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CONSERVATION THROUGH COMMERCIALIZATION
Rio Camuy Development Proposal

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Rio Camuy Development Proposal

JEANNE GURNEE, GUEST EDITOR

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*Spanish translations by Dr. Maria Luisa Muñoz and Carmen M. Henriott

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NATIONAL SPELEOLOGICAL SOCIETY

The National Speleological Society is a non-profit organization devoted to the study of caves, karst and allied phenomena. It was founded in 1940 and is chartered under the law of the District of Columbia. The Society is associated with the American Association for the Advancement of Science.

The Society serves as a central agency for the collection, preservation and publication of information relating to speleology. It also seeks the preservation of the biota, minerals and natural beauty of caverns through proper conservation practices.

The affairs of the Society are controlled by an elected Board of Governors. The Board appoints National Officers. Technical affairs of the Society are administered by a Research Committee of specialists in the fields that relate to speleology.

Publications of the Society include the BULLETIN published quarterly, the NEWS appearing monthly, and the OCCASIONAL PAPERS. All members receive the BULLETIN and NEWS.

A library on speleological subjects is maintained by the Society. Material is available to Society members at a nominal charge to defray the cost of handling and to others through inter-library loan.

The Rio Camuy Cave Project, Puerto Rico

By Russell H. Gurnee

PURPOSE

The National Speleological Society, in studying and exploring Rio Camuy Cave in Bayaney, Puerto Rico, has disclosed an extensive cave system, unique, majestic and awe inspiring to whomever might see it. As with the discovery of any unusual site, the disclosure opens the area to the possibility of vandalism and defacement by unthinking and undisciplined visitors. This possibility has prompted the proposal that this cave be developed for the public in the belief that this plan will provide the controlled protection necessary to preserve the bulk of the cave system for the future.

While the problems and solutions offered here are specific for this cave, they are not unique; similar problems must be faced by anyone who considers the development of a natural phenomenon. The general information and outline given here are offered as an aid to those who may in the future plan to develop a cave.

We feel that the responsibility for the protection and preservation of our natural resources is the duty of every man. The proper development and exhibition of this cave will show to every visitor a feature of nature's work in as natural and aesthetic a condition as is possible.

Only a small portion of this extensive cave system is to be considered for development. The remote portions will be left in a pristine state for the study of biology, geology and other disciplines. The commercial development will serve to preserve and protect the access to the remote areas.

Conservation has been called "the optimum sustained use of a natural resource." The development of the Rio Camuy area as proposed in this report will provide protection for this natural resource as well as enjoyment and education for millions of people in this and coming generations —a truly natural heritage of the people of Puerto Rico.

PROPOSITO

Por Russell H. Gurnee

La Sociedad Espeleológica Nacional, mientras exploraba y estudiaba la Cueva del Río Camuy en Bayaney, Puerto Rico, descubrió una serie de cuevas formando un sistema único y majestuoso que inspira a todos los que tienen la oportunidad de verle. Como cualquier descubrimiento de esta importancia, conlleva cierto grado de publicidad, es casi seguro que la misma traerá consigo actos de vandalismo y de destrucción por aquel público ignorante e indisciplinado. Esta posibilidad nos hace pensar en la necesidad de tener en cuenta a esta clase de las personas al hacer planes para su desarrollo. Asi únicamente, se podrá proveer la protección necesaria para preservar en su forma original la mayor parte de este sistema de cuevas para beneficio de generaciones venideras y de los turistas visitantes que lleguen a este lugar a deleitarse con su magnífica belleza.

Aunque los problemas existentes y las soluciones sugeridas son específicos para este lugar, la información general y el bosquejo ofrecido en este trabajo serán beneficiosos a cualquiera que considere el desarrollo de otros fenómenos de esta naturaleza.

Creemos que la responsibilidad de proteger y preservar los recursos naturales de un país es obligación de todo ser humano. Es de suma importancia el desarrollo de un plan que permita presentar al visitante la interesante formación de esta cueva en todo el esplendor de su belleza natural y dentro de la mejor forma estética posible.

Solamente una pequeña parte de este gran sistema de cuevas será desarrollada. Las partes más remotas quedarán en su estado virgen para permitir el estudio de la biología, la geología y otras disciplinas especializadas. El desarrollo comercial de estas cuevas servirá tanto para preservar como para protejer el acceso a dichas partes.

Conservación es una palabra que ha sido definida como "la máxima y continuada utilización de las maravillas naturales." El desarrollo de la región del Río Camuy tal como se propone en este informe provee para la protección de esta cueva y para el deleite y la educación de millones de personas del presente y de futuras generaciones — una verdadera herencia natural de los puertorriqueños.

Headquarters building in Bayaney, Puerto Rico, used by members of the Rio Camuy expeditions. Pencil sketch by John Schoenherr.

INTRODUCTION

Development of tourist caves in the United States dates back to the late 1700's. Many caves were known at that time but only a few were visited purely for their aesthetic beauty. The European background of many of the early settlers gave them a knowledge of the caves of Europe, but limited travel and difficulty in making a living from the soil limited the number of tourists and travelers who might have supported caves specifically developed for that purpose.

One of the first commercial caves in the United States still in operation is Grand Caverns in Virginia. Originally known as Weyer's Cave, it was discovered in 1806 and has been open to the public nearly continuously since. During the War Between the States soldiers took shelter in the cave, and saber cuts and names were etched into the walls. These scars are now considered part of history and are exhibited as an attraction for the present-day public to view.

As the transportation system of the country improved and railroads were built, those caves favorably located became popular places to visit. In 1816, Mammoth Cave in Kentucky was opened for tourists. The cave was already known and exploited as a mine for saltpeter (an ingredient in the manufacturing of gunpowder), but when the market for this decreased after the War of 1812, the owners supplemented the income from their investment by inviting tourists to tour the cave. Mammoth Cave received a world-wide reputation early in the 1800's — a fame which continues today.

Wyandotte Cave in Indiana, known and mined for saltpeter at the same time as Mammoth Cave, was not opened for tourists until 1850 when the "New Cave" was discovered and the major portion of the cave opened.

Howe Caverns, New York, discovered in 1842, was developed by its discoverer, Lester Howe, in 1845. The business was not successful, and the portion of the cave first exhibited was destroyed by the quarrying operations of a limestone company. In 1929, the opposite end of the cave was opened by drilling, and an elevator was installed. This improvement permitted the successful operation of the cave, and it remains today as an important attraction in New York State.

In the late 1800's, Mr. Andrew Campbell of Luray, Virginia, felt that it would be profitable to have a show cave in this steadily thriving area. In 1878 he discovered what is now Luray Caverns — one of the first caves sought specifically for show purposes. In time many other caverns were developed in the Shenandoah Valley, one of the finest cave regions for the tourist.

As transportation improved and travelers increased, even the obscure cave regions of the country were visited. By the time of the automobile and the further development of roads, there were over 50 caves open to the public. Most of these are still tourist attractions, but some were unable to survive the competition of other caves or the lack of available tourists.

Perhaps the best known American cave is Carlsbad Caverns in New Mexico. Located in an obscure corner of the great American west, by all the rules governing successful tourist attractions, it would appear that it could never attract large numbers of people. It was too remote; there were no overnight accommodations, no rail transportation, and it was 32 miles from the nearest town. For 20 years, according to the story of Jim White, the first exhibitor of the cave, no one paid any attention to the stories and tales he told. Finally he interested some influential people to visit, including a photographer

from National Geographic Magazine, who made a picture coverage of the cave. This report focused national attention on Carlsbad Caverns and in a few years it was purchased and made part of the National Park System. Today half a million people a year visit this cave. In total, ten per cent of the people of the United States have passed through its entrance since the cave opened.

Today there are approximately 210 caves in the United States open to the public; and each year several new ones are added. The information contained in this report might be of interest and aid to entrepreneurs who now control the access to caves or will soon be the custodians of these examples of nature's handiwork.

Conditions today are the most favorable in history for the protection and development of this country's caves. The economy at present has created an unprecedented amount of leisure time for a great mass of people. All signs point toward more people with more leisure time and a greater pressure on recreational areas. Property values have increased in almost all regions, and the automobile has opened areas once remote. Instead of the occasional traveler, thousands of people move throughout the length and breadth of the country.

Natural resources are also being pressured. The wilderness of only a few generations ago is almost gone. Only in National Parks and Forests and remote regions bypassed by highways can we find the expanse and grandeur of what was once a natural condition.

It is not enough that we develop an area for recreational or educational use; we must carefully assess the potential of success of the venture, for it is possible that our best intentions might be in actuality a disservice rather than a benefit to man.

If a regular business venture fails, a man can turn to something else and dissolve his assets. For the man who develops a cave, however, there rests a responsibility. He must assure the future of the physical condition of the cave which, once defaced, can in most cases never be restored.

Opening a cave to the public takes not only enterprise and ingenuity but a sound financial plan. The cave owner will have difficulty finding proper advisors to help him, and he will discover that he cannot do a limited development (undercapitalized) without perhaps risking all his time and investment. If he proceeds with the expense of improvements and advertises his cave to attract tourists, he must still realize enough from this revenue to pay off his investment. Unfortunately, it sometimes occurs that his business is not successful and the cave is closed. This is usually the end of the cave from a conservation viewpoint, as at this time the only thing which protects the cave from vandals is a barred gate — a most fragile form of protection. There are many caves in the United States which are "formerly commercial" — some of them ruined for further consideration commercially because of uncontrolled access.

Some successful caves are incorporated, giving them some sense of permanence in their continued preservation. Most of the major world caves are now government controlled. This is understandable as most of these caves are so large that the expense of development is beyond the realistic investment-return formula. These caves are also of sufficient importance as examples of a natural phenomenon that they should not be tied to the ownership of an individual. The life span of a man is infinitesimal compared with the life of a cave. In the future, as major world caves are discovered and recognized, they probably may fall into the category of "heritage of the people" and be made parks or preserves.

HISTORY

Puerto Rico has been occupied for at least a thousand years, first by Indians who settled on the island possibly in migration from South or Central America. Later, with the arrival of the Spanish and the introduction of new diseases, the Indian population was nearly exterminated. The interior and northwest portions of the island became the last refuge for these people. Evidence of their occupancy can be seen in the several archaeological sites in this section of the island. It can only be assumed that they knew of the underground river and that they visited what are now the Empalme and Tres Pueblos entrances.

Hubbard, in his study of the Lares area for the New York Academy of Science in 1917, showed the Blue Hole as it appeared at that time. On his map he sketched in the possible course of the river beneath the limestone. At some time in the past 25 years someone rigged the Espiral Sink and placed a steel bar at the dropoff, probably as an anchor for a rope, but no record of this descent can be found.

The first published report in the United States was made by an N.S.S. member, Ted Lane, who was stationed in Puerto Rico with the Air Force in 1958. He saw the Tres Pueblos Sink from a helicopter and later made a ground reconnaissance. Mistaking the Empalme for the Tres Pueblos opening, he entered and went upstream to a waterfall — a remarkable exploration without boats. His description in the November, 1958, issue of the *N.S.S. News* is a report of this trip.

In 1960 a group of N.S.S. members, in making a general survey of and visit to the caves of the island, photographed the Empalme Cave and the river. At that time the water was so high that it was impossible to go upstream as Lane had done.

In February, 1962, Russell Gurnee obtained joint sponsorship from LIFE Magazine and the National Speleological Society and led a field trip to attempt to explore the underground route of the river and make a traverse to Blue Hole.

This trip resulted in the discovery of the passage from Tres Pueblos Sink to Natural Bridge — most of the area now proposed as a tourist route. The original discoverers on this trip (February 20, 1962) were Albert C. Mueller, José Limeres, Gerald Frederick, Joseph Lawrence, A. Y. Owen and Russell Gurnee.

The maps, photographs and information from this trip were presented to the Puerto Rican Government on December 11, 1962, with the suggestion that this area be protected as a park. No action was taken at that time and in September, 1963, Russell Gurnee purchased the farm which encompassed the three entrances for the purpose of the study and continued preservation of the cave. This purchase was made possible by the kind help and cooperation of Mr. Rafael Limeres of San Germán, Puerto Rico.

In February, 1964, an official expedition of the Society in joint sponsorship with the National Geographic Society was held. This exploration resulted in doubling the known area of the cave and included a report on the cave life and geology. Two members of the Economic Development Administration of the Puerto Rican Commonwealth were invited on this trip, and their favorable report helped in creating interest in the protection of the area.

In August of 1965 the Land Administration of the Commonwealth began to acquire the property surrounding the entrances of the cave. When this acquisition is complete, a total of 500 acres will be transferred to the Department of Parks with provision for zoning an additional four-square-mile area surrounding the park for limited development.

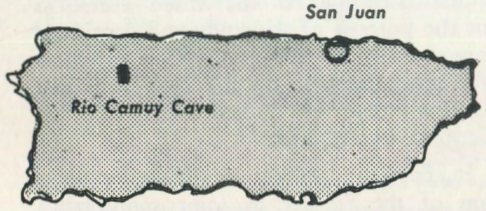
In February, 1966, under a grant from the Commonwealth, the National Speleological Society fielded another expedition to prepare a master plan for the development of the cave. This report is the result of that study.

CAVE LOCATION, Its Importance to Development

One of the most valuable assets a potential tourist cave can have is a favorable location near a population center. Many caves have been developed merely because they were convenient to large numbers of people. However, because most caves occur in limestone, often in karst areas with low population density, it is not always possible to find suitable caves in the most profitable locations.

Not all caves need be near tourist routes or population centers. However, these are usually the rare, unique caves — so well known that they are visited as the object of a trip or the special destination of a group trip. Mammoth Cave, Kentucky; Carlsbad Caverns, New Mexico; Luray Caverns, Virginia; Howe Caverns, New York; and several others have such a reputation and are listed in textbooks and encyclopedias as examples of cavern development. Rio Camuy Cave in Puerto Rico falls into this category.

CAVE LOCATION, Rio Camuy Cave



The Camuy River, originating in the midland plateau of northwest Puerto Rico, drains about 25 square miles of gently sloping Cretaceous rock and flows north to the ocean. In its route to the coast, it sinks underground at a place called "Blue Hole" and for about five miles flows a subterranean course, reappearing in a canyon.

The cave is developed in limestone of Tertiary age which extends in a broad, east-west belt along the north coast of the island. The Rio Camuy has found a path through this rock and, because of the depth of the channel (averaging 300 feet beneath the surface), the underground tunnel has suffered little collapse. In at least four places it is possible to reach the river from the surface by means of natural openings. It is through these openings our exploration was carried on; and because these entrances are strategic to the development of the region, a general description of each is given to aid in the understanding of the plan and proposals in this report:

Blue Hole

This "swallow hole" disappearance of the river is at the end of a canyon, directly beneath Route 129, and is visible from the road. The opening into which the river sinks is choked with logs and debris making access to the cave impossible.

La Ventosa

One mile north of Blue Hole on the side of a steep hill is a small opening, remarkable because of the steady stream of warm air blasting from the entrance. This small hole leads to a series of chambers terminating at the edge of a pit where the roar of the river can be heard. Survey shows this entrance to be 410 feet above the level of the river and the connection to be above the resurgence of the main path of the river at a place shown on the map as Natural Bridge. The draft of warm air is caused by the hot, fetid air generated in a long dry upper passage where millions of bats have deposited tons of guano. The temperature of this side passage is 15 degrees Fahrenheit above the average temperature of the cave.

Espiral Sink

One third of a mile downstream of La Ventosa is a large sinkhole open at the bottom known as Espiral Sink. The opening, when viewed from below, appears as a huge winding staircase which extends

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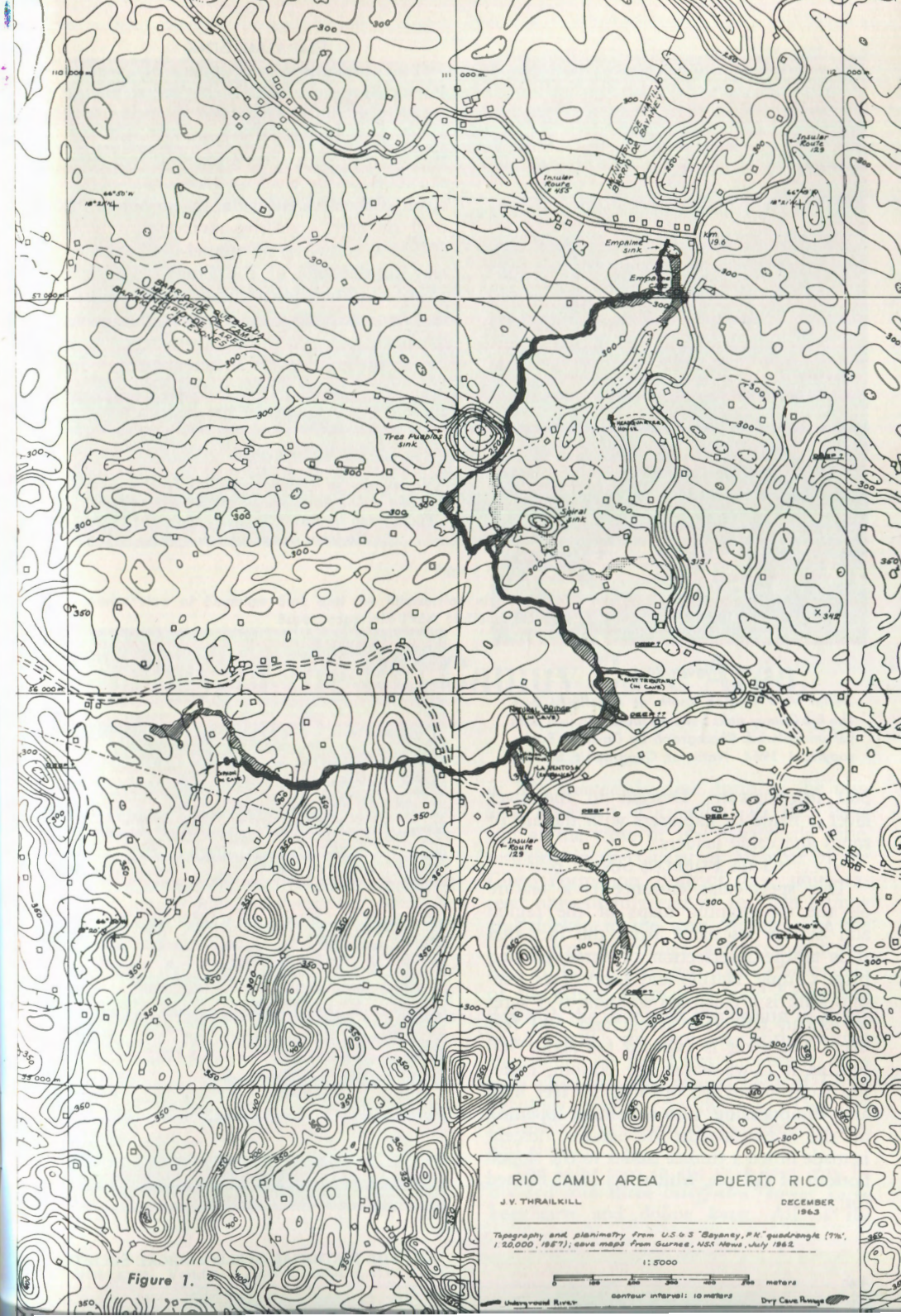


Figure 1.

Figure 2.

Aerial view looking south at kegelkarst belt. The Rio Camuy sinks beneath these hills in a path yet unexplored. Photograph by David S. Boyer, copyright 1964, National Geographic Society.

300 feet upward. Descent to the river level is made by explorers with the aid of ropes and cable ladders.

Tres Pueblos Sink

This spectacular entrance is a feature on the topographic maps of the region and derives its name from the fact that it is at the intersection of three municipios: Camuy, Hatillo and Lares. Tres Pueblos Sink is a collapsed sinkhole 6½ acres in extent, 650 feet across and 300 feet deep. The river is exposed for about 500 feet as it flows across the bottom, entering from an arched opening 50 feet high and disappearing into a similar opening on the opposite side. At present, descent is made down a timber ladder to the sloped bottom of the pit, which has been farmed for years.

Empalme Sink

Two thousand feet northeast of the Tres Pueblos Entrance is the best known of the accesses to the underground river. Located at the intersection of Routes 129 and 455, this deep pit is a sheer drop 400 feet from the level of the road to the surface of the river. Entrance is made by means of a trail through a nearby ravine, through a 650-foot remnant of tunnel-like passageway to the side of the Empalme pit. A steep scramble down the floor of the pit leads to the river. The river at this point disappears beneath the downstream wall of the pit and travels an unexplored route for several miles where it reappears as the surface water course — the Rio Camuy.

Figure 3.

Aerial view of Tres Pueblos Sink looking west at the doline karst belt of the Lares Limestone. Photograph by David S. Boyer, copyright 1964, National Geographic Society.

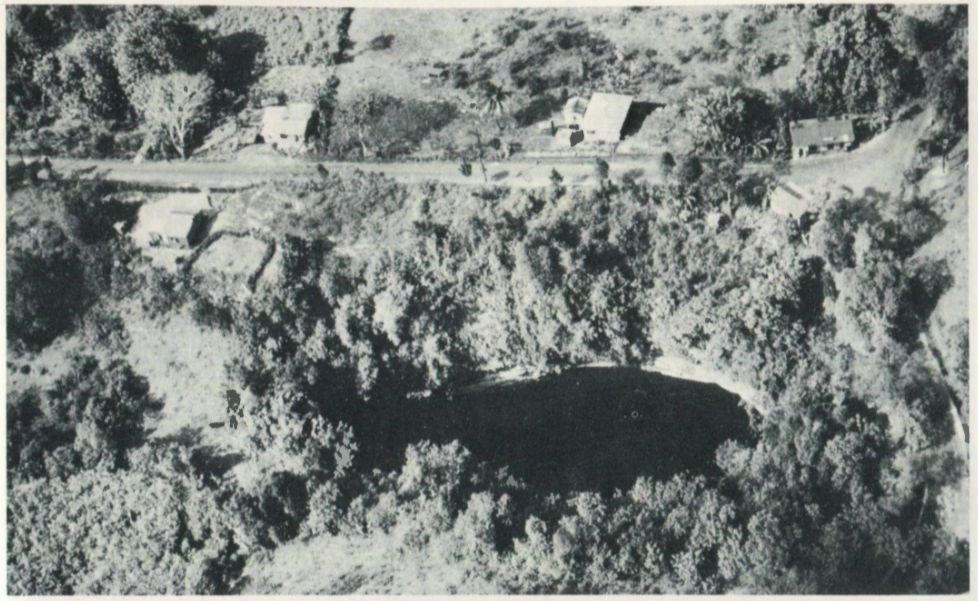


Figure 4.

Aerial view of Empalme Sink and the intersection of Routes 129 and 455. Photograph by David S. Boyer, copyright 1964, National Geographic Society.

Geology of the Rio Camuy Cave Area, Puerto Rico

By John V. Thrailkill

Tropical karst is well developed in the northwestern portion of Puerto Rico. The characteristic cone shaped hills, locally called "pepino hills" or haystacks which are common features of tropical karst are particularly conspicuous throughout this portion of the island.

All of the rocks exposed in the vicinity of the cave area have been assigned by Zapp, *et al.* (1948) to the Rio Guatemala Group of Middle Oligocene age (the upper part may be somewhat younger) which forms the lower half of the Tertiary section in this area. To the east of the cave area along strike, the entire thickness of the Rio Guatemala Group consists of massive reef limestones, the Lares Limestone. In the area of the cave, sand and gravel deposition took place both early in Rio Guatemala time, forming the thin San Sebastian Formation at the base, and at the close of Rio Guatemala time, resulting in the Guajataca Member of the Cibao Formation. Both of these units extend only slightly east of the Rio Camuy and thicken to the west. At the time the upper reef limestones were being deposited to the east, the soft, chalky limestones of the Cibao Formation were being laid down in the cave area. According to Zapp, *et al.* (1948), the cave lies entirely within the limits of the Lares Limestone as a map unit, however several beds of Cibao lithology crop out in the area. They are relatively uncommon in the deeper caves and sinks.

The karst seen in the cave area may be divided into three categories: tower karst, kegelkarst and doline karst. All of the

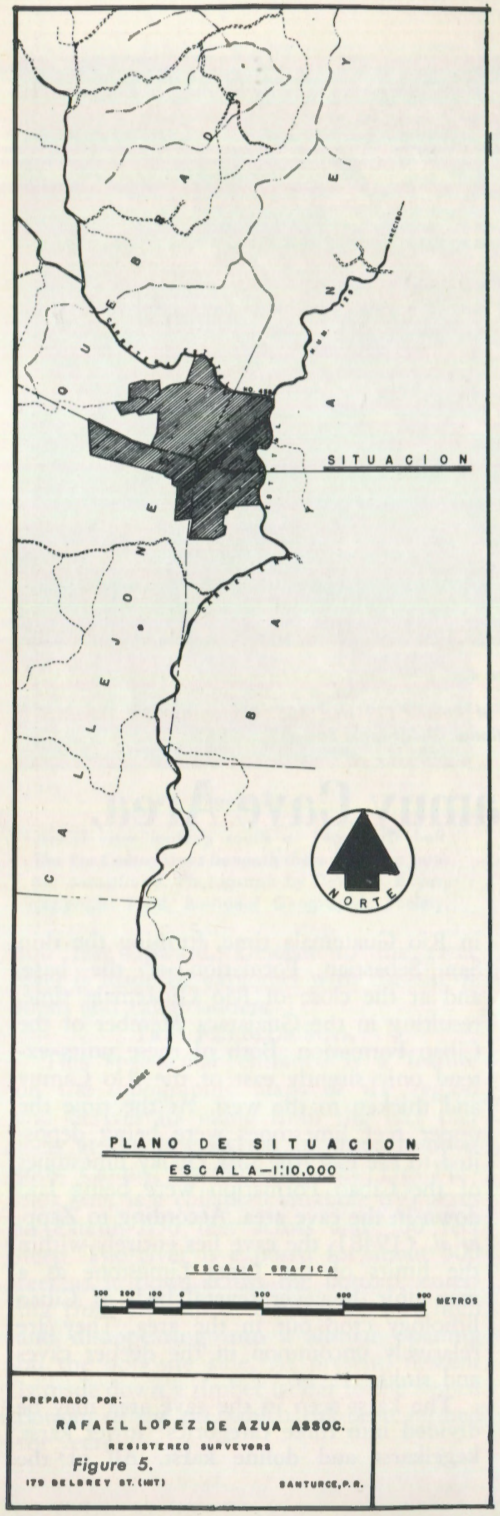


Figure 5.

portions of the cave explored to this time are in the doline karst, and it is not known whether the pattern or appearance of the cave passage changes in its course beneath the kegelkarst.

Tower karst, which occurs in two east-west belts that border the north and south edges of the cave area, contains distinctive truncated cones having steep sides with the upper and lower surfaces quite level.

Kegelkarst appears, again in two belts, within the border of the tower karst; it is made up of small isolated residual hills (haystacks) separated by equally isolated sinks. The Rio Camuy disappears at Blue Hole and follows an unknown path beneath the kegelkarst to its probable resurgence in the cave at La Ventosa, 1½ kilometers to the north (see map, fig. 1).

In the vicinity of the Rio Camuy a doline karst occupies an east-west belt about four kilometers wide — from the south edge of the cave area north to the southern boundary of the Camuy Quadrangle. The northern part of this belt is underlain by the soft limestones of the Cibao Formation; the southern part by the upper Lares Limestone. This region is nearly level and distinguished by scattered sinks (dolines). The first appearance of the main stream of the Rio Camuy in the cave is probably from beneath the east wall below La Ventosa. The huge room and high passage at this point opens to the surface through the tiny opening of La Ventosa, although the light of this entrance is not visible from the river below. Passage can be made through the cave from this point to the Empalme entrance with only minor obstructions. The impressive view from the river toward the Espiral, Tres Pueblos and Empalme entrances clearly shows the exposure of the limestone for a vertical distance of over 300 feet. It is possible that there are other sinks that penetrate from the surface to the river, however they are not known at this time.

*Dr. Thrailkill is teaching at the Department of Geology of the University of Kentucky, Lexington, Kentucky. He is a member of the Board of Governors of the National Speleological Society.

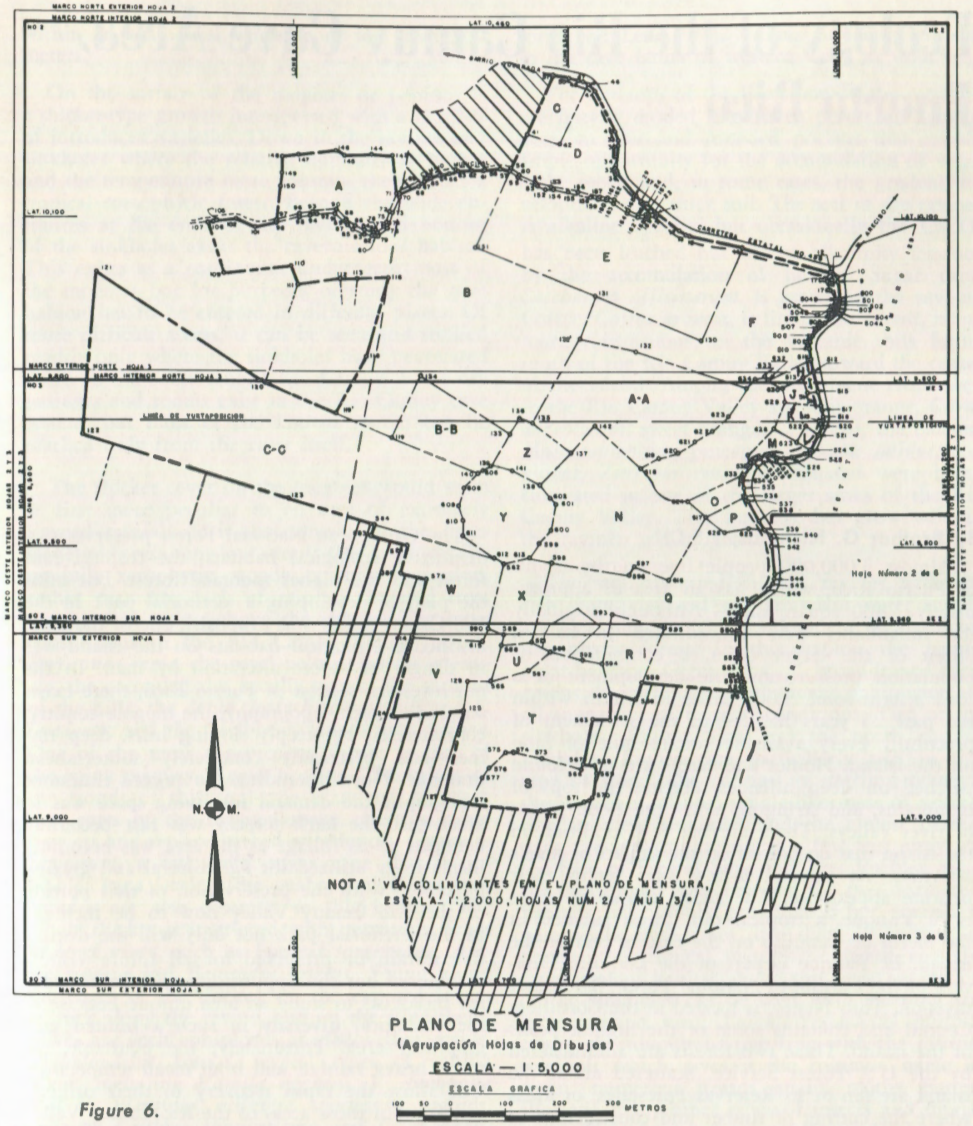


Figure 6.

PROPERTY PURCHASE

Acquisition of the land shown on the property map is now under way by the Land Administration of Puerto Rico, and the proposed plan is that this total area be secured by the government as a park and preserve for the protection of the cave and its environs. It has also been proposed by the Planning Board that the total four square miles of land shown on the map (fig. 1) be zoned for agricultural and residential use only. This has been suggested to prevent the possible contamination of the underground river and change of the natural scenery of the region.

Ecology of the Rio Camuy Cave Area, Puerto Rico

By Brother G. Nicholas, F.S.C.*

Almost 3,000,000 people live on the island of Puerto Rico, which has an area of approximately 3,400 square miles. Although originally the inhabitants were concentrated in half a dozen of the larger cities, a combination of population pressure and the development of a road system some 3,000 miles in length within the past 25 years has led to the settlement of practically every available square mile of land on the island. Homes and farms are now found perched on steep hillsides, dotting the tops of mountains, and stringing along the flood plains of river valleys. There are but few localities on the island that do not reflect the impact of man's activities. At present, a few sites retain their pristine appearance. The most famous of these is El Yunque, a tropical rain forest situated in the Sierra de Luquillo on the eastern end of the island. El Yunque is part of the Luquillo Division of the Caribbean National Forest. The other division, Toro Negro, is located in the Cordillera Central and contains some of the highest peaks of the island. These two forests are administered by the U.S. Forest Service. Scattered about the island are ten or so Reservas Forestales, or areas where the cutting of timber and construction of residences is closely supervised by the Puerto Rican government. However, these are not developed for casual visitation.

The Carribbean National Forest preserves two distinctive ecological habitats; the tropical rain forest and the higher montane forest. But until the plan of developing a territorial park in the Rio Camuy valley was proposed, one of the most distinctive ecological habitats on the island was in danger of severe alteration by man. In the northwestern section of Puerto Rico, there exists an area of karst topography, the mogote country, characterized by steeply sloping hills, deep ravines and practically completely subterranean drainage. Notwithstanding the rugged limestone topography the demand for living space was so great that the karst terrain was fast becoming denuded of its foliage as the area was becoming increasingly utilized for agricultural and grazing purposes. With the preservation of that portion of the Rio Camuy Valley now to be included in the territorial park not only will the distinctive terrain be preserved for all future visitors to observe but the opportunity will be afforded for biologists to study an area unique because of the ecological diversity in such a limited geographical area. Fortunately, the equitable climate, heavy rainfall and high mean temperature will allow the rapid recovery to their original condition of those areas of the Rio Camuy Valley that are now occupied by man.

Brother Nicholas is Assistant Professor of Biology at La Salle College in Philadelphia. He is a past president of the National Speleological Society, has traveled and lectured throughout the world, and has participated in a number of expeditions and field trips to the Rio Camuy area.

Preliminary reports on the geology and topography (Gurnee, *et al.*, 1966) and the biology (Nicholas, 1966; 1967) have recently appeared. This report will serve as a summary of the distinctive ecology of the Rio Camuy Valley. It is rare to find such an amazing diversity of living organisms within such a restricted area. Three totally different environmental habitats can be seen (with less obvious transitional zones), all within an altitudinal variation of less than 100 meters.

On the surface of the mogotes or pepinos is a thicket-type growth interspersed with a number of introduced varieties. Down in the ravines and sinkholes where the relative humidity is higher and the temperature more constant there exists a tropical mesophytic forest. Beyond the wide entrances at the ends of the ravines and bottom of the sinkholes exists the cavernicolous habitat. This exists as a continuum underneath most of the mogotes but for purposes of study the cave habitat has to be entered in different places. Of more difficult access, it can be seen and studied readily only where the sinkholes have penetrated down to the subterranean Rio Camuy. Some dry passages and rooms exist in the Rio Camuy cave system, but most of the known system can be reached only from the river itself.

The thicket cover on the mogotes would seem at first more peculiar to an area of extremely limited rainfall. It is the porosity of the limestone with resultant low runoff that produces the typically xerophytic, woody, scrubby vegetation, rather than any lack of rainfall. Isolated trees can be seen rising above the shrubs. The most conspicuous in the Rio Camuy Valley include *Roystonea regia,* the royal palm; *Gaussia attenuata,* the coconut palm usually seen at the summit of the hills; the dense, leafy *Fiscus stahlii* and *F. laevigata;* and the Caribbean pine, *Pinus caribea.* One of the most conspicuous shrubs is that of the spiny maguey, *Agave sisalana.* The spines of the fronds of this sisal-type plant are so sharp that rows of the maguey make effective cattle barriers and replace barbed wire fences. *Gyneuim sagitatum,* a tall, wild sugar cane that is inedible; *Inga lavrina;* the guaba; and *Ceiba pentrandra* are also common to this habitat. The whole thicket is interlaced with numerous lianas or long vines, such as *Lasiacis sorghoidea, Acacia riparia* and *Batocydia unguis.* Found along the edges of the thicket, on the exposed ledges of rock along the ravine, and on the trees themselves are such ephiphytes as *Anthurium acaule, Philodendron krerssi,* several types of vanilla plant, including *Vanilla eggersii, V. pompona* and *V. Planifola,* different species of orchids, such as *Cattleya speciosissina* and *C. mendeli;* and *Pitcairnia augustifolia.* Exotics collected or seen near the building used as expedition headquarters during the time of exploration in the Rio Camuy cave system include the Asiastic malanga, *Colocasia esculenta;* the avocado, *Persea americana;* the African tulip, *Spathodea campanulata;* wild begonia, *Begonia obliqua;* the edible guava, *Psidium guajava;* wild eggplant, *Solanum melogena;* the breadfruit, *Artocarpus altius;* and the colorful "lobster claw" *Heliconia rubro-striata.* The thicket vegetation covering the mogotes of Puerto Rico is similar to that found on the mongotes or "guaniguanicos" in the Cordillera de Los Organos of western Cuba (Victorin and Leon, 1942). This similarity extends to the cave fauna of western Cuba as well.

The outcrops of the limestone on the mogotes are heavily eroded into sharp points and edges, deep crevices and rounded pockets that supply ample opportunity for the accumulation of vegetable debris and, in some cases, the gradual development of a thick soil. The soil in the ravines is alkaline usually, but occasionally the $CaCO_3$ has been leached out or the alkalinity lessened by the accumulation of humus. Sugar cane, *Saccharum officinarum,* is grown in the ravines. Coffee, *Coffea arbacia,* is limited in extent, being more conspicuous on the volcanic soils found south of the Rio Camuy Valley toward the center of the island. Among the prominent crops seen in the Rio Camuy Valley are sour orange, *Citrus auranticum;* sweet orange, *C. sinesis;* the banana, *Musa sapientum;* pineapple, *Ananas sativus;* and ginger, *Zingiber zingiber.* Bananas were being cultivated in one of the larger sinks of the Rio Camuy Valley, Tres Pueblos, but grow wild in the ravines and mogotes.

The well-protected, humid ravines with the rich loam, clay soil and abundant water supply are ideal sites for the development of a tropical mesophytic forest. In this habitat the palms, giant bamboo, *Giganticloa sp.,* broad-leaved evergreens, bromeliads and abundant ephiphytes are all suggestive of tropical conditions. Two of the sinkholes, Espiral Sink and the north end of Empalme Ravine, are particularly rich in this type of flora. The contrast is startling between the luxuriant, almost jungle-like mass of vegetation in these sinkholes and the almost barren, dark cave environment just a few feet away. At the base of Espiral Sink and Tres Pueblos Sink, the transitional zone between the two distinctive habitats is not only pronounced but amazingly narrow. In both cases, less than 70 meters separates the tropical mesophytic forest and the cavernicolous habitat. Amid the dense vegetation of the sinkholes can be seen *Bufo marinus,* the large marine toad; *Euleutherodactylus portoricensis,* the ubiquitous tree frog with the distinctive call which gives it the common name of coqui; numerous lizards, snails, moths, butterflies and many other types of insects and myriapoda. The environment at the base of the sinkholes and ravines is the immediate source for much of the nutrient input of the cave ecosystem. The leaf litter and cover in the rich, loamy soil contains numerous types of microfauna contributing directly or indirectly to the trophic equilibrium of the cave.

Within the cave environment the predominant taxa are all faunistic, as opposed to the large number of floral taxa in the forest. Large quantities of organic material in the form of debris and detritus are washed into the Rio Camuy caves and support a fauna more abundant and diverse than that found in the temperate climates.

Proposed Development Plan for Rio Camuy Cave, Puerto Rico

Figure 7.

The surface facilities at Weyer's Cave, Virginia, about 1854.

SURFACE FACILITIES

By Russell H. Gurnee

The earliest surface facilities for commercial caves were probably foot trails to the entrance and a gate. Some caves today still are no further developed, either because the owner has few financial resources or, as in the case of the National Parks, the natural aspect of the cave entrance is to be preserved.

Weyer's Cave in Virginia (now Grand Caverns) had a tiny building over its entrance for many years. This was replaced by a masonry building, and a paved trail was made leading to the cave. It is no longer possible to see what the original entrance looked like as the buildings have greatly changed over the years.

Colossal Cave in Kentucky, now closed to the public, had an artificial entrance. This entrance was sheltered by a shed roof, and the improvements for the tourist were extremely limited (fig. 8).

Carlsbad Caverns in New Mexico has a huge natural entrance. The difficulty of descending into the cave necessitated mechanical assistance. Jim White, the early developer of the cave, used a primitive elevator to lower visitors (fig. 9). It is little wonder that the cave was not visited more often in the early 1900's.

Each cave requires individual consider-

Figure 8.

Shed-roof entrance to Colossal Cavern, Kentucky, as it appeared in 1912.

ation for its surface facilities. Unfortunately the interior of the cave is often judged by the visitor before he even enters by the appearance of the buildings on the surface. It is not possible to generalize on the best or even suitable architecture for these facilities. It can only be hoped that the design, landscaping and general upkeep of the whole area will be in good taste, durable design and in keeping with the culture and mores of the region.

An important consideration in planning for the surface facilities of any commercial cave is the protection and preservation of the cave below. Because most caves open to the public have an abundance of secondary calcite formations, the presence of dripping water is important to the showing of the cave at its best. This means that owners should have concern for the vegetation above the cave and for the control of the disposal of wastes from surface buildings.

Some caves have become dead — the formations dry and dusty — after the owners stripped the land above of the natural ground cover and changed the natural drainage of the region in order to construct parking areas and other surface facilities. Sometimes the planting of pines or other trees above the cave will prevent normal drainage and as a result hinder or even stop the growth of formations below. Serious thought should be given to surface development and expert advice sought before any major changes to the terrain are undertaken.

In certain instances, artificial tunnels and elevator shafts will change the humidity conditions within a cave causing it to dry out and become dusty. This can be controlled by installing vestibule doors in the cave to eliminate draft action.

Figure 9

Bucket elevator devised by Jim White and used around 1920 by visitors to enter Carlsbad Caverns, New Mexico. The bucket was used for many years to haul guano from the cave.

SURFACE FACILITIES, Rio Camuy Cave

For Rio Camuy Cave it is proposed that an administration building be constructed which will provide the necessary facilities for visitors and will include a waiting room, dining area and sanitary facilities. It will also be the station for the cable car and sugar cane train as well as a ticket office and museum display area for the park. The tentative design given here permits inside as well as outside dining area, a covered loading area and an observation deck for the viewing of the Tres Pueblos sinkhole. The schematic diagram of the tour as shown plans a dual flow of traffic in the peak periods to provide optimum use of the transportation facilities.

It is not the purpose of this report to dictate the design or architecture of these facilities. The important consideration is to suggest the physical facilities necessary to permit the accommodation of a large number of visitors daily at the cave site.

Surface Transportation

The proposed development plan for the Rio Camuy Cave necessitates a mechanical means of transporting a large number of visitors quickly to the cave entrance and avoiding the retracing of steps. The surface trip to the elevator, La Ventosa entrance, will be accomplished by the installation of a narrow-gauge railroad in a winding, circuitous route over the hilly, karst topography above ground. In order to provide a comfortable, yet memorable trip, it has been recommended that the conveyance be an early steam locomotive used in the harvesting of sugar cane on the island. It may be possible to get an actual engine and track from those on the island. The passenger cars would be constructed to provide a sheltered, comfortable, unobstructed view of the region, as the train travels from the administration building to the La Ventosa entrance.

Exit from the Tres Pueblos sinkhole will be made by means of a cable car operated by an electric motor and acting as a funicular. This conveyance will climb the steep slope of the sink and provide a fine view of the opening. Each train will seat 50 people and a trip would take two minutes. The train will be built on an angle to provide level seating; and the trestle and track will be designed to provide minimum defacement of the natural beauty of the sink.

A foot trail with lookout areas will be provided to permit viewing of the Tres Pueblos sink from the rim. Walkways and paths will lead from the parking lot and entrance road.

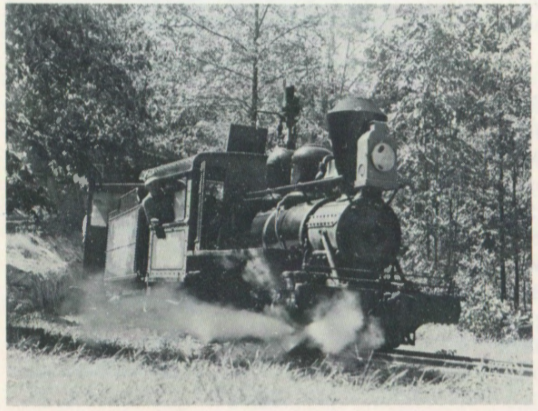


Figure 10.

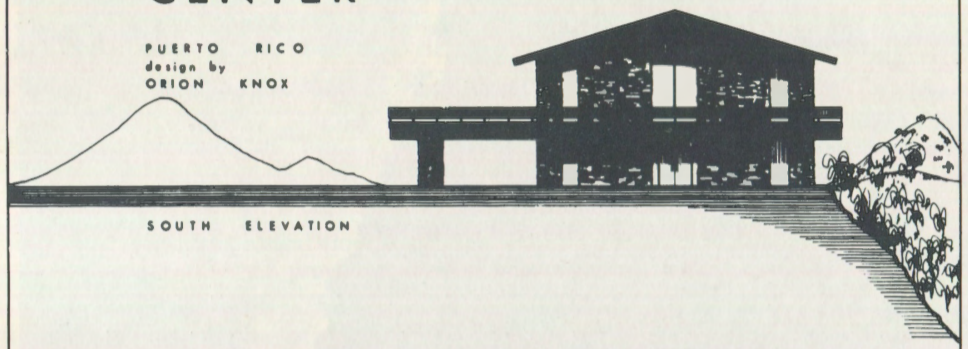
Train of this type to transport visitors from the administration building to the La Ventosa entrance. Photograph courtesy of Marvel Cave Park.

Figure 11.

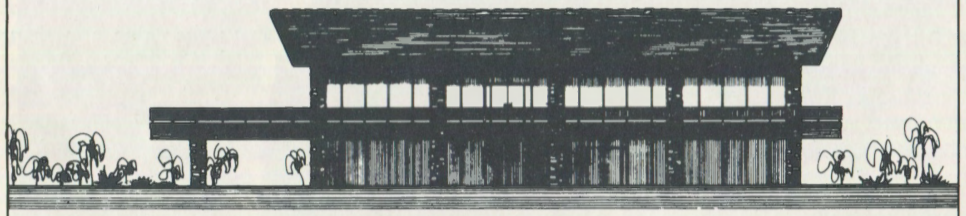
Opposite page. Surface facilities at Tres Pueblos Sink. Painting by John Schoenherr.

RIO CAMUY TOURIST CENTER

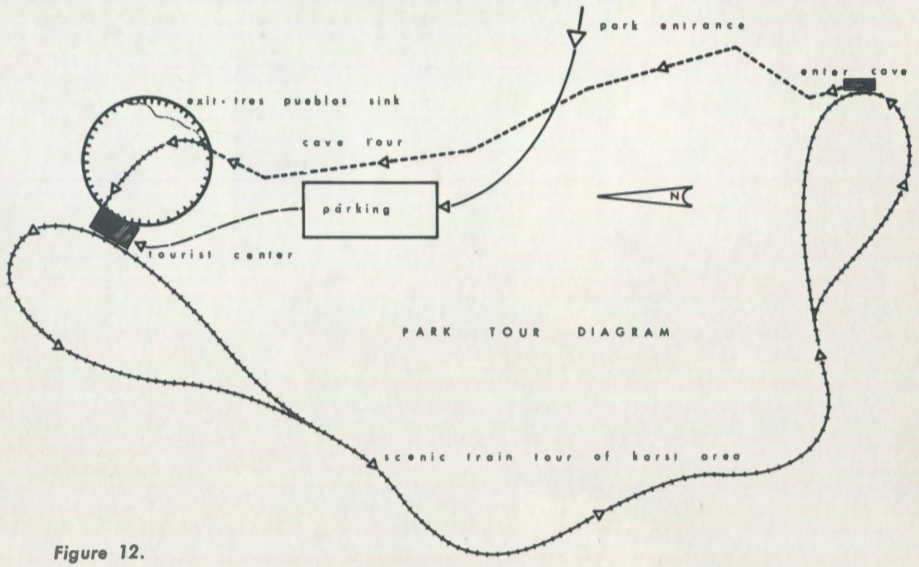
PUERTO RICO
design by
ORION KNOX



SOUTH ELEVATION

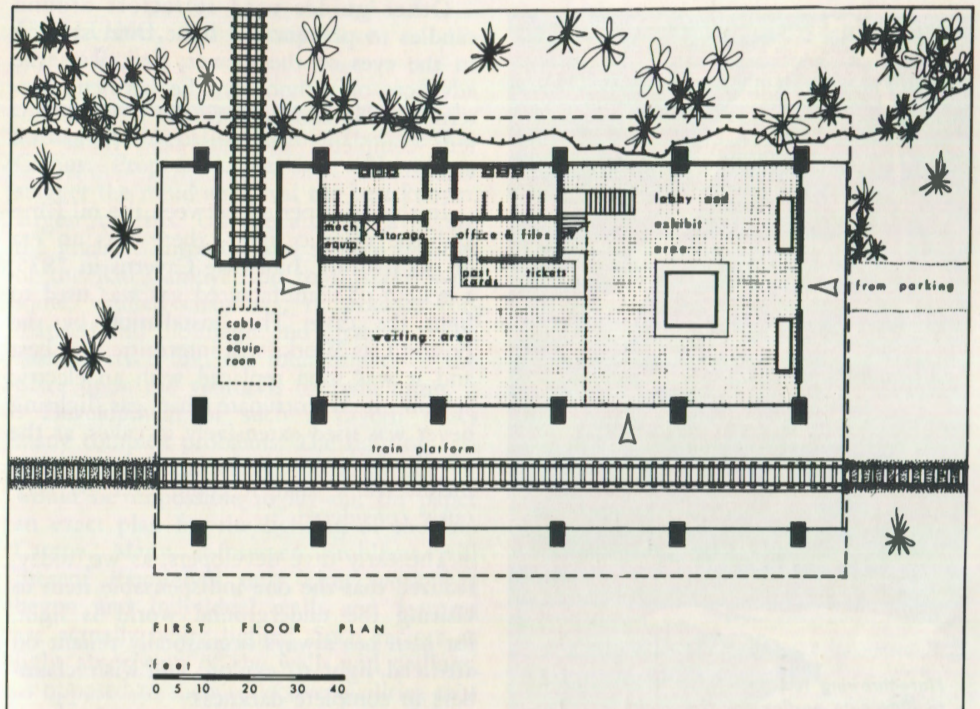


WEST ELEVATION

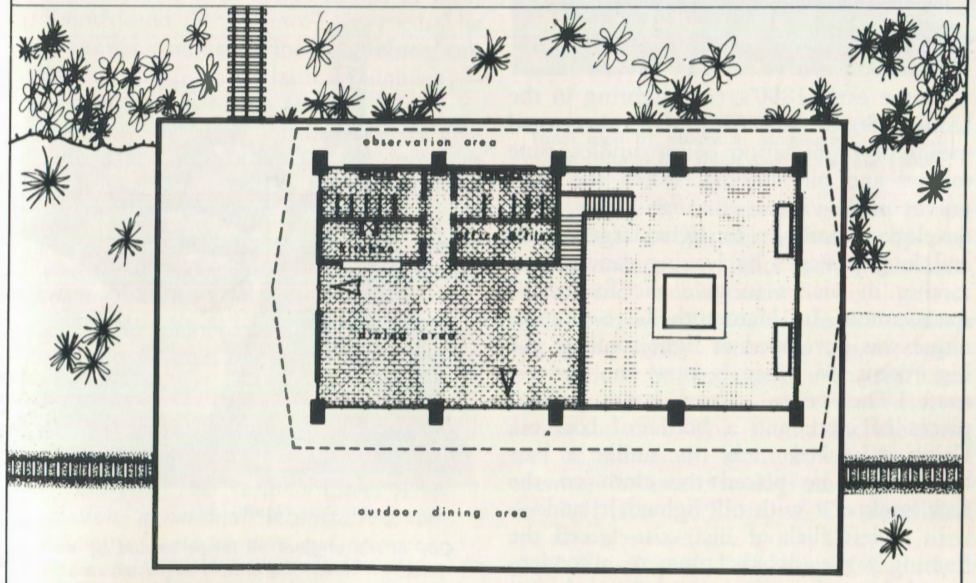


PARK TOUR DIAGRAM

Figure 12.



FIRST FLOOR PLAN



SECOND FLOOR PLAN

Figure 13.

Figure 14.

Flare-throwing technique used by early guides to illuminate portions of Mammoth Cave. Photograph courtesy of National Park Service.

In the early 1800's, cave lighting in the United States was primitive, the usual means of illumination being candles, pine torches and oil lanterns. When the early guides took visitors through caves, they developed methods to light large rooms and long passages by leaving candles and torches in niches to give the feeling of spaciousness. In Mammoth Cave a technique was developed to light some of the big rooms on what is now the historic route. The guide carried some twisted pieces of cloth and a bottle of coal oil. Using a hooked stick, not unlike a barbecue fork, he placed the cloth on the fork, soaked it with oil, lighted it, and — with a deft flick of his wrist—arced the flaming rag across the room to a convenient ledge where it burned brightly for several minutes. The flickering light cast strange shadows about the room giving action to what was otherwise a static scene.

Other guides used reflectors around candles to prevent the light from shining in the eyes of the viewer; and, with the advances of technology, the kerosene lantern, carbide lamp and finally gasoline lantern completed the hand-held flame devices.

In the brief period between the oil lamp and the electric lights, there was an era of gas lighting. In Howe Caverns in 1875, a system of manufactured gas was used to light the cave. This installation by the Boston Gas Works was intermittent at best and it was soon replaced with an electric system. It is fortunate that gas lighting never was used extensively in caves, as the potential danger was so great it seems inconceivable that it could ever be seriously considered.

The early cave developers, as we, today, realized that the one indispensable item to visiting the underground world is light, for man has always been totally reliant on artificial light to explore and visit chambers in complete darkness.

Figure 15.

One of the original oil lamps carried by each visitor to Howe Caverns, New York, in the 1840's. Photograph courtesy of Howe Caverns, Inc., Howe's Cave, New York.

LIGHTING, Rio Camuy Cave

By Roy Davis*

Few cave systems in the world offer the variety of magnificence found at the Rio Camuy. Proportions of size and volume stagger the mind and rival the best known, largest caverns. Unique among caves are the gigantic entrances and surface features of the Rio Camuy. Add to this the awesome, vaulted chambers, remarkable formations and the magic and mystery of the rushing river, and the total impact of the place upon the visitor is overwhelming.

Development of such a cavern poses many complex problems. The lighting system suggests an enormous challenge. It would be impossible to lay out on paper an exact plan for the lighting of the Rio Camuy. Many unforeseen problems will present themselves only after work has begun and individual walls and features are actually being lighted. Such factors as light absorption of the walls and ceilings, as opposed to their reflective qualities cannot be forecast until actual beams of light are aimed and the "bounce" observed. The following recommendations, therefore, can only be considered as basic guidelines — a mere approach to the task.

Probably the most outstanding features of the Rio Camuy are (1) the entrances and surface features, (2) the activity and work of the river and (3) the great size and volume of chambers, in that order. These, and the various formations, should receive greatest emphasis.

(1) The major opening, Tres Pueblos, should be lighted for nighttime viewing. Tres Pueblos would make an especially exciting first impression for visitors—with bluffs and entrances illuminated, together with the tangle of vegetation, banana trees and vines covering the talus slope. The

Figure 16.

Torch used by guides in Mammoth Cave, Kentucky, to light The Dead Sea in the late 1800's.

river, where it crosses the bottom of the sink, could be further enhanced by providing underwater lights at strategic locations, which would catch the highlights of the active, white water. If Espiral Sink is not to be viewed from the top, it should nonetheless be provided with sufficient light to illuminate it when viewed from inside the cave. This should include some sort of simulated "sunlight" to show the opening on overcast days and after sundown. If later the Empalme Cave and sink are also shown, these would likewise need to be illuminated. Providing of nighttime illumination of entrances would not be necessary at the outset of the development, of course, but it would be well to keep in mind.

Continued on page 50

**Roy Davis is president of Cumberland Caverns, Inc., and secretary-treasurer of the National Caves Association, a national organization consisting of cave owners and operators. He has designed and executed lighting systems for a number of the larger tourist caves. He has served as past board member and past editor, N.S.S. News, of the National Speleological Society.*

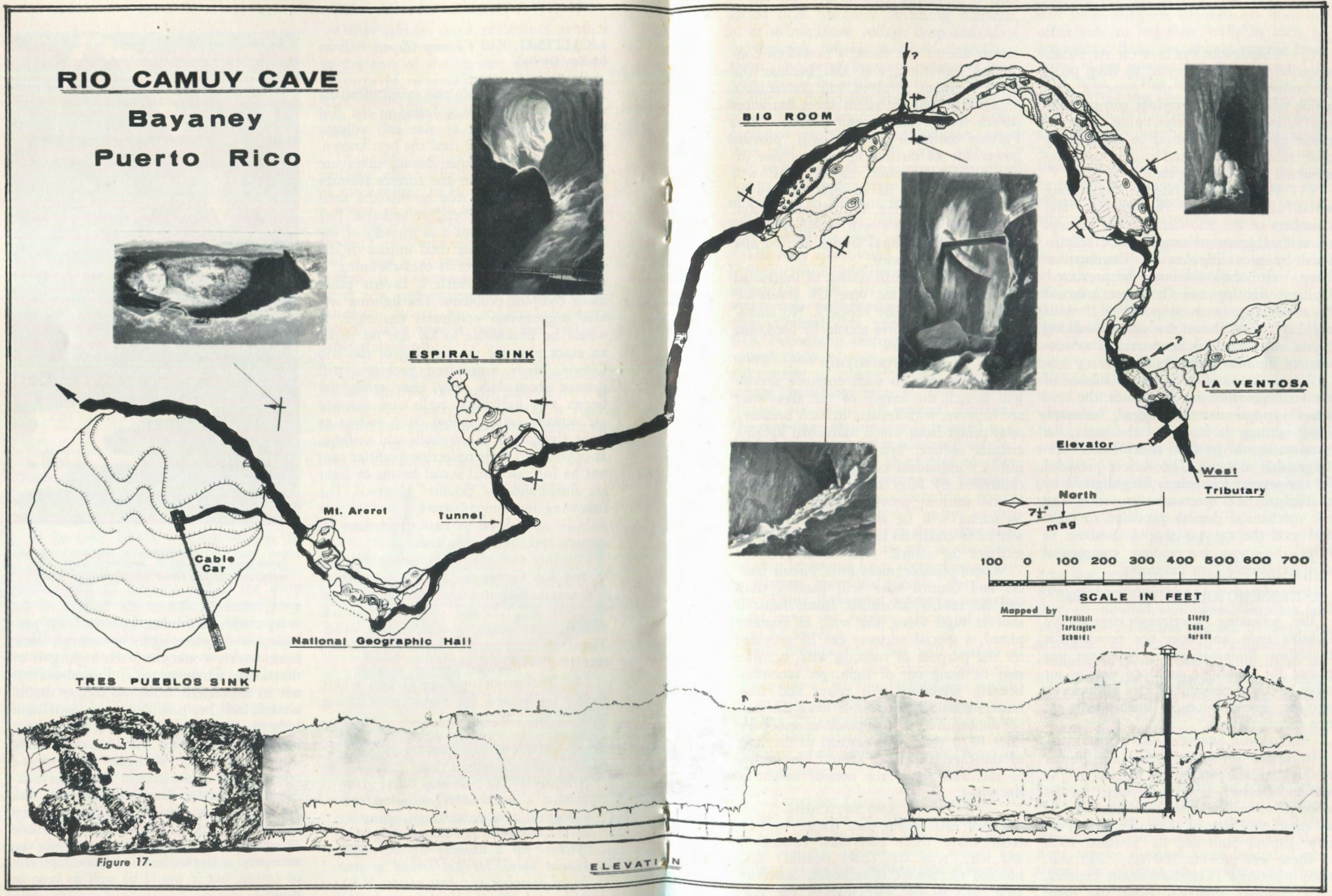

RIO CAMUY CAVE
Bayaney
Puerto Rico
BIG ROOM
ESPIRAL SINK
LA VENTOSA
Elevator
West
Tributary
North
7½°
mag
Mt. Ararat
Tunnel
Cable
Car
National Geographic Hall
TRES PUEBLOS SINK
100 0 100 200 300 400 500 600 700
SCALE IN FEET
Mapped by
ELEVATION

Figure 17.

(2) Throughout the cave the river calls attention to itself. Whether by deep pools or rushing cataracts, the presence and action of the river is obvious and interesting... even a little frightening. This intrigue of the river should be featured by cool, subtle lighting and underwater illumination where appropriate.

(3) High ceilings, far-apart walls, long vistas, all characterize the corridors and chambers of the Rio Camuy. The concept of vaulted greatness ought to be emphasized by providing low-key illumination. Long, weird shadows should be preserved. Brilliant lighting and "hot spots" should be avoided as much as possible. If trails are kept high above the river, "walking lights" will need to be provided to adequately illuminate the walkways.

Below the comfort and convenience of the trails provided for the visitor, the cave should appear natural, rugged, untamed. Low lighting, the sound of the water, the vastness should produce this effect in unforgettable measure. The variety provided by the several formations (highlighted by spotlights), the spectacular entrances and the mechanical devices provided to enter and exit the caverns should combine to offer the most outstanding commercial cave experience ever developed.

I. DESCRIPTION OF THE SYSTEM

The following description covers cave lighting only, and does not provide for nighttime illumination of entrances nor power for buildings, entrance devices, or other electrical needs associated with development. Presentation is intentionally in non-technical form.

A. Entrance Service and Main Line

In order to assure adequate power throughout the 4000-foot length of the section of cave being contemplated for development, service should be provided at all three entrances of the cave: Tres Pueblos, Espiral Sink and La Ventosa. Each of these will provide 200 amp, 240 volt, relay operated fuse/disconnect centers, each remotely operated from the main building. 240 volts is specified rather than using high-voltage carrier throughout the cavern due to wet, thereby hazardous conditions prevailing, and also because the short distances involved and convenience of available power at all three entrances makes voltage drop a minor factor. Tres Pueblos entrance service will provide power for all circuits up to, but not including Espiral Sink. Espiral Sink will supply itself, Big Room and the area up to, but not including, formational section. La Ventosa entrance will supply the formational area, Natural Bridge section and access to the entrance.

All main lines shall consist of individual conductors, 2-0 wire, type UF insulation (neutral may be bare copper). No aluminum wires or fixtures should be used, due to corrosive qualities.

B. Distribution

Main lines from each entrance service will stretch the length of the areas they are to serve, with feeders to each breaker/relay center from which individual lighting circuits radiate. System will be divided into 13 individual circuits, each remotely controlled by relay switching from push-button stations provided along the trail. Switching will be overlapped in such a way as to create no interruption in lighted trail for the visitor.

Where possible, main lines, circuit feeders and control wire will parallel trails and be readily accessible from them. If trail is high along the wall, as contemplated, a special wireway can be provided for the purpose of running wire, or, wire may be hung out of sight, yet accessible, beneath walkways. All relays and fuse-centers should be accessible from the trail, yet unobtrusive. Where possible, only bulb-lines (120 volt) will descend to the floor of the cave, and these should be attached to the wall above the normal height of the water.

C. Fusing and Switching

From each main line short runs of feeder-cable, three individual conductors, #4 wire, type UF (bare neutral) shall proceed to breaker/relay boxes, delivering 240 volts to the line side of the relay through 15-60 amp circuit breakers (as the load requires).

The relay method of switching is preferred over threeway switching methods, so as to minimize voltage drop and more conveniently provide multiple control stations. The relay/breakers, wherever possible, should be located in the approximate middle of the circuit they will control so as to further reduce voltage drop. Relay preferred is the mercury-plunger type, three-pole, 240 volt, 60 amp, with 120 volt switching coil. This type is specified due to its silent operation and the enclosure of contacts in vacuum, free from moisture and dirt. The third pole is for "lock-up" operation of the relay, to ground.

The relay is activated from each end of a given circuit (additional stations may be added for each circuit as desired) by waterproof, push-button (NO/NC) stations. Control line need not be heavy. #18, 2-conductor thermoplastic thermostat control cable is quite adequate. 120 volt coil-voltage is selected rather than low-voltage switching because it is able to operate efficiently for greater distances. The amperage of this line is reduced to a non-hazardous degree by resistance induced in the coil. "Lock-up" third pole of relay allows circuits to be turned off remotely throughout the cave by interrupting power at entrance. "Dropping out" relays in this manner at the close of a day's operation assures that all lights are off in the cave, but may be started from any station within by pushing individual circuit "start" buttons. (This is helpful where a forgetful guide leaves the furthest circuit of lights on as he leaves.)

Each breaker/relay box will contain a small, 25 watt, 750 ohm resistor connected on line side of relay, providing heat within box to raise ambient temperature sufficient to drive out moisture and protect relay and breaker. Main lines should be left energized at all times to provide "heat" in switching centers.

D. Lighting Lines and Fixtures

From load side of relay two separate, 120 volt bulb lines will proceed to individual lighting fixtures. These should be arranged in such a manner that a breaker tripping on one side of the line would still allow sufficient illumination from the other side to negotiate trails in such an emergency. Bulb lines should emerge from relays in not smaller than 2-conductor, UF, #10 wire — and larger where load demands. This line size would decrease proportionately to the distance from fuse-center and size of load demanded—through range of 10, 12 and 14 wire. No bulb lines should be smaller than #14. Neutral may be picked up at closest available place, and should be tied back into main neutral whenever it comes within reach.

Bulb fixtures themselves should be firmly anchored to the cave walls or heavy slabs of rock—where possible above the reach of rising water (occasional dousing of fixtures is not serious, though fixtures should be protected from floating debris, and the fixtures themselves should be carefully grounded). Fixtures should be of steel construction (never aluminum) of the "utilite" design, and attached by a single ¼" plastic anchor through the base. Bulb should be of the 150 watt, or 300 watt PAR design, with pyrex glass lens and built-in reflector. Once a fixture is placed and aimed, it should be permanently tightened in place so that changing bulbs will not disturb the focus.

E. Placement

Wherever possible, lights should be kept low, and directed upward along walls, formations, breakdown, etc. Rarely should they be pointed downward, flooding an area below. Fixtures should be kept as accessible as possible to facilitate bulb-changing. Try to avoid locating lights on high ledges, at the top of domes, bottom of pits, etc., except to produce special effects—in which case the inconvenience of the inaccessibility will have to be borne.

All lighting should be kept indirect. Never flood light directly on trail so that bulb and fixture are visible to visitors. Never assume that the visitors will be traveling in one direction only and that light can be directed from behind. Light should be indirect and unobtrusive from

any point on the trail and traveling in any direction.

If trail lights or walking lights are provided to illuminate pathways (and this would seem desirable where low-key lighting is contemplated), keep such lights well below eye level and adequately hidden from view by some type of rock cairn or metal cover-shade.

F. Special Effects

Areas for special treatment that suggest themselves are as follows:

1. Nighttime illumination of entrances, particularly the Tres Pueblos, would be unique. Illuminating the walls of the sink, the cave entrances, the water flowing across the bottom and the jungle-like vegetation could be treated in the same manner as individual circuits inside the cave.

2. Underwater illumination would be effective in several locations within the cave; particularly at the deep pool just inside the Tres Pueblos entrance, at the rimstone pool, beneath the whirling waters of the resurgence, and at the pool at the Espiral opening. The use of pale green light directed on the water can provide some surprisingly pleasant effects. Also, light directed through the surface of the water from below at walls and ceilings creates myriads of shadows and liquid motion on walls and ceiling.

3. The Big Room, representing the largest chamber, could be shown in degrees, lighting its extremities and ceiling first, and gradually bringing it to full illumination. This would also be an excellent location to present a recorded narration describing the development of the cavern by the river's unceasing motion.

4. The Espiral Sink, with daylight penetrating from above will be spectacular from first sight. This view might be further enhanced by providing illumination of the shadowy area below the daylighted opening, and also underwater lighting in the stream. For nighttime showing some simulated daylight should be provided at the sink mouth.

II. INSTALLATION PROCEDURES

A. Preliminary: Three entrance services may be installed (power supplied at pole and transformered by power company) and main line temporarily laid, taking care to allow for its final installation in wire-way to be provided. Power will then be available for work lights, power tools, etc.

Final lighting installation will not be undertaken until trails are completed and other construction details finished.

B. At completion of other work, main line will be placed in proper position. Feeders may then be attached and all relay/breaker centers installed, along with their controls.

C. Wiring of individual circuits will then begin, one at a time, beginning at Tres Pueblos sinkhole and finishing with La Ventosa entrance.

Bulb lines will be radiated to areas in circuit to be lighted. Fixtures and bulbs will be "spotted in," one at a time, carefully observing the effect created, its ease or difficulty of being concealed and serviced, before being permanently installed.

After the circuit is installed and adequately lighted, the trail will be noted as to degree of "bounce" light created for walking. In most instances this will not be sufficient and additional trail lights will be needed.

After completion of the above steps, the final "touch-up" will be added, unless special effects are to be incorporated. These include burying and cementing wire, building cairns and otherwise tidying up.

Two crews of men will be employed to install the lighting system. The first will be headed by the lighting specialist who will direct work, spot all fixtures and plan system. Under him will be a master electrician who will be responsible for all actual hookups and installations. Under him, two additional electricians will assist with wiring, fixtures, installation, etc.

A second crew will be headed by a foreman (under supervisor of lighting) who will build cairns and conceal fixtures and wire. Additional help, in the form of laborers for wire burying, etc., may be hired as needed in the final stages of installation procedures.

Estimated cost:

Specialist (planning, consultation, overseeing)	$20,000.00
Electricians, masons, labor	10,000.00
Materials	20,000.00
Total, installed	$50,000.00

RIO CAMUY LIGHTING LAYOUT — Circuit Distribution

Main A. From Tres Pueblos entrance service:

Circuit	Trail Length	Area covered	Estimated Fixtures	Watts	Amps	Fuse
1	175′	Tres pueblos entrance to Mt. Ararat	17	2550	11	20
2	200′	—To narrows beyond rimstone pool*	24	3600	15	20
3	250′	—To beginning of water-filled channel	30	4500	19	30
4	400′	—To Espiral Sink (but not including it)	48	7200	30	40
Special*	—	*Special circuit on rimstone pool	5	750	3	15
TOTALS	1025′		124	18,600	77.1	200

Main B. From Espiral Sink entrance service:

Circuit	Trail Length	Area covered	Estimated Fixtures	Watts	Amps	Fuse
5	300′	Espiral Sink (as special)	24	3600	15	20
6	350′	Espiral to halfway to Big Room	40	6000	25	40
7	350′	—To Big Room	40	6000	25	40
8	350′	—Big Room	50	7500	32	40
Special*		*Special, 2 circuits, Big Room	25	3750	16	30
TOTALS	1350′		179	26,850	112	200

Main C. From La Ventosa entrance service:

Circuit	Trail Length	Area covered	Estimated Fixtures	Watts	Amps	Fuse
9	450′	Big Room—to first half formations	40	6000	25	40
10	500′	Second half formations	48	7200	31	40
11	250′	Natural Bridge area	25	3750	16	30
12	200′	Resurgence	20	3000	14	30
13	400′	Upper cave, La Ventosa	32	4800	21	30
Special*		*Special—formational area	20	3000	14	20
TOTALS	1800′		185	27,750	121	200
GRAND TOTALS	4175′	ALL CIRCUITS AND SPECIALS	488	62,200	310	600

TRAILS

The routing of tourists through a cave in such a way as to provide them with a pleasant and memorable experience is the aim of every commercial cave owner. Unfortunately, the mechanics of such a trip might become so involved that the entire enterprise could become impractical.

Figure 18.

The first wedding in Howe Caverns, September 27, 1854, showing trail to the bridal chamber. Photograph courtesy of Howe Caverns, Inc., Howe's Cave, New York.

In the early days of cave development, the tourist was expected to exert himself by getting down and crawling; and, in order to prevent his becoming muddy and stained, he wore a special costume. The trails were primitive, and the handrails, ladders and safety devices limited. Sometimes the "development" of a wild cave was simply to install a gate at the entrance to prevent non-paying visitors. Guests scrambled, slid and splashed through the cave, sometimes in pursuit of the guide rather than being shepherded by him. Many guides simply adapted the route to the traffic or occasion, and passageways soon resembled a plowed field. Larger rooms looked like variegated cattle trails in a pasture. Some owners solved the problem of mud and irregular floors by simply paving the floor wall-to-wall with stone, gravel or brick. This made it very convenient for the tourist but it destroyed some of the natural aspects of the cave. As traffic increased, the need for better planning was necessary. Gradually, where possible, a loop route was developed or another entrance dug to prevent retracking and retracing of steps.

Many successful tourist caves have been redeveloped to permit a better tourist flow and to prevent the bottlenecks caused by excessively large parties. Howe Caverns, New York, failed in its first attempt, and it was only when an elevator was installed at the opposite end of the cave that the venture was successful.

Marvel Cave, Missouri, has a spectacular stairway into its entrance room. The same 570 steps required to leave the cave were enough to discourage anyone from revisiting it. The installation of an inclined railway at the back end of the cave eliminated back tracking as well as the climb on foot and provided an additional point of interest for the tour.

The developers of Luray Caverns, Virginia, and Crystal Cave, California, have dug short tunnels to permit loop arrangements

Figure 19.

Opposite page. Canopy formation and rimstone pool along trail, Rio Camuy Cave. See fig. 17. Painting by John Schoenherr.

and prevent the doubling back of tours. Practically every major cave in the country has modified its trails to permit a safer, more comfortable trip for its visitors.

Easy access to the entrances should be made to expedite the entry of material and personnel into the cave. Temporary power should be provided to permit the work to carry on. All these outside and preliminary preparations are similar to a mining operation and information on this can be obtained from many sources. Unlike a mining operation, however, a degree of sensitivity is required by the superintendent of the work in that he must guard against the destruction of the features of the cave which he is attempting to display.

It is possible that the delivery of working materials into the cave might be accomplished more cheaply and with less effort by drilling an access from the surface in an area where cement, stone and gravel can be dumped without harm. Power can also be supplied through alternate openings to permit the use of compressed air or welding equipment without the danger of gasoline fumes.

It might be necessary to build temporary bridges and trails to ease workmen's travel in the cave and enable several gangs of men to work at one time.

Hand labor cannot be eliminated. The workmanship necessary for the construction of retaining walls, abutments and handrails should enhance the development of the cave and not detract from it in any way. It is important to avoid massive alterations that require large artificial areas. Where it is necessary to make supports and braces for the trails and walkways, they should be made to appear natural and conform with the contours as much as possible.

It is desirable to limit the amount of pitch to the trails and stairways to allow comfortable walking. This does not preclude the psychological fact that some fairly narrow and low passages are important to give a sense of adventure to the trip.

In all areas of the cave where there is any danger of slipping or where there are steps, handrails should be provided. These should be of metal with non-corrosive coating and not wood as the humidity of the cave would soon rot wood and cause dangerous spots. Where possible 6'8" headroom should be maintained, and the trails should be a minimum of six feet wide to permit two people to walk abreast.

Where possible the trails should be of a material which will withstand the traffic and not become slippery from dripping water. Cement trails should have a rough finish to give better traction. Gravel trails should have shoulders to prevent the stones from scattering over onto the slopes or into pools. If fine material is used, it should be with the knowledge that it picks up on feet in dry areas and stacks up in wet places in the cave. All trails on a slope should be anchored to prevent washing away, and cantilevered walkways should be securely braced to prevent accident.

TRAILS, Rio Camuy Cave

By Jack Burch*

Entrance to Rio Camuy Cave will be made by way of a high-speed elevator accommodating 25 people which will descend from La Ventosa entrance 400 feet to the cave floor in 30 seconds. This elevator will discharge passengers in an artificial tunnel 50 feet to the west of the main passage. This assembly area will have an entrance into the cave 50 feet upstream of the Natural Bridge and about ten feet

Figure 20.

Opposite page. Bridge spanning the Rio Camuy on the visitor's route. See map fig. 17. Painting by John Schoenherr.

below it. A wide, artificial bridge at this point will mark the beginning of the underground tour. All the bridges spanning the main passage will have slightly curved or I-beam bracing with a level, concrete floor.

The walls of the cave are nearly vertical for a distance of nearly 200 hundred feet at this part of the cave which will make it necessary to notch a six-foot-wide trail along the east wall. Three feet of the width will be cut into the wall and the remaining three feet cantilevered.

The room then widens and the trail will leave the wall and be constructed over huge boulders. Retaining walls of stone between the boulders will provide stability for the trail. Some of the boulders can be removed and used for fill in other places. There are fine stalagmites for the tourist to see in this area. The trail, now eight feet wide, will pass behind and through these large formations (fig. 19).

Fifty feet upstream of the Big Room it is necessary to cross the river. A bridge and cantilevered trail 40 feet above the normal water table would provide a fine view of the river below (fig. 20).

Across the Big Room, the trail will cut through the breakdown-strewn slope, still well above the high water mark (fig. 22).

At the downstream side of the room the trail again spans the river and the tourist proceeds through a narrow canyon on a cantilevered trail to the bottom of the Espiral Sink. Here the trail broadens and the grouping area permits a fine view of the sink and the reflected green light which bathes the cave (fig. 21). The trail then leads along the upper part of the downstream canyon to an artificial tunnel which cuts through a flowstone barrier into National Geographic Hall. Along this trail are examples of calcite formations which are close enough for the inspection of the tourist. The trail will proceed above rimstone pools on the east wall to the top of Mount Ararat. A grouping area here permits a view of the river-filled entrance at the bottom of Tres Pueblos sinkhole. A bridge will span the river at this spot to the west wall where a short tunnel will bring the visitor out west of the main entrance and about 40 feet above the river. The tunneling here will be extremely delicate to preserve the old stalactites on the ceiling nearby.

The trail will now expand to a grouping area which will provide an overlook to the river and a view up the spectacular walls of the enormous Tres Pueblos sinkhole. Tree ferns, tropical plants and flowers will line the trail cut into the steep slope of the bottom of the sink. A short walk through the trees will lead the visitor to a waiting cog railway which will take him up through the dense vegetation to the rim of the sink and the administration building.

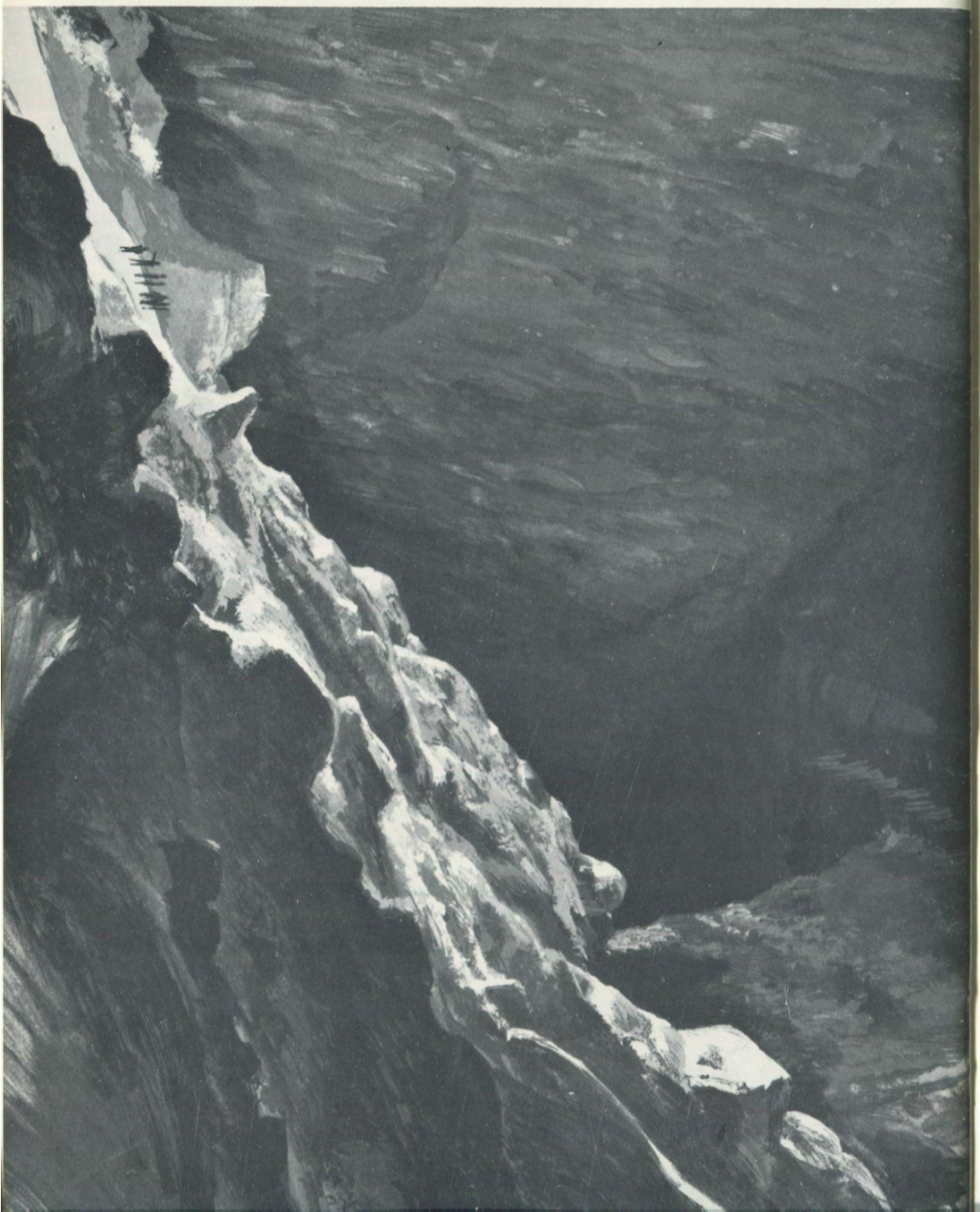
In times of heavy tourist traffic, visitors may begin the tour either on the cog railway or elevator entrance to take the best advantage of the available facilities.

In this entire 3500-foot walk, the visitor has not climbed more than a few steps and in a brief period of time, he has traveled one of the most spectacular parts of the underground course of the Rio Camuy.

Figure 21.

Opposite page. View looking upward at Espiral Sink entrance 300 feet above the tourist walkway. River is 40 feet below the trail at this point. See map fig. 17. Painting by John Schoenherr.

**Jack Burch is cavern developer and engineer, Natural Bridge Caverns, San Antonio, Texas. He has also helped develop other caves including Sonora Caverns in Texas.*



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GUIDES

By Russell H. Gurnee

One of the most important factors in presenting a memorable experience to the cave visitor is the excellence of the guide. The confidence and enthusiasm of this leader directly influences the enjoyment and understanding of the party. His ability to provide the information necessary, show the cave to its best advantage, and maintain a personal rapport with each group adds greatly to the impressions taken away by each person.

One of the most famous guides in American cave history was Stephen Bishop (fig. 23), a slave, who was one of the guides in Mammoth Cave in the years of its greatest exploration—the 1830's. Although he was self-educated, he acquired a knowledge of geology, languages and a fine sense of perception regarding people in the many years he conducted tours through the cave. Snatches of the man's personality are glimpsed in the letters and writings of visitors of that day. He was personable, energetic and certainly a capable guide. His courage and enthusiasm are shown by his explorations. He was the first to cross the "Bottomless Pit" and his discoveries of Echo River, Cleveland's Cabinet and many other regions of the cave made him a legend in his own lifetime.

In the early 1800's the guides used much the same techniques necessary today, but they had to obtain viewing effects using only the primitive equipment of the time. Each of the visitors carried a lamp—the guide with an oil lantern and a supply of oil. Certain areas of the cave were used as storage points for oil and on longer trips (some lasting 12 to 16 hours), the guides carried food and drinks for the party.

Certain lighting effects were obtained by the use of candles or Bengal lights. The imagination of the viewer was sometimes stretched, as it is today, to permit him to see the outlines of animals, birds and "Martha Washington's Statue."

Daily visits both in the past and today give a guide an intimate knowledge of a cave. The boredom of a repetitious route is a challenge to the ability of a man to interest and entertain his charges. Certainly a sense of humor is a necessary part of a guide's character. The personality of the individual in charge is a serious consideration, for visitors are in a strange environment and the guide does a great deal to lessen the concern and perhaps fear that may disturb some of the people.

The information which a guide gives the public is generally accepted without question. If it has to do with the history, folklore or development of a specific cave, he is on firm, authoritative ground, as the management should be able to provide him with the proper facts for such a talk. However, if it has to do with general information concerning the origin of the cave—biology, geology or hydrology — he may possibly be misinformed or not qualified to pass on proper information to the public. It should be the responsibility of the management to provide a good basic educational background for guides so that errors, misinformation and old wive's tales are not passed on to the public. A guide in a popular tourist cave may speak to thousands of people in one season, and the information that these people take away might be the only introduction to caves they may ever have.

The ill-informed, unsympathetic and disinterested guide can make a superb cave seem dreary and unpleasant, while an informed, articulate and enthusiastic guide can make even a moderately interesting cave an adventure.

There are several unique problems in planning for the conducting of tourists through Rio Camuy Cave. The first problem is physical in that the train, tram and elevator separate the visitors from the

guide and so it will be necessary to provide a public address system in the train and tram in order for information to be enjoyed by all. The second problem is that in the cave there is competition of sounds. The river is extremely noisy and it will be difficult to be heard except at special grouping areas. Some means of amplification will be necessary in order that the guides may be heard. The third consideration is the need for a bilingual presentation. It will be necessary to have guides give information in both Spanish and English in order to provide the most enjoyment for all. During the slack periods dual translations can be given by individual guides; in the rush hours it would be advantageous to have tours for each language group.

Figure 23.

Stephen Bishop, famous guide in Mammoth Cave, Kentucky, in the 1800's.

The typical tour talk will follow this general format and include the following information:

An introduction at the administration building will give general information on the history of the cave and its development. The train trip through the haystack hills will tell of the geology of the region and the manner in which these peculiar and unusual features were formed. The stop at the elevator tower will permit a view of the surrounding country and, on a clear day, a view of the ocean ten miles to the north. The group will descend by means of an elevator about 400 feet to a grouping area at Natural Bridge. At this point the guide will tell of the river and the general dimensions of the cave. The walking tour will then start along the foot trails, with tourists viewing the formations, waterfalls and corridors. The guide will pause at several grouping areas to explain the features seen along the way. The lighting effects and sound of the river will give a dramatic feeling to the cave which will be enhanced by the information supplied by the guide at critical points.

During the tour the guide will provide general information on special cave features, geology and cave life. A period will be allowed for questions at various places, and adequate time will be allowed for the complete tour.

When the group leaves the cave at the bottom of the Tres Pueblos opening, the guide will give a description of the sinkhole and point out some of the plants and flowers at the bottom of the sink. In the brief trip up the cable car, the view itself will be spectacular enough without narration.

When this cave is developed it will create a need for trained cave guides. This profession can be filled adequately by the young men of Puerto Rico. It would be necessary to provide an adequate training program for these men, however, but the benefits from such training would provide a fine, articulate accompaniment for the cave tour.

FINANCIAL PLAN

By Jack Herschend*

Although there are over 200 commercial caves open to the public in the United States, only a small number can be termed financially successful. These seem to fall into two categories. First, there are the caves which are located close to heavy traffic, highways, or within easy reach of a large population center. The success of these operations seems to have little correlation with their merit as natural attractions but is in proportion to how well they are publicized.

In the second category are those cave operations which have been institutionalized. These caves have been promoted on a regional or national scale publicly or privately as a natural wonder which the traveling public must see. These caves depend to a large extent on the merit of the particular natural wonder and its proper development, as well as on the ability of the operator to promote on a national or a regional scale.

The financial success of the caves in both categories also depends to a large extent on the development and execution of a long-range plan. A large portion of expenses are capital improvements which will depreciate over a 20 to 50-year period. In many cave operations, fixed expenses will be 30 percent or more of gross income. More than one commercial cave has experienced growth problems as they found that their planning had not taken into consideration the handling of large numbers of people therefore necessitating the change of trails and lighting systems as well as conveyances.

The Rio Camuy Cave should be compared with the caves in the second category. That is, it is a cave that will need to be sold as one of the "must see" attractions on the island of Puerto Rico, and certainly deserves this notoriety for the cave itself. The entrances to the cave, particularly, are outstanding natural phenomena. In the case of the Rio Camuy, financial success will depend on a well-executed, long-range plan. Because of its immense size and rather difficult problems, the initial investment will be quite large. There is no feasible way to open the Rio Camuy Cave on a small scale because, other than the problem of entering and exiting, there are flooding considerations within the cave itself.

**Jack Herschend is manager of Marvel Cave Park, Branson, Missouri, and President of the National Caves Association.*

POTENTIAL OF THE RIO CAMUY CAVE

In 1965 the island of Puerto Rico was visited by 3½ million tourists. By 1970 the island officials estimate this number will top seven million. Because the island is 35 miles wide and 100 miles long, it is not difficult to traverse in a rather short time. There are at present 6,000 car rentals which are rented for an average of a three-day period, and are rented for approximately 80 percent of the entire year. The average car is rented to just under three people per car. This means that 1,700,000 people travel in rented cars on the island each year. Also, several bus tours are offered at the present time and all of them seem to be enjoying good business. In addition, the island's population of over two million offers still another good potential market. Although there are some areas of the island which are served by narrow roads, many areas have excellent two and four-lane highway systems. Successful development of the Rio Camuy would be dependent upon construction of an improved road from San Juan to the cave's location. The cave's success would also depend upon the degree of government commitment to promotion of the Rio Camuy as one of the leading attractions of the island. The Puerto Rican Government has been working with private enterprise for the development of tourism on the island, and their support in the cave's development will be important to the entire project.

Total project investment would be $1,020,000 with a break-even point of

$262,000 on cave admissions. In addition, revenue would be forthcoming from food and drink facilities. It is recommended that the adult admission be $3 and the children's admission be $1. So as to afford island residents an opportunity to visit the cave one or possibly two days a week in the slower months, prices could be lowered to $1 for adults and 50¢ for children.

THE DEVELOPMENT OF THE RIO CAMUY

Capital expenditures for the development of the Rio Camuy are found following this section. A description of each category may be of some help in the final development of a long-range plan.

The entrance road from the present highway, as well as the parking lot, would necessitate an expenditure of approximately $51,000. A 22-foot, double-sealed, built-up road is suggested along with a parking lot to be almost square with a surface of 95,200 square feet which would accommodate 400 cars. The lot would be adequate as long as it serves only cave visitors. If other facilities are planned, the parking lot should be enlarged.

The administration building has been located at the southwest corner of the Tres Pueblos sink and is planned to cantilever over the sink so as to give a spectacular view of the 310-foot-deep abyss. The administration building is planned in such a way that it should give a very fine first impression. On one side of the building would be a tremendous sinkhole, and on another side would be the funicular cable train descending into the sinkhole. On still another side would be the depot for the sugar cane train. The building will house lobby, observation area, restaurant, and ticket sales and will be approximately 8,000 square feet, with an estimated cost of $10 per square foot.

The allocation of $30,000 lor landscaping would include not only trees, shrubs and flowers planned for the entrance at the highway, the parking lot, and the administration building, but also the careful landscaping of walkways through the bottom of the Tres Pueblos sink. The restoration of this natural rain forest would be an outstanding feature of the cave tour.

At the present time, water lines are being run by the government through this particular part of the island, therefore a $12,000 expenditure would bring water to the various landscaped points and also to the administration building.

Rest rooms and sewage disposal facilities located close to the administration building should include four toilets and four urinals for the men and eight toilets for the women with future expansion to double this capacity. A lagoon type of sewage disposal is suggested with a surface of 16,000 square feet.

The funicular cable train would have a capacity of 50 people on each of two trains with a travel time of approximately two minutes. Total distance traveled would be 625 feet. The Vulcan Denver Corporation located in Englewood, Colorado, makes a double drum unit with a 50 hp. electric motor which would be adequate to do this job. A 7/8-inch cable is recommended for this particular installation. Care must be taken in the installation of the track and trestle so as to afford visitors the best possible view of the Tres Pueblos sink without marring the natural beauty of the sinkhole itself.

The immense and unusual type of cave passageways offer an opportunity to do some rather spectacular things in trail layout and lighting. Because the trails must necessarily be built quite high above the stream and because of the immense size of the room, the estimated cost of these two items may seem a bit high. 3,600 feet of trails are planned in the cave at a cost of $45 per foot, and the lighting is planned at a cost of $14 per trail foot.

The cave tour includes an elevator located at the natural bridge within the cave, which would necessitate a shaft approximately 400 feet deep at a cost of $90,000; and an elevator with a capacity of 25 people and a travel time of 30 seconds would cost $50,000. Here, as with the installation of the funicular cable train, particular care must be exercised by supervisory personnel to see that the shaft as well as the elevator will be installed in such a way as to not mar the natural beauty of the Natural Bridge area within the cave.

Although the most remembered feature of the experience in visiting the Rio Camuy area will be the cave and particularly Tres Pueblos sink, the sugar cane train which is made necessary to eliminate the need for backtracking through the cave as well as to accommodate large numbers of people, will be an unusual and long-remembered experience because as planned it will afford the visitor an excellent, narrated view of most unusual topography as well as a spectacular view of the Espiral sink. This train should be, as nearly as is practical, identical to the steam train used for years on the island to haul sugar cane from the fields to the mill.

The elevator, the funicular cable train, the sugar cane train, as well as the trails, are planned in such a way that tours could be started from the administration building either on the sugar cane train or on the funicular cable train thereby making it possible to handle the maximum of visitors—that is 10 to 12 thousand visitors per day.

The work to be accomplished in this project is quite unusual. It is also difficult to blueprint or otherwise lay out for a contractor. It will be difficult to complete the necessary facilities without marring the natural beauty found in the cave as well as on the surface. It is for this reason that it is suggested that the National Speleological Society be retained as consultant in the development of this project.

SUMMARY

The Rio Camuy is an outstanding natural attraction and should be developed for the traveling public and for island residents alike to enjoy. To be financially successful, this venture needs three things: the promotional support of the Puerto Rican Government, a good access road from San Juan and the sound financial backing necessary to develop the cave initially on a large scale.

CAPITAL EXPENDITURES

Entrance	$ 16,000
Parking Lot	35,000
Administration Building	100,000
Landscaping	30,000
Water Lines	12,000
Rest Rooms and Sewage Disposal	35,000
Funicular Cable Train	131,000
Cave Trails	162,000
Cave Lights	50,000
Shaft and Elevator at Natural Bridge	140,000
La Ventosa Entrance Building	20,000
Sugar Cane Train	223,000
Consultant Fee	66,000
Total Capital Investment	$1,020,000

OPERATING EXPENSES

Variable			
Salaries	32%*		
Advertising	12%	(Government support equals an	
Maintenance	6%	additional 12%)	
Supplies	1%		
Utilities	3%		
Social Security	1%		
Insurance	1.5%		
Legal and Audit	1%		
Miscellaneous	4%		
Fixed			
Depreciation			
Parking	50 yr.		1,750
Administration Building	25 yr.		3,840
Funicular Train	20 yr.		6,050
Trails	50 yr.		3,240
Lights	20 yr.		2,500
Elevator	20 yr.		2,500
Sugar Cane Train	20 yr.		11,150
La Ventosa Building	25 yr.		800
Road	20 yr.		800
Rest Rooms and Sewage	25 yr.		1,000
Landscaping	no depreciation		0
Miscellaneous	25 yr.		6,000
Water Lines	20 yr.		600
			40,230
Interest	(6% x 1,020,000)		61,200

*% are estimated percent of gross admissions

Summary and Recommendations for the Development of Rio Camuy Cave, Puerto Rico

By Russell H. Gurnee*

The plan for the development of the Rio Camuy Cave as shown on the preceding pages is based on a study made by the National Speleological Society and those members who are specialists in various phases of tourist cave development. This cave in their opinion justifies this type of development as it is an excellent example of a unique natural phenomenon. There are exceedingly few natural wonders of this size and importance remaining in large population areas of the world. Therefore, it is most important that the development be carried out properly with a view to the future.

This venture will have far-reaching effects on the northwestern portion of the island beyond the project itself. The attraction of about 100,000 people a year to this little-visited section of the island will have great influence on the economy of the region. Close cooperation with the Planning Board and other departments of the Commonwealth of Puerto Rico is necessary to prevent this prosperity from destroying the very spirit and quality which makes this entire karst area so attractive to the traveler. Control of the satellites which might grow up outside the park and deface the natural beauty of the region is a most important consideration. Control of the surface drainage is also imperative, as the pollution of the underground river would invalidate the entire plan.

It is unusual that we have the opportunity to provide planned protection almost at the time of discovery and can obtain the best advice available in order to achieve the maximum usefulness of the region with a minimum of conflicting problems.

In order to assure that the development of this cave will be carried out following the standards presented in this report, it is strongly recommended that the National Speleological Society be retained as a consultant in this project.

The program presented provides three factors which will also aid the cause of conservation:

1. The exhibition of the area shown in this report will provide an educational as well as dramatic experience for millions of people in the coming years.
2. The protection of the surface area will preserve a potable water supply in the river.
3. The remote portions of the cave will be preserved as a scientific laboratory for the study of speleology.

The combination of these three points will permit the entire four square miles of this section of Puerto Rico to be an oasis of natural scenery, easily accessible and perpetually protected.

The study of the cave system has only just begun. The knowledge to be gained from the study of the creatures that survive and flourish in this environment may have far-reaching effects on man's relationship to the total environment. The study of the geology might provide answers to the economic questions of all great karst regions. These areas now provide only marginal productivity for the inhabitants. A greater knowledge of the hydrology, the pattern of underground water flow and distribution, will aid in the understanding of the conservation of precious water supplies.

Brother G. Nicholas of La Salle College in Philadelphia has started the study of

Russell Gurnee is a past president of the National Speleological Society and is presently Chairman of the Board of Governors. He was the leader of the Rio Camuy expeditions.

the ecology and biology of the cave and its environs. Dr. John Thrailkill of the University of Kentucky has established the base maps and presented the foundation for further geological study in the area. Their published work on the subject is listed under REFERENCES.

If the plans for the development of the Rio Camuy Cave as herein outlined are carried out, the following specific recommendations are suggested as possible further attainments:

1. The National Speleological Society continue to serve as advisor to maintain the standards established in the initial development.

2. Certain areas of the cave be left for the scientific study of the cave environment and cave life. Facilities provided for this protection and supervision be supplied at the cave site.

3. Archaeological investigation in the Empalme entrance and protection and exhibition of any discoveries.

4. Further preparation of the surface area as a natural park, providing nature trails and kindred facilities.

5. Purchase by the Commonwealth of the Blue Hole area to control flooding and the pollution of the river before it enters the cave.

We have come to the end of the first phase of our work at the Rio Camuy: the preliminary exploration, the assessment of the potential value of the cave as a natural treasure, and the presentation of a plan for its protection. We hope that those who will now consider the development of this region will do so with deliberate care, for we have this opportunity only once.

**Russell Gurnee ha sido presidente de La Sociedad Espeleológica Nacional y es ahora director de la Junta Directiva de la misma organización. Fué el líder de las expediciones al Río Camuy y de quien nació la idea de conservar este fenómeno como un parque insular.*

RESUMEN Y RECOMENDACIONES

Por Russell Gurnee*

El plan para desarrollar la Cueva del Río Camuy, según queda demostrado en las páginas que preceden, está basado en un estudio hecho por la Sociedad Espeleológica Nacional y por algunos de sus miembros especializados en las diversas fases del desarrollo turístico de una cueva. Según la opinión de estos especialistas la Cueva del Río Camuy justifica el desarrollo que recomendamos ya que la misma es un excelente ejemplo de un fenómeno natural único. Son muy pocas las maravillas naturales existentes en las areas superpobladas del mundo que tienen el tamaño y la importancia de la cueva que nos ocupa. Por eso creemos que su desarrollo es sumamente importante y el mismo debe ser realizado teniendo en cuenta los tiempos venideros.

Esta empresa tendrá efectos sobre el futuro de la región noroeste de la isla y estos no se limitarán al proyecto en sí. Cada año, alrededor de cien mil personas han de visitar esta sección de la isla, actualmente poco conocida, lo cual en cambio tendrá una influencia beneficiosa en la economía de toda la región. Por eso necesitamos la más absoluta cooperación de la Junta Planificadora y de los otros Departamentos del Estado Libre Asociado de Puerto Rico, cosa de evitar que esa prosperidad pueda ser causa de la destrucción del verdadero espíritu que allí existe y de la belleza que rodea esta región calcárea (karst) con tanto atractivo para el viajero. Habrá que controlar las construcciones de mal gusto que puedan aparecer por los alrededores de este parque destruyendo la belleza natural del recinto. Habrá que controlar el drenaje del suelo, necesidad imperiosa para evitar la contaminación del río subterráneo y la consiguiente destrucción de nuestros planes en su totalidad.

Es raro que hayamos podido tener la oportunidad de proteger esta cueva desde el momento de su descubrimiento, obteniendo al mismo tiempo los mejores consejos para explorar al máximo sus posibilidades de uso con un mínimo de problemas y de complicaciones. Para estar seguros de que el desarrollo de esta cueva se realiza de acuerdo con las especificaciones presentadas en este informe, recomendamos enfáticamente que se retengan los servicios de la Sociedad Espeleológica Nacional como asesora de este proyecto.

El programa que hemos preparado tiene en consideración tres factores que también ayudarán en la conservación de estos terrenos:

1. Al presentar esta área para el uso del público estaremos proveyendo una experiencia dramática al mismo tiempo que educativa a millones de personas que la visitarán en años venideros.

2. La protección de los alrededores mantendrá sin contaminación alguna el agua potable del río.

3. Las partes más remotas de la cueva deben ser reservadas para establecer un laboratorio científico en el estudio de la espeleología.

La combinación de estos puntos ayudará a conservar el área total de cuatro millas cuadradas, las cuales servirán de oasis natural en uno de los parajes más bellos de Puerto Rico, fácilmente accesible y perpetuamente protegido.

El estudio del sistema interior de esta cueva ha sido solamente iniciado. Los conocimientos que hemos de derivar al estudiar los seres vivientes existentes en este medio ambiente serán de incalculable valor al relacionarlos con el estudio del hombre en su propio ambiente. Las investigaciones geológicas podrán ofrecer una explicación sobre las condiciones económicas de todas las regiones calcáreas (karst), actualmente de poca productividad para sus habitantes. Un mejor conocimiento de la hidrología, la forma en que el agua fiuye y se distribuye debajo de la tierra, nos ayudará a comprender el valor de esta valiosa fuente de reserva.

El Hermano G. Nicholas del Collegio La Salle de Filadelfia ha comenzado un estudio ecológico y biológico de esta cueva y de sus alrededores. El Dr. John Thrailkill de la Universidad de Kentucky ha trazado los mapas básicos y ha comenzado estudios geológicos en esta area. Los trabajos publicados sobre esta materia aparecen mencionados en la bibliografía de este informe.

Si los planes para desarrollar la Cueva del Río Camuy, según aparecen bosquejados en este informe, se llevan a su realización, hemos de sugerir las siguientes recomendaciones específicas para ser consideradas en el futuro:

1. La Sociedad Espeleológica Nacional debe continuar sirviendo de asesora para ayudar a mantener, en su más alto nivel, los requisitos establecidos en el comienzo del desarrollo de estos terrenos.

2. Las partes reservadas para hacer estudios científicos sobre las condiciones del medio ambiente y de la vida existente en la cueva deben ser protegidas y supervisadas. Deben proveerse todas las facilidades necesarias en el mismo lugar para asegurar el éxito de los trabajos.

3. Deben realizarse investigaciones arqueológicas en la entrada del Empalme, ofreciendo todos los medios de protección. Además se proveerá para la exposición de cualquier descubrimiento de importancia.

4. Deben proveerse facilidades de todas clases para transformar los alrededores en un bello parque natural con veredas estrechas que añadan interés al paisaje.

5. El Estado Libre Asociado debe comprar el terreno que rodea el "Blue Hole" para así controlar cualquier inundación y la indebida contaminación del río antes de entrar en la cueva.

Hemos terminado la primera fase de nuestro trabajo en el Río Camuy: la exploración preliminar, el estimado del valor potencial de la cueva como un tesoro natural, y la presentación de un plan para su protección. Esperamos que aquellos responsables del desarrollo de esta región lo hagan con gran cuidado y deliberación. Tenemos esta gran oportunidad en nuestras manos que se presenta una sola vez.

EXPEDITION PERSONNEL NAME AND TEAM POSITION	ADDRESS	N.S.S. EXPEDITION YEAR
David S. Boyer Photographer	National Geographic Society, Wash. D.C.	1964
Jack Burch Cave trails	Rt. 3, Box 515, San Antonio, Texas	1966
Roy A. Davis Cave lighting	Cumberland Caverns, McMinnville, Tenn.	1964, 1966
Jeanne Gurnee Secretary and supply	231 Irving Avenue, Closter, N.J.	1964, 1966
Russell Gurnee Expedition leader	231 Irving Avenue, Closter, N.J.	1964, 1966
Jack Herschend Cave financing	Marvel Cave, Branson, Missouri	1966
Orion Knox Architect and explorer	611 West 23rd, Austin, Texas	1966
Joseph Lawrence Leader, Team II	115 Gershwin, Houston, Texas	1964
José Limeres Doctor and explorer	146 Washington Ave., Union, N.J.	1964, 1966
Carol Lochner Cook	121 Ridge Street, Pearl River, N.Y.	1966
Albert C. Mueller Communications and explorer	631 Lincoln Park East, Cranford, N.J.	1964, 1966
Brother G. Nicholas Biology	La Salle University, Phila., Pa.	1964, 1966
Jeffrey Poxon Cook	105 East Navajo, W. Lafayette, Ind.	1964
Victor A. Schmidt Surveyor and explorer	Box 393, Carnegie Tech, Pittsburgh, Pa.	1964
John Schoenherr Artist	R.D., No. 2, Stockton, New Jersey	1966
John Spence Supply	16 Bay St., Center Moriches, N.Y.	1964, 1966
James Storey Rope work and explorer	P.O. Box 38501 Capital Hill Station, Atlanta, Georgia	1964, 1966
Terry Tarkington Surveyor and explorer	206 Arcadia Street, Hartselle, Alabama	1964
John Thrailkill Geologist	University of Kentucky, Lexington, Ky.	1964
Leovigildo Vásquez Geologist	Office of Industrial Research, Hato Rey, P.R.	1964
Arlan Wiker Photographer	National Geographic Society, Wash., D.C.	1964

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Papers in any discipline of speleology are considered for publication in the BULLETIN. The upper limit for length is about 10,000 words or approximately 40 pages of manuscript, typed double-spaced. At least one copy but preferably two copies of the manuscript (typed, double-spaced) should be submitted to the Editor, Jerry D. Vineyard, Missouri Geological Survey, Box 250, Rolla, Missouri 65401. Photographs and line drawings, if required, should be submitted with the manuscript. In general, prints and line drawings will be photo-reduced to the size necessary for use in the BULLETIN.

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