City of Austin, Austin Water Utility,

Wildland Conservation Division,

Balcones Canyonlands Preserve

Soft Tick Monitoring in Austin Caves

By Colin Strickland & Drew Thompson



Soft-bodied tick in Airmen's Cave January 22nd, 2018

Background

We have been collaborating with Texas State University, Baylor School of Medicine, and the Centers for Disease Control (CDC) on a study to further understand and document the recent increased occurrence of Tick-borne Relapsing fever (TBRF) in Central Texas. TBRF is a bacterial infection that can cause recurring bouts of fever, headache, muscle and joint aches, and nausea. *Borrelia* bacteria that cause TBRF are transmitted to humans through the bite of infected soft-bodied ticks of the genus *Ornithodoros*. All recent confirmed cases of TBRF in the Austin area have been attributed to *Borrelia turicatae*, and the ticks have all been confirmed as *Ornithodoros turicata*. Soft-bodied ticks (Family: Argasidae) differ from the more familiar hard ticks (Family: Ixodidae) in two main ways. They have a short feeding duration, usually less than half an hour, and they do not search for hosts in grass or brush but instead reside in animal burrows (CDC TBRF, 2015).

It has been known that a few caves in the Austin area harbor soft-bodied ticks, but until recently cases of TBRF have been very rare. During 2013–2016, no cases were reported to Austin Public Health. In 2017 there were a large number of cases of TBRF. Eleven people attending a writing retreat in Austin contracted TBRF. Eight of the 11 reported insect bites, primarily on feet, ankles and legs (Kliioueva, 2018). This cluster of occurrences was likely due to the rustic setting of the writing retreat, with infected ticks residing in rodent nests. Most cases of TBRF in the United States are associated with people sleeping in rodent-infested cabins (CDC TBRF, 2015).

Additionally, in 2017 three people working in Austin area caves were diagnosed with TBRF and two more tested positive for antibodies against the *Borrelia* bacteria (*Borrelia turicatae*). The soft-bodied ticks are found in caves that are inhabited by mammals such as mice, rock squirrels, raccoons, etc. The two caves where people became infected were Little Black Hole and Live Oak Cave. Little black hole is gated and relatively inaccessible so poses little risk to the public. Live Oak Cave is located in an urban park, and is surrounded by a fence and gated. Interestingly Live Oak was excavated for many days in previous years by COA employees with no reports of TBRF, until December 2016 when Nico Hauwert and an Austin Park Ranger contracted TBRF after entering the cave. Several years ago, many groups of children visited Live Oak Cave during cave education open house days, and there were no reports of TBRF.

Methods

It is clear that some local caves have ticks carrying TBRF and that risk of infection with TBRF it is not static. To better understand the level of risk associated with caves accessed by large numbers of people we have started surveying and monitoring soft-bodied tick populations. Priority was given to the education caves due to the large number of children visiting them. The next level of priority was given to caves in the Barton Creek Greenbelt that are well known hangouts for hikers, offering relief from the Texas heat.

To survey soft-bodied tick populations, we deployed pit fall traps using dry ice as an attractant in 19 separate caves in the Austin area (Table 1). Specimens were collected alive and stored in ventilated plastic vials for transport to Texas State University's Professor Dr. Ivan Castro and his students Rosa Ramirez and Matt Milholland. The collected ticks were then sent to Job Lopez at

Baylor College of Medicine for *Borrelia* identification and further TBRF research. The information gathered is being shared with Jeff Taylor and Anna Klioueva with the Epidemiology and Disease Surveillance Unit of the Austin Public Health Department, and the Centers of Disease Control (CDC) to document and compile data about the TBRF in Central Texas.

Cave Name	Survey Dates
Airmen's Cave	6/14/2018
Baby Fox Cave	11/14/2017
Big Oak Cave	11/14/2017
Bowie Cave	6/8/2018
Bullet Cave	6/14/2018, 6/27/2018
Confusion Cave	8/10/2018
District Park Cave	11/7/2017, 6/8/2018
District Park Annex Cave	11/7/2017
Get Down Cave	11/7/2017, 6/8/2018
Grassy Cove Cave	11/7/2017, 5/24/2018
Hideout Cave	10/31/2017, 11/14/2017
LaCrosse Cave	10/31/2017, 5/24/2018
Live Oak Cave	11/7/2017, 11/14/2017, 6/27/2018, 8/10/2018
Lost Oasis Cave	12/15/2017
Maple Run Cave	12/15/2017
Millennium Cave	12/15/2017, 6/8/2018
Pipeline Cave	8/10/2018
Wade Cave	10/31/2017, 11/14/2017
Wildflower Cave	10/31/2017, 5/24/2018

Table 1. Soft tick surveys conducted in 2017 & 2018

The pitfall trap consists of a plastic storage container that is 6 x 10 inches and 3 inches deep that is buried to the edge of the rim on the cave floor. A piece of felt is placed along the bottom of the trap to absorb condensation. A paper cup with air circulation holes cut in the bottom and sides is placed upside down on top of the felt. Dry ice is placed on top of the cup (Figure 1). As the dry ice sublimates, CO2 falls down the cup and fills the plastic container and then overflows on the cave floor. The soft-bodied ticks are attracted to CO2 and fall into the plastic container as they seek out the CO2 source. After the trap is set the time is noted and the cave is exited for 90 to 120 minutes depending on the size of the dry ice block. When retrieving the trap, the collector dresses in a full body Tyvek suit and heavy-duty rubber gloves with all openings sealed with duct tape. An aspirator is used to quickly collect all the ticks along the sides of the trap, and then the lid is put on to remove the trap from the cave. Once outside of the cave the collector is examined to ensure that there are no ticks on their suit. The ticks are counted as they are gathered out of the trap. They are placed into a ventilated plastic vile for storage and transportation to Texas State University.



Figure 1. Tick trap with dry ice



Figure 2. Soft ticks in trap



Figure 3. Drew Thompson removing trap from Wade Cave, October 31st, 2017



Figure 4. Ticks collected from Live Oak Cave November 7th 2017 (pencil for scale)

Results

The results from our surveys in 2017 & 2018 are shown in Table 2. Live Oak Cave by far has the highest number of soft ticks, followed by Bullet Cave. Not finding ticks does not mean there are none present. The photo at the beginning of this report is of a soft tick seen far back in Airmen's cave, yet no ticks were found in traps set at the entrance.

Date	Cave	# of Ticks
10/31/2017	Hideout	0
10/31/2017	LaCrosse	0
10/31/2017	Wade	0
10/31/2017	Wildflower	0
11/7/2017	District Park	0
11/7/2017	District Park Annex	2
11/7/2017	Get Down	2
11/7/2017	Grassy Cove	0
11/7/2017	Live Oak	10
11/14/2017	Baby Fox	0
11/14/2017	Big Oak	1
11/14/2017	Hideout	1
11/14/2017	Live Oak	~40
11/14/2017	Wade	0
12/15/2017	Lost Oasis	0
12/15/2017	Maple Run	0
12/15/2017	Millennium	0
5/24/2018	Grassy Cove	0
5/24/2018	Lacrosse	0
5/24/2018	Wildflower	0
6/8/2018	Bowie	0
6/8/2018	District Park	0
6/8/2018	Get Down	3
6/8/2018	Millennium	0
6/14/2018	Airmen's	0
6/14/2018	Bullet	15
6/27/2018	Bullet	8
6/27/2018	Live Oak	~50
8/10/2018	Confusion	0
8/10/2018	Live Oak	~50
8/10/2018	Pipeline	0

Table 2. Number of soft ticks collected from Austin area caves

Discussion

Our methods are still evolving as we learn what works and what does not. Our initial traps lacked the cup and did not draw as many ticks. Our next design brought in more ticks, but many drowned in the condensate caused by dry ice in near 100% humidity. The addition of felt to absorb condensate has stopped that problem, but other challenges remain. The timing of trap placement is a factor we are trying to perfect. Caves "breathe" due to temperature differences and changes in barometric pressure. The timing of the inward or outward flow of air is hard to predict. When setting the traps in Airmen's Cave on July 14th 2018 the outward flow was fairly strong and all the CO2 was being visibly blown out the entrance. This may have caused the negative result during that collection.

Due to the high number of ticks found at Live Oak Cave and Bullet Cave, warning signs were placed at their entrances to hopefully minimize the public's exposure to TBRF (Figure 5). We will continue to monitor education caves, as well as caves that are often visited by the public, such as Airmen's Cave and Bullet Cave. We do not want the presence of a single tick to scare people away from a cave, but they should be informed about the TBRF risk level of each cave. Use of insecticides or "bug bombs" is not recommended, as these caves are also home to many rare and sometimes endangered invertebrate species. To convey our findings to the cave educators, a color-coded table has been made (Table 3). Updated versions of this table will be sent to educators after each round of surveys.

Hopefully we will eventually learn why there has been an increase in cases of TBRF in Central Texas. For now, we can at least try to evaluate the risks of entering local caves and provide this information in the appropriate format to educators, researchers, and the general public.

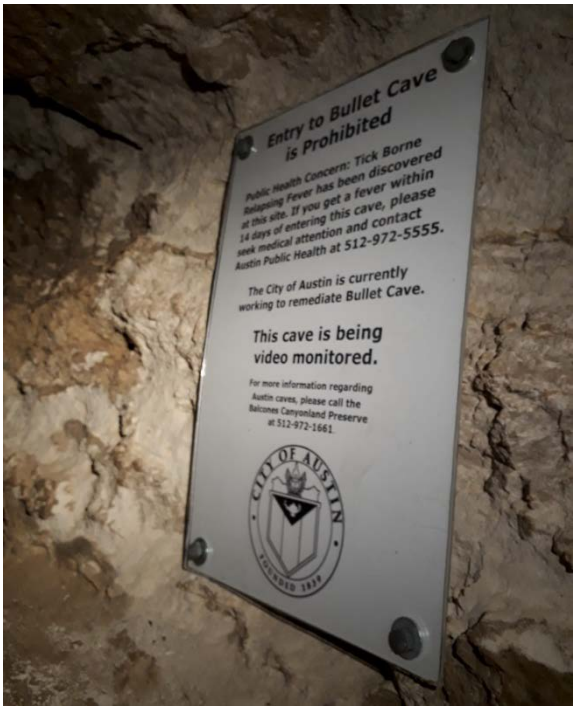


Figure 5. TBRF warning sign in entrance of Bullet Cave

Date	Cave	Tick Level
11/14/2017	Baby Fox	Safe
11/14/2017	Big Oak	Use Caution
6/8/2018	Bowie	Safe
6/27/2018	Bullet	Do Not Enter
8/10/2018	Confusion	Safe
11/7/2017	District Park	Safe
11/7/2017	District Park Annex	Use Caution
6/8/2017	Get Down	Use Caution
5/24/2018	Grassy Cove	Safe
11/14/2017	Hideout	Use Caution
5/24/2018	Lacrosse	Safe
8/10/2018	Live Oak	Do Not Enter
12/15/2017	Lost Oasis	Safe
12/15/2017	Maple Run	Safe
6/8/2018	Millennium	Safe
8/10/2018	Pipeline	Safe
11/14/2017	Wade	Safe
5/24/2018	Wildflower	Safe
Note: Dates are most recent survey done.		
0 = No Ticks	1-4 = Some Ticks	>4 = Many Ticks
Safe	Use Caution	Do Not Enter

Table 3. Tick risk levels

Literature Cited

Campbell SB, et al. (2018, April 18). Evaluating the risk of tick-borne relapsing fever among occupational cavers — Austin, TX, 2017. Presented at: Epidemic Intelligence Service conference; April 16-19, 2018; Atlanta.

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