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The Effect of Agkistrodon Contortrix and Crotalus Horridus Venom Toxicity on Strike Locations with Live Prey.

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THE EFFECT OF *AGKISTRODON COTORTRIX* AND *CROTALUS HORRIDUS* VENOM TOXICITY ON STRIKE LOCATIONS WITH LIVE PREY

by

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Abstract

THE EFFECT OF *AGKISTRODON COTORTRIX* AND *CROTALUS HORRIDUS* VENOM TOXICITY ON STRIKE LOCATIONS WITH LIVE PREY

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This paper aims to uncover if there is a significant difference in the strike location of snake species that have different values of LD50% venom. It is thought that most snakes strike their prey in the anterior (head) area in order for their venom to work quicker in killing them. Venom toxicity is measured by its LD50% value, which is the amount of venom, in mg/kg, to kill 50% of a test population. The Copperhead has an LD50% value of 10.9 mg/kg, and the Timber Rattlesnake has an LD50% value of 1.64 mg/kg. The hypothesis was that if venom toxicity had an impact on strike location, then the Copperhead species would strike at a higher rate towards the anterior area of their prey compared to the Timber Rattlesnake. Three Copperheads and Three Timber Rattlesnakes were used in the study. Strike location data was collected over the course of a seven-week period. The snakes were placed into an eight-foot wide by three-foot deep arena filled with materials to simulate their natural habitat. The snakes were fed rats or mice depending on their size, and strikes

were recorded on an iPhone XR and a GoPro. Strikes were designated as either on the anterior or posterior of the prey, and a t-test was conducted to determine if there was a significant difference present. A t-test was conducted on the number of strikes on the anterior of prey of both the Timber Rattlesnake and the Copperhead, as well as the total number of strikes on the anterior vs. the total number of strikes on the posterior. It was determined that there was not a significant difference in any of the data meaning that there is not a clear connection between strike location and venom toxicity in Timber Rattlesnakes and Copperheads.

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Introduction

There are over 3000 species of snakes in the world (Wallach, 2020). Of those species, the vast majority are nonvenomous. Nonvenomous snakes use various methods to kill their prey, such as constrictors that squeeze their prey with their body until it suffocates. Venomous snakes are a much smaller group of snakes at around 300 species (Wallach, 2020). What venomous snakes lack in number of species, they make up for in threat. Venomous snakes use venom to effectively subdue and kill their prey. Although snake venom is primarily used to secure prey, it is also used to aid digestion in the stomach, and act as a defense mechanism if they feel threatened. Unfortunately, an estimated 5 million people are bitten per year, and cause between 80,000 and 140,000 deaths (Snake envenoming, 2020). Even though the death rate between 1.6% and 2.8 % has been decreasing annually, this has caused many people to despise and fear snakes for this negative reputation that they cannot seem to escape. Ironically, the reason the death rate from snake bites has been decreasing is due to the advancement in our knowledge of antivenom. Antivenom is specific to the venom of each snake species and is made by purging the original venom of its toxins, adding purified antibodies into the antivenom, then reinjecting it into the victim (Fry, 2003). This causes a massive immune response that the body uses to fight the venom's effects. Many lives have been saved due to the various research done on sequencing snake venom to make antivenom, including many studies on various venom' effects on humans. This research paper will focus on the venom of different snake species to see if the difference in toxicity has an effect on the hunting and striking behaviors of those species.

Because each snake species is different, they all have different types of venom. Certain snake species have more toxic venoms than other species, and this study will examine if these differences have an effect on the striking behavior of venomous snakes. This study will attempt to generate new data about snake's usage of venom on their prey and could potentially give further insight into the cognitive ability of venomous snakes when it comes to how they hunt their prey. Additionally, this research looks to determine if snakes with higher Lethal Dose 50% (LD50%) venom strike their prey in locations containing vital organs, like the head or neck, significantly more than venomous snakes with lower LD50% venom. The primary hypothesis is that there will be a significant difference on the amount of strikes on the anterior region between snakes with high LD50's and snakes with low LD50's. The reasoning here relates to snakes with less toxic venom strike their prey in vital organs so the weaker venom can work quicker to kill the animal. Conversely, snakes with more toxic venom do not need to target a specific body part, since their venom is so potent.

To fully understand this study, it's important to clarify the difference between poison, venom, and toxins. While these three words are often used interchangeably, there actually is a difference between two of the three. In general, toxin is used as an overarching word to describe both poison and venom more broadly as a biologically synthesized substance that harmfully changes normal physiological functions. Poison is used to describe a substance that causes pain or irritation when you touch or ingest that substance i.e. poison ivy or poison dart frog. Venom is used to describe a substance that is injected into you i.e. snake bite, spider bite, or bee sting (Nelsen, 2013). Thus, snakes are considered venomous not poisonous.

There are three main types of toxins found in different snake species' venom, cytotoxins, neurotoxins, and hemotoxins (Bailey, 2020). Cytotoxins are arguably the most destructive to body cells compared to neurotoxins and hemotoxins. Cytotoxins work by directly attacking and killing all the cells in a specific area. This condition is called necrosis and can affect cells around the tissue and spread to an organ if it is close enough (Bailey, 2020). While the cell damage is massive at that area, the effects of the toxin are usually contained to the area surrounding the bite location. Snakes like the Gaboon Viper and the Puff Adder have cytotoxins in their venom. The second type of toxin is neurotoxin. Neurotoxins are substances that work to disrupt chemical signals in the brain or that get transmitted to the brain. The effects of neurotoxins include limb paralysis, trouble breathing, decreased cognitive function, and death in extreme cases (Bailey, 2020). Snakes in the *Elapidae* family have neurotoxins as the primary toxin in their venom. Snakes in this family include cobras, mambas, sea snakes, and coral snakes, among others. The final type of toxin is hemotoxin. Hemotoxins have physiological effects that interrupt the bloods' ability to coagulate. The anticoagulants in the toxin keeps blood from clotting and can cause increased hemorrhaging and internal bleeding, depending on the location of the bite and the affected person (Bailey, 2020). Snakes in the *Viperidae* family contain hemotoxins in their venom and include Rattlesnakes, Copperheads, and the Cottonmouth. Referring back to the hypothesis, it is thought that the Copperhead must target the head of its prey so that the hemotoxins in its venom can cause the most damage to the prey item, in the form of brain hemorrhaging. Due to the larger LD50% value of the Copperhead's venom, it would take more time for the hemotoxins to kill the animal if the bite occurred on the posterior region of the animal. It is important to understand the types of toxins and their effects in certain venom when working with the lethal dose and the effects of a venom in an experimental situation.

For the purpose of this study, references made to venomous snakes will only include the family *Viperidae*. Two different snake species will be used; the Timber Rattlesnake (*Crotalus horridus*) and the Copperhead (*Agkistrodon contortrix*), which are both part of the family *Viperidae*. These species have solenoglyphous fangs which are hollow fangs in the front of the jaw that "pop up" when the mouth is opened (Ferraro, 2020). The venom is delivered through the openings in the hollow fangs and is very hemotoxic, which as previously mentioned, prevents blood clotting and can cause severe tissue damage. One other important aspect of this research is the discussion of the LD50%. The LD50% is the measurement of the toxicity of a certain venom and is measured in milligrams of the venom over kilograms of the test animal. When measuring the LD50% of venom, it must be obtained from the snake. This is a process called milking. Because snake venom is released when the hydraulics in the mouth experience downward pressure (usually in the form of a bite), a snake can be "milked" by pushing its fangs through a sheet of parafilm over a jar for collection. Milking snakes for their venom is one of the key venom collection techniques that lead to the development of antivenoms and other cures (Hayes, 2020). Once the venom has been properly milked from the snake, the tests on the venom to determine the LD50% can begin.

The Lethal Dose 50% is achieved when a certain amount of a venom kills 50% of the animals in the tested population. For example, if a toxin can kill 50% of a test population of rats with only 5 mg/kg, the LD50% for that toxin would be 5 mg/kg. The lower the LD50% value, the more toxic a venom is said to be. These species were chosen for this study because the Timber Rattlesnake and the Copperhead are both native snakes in Nebraska, and both are available to use in Professor Dennis Ferraro's lab. They are also the perfect snake species to study their LD50% values because their LD50% values are significantly different from each other. The Timber Rattlesnake has an LD50% around 1.64 mg/kg and the Copperhead has a LD50% of 10.9 mg/kg (Ferraro, 2020). For comparison, the Hook-nosed Seasnake (*Enhydrina schistose)* is the world's most venomous snake and has a LD50% of .02 mg/kg, followed closely by the Taipan (*Oxyuranus microlepidotus)* at .03 mg/kg (Ferraro, 2020). The vast difference in the LD50% values between the Timber Rattlesnake and the Copperhead should be large enough to show a difference in strike location, if there is one. In terms of limitations, I was unable to obtain a certification to handle venomous snakes, due to Covid-19 restrictions, so I will not be directly handling the venomous snakes in the lab. Overall, this study intends to highlight any differences on strike locations on prey of venomous snakes with different venom LD50's. If correct, this information will support the hypothesis that snakes with larger LD50% values will need to target the anterior region of the body, so their venom can be more effective. The understanding of what venom is, the different types of toxins present and their effects, and the calculation and interpretation of the LD50% values are key components that went in to developing this hypothesis through the literature review, and the overall research objectives for this project.

Literature Review

Conducting a literature review on this topic was difficult as there was not an abundance of specific information relating to this research topic. Many studies have been done with human applications of snake venom or specific gene sequencing and analysis within the venom, but little research exists about strike locations. One study was found that was similar to what is going to be tested, *"Feeding behavior and venom toxicity of coral snake Micrurus nigrocinctus (Serpentes: Elapidae) on its natural prey in captivity."* This research recorded the strike location of coral snakes to be on the anterior region (towards the head) 45% of the time, which will be a good reference point for both of the different LD50's doses. Unfortunately, this was the only study found that recorded results like this. As such, trying to find information surrounding the topic that would help conduct the study was the next logical step. There are many variables to consider when researching this area, and most of this research was focused on addressing these possible variables.

Snakes need to have specific conditions met in order for them to feel comfortable enough to feed, especially in captivity. Many snakes use a 7-step process when hunting/striking their prey. First, they search for their prey. Once they have found it, they approach and get in position. They then "glide" their head forward slightly before the strike by quickly opening their jaws and straightening their body out. Once close enough, the snake bites down and releases venom into the prey. Finally, they release their prey and wait as part of the "post-release" step for the venom to take hold (Kardong, 1975). Knowledge of this is important when conducting this study so the process the snakes goes through before, during, and after its strike is properly understood. The amount of cover available is a key condition that affects feeding behavior in snakes. Prairie rattlesnakes prey retrieval times after the initial bite and release were significantly faster in terrariums with cover that in those without cover (Chiszar, 1996). In the wild, if a snake has cover, it will be more protected from predators as it goes to retrieve its prey. If there is not as much cover present, it will have to wait until an ideal time to retrieve its prey, which takes longer. This is significant to this study because the snake can be removed from the arena before it starts consuming its prey. It is also important to note that snakes use larger amounts of venom for larger prey items (Hayes, 1995), so all the prey items used in the study will have to be similar in size, relative to each snake, to keep the results consistent.

Because this study involves the use of video recording the snakes strikes and analyzing that data, the use of a high-speed camera will be imperative. An experiment done by Timothy Higham in 2017 looked at the strike speeds of Mohave Rattlesnakes when hunting kangaroo rats in nature. In their study, they used a camera that recorded up to 500 fps of three-dimensional video. Their experiment was done at night so the camera they used for their experiment was more powerful than the one that this experiment would require. Another study was done on the

Eastern Brownsnake that used a Super VHS video tape to record the strikes at 25 frames per second at a 1/8000 shutter speed (Whitaker, 2000). The cameras used in these two experiments have a wide range in frames per second, which means that this study can use a camera that ranges from 100-300 fps, and it should be sufficiently powerful enough for the purposes of this study.

This study will use both the Timber Rattlesnake and the Copperhead for the low and high LD50's, respectively. The LD50% for the venom in both the Timber Rattlesnake and the Copperhead were found and recorded (Corbett, 2020) (Rokyta, 2013) (Ferraro, 2020). The Timber Rattlesnake has an LD50% around 1.64 mg/kg and the Copperhead has a LD50% of 10.9 mg/kg. The frequency of dry bites was also researched, which are when the snake bites, but no venom is delivered. Dry bites occur about 20-60% of the time with humans (Naik, 2017), this is most likely due to snakes using strikes as a defense mechanism and many do not even puncture the skin. The number of dry bites on natural prey is much lower than with humans. This is important for this study as the use of venom is a key component and a dry bite should try to be avoided. Even though I will not be directly interacting with the venomous snakes, research was done on some of the proper handling tools and techniques. Tools like the snake hook and hoop bags are used to keep snakes away from the body and as protection from being bitten (Lock, 2008). Tubing is a much safer and less stressful way of capture of snakes and one that Professor Dennis Ferraro uses regularly. It involves putting the head of the snake into a clear plastic tube so that the snake cannot move around in it or turn and bite you (Johnson, 2011). Mitchell, 2004 provides basic snake husbandry tips like safe capture/restraint, anesthesia, and recognizing sickness. This review of the literature, while not all directly related to this specific topic, helped broaden the scope of what was already known. It will help in performing this study to be as scientifically accurate as possible, while being cognizant of the results from other studies that have already been published.

Methods

I. Research Design and Approach

This research project aims to determine if there is a significant difference between the LD50% value of snake venom and those species strike locations on their prey. Cameras will be used to record the strike behaviors and strike locations of both *Agkistrodon contortrix* (Copperhead) and *Crotalus horridus* (Timber Rattlesnake). Venomous snakes in the wild tend to aim for the vital organs in their prey, most commonly the head and neck area, to ensure a quicker death for the prey animal. Certain species of snakes are so venomous that a single drop of venom located anywhere in the prey's body will kill them in minutes. Copperhead venom has a LD50% over six times higher than the LD50% of Timber Rattlesnake venom. This leads to a hypothesis that the Copperhead will strike its prey in the anterior area significantly more than the Timber Rattlesnake.

II. Sampling Methodology and Data Collection

This research project will be conducted at the herpetology lab on the east campus of the University of Nebraska-Lincoln. The laboratory experiment will be assisted by Professor Dennis Ferraro, who will help conduct the parts of the study that include interacting with the venomous snakes i.e. transport, feeding, etc. Six individuals will be used for this study, three Copperheads and three Timber rattlesnakes. We were restricted to these six individuals as time and Covid-19 restraints prevented Dr. Ferraro from obtaining more. The study will begin in late February and will conclude in late April. Data will be constantly collected every

Wednesday and will occur weekly for seven weeks. A single eight-foot wide by three-foot wide, round terrarium will be converted into an experimental arena for the snakes to encounter their prey. These terrariums will be filled with sand, sticks, leaves, and other minor "obstacles" such as branches and rocks to simulate conditions in their natural habitat. The terrarium should not be under too much cover as to not interfere with the video recording of each strike.

Each week, one individual will be put into the terrarium and allowed to adjust to its surroundings for a five-minute period. Once adjusted, its prey item (mice for the Copperheads and rats for the Timber Rattlesnakes) will be added. The prey item will be dropped into the terrarium away from the snake, as to not scare them at the start. The snake will be given 20 minutes to strike the prey. Strikes will be recorded until the prey dies or no strikes are recorded after 20 minutes. If the snake strikes the prey before the end of the 20 minutes, the prey will be left in the arena until it dies. This allows for additional follow-up strikes by the snake if the first strike was a miss or a dry bite. Once the prey dies, the snake will be removed from the arena back to its respective enclosure in the lab and it will be fed the prey item it struck in the arena. If the snake fails to strike the prey within the 20-minute period, the snake will be removed from the arena, and the data of "no-strike" will be recorded. As mentioned above, the absence of cover leads to longer prey retrieval time, which is advantageous for the study because the snake can be removed before it starts to consume the prey. This process will then be repeated for the remaining five individuals. This allows for a minimum of three data points per species, or six total data points, each week. There is a possibility for more or less data each week depending on if snakes strike multiple times or not at all. In order to stay consistent with their feeding, the same order of snakes will be used each week. Starting with Copperhead 1, then Timber 1, to Copperhead 2, and so on. Due to time constrains of scheduling, there will be some weeks that not all six snakes will be finished on Wednesday. In those instances, the remaining snakes will be fed, and data will be recorded on Thursday, that next day.

III. Data Collection Tools and Data Analysis

Data collection will come from a recording of the strike from a mounted GoPro camera on a tripod and an iPhone XR. A normal iPhone 10 can record video at 240 fps which should be fast enough to be used to effectively analyze the strike location for each data point. The GoPro camera will be focused on the entire arena and will be recording for the entire 20-minute period the snake is in the arena. The iPhone XR will be used as a “spot record” method, meaning it records whenever the snake and prey item are close, and a strike could occur. Once all the data is recorded on the camera for each week, that data will be interpreted and analyzed through the video and compiled on an excel spreadsheet. When looking at the video, several data points will be collected. The location of the strike (either on the anterior or posterior section of the body), the direction of the approach (whether the snake struck from the front, side, or back of the prey), the number of hits and misses, the number of strikes on the prey item (if there are multiple), and other smaller behavioral details like tongue flicking or willingness to explore the arena.

In order to be as consistent as possible, there will be a number of variables that will be measured to ensure they are constant throughout all the trials. The temperature of the part of the lab where the terrarium is located, the order the snakes are fed, the time of the day the experiment is conducted, the size of the prey items respectively for each snake species, the time allowed for the individuals to adjust to the terrarium, and time given for the snake to strike the prey will all be recorded in order to keep them as consistent as possible. Repeating this experiment weekly, over two months, should result in approximately 35-40 data points total or 15-20 data points for each species. Data analysis will be conducted through a t-test to determine if there is a significant difference in strike locations as a whole, as well as the strike location relative to the nature of the strike. Strikes will be designated as either on the anterior (head) region or the posterior (back) region. Once all the data points have been collected from all individuals from both species of snakes, the data will be run through a t-test. A specific p-value of less than .05 will indicate that there is a significant difference in the data.

Results

I. Overview

Over the course of the seven-week study, a total of 50 strikes were recorded as data points. 26 of the strikes were from the Copperheads and the other 24 were from the Timber Rattlesnakes. Many different data points were recorded as part of the data analysis. Each snake had data on the total number of strikes, number of strikes on the anterior of prey, number of strikes on the posterior of prey, number of hits, number of misses, and the direction of the approach towards the prey. The main data table (Table 1) shows all of the data as one before it was broken down for each section of analysis.

Snake	Total Strikes	Anterior	Posterior	Hits	Misses	From Behind	From the Side	From the Front
Copperhead 1	8	5	3	3	5	0	4	4
Copperhead 2	14	6	8	8	6	1	8	5
Copperhead 3	4	3	1	3	1	0	3	1
Timber 1	9	8	1	9	0	0	6	3
Timber 2	6	5	1	6	0	0	4	2
Timber 3	9	4	5	7	2	1	5	3
Totals	50	31	19	36	14	2	30	18

Table 1: The data table that shows all the relevant data including strike location, hits, misses, and direction of approach.

II. Number of Strikes on Prey by Location

In the context of this project, a strike was considered on the anterior if the strike was located on the head or neck area of the prey. Anything lower on the body would be counted as on the posterior area. Four t-tests were conducted to determine if there was a significant difference in any of the relationships. All anterior strikes vs. all posterior strikes aimed to find a significant difference in the location of the strike regardless of the species of snake

Snake	Anterior	Posterior
Timber	17	7
Copperhead	14	12
Totals	31	19

Table 2: The totals of both the strikes on the anterior and the posterior.

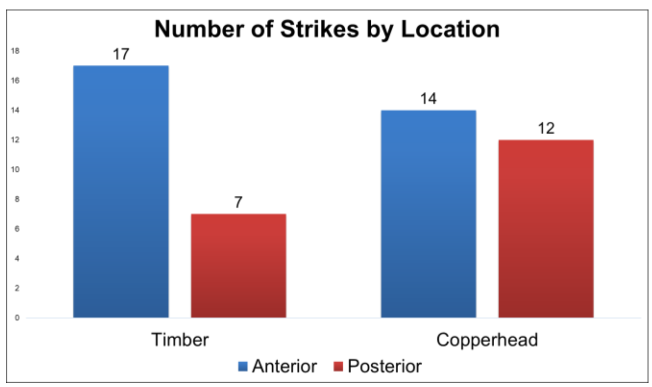

Figure 1: Number of strikes by location from each snake species.

(Table 2 and Figure 1). No significant difference was found as the t statistic was 1.49 and the p-value was .09. The next two tests conducted were on all the Copperhead anterior strikes vs. all the Timber Rattlesnake anterior strikes and on all the Copperhead posterior strikes vs. all the Timber Rattlesnake strikes (Table 3). No significant difference was found for either with t statistics of .86 and .52 and p-values of .23 and .32, respectively.

Strike Location	Timber 1	Timber 2	Timber 3	Timber Totals	Copperhead 1	Copperhead 2	Copperhead 3	Copperhead Totals
Anterior	8	5	4	17	5	6	3	14
Posterior	1	1	5	7	3	8	1	12

Table 3: The comparison of anterior and posterior strike locations by individual snake.

The last t-test was conducted to see if there was a significant difference in the number of anterior strikes by the Timber Rattlesnake vs. the posterior strikes of the Timber Rattlesnake (Table 3). There was no significant difference in this data with a t statistic of 1.42 and a p-value of .14.

III. Hits Vs. Misses

As the project progressed, some of the strikes did not connect with the prey. These strikes were counted as misses (Table 4 and 5). A miss was still counted as a reliable data point if it contained two parameters. The strike had to be an “open-mouth-strike” and if there was clear video evidence where the strike would have landed. An “open-mouth-strike” was a strike where the snake fully opens its mouth with the intent to hit the prey. Clear video evidence must be present when recording misses as usable data points. If it was not possible to gauge where the strike would have hit the prey from the video, the strike would be thrown out and not used. Only if the strike fulfilled both of these parameters would it be used as a legitimate data point.

Snake	Hits	Misses
Copperhead 1	3	5
Copperhead 2	8	6
Copperhead 3	3	1
Timber 1	9	0
Timber 2	6	0
Timber 3	7	2
Totals	36	14

Table 4: The number of hits and misses for each individual snake.

Snake	Hits	Misses
Timber	22	2
Copperhead	14	12

Table 5: The total number of hits and misses for each snake species.

IV. Location of the Strike Based on Direction of Approach

The direction of approach was also recorded for each strike. This was classified as how the snake stuck the prey based on their approach. The snake could approach the prey from behind, from the side, or from the front. This was recorded to see if the approach had any impact on the strike location on the prey. The data (Table 6 and Figure 2) shows that the snakes preferred to strike the posterior when approaching from behind, and the anterior when striking from the front. There was no discernable difference in strike location when the prey was approached from the side.

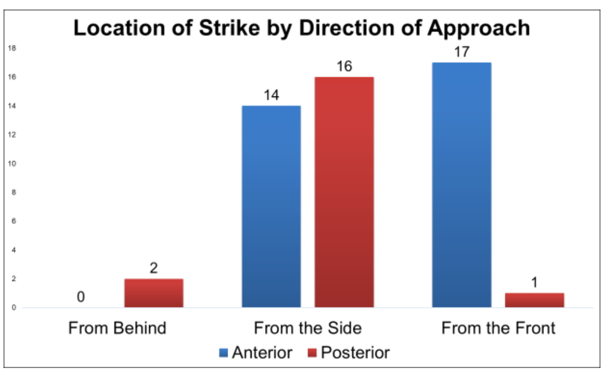

Figure 2: The location of the strikes, either anterior or posterior, based on how the snakes approached their prey.

Location	From Behind	From the Side	From the Front
Anterior	0	14	17
Posterior	2	16	1

Table 4: The location of the strikes, either anterior or posterior, based on how the snakes approached their prey.

Discussion

A total of 50 data points were collected over the 7-week study period. This amount was more than the amount that was expected due to some snakes striking their prey more than once on certain weeks. The total amount of 50 data points meant that a t-test could successfully be conducted. It was determined that there was no significant difference in any of the data that was tested. While there was no significant difference in any of the data that was tested, there was a visible numerical difference in the number of the strike locations between the Copperheads and Timber Rattlesnakes. The Timber Rattlesnakes had a total of 17 strikes on the anterior and 7 strikes on the posterior compared to the Copperheads which had 14 strikes on the anterior and 12 strikes on the posterior. The Timber Rattlesnakes struck the anterior area of their prey 70% of the time compared to 53% of the time for Copperheads. Ultimately, the Timber Rattlesnakes struck the anterior area more than Copperheads did, which is the opposite of what was expected.

It is important to discuss the matters of misses in the data. Misses were not super common in the Timber Rattlesnakes, only happening twice out of the 24 strikes. The Copperheads were affected more by misses. Copperhead 1 and 2 combined for 78% (11/14) of the total misses by all snakes. This was because Copperhead 1 was old and could not see very well, which impacted his ability to successfully strike his prey. Copperhead 2 was the youngest and thus was not as experienced with striking live prey as some of the other snakes were. Even though these two snakes accounted for a large number of misses between them, it is not thought that this would skew the data as all of the data were “open-mouth-strikes” and had clear video evidence of where the strike would have landed. Deciding what counted as clear evidence was a subjective measure as there was no numerical measure on what was “close enough” to be counted. Even though clear evidence was judged subjectively, there was a consistency in the subjectivity between each miss. Ultimately, these misses should not have had a large impact in skewing the results one way or the other.

One variable that was recorded that could have resulted in skewing the data was the direction of approach that each snake had before striking. It was sought to find if the direction of the approach would affect the snakes strike location. Of the 50 strikes, 2 were approached from the back, 30 were approached from the side, and 18 were approached from the front. Both of the strikes that were approached from the back resulted in strikes located on the posterior area of the prey. Of the prey that was approached from the side, 94% (17/18) resulted in strike locations on the anterior area of the prey. The surprising result out of these was the numbers for when the prey was approached from the side. When approached from the side, the snakes struck the posterior area of the prey 53% (16/30) of the time. All three of these results suggest that these snakes don’t strike based on their venom toxicity. Instead, the snakes strike based on what part of the body is closest to them; approaching from the back results in posterior strikes and vice versa. The surprise comes when they approach from the side. The nearly 50/50 split in strike location seems to suggest that the strike location is completely random rather than calculated by the snake based on the effectiveness of their venom. It does seem that strikes when approached from the front are skewed toward the anterior area of the body, but it is difficult to determine if this impacted the results of the project as it still was not enough to create a significant difference in the data.

Summary and Conclusion

The objective to record and analyze the number of strikes on different locations of prey was collected successfully. The hypothesis was that if venom toxicity had an impact on strike location, then the Copperhead species would strike at a higher rate towards the anterior area of their prey compared to the Timber Rattlesnake. This was thought because Copperheads have a higher LD50% than Timber Rattlesnakes do, and they would strike the anterior region at more for their venom to work effectively. This project was able to determine that there is no significant difference between strike location and venom toxicity in these two snake species. There is no known reason why this result was the case. It could be that the species of Timber Rattlesnake and Copperheads have LD50% that are not different enough to result in a significant difference, but if this were the case the Copperheads still should have struck the anterior area more than the Timber Rattlesnake. Strike location could also be completely random or be dependent on the direction of approach, or the specific species or individual being tested. The lack of scientific research on this topic makes it difficult to make educated guesses on the results of other tests that could be done similar to this. More research and testing would be required to truly conclude if a significant difference occurs between strike location and venom toxicity.

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