

SPELEOLOGICAL HISTORY OF BERMUDA

ZGODOVINA SPELEOLOGIJE NA BERMUDI

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Izvleček

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Illiffe, Thomas M.: Zgodovina speleologije na Bermudih

Jame na Bermudih so zabeležene in zgovorno opisane v večini knjig o tem srednje atlantskem otoku. Najmanj sedem jam so razkazovali turistom, vendar pa danes samo dve služita tem namenom. V zgodovini pa so igrale tudi pomembno vlogo v speleologiji. Globoko potopljeni kapniki v notranjosti slanih vodnih jezerc so geologom služili za različne interpretacije izvora tako otoka kot jam. Že 1864 so poskusili določiti starost masivnega bermudskega stalagmita, kar je najzgodnejša indikacija velike starosti jam. Žal pa so jame tega majhnega, a gosto poseljenega otoka precej poškodovane, voda je onesnažena, jame so uničevali kamnolomi, na kapnikih so sledovi vandalizma.

Ključne besede: speleologija, zgodovina speleologije, morska jama, "blue hole", datacija sige, degradacija krasa, Amerika, Zahodna Indija, Bermudi

Abstract

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Dating from the island's earliest history, the caves of Bermuda have been noted and eloquently described in the majority of books depicting these mid-Atlantic isles. At least seven Bermuda caves have been commercially shown as tourist attractions, although today only two still serve this purpose. In addition to their aesthetic beauty, Bermuda's caves have also played an important role in speleology. The presence of deeply submerged speleothems in interior salt water pools of Bermuda caves has provided geologists with variously interpreted data pertaining to the origin of both the island and its caves. An attempt in 1864 to determine the age of a massive Bermuda stalagmite provides one of the earliest indications of the great age of caves. Unfortunately, the caves of this small but densely populated island have suffered considerable abuse from man including water pollution, the destruction of caves by quarrying and construction activities, and the vandalism of speleothems.

Key words: speleology, history of speleology, sea-cave, "blue hole", flowstone datation, karst degradation, America, West Indies, Bermuda

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BERMUDA CAVES AND CAVE GEOLOGY

The islands of Bermuda are located 1000 km off the east coast of the United States at 32°N, 65°W in that part of the west central Atlantic Ocean known as the Sargasso Sea. Bermuda was formed as a mid-ocean volcanic sea mount about 100 million years and has never been part of a continental land mass. The emergent islands, with a land area of only 50 km², consist of Pleistocene and Recent, eolian (wind-deposited) limestone with a thickness of less than 100 m. A broad, shallow reef tract surrounding an interior lagoon lies to the north and west of the islands. Bermuda's known caves are situated wholly within the island's eolian limestone cap-rock and primarily occur in the oldest and most highly consolidated strata.

The air-filled portions of Bermuda's caves are characterized by collapse features consisting of fissure entrances to large irregular breakdown chambers with little or no true passage development. Many of these inland caves extend down to sea level, tidal pools containing clear brackish waters. Recent diving explorations in these pools have resulted in the discovery of extensive, interconnecting networks of cave passages submerged at an average depth of 18 m below sea level. Large stalactites, stalagmites and other speleothems are present in all parts of Bermuda's caves including the submerged portions.

The presence of submerged stalagmites in Bermuda caves led to debate among geologists as to the tectonic stability of the island and to possible changes in sea level over geologic time. Lieut. R.J. Nelson (1840) mistakenly suggested that these speleothems were formed underwater, while W.F. Williams (1848)

interpreted them as indications that the land was slowly sinking. After the publication of Darwin's theory on the origin of coral atolls, geologists such as C.W. Thomson (1878) theorized that the island of Bermuda was the peak of a volcanic mountain undergoing gradually subsidence. R.W. Sayles (1931) was first to suggest that the island remained stationary, while interglacial and glacial sea levels alternately advanced and retreated.

Several theories have been proposed concerning the origin of the island's caves. A.C. Swinnerton (1929, 1932) believed that Bermuda caves had a vadose origin above the water table. He stated that these caves were formed:

...as zones of solution by downward migrating rain water along steeply dipping and intersecting joints. Crystal, Wonderland, Leamington, Admiral's, and Bassett's, to mention

only the largest caves, show clearly the control of jointing in the formation of large openings. Crystal, Bassett's, and Admiral's caves include tunnel-like passages also. The cave in Tucker's Town is the only large one in which the effect of joint control is not clear (Swinerton, 1929).

W.M. Davis (1930) viewed the caves of Bermuda as being "one cycle caverns in porous limestones". These are in contrast to most other caves that, he felt, were formed two cycles - one cycle of solutional excavation occurring below the water table, and another of depositional replenishment taking place following lowering of the water table when the cave became air-filled.

J.H. Bretz (1960a & b) interpreted the horizontal elongation of the caves as evidence for their formation beneath the water table by horizontally circulating fresh ground water, supplied and maintained by rain. According to Bretz, the large fresh groundwater body necessary for cave formation could only have occurred in Bermuda during low stands of glacial sea level when the islands' total landmass would have been about 13 times as large as it is today.

Bermuda's caves also proved to be scientifically interesting due to the presence of many bird fossils (Shufeldt, 1916). Numerous bones from the caves and even feathers embedded in stalactites belong to the Cahow bird, *Petrodama cahow*. As recounted by Shufeldt (1916):

At one time the 'Cahow' was extremely abundant on these Bermuda Islands, and bred there in untold millions at the time of the early settlers, some three centuries ago. It was a nocturnal species, possessing discordant notes; and so fearless of man were these birds that they would alight on the head, shoulders, and arms of any person visiting their breeding-grounds. This unusual fearlessness resulted in the final extermination of the species; for the first inhabitants of the island, and those that followed them in a comparatively short period, utterly destroyed the birds for food, notwithstanding their enormous numbers.

Fortunately the story of the Cahow does not end here. Although thought to be extinct for over 300 years, a small nesting colony of cahows was discovered in 1951 (Wingate, 1960). These seabirds were breeding in shallow holes in sea cliffs located on tiny offshore islets at the entrance to Castle Harbour.

HISTORICAL SPELEOLOGY

The caves of Bermuda have been a source of mystery and fascination since the earliest colonists landed on the island. Shakespeare's play "The Tempest", inspired by the Bermuda shipwreck of Sir George Somers in 1609, takes place in and around a cave. The first published reference to Bermuda's caves was by Captain John Smith in 1623 who reported, "in some places varye strange, darke, and cumbersome Caues." In a poetic description of Bermuda from 1671 by John Hardy (quoted in Lefroy, 1877), caves were specifically portrayed:

The water flowing to them [Harrington Sound] underground,
Being most salt, and all along the shore
There are dark caves, of a miles length or more
Extending under ground, in which there be
Deep holes with water, though no one can see
A passage for it in. . . .

Lefroy (1877) footnoted this passage with a personal observation:

I believe the Island is hollow, for there is some holes that none can find the end of them
some hot as a Stove upon the Northerly wind, as that near Tucker's Town; and that there is

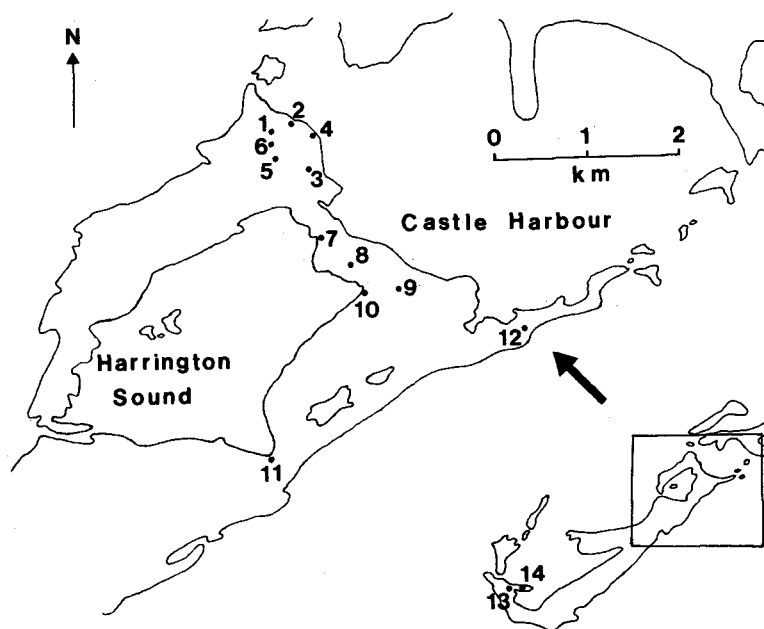


Fig. 1: Map of Bermuda showing the location of the principle caves - 1: Admiral's Cave, 2: Joyces Dock Caves, 3: Walsingham Caves, 4: Castle Grotto, 5: Crystal Cave, 6: Wonderland Cave, 7: Leamington Cave, 8: Peniston's Cave, 9: Paynter's Vale Cave, 10: Sharks Hole, 11: Devil's Hole, 12: Tucker's Town Cave, 13: Bassett's Cave, 14: Tucker's Island Cave.

Sl. 1. Karta Bermudov z vrisano lego najpomembnejih jam - 1. Admiral's Cave, 2. Joyces Dock Caves, 3. Walsingham Caves, 4. Castle Grotto, 5. Crystal Cave, 6. Wonderland Cave, 7. Leamington Cave, 8. Peniston's Cave, 9. Paynter's Vale Cave, 10. Sharks Hole, 11. Devil's Hole, 12. Tucker's Town Cave, 13. Basset's Cave, 14. Tucker's Island Cave.

water in them may be proved: by the Cooper's Hole, the Devil's Hole, and a place near Walsingham Bay which water, though a good distance from the Sea, is briny and salt as it is.

Bermuda's caves have been used and abused for many hundreds of years. At least 9 caves in Bermuda have been commercially shown to tourists at one time or another. These include Island, Cathedral, Admiral's, Castle Grotto, Wonderland, Crystal, Walsingham, Leamington, and Tucker's Island Caves (Fig.1). Stalactites and associated crystalline deposits have been literally mined from the caves. The Catalogue of the 1872 Bermuda Industrial and Loan Exhibition lists stalactites as an "article of industry" for which prizes were awarded to the best collections. Prisoners on convict hulks moored at Bermuda's Naval Dockyard in the early 1800's sculpted stalactite carvings in the form of chess pieces, rosary beads, jewelry and other items (Addams, 1990).

Numerous authors have presented descriptions of Bermuda caves. These eloquent and original narratives will be here extensively quoted from. John Matthew Jones (1859) portrayed the island's caves as follows:

To the caverns of Bermuda, which are so remarkable for their singularity and beauty, it will be well to devote a short space; for we doubt if in interest and varied appearance, anything else on the Islands can be compared to them. It would be difficult to describe them, as any account must necessarily fall far short of the reality; but if the reader can imagine an opening of tolerably large dimensions in the limestone rock, and charmingly irregular in outline from the roof of which shining stalactites descend, reflecting their protracted forms in the light blue-green water below, which cover the floor of the cavern, and in whose pellucid depths may be seen floating the forms of fishes, garbed in coatings of the most resplendent hues, he will have some idea, albeit a faint one, of the interesting features of these subterranean recesses.

Geologist A. Heilprin (1889) contended that:

These sea-grottoes are among the most attractive features of the Bermudas, and they would, even in regions far famed for their caves, attract attention. The principal vaults are of fairly large size, but the connecting passages are low and contracted, rendering deep penetration difficult.

Another geologist, A.C. Swinnerton (1929), wrote:

The caves of Bermuda are caves in miniature to those who are familiar with the caverns of Kentucky and Virginia. The accessible parts are not over a few hundred yards in length, although it is undoubtedly true that a network of passages underlies much of the cave area. The presence of sea water in the caves, the variously coloured deposits stained with orange cave-earth, and fossil soils contrasted with the many brilliant white stalactites and stalagmites make the cave extremely picturesque and memorable spots for the tourist to visit and likewise for the geologist to study.

ADMIRAL'S CAVE, HAMILTON PARISH

Admiral's Cave, named after Admiral Sir David Milne, is perhaps one of the more historically significant caves in Bermuda. According to Home (1864):

[It] is situated at Walsingham, in the Parish of Hamilton, and upon the side of a hill, about 40 or 50 feet above sea level, and a quarter of a mile distant from it. . . . The cave inside might be about 25 or 30 feet high at the greatest height of the roof, about 50 or 60 yards in length, and 20 to 30 yards in breadth. But is quite irregular in shape. It contains an immense number of both stalactites and stalagmites of all sizes. Some of the latter had grown up so high as to have reached the roof and become supports to it, and were from 30 to 40 feet in girth. At the bottom or lowest part of the cave there is a large and deep pool of salt water, rising and falling with the tides - proving a connection with the sea.

In 1819, Admiral Milne, commander of the British North American and West Indian Station in Bermuda, collected a number of speleothems from Bermuda caves that he presented to the University of Edinburgh. The largest of these was a stalagmite, 3.4 m high, 63 cm in average diameter and weighing nearly 3.5 tons, removed from Admiral's Cave (Fig. 2). Forty-four years later, Milne's son, Sir Alexander Milne, returned to Bermuda and revisited the cave where he made the following observations:

He noticed five drops of water falling on the trunk - two at the rate, each of them, of three or four drops in the minute. The other three dropped much less frequently. On the part of the trunk where the last-mentioned drops were falling, the deposit consisted of only a thin crust. One of the knobs measured in height above the fractured surface five-eighths of an inch, and had at its base an area of about 3 3/4 inches in diameter. The other knob measured in height four-tenths of an inch, and had at its base an area of about 2 1/4 inches (Home, 1864).

David Milne Home (1864) calculated from the measurements taken by his brother that the volume of the freshly deposited knobs totalled five cubic inches. Since these knobs had formed in 44 years, Home determined, assuming a constant rate of deposit, it would have taken "the astounding and incredible period of more than 600,000 years" to form the entire original stalagmite.

Home (1864) believed however that:

. . . in the early history of the caves, the water flowed much more copiously than afterwards On these grounds [Home] entirely repudiated the notion that this stalagmite has taken the enormous period to grow.

Sir Wyville Thomson, a professor at the University of Edinburgh, became interested in these studies. In 1873, Thomson served as chief scientist on the round the world voyage of the H.M.S. Challenger and had the opportunity to visit Bermuda where he reported on the condition of the Admiral's Cave stalagmite:

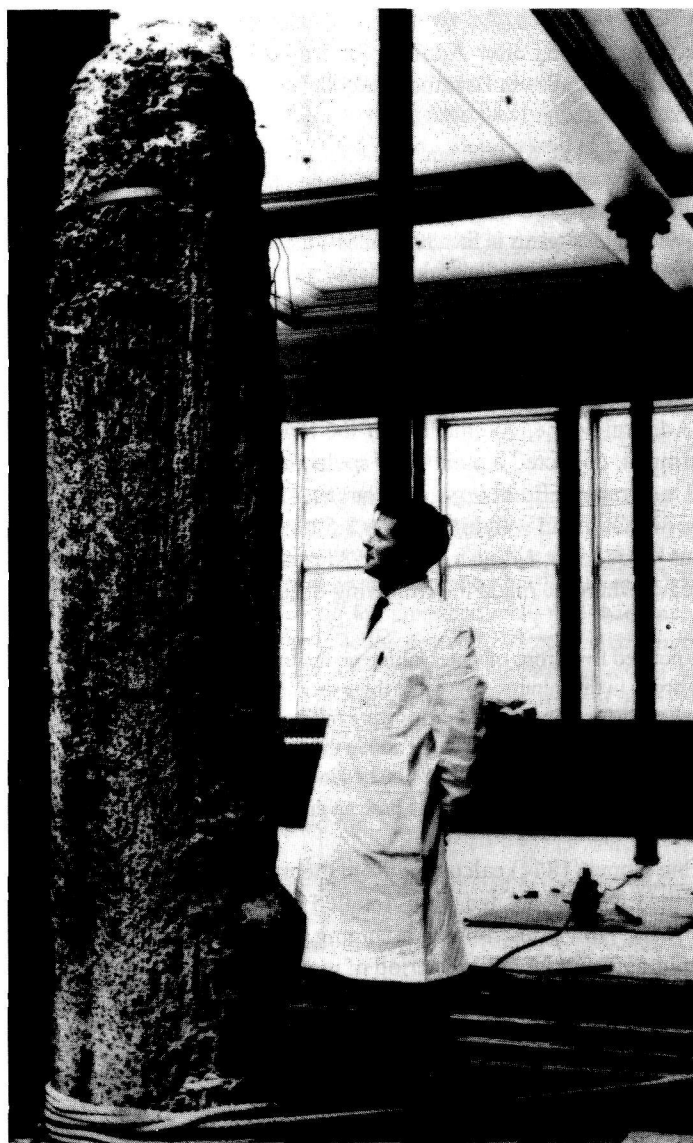


Fig. 2: Photo of the Admiral's Cave stalagmite taken in October 1969. This stalagmite was removed from the cave by Admiral Sir David Milne in 1819 for display at the University of Edinburgh.

Sl. 2. Slika stalagmita iz Admiral's Cave, posneta 1969. Ta kapnik je odnesel iz jame admiral Sir David Milne leta 1819 in ga razstavil na Univerzi v Edinburghu.

The roof of the cave at the point whence the stalagmite was removed is at a height of about fifteen feet, and facing the stump there are two majestic columns uniting the roof and the floor, one of them upwards of 60 feet in circumference. They are beautifully fluted and fretted with stalactite, and shone out with a pure white-frosted surface in the magnesium light (Thomson, 1878).

Thomson (1878) further observed that,

“About ten years later [than Alexander Milne’s observations], the two drops were still falling, but apparently somewhat more slowly, one not quite three times in a minute, the other twice; this must depend, however, in some measure upon the previous weather.” After unsuccessfully attempting to photograph the stump, Thomson ordered that a slice be taken from the stump “showing the amount of reparation during half a century, as an accessory to the Edinburgh specimen.”

Admiral’s Cave was briefly operated as a commercial tourist attraction in the early 1900’s and was described by Hayward as follows:

The Admiral’s Cave is a long one, the first chamber being decorated by hundreds of stalactites that assume forms of the vegetal world. Farther down into the earth, the way being illuminated by gas lights, is the organ chamber where stand one large and a series of smaller columns - the organ - resulting from the union of stalactite and stalagmite. These when struck by metal send forth musical notes that echo and re-echo against the dripping roof. Another descent brings the explorer to a lake of clear water, the strange silence of this chamber being disturbed only by the occasional rumble of vehicles passing directly overhead on the St. George’s highway.

Swinnerton (1929) also made observations relative to speleothem growth rates in Admiral’s Cave:

Some Bermuda caves have been open to the public for fifty years. At first burning torches and fires were used for light, later acetylene, now electricity. In the caves formerly open to the public, like Admiral’s cave, clean white stalactites, presumably new, grow from the tips of old soot-coated stalactites. It seems likely that the clean ones have grown since the time when the caves were illuminated with smoky lights - not over twenty years ago.

One old stalactite may have five clean ones hanging from it. One of these new ones may be half an inch in length, another may be 6 inches; one may be of large diameter, another very small.

JOYCES DOCK CAVES, HAMILTON PARISH

The Joyces Dock Caves are a group of five caves (Coffee, Bluebell, Sibley’s, Cathedral and Island Caves) located at the northern end of the Walsingham Tract on the shores of

Castle Harbour. These caves have been commercially shown to the public for well over a century.

The two principal caves in the Joyces Dock group are Cathedral and Island Caves. An early tourist guide (Anonymous, 1906) presented descriptions of these caves:

The entrance to this fine cave [Cathedral Cave] is through a gateway on each side of which stands a natural pillar apparently supporting the overhanging rock. After making an abrupt descent between walls of living rock, the visitor stands in a large grotto, known as the Pulpit Cave - so called because of an immense stalagmite standing near the centre which closely resembles an old fashioned pulpit. Scores of acetylene gas jets illuminate the grotto and reveal its beauties. On the right side the roof slopes down sharply and on that side bounds a lake in whose clear, placid water the elegant stalactites that depend from the ceiling are reflected. The water in this lake is from 15 to 18 feet deep. Great natural pillars support the roof of the cavern and the whiteness of the stalactites is dazzling. . . .

Magnificent as is the Cathedral Cave with its numerous chambers, and much as the visitor may be impressed by its grandeur, nevertheless he is quite unprepared for the vision of beauty that bursts upon his gaze as he enters the Island Cave, which in many respects recalls the views one has seen of the famous grotto of Antiparos.

The Island Cave is a circular grotto covering an area of nearly half an acre. Groups of beautifully wrought natural pillars around the sides support the dome-shaped roof from which hang exquisite stalactites of snowy whiteness and of every conceivable length. The grotto is filled with water clear as crystal and ranging in depth from 18 to 30 feet, and the colouring of blue and brown, of green and opal, is most beautiful. From the center of the pool rises an immense stalagmite not unlike a beacon in appearance, and this resemblance is increased when the numerous gas jets that have been placed upon it are lighted. A former proprietor saw in the stalagmite a strong resemblance to an island in the ocean: hence the name - Island Cave.

Although not as well visited, the other three caves of the group had their own interesting features.

Sibley's Cave owes its name to an episode connected with the sojourn of the XXXth Regiment of Foot at St. George's (1830-1833). At that time St. George's was still isolated from the mainland and the Walsingham Tract had not been denuded of the original groves of cedar and the accompanying undergrowth. Five men of the Regiment, led by a corporal named Sibley, deserted, and for several weeks the military authorities could not discover any trace of the men. One morning, a man who happened to be passing through the woods in the vicinity of the cave was attracted by the odour of tobacco. Following the scent, he discovered the missing soldiers - in the Cave, since that time called Sibley's Cave after the leader of the party (Anonymous, 1906).

Bluebell or Convolvulus Cave, located next to Sibley's Cave, derives its name from vines of the blue, bell-shaped convolvulus flowers that abound nearby. Thomson (1878) visited the cave and a picture of its entrance appears in his book. The cave was described as containing:

... a pool of clear water - extending beneath the rocky sides - and this pool is the principal object of attraction in the cave. Each bright day, between 1 and 1:30 p.m., this water undergoes a transformation that has excited the admiration of everyone who has witnessed it. At first dark and ugly-looking, as the first glint of the post-meridian sun strikes through a rift in the overhanging rock and falls upon the pool, a sharp line of emerald green is visible on the surface. As the sun travels onward and his rays enter more directly and fully, the line of colour gradually broadens and changes until all the tints of the rainbow are visible in the clear, sparkling water through which the light penetrates to the very bottom to the pool. Then, after a time, upon the surface farthest away a shadow falls - gradually moving across until finally it has obliterated the last line of colour and has covered the pool in gloom once more (Anonymous, 1906).

Coffee Cave is situated on the opposite side of the road and is named for an abundant growth of coffee trees at that spot.

WALSINGHAM CAVES, HAMILTON PARISH

This group of caves is located in the highly karstified area between Castle Harbour and Harrington Sound. In 1803, the Irish poet Thomas Moore (1779-1852) stayed for four months in Bermuda spending much of his time writing poetry in the shade of a calabash tree at Walsingham. His Odes and other Poems published in 1806 mentions the "sparkling roofs and pearl-blue ponds" of the Walsingham Caves (Hovey, 1896).

As portrayed by Hayward (1910):

There is no part of Bermuda where the vegetation is wilder, more luxuriant, or the colouring more intense than at Walsingham, named after its first explorer, the coxswain of the Sea Venture [Sir George Somers's ship wrecked in Bermuda in 1609]. It is almost a riotous tangle as it was in the days when Tom Moore sallied forth from Walsingham House, beside a rocky pool, and rambled through the woods to his hospitable calabash tree, now struggling against age in a cool, green glen. Here cedar brush is shrouded in jasmine, which in early summer is white with blossoms and heavy with perfume; there are coffee trees, oranges, lemons, and wild olives; stalactitic walls of fallen caverns and mouths of subterranean chambers are masked by creepers, ferns and moss, while the fiddlewood, which assumes as its regular dress soft autumn tints, lends touches of brown and red to the fresh green of the undergrowth. . . . Some of the caverns grew too large to support their roofs, and so we find throughout Walsingham 'sinks' or depressions caused by the collapse of the structure overhead. In such rocky glens there are broken boulders and irregular curtains of honeycombed limestone - damp, shadowy glades that try shoe leather but delight the eye and fire the imagination.

According to Verrill (1908), the Walsingham Caves were the most frequently visited caves in Bermuda. In the 1930's, a commercially operated nature trail led tourists along concrete pathways to the caves and karst features of this area.



Fig. 3: Carl Gibbon (on right), discoverer of Crystal, Wonderland and Leamington Caves, and his cousin Harold Gibbon (from Paine, 1911).

Sl. 3. Carl Gibbon (na desni), odkritelj jam Crystal, Wonderland in Leamington in njegov bratranec Harold Gibbon (iz Paine 1911).



Fig. 4: One of the caves discovered by Carl Gibbon (from Paine, 1911).

Sl. 4. Ena od jam, ki jih je odkril Carl Gibbon (iz Paine 1911).

CASTLE GROTTO, HAMILTON PARISH

This cave is located along the coast of Castle Harbour near the Blue Grotto pool about 100 m south of the Causeway bridge. Castle Grotto was used as the throne room of Neptune in the 1914 movie *Neptune's Daughter*, while other scenes were filmed in Crystal Cave and at Shark's Hole (Rider, 1928). According to Forney (1973), *Neptune's Daughter* was probably the first movie to use footage shot in a cave.

Bushell's (1926) tourist guide to Bermuda stated that:

[Castle Grotto] consists of three chambers, each of which has its own entrance - all easy of access. Suspended over water of crystal clearness with an emerald or turquoise tinge, showing the white sand beneath, there are formations of wondrous beauty. . . . In order to view the northern chamber to advantage, we must embark on a large flat bottom boat, which is guided through this grotto by an experienced boatman. Twisting in and out among the low-hanging stalactites, our boat glides over the placid waters and we come into a low chamber with a beautiful arched roof. We see the large columns and pipe-like formations, fantastic shapes of putty and flint in gray, all shades of pink, snow white and sparkling crystal, with the clear water reflecting the dome and glittering lights all combining to make this scene a veritable fairyland.

CRYSTAL CAVE, HAMILTON PARISH

Paine (1911) related the discovery of Crystal Cave by Carl Gibbon (Figs. 3 & 4):

It was a March afternoon, 1905, when Carl found his first cave. He was barely fourteen years old then, and with a playmate, Edgar Hollis, had climbed a pleasant hill overlooking the sea. . . . By and by Carl realized that a small and curiously cool current of air was fanning his cheek. He thought it strange and wondered where it came from. Then he noticed a crevice in the loose coral formation he had been using as a pillow, and, holding his hand over it, felt the cool air coming through.

'There is something down in there,' he said, 'to make that,' and the boys began pulling away the broken sections of stone.

All at once quite a large piece 'fell through,' as Carl described it afterward - dropping away in front of them, leaving a hole like a well, though somewhat less perpendicular. Yet it was a steep, uncertain place, and the boys peered onto the darkness of that mysterious entrance, and spoke in whispers.

So they. . . went home, quietly borrowed two lamps, and hurried back. Then they descended into that narrow, steep place again and slid down, down - holding their lamps with one hand, clinging and steadying with the other.

Deeper and still deeper; fifty feet, seventy-five feet, a hundred feet - deep as a ten story building is high, the opening getting somewhat larger as they descended. Then suddenly they reached a level, the walls opened out, and by the light of their lamps the young explorers beheld an enchantment such as the lamp of Aladdin might reveal. Stretching away into the darkness before them was an arched ceiling, hung with gleaming pendants - a myriad of huge crystal icicles they might have seemed to a boy of the North, only that some were delicately

cream-tinted, others were of a pinkish hue, while from the floor beneath a myriad of inverted icicles stretched up to meet them. Crystal stalactites and stalagmites they were - the work which nature for ages had been carrying on, preparing there in total darkness a habitation suitable for kings. In the center of all this marvel the boys caught the shine of water - a clear, silent lake, catching the light on its still surface and reflecting the splendor overhead for the first time in all the ages.

Holding their lamps high, the boys looked out on this sheet of water and faintly caught the gleam of stalagmites on its farther shore. Carl set his lamp down. 'You stay here,' he said; 'I'll swim across and see what's over there.'

Half swimming, half wading, the boy made his way across. Then he saw he had reached an island; also that the crystal chambers stretched and branched away into the darkness, and that the lake, or arms of it, followed them. What a wonderful place! The most marvelous cave yet found in Bermuda - the boy realized that.

He came back to his companion, and the two made their way around among the stalagmites and broke off some pieces to show at home. Then they scrambled and tugged their way back to daylight, for it was evening. They had been down over three hours in all.

Hayward (1910) described this cave (Fig. 5) as follows:

Just off the road [Wilkinson Avenue] is Crystal Cave and Cahow Lake, a recent discovery, the most dazzling cavern in Bermuda. You enter at the top of a hill and descend ninety feet through a rift in the strata by means of a stairway fitted at intervals with rest-platforms. At the bottom you stand on the shore of Cahow Lake, across which is moored a pontoon

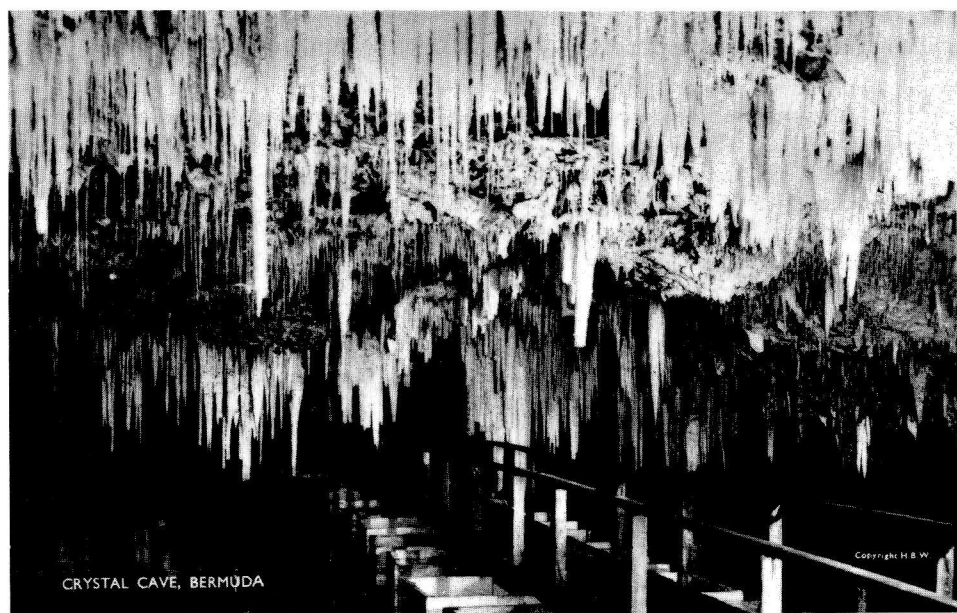


Fig. 5: The ponton bridge spanning Cahow Lake in Crystal Cave.
Sl. 5. Pontonski most, ki povezuje jezero Cahow in Crystal Cave

bridge, lighted by gas. The scene is not to be conjured. It is another world, a scintillating creation of lime and water, the drip, drip, drip signifying the slow but steady growth of pendants clinging to the salmon-tinted ceiling. . . . Cahow Lake takes its name from the fact that in one of the chambers were found deeply embedded in the calcite bones and fossilized feathers of the cahow, which became extinct about 1630. . . . The lake is subject to tidal changes, indicating connection with Castle Harbour or Harrington Sound, the whole of the hill apparently being undermined. The depth of water is thirty feet or more, but at some remote period the floor was not wholly submerged, for numerous stalagmites of large size are visible, these having been formed by the drip from the ceiling.

WONDERLAND CAVE, HAMILTON PARISH

Paine (1911) also recounted the discovery of Wonderland Cave by Carl Gibbon:

It was about two years after the first adventure [the discovery of Crystal Cave], that a Mr. Haycock one day sent for him [Carl Gibbon] to come and examine a hole among the rocks on his land. . . . Mr. Haycock had noticed a piece of paper which seemed to be blowing away from a hole among the rocks, and when Carl arrived he agreed that the opening indicated a big cave.

They enlarged the hole, and Carl went down. At first he found nothing but a small room, a few feet below the surface. Then he noticed a narrow place between two stones, just wide enough for a slender boy to squeeze through. He wormed through it and thought the ground on the other side sounded hollow. He tapped it with his foot, and a piece the size of a barrel-head tumbled in, leaving a dark, steep hole like that which had led to the Crystal Cave.

The boy climbed down into it a few feet, saw it was really a passage, and went back for a rope and lantern. It turned out a genuine cave - not as large as the first discovery, but very fine with a lake in it. Mr. Haycock, a man of means, decided to open the cave for private exhibition and kept Carl employed a good while at the work paying him very well.

One day while crawling around among the stalagmites, near what he thought to be the end of the cave, the boy found a small opening, and, creeping through, discovered another large chamber, the largest of all.

The Haycock cave is about a quarter of a mile from the Crystal Cave and is very likely a part of the same formation.

LEAMINGTON CAVE, HAMILTON PARISH

Carl Gibbon discovered a third cave which, as with the other two, was soon open as a commercial tourist attraction. Again, Paine (1911) related this discovery:

It was only a little while ago that Carl discovered his third and largest cave. On the 26th of November 1909. . . . They [Carl and his cousin Harold Gibbon] were passing a big rocky bluff when Carl said: 'I believe there must be a cave under that bluff.'

He hardly knew why he thought so, but he had a feeling, somehow, that a cave was there.

...
From a rift in the coral a breath came that was decidedly cooler than the warm air of the surface. Then they went to work, pulling and prying away the loose formation, and presently had widened the opening into an entrance. There seemed to be a roomy passage below, and lighting their lantern, the boys went down.

They descended that cool, silent corridor to water-level and came to a big lake and great vaulted and columned chambers gorgeously hung with crystal pendants - a cave more grand than anything yet found. The boys wandered along the margin of the quiet lake, turning this way and that to explore diverging chambers, until they happened to notice that their lantern was getting very low. They set out for home then, but suddenly realized that they did not know the way.

Down in the black depth, with a failing lantern, they were lost. They made a turn or two, but nothing looked familiar; that is to say everything looked alike. They stopped still to consider it would not do to lose their heads. Presently Carl said:

'The opening is east of here; we must go east.'

Now that is a curious thing. The boys had wandered about and made many turns, at many angles; yet this boy had kept the points of the compass in his head.

'I can always tell the points of the compass,' he said afterward, 'wherever I am.' Which must be a sort of instinct - certainly a useful one.

At all events, the boys did 'go east,' and before the lantern had quite given out they came to some broken pieces of stalagmite which marked their trail. They followed it and soon thought they felt a current of the warm air from outside. It was, in fact, the opening and they climbed back to daylight and reported to Mr. Anderson [the landowner] their great find.

PENISTON'S CAVE HAMILTON PARISH

As described by Verrill (1908):

One of the most interesting caves, because of its peculiar situation and its elegant and profuse pure white stalactites and drapery-like sheets of stalactitic material, is Peniston's Cave, on the land of W.S.O. Peniston. It was not open to the public at the time of my visit, and partly on that account its stalactites retained their original purity of color. The entrance is near the top of a wooded hill somewhat south of Harrington House, toward Castle Harbour. There is a large, dry, cultivated sink to the north of it. The entrance is nearly perpendicular and barely large enough for a man to enter, it being only the wider part of a fissure. The fissure expands below to form the cave. The floor and roof both slope rapidly downward for about 80 feet. The height of the roof varies from 4 or 5 feet up to 10 or 15 feet. It is thickly covered in most places with multitudes of rather small stalactites, though large ones occur. These stalactites are still forming. Water was dripping from most of them. Many of the small and very slender ones were tubular and porous at the end, and had a drop of water hanging there, in which, with a lens, loose or but slightly attached crystals of calcium carbonate could be seen forming.

In the bottom of this cavern there is a pool of very clear sea water, about 8 to 10 feet deep, so that it goes below the level of Harrington Sound and Castle Harbor to that depth, but the connection with the sea is probably only by small crevices. No fishes live in it.

PAYNTER'S VALE CAVE, ST. GEORGE'S PARISH

During H.M.S. Challenger's visit to Bermuda in 1873, Wyville Thomson (1878) observed that in his opinion:

Paynter's Vale cave is the prettiest of the whole. The opening is not very large. It is an arch over a great mass of debris forming a steep slope into the cave, as if part of the roof of the vault had suddenly fallen in. At the foot of the bank of debris, one can barely see in the dim light the deep, clear water lying perfectly still and reflecting the roof and margin like a mirror. We clambered down the slope, and as the eye became more accustomed to the obscurity, the lake stretched farther back. There was a crazy little punt moored to the shore, and, after lighting candles, Captain Nares rowed the Governor back into the darkness, the candles throwing a dim light for a time while the voices became more hollow and distant - upon the surface of the water and the vault of stalactite, and finally passing back as mere specks into the silence. After landing the Governor on the opposite side, Captain Nares returned for me, and we rowed round the weird little lake. It was certainly very curious and beautiful; evidently a huge cavity out of which the calcareous sand had been washed or dissolved, and whose walls, still to a certain extent permeable, had been hardened and petrified by the constant percolation of water charged with carbonate of lime. From the roof innumerable stalactites, perfectly white, often several yards long and coming down to the delicacy of knitting-needles, hung in clusters; and wherever there was any continuous crack in the roof or wall, a graceful, soft-looking curtain of white stalactite fell, and often ended, much to our surprise, deep in the water. Stalagmites also rose up in pinnacles and fringes through the water, which was so exquisitely still and clear that it was something difficult to tell where the solid marble tracery ended and its reflected image began. In this cave, which is a considerable distance from the sea, there is a slight change of level with the tide, sufficient to keep the water perfectly pure. The mouth of the cave is overgrown with foliage, and every tree is draped and festooned with the fragrant *Jasminum gracile*, mingled not unfrequently with the 'poison ivy' (*Rhus toxicodendron*).

Based upon Thomson's description, it is believed that Paynter's Vale is synonymous with Church Cave, located on the south side of the driveway leading in to the Castle Harbour Hotel. The cave was given this second name after a persecuted, 17th century religious group that supposedly used the cave for worship (Forney, 1973).

SHARKS HOLE, ST. GEORGE'S PARISH

An excursion to this small cave along the coast of Harrington Sound was recounted by Lloyd (1835):

Under a rising bank, is the mouth of a curious cavern, called Sharks Hole, into which we put our little boat. It received this name from having once been a favourite retreat of these voracious fish. Being pretty certain that we were not likely to find any of its unwelcome inmates at home, we enjoyed the delicious coolness of the grotto, and the water being per-

fectly transparent, we examined with interest its variegated bottom. As our boat glided along, we beheld innumerable beautiful fish sporting in the depths beneath us, or leaping and bounding to the surface.

DEVIL'S HOLE, SMITH'S PARISH

The Devil's Hole was walled by its owner, Mr. Trott, in 1830 and was opened to the public for an admission fee as Bermuda's first commercial tourist attraction in 1843 (Zuill, 1946). According to Hayward (1910):

The Devil's Hole or Neptune's Grotto. . . is a natural grotto, in the side of a hill, and is fed with water by underground channels that are connected with the Sound. It contains about two thousand fishes, representing thirty different species, with the wide-mouthed, voracious grouper in the majority. Standing on the bridge, you look down into the red jaws lifted out of water as the groupers listen for the rattle of the keeper's bait can. The pool is quiet, and one may study the mottled bodies until bait is thrown in; then there is great commotion, and the water is churned into a whirlpool. When the ripples smooth out, there is a surprising transformation, for the groupers have changed their dress to black - an instantaneous and unseen process. Let no one entertain the delusion that these fish are not dangerous. A British officer once ridiculed the fact and to test its truth threw his dog into the pool. In a second the animal was torn to pieces, and its master departed much chastened in spirit.

Harshberger (1914) observed that blue-green algae were contributing to the formation of stalactites present along the open sides of Devil's Hole by removing carbon dioxide from the water, thus enhancing deposition of calcium carbonate.

TUCKER'S TOWN CAVE, ST. GEORGE'S PARISH

Tucker's Town Cave is located in a hillside on the Tucker's Town Peninsula. The cave is entered by a 15 m deep shaft leading to a large salt water lake. Deteriorated remains of steps and a wooden and concrete platform in the cave indicate that it was partially developed for an unknown purpose at some time in the past.

Swinerton (1929) noted that:

Within the caves so slight has been the influence of sea water on the submerged deposits and limestone walls that if the water were now drawn away evidences of its previous presence would scarcely be observed. Only one cave Tucker's Town - seems to show any mark of sea-level. In that cave the influence of the tide has been to retard the mural deposits along a 2 ft. zone. The general absence of this effect suggests recent change of level.

BASSETT'S CAVE, SANDYS PARISH

Nelson (1840) depicted Bassett's Cave in his descriptions of Bermuda's caverns:

The largest and, geologically speaking, the most instructive [cave in Bermuda], is Bassett's, near Somerset bridge. It is said to extend for more than a mile; but the first few hundred yards of toilsome progress usually satisfies the curiosity of the majority of its visitors. It seems to be comparatively recent, from the fresh state of its surfaces, and the small quantity of stalactite observable; this absence of incrustation, however, renders the origin of this cavern very palpable; namely, the undermining of the substrata by the sea, the waters or which lie in pools at the bottom."

Lloyd (1835) mentions the first and only known caving fatality in Bermuda's history in this cave:

Near the sea-shore, I visited a large cavern called Bassett's Cave; the entrance is wide, and lies quite exposed: after proceeding a little way, we came upon a spring of deep water, in which an unfortunate young man lately drowned himself. He had been missing for some days when his body was discovered by a favorite dog.

A calcite-covered skull and beak of a seabird, the Strickland's shearwater, was collected from Bassett's Cave in 1907 (Shufeldt, 1916).

TUCKER'S ISLAND CAVE, SANDYS PARISH

Verrill (1907) described this cave as follows:

In the large cavern on Tucker's Island, the bottom is covered by 6 to 10 feet of clear sea water, beneath which I saw, in 1901, many large pointed stalagmites standing upright, but not reaching the surface. Some of these were more than a foot in diameter. This cavern, which is open to visitors on payment of a fee, has to be explored in a boat. Its roof is supported by large stalactitic columns, many of which are of hardened limestone, thickly encrusted with dull-colored stalactitic material, but most of them extend beneath sea water to the bottom.

Hayward (1910) stated that:

Tucker's Island should be visited, if only to see its cavern and underground lake, which is lighted by acetylene gas. The stalactites are of great size - much larger, indeed, than the roof pendants of caves in other localities.

Nelson (1840) described what was apparently another partially submerged cave on Tucker's Island:

Tucker's Island cavern was a perfect bijou; with one splendid exception it has hitherto stood unrivalled amongst the caves of Bermuda. This little cavern had a length of eighty feet, a breadth of fifty, a height above the little lake within of at most fifteen, and a depth below its surface scarcely exceeding fourteen. The stalactites were remarkably clear and beautiful, varying from the massive pendant of six or seven feet in length, to the slender incipient fragile tube, which crumbled at the slightest touch. It was a scene not to be readily forgotten, when we launched a little boat into the miner's first and narrow opening, through which the sun shone strongly, and reflecting its light from the face of the water upwards and with power to the sparry fretted ceiling of the vault, illuminated it in a way which can only be appreciated by those who have been eye witnesses of such effects. This cave was shortly afterwards destroyed, as interfering with the safety of the works.

BERMUDA'S CAVES TODAY

In the intervening centuries since the above quoted cave descriptions were composed, profound alterations have modified most of the island's caves to their detriment (Iliffe, 1979). Only two caves - Crystal and Leamington - in addition to the Devil's Hole, are still commercially shown to tourists.

The staff quarters of the Grotto Bay Hotel was constructed directly over the largest chamber in Admiral's Cave. The stump of the famous stalagmite, bearing the drill holes used by Wyville Thomson to obtain a slice from the stump in 1873, is still clearly visible within the cave. However, several of the once clear sea level pools have turned murky and anoxic, possibly due to sewage pollution from the overlying hotel staff quarters. The stalagmite itself was on display for many years in front of the mathematics classroom at the University of Edinburgh, but was destroyed when the building housing it was demolished (W.J. Baird, pers. comm.).

The Joyces Dock Caves are now also part of the Grotto Bay Hotel. The saltwater pool in Cathedral Cave is now used as an indoor swimming pool by the hotel's guests. Island Cave, now called Prospero's Cave, has been converted into a subterranean bar and discotheque. A large stalagmite in undeveloped Sibley's Cave had been cut from its base and was found packed with styrofoam pieces in a oil drum in a failed attempt to transport it out of the cave. The pool in Bluebell Cave noted for its reflected sunbeams was destroyed by filling of the floor of the cave in an abortive effort at constructing an underground dance floor.

The Walsingham Caves have been preserved in a privatelyowned nature preserve, the Walsingham Trust. The concrete walkways and steps constructed through this area have disappeared into the undergrowth, though Tom Moore's ancient calabash is still to be found in an isolated woodland glen.

The Blue Grotto was recently operated as a commercial dolphin show, while dolphin food was stored in Castle Grotto. Wonderland Cave was purchased by the owners of Crystal Cave and has not been shown to tourists since before World War II (Forney, 1973). Fortunately, an entrance gate has protected many of the delicate formations within this cave.

Within the last decade, pools in Leamington and many other caves in the vicinity of the Government Quarry have become anoxic and polluted, probably due to extensive dumping of garbage and other organic wastes into a large cave pool in the quarry (Iliffe, Jickells & Brewer, 1984). Peniston's Cave, believed to have been situated at or near this quarry, has probably been buried or destroyed. Bassett's Cave, located on the grounds of the U.S. Naval Air Station Annex, is being used as a natural cesspit by the base for disposal of raw sewage and waste fuel oil. Sea level pools within the cave are covered by a half a meter or more oil, rising and falling with the tides. Nearby Tucker's Island Cave was destroyed during World War II era construction of the Naval Base.

Paynter's Vale or Church Cave, on the grounds of the Castle Harbour Hotel, is little visited. A few rotten planks on the bottom of the cave pool may be the remains of the boat Thomson used to explore the cave. Tucker's Town Cave is situated on a small tract of land between affluent private estates in Tucker's Town. The wooden steps that once led down into the cave have long since disappeared and a large platform covering a portion of the pool has collapsed into the water.

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LITERATURE CITED

- Anonymous, 1872. Catalogue of the articles exhibited at the Bermuda Industrial & Loan Exhibition.
- , 1906. Souvenir of Joyces Dock Caves, Bermuda. Bermuda: Colonist Press, 9 p.
- Addams, C.G., 1990. Carvings. *Sea Frontiers*, December, p. 40-45. Bretz, J.H., 1960a. Origin of Bermuda caves. *National Speleological Society Bulletin*, 22:19-22.
- , 1960b. Bermuda: A partially drowned, late mature Pleistocene karst. *Geological Society of America Bulletin*, 71:1729-1754.
- Bushell, J.J., 1926. Bushell's Bermuda handbook. Bermuda, xlv + 118 p.
- Davis, W.M., 1930. Origin of limestone caverns. *Bulletin of the Geological Society of America*, 41:47-628.
- Forney, G.G., 1973. Bermuda's caves and their history. *Journal of Spelean History*, 6:89-103.
- Harshberger, J.W., 1914. Algal stalactites in Bermuda. *Torreya*, 14:195-197.

- Hayward, W.B., 1910. Bermuda past and present. New York: Dodd, Mead & Co.,
- Heilprin, A., 1889. The Bermuda Islands. Philadelphia: Academy of Natural Sciences, 231 p.
- Hovey, H.C., 1896. Celebrated American caverns. Cincinnati, Robert Clark, 228 p.
- Iliffe, T.M., 1979. Bermuda's caves: A non-renewable resource. *Environmental Conservation*, 6:181-186.
- , T.D. Jickells and M.S. Brewer, 1984. Organic pollution of an inland marine cave from Bermuda. *Marine Environmental Research*, 12:173-189.
- Jones, J.M., 1859. The naturalist in Bermuda. London: Reeves & Turner, xii + 200 p.
- Lefroy, J.H., 1877. Memorials of the discovery and early settlement of the Bermudas or Somers Island, 1511-1687, v. 2. London: Longmans, Green, xix + 760 p.
- Lloyd, S.H., 1835. Sketches of Bermuda. London: James Cochrane and Co., 258 p.
- Home, D., 1866. Notice of a large calcareous stalagmite brought from the island of Bermuda in the year 1819, and now in the College of Edinburgh. *Royal Society of Edinburgh Proceedings*, 5:423-428.
- Nelson, R.J., 1840. On the geology of the Bermudas. *Geological Society of London Transactions*, ser. 2, 5:103-123.
- Paine, A.B., 1911. The boy cave-finder of Bermuda. *St. Nicholas Magazine*, 38:447-451.
- Rider, F., 1928. Rider's Bermuda. New York: MacMillan, xxxvi + 247 p.
- Sayles, R.W., 1931. Bermuda during the Ice age. *American Academy of Arts and Sciences Proceedings*, 66:381-467.
- Shufeldt, R.W., 1916. The bird-caves of the Bermudas and their former inhabitants. *Ibis*, ser. 10, 4:623-635.
- Swinerton, A.C., 1929. The caves of Bermuda. *Geological Magazine*, 66:79-84.
- , 1932. Origin of limestone caves. *Bulletin of the Geological Society of America*, 43:663-694.
- Thomson, C.W., 1878. The voyage of the "Challenger": The Atlantic, v. 1. New York: Harper, xxix + 424 p.
- Verrill, A.E., 1907. The Bermuda Islands, Part IV: Geology and Paleontology. *Transactions of the Connecticut Academy of Arts and Sciences*, 12:45-348.
- , 1908. The caverns of Bermuda. *Tropical and Sub Tropical America*, 1(3):107-111.
- Williams, W.F., 1848. Account of the Bermudas. London: Newby, 346 p.
- Wingate, D.B., 1960. Cahow, living legend of Bermuda. *Canadian Audubon*, 22(5):145-149.
- Zuill, W., 1946. Bermuda journey: A leisurely guidebook. New York: Coward-McCann, 426 p.

ZGODOVINA SPELEOLOGIJ NA BERMUDIH

Povzetek

Bermudi leže v Atlantiku na 320N in 650W, 1000 km oddaljeni od ameriške obale. Nastali so kot podmorski vulkan pred okoli 100 milijoni let. Kopno, vsega skupaj okoli 50 km², sestavljajo pleistocenski in recentni eolski apnenci, do 100 m debeli. Vse jame so v teh apnencih, predvsem v starejših, bolj konsolidiranih. Posebno pozornost raziskovalcev in krasoslovcev so vzbujale jame, zalite z morskovo vodo ("blue holes") in kapniki pod morskovo gladino (Williams, Swinnerton, Davis, Bretz).

Jame so bile omenjane v literaturi od odkritja otokov dalje (Shakespeareov "Vihar", Smith 1623, Jones 1859, Lefroy 1877). Tekom zgodovine je bilo devet jam urejenih za turistični obisk, od tega sta danes še dve. Kapnike in sigo so lomili po številnih jamah in jih uporabljali za surovino. Jetniki in kaznjenci so iz njih delali vse mogoče, od šahovskih figur do nakita. Admiral Milne je zbirko kapnikov podaril univerzi v Edinburghu, med njimi 3,4 m visok in 3,5 tone težak stalagmit. Zanj je D. M. Home (1864) izračunal (po sigi, odloženi na odlomljenem mestu) starost preko 600.000 let.

Danes so jame močno spremenjene in degradirane zaradi gradenj (nekaj jih je vključenih v hotelski kompleks, ena služi hotelu kot pokrit bazen), zaradi odpadnih voda, ki so napeljane v jamske lagune, jame zasipajo z odpadnim gradivom, neka jama služi za predstave delfinov, v sosednji pa je vskladiščena hrana za te delfine. Zaradi odlaganja odpadkov v jame, tudi odpadnih olj, je gladina vode v nekaterih jamah prekrita s preko pol metra debelo plastjo olja, ki se dviga in pada skupaj s plimovanjem.