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Bubble-drip and Bubble-blowing Straw Stalactites - a small remarkable natural wonder

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Abstract

Bubble-blowing straw stalactites are not common and are a result of solution pushing gas bubbles out the end of a straw. These bubbles consequently burst shortly after exiting the straw's central channel. However, a handful of these rare oddities have been recorded with a bubble that remains intact at the base of the straw, while solution flows over the bubble surface and drips from beneath. Some of these bubbles can be 20 mm or larger in diameter. It is proposed that these small remarkable natural wonders should be called 'bubble-drips' - if the bubble remains intact for several consecutive solution drips. This would distinguish the phenomenon from bubbles that burst upon exiting the straw and those which remain at the straw tip for some period of time. Research by Johnson (2022) suggests that the rare speleothems termed 'cave turnips' are created by bubble-blowing stalactites and, more specifically, the variant to be now called bubble-drips.

Very little research appears in available literature surrounding both bubble-drips and bubble-blowing straws. A number of hypotheses relating to the possible environmental conditions leading to the creation of bubble-drips are provided. This paper makes suggestions for research that could be undertaken to validate or disprove the hypotheses provided.

Introduction

On a recent trip to Takaka in the far north of New Zealand's South Island, while attending the ACKMA conference in 2023, the author was told about a nearby cave containing an unusual phenomenon of a *bubble-drip straw*. Several days later, Keiran Chandler and John (Oz) Patterson took a group of us to see the bubble drip in Elliots Cave, located on private property.

Our group was fortunate to see this unusual occurrence close up (Figure 1). Photographs and videos were taken of the relatively large air bubble hanging from a very short straw stalactite (with a flared tip) as solution flowed from the straw's central canal, over the surface of the bubble and dripped from the bottom of the bubble. This bubble remained intact as more solution ran over its surface and dripped from the bubble at a rate of approximately a drop every 4 seconds. As each drop of water fell from the vertically elongated bubble, the separation created a change in stress on the bubble causing it to rebound to a slightly horizontally-flattened ball, then back to round. As more solution was observed flowing over the bubble surface, it again became vertically elongated, until the next solution drop fell from the bottom and the process repeated (Figure 2).

Figure 1. A solution bubble in Elliots Cave at Takaka in the far north of New Zealand's South Island.
Photo Garry K. Smith

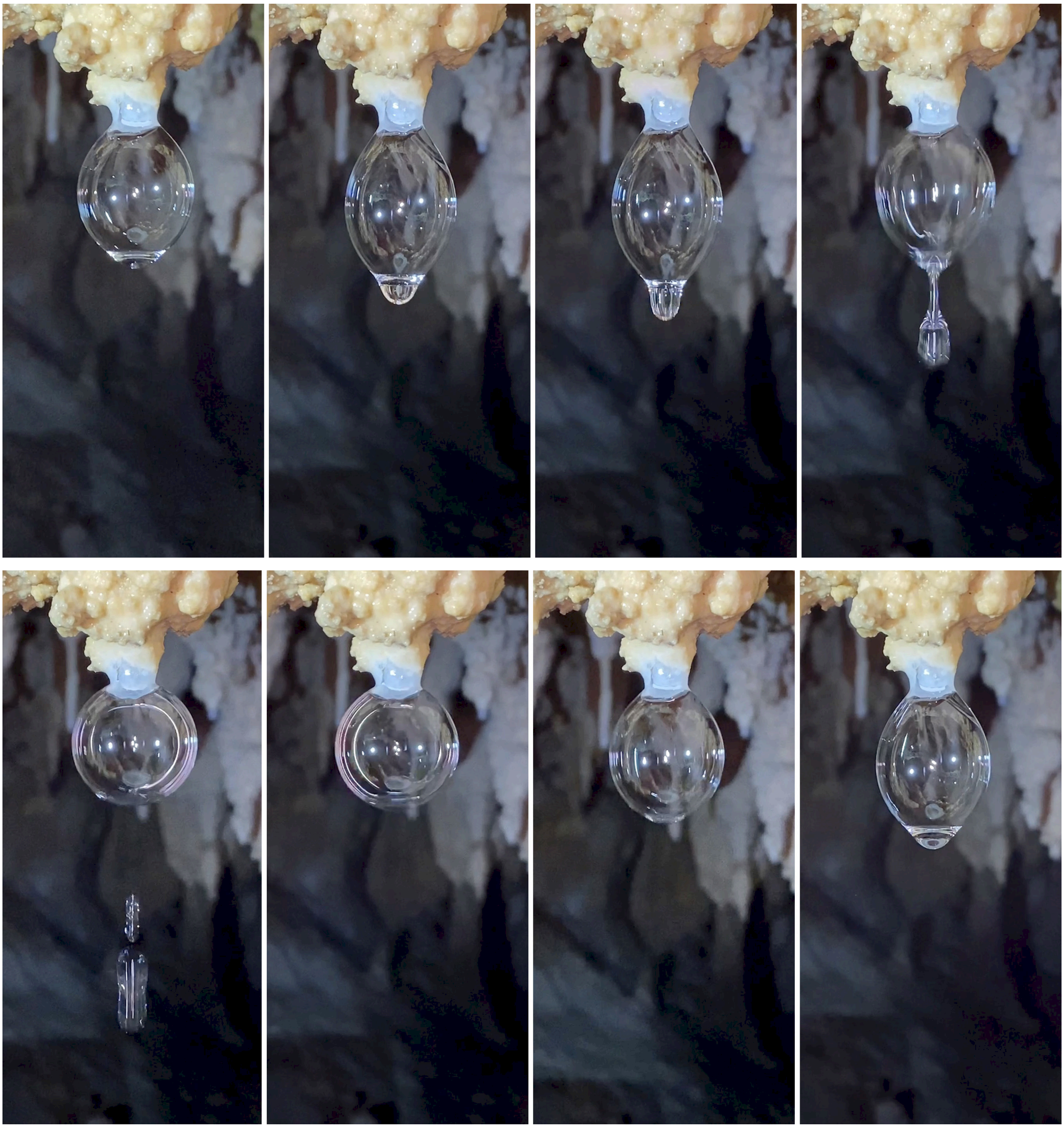

Figure 2. Sequence of a solution bubble beneath a short straw, showing a drop forming and falling from the base of the bubble that remains intact as the sequence is repeated many times before eventually bursting. Photo Garry K. Smith

This is certainly a small, but remarkable, natural wonder that is rarely seen.

So how does this happen without the bubble bursting every time a drop falls from the bottom of the air bubble? How does the gas get into the solution? Is there some chemistry involved that changes the solution's surface tension to maintain the bubble, despite the force exerted on it by the dripping solution? These questions and many others sent me on a quest for answers.

As an active caver for approximately 60 years, I have never before seen a bubble at the end of a straw with solution dripping from the bottom. Available literature broadly refers to this phenomenon as 'bubble-blowing soda straws' but does not make distinction between constantly bursting bubbles and those that remain intact. Hence this category is very broad and does not reflect the two distinct variants.

To clarify the phenomena, I propose that there should be two distinct categories: 'bubble-blowing straw', and the now-proposed variant to be called a 'bubble-drip':

1. Bubbles and solution come out the end of a straw, however the bubbles usually burst before, or as, a solution drop falls. To be referred to as ‘bubble-blowing straws’ in this paper.
2. The bubble at the bottom of the straw remains intact for a period of time while solution drops fall from the bottom of the bubble. These will be referred to here as ‘bubble-drips’.

This short paper has been written in the hope that other cavers who have observed this rare wonder will help shed more light on their occurrence and behaviour. If you have ever seen a bubble-drip or bubble-blowing straw, please contact the author.

The documented locations, some of which appear on the internet in social media, have been listed in this paper, along with the identified environmental conditions and morphology of the straw stalactites.

Known Occurrences

The earliest report found during literature searches for bubble-blowing stalactites dates from 1938. Custodian T.O. Thatcher at Lehman Caves, Great Basin National Park, Nevada, USA, observed bubbles issuing from a stalactite after hearing what he thought was water dripping into a pool in the Cypress Swamp section of Lehman Cave. Upon investigation he reported, “Both water and air were coming down the channel, about the size of a match, in the centre of the formation, thus forming bubbles which made the sound when bursting” (Anon. 1938, 1972). This example is not quite the same as the one in Elliots Cave, NZ, in that the bubbles were not remaining intact while water continued dripping.

In their book *Cave Minerals of the World* (Second Edition), Hill and Forti (1997, p. 107), provide a photo by Michael Lichon of a “bubble-blowing soda straw” in Baldocks Cave, Mole Creek, Tasmania. This appears to be what is here termed a bubble-drip.

Internet searches have revealed just a few occurrences of bubble-drips in the USA, including several examples in Lehman Caves, Great Basin National Park, Nevada. Baker (2017) provides several images of bubble-drips in her blog ‘Desert Survivor’ (Figure 3a-d).

Also the website page at <https://www.us-parks.com/great-basin-national-park/caves.html> refers to the Lodge Room area of Lehman Cave having some soda straws with a bubble on the end of each and water dripping from the bubbles. They occur at a depth of about 24 m below the surface (Baker, G.M., pers. comm). Pinyon pine and juniper grow on the surface above the chamber with the bubble drips.

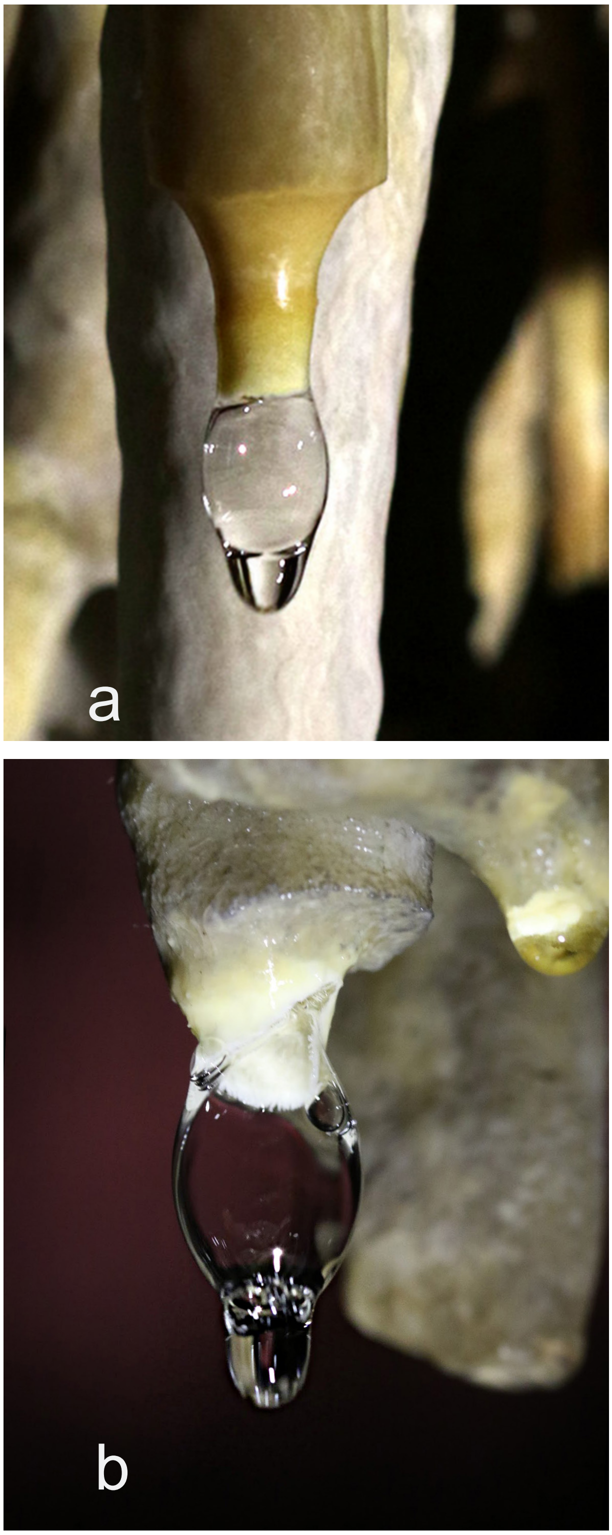

Figure 3a, b. Bubble-blowing straws at Lehman Caves, Great Basin National Park, Nevada, USA. Photos Gretchen M. Baker.

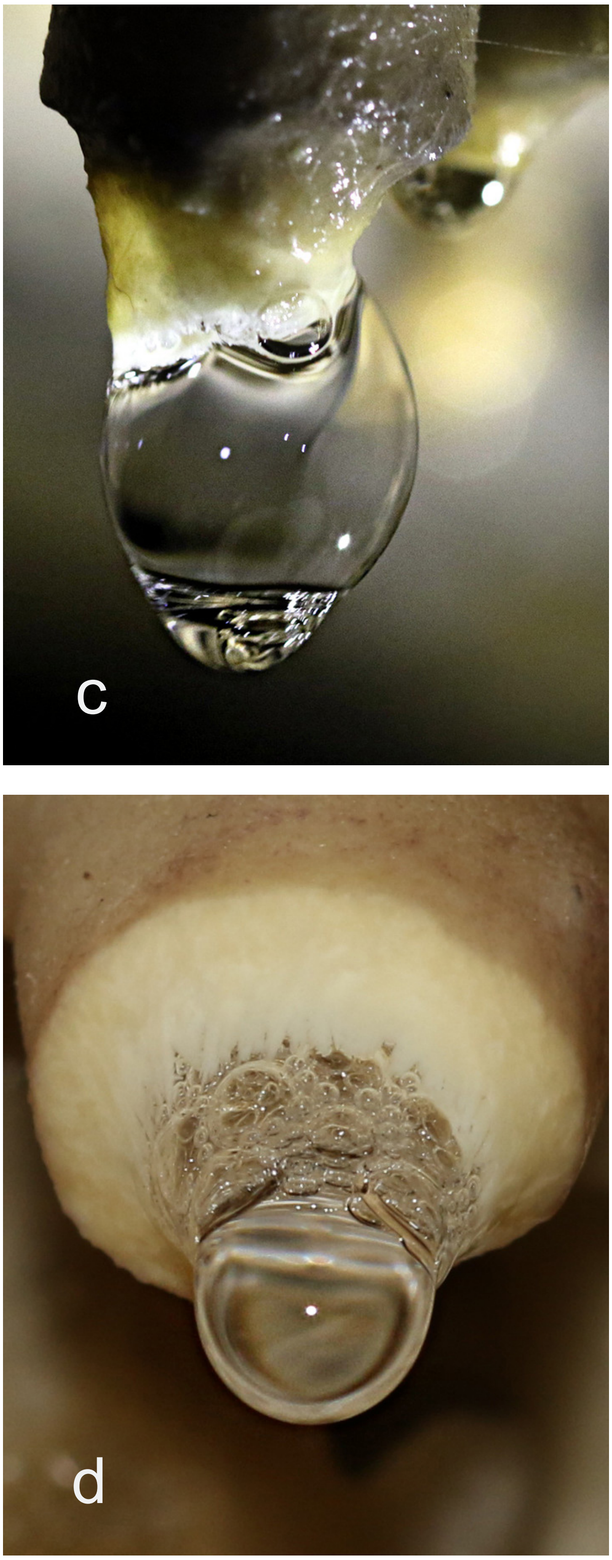

Figure 3c, d. Bubble-blowing straws at Lehman Caves, Great Basin National Park, Nevada, USA. Photos Gretchen M. Baker.

At Timpanogos Cave National Monument, Utah, USA, it is also reported that on rare occasions bubbles can form, at the end of soda-straws in Middle Cave, typically during wet springs such as in June 2019. A video of a bubble-blowing straw can be seen at <https://m.facebook.com/timpanogoscavenps/videos/cave-bubbles/347795159233822/?_se_imp=0x1NYp4Xwd5Vdo9Xe>. And also at <https://www.facebook.com/reel/2901107923506582>

Another occurrence of a bubble-drip has been reported in Lewis and Clark Caverns State Park, Montana, US and a photo by Zack Story is posted at <https://www.instagram.com/p/CQHMuXJLiMQ/?img_index=2>.

There are two bubble-drips in close proximity to one another in a video posted on Facebook by “Indian Caverns” in October 2012. They both drip at rates faster than a drip every two seconds and there is a comment that the faster one of these bubble drips existed one year earlier. See <https://www.facebook.com/100040793987008/videos/4365823336975/?__so__=permalink>.

How do they occur?

The only explanation I have found as to how these bubble-drip and bubble-blowing straws occur is given by Hill and Forti (1997). They state that bubble-blowing stalactites are thought to be caused when the straw stalactite’s internal flow is temporarily interrupted while external flow continues. Capillary pressure may draw water and air into the end of the straw. When internal flow resumes, the result may be a bubble-blowing stalactite.

Observations

In the quest for more answers, the author searched the internet and located a couple of photos and videos of other bubble-drips to compare with the one in Elliots Cave, NZ. There appears to be a common theme across all the available images and videos, in that the straws from which the bubble-drips have formed are typically short in length and their diameter at the end is about 1-3 mm larger than standard speleothem straws which are typically between 4.5 and 6.45 mm (Smith 2019, 2021a, b). The solution drip rate is typically one drop every 2 to 4 seconds. The straws with bubble-blowing drips appear to be located in shallow depth caves (<15 m) with some vegetation at the surface in the solution catchment area. The videos on the internet and the bubble-drip video taken by the author in Elliots Cave, do not show any obvious solution flow on the outside of the straw which could be attributed to the high solution drip rate. This would suggest that something different is occurring, not capillary pressure and solution flow on the outside of the straw as suggested in Hill and Forti (1997).

Hypotheses for Bubble-drip Formation

A possible explanation is that active bacteria breaking down rotting vegetation and growing tree roots (Smith 2022), are creating a significantly elevated carbon dioxide (CO_2) concentration in the soil above the cave. Another contributing factor may be that during winter the outside air temperature can be significantly colder than the cave air. This scenario is strengthened by the well documented fact that cold water can absorb and retain a higher concentration of CO_2 and other gasses than warmer water. If this is the case then rain water passing through the soil can absorb the high concentration of CO_2 and carry it down to the cave where degassing is occurring at a faster rate than usually occurs at a straw tip. Degassing in caves typically occurs because CO_2 in the drip solution at a higher concentration diffuses into the cave atmosphere with a lower concentration (generally without bubbles). However, physics shows that bubbles may form if the gas is forced out of solution too fast, such as when a solution is warmed up just a few degrees. Such conditions could well have created the bubble in Elliots Cave as it had been very cold and raining for several days before our visit and the cave temperature was noticeably warmer than the above-ground temperature.

A simple demonstration of how gases and liquids interact is given when the cap is unscrewed from a cold bottle of carbonated water: the rapid reduction in pressure causes CO_2 bubbles to be released from solution. More bubbles continue to form as the soda water warms up to room temperature.

All the photo and video examples of bubble-drips I have located on the internet depict bubbles attached to short straws, which generally appear to be 1-3 mm larger than the average straw diameter. Certainly, the observed straw in Elliots Cave was a larger diameter, very short and flared at the tip. This would suggest that the solution may be more acidic and as the drip rate was relatively fast, calcium carbonate is mostly being deposited on the cave floor and not at the straw stalactite tip.

In addition to the possible effect of an elevated concentration of CO_2 in the solution, there may be other chemistry involved that is altering the solution surface tension. Could there be an introduced compound from plant, algal or other microbial life, that is decreasing the drip solution surface tension, thus increasing the bubble size and resistance to bursting when the drops fall from the bubble?

Contrary to what one would expect, decreasing the surface tension of water allows bubbles to form and resist bursting. For example, if air is blown into water with a drinking straw to create bubbles, they burst quickly because the surface tension of the water is relatively high and the water is not very stretchy. Adding soap decreases the surface tension so that the water can stay stretched around the bubble.

In nature there are substances such as saponins that act like soap and reduce water surface tension. Natural plant saponins are compounds that can dissolve in water, and will latch onto oils. Thus saponins have historically been extracted from some plants and used to make soaps. So, in summary saponins are a group of steroid or triterpenoid glycosides and related chemicals found in roots, shoots, seeds and flowers of many plant species. Saponins can be released into the soil by secretion from roots and/or leaching from living or decaying plant material (Mishustin and Naumova 1955; Oleszek and Jurzysta 1987).

The existence of saponins could be an explanation for the relatively large bubble-drip size in Elliots Cave and why the bubble remains intact, while solution drips from the bottom of the bubble.

Given that bubble-drips appear to be rare worldwide, it may be that a number of conditions need to exist at the same time for this quirk of nature to occur.

These possible explanations are suggested on the basis of limited evidence and as a starting point for further investigation. It would be useful to analyse the bubble gas and the solution chemistry.

Gas bubbles influence speleothem morphology

A study documenting unusual bulbous speleothems called ‘cave turnips’, was undertaken in Lehman Caves, Nevada, USA, by Ryan J. Johnston (2022) and revealed a link with gas bubbles on straw stalactites. ‘Cave turnips’ are hollow inside and were named cave turnips by Dr. Louise Hose, a prominent Lehman Caves researcher. The research team identified and measured a total of 1017 cave turnips scattered over nine locations in the cave.

Johnson hypothesized that the "turnip genesis begins as a soda straw, an abnormal bubble forms on the tip, and calcitic water flows over the bubble, creating the unique hollow turnip shape". As calcite-rich water flows down the straw over the bubble, calcium carbonate is gradually deposited, causing the straw diameter to flare out, following the shape of the bubble. If the speleothem continues to grow, it may end up as a hollow turnip-shaped stalactite (Figures 4 and 5).

Figure 4. A cave turnip column in Lehman Caves, Nevada, USA. Photo Ryan J. Johnston.

While common in Lehman Cave, this type of turnip speleothem is relatively rare worldwide. The turnips at Lehman Caves have formed as a result of prolonged favourable conditions in past millennia. In today's present climate, "According to park geologists, these bubbles form during pluvial periods, the most recent occurring in 2018" (Johnson 2022).

Figure 6 shows examples of cave turnip speleothems in Hill Cave (TR7-8) at Timor Caves, NSW, Australia, that may have been created by this process.

Figure 5. Photograph showing the hollow inside of a cave turnip caused by condensation corrosion removing the thin cave turnip wall. Lehman Caves, Nevada, USA. Photo Ryan J. Johnston.

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Figure 6. Cave turnips in Hill Cave (TR7-8) at Timor Caves NSW, that could have been created by bubble drips on straws. Note, on broken turnip, the internal crystals radiating inwards toward the centre of a ball-shaped speleothem. Photo Garry K. Smith.

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