Rio Grande itself I have seen while navigating the precipitous canyons that total nearly one-third of the river's 150-mile course along the border of the Park. At the western edge, in Santa Elena Canyon is the huge arched entrance of Hermit or Cow Cave, a rock shelter, while in Boquillas Canyon, far to the east I saw shallow caves on both sides and explored one fine cave shelter whose entrance has been walled. It showed considerable use by trappers but the floor debris had not been disturbed.

A large opening high on the wall of Santa Elena Canyon, on the Mexican side, was described by W. A. Ownby in a feature article in the *Dallas Morning News*, June 23, 1929:

The opening of the cave is about 800 feet from the top of a 2500 foot perpendicular bluff . . . and from a distance appears to be mammoth in size . . . about 200 feet in diameter. Although it has not been entered since its discovery (about 1925) rumors have been circulated that a lost treasure which was smuggled out of Mexico City during the Spanish regime lies hidden away somewhere in a subterranean chamber of immense size.

The cave also is said to be haunted, and once a year, the second day of each May, the Indians gather on the bluff above and build fires which are kept burning throughout the night, supposedly to frighten away the evil spirits.

It is reported that Alpine, the county seat of Brewster County and situated about 90 miles from this cave, is ready to offer any intrepid explorer a banquet if he succeeds in entering the famous cavern.

I did not see this cave myself nor do any of the Park officials know its location. Another newspaper account of the same period describes a tunnel, likewise unknown to anyone with whom I have talked.

The tunnel under the Rio Grande in the Big Bend is one of the Wonders of Texas. This remarkable cave was brought to the attention of the public less than two years ago (1927), when members of the Sweeney family informed A. H. Dunlap (now deceased), of the state board of water engineers, of its existence.

It is located near Santa Helena at the lower end of the long canyon through which the

river flows. Sixteen years ago three of the Sweeneys ventured into this long cave and followed through it, coming out on the Mexican side three miles from the border. They say there was a small amount of water in the cave at that time, but quote explorers as stating that the water is present only in the rainy season, and does not seep down from the river above.

I feel that there are more promising areas in which to prospect for caves particularly in the southeast corner of the Park. While the Chisos Mountain mass is chiefly volcanic residue and lava, Mariscal Mountain, The Mesa de Anguilla, and the Sierra Del Carmens, all lying around the southern and eastern perimeter of the Big Bend, are limestone. This territory, wilder, rougher and less known than the Chisos should be more productive. It will take a great deal of exploration, but this limestone area is more likely to yield them than the lava. So far nothing beyond the usual shelter caves has been found.

There is a report of an entrance to a cave in the American Sierra del Carmens that sounds interesting. I log it here for what it may be worth. The principal peak of this range, sometimes called the Deadhorse Mountains, is Sue Peak. Near Sue Peak is an opening in the lime-

stone from which cold air blows. Soundings made by dropping rocks indicate that there is a cave too deep and too large to explore without suitable equipment. I have heard about this cave from several reliable sources and believe it to be worth investigating. Such an investigation cannot be undertaken casually, though, because there are no roads nor trails in this wilderness, and no water.

Geologist Charles Laurence Baker encourages us to look here for great caverns. If we have so far failed we should recall the words of the old Padre who logged the adventures of Coronado's expedition in 1540, ". . . we must admit that we have failed to find the seven golden cities of Cibola, and the fabulous wealth of the Gran Quivira, but it must be granted that we have found a vast territory in which to look for it." The Big Bend is just such a country!

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Proposed: A Seminole Canyon Park

Some ten years ago a geologist and this writer accompanied representatives of the National Park Service and the Texas State Parks Board on a trip to West Texas. One purpose of the trip was to show them Seminole Canyon, and point out features we thought recommended it for park uses.

Nowhere else in Texas is there a combination of greater marvels of nature and more interesting remains of prehistoric man, compressed into so small an area and so accessible to a paved highway: three miles down Seminole Canyon, two miles along the high cliffs of the Rio Grande, and a return by way of Presa and Painted Canyons. A 12 to 15-mile round trip takes the visitors to awe-inspiring works of nature, no less than 15 huge cave-like shelters in which there are hundreds of rare Indian paintings, as old as any in the

Southwest. This is American art at its beginning.

To these geological and archeological attractions should be added a trailside museum, filled with interesting and instructive specimens gathered in the area. To top it off, a display in situ could be made, showing an actual cross-section of a deep midden deposit in the largest shelter.

For reasons not disclosed, the project was never undertaken. Today there is still no protection from vandals for irreplaceable works of art—in the form of huge murals on the walls. There is still time for the area to be given park status—if we work hard and fast. In the meantime, it is the responsibility of each visitor to see that he leaves everything in as good condition as he finds it.

—A. T. JACKSON

Ectoparasites and Other Arthropods

Occurring in Texas Bat Caves¹

By GLEN M. KOHLS and WILLIAM L. JELLISON²

IN THE LATE SUMMER of 1940, several weeks were devoted to a field trip in Texas for the purpose of collecting ticks and other arthropods for use in disease investigations. In addition to collecting from domestic animals, vegetation, and rodent burrows, search was made in bat caves as opportunity afforded. A list of the various species of arthropods found in six caves visited is presented in this report.

Ectoparasites were found by examining living or killed bats, the cracks and crevices in the rocks of the walls and roof of caves with special attention to areas where bats cluster, and the guano deposits on the cave floors.

Collection of ectoparasites from killed bats was facilitated by keeping the animals in small white muslin bags for several hours. The bags were then opened and if any parasites were present they usually would have left the host and could be readily found. However, larval ticks required longer periods for detachment and these were best found by careful inspection of the animals. When fully fed nymphal or adult ticks were wanted, living bats were bagged and left for a few hours in order to permit the partially fed ticks present on the bats at the time of capture to complete feeding and detach. In instances when no tick-infested bats were found in caves where ticks were present, ticks were collected and confined with captured bats in bags in order to demonstrate that bats were actually serving as hosts as well as to provide fed specimens for rearing and for other purposes.

Search of rock crevices at or near bat roosting sites proved to be an excellent method for finding parasites. In caves inhabited by small numbers of bats, such sites were indicated by the

presence of small mounds of guano directly below them.

Examination of guano for ticks, fleas and other arthropods such as beetles and spiders was facilitated by collecting samples in bags for later inspection under circumstances permitting more careful search.

It is perhaps unnecessary to add that when collecting in caves a good light is essential both for safe traveling and in searching for specimens. The writer has found that in addition to a flashlight, a miner's carbide lamp is very useful. To have a flashlight fail when one is working in the farther recesses of a large bat cave adds nothing to the enjoyment of work that has its unpleasant aspects at best. Besides the vials, forceps, etc., a tool such as a strong screw driver is essential for use in prying off loose pieces of rock in order to search for parasites in crevices. Particularly desirable would be a jaded sense of smell to enable the collector to tolerate the almost overpowering stench present in poorly ventilated caves harboring many thousands of bats. Some relief can be obtained, however, by the use of a mask, the filter pad of which is saturated with a strong vinegar solution.

A List of Specimens:

BRACKEN CAVE, Comal County

BATS

Tadarida mexicana (Saussure) det K. E. Stager
Myotis velifer incautus (Allen) det K. E. Stager

TICKS

Ornithodoros stageri Cooley and Kohls
det R. A. Cooley
on guano. (Parasitic on bats.)

MITES

Liponyssinae det H. E. Ewing
on bats.

BEETLES

Alphitobius diaperinus (Panz.) det R. E. Blackwelder
on guano.
Trox suberosus F.
on guano.
Dermestes carnivorus F. det H. S. Barber
Very numerous on guano. Large numbers
clustered around and feeding on dead bats.

¹ From the Rocky Mountain Laboratory, Hamilton, Montana, Division of Infectious Diseases, National Institute of Health.

² United States Public Health Service.

STREBLIDS		
<i>Trichobius major</i> Coquillett		det C. H. Curran
on bats.		
FLEAS		
<i>Sternopsylla texana</i> (Fox)		det G. M. Kohls
on bats.		
<i>Myodopsylla collinsi</i> Kohls		det G. M. Kohls

BREHMMER CAVE, Comal County

BATS		
<i>Myotis velifer incautus</i>		det K. E. Stager
TICKS		
<i>Ornithodoros yumatensis</i> Cooley and Kohls		det R. A. Cooley
on guano and in crevices.		
MITES		
<i>Spinturnix grossus</i> (Banks)		det H. E. Ewing
<i>Liponyssinae</i> sp.		det H. E. Ewing
on bats.		
FLEAS		
<i>Myodopsylla collinsi</i> Kohls		det G. M. Kohls
on bats.		
STREBLIDS		
<i>Trichobius major</i> Coquillett		det C. H. Curran
on bats.		
SPIDERS		
<i>Gaucelmus angustinus</i> Keyserling		det W. J. Gertsch
<i>Cicurina</i> sp.		det W. J. Gertsch
CAVE CRICKETS		
<i>Ceuthophilus conicaudus</i> Hubbell		det T. H. Hubbell
<i>Ceuthophilus cunicularis</i> Hubbell		det T. H. Hubbell

LITTLE BREHMMER CAVE, Comal County

TICKS		
<i>Ornithodoros yumatensis</i> Cooley and Kohls		det R. A. Cooley
in rock crevices.		
<i>Ixodes conepati</i> Cooley and Kohls		
New species described in 1943 ¹ . Host of one specimen found in this cave is not known. A paratype was taken from <i>Conepatus</i> sp., Brewster Co., Texas.		
SPIDERS		
<i>Latrodectus mactans</i> F.		det W. J. Gertsch
SCORPIANS		
<i>Vejovis crassimanus</i> Pocock		det W. J. Gertsch
CAVE CRICKETS		
<i>Ceuthophilus secretus</i> Scudder		det T. H. Hubbell
<i>Ceuthophilus conicaudus</i> Hubbell		det T. H. Hubbell

WEBB CAVE, Kinney County

BATS		
<i>Myotis velifer incautus</i>		det K. E. Stager
FLEAS		
<i>Myodopsylla collinsi</i> Kohls		det G. M. Kohls
STREBLIDS		
<i>Trichobius major</i> Coquillett		det C. H. Curran
BEETLES		
<i>Dermestes carnivorus</i> F.		det H. S. Barber
<i>Embaphion</i> near <i>muricatum</i> Say		det R. E. Blackwelder
<i>Embaphion</i> near <i>contractum</i> Blair		det R. E. Blackwelder
CAVE CRICKETS		
<i>Ceuthophilus cunicularis</i> Hubbell		det T. H. Hubbell

NEY CAVE, Medina County

BATS		
<i>Tadarida mexicana</i>		det K. E. Stager
TICKS		
<i>Ornithodoros stageri</i> Cooley and Kohls		
Originally found by Stager in Ney Cave in 1939. Described by Cooley and Kohls in		

1941². Numerous specimens found by Jellison and Kohls on the guano on top of large rocks on floor of cave. *This tick will bite man readily when opportunity affords.*

Antricola coprophilus (McIntosh) det G. M. Kohls
Found on guano in deeper recesses of cave. Hosts undoubtedly are bats.

CIMICIDAE

Primicimex cavernis Barber
New species described by Barber⁴ in 1941. This new genus and species was first collected by Mr. Stager in Ney Cave in 1939. Numerous specimens found by Kohls and Jellison in this cave in 1940. Specimens found on guano and rocks on floor of cave, also on walls. None actually found on bats.

BEETLES

Dermestes carnivorus F. det H. S. Barber
Trox suberosus F.

STREBLIDS

Trichobius major Coquillett det C. H. Curran
Trichobius sphaeronotus Jobling det C. H. Curran

FLEAS

Sternopsylla texana (Fox) det G. M. Kohls

FRIO CAVE, Uvalde County

BATS		
<i>Tadarida mexicana</i>		det K. E. Stager
<i>Myotis velifer incautus</i>		det K. E. Stager
TICKS		
<i>Ornithodoros concanensis</i> Cooley and Kohls		
New species described in 1941 ³ . Collected from guano and rock crevices.		
<i>Antricola coprophilus</i> (McIntosh)		det G. M. Kohls
FLEAS		
<i>Sternopsylla texana</i> (Fox)		det G. M. Kohls
STREBLIDS		
<i>Trichobius major</i> Coquillett		det C. H. Curran
<i>Exceedingly abundant and extremely annoying.</i>		
<i>Trichobius sphaeronotus</i> Jobling		det C. H. Curran
CAVE CRICKETS		
<i>Ceuthophilus cunicularis</i> Hubbell		det T. H. Hubbell

REFERENCES

- COOLEY, R. A. and KOHLS, GLEN M.: *Ixodes californicus* Banks 1904, *Ixodes pacificus* n. sp. and *Ixodes conepati* n. sp. (Acarina: Ixodidae). *Pan-Pac. Entomol.* 19: 139-147, 1943.
- COOLEY, R. A. and KOHLS, GLEN M.: Three new species of *Ornithodoros* (Acarina: Ixodoidea). *Pub. Health Rep.* 56: 587-594 (March) 1941.
- COOLEY, R. A. and KOHLS, GLEN M.: Further new species of *Ornithodoros* from bats (Acarina: Argasidae). *Pub. Health Rep.* 56: 910-914 (April) 1941.
- BARBER, HARRY G. Description of a new bat bug (Hemiptera-Heteroptera: Cimicidae). *J. Wash. Acad. Sci.* 31: 315-317, 1941.

Rare Cave Crickets

In an unnamed cave near Phantom Lake, Toyahvale, Jeff Davis County, in 1938, Dr. Carl L. Hubbs collected eleven specimens of the pale cave cricket, *Ceuthophilus carlsbadensis*.¹ This was the first time it has been found away from the vicinity of Carlsbad Cavern.—T. H. HUBBELL.

¹ HUBBELL, T. H. A Monographic Revision of the Genus *Ceuthophilus*. *Univ. Fla. Publ., Biol. Sci., Series* 2 (1), 1936.

Phosgene in the Dark?

An unusual report dealing with cavern gas has been made by B. H. Cartwright of Boerne, the former owner and developer of Fairy Cave and a pioneer Kendall County cave explorer.

Mr. Cartwright reports that while exploring a water cave near the town of Edge Falls (Edge Falls Cave) his party of about 11 persons encountered a gas which produced extreme fatigue and sleepiness. According to the report, the gas bubbled up through the water as though it had been released by the treading of the explorers through the deep, clinging mud. The effects were most manifest to those walking in the rear of the party which was strung out single file. Mr. Cartwright, the fifth in line, felt severe effects but persisted in his journey. However the six men behind him were forced to abandon the trip. The effect was so severe that Mr. Cartwright says it "cured" him of cave exploration for all time. He reports that a mining engineer to whom he described the incident said that the gas was probably phosgene released by their treading in the mud.—P. J. W.

A Texas Snake Den

Writing on "The Problem of Too Many Snakes," Dr. Harold K. Gloyd (1944, *The Chicago Naturalist*, 7 (4): 87-97) published a photograph of four rattlesnakes in a cave near New Braunfels, Texas. I wrote to Dr. Gloyd and learned that the cave is on the ranch of E. L. Heidrich.

"On our short stay in that vicinity, in the summer of 1931," wrote Dr. Gloyd in a letter to me, "I did not learn much about the caves or their inhabitants. I was told that in the late '20's a chap named Carlson collected a large number of diamond-backed rattlesnakes in these caves. He made some very striking photographs which he sent to me about that time. The snakes shown in my photograph were caught in the immediate vicinity and brought into the cave for the picture. Heidrich said that he had seen them often, but that they seldom went very far away from the en-

Inspiration

Raymond Medellin and I had come up across the mountains all the way from Acapulco on the sea in a car of such venerable age that we were prepared to abandon it in the event of a major breakdown. Dog tired, we had spent the previous night in the open atop a cold and drizzly 10-thousand foot pass, we stabled the car in a small garage in Mexico City one night and did not return for it for two days.

It developed that during our absence joy riders "borrowed" it from the garage and after some 14 hours returned it unharmed. Subsequent investigation revealed the "borrowers," and poetic inspiration in their choice. The ancient vehicle which had taken Medellin and me to caves all over Texas and Mexico had been chosen to go a 'caving once again—to Mexico's great subterranean wonder, Cacahuamilpa Caverns, which the "borrowers" had never seen.—PATRICK J. WHITE.

trance. The arrangement of the snakes was made under his supervision in an effort to simulate a situation similar to those which he had observed on occasions earlier in the season."—JAMES A. FOWLER, *Academy of Natural Sciences of Philadelphia*.



Harold K. Gloyd, Courtesy of *The Chicago Naturalist*
DIAMOND-BACKED RATTLESNAKES pass winter in cave.

Speleological Abstracts

Compiled by EDWARD F. MOORE and E. L. KRINITZSKY

THIS BIBLIOGRAPHY will be continued from time to time in the *N. N. S. Bulletin*. It will contain complete bibliographic descriptions and short abstracts of each publication included. The number of items which could be listed is so large that no attempt can be made to attain completeness, except that all known journals published by speleological societies or devoted exclusively to speleology will eventually be listed.

Of the other items (i.e., books and articles concerning caves), most have been rejected as being only of local interest. Publications have been selected for inclusion only if they have one or more of the following properties: general interest, special scientific value, definitiveness, importance, or an extensive bibliography. However, the omission of any publication does not imply that the compilers think it lacks all of these qualities, for a large number of references have been considered but omitted this time because they deal with other aspects of caves than are included in this first part of the bibliography, or else because no copy has yet been consulted. These publications will eventually be included.

Nevertheless, there are undoubtedly many equally important books which have been overlooked entirely. Therefore, suggestions of items for future inclusion will be welcomed.

An attempt will be made to include in the successive parts of this bibliography the most important works concerned with each of the scientific aspects of caves (as well as unusual scientific papers devoted to special cave subjects of probable interest, and also other books of less scientific value devoted to general descriptions of caves for their own sake), but the perspective of the compilers will naturally be restricted by the limitations of their experience, scientific training, and present knowledge. Suggestions (and even abstracts) of appropriate publications are especially solicited relating to those subjects which have not yet been treated.

In order to make this bibliography more generally useful, each part will be devoted prin-

cipally to some particular kind of subject matter. Parts contemplated for the near future include *Speleological Periodicals*, *Cave Biology*, and *Cave Archaeology and Art*, in addition to other, more specific, subdivisions.

In the case of recent (since January, 1947) publications, the standards for inclusion have been somewhat relaxed in an effort to encourage the dissemination of new information. These recent abstracts, regardless of their subject matter, will be published as soon as possible after the appearance of the original publication.

A larger amount of information is included than is customary in bibliographies, because of the international scope of the work, and also because of the difficulties often encountered in locating material of this nature when it is wanted. Also this policy will enable this bibliography to be used to assist the purchases and exchanges of the various individual and speleological society libraries throughout the world.

To assist in locating copies of the publications listed, location symbols for several libraries in which one is to be found have been appended. The standard location symbols used in the *Union List of Serials* have been employed (which begin with the initial letter of the state in which the library is located: e.g.; DGS for the U. S. Geological Survey Library, Washington, D. C.; DLC for the Library of Congress, Washington, D. C.; ICJ for the John Crerar Library, Chicago; MH for the Harvard University Libraries, Cambridge, Mass.; NNM for the Museum of Natural History, New York; PPA for the Academy of Natural Science of Philadelphia; RPB for the Brown University Libraries, Providence, Rhode Island; and VBP for the Virginia Polytechnic Institute Library, Blacksburg, Va.). Also the symbols BM, DNSS, and EFM have been introduced for the British Museum, the N.S.S. Library, and the personal collection of E. F. Moore, respectively.

In the case of individual articles from periodicals, the references have been arranged and punctuated as follows:

Full name of the author, [date of birth-date of death]: Title of Article, *Name of Journal* Volume (Number): inclusive pages (date of publication). [Language in which article is written. Statement as to whether or not copies of the article or back numbers containing it can be purchased, and if so, the price, and the address to which orders should be sent. Location symbols of libraries in which the article can be consulted.]—Abstract and evaluation of article.—Extent and nature of the bibliography with the article, unless it consists merely of the customary footnotes.

As is conventional, brackets [] have been placed around any information not stated in the article itself. To avoid confusion, the titles of journals have not been abbreviated at all (except where the exact full titles have been given as a footnote).

Obvious modification of the above format have been used in the case of books and entire speleological journals.

Acknowledgements and thanks are due to many who have contributed reprints, and especially to P. A. Chappuis, G. Platten, C. E. Mohr, E. Simpson, R. de Joly, R. E. Morgan, and W. J. Stephenson, for suggestions, assistance, and information received for use in this and future parts of the bibliography.

Part 1a—Cave Geology

(including *General Description of Caves*)

1. BRETZ J HARLEN, [1882-]: Vadose and Phreatic Features of Limestone Caverns, *Jour. Geol.* 50 (No. 6): 675-811 (August-September, 1942). [In English. Availability¹. Location¹: DNSS, EFM.]—This is a long and exhaustive scientific study which treats a great variety of cave geology problems. The author upholds the Davis two-cycle theory of cave origin but introduces a third cycle of clay fill.

2. DAVIS, W[ILLIAM] M[ORRIS], 1850-1934]: Origin of Limestone Caverns, *Bull. Geol. Soc. Am.* 41 (No. 3): 475-628 (September, 1930). [In English. Availability². Location²: DNSS, EFM.]—The paper is a monumental and exhaustive scientific study which deals with practically all of the geological aspects of cave science. In particular, cave origin is dealt with at great length with the author introducing his

two-cycle theory which postulates an abrupt change of conditions between the stages of cave enlargement by solution and cave replenishment with dripstone.

3. DOLE, R[ICHARD] B[RYANT], 1880-1917]: Use of Fluorescein in the study of Underground Waters, *U. S. Geological Survey Water Supply Paper* 160:73-85 (1906). [In English. Out of print. Location: DGS, DLC, MH, RPB.]—The standard procedure is described for tracing the flow of underground streams by adding fluorescein and noticing the location of its re-appearance. Discussion is given of the conditions under which this method can be used and the time and quantities required. The information is compiled entirely from results published in France.—Bibliography contains 69 items, all of which are in French.

4. GARDNER, JAMES H[ENRY], 1883-]: Origin and Development of Limestone Caverns, *Bull. Geol. Soc. Am.* 46.2 (No.8): 1255-1274 (August, 1935). [In English. Availability². Location².]—The writer covers several cave geology topics in addition to the origin problem, and deals with specific caves. Origin of limestone caves is attributed to the tapping of static water zones in porous strata which are cut into by surface streams during base-levelling. As a side-issue, Gardner asks why fossil caves are not found in ancient calcareous rocks.

5. HENDERSON, JUNIUS, [1865-]: Caverns, Ice Caves, Sinkholes, and Natural Bridges, *University of Colorado Studies* 19 (No. 4): 359-405 and 20 (No. 2/3): 115-158 (October, 1932 and February, 1933). [In English. Available for \$3.00 from Editor of University of Colorado Studies, Boulder, Colorado. Location: BM, CLU, DGS, DLC, DNSS, EFM, ICJ, ICU, MH, NNM, PPAN, RPB, VBP.]—This article contains lists of each of the states and countries in which the author could find records of the occurrence of caverns, ice caves, sinkholes, and natural bridges, together with summaries of and references to the original information. Much miscellaneous information of doubtful scientific value is included.—Bibliography contains 314 items, and is particularly good on U. S. caves.

6. HORUSITZKY, HENRIK, [1870-]: *A Magyarországi Barlangok s az Ezekre Vonatkozó Adatok Irodalmi Jegyzéke*: 77 pp., Budapest (1914). [Parallel columns in Hungarian and German. Location: DGS.]—An exhaustive review and bibliography of the Hungarian literature (both biological and geological, with other material also) on caves from 1549 to 1913. There are critical comments on the contributions of each of the authors cited. —Bibliography includes 699 references.

7. HOVEY, HORACE C[ARTER, 1833-1914]: *Celebrated American Caverns, Especially Mammoth, Wyandot, and Luray*: 228pp., Cincinnati, R. Clarke & Co. (1882 [and later editions.]) In English. Out of print. Location: BM, DGS, DLC, DNSS, EFM, MH, RPB.]—The author of this book was a clergyman who had sufficient interest in caves to write approximately thirty popularized books, pamphlets, and articles about them, of which this one is the best known. This book was written to give popular descriptions of the commercial caves listed in the title, but there are also several chapters containing varied compilations of miscellaneous information about caves in general. These and the widespread distribution of the book in American collections and libraries have caused this book to be better known and quoted more frequently than any other American book on caves. —Many bibliographic references are given in the text, but the information is sometimes so incomplete that it is impossible to identify the book referred to.

8. LANDES, KENNETH K[NIGHT, 1899-]: *Caverns in Loess, American Journal of Science* 225 (No. 146): 137-139 (1933). [In English. Back copies available from American Journal of Science, New Haven, Conn., for \$.60. Location: DGS, ICJ, MH, PPAN, RPB.] —Landes reports one cave and two sinks, which may have been caves, as occurring together in loess in Mitchell County, Kansas. It is suggested that solution of a pebble layer formed an initial tiny tube into which roof falls of loess were dropped and thereby removed by water. This is perhaps a unique report of cave excavation in an insoluble material of this sort. —No bibliography.

9. MCGILL, WILLIAM M[AHONE, 1897-]: *Caverns of Virginia, Virginia Geological Survey Bulletin* 35: 187 pp. (1933). [In English. Available for \$1.00 from the Virginia Geological Survey, University, Va. Location: DGS, DLC, DNSS, EFM, MH, NNM, VBP.]—This is a large, beautifully printed and well illustrated collection of popularly written, lengthy descriptions of most of the commercial caves in Virginia. It has very little factual information of scientific value. —Bibliography contains about 50 titles, with emphasis on Virginia caves.

10. MALOTT, CLYDE A[RNETT, 1887-]: *Invasion Theory of Cavern Development, Proceedings of the Geological Society of America* 1937: 323 (Abstract). [In English. Location: DGS, MH, NNM, PPAN, RPB.]—The author presents the view that large caverns are formed chiefly by diverted surface waters in underground routes.

11. MARTEL, E[DOUARD] A[LFRED, 1859-1938]: *Nouveau Traite des Eaux Souterraines*: 838 pp., Paris, Librairie Octave Doin (1921). [In French. Out of print. Location: BM, DGS.]—The author of this book undoubtedly explored more caves and did more to arouse interest throughout Europe in speleology than any other person. He devoted his life to speleology, writing hundreds of articles and books on the subject. He was the first to explore many deep vertical caves in England, France, and elsewhere. Unfortunately, although he knew far more from his experience about the structure and morphology of caves than anyone else has known before or since, his attitude toward the theoretical aspects of cave geology was somewhat unscientific. By virtue of his great experience he set himself up as an authority, and he tended too much to ridicule all geologists and geographers who disagreed with his own theories (some of which now appear rather preposterous) on cave origin and hydrology. Nevertheless, this book is very valuable because it is usually quite factual and contains much detailed information and accurate data gleaned from a lifetime of extensive exploration, observation, and reading. It deals, despite its somewhat more general title, mainly with caves, and karst and cave hydrology. —Bibliographies

at the end of each chapter are thorough and contain, altogether, several hundred references.

12. MONEYMAKER, BERLEN C[LIFFORD, 1904-]: Subriver Solution Cavities in the Tennessee Valley, *Jour. Geol.* 49 (No. 1): 74-86 (1941). [In English. Availability¹. Location¹: DNSS, EFM.]—This author produces evidence that solution can occur below the water table. His investigations have shown large cavities as much as 100 feet below the water table and directly under the course of the Tennessee River.

13. PUIG Y LARRAZ, GABRIEL: Cavernas y Simas de Espana, *Boletin de la Comision del Mapa Geologico de Espana* 21: 1-443 (1896). [In Spanish. Available from the Instituto Geologico y Minero de Espana, Rios Rosas 9, Madrid, Spain. Location: BM, CLU, DGS, DLC, EFM, ICU, MH, NN.]—This comprehensive and well-indexed compilation lists approximately 2000 caves of the Iberian peninsula and adjacent islands. It gives locations and short descriptions of all of them for which such information was available. —Bibliography contains 141 items, mainly Spanish, with abstracts of most, and is well indexed.

14. SWINNERTON, A[LLYN] C[OATS, 1879-]: Origin of Limestone Caverns, *Bull. Geol. Soc. Am.* 43 (No. 3): 663-693 (September, 1932). [In English. Availability². Location²: DNSS, EFM.]—The author reviews the literature on cave origin, discussing the Davis two-cycle hypothesis and the Matson view of the vadose water theory. Discussions are made of related topics of ground water movement, physiographic development, and physical chemistry. A lateral-flow hypothesis of cave origin is suggested.

15. TENNESSEE ACADEMY OF SCIENCE: *Journal of the Tennessee Academy of Science* 5 (No. 3): 136 pp. (July, 1930). [In English. Available for \$.50 from Kendall Born, 929 Woodmont Blvd., Nashville 5, Tenn. Location: BM, DGS, DLC, DNSS, EFM, MH, PPAN.]—This entire number consists of five popularly written articles on the different scientific aspects of caves, and there are numerous photographs (particularly of cave deposits) from the various commercial caves of Tennessee.

16. WALTERS, ROBERT F.: Buried Pre-Cambrian Hills in Northeastern Barton County, Central Kansas, *Bulletin of the American Association of Petroleum Geologists* 30 (No. 5): 660-710 (1946). [In English. Available for \$1.50 from American Association of Petroleum Geologists, Box 979, Tulsa 1, Oklahoma. Location: DGS, ICU, MH, PPAN.]—This paper contains one of the very few discussions in geologic literature of ancient buried cave areas. Oil well borings have unearthed buried Cambro-Ordovician rocks which had been in the form of a youthful karst plain pitted with sinkholes and solution valleys. These valleys are partly filled with untransported leached residuum, which is immediately overlain by a thousand foot thickness of marine sediments.

Part 1b—Recent Publications

17. BAKER, GEORGE, and FROSTICK, A. C.: Pisoliths and Ooliths from some Australian Caves and Mines, *Journal of Sedimentary Petrology* 17 (No.2) 36-67 (August, 1947). [In English. Available for \$1.50 from P.O. Box 979, Tulsa 1, Oklahoma. Location: CU, CLU, ICJ, ICU, MH, PPAN.]—This paper is a thorough and excellently illustrated treatment of the calcareous concretions which develop in the pools on the floors of caves and mines. The investigation indicates that foreign nuclei are not essential for the development of pisoliths, and that rolling is necessary for the buffing and polishing leading to the development of cave pearls. —Bibliography contains 26 references.

18. BRITISH SPELEOLOGICAL ASSOCIATION: *Cave Science* No. 1: 1-33 (June, 1947); No. 2: 34-67 (September, 1947). Published at Settle. [In English. Available³ at 4/6 per copy for non-members from B.S.A. Publications, Duke Street, Settle, Yorkshire, England. Location: DNSS, EFM.]—This mimeographed journal will be published several times per year. It is intended to replace *Caves and Caving*, which will not resume publication. Each number contains a "Scientific Research Section" consisting of several well-written articles giving popularized expositions of mineralogical, geological, and biological aspects of caves. The remainder of each issue is devoted principally to accounts of explorations of individual British caves, to-

gether with some miscellaneous non-scientific and news articles. Several cave maps and pictures printed on glossy paper are bound in with each number.

19. CAVE RESEARCH GROUP: *Newsletter* No. 1- (February, 1947-). [In English. Available³ by membership and at 3/-per number for non-members from Cave Research Group secretary E. A. Glennie, 99A, Cross Oak Road, Berkamstead, Herts., England. Location: DNSS, EFM.] —This mimeographed publication appears monthly and contains about 6 pages per issue. It gives news of the activities of many speleological societies in England and throughout the world, and also contains short signed discussions concerning speleological nomenclature, standard symbols for cave maps, cave fauna information and lists, mineralogy, and the origin and development of caves. Occasional printed illustrations. —Contains book reviews, list of the Group library, and other scattered bibliographic references.

20. GLENNIE, E [DWARD] A [UBREY, 1889-]; *Cave Fauna, Cave Research Group Publication* No. 1 (Part 1), 16 pp. (1947). [In English. Available³ for 10/—from Cave Research Group Secretary E. A. Glennie, 99A, Cross Oak Road, Berkhamstead, Herts., England. Location: DNSS, EFM.]—An introduction to the study of cave fauna, outlining the history, classification and terminology, evolutionary and ecological questions, and special environmental conditions. —Bibliography contains 21 titles, and is general in scope.

21. HAZELTON, MARY, and GLENNIE, E [DWARD] A [UBREY, 1889-]; *Cave Fauna, Preliminary List, Cave Research Group Publication* No. 1 (Part 2), vi+20 pp. (1947). In English. Available³ for 10/—from Cave Research Group Secretary, E. A. Glennie, 99A, Cross Oak Road, Berkhamstead, Herts., England. Locations: DNSS, EFM.]—A check list of 196 species of cave fauna collected in the British Isles. —Bibliography contains 23 references giving sources of some of the information.

22. KRINITZSKY, E [LLIS] L [OUI, 1924-]; *A Fault-Plane Cavern, Journal of Geology* 55 (No. 2): 107-119 (March, 1947). [In Eng-

lish. Availability¹. Location¹: DNSS, EFM.] —The Goodwins Ferry Cave, located in Giles, County, Va., is presented as being situated on a fault plane of large magnitude, and is presumably the only such cave reported in the North American literature. Origin through hydrological control by a nearby major river is suggested, as well as is a possible correlation with the regional physiographic history. The helictites from the cave are described, and possible tectonic influences on rock falls are discussed.

23. STONE, RALPH W [ALTER, 1876-]; *Speleology, a New Field of Science, Proceedings of the Pennsylvania Academy of Science* 21: 80-83 (1947). [In English. Reprints available from author. Location: DGS, DLC, DNSS, EFM, ICJ, NNM, PPAN.]—A popularly written review of the opportunities and possibilities of various kinds of scientific work related to caves.

24. THORNBURGH, NORMAN: *Pennine Underground*: 208 pp. (1947). [In English. Available³ for 4/9 from the Dalesman Publishing Co., Clapham (Yorkshire) Via Lancaster, England. Location: DNSS, EFM.]—A guidebook for cave explorers with locations and descriptions of several hundred caves of the Northern Pennine country (England). —No bibliography.

25. JANSSEN, RAYMOND E [LLSWORTH, 1903-]; *Wonders Underground, Natural History* 56 (No. 10): 440-447 (December, 1947). [Back copies available for \$0.50 from Amer. Mus. of Natural History, 79th St. and Central Park West, New York 24, N. Y. Location: BM, DGS, DLC, DNSS, ICJ, ICU, MH, NNM, PPAN, VBP.]—An informative non-technical article about caves and cave geology. —No bibliography.

AVAILABILITY

¹ Back Copies of *The Journal of Geology* are available at \$1.25 each (\$1.35 to foreign countries) from the Univ. of Chicago Press, 5750 Ellis Ave., Chicago, Ill. It is located in the following libraries: BM, CLU, DGS, DLC, ICJ, ICU, NNM, MH, PPAN, VBP.

² Back copies of the *Bulletin of the Geological Society of America* are available at \$1 each (\$2.50 for the number containing the Davis article) from the Geological Society of America, 419 W. 117th St., N. Y. 27, N. Y. Location: BM, CLU, DGS, DLC, ICJ, ICU, NNM, MH, PPAN.

³ American orders accepted by LeRoy Foote, R.D. No. 1, Middlebury, Conn.

Review: Early Man

SELLARDS, E. H. *Early Man in America, Index to Localities and Selected Bibliography, 1839-1939.*

Geological Society of America, Bulletin 51, 373-431, March 1940.

—Early Man in America, Index to Localities and Selected Bibliography, 1940-1945.

Geological Society of America, Bulletin 58, 955-978, October 1947.

In any science one of the most important reference tools is a bibliography. Unfortunately speleology lacks a comprehensive bibliography but to some extent this is compensated by bibliographies in the various specialized branches of other sciences that make up speleology. A recent bibliography of this type is E. H. Sellards' work on Early Man in America.

The first part of this bibliography was published in 1940 and covered the period 1839 to 1939. The second part covers 1940 through 1945. Since the bibliographies are supplementary and similar in style they are reviewed as a unit.

The bibliographies cover references to localities throughout Alaska, Canada, Mexico, Cuba, Nicaragua, Ecuador, Chile, Argentina and the United States (28 States). About 700 references are cited in the bibliographic sections and over 152 localities are briefly described as to condition of occurrence and association with

geologic formations and mammalian fossil faunas. Occasional illustrations amplify the text.

These works of E. H. Sellards are of considerable use to the speleologist. Seventeen caves are cited in the List of Localities which is a fairly complete listing of all caves in the Western Hemisphere where remains of ancient man have been found. In addition the listings serve to add several caves to the records of those now on file at the National Speleological Society. The brief descriptions of localities, while ranging from a few words to many paragraphs, are concise yet comprehensive enough to give a good picture of the condition of the site.

In concluding it seems appropriate to mention two similar bibliographies that have appeared in print recently. The periodical, *American Antiquity*, regularly publishes bibliographies that contain considerable information on speleology. Brew's recent work on American Indians* also is a "must" on all speleologist's book shelves.

Dr. Sellards' bibliographies should be accepted as a guide by all speleologists towards the production of similar references, so obviously missing, yet so urgently needed in speleology.

—W. E. D.

* BREW, JOHN OTIS. A Selected Bibliography of American Indian Archeology East of the Rocky Mountains, *Excavators Club Papers*, 2 (1): 1-90, 1943.

Blind Fish

(continued from page 111)

southernmost Bexar County), the fish live under great hydrostatic pressure.

Other specimens of blind fish from wells have been reported. Unfortunately none have been preserved. Member Patrick J. White made vigorous but unsuccessful radio appeals for information on specimens which might be in private hands. No blind fish have been collected in Texas caves, but their occurrence seems almost a certainty in view of the extensiveness of underground solution channels in this region.

REFERENCES

¹ EIGENMANN, CARL H. *Trogloglanis pattersoni* a New Blind Fish from San Antonio, Texas. *Proc. Amer. Phil. Soc.* 58: 397-400, Figs. 1-2. 1919.

² HUBBS, CARL L., and REEVE M. BAILEY. Blind Catfishes from Artesian Waters of Texas. *Occ. Papers Mus. Zool. Univ. Mich.* 499: 1-15, Pl. 1. April 28, 1947.

An unusual phenomenon called the *Devil's Kitchen* may be seen on the Short Ranch southwest of Kerrville, just within the borders of

Bandera County. Five or six acres have apparently dropped about 40 feet. This great depression is surrounded by sheer cliffs and there are only two or three passes to the floor which is heavily wooded and a favorite lair of small animals.

Audubon Camp in Cave Country

During the summer of 1948 the National Audubon Society will operate a 10-week nature and conservation camp for teachers, youth leaders, and other adults in the neighborhood of some of Texas' best caves.

The camp will be conducted at Kerrville, within 40 miles of Ney Caves and two commercial caves. Other interesting caves are even closer.

The spectacular bat flight at Ney Cave and fossil and geological attractions at other underground sites will provide unique objectives for field trips.

Grotto Reports

Introduction

The following reports from the various grottoes of the National Speleological Society were written in the latter part of February. They bring the latest word of what's happening in the centers of speleological activity in this country.

It is encouraging to see how many of the reports mention programs on SAFETY and of steps being taken to insure that adequate safety rules be observed in all cave exploration. Noteworthy, too, are the different references to definite projects being undertaken by the grottoes, and services rendered to the Society as a whole.

Appended to every report was a cordial invitation to all NSS members to "visit with us" anytime they are in the area. In order to conserve space, the many invitations are condensed into this paragraph.

Finally, a word to NSS members who don't belong to a grotto. It's easy to form a grotto—only five members are needed. As Charlie Erftenbeck says below, "Caving by oneself lacked something." So he went out and rounded up enough members to form a grotto. That is when caving really begins. Philadelphia Grotto grew from five to forty members in one year. Let's have more grottoes! —Ed.

CHARLESTON

The Charleston, W. Va., Grotto was founded in the spring of 1946, mainly through the untiring efforts of Alice Williams. Without her enthusiasm for caving and the NSS, I believe that Charleston would still be without an organized Grotto. Charleston is located in Kanawha County and its present enrollment of sixteen represents numerous vocations including chemists, chemical engineers, bankers, stenographers and college students. However, we cannot boast of any speleologically inclined scientists and, as a result, we find that our chief purpose as a Grotto is to enjoy cave exploring as an excellent form of recreation.

Theoretically, our Grotto meets only once a month but actually we meet three or four days prior to each field trip to make detailed plans for exploring a particular cave area. Since we have an average of only ten members present at each meeting, we are still able to use the time honored custom of meeting in the homes of various members. When, and if, our active

membership increases, we will probably be forced to hold open air meetings, S. A. fashion.

From Charleston, W. Va., to the nearest cave area, is slightly over 100 miles of "West Virginia quality" highway. We, therefore, limit our field trips to a radius of 225 miles, which includes Greenbrier, Monroe, Pocahontas, Hardy, Tucker, Pendleton, Randolph and Grant Counties. We further limit our systematic exploring to W. Va. since we feel that there is plenty of virgin territory to explore without looking for more on the other side of the "state fence."

Anyone who has ever talked with members of the Charleston Grotto will recognize the names of General Davis Cave, Hedrick's, Piercy's Mill, Mystic, Blowhole, Sneadegar's and many others. He who reads the Bulletin need not be reminded of Schoolhouse, Hell-Hole and Grapevine, since these caves have certainly received their share of superlatives. Dr. Henri Herrot (now in France) is probably still untangling the 300 blind beetles which he collected in five hours in General Davis Cave in 1946 with his special "beetle-picker-upper." His French exclamations while collecting this unprecedented number of beetles is, unfortunately, not printable. Piercy's Mill still claims undisputed title to the largest rimstone formations in any cave in the country. How was the bath, "Pete," chilly? Our major discoveries of the 1947 season included Poorfarm, Head-of-mill-pond and Laurel Creek caves. Poorfarm Cave to date has not been completely explored. Head-of-mill-pond Cave has four walk-in entrances all communicating with the main portion of the cavern. Laurel Creek is still not entirely explored and possesses a yawning entrance 110 feet wide. Can you top this one?

Thanks to an inspiration of our Grotto founder, Alice Williams, the most interesting project that our Grotto has participated in was the trip into Greenbriar County with LIFE'S photographer (see LIFE Magazine November 4, 1946). Needless to say, we were an excited Grotto since we had only been chartered for six months and we did not know until 36 hours before we left that the trip was to be a reality. Then after all the backbreaking work we could not be assured that the pictures and article would appear in the magazine. The photographer was a swell fellow and a demon for work, accomplishing in a weekend what he normally would do in one week. Grapevine Cave was the last one photographed, however, and the over-ripe cows at the bottom of the pit produced an adverse effect on the photographer's constitution and almost cut the number of pictures of that cave to the vanishing point. The story of the trip was written from a remote point since the female script writer had a severe case of claustrophobia. She made three unsuccessful at-

tempts to go into Henrick's Cave and flatly refused to go down into "that dreadful hole" of Grapevine. It was only by constant reassuring and constant hand-holding (lucky boy) that yours truly was able to lead the little lady into Piercy's Mill Cave so that she would be able to write at least one portion of her report on the scene of action. It will be many-a-year before our members forget that trip.

In 1948 we plan to continue our overall policy which is, eventually, to locate accurately and explore every limesone cave in W. Va. In addition to the usual plotting of entrances, photography, collecting of specimens, etc., we plan to begin mapping operations in several of the larger caves. This work will be done under the able leadership of our 1948 Grotto Chairman, Lawry Bennetts. —BERTRAND L. ASH, 409 Columbia Ave., Charleston 2, W. Va.

CHARLOTTESVILLE

The Charlottesville Grotto was organized in November, 1946 and a charter was granted in the Spring of '47.

The Grotto is well situated with respect to some of the best cave territory in the country. This exploring territory is roughly limited by the quadrangle formed by Lexington, Va., Covington, Va., New Market, Va., and Franklin, W. Va., with special interest being given to Virginia's Augusta County.

During 1947 the Grotto made some 27 field trips to about 30 different caverns. Among these caverns the Grotto had two pets, Breathing (Sounding Knob) Cave and Gibson's Hole near Waynesboro, Va. Extensive exploration and mapping have been carried out in both. Other well known caverns visited by the group have been Clark's, Fountain, Madison, Sinnit, Mystic, Trout, Hamilton, Murdering Run, Hell-Hole, Grand and Endless Caverns, and Sinks of Gandy. The average attendance has been six persons per trip.

The Grotto has several special interests and aims. One of these is the survey of Augusta Co., Va. for hitherto unreported caves. Another aim is the filing of all known caves in the territory on "topo" maps, which project is now fairly well completed. Another project is to provide sketch maps of hitherto unmapped caves and parts of caves which are explored on Grotto field trips and the collection of all cave fauna encountered. (The fauna collection does not include bear too big to fit in collection bottles, nor stray NSS members.) Richard Hoffman and Dr. Hobbs of the University of Virginia's Biology Dept. are respectively interested in cave millipeds and cave crustacea (crayfish and all other little critters found in pools of water). They appreciate receiving reports from members in other localities regarding specimens.

Meetings are held every two weeks in the Grotto's "Den" in the Geology Bldg. of the University of Virginia. Attendance is usually about 10 members out of a total roster of 20. —KARL G. HENIZE, Box 1667, University, Charlottesville, Virginia.

CLEVELAND

In 1943 and 1944 a group of five Clevelanders, interested in hiking, photography, and adventure, became curious about caverns in Ohio and visited and explored every nook and cranny in the Cleveland and northern Ohio area. One day, while scanning a photography magazine, Bill Blaha came across an article on cave photography that mentioned the National Speleological Society and was prompted to write Secretary Petrie for information pertaining to the organization.

After thoroughly discussing the possibilities and advantages of joining the National Speleological Society all five Clevelanders signed up for membership, and upon receiving notice that a group of five or more were eligible to form a Grotto, promptly sent in their application for same, which application was accepted and approved by the Board of Governors at the January meeting in 1945. William G. Blaha (Bill) is president and Al Mislav is vice-president.

Meetings of the Grotto are very informal, held at various members' homes (mostly at the Blahas) whenever an occasion arises with something of interest to be presented or to be discussed by the members. Outings are planned with the prospect of further cave exploration in Ohio and the neighboring states.

In view of the fact that there are not very many caves in the Cleveland territory, and because not much traveling could be done in the winter months, the Grotto offered, in 1945, to take over the mimeographing and mailing of the monthly NEWSLETTER. Secretary Betty Yoe served as assistant editor to William S. Hill. After three years, due to the increased membership of the Society, the Clevelanders found it increasingly difficult for such a small group to continue the publication of the Newsletter, and in 1948 the Newsletter was transferred to the Philadelphia Grotto.

At the present time, the Cleveland Grotto is discussing possibilities of taking over some other project in connection with the Society that could satisfactorily be handled by a group of this size. Most of the members make it a *must* to attend the Annual Meeting in Washington, and of course try to take part in as many of the various caving expeditions as they possibly can. —BETTY A. YOE, 2618 East 89th St., Cleveland 4, Ohio.

DISTRICT OF COLUMBIA

This Grotto is located in Washington, D. C. It was not very active during the war but was rejuvenated in 1946, revised its Constitution in January 1947, and has been thriving ever since. Chairman John J. (Jack) Wilson heads the executive committee; Nancy Rogers is secretary, and W. Howard Watkins is treasurer.

Last year we had regular monthly meetings with speakers, sometimes our own members, but more often it was outside talent. While all the talks have not been concerned directly with caving, they have always referred to some outdoor activity of interest to spelunkers, such as minerology or rock climbing. We have also enjoyed some very interesting films. Having several amateur photographers in the group, we have the privilege of viewing beautiful color slides—and some very funny ones with ourselves as subjects.

Our early meetings, held in homes, were found to be somewhat crowded, so last year's chairman looked about for a more suitable meeting place that wouldn't be too expensive. We rented a room in a down-town K of C building but the room was rather depressing, due to age and lack of paint. This year we have been fortunate in securing a lovely room in All Souls' Unitarian Church which provides a congenial meeting place at a nominal rental. With about one hundred members in Washington and the surrounding suburbs, our attendance averages 25 to 30.

Because there are so many members of the N. S. S. in this area who are primarily interested in the Bulletin and publications of the National Society, and not in local activities, we have decided that we can offer to mail Grotto notices only to those members who show real interest.

So far, this Grotto has not planned regularly scheduled trips, but members are informed through our newssheet known as the *Speleograph* wherever a trip is set up. Individual members often get up trips on the spur of the moment, but these are not considered Grotto sponsored.

In order to finance the purchase of ropes and other equipment, each person going on a trip must pay a trip fee of 25c. The equipment chairman, in addition to taking care of Grotto owned equipment, keeps in stock such material as carbide, batteries, flash bulbs, caps, carbide light parts, etc. which members can purchase at regular retail prices. This gives the Grotto the income on sales and is very convenient for members. *Auto plates reading "Member of National Speleological Society" are available to any member of the N. S. S. at \$1.00 each.*

Last year our June meeting was in the form of a picnic—family style. It started out in a grand way, but a sudden violent thunder storm

ended the meal rather abruptly. We hope for better luck this year.

The eight people on our board are elected by written ballot by the Grotto membership. The Board chooses its own officers.

This year, at the request of the Convention Chairman of the N. S. S. our Grotto will act as official hosts at the Convention to be held April 2nd to 4th.

Our field trips reach into four states: Virginia, West Virginia, Maryland, and Pennsylvania, which means that caves of all kinds and sizes are within the circle of our activities—little ones, big ones, wet ones and dry ones, some that a novice can enjoy and others that call for veteran climbers. This area also takes in a great number of commercial caves, many of which are Institutional Members of the N. S. S., and all of whom are most congenial to our members.

Bill Stephenson reminds us every so often how much more we could do for the N. S. S. Now we are well under way, we may surprise him some day and do it. —CHRISSEY MANSFIELD, 3102 N. Pershing Drive, Arlington, Va.

ELKINS, WEST VIRGINIA

The earliest caving known to have been performed in the Elkins area by anyone of this generation, and to any extent, was by a group which called itself the A.C.E., Association of Cave Explorers. This group consisted of five or six high school boys who visited any hole within walking distance of Elkins. This sort of thing went on until one day in the summer of 1943 several of us met Mr. Sam Allen and party on their way to a small cave near Bowden, a settlement some nine miles from Elkins. Mr. Allen explained this mission and the talk that followed was naturally about caves. The day ended by his inviting Eugene Perkins and Robert Lutz to go on a trip to Mystic Cave in the near future, and they, of course, accepted with enthusiasm. With this trip they were invited to become members of the NSS and accepted.

At this time the war was in full swing and most of the old A.C.E. was in the service. However in the late spring of 1946 the greater percentage of the group was back from the corners of the world, and it was then but a short time till they were all out in the field again. Up until this time only two were members of the Society, but on the 4th of July of that year a group of them were attending the big doin' at Hell-Hole. Here Mr. Petrie applied his best arm-twisting technique and was rewarded with three new members. After this it was only a matter of time till the minimum number of members could be

recruited and plans for a grotto were started. Being a small group we have no definite time and place for meeting, getting together only when matters must be brought to the attention of the members.

Elkins is a city of some 10,000 located in the northeastern section of the main body of West Virginia, within easy driving distance of Washington, Pittsburgh, Richmond, Charleston, Bluefield, and Clarksburg. We sit on top of a small run of Greenbrier Limestone, depth of about 400-450 feet at Simmons Cave, with the old Ordovician at the Mouth of the Seneca, only 60 miles away to the southeast. Going south, as the crow flies, only 100 miles lie between us and the deep limestone of Lewisburg, and it is not more than a couple of hours driving time from Elkins to caves such as Hell-Hole, Mystic, Schoolhouse, Blow Hole, Poor Farm, Simmons, Gandy Sinks, Hermit, Falling Springs, and numerous other caves. There are 50 or more openings within a 20-mile radius of Elkins.

This proximity to the cave area would seem to indicate that we are unusually active. We usually have trouble, however, in getting more than five men in the field at a time, due to the divergence of occupation, leaving us nearly at a standstill in the winter when most of our members are away at school, or the roads are bad, and then anything is likely to happen.

Most of our work has been crawling into the many rat holes, trying to find a cave large enough to get more than three people in at a time. We have been successful at least twice, the first being the huge, tangled, treacherous black mass of Simmons at Mingo and the other being Falling Springs. Falling Springs Cave hasn't had a compass and surveying gear in it as yet. Simmons has a large map drawn from memory, since our notes were last seen disappearing down a deep chimney. The area on the Dry Branch of the Elk River is a mass of sink-holes yet to be looked into. —ROBERT L. LUTZ, 302 Center St., Elkins, W. Va.

LEXINGTON

In Lexington, there has always been great interest in caves, particularly Cave Springs, or the Geology Cave (this is called "Spring Hill" by the N. S. S. Why, we Lexingtonians have never figured out.) From time immemorial Washington and Lee and Virginia Military Academy students have been wallowing in Cave Springs mud without anyone's ever finding what could formally be called *an end* to this labyrinth. The latter fact, of course, adds glamour, and each new generation tries its hand without better luck and often without confirming the fabulous tales passed on from the previous ones. A visit to the cave is part of a Wash-

ington and Lee geology course, and here the story of the Lexington Grotto begins.

In October, 1946, Dr. Marcellus H. Stow headed a field trip in Physical Geology to Cave Springs. He gave his usual lecture on cave formation and characteristics, illustrating his talk with the real thing. This completed, he brought his group out, counted noses, and headed back to town and a hot shower.

The following morning four students who had been on the field trip didn't show up for class. This sounded the first note of alarm. Rapid inquiry by Dr. Stow revealed that none of the students had been in the previous night. Adding two and two together, the only answer was four students lost in Cave Springs. A hasty roundup of students with cave experience constituted an emergency rescue party.

Soon after entering the cave, the shouts of the rescue party were rewarded with return shouts, and the missing four were soon located. An explanation was in order, and it was simple. Possessed with the spirit of adventure, these four had returned to the cave after the dismissal of the field trip on the previous afternoon and had become so engrossed in exploring that they had completely failed to notice that their light resources were getting low. Realizing this too late, they did the wisest thing possible and "sat-tight", waiting to be looked for. None was the worse for wear, only cold and hungry (one scholar had burned his Greek notes to keep warm).

This story made nation-wide news, including broadcasts, and Lexington suddenly found itself thrilling with cave-consciousness. At this time President Stephenson of the NSS wrote Dr. Stow, inviting him to start a local Grotto. The latter gentleman, having enough geologic projects on hand to keep him busy *twenty-five* hours a day, turned the matter over to John Funkhouser, a natural history major at Washington and Lee, who had been exploring and studying caves for some years. The latter contacted Colonel R. P. Carroll, head of the VMI Pre-Medical Department, who also was interested in caves, particularly from a biological standpoint, and who had accumulated a mass of information on locations of local caves.

A short time later, the Lexington Grotto was officially formed with Dr. Stow and Colonel Carroll as advisors and Funkhouser as president. It was arranged to be composed jointly of VMI and W and L students, and townspeople.

Since its formation, the membership has averaged about twenty-five active participants. Being hindered both by lack of time and transportation, the activities have largely been local, and in this respect the group is lucky in having several caves within hiking distance. As with most Grottoes, there is a full proportion of those interested primarily in exploring and the "thrill

of caving", but the group is fortunate in having a large number of men with training and interest to do scientific work; and the science departments of both schools give their full backing and allow the use of their facilities. —JOHN W. FUNKHOUSER, 114 S. Lee Ave., Lexington, Va.

NEW ENGLAND

In the far dim past of our Grotto's history, there was a time in which we were dormant; but like all dormant things, if they are to live, there comes a time of awakening—and so it was with the New England troglodytes.

Under the guiding hand of some of the "old faithfuls" of the Society, like Clay Perry, Roger Johnson, LeRoy Foote, and others, a reorganization meeting was held in July of 1946, at the Strickland Quarry in Portland, Connecticut. Dick Logan was the first Chairman of the new Grotto. At the time he went into office there were 12 members, and when the end of his year rolled around, the membership totaled 31. Our membership now totals 51; we are proud of our rapid rise in membership, and know we will continue to grow.

Because of our large area, most of our field work is done by local groups; making usually a one-day outing, and accomplishing all that is possible in such a short time. Nature was cruel to us here in New England—when the last glacier covered our area and then in time moved on, it took practically all of our limestone deposits with it. Consequently, we generally have to travel quite a distance to get to the cave we wish to explore. Most of our exploration takes place along our western boundary and into New York State.

Our specialty, and something that other Grottos might look into, is our annual meeting and Cave Man's Field Day, held usually on the second Sunday in July. On that day we hold the election of officers, hear the reports of the outgoing officers, have a picnic, explore a cave, and have a general all around good time.

During the year we have two Grotto sponsored field trips; one in the Spring—a one-day trip; and one in the Fall—usually a two-day trip. We gather interested persons and any members in the surrounding area and try to inspire interest in forming other Grottoes.

This winter we arranged a program of indoor meetings to keep up the interest of our members in the Waterbury and surrounding areas. We chose "Cave Safety" as a theme for the year—trying at every meeting to bring out points of safety that will be of use to us in our field work. John Meenehan started us off on this theme by coming up from Washington and showing us some of his very interesting color slides.

Some of the projects we are undertaking are the opening of the Hungerford Cave in Sherman, Conn. The entrance of this cave was filled in a good many years ago to keep out children. Now with the permission of the present owner, we are attempting to open it. We are also trying to open a supposed connection to the rear of Eldon's Cave in West Stockbridge, Mass. Then, something of a little different nature is the job of helping Charles E. Mohr and Harold H. Hitchcock in their bat-banding work.

The New England Grotto is the oldest in the society, but we also claim quite a few firsts in our reorganized period. We are the first Grotto with a geographical boundary; the first to have an annual meeting and field day; the first to place a *cave register* at a wild cave to get accurate information as to the number of people who visit such caves. About 200 non-members registered during the summer months at the Twin Lakes Cave register at Salisbury, Conn. Most of these people had literature sent to them telling about the Society; and it is pleasing to know that several persons have joined the Society as a direct result of our efforts and the use of the *cave register*. None of these ideas are patented, so it might be a good move for some of the other Grottoes to try some of these things themselves.

Several of our members were looking for some of the necessary caving equipment, so we took it upon ourselves to scout out some good sources of supply. As a result, we can now sell lamps, caps, etc., to our members at a saving to them, and yet net a profit for the Grotto to meet our running expenses. Also, with the approval of the Board of Governors of the Society, we purchased pennants bearing the Society name, in royal blue and white. *Write to the Secretary of this Grotto for information if you desire one or several of these NSS penants.* —GEORGE R. ANGRAVE, JR., 40 Gen. Dalton Drive, Naugatuck, Conn.

NORTHERN CALIFORNIA

In June, 1947, Charlie Erfttenbeck decided that belonging to the NSS was a very fine thing; but, caving by oneself lacked something. So he determinedly set out and signed up seven new members. These members were the nucleus of the "Northern California" Grotto, which has already grown to the promising total of 15. The last six months of 1947 were quite well spent in exploring caves, with a grand total of six caves visited and crawled or wiggled through. That stacks up to the average of one cave a month for the year 1947.

The outstanding thing in cave exploring out here is that curse called GOLD. You may find that metal anytime and when one does: "that's it!" On a return trip to Erfty's cave discovery,

the Grotto members left the area on a Sunday, only to read in the paper that two fellows were just below them in the valley that same day and struck a pocket of gold worth \$7,000.

The grotto members in Weaverville, California, went forth to check the story about bags of gold being thrown into a water-filled shaft in a cave. The gold, worth \$40,000, was supposed to still be there. They located the cave and the water is still there and the gold, also, if the story is true. You probably wonder why someone hasn't gotten the gold! Well, it has been attempted and to no avail. The water just fills the shaft up as fast as one tries to drain same.

Another cave trip that had its thrills attached was one to explore a shaft that was supposed to contain a woman's body dumped there 15 years ago. The sheriff's office had the records about the case and the sheriff, at that time, went down as far as he dared but didn't reach bottom. He gave up, but the woman hasn't been found to this day. The "Nor-Cal" grotto made the trip, since one of its members now owned the property which contained the cave. The exploration was enjoyed by all and no body was found, but it was granted that it may be there. So much dirt fill has become packed at the bottom of the shaft that a body could still be buried beneath same. Crazy? No! That's what gives cave trips their extra thrill and drive.

The only near accident the Grotto has had came on a trip to Mercer Caverns, a commercial cave. After taking the tour the owner showed us around and allowed us the free run of the property for camping and exploring. Phil Swift, our youngest member, took his second try at rappelling down a shaft. He did fine and proceeded out of sight and went under a ledge. The next we heard of Phil was a cry for assistance. He had ducked under a ledge and then dropped over another ledge to find himself in mid-air with no way of reaching either wall. This wouldn't have been so bad, but it seems that Phil succeeded in getting tangled up in the rope and he couldn't break loose to rappel to the bottom. There he hung in mid-air and his strength was rapidly giving out. With the encouraging yells from others above and below, he hung on until Vernon Bengal came from below on his own rope and helped him out of his nasty predicament. Then with Bill Gorton in a belaying position at the top of the shaft, the rest of the Grotto hoisted Phil right out of the cave.

The members have agreed that wearing one-piece, slip-on overalls is required to avoid similar mishaps. Phil wore a leather jacket which slipped up and fouled the rope, thus causing what would have been disaster if others had been unable to come quickly to his aid.

There is nothing else to say about this grotto until it gets to be a little older and really be-

comes organized as to meetings and such.—
CHARLES F. ERFTENBECK, 13850 E. 14th St.,
San Leandro, Calif.

PHILADELPHIA

The Philadelphia Grotto has the Academy of Natural Sciences of Philadelphia to thank in great part for its organization and continuation. Back in November of 1946, a group of Academy members, under the leadership of Charles E. Mohr (who was then the Academy's Director of Education) visited Crystal Cave, near Kutztown, Pa. Some of the group also visited Schofer's Cave, nearby. Those who had never seen the inside of a cave had a well-rounded initiation, taking in both a commercial and undeveloped cave, the latter containing a stomach crawl of some ten feet through mud, and several pools.

After this taste of caving, some of the Academy members joined the NSS, and others in the Philadelphia area who were already NSS members wanted to form a Grotto. Accordingly, in January of 1947, 20 persons—17 of them NSS members—met to draft a charter and form a Grotto.

The Philadelphia Grotto has become one of the ten science groups privileged to meet at the Academy of Natural Sciences (Nineteenth and the Parkway). Meetings are held on the first Thursday of each month (summer months included), beginning at 8:00 P.M. An average of 28 persons, including guests, have attended the 13 meetings held so far. While most of the Grotto members come from the Philadelphia area, a very active group from Trenton, New Jersey, has joined the Grotto.

Both spelunkers and speleologists make up the Philadelphia Grotto. The group has attracted those who explore caves for the fun of it, and those whose main interest is mapping, geology, mineralogy, etc.

Grotto meetings are never dull. There is always a lively discussion on some subject, such as safety. Besides, there is always entertainment in the form of a description of field trips and the showing of slides of cave scenes. At one recent meeting the group was fortunate, indeed, in having John Meenehan, of Washington, D. C., show his marvelous colored slides of various caves in the United States, which also illustrated rope technique and fitted in with his topic of "Safety."

Speaking of safety, the Grotto elected a Safety Director, who stands ready to advise any member on equipment and its care, and who must give his O. K. on the equipment of every person entering a cave on a Grotto field trip. Any would-be caver without a hard hat and at least one source of light is forbidden to enter the cave. The Safety Director also places pencil

and paper at the entrance of any cave entered on a Grotto trip for recording the signature of everyone who goes into the cave, and he sees that everyone who entered is out before the group leaves. The Grotto has "black-listed" Durham Iron Mine (not to be confused with Durham Cave, nearby) in Bucks County, because of the unsafe condition of the ceiling in many places. No official trips are made to it and members are warned of the hazards of exploring it.

The Grotto also has an Exploration Committee, headed by Jack Parker, to locate caves to visit on Grotto field trips. With caves scarce around Philadelphia, this committee really has a job. Expeditions, accordingly, require considerable driving and some over-night trips have been made. In fact the very first trip, in April of 1947, was made over a week-end, to Kook-en's Cave, in Blair County, near Huntingdon, Pa.

A work party put in many hours enlarging a small, almost submerged opening into a newly discovered room in Schofer's Cave, but finally abandoned the project as both dangerous and not worth the effort. Another group began the systematic study of the caves of Pennsylvania, starting with those in Franklin County. Maps and detailed descriptions are part of this project. Completion is expected to take about two years. The members from Trenton are proud to have discovered a cave in New Jersey (near Newton), where caves are indeed hard to find. A report on this cave is in the hands of the NSS.

Grotto members Bob Lewis, Jim Gossett, and Charles Zensen have given considerable time and effort to the publication of *The NSS News*, beginning with the January, 1948 issue. Other members of the Grotto have helped prepare these issues for mailing. Bob Lewis (more formerly known as Dr. Robert R.) also shares in the credit for being one of the original organizers of the Grotto, has been its chairman since the first meeting. NEWS Editor and national board member, William S. Hill is another of the group's prominent members. — MARGARET LOYE, 625 Fordham Rd., Bala-Cynwyd, Pa.

PITTSBURGH

In October of 1947 the organization meeting of the Pittsburgh Grotto was held in one of the rooms of the Department of Herpetology in Carnegie Museum. Professor M. Graham Netting, Director of Herpetology at Carnegie Museum and a national board member of NSS, along with Robert Dunn of Verona, Pa., had sparked this get-together.

Although there were only nine NSS members present at the first meeting, plans were being made for a larger membership and an active

schedule of caving programs. An executive board of five members was elected to serve until the end of 1947. The board was made up of J. R. Fisher, Chairman, Robert Dunn, Secretary, Rev. Clifford E. Davis, M. Graham Netting, and Richard Hoffmaster. Regular meetings were scheduled for the second Sunday in each month.

Dulaney's Cave, near Uniontown, Pa., was the site of the first field trip, taken on November 23. This trip to the state's largest cave was taken to establish an "esprit de corps" among Grotto members. Prospective members were the guests of the Grotto.

Inclement weather whittled down the size of the group on the second field trip to Barton's Cave, near Dulaney's. The small party started mapping operations. Bob Dunn is going to return to Barton's Cave with a surveyor friend to make a rigid transit survey.

The third trip was to Strangford Cave. It is located in an abandoned stone quarry near Strangford, Pa., and above the Conemaugh River. The trip was made in zero weather, on January 18, 1948, and 15 cavers braved the cold. Huge icicles adorned the face of the quarry. It was a beautiful but chilly sight (site). Part of the group tried to extend the end of the main passage; but after digging through one sandy deposit, they were stopped by solid rock a few feet further on. A new portion of the cave was found at the end of a crawlway where an undisturbed small river of white calcite was discovered. John Guilday collected some large brown and small brown bats for the fauna collection.

On February 7, six of the Pittsburgh Grotto accompanied Hal Harrison, free lance writer, photographer, and lecturer, to Dulaney's Cave with the express purpose of photographing bats. After a trek from the road to the cave entrance through snow two and one half feet deep, the spelunkers were delighted to find impressive ice formations within the cave. One column was approximately 30 feet in height. A "frozen Niagara" and a smooth "toboggan" run were traversed quickly by the simple expedient of sitting down. Photographs taken on this jaunt will be incorporated with those to be taken on a later field trip to make up a feature story on the Pittsburgh Grotto and the NSS.

Board members of the present year are W. R. Schnarrenberger Chairman, Robert Dunn, Secretary, J. R. Fisher, M. Graham Netting, and Robert Ruffing.

With the advent of drier weather the Pittsburgh Grotto plans to explore and map Coon Cave on Chestnut Ridge. It was discovered by two Pittsburgh members, Carl Huttenstine and William Cellich. Coon Cave gives promise of being the largest cave in Pennsylvania and has not been completely explored or mapped. The Pittsburgh Grotto proposes to do both.

The Grotto has as its main objectives the collection of fauna and flora, and minerals, and the compilation of a file on Pennsylvania caves, with pertinent data. A photographic record of the caves explored will also be made. Although Pennsylvania caves are the immediate concern, trips will be made to caves in nearby states, also.

Since the organization meeting in October, a scant four months at this writing, the Pittsburgh Grotto has acquired eight new members and has prospects of adding many more. An interesting program schedule in addition to attractive field trips is on the agenda. —J. R. FISHER, 1700 Crafton Blvd., Apt. 7, Pittsburgh 5, Pa.

RICHMOND

The Richmond Grotto, Richmond, Virginia, was formed in the summer of 1943 by the spelunking members of the United States Patent Office, then located here, with Elton Brown as its first chairman. At that time it contained some of the most active members in the NSS. At the present time it has about 14 members, who, while not holding meetings on any specific schedule, get together occasionally for planning trips, outings, etc., besides attending to routine business. The meetings are usually held at the home of G. Alexander (Robbie) Robertson. Members are drawn from Richmond and its immediate environs, with some living as far distant as Waynesboro.

The area within the scope of exploration of the Grotto could best be described as being the western portion of a triangle, designated by Richmond on the east, Lewisburg, West Virginia, on the west and Davis, West Virginia, on the north, with occasional trips extending into southwestern Virginia and West Virginia, nearly to the Tennessee border. If a contest were conducted to determine the cave popularity in the above Grotto, it most certainly would show Breathing Cave (also called Sounding Knob Cave), Bath County, Virginia, heading the list, with Clark's Cave, also in Bath County, Virginia, and Sinit Cave, Pendleton County, West Virginia, tying for second.

We are justly proud of the reputation we have earned for operating the best *Caver's Mail Order Supply House* in these United States, where orders are never too large or too small for prompt consideration. The territory served extends from New England to Georgia and from Texas to England (can any other grotto equal this?). We are continually on the alert for the development of new and efficient equipment, two well known items in this line being the Richmond Grotto *Minimum Essential Bag*, now becoming so popular that they are being ordered in lots of six or more at a time (this is the same bag being offered as a prize for the second

consecutive year to the member securing the greatest number of new applicants); the other being the sound-powered telephones and unique methods of adapting them to cave use—more than 30 of these sets have been distributed throughout the country.

Some members have specialized extensively in cave photography, and besides donating several groups of kodachrome slides to the NSS collection, pictures have and are being furnished for several publications, and illustrated talks are frequently given before other organizations. The latest project to emerge from an experimental stage, is the super-duper *cave location map*, a copy of which will make its debut at the 1948 Annual Convention, the sole purpose of this map being to present legibly on *one sheet* such information and pictures as to make it well nigh impossible for a spelunker NOT to find the cave he is looking for, although never having been there before. —G. ALEXANDER ROBERTSON, 3718 Brookside Road, Richmond 24, Va.

ROANOKE

Roanoke Grotto draws most of its members from Roanoke County, Va. Students of Roanoke College are usually included in its membership. This, of course, causes a turnover in membership which is a problem in the administration of the Grotto affairs.

The Grotto has no definite time nor place for meetings. But, since the list of members is not large, a few phone calls are enough to call the group together for special purposes and for field trips.

Roanoke Grotto is extremely fortunate in its location with respect to good caves. Roanoke County, itself, contains several and southwestern Virginia is, in general, wonderful cave country. Quite a number of field trips have been made, with Messers. Ritter, Frantz, Nelson, and Comer, Jr., taking the most active part. Miss Ethlyn Fusselle, only woman member of the NSS Board of Governors, was formerly the real "sparkplug" of the organization but Miss Fusselle's interests have, unfortunately for us, shifted to California.

A number of caves on New River and Sinking Creek have been visited. An attempt was made to explore a cave on Yellow Mountain but a large stone had been placed over the entrance. It was found impossible to move. Catawba Murder Hole has been visited and several trips have been made to New Dixie Cavern. Several members have accompanied field trips sponsored by the Lexington Grotto.

The Tazewell Indian Caves have also come in for their share of interest on the part of our members. Dr. Jackson has taken some of us to these caves along with the VPI Grotto. —J. E. COMER, R.D. 3, Salem, Virginia.

VPI

The VPI Grotto was organized in Blacksburg, Virginia in the Fall of 1942. The Grotto was granted a constitution as a Student Grotto and holds the distinction of being the first and only Student Grotto of the NSS. In the spring of 1947 the Grotto was reorganized and became a regular Grotto of the Society.

The membership consists mainly of students and faculty members of the Virginia Polytechnic Institute. Meetings are held every Friday night in the Student Activities Building on the campus. The meetings consist of a short business meeting followed by either a program or a "bull session." Field trips of location and exploration are generally held every Sunday. The average attendance both on trips and at meetings is about 25 persons. All trips are taken by the Grotto as a group and a truck rented by the Grotto furnishes transportation.

The area of normal activity is within a radius of about 30 miles of Blacksburg. About once every three months an overnight field trip is taken to some more distant point of interest such as the recent trip to the Tazewell area where the cave containing the Indian remains had recently been located.

The VPI Grotto is indeed fortunate in being situated right in the heart of "cave country." *In its four years of operation the Grotto has located and visited more than 150 caves in the immediate area.* Ten of the larger caves have been accurately surveyed and mapped and many of the smaller ones have been sketched sufficiently to give an accurate idea of size and appearance.

Among the larger and more interesting caves in the area are: New River Cave at Goodwin's Ferry, Clover Hollow near Newport, Pig Hole near Mt. Lake, and New Castle Murder Hole near New Castle.

Probably the largest and most interesting of these is New River. The cave is located in the fault plane of the Saltville fault and is in part a fault cave and in part a solution cave. The cave is reported to be seven miles long; but the Grotto has located only about one and one-half miles of passages. There are, however, parts of the cave still to be explored.

The Grotto is assisting the U. S. Army in its study of the location and characteristics of caves for their potential military value. As a part of this study the Grotto is assembling a monograph covering the characteristics of New River Cave. Hydrology, air flow studies, biology, and geology are some of the subjects which will be included in the study. The work has been planned so that it will cover an indefinite period, depending upon the interests of members and the availability of time and equipment. At present the work is being concentrated mainly on air studies and cave life. It is hoped that the information obtained might be applicable to other caves.

The Grotto has made extensive efforts to locate new caves. One of the most effective methods being used is *advertising in the local newspapers offering a standing reward of five dollars per mile (of cave) to anyone giving information leading to the location of a new cave.* —JOHN F. GRIFFIN, Box 477, V.P.I., Blacksburg, Va.

Edwards Plateau a Vast Reservoir

The Edwards Plateau covers 30,000 square miles. It is the greatest underground water reservoir in the United States, extending approximately from Austin and San Antonio westward and northwestward to the Pecos River. From this thick stratum of limestone flow numerous springs. The water table is so close to the surface that shallow wells furnish plenty of water even during dry seasons. Many towns and cities on the plateau, including San Angelo, Del Rio, San Antonio, and Kerrville receive their municipal water supply from wells tapping this great reservoir.

What Causes Fires in Caves

Considerable difference of opinion exists regarding the cause of fires in caves. Natural gas and methane are suggested as possible causes, as well as the spontaneous combustion of fresh guano, but no one seems to have actually investigated the matter. Likewise there is disagreement as to the relation between guano and saltpetre. Burton Faust who has spent years studying the history of saltpetre mining doubts that "bat guano per se ever was used or leached to produce saltpetre." It is expected that a definite article on the subject will appear in a subsequent number of the NSS Bulletin.

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WHO'S WHO

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LECTURER PETER KOCH went to the Big Bend National Park to spend two and a half months preparing a lecture film. That was more than three years ago, and Pete and his family have been living there ever since, except for the part of the winter when Pete is on the road lecturing. He took the picture of Cattle Cave in late March, 1948, on a short trip back to Texas. The editor was just able to squeeze it in as the last section of the Bulletin went to press.

MUSEUM DIRECTOR KENNETH N. DEAROLF, newly appointed head of the Pennsylvania State Museum, Harrisburg, explored Texas caves with Mohr in June 1938. He specializes in invertebrate cave fauna.

ICHTHYOLOGIST CARL L. HUBBS also visited Texas caves in June 1938. He located the new species of blind fish recently described. Only an unexpected opportunity to go on a whaling expedition last winter prevented Dr. Hubbs from writing an article for us on Texas blind catfish.

RANCHMAN EDWIN C. VINTHER became interested in caves while studying geology at Southwestern State Teachers College, San Marcos. Back from the Army, he is busy running his ranch near Williamstown, finds occasional moments for crawling in nearby caves. His former geology professor, Dr. Lorus J. Milne, now at the University of Vermont, has written an interesting account of the fauna of Ezell's Cave in a new book, "A Lot of Living Things." (Dodd Mead, 1947).

Errata

page 21, line 17, for Guadeloupe River read Guadalupe River. Also pages 47, 55, 66, read Guadalupe (County, River, Mountain).

page 32, line 23, for *Ornithodorus* read *Ornithodoros*.

page 43, caption, for Richard Springs read Richland Springs.

page 46, column 2, line 29, for 100 feet read 1000 feet.
line 38, for northwest read northeast.

page 47, line 2, for southeasterly read southwesterly.

page 48, line 38, for Deadman's Cave read Deadman's Hole.

page 52, column 2, line 10, for Whitting Cave read Whistling Cave.

page 66, line 47, for Chianti Mountains read Chinati Mountains.

Who's Who in Texas Speleology

ATTORNEY VICTOR S. CRAUN laid the groundwork for Bulletin Ten when he submitted a short article on three commercial caves of Texas. Vic, a Cincinnati attorney, and a writer and lecturer on caves, has explored caves in Europe, South Africa, Australia, and New Zealand. His article on Cacahuamilpa Caverns, Mexico, appeared in Bulletin Eight. With the help of various Texas members Vic added greatly to his original notes on commercial caves to round out the comprehensive article in this issue.

CAVE MANAGER THOMAS W. GOELLER had recently come from Wyandotte Cave, Indiana, to take over the operation of the Cave Without-a-Name, when our Texas survey got under way. Tom's hobbies include "motor-cycling, Egyptology, aviation, music, and solitude." He became a member of the NSS while in the army in Japan and wrote on his application, "Very probably no one will ever see me. I emerge into the daylight only on rare occasions." Tom signed up Pat White as a member, contacted geologist Charles Laurence Baker (see article on Prospecting), and contributed heavily to Bulletin Ten through his help to other authors. Now he has moved to Virginia where he is manager of Grand Caverns.

STUDENT FLOYD E. POTTER, JR. came into the NSS through his interest in herpetology—particularly in cave salamanders. He already has one new salamander to his credit. Floyd is enrolled in the University of Texas.

EDITOR CHARLES E. MOHR also was attracted to Texas caves by the salamanders that inhabit them, and has made three trips to the Lone Star State. A biographical sketch of the NSS vice-president appeared in the February NEWS. He is director of the Audubon Nature Center, Greenwich, Connecticut.

DOCTOR A. V. KIDDER is Chairman of the Division of Historical Research, Carnegie Institution, and one of the country's leading archeologists.

GEOLOGIST CHARLES LAURENCE BAKER has explored the Southwest for 30 years. Long head of the department of geology at the University of Texas, Mr. Baker is now with the South Dakota Geological Survey.

RADIOMAN PATRICK J. WHITE studied medicine for one year, but the fascination of electronics, mineralogy, and cave exploration, plus an attractive opening in radio crowded out the pills and potions. For ten years he was in radio as announcer, news editor, and production manager. In the months since August 1946 when Pat joined the NSS, he has explored almost sixty caves in central Texas, fully half of which he located through his own inquiries. Pat has given up radio for the moment, perhaps to try out a theory on prospecting for minerals in caves, about which he has written an interesting article for the next Bulletin.

DOCTOR LYTLE S. ADAMS, who conceived and directed the bat-warfare project, recently became a sustaining mem-

ber of the NSS. Dr. Adams has a number of other inventions to his credit, including an ingenious method of aerial seeding of large areas. As described in FORTUNE, June 1945, the method makes possible the planting of 20,000 acres per hour. With his deep interest in conservation, Dr. Adams sought a way of planting the millions of acres of arid land, as well as extensive deforested acreage. To counteract the lightness of most seeds, he provides weight with a coating of adobe or clay, and gives the seeds a good start by mixing nitrogen, phosphorous, potash, and vitamins in the protective coat—also a rodent and insect repellent. In caves his principal interest is bats. He has visited "most of the caves of the United States and northern Mexico."

STUDENTS JACK C. COUFFER and DENNY G. CONSTANTINE both worked for Dr. Adams. Jack in uniform, Denny while still a high school student. Both are promising young scientists and speleologists, and contributed generously of their time and notes in preparing Bulletin Ten.

ARTIST TOM CULVERWELL, whose hobby is rock-climbing, is an illustrator for the U. S. National Park Service. We hope that his splendid frontispiece in this issue is just the first of a long series for the NSS Bulletin.

CARTOONIST J. ROY CHAPMAN, of Atlanta, has for years been delighting NSS officers and board members with handsomely illustrated letters in color. Only the prohibitive cost of color printing has prevented the reproduction of some of these stunning letters. We've been happy to introduce a few of his sketches on page one and ninety-six. We hope to have many more.

SCIENTISTS STAGER, JELLISON, and KOHLS are examples of the busy professional workers who have squeezed a few extra hours from their exacting schedules to write reports for us on their collecting trips to caves. There are others also who have volunteered to tell us about cave life, and suggest ways by which we can make our cave trips more productive scientifically.

ARMY MAP CHIEF WILLIAM E. DAVIES is our authority on cave mapping. Unfortunately neither he nor any of our Texas members were able to secure for publication the several maps of Texas caves made by the Army. With the explicit mapping directions published in Bulletin Nine, however, the surveying of Texas caves by the NSS should soon get under way.

ARCHEOLOGIST A. T. JACKSON came to the Editor's assistance time after time. His 16 years of exploration and excavation of Texas caves and shelters plus his extensive knowledge of the literature, proved a tremendous help in the preparation of this Bulletin. For a number of years Mr. Jackson was field archeologist for the University of Texas. Happily for us, Mr. Jackson also was an enthusiastic photographer.

(continued on page thirty-six)

