



Toxic Species in the Sonoran Desert: Perception vs. Reality

Do you know the difference between poison and venom? What desert species are you afraid of? You might be surprised what can actually harm you. Come learn about about the amazing species of the Sonoran Desert.

Toxic Species of the Sonoran Desert: Perception Vs. Reality

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Summary

Short Elevator Speech:

We are students from the University of Arizona with a goal to educate the public about toxic species of the Sonoran Desert. Our mission is to teach the difference between poison and venom. Residents of the Sonoran Desert should have the knowledge to determine what species can harm you and which species will not.

Long Elevator Speech:

We are students from the University of Arizona with a goal to educate the public about toxic species in the Sonoran Desert. Our mission is to teach the difference between venom and poison. Venom is a toxic that must be actively injected through a bite or a sting. Poison on the other hand is passive, meaning it must be ingested, inhaled or absorbed for its effects to be felt. Our focus is aimed on four species: the Sonoran Desert Toad, the Fly Agaric Mushroom, the Bark Scorpion, and the Arizona Blond Tarantula. We will discuss the use of toxins as a defensive mechanisms and how that gives a species an advantage over both predators and prey.

Target Audience

This workshop is geared towards children in grades 5 and up, however for adults we can offer more in-depth information on any of our target species through our background information. The activities for this workshop are for any age group, but younger audiences may be more interested to participate in them. We will try to actively engage adults through conversation and get them to ask us questions about the species.

Introduction

The Sonoran Desert is a vast area of roughly 120,000 square miles, stretching from southeastern California across southern Arizona, and extending south into Sonora, Mexico. This region has a large diversity of species and habitats. Surviving in the Sonoran Desert proves to be a challenge for many outsiders. It is an environment where temperatures can reach well over 100°F and those who are not well adapted may not survive. Both plant and animal species, found in the Sonoran Desert region, have specialized functions that allow them to survive. Defense mechanisms in particular are very important to animal life. Animals must eat and avoid being eaten. A defense mechanism gives prey an advantage against its enemies and increases their chance of survival. Adaptations that benefit an organism, such as chemical and physical defenses secure the species survival.

Specialized defense mechanisms aid in the protection of prey from predators. A specific type of defense mechanism involves the use of toxins to ward off predators. Often, there is confusion between whether a species is venomous or poisonous. A simple way to explain the difference between venom and poison is by looking at the method of action. A venomous species will inject a toxin through a bite or sting into your body while, a poisonous species will have a toxin that if touched or ingested will cause disturbances (Jadin 2009). The difference between venomous and poisonous is a common misconception among the general public.

The goal of this workshop is to educate the public on the difference between poisonous and venomous species and to raise general awareness about toxic species found in the Sonoran Desert. The concept of perception vs. reality will be explored through the use of specific examples of both venomous and poisonous species. The adaptation of toxins in species will also be discussed, primarily focusing on toxins as a defense mechanism.

Poison as a defense mechanism

In biological terms poison is referred to as a chemical substance that causes structural or functional disturbance when ingested, inhaled, or absorbed within the body (Dorland's Medical Dictionary 2010). Disturbances can range from mild discomfort to paralysis to hallucinations and in some cases death. Poisons acts as a passive defense mechanism because the species does not need a method of injection (Babb 2010). Poisonous species typically deliver toxins when harassed or ingested by other species.

An interesting example of a poisonous species found in the Sonoran Desert is the **Sonoran Desert Toad** or *Incilius alvarius* (Rorabaugh 2008). The Sonoran Desert toad is the largest toad native to North America, reaching up to 7 ½ inches long. As shown in the picture to the right, this toad has smooth leathery skin that is sparsely covered with pale orange warts. The skin color can range from a dark brown to olive or grayish green in color. The belly of the toad is cream colored and usually unmarked. The most identifying characteristic is the presence of large granular glands on the neck and limbs (Philips 2000). These glands secrete thick, milky-white, neurotoxin venom called bufotenine (Babb 2010). Bufotenine contains the chemical compound 5-MeO-DMT (5-methoxy-dimethyltryptamine), a highly potent hallucinogen (Clare 2009).



The poison is typically released when other animals harass the toad. Dogs are especially at risk of toad poisoning. A dog can suffer from toad poisoning if the toad sits in the dogs drinking water long enough. When ingested by dogs the poison is known to cause severe discomfort, paralysis, or even death (UA College of Pharmacy 2008). Pet owners who are unaware of the effects of toad poisoning should be aware of the common symptoms associated with toad poisoning.



Bufo alvarius (Sonoran Desert Toad/Colorado River Toad)
Poison emission demonstrated by Zookeeper
August 9th 2008

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<http://www.caudata.org>

Symptoms of toad poisoning, in dogs:

- Excessive salivation or foaming at the mouth
 - Head shaking, red or irritated gums
 - Drunken gait
 - Confusion
 - Weakness or complete collapse
 - Heart arrhythmia
 - Vomiting
 - Diarrhea
 - Pawing at the mouth
- (Philips 2000)

If you see your dog with a toad in its mouth, do not disregard it, you should:

- Rinse area with water
 - Run the water from one side of the mouth to the other to allow the toxic rinse water to run out of the mouth and not down your dog's throat.
 - If any unusual symptoms occur, take your dog to the veterinarian.
- (UA College of Pharmacy 2008)

Called the “psychedelic toad” this species has been abused by misguided recreational drug enthusiasts for its hallucinogenic capabilities (Clare 2009). When vaporized by heat and taken into the lungs in the form of smoke, the toxins from the Sonoran Desert toad are extremely hallucinogenic (Most 1983). 5-MEO-DMT, a chemical compound secreted in the poison, has ten times the relative potency of diethyl tryptamine (DMT), the popular synthetic psychedelic drug of the 1960's (Most 1983). Buffoteine is a Schedule 1 controlled substance in the United States. Possession of the toad is not a crime itself but if it can be shown that possession of this toad is with the intent to milk and smoke its poison then it is considered illegal (Arizona Game and Fish 2009).

The Fly Agaric Mushroom (*Amanita muscaria*) is a poisonous mushroom found in the Sonoran Desert. Mushrooms, also known as basidiomycetes, are fungi that can range from being completely edible to toxic and deadly. The fly agaric is a psychoactive mushroom containing poisonous toxins (Arkive). This fungus can be identified by its bright red cap measuring three to eight inches in diameter and anywhere from two to eight inches in height. The mushroom cap is usually bright red, but has been found in varying shades of brown, orange, yellow, and pink. The stem and gills are white in color. The



mushroom can be identified by the many pyramidal warts that are white to yellow in color sprouting from the mushroom's cap. After a heavy rainfall, the white spots on the mushroom cap can wash away leading to misidentification (Christianson).

Through adaptation, the fly agaric mushroom has adopted a system of toxic poison as a defense mechanism. Much energy must be expended in order to produce fruiting bodies; therefore natural selection has given rise to mushrooms containing poison. Wild animals and humans alike learn to avoid this fungus, as result of its undesirable side effects. Poison in the mushroom ensures that the species will survive (Volk).

The fly agaric mushroom contains two poisons that lead to hallucinations. Muscimol and Ibotenic acid are the psychoactive agents present in the mushroom. Erik Christianson explains that, "These chemicals act on the nervous system as neuropeptide receptors to induce the inebriating effect" (Christianson). Ibotenic acid is a highly potent neurotoxin that can cause brain lesions. Muscimol attacks the neurotransmitter responsible for fear, which causes victims of ingestion to experience a loss of the emotion fear (Volk).

Ingesting just one mushroom cap can be enough to cause symptoms. Symptoms of poisoning include nausea, drowsiness, sweating, hallucinations, mood changes, euphoria, relaxation, and loss of equilibrium. In very serious poisonings, seizures and/or coma can ensue. Fatal dosage is estimated at 15 mushroom caps, therefore it is highly unlikely for death to occur from the mushrooms if medical attention is given (Christianson).



Within our society, drugs are perceived with very negative connotations. Entheogen, better known as a hallucinogenic drug, has been used for many beneficial purposes throughout history. Ethnogen mycologist James Arthur explains that hallucinogenic drugs can, "expand consciousness, increase awareness of self, and initiate one into the spirituality of health" (Arthur). The fungus has been used in various cultures in a positive light, but there is still much taboo surrounding the use of mushrooms to get high. Although, some people perceive this mushroom as being helpful in accomplishing vision quests, great care should be taken when deciding to ingest wild mushrooms. James Arthur urges those who seek mushrooms for hallucinogenic purposes to ask an expert mycologist for help identifying mushrooms. A person could easily die from ingesting a misidentified mushroom that is more lethal than expected (Arthur).

Venom as a defense mechanism:

Venomous species differ from poisonous species because they inject their toxin through a bite or sting, this is considered an active mechanism. Arizona stands out from

the rest of the United States in that it has the largest diversity of venomous species. These species use their venom as either a defensive mechanism or for hunting their prey (Babb 2010). One of the most common venomous species in Arizona is the scorpion. There are around 90 species of scorpions in the United States and of those 40 to 60 species are found in Arizona. Two of the most common misconceptions about scorpions are that the bigger ones are more dangerous and all scorpion stings are life threatening, both of these statements are false. Size is not a factor when it comes to how dangerous a scorpion's sting will be and of all the species in the United States there is only one that is considered life-threatening, the **Bark Scorpion** or *Centrioides exilcauda* (Scorpions 2009).

Compared to most scorpions, Bark Scorpions (image on right) are small, growing only to an inch and a half as an adult. Their tail segments and pincers help to identify them from other scorpions because they are more slender (Scorpions 2009). This scorpion is most common in rocky areas but it also found under logs and tree bark. It stands out from other scorpions because of its ability to climb so they are the most commonly encountered scorpions in homes. Climbing also has given them the ability to hide in trees and on walls (Gouge 2010). They like cool and moist areas so they are usually hiding during the day, which according to the poison center is why the majority of stings that are reported happen during warm summer nights (Scorpions2009).



Scorpions have many adaptations that allow them to survive in the heat of the Sonoran Desert. They have “hairs” on their legs that can sense vibrations in the air to help them find their prey. During the day they will hide in shady areas and come back out at night to hunt. Most scorpions are solitary creatures, however in the winter, the Bark scorpion often hibernates in large groups of 20 to 30 scorpions (Animal Fact Sheet 2010). The majority of scorpions live about two to six years, however they can live much longer. The females give live birth to on average 25 young, which will crawl onto her back (see photo below) and stay there until their first molt in 7 to 21 days. To reach adulthood they usually molt 5 to 6 times over a course of 2 to 6 years (Animal Fact Sheet 2010).

The first defensive instinct of scorpions is to run and hide, however they will sting and use their venom if necessary. Scorpions can control the flow rate of their venom so the severity of stings can vary. The venom is a mixture of neurotoxins and other substances that can cause a variety of signs and symptoms (Gouge 2010). Their sting only produces minimal swelling in humans, if any at all, but it can cause severe pain, numbness and tingling in the sting area. The area may also become very sensitive to any touch or pressure. Others severe signs in humans include muscle twitching, convulsions, frothing at the mouth and difficulty breathing (Scorpions 2009). There is an antivenin

available but it is only used in the most severe cases, such as in children under 5 years of age. However any patient who is experiencing severe symptoms should seek medical help immediately. In the majority of cases from healthy adults there are some first-aid techniques that can be used for minor stings, such as cleaning the area with soap and water, using a cool compress and elevating the area to about heart level. For pain, aspirin or Tylenol is recommended (Scorpions 2009).

In dogs and cats, the severity of a scorpion sting often depends on the size of the pet and the type of scorpion. Even for pets the Bark Scorpion is still the most dangerous species to be stung by. In dogs the most common signs after they were stung included yelping, limping and pawing or licking the wound. In some cases there are more serious symptoms such as tremors and problems breathing. Cats experienced the same common signs as those in dogs, however one of the more severe reactions that is seen in only cats is roving eye movements (Boesen 2010).



A second venomous species of the Sonoran Desert is the **Arizona blond tarantula** (*Aphonopelma chalcodes*). Many people experience arachnophobia, more commonly known as the fear of spiders. Many spiders can be harmful to humans through different variations of venom. Tarantulas, on the other hand, have venom that is impotent to humans. For this reason, tarantulas can be kept as pets. The Arizona blond tarantula is a spider specifically found in regions dominated by saguaro cacti. The female tarantula has a tan color, where it derives the blond in its name. The male has black legs, a tan cephalothorax, and a red abdomen. Tarantulas must molt once a year to push out their exoskeleton. During this time, a tarantula can be extremely vulnerable. The Arizona blond tarantula is a large tarantula species and can be three to four inches in size when fully mature (Phillips 2000).



This spider uses venom in order to capture and eat prey. The tarantula uses its venom to liquefy its prey and begin the digestion process, as it does not have any teeth. They feed on small insects such as grasshoppers, beetles, and small spiders (Tarantula Fact, 2008). Its venom is very weak, and is not harmful to humans, unless the person has an allergy to the spider's venom. The book, A Natural History of the Sonoran Desert explains,

“In Arizona, only the widows and the brown spiders have venom dangerous to people. Other species may bite and cause some local swelling, but unless one is allergic to the venom, no medical attention is necessary.” (Philips 2000).

Also, the Arizona blond tarantula uses “urticating hairs”, which are tipped with barbs. The tarantula uses these hairs as a defense mechanism when bothered. These barbs are pushed into the face or paw of its predator (Tarantula Fact, 2008).

As opposed to many of the other species explained, the tarantula cannot harm humans as their venom has a low potency level. Society’s common perception of spiders involves fear. In the tarantula’s case, this is a friendly spider to humans and they can even be kept as pets. Comparing the Sonoran Desert Toad and the Arizona Blond Tarantula, it is likely that most people will fear the tarantula. In this sense more awareness can be promoted through teaching the public about these species. In the UK, videos of tarantulas have been used to help cure arachnophobia (Gizmodo, 2010). It seems likely that many people could overcome their fears with more education and awareness.

The species mentioned above are just a sample of the wide variety of toxic species found in the Sonoran Desert. The reason why we chose to focus on these four is because we personally found the species interesting and have had little previous knowledge of the species. There are many other species found in the Sonoran Desert that are either poisonous or venomous. In our workshop we discuss additional poisonous species such as the Mexican bird of paradise, the agave cactus, and lantana. For the venomous species we discuss the Arizona brown spider, the coral snake, and the Gila monster.

Workshop Abstract

The goal of our presentation is to create awareness about how the species of the Sonoran Desert use toxins and which species to be cautious of. We want to specifically focus on the difference between venom and poison. Often, people living in the desert are scared of species that may not be harmful and neglect those which are. Many don't realize what species can actually be dangerous to them. This workshop will raise awareness about some of the toxic species in the desert so that the general public can take precautions when encountering these species. The species we have chosen to highlight in our presentation are those that commonly have many misconceptions, such as scorpions, mushrooms, tarantula and toads. The concept of perception vs. reality will be explored through the use of specific examples of both venomous and poisonous species such as the Bark Scorpion, the Fly Agaric Mushroom, the Blond Tarantula and the Sonoran Desert Toad.

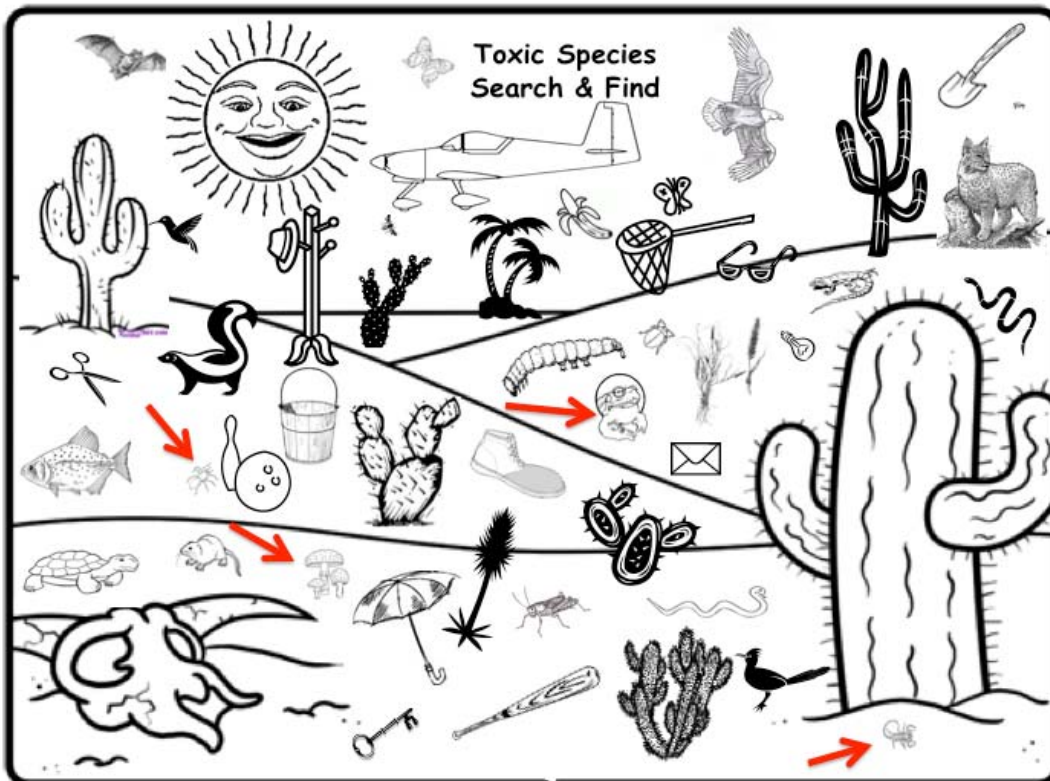
Workshop Activities

I. Poisonous vs. Venomous: Which one am I?

For this activity we have several pictures of various species found in the Sonoran Desert. The species will include both poisonous and venomous species and will also include other species that are neither. Individual pictures will be printed with information written on the back of each photo. Ideally the pictures should be laminated with Velcro on the back. The audience will be able to pick up the pictures and Velcro them, to a board, under three categories, poisonous, venomous, and neither. If they get them all correct they will receive a small prize (i.e. candy), if they do not get them correct then it will be another opportunity to start a conversation about the species that they misidentified.

II. Toxic Species Search & Find

This activity is mainly geared towards younger children. For this activity a search and find worksheet was created. The worksheet includes species found in the Sonoran Desert and also includes other random objects and animals. The goal of the worksheet is to find and identify the toxic species that we discuss in our presentation. Individual search and find worksheets will be printed so that children can use crayons to circle the toxic species and also color the picture. There are only four toxic species, that we are looking for, however there is a combination of random objects and desert wildlife included in the search and find that may be related to other presentations. Children can also try to identify the other animals that are found in the Sonoran Desert and will also be able to find and circle what “doesn’t belong”. An example of the toxic species search and find can be seen below.



III. Species Examples


For the presentation a live Arizona Blonde Tarantula was used. We also used a preserved Sonoran Desert Toad and an example of the Bark Scorpion. A model of the Fly agaric mushroom was built as a visual aid for the audience. With these examples people will be able to pick up and observe each species from a closer view.

IV. Pamphlets

On the University of Arizona’s website under on the Pharmacy webpage is a pamphlet that has information on Arizona’s Poison and Drug Information Center. This pamphlet explains what to do if you come in contact with poisonous plants. The pamphlet also includes first aid information. This pamphlet should be printed and available at the presentation site for people to look at and take home. The link provided below will take you directly to the online pamphlet.

http://www.pharmacy.arizona.edu/outreach/poison/documents/poisonplant_sbroch.pdf

V. Poster




Ecology & Evolutionary Biology

Toxic Species of the Sonoran Desert:


Perception vs. Reality

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Venomous species

Bark Scorpion



- One of the smallest species of scorpions.
- Very slender tail & pincers
- Size does not affect sting potency.
- Only species that is considered life-threatening in the U.S.


Arizona Blond Tarantula



- Venomous spider, that uses venom to kill prey
- Not harmful to humans
- Found in areas with Saguaro Cacti.

Poison vs. Venom: What's the difference?


VENOM = ACTIVE



Venomous:

Toxin is stored internally then injected through a bite or sting. Venom is used for prey-immobilization, predigestion, and defense.

POISON = PASSIVE



Poisonous:

Toxin is usually secreted through the skin and causes structural or functional disturbance when ingested, inhaled, or absorbed.

Toxins as a Defense Mechanism

A defense mechanism: gives prey an advantage against its predators and increases their chance of survival. A specific type of defense mechanism involves the use of chemical toxins to ward off predators. Toxins can be either venom or poison.

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http://www.desertmuseum.org/books/nhsd_desert_toad.php


<http://www.desertmuseum.org/kids/oz/long-fact-sheets/tarantula.php>

http://botit.botany.wisc.edu/toms_fungi/dec99.html

<http://ag.arizona.edu/academicprograms/spotlight/venomous-poisonous-animals-arizona-quick-reference>

Poisonous Species


Sonoran Desert Toad



Parotoid Gland

- Toxins released from glands in skin.
- Predators intoxicated through mouth, nose or eyes.
- Identifying characteristic is presence of large granular glands on neck and limbs

Fly Agaric Mushroom



- Psychoactive toxins that can cause hallucinations.
- Identified by the pyramidal warts that are white to yellow sprouting from cap.

Materials

- Table
- Crayons
- Picture of Toxic Species Search and Find
- Board game for poison vs. venom identification, including pictures of other venomous or poisonous species as well as species that are neither.
- Live specimen with containers
- Candy
- Budget for printing and laminating

Beyond the Activity

This workshop is designed to make science appealing to adults and children; they will learn about some of the toxic species commonly encountered in Arizona. The topics that we cover through this presentation are just a small portion of a much larger ecological picture. We offer a brief introduction to one of the many different types of defense mechanisms that are used by the species of the Sonoran Desert. By learning about one of the defense mechanisms we hope our audience will be encouraged to explore some of the others, such as coloration, mimicry or physical combat. For teachers, this workshop is a great way to introduce information in a fun manner that will help the students start to explore other aspects of ecology. This workshop could also serve as an introduction to learning about other species that live in the Sonoran Desert such as rattle snakes, javelina or even hummingbirds. The goal of the perception vs. reality topic is to get people to start asking more questions about the species that are around them and learn how much of it is fact or misconceptions. Most importantly, we hope that our listeners will have a greater appreciation for the Sonoran Desert and the species that inhabit it. For those who are particularly interested in learning more about our topic, a brochure is available for them take home that expands on some of the information we talked about.

Assessment

This workshop is designed to engage listeners and encourage individuals to actively participate in the learning process. Educational goals will be achieved by presenting information that will encourage the audience to want to ask questions about the species on display. With the activities a small prize, such as candy, will be awarded to those who answer questions or participate, which may also encourage others to do the same. Our activities are designed in a way that will quiz the audience on the information that we have discussed during the presentation and be fun at the same time.

Toxic Species Summary Evaluation and Recommendations

Some of the best ways to get people interested in a workshop is through the use of living examples of the species that you are presenting. For the people hesitant to talk to us, this defiantly draws them in. Those already interested in talking to us get more excited and involved with the use of a live animal. When presenting at Flandrau, many students said that the tarantula wasn't as scary as they thought it was. This was a great success considering that was our goal in using the tarantula in our presentation. Live species engage people to start asking questions because many are naturally curious to learn more.

The game board worked well for some and not for others. For those who were more willing to participate in our presentation had fun doing our game board and testing themselves. For the people who didn't want to do it, but were curious about the pictures displayed on it, it was a great talking point and a way to get them to ask questions and make comments. Some people did seem a bit confused by the pictures and when they were out of order. It would be beneficial to somehow make the game more clear. At Flandrau, this worked extremely well as it got the kids involved and the game was used to test their knowledge. At the end of the game board activity, many students actually understood the difference between poison and venom. Overall, this was a good tool to implement in our workshop.

For anyone presenting this workshop, the best way to proceed is through studying the species involved and interacting with these species. The use of personal experiences in the workshop is very helpful in promoting more conversation with the public.

In terms of presenting, it was really nice to have a scheduled group of children to talk to as opposed to people strolling by. The best presentation by far was at Flandrau because the setting promotes learning. Whereas at Biosphere 2 and the Desert Museum people stopping by seemed less interested. The use of more scheduled workshops could be beneficial in the future.

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Glossary

5-MeO-DMT (5-methoxy-dimethyltryptamine)- Powerful psychedelic compound found in many plant and toad species.

Adaptations- A form or structure that has been modified to allow an organisms to better survive in its environment.

Arachnophobia- Fear of spiders

Arthropod- An invertebrate that has an exoskeleton, segmented body, and jointed appendages.

Basidiomycetes- Any of a group of fungi in the phylum basidiomycota in the Fungi Kingdom.

Bufotenine- A toxic hallucinogenic obtained from poisonous secretions from toads and some mushrooms.

Cephalothorax- In arachnids the anterior portion of their body, consisting of the head and thorax.

Diversity- Variety or multiformity

Diethyl Tryptamine (DMT)- A popular synthetic psychedelic drug of the 1960's

Ethnomycologist- A person who studies the historical uses and sociological impact of fungi.

Hallucinogen- A substance that causes hallucinations.

Herpetologist- A branch of zoology that deals with reptiles and amphibians

Ibotenic Acid- A highly potent neurotoxin acid that can cause brain lesions

Muscimol- A psychoactive compound found in many species of mushrooms.

Neurotoxin- A natural substance that can interfere with the electrical activity of nerves and prevents them from functioning properly.

Poison- A chemical substance that causes structural or functional disturbance when ingested, inhaled, or absorbed within the body

Psychoactive- A substance that has profound effects on mental processes.

Schedule 1 controlled substance- A drug or substance that has a high potential of abuse

and no current medical use in the United States.

Toxin- A poison produced by an organism (plant or animal).

Urticating hairs- Hairs that are found in plants and invertebrates that cause a stinging or prickling sensation.

Venom- A fluid secreted by certain species and transmitted by a bite or sting.