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Mexican Red Kneed Tarantula (*Brachypelma smithi*) CARE MANUAL

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ASSOCIATION OF ZOOS & AQUARIUMS

Mexican Red Kneed Tarantula (*Brachypelma smithi*) CARE MANUAL

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Disclaimer: This manual presents a compilation of knowledge provided by recognized animal experts based on the current science, practice, and technology of animal management. The manual assembles basic requirements, best practices, and animal care recommendations to maximize capacity for excellence in animal care and welfare. The manual should be considered a work in progress, since practices continue to evolve through advances in scientific knowledge. The use of information within this manual should be in accordance with all local, state, and federal laws and regulations concerning the care of animals. While some government laws and regulations may be referenced in this manual, these are not all-inclusive nor is this manual intended to serve as an evaluation tool for those agencies. The recommendations included are not meant to be exclusive management approaches, diets, medical treatments, or procedures, and may require adaptation to meet the specific needs of individual animals and particular circumstances in each institution. Commercial entities and media identified are not necessarily endorsed by AZA. The statements presented throughout the body of the manual do not represent AZA standards of care unless specifically identified as such in clearly marked sidebar boxes.

Table of Contents

Introduction

Preamble

AZA accreditation standards, relevant to the topics discussed in this manual, are highlighted in boxes such as this throughout the document (Appendix A).

AZA accreditation standards are continuously being raised or added. Staff from AZA-accredited institutions are required to know and comply with all AZA accreditation standards, including those most recently listed on the AZA website (http://www.aza.org), which might not be included in this manual.

Taxonomic Classification

Table 1. Taxonomic classification for Mexican red kneed tarantula

Classification	Taxonomy	Additional information
Kingdom	Animalia	
Phylum	Arthropoda	
Class	Arachnida	
Order	Areneae	
Suborder	Mygalomorphae	
Family	Theraphosidae	

Genus, Species, and Status

Table 2. Genus, species, and status information for Mexican red kneed tarantula

Genus	Species	Common Name	USA Status	IUCN Status	AZA Status
Brachypelma	*smithi*	Mexican Red-kneed tarantula	CITES Appendix II	Near Threatened	Yellow Program

General Information

The information contained within this Animal Care Manual (ACM) provides a compilation of animal care and management knowledge that has been gained from recognized species experts, including AZA Taxon Advisory Groups (TAGs), Species Survival Plan® Programs (SSPs), Studbook Programs, biologists, veterinarians, nutritionists, reproduction physiologists, behaviorists and researchers. They are based on the most current science, practices, and technologies used in animal care and management and are valuable resources that enhance animal welfare by providing information about the basic requirements needed and best practices known for caring for ex situ *Brachypelma smithi populations. This ACM is considered a living document that is updated as new information becomes available and at a minimum of every five years.*

Information presented is intended solely for the education and training of zoo and aquarium personnel at AZA-accredited institutions. Recommendations included in the ACM are not exclusive management approaches, diets, medical treatments, or procedures, and may require adaptation to meet the specific needs of individual animals and particular circumstances in each institution. Statements presented throughout the body of the manuals do not represent specific AZA accreditation standards of care unless specifically identified as such in clearly marked sidebar boxes. AZA-accredited institutions which care for Brachypelma smithi must comply with all relevant local, state, and federal wildlife laws and regulations; AZA accreditation standards that are more stringent than these laws and regulations must be met (AZA Accreditation Standard 1.1.1).

AZA Accreditation Standard

(1.1.1) The institution must comply with all relevant local, state, and federal laws and regulations, including those specific to wildlife. It is understood that, in some cases, AZA accreditation standards are more stringent than existing laws and regulations. In these cases the AZA standard must be met.

The ultimate goal of this ACM is to facilitate excellent Brachypelma smithi management and care, which will ensure superior Brachypelma smithi welfare at AZA-accredited institutions. Ultimately, success in our Brachypelma smithi management and care will allow AZA-accredited institutions to contribute to Brachypelma smithi *conservation, and ensure that Brachypelma smithi are in our future for generations to come.*

General Information

Caring for any animal is more of an art than a science. What works for one keeper may not necessarily work for another. This may be based on unnoticed nuances, local climate or weather patterns, the personalities of the individual animals, or other minute details. This is a basic husbandry and breeding guide to the Mexican red knee tarantula (*Brachypelma smithi*). Any more specifics will have to be discovered personally or discussed with colleagues. Where many vertebrates have been kept in captivity for centuries a lot of invertebrates are relatively new to the husbandry world. Even though humans have kept and captive bred many tarantulas for decades; keepers and hobbyists around the world are still discovering new husbandry techniques and new species to keep every year.

The Mexican red knee tarantula (*Brachypelma smithi* (F. O. Pickard-Cambridge, 1897)) is a species of robust spider. The genus is found only in Southern North America and Central America; primarily Mexico to Panama (Valerrio 1980; Smith 1994). *Brachypelma smithi* is found along the Western faces of the Sierra Madre del Sur and Sierra Madre Occidental mountain ranges in Mexico. This terrestrial species rarely leaves the comfort of its burrow in the wild. Their burrows can be found near rocks or at the base of vegetation (Lockt, 1999). Mature males will participate in an annual migration to find willing partners but females and immature specimen stay relatively stationary.

Like all arachnids, *Brachypelma* are characterized by two body segments and eight legs. Their fangs are oriented vertically, grouping them into the Suborder Mygalomorphae. The Mexican red kneed tarantula sports a black abdomen covered by brown/ red hairs. The cephalothorax is also black with a khaki colored ring. The *Brachypelma smithi* is renowned for the bright orange to red-orange splashes of color on their patella; they may also sport smaller patches of color on the legs below the patella (Gurley, 1993).

New World tarantulas are notorious for their ability to discharge urticating hairs. When the spider feels threatened it may scrape the back of its abdomen and flick a cloud of microscopic needles that is capable of causing pain and discomfort to those that are easily irritated. *Brachypelma* are generally mild mannered and do not always respond to disturbances by flicking hairs or displaying a threat posture. The venom is an insect specific neurotoxin (Zhong, Y., Song, B., Lu, Q., et al., 2014). However, it can cause pain and discomfort similar to a bee sting.

The tarantulas of the genus *Brachypelma* are long-lived. The males reach maturity in 3-7 years, living only one year or less after the last molt. The females however, reach maturity in 4-10 years, and then are capable of living another decade or two (Locht, 1999).

The *Brachypelma* species from the west coast of Mexico are particularly docile and colorful. These traits have led to their being collected in large numbers for the pet trade. The destruction of the natural habitat and the high mortality before sexual maturity (99%) (Baerg, 1958) are two factors that affect the populations of these species, and combined with the illegal trade that normally involves the capture of pre-adult and adult tarantulas, can cause the extinction of these tarantulas. To regulate this trade and prevent their endangerment, all the species of this genus have been listed in appendix II

of CITES (Locht, Yanez and Vazquez 1999). The IUCN lists the Red Knee tarantula as a Near Threatened species.

Mexican red kneed tarantulas are widely used as educational ambassadors within many AZA facilities. Although being a long lived species, precautions were needed in order to keep this species in collections. Captive reproduction for this genus is common in the private tarantula hobby. However, this species is rarely bred in AZA institutions. In 2007 the Mexican red kneed tarantula became an AZA managed program within the Terrestrial Invertebrate Taxon Advisory Group.

Chapter 1. Ambient Environment

1.1 Temperature and Humidity

Mexican red kneed tarantulas are a subterranean species. With the deserts of Mexico exceeding 110°F, the tarantulas survive this heat by retreating underground. The burrow of a tarantula acts as temperature and desiccation buffer in the wild. The key to successfully maintaining and displaying all tarantulas is to remember their microhabitat. The closer the keeper can replicate the tarantula's burrow in their enclosure the more success they can expect. The tarantulas spend the majority of their lives in their burrows, only to venture out for food and potential mates when the temperatures have dropped. Ambient air temperatures within the tarantula's enclosure should range from the lower to mid-80°F. *Brachypelma* can be comfortably kept at this temperature during their entire life cycle, from first instar to adult. If external heat is needed to maintain temperatures, caution should be used. Lights and heat pads can cause small containers to overheat and potentially lead to fatalities. Placing heat pads on one section of an enclosure can allow the tarantulas to thermo-regulate as needed. If a light is used as a heat source care must be taken to make sure a low wattage bulb is used and temperatures within the enclosure is monitored. As with a heat pad, place the light to one side of the enclosure so that the tarantula can regulate its temperature. Be aware that heat light bulbs are also capable of sapping the ambient humidity in a habitat and desiccating it.

AZA Accreditation Standard

(1.5.7) The animals must be protected from weather, and any adverse environmental conditions.

Many keepers attempt to replicate the Mexican desert habitat and keep their animals too dry. This will cause the tarantula to visibly shrivel and have terrible molts. A sign of dehydration to be aware of is if the tarantula is curling its tarsi inwardly and is lethargic. Keep them moist but not wet. A good rule of thumb is to squeeze the substrate; if any water drips from your hand it is too wet but your hand should be moist. Potted plants also help with the hydration of the soil. If the plants are wilting, it is too dry. If the soil becomes saturated the plants will help remove some water. Humidity can also be maintained by adding a small water dish. Adding something to break the water surface, like a stone, will allow prey items an escape without drowning. Spritzing the habitat with water will also help raise the ambient humidity.

AZA Accreditation Standard

(10.2.1) Critical life-support systems for the animals, including but not limited to plumbing, heating, cooling, aeration, and filtration, must be equipped with a warning mechanism, and emergency backup systems must be available. All mechanical equipment must be kept in working order and should be under a preventative maintenance program as evidenced through a record-keeping system. Special equipment should be maintained under a maintenance agreement, or a training record should show that staff members are trained for specified maintenance of special equipment.

Only if captive propagation is desired should a change in temperature, photoperiod, and humidity be necessary.

The animals must be protected from weather, and any adverse environmental conditions. (AZA Accreditation Standard 1.5.7). Animals not normally exposed to cold weather/water temperatures should be provided heated enclosures/pool water. Likewise, protection from excessive cold weather/water temperatures should be provided to those animals normally living in warmer climates/water temperatures.

AZA institutions with exhibits which rely on climate control must have critical life-support systems for the animal collection and emergency backup systems available, while all mechanical equipment should be included in a documented preventative maintenance program. Special equipment should be maintained under a maintenance agreement or records should indicate that staff members are trained to conduct specified maintenance (AZA Accreditation Standard 10.2.1).

1.2 Light

Tarantulas spend a majority of their lives underground. Males only emerge during the monsoon season to find suitable mates. Because they are almost completely fossorial special lighting requirements are not necessary. However, light that is too intense may stress spiders that are not capable to escape it. Always offer a dark retreat for the tarantula to feel secure. A normal light cycle of 12 hours on and 12 hours off is acceptable.

When captive breeding is desired the photoperiod should be adjusted to match the natural light cycle.

Careful consideration should be given to the spectral, intensity, and duration of light needs for all animals in the care of AZA-accredited zoos and aquariums.

1.3 Water and Air Quality

Clean water bowls are not necessary for all tarantulas, although they may be occasionally used. Most fluid is acquired from the tarantula's prey and the ambient humidity of the environment. A standing water source is dangerous to small tarantulas which may drown in them. Instead light misting will allow for water droplets to accumulate so that the tarantula can drink. A common misconception about tarantula hydration is that they must drink from a sponge. This is untrue and more detrimental than beneficial. The sponge will become laden with bacteria and a tarantula is unlikely to drink from a sponge to begin with. However, it is a good idea to place a small stone or plastic plant in the bowl to allow for prey or even small tarantulas that may fall in to escape.

Air quality is not an issue. Respiration is much lower than many other animals. Make sure to not keep the spiders in air tight containers. A soldering gun or drill with a small bit can be used to poke holes in any habitat cages. Conversely, don't poke so many holes that you reduce the humidity. The environment where the containers are housed will dictate how many holes should be drilled. If it is a humid room, more holes are fine. If it's a dry room, fewer holes will help retain humidity.

AZA-accredited institutions must have a regular program of monitoring water quality for aquatic animals and a written record must document long-term water quality results and chemical additions (AZA Accreditation Standard 1.5.9). Monitoring selected water quality parameters provides confirmation of the correct operation of filtration and disinfection of the water supply available for the collection. Additionally, high quality water enhances animal health programs instituted for aquatic collections.

AZA Accreditation Standard

(1.5.9) The institution must have a regular program of monitoring water quality for fish, pinnipeds, cetaceans, and other aquatic animals. A written record must be maintained to document long-term water quality results and chemical additions.

1.4 Sound and Vibration

Almost all terrestrial arthropods are covered in tiny, atmosphere-sensing hairs called setae. These are sensitive to loud noises and vibrations. Tarantulas generally don't seem to mind average vibrations. Unless it is a female holding an egg sac no great care needs to be taken to reduce average noise level.

Consideration should be given to controlling sounds and vibrations that can be heard by animals in the care of AZA-accredited zoos and aquariums.

Chapter 2. Habitat Design and Containment

2.1 Space and Complexity

When keeping tarantulas in captivity it is important to remember to replicate their natural history. From first instar to adult *Brachypelma smithi* rarely leave their burrows. Not only do they not require much space but it can actually stress the animal out. Young tarantulas feed, molt, and grow exceptionally well in dram vials and deli cups. Adults can be housed in something no smaller than a 12 quart plastic “shoe box” container.

Design of the habitat should allow for ~50% of the exhibit to be an open/ flat area, this can be used to capture prey, reproduce, or molt. ~25% should be dedicated to hiding areas, such as PVC pipes appropriately cut and buried under substrate, coconuts cut in half, etc work well for spiders to hide under. The other ~25% should allow for miscellaneous furniture, live plants, logs, and a water bowl if desired.

AZA Accreditation Standard

(1.5.1) Animals should be presented in a manner reflecting modern zoological practices in exhibit design, balancing animals’ functional welfare requirements with aesthetic and educational considerations.

Substrate is an essential component to a fossorial animal’s habitat. Ideally, the soil should mimic the natural environment as much as possible. However, there are a few factors to be considered. Ensure that the soil will retard bacterial or fungal growth, that there is enough drainage so that it doesn’t remain saturated and become anaerobic, and that it isn’t abrasive to the sensitive abdomen or tarsi.

A general recipe is composed of ~50% cocofiber, ~25% fine-coarse sand, ~25% top soil by volume. Cocofiber is an excellent base for most terrarium substrates. It is made of finely shredded coconut husks and comes dehydrated in bricks. Cocofiber works exceptionally well at hindering mold growth, it retains water, and it doesn’t decay like other organic material. Sand adds more substance and allows water drainage. Top soil helps the soil stick together, this is valuable if you want to let your tarantula dig its own burrow or you desire some geological features in the terrarium. Mix these three components in a bucket before adding it to your cage. This is a general guideline; common sense will come into play since the ingredients can be different from one location to another. The ideal soil should be able to retain some moisture and when squeezed in the hand should clump like the consistency of clay. If the substrate is too powdery or crumbles this will cause burrows to collapse and features in the tank to erode away. Keeping *Brachypelma* on rough gravel or large rocks will abrade the abdomen and could cause serious damage. Be creative when working with your soil and you can easily match the tarantula’s natural habitat for display purposes. Sprinkle dried leaves or sand on the surface for aesthetics if necessary.

AZA Accreditation Standard

(1.5.2) All animals must be housed in enclosures and in appropriate groupings which meet their physical, psychological, and social needs. Wherever possible and appropriate, animals should be provided the opportunity to choose among a variety of conditions within their environment. Display of single specimens should be avoided unless biologically correct for the species involved.

It is beneficial to allow a drainage layer beneath the soil. This will help keep the substrate moist but not overly saturated and can add a reservoir if the soil becomes too dry. Placing 2” layer of aquarium

gravel or Hydroton clay balls at the bottom of the terrarium and laying fiberglass screen mesh over it is the easiest way to construct a drainage layer. The mesh reduces the amount of soil that will settle into the gravel.

"Living soil" is a relatively new concept to tarantula keeping. This technique was adopted from the marine reef keepers and dart frog enthusiasts that utilize numerous organisms to help break down waste in their aquariums. Instead of hermit crabs and snails the tarantula terrarium can employ isopods, collembula, and other micro-fauna. This works particularly well in planted terrarium. These organisms will help break down uneaten prey, spider boluses, and feces into excellent plant food. Off exhibit, a 12 quart shoe boxes can house hardy plants with lower light levels. Each holding tank can be seeded from established exhibits. This living soil greatly reduces the need to strip the exhibit out for a thorough cleaning. This technique helps create a microcosm in the terraria which will quickly break down organic material before it rots, this may reduce potentially dangerous fungal, nematode, or bacterial outbreaks.

Careful consideration should be given to exhibit design so that all areas meet the physical, social, behavioral, and psychological needs of the species. Animals should be presented in a manner reflecting modern zoological practices in exhibit design (AZA Accreditation Standard 1.5.1). All animals must be housed in enclosures and in appropriate groupings that meet their physical, psychological, and social needs. (AZA Accreditation Standard 1.5.2).

AZA Accreditation Standard

(11.3.6) In areas where the public is not intended to have contact with animals, some means of deterring public contact with animals (e.g., guardrails/barriers) must be in place.

The same careful consideration regarding exhibit size and complexity and its relationship to the Brachypelma smithi *overall well-being must be given to the design and size all enclosures, including those used in exhibits, holding areas, hospital, and quarantine/isolation (AZA Accreditation Standard 10.3.3). Sufficient shade must be provided by natural or artificial means when sunlight is likely to cause overheating or discomfort to the animals (AZA Accreditation Standard 10.3.4).*

2.2 Safety and Containment

Mexican Red kneed tarantula are solitary by nature and should be housed the same way. The size of the tarantula will dictate the size of their holding. No matter the size of the container, three elements must be taken into account:

- Substrate must be non-abrasive
- Appropriate ventilation
- Tight fitting or securable lid

Tarantulas do not necessarily have to be inspected on a daily basis. On that note, disturbing them and their habitat too often could stress them out. This is particularly true for recent acquisitions, young spiders, or gravid females. A commonly practiced protocol is to do a visual check of the spider cage every day. Whether or not the tarantula is on display or in back-holding simply checking through the glass without opening the display works well. When doing a rudimentary inspection temperature, humidity, and health of the spider should be checked. 2-3 times a week the cage should be opened and assessed; a good practice is every Monday, Wednesday, and Friday. During this time the water bowl should be refilled, a light misting could be performed if necessary, and a prey item or two can be offered.

Animal exhibits and holding areas in all AZA-accredited institutions must be secured to prevent unintentional animal egress (AZA Accreditation Standard 11.3.1). Pest control methods must be administered so there is no threat to the animals, staff, and public (AZA Accreditation Standard 2.8.1). Exhibit design must be considered carefully to ensure that all areas are secure and particular attention must be given to shift doors, gates, keeper access doors, locking mechanisms and exhibit barrier dimensions and construction. Exhibits in which the visiting public is not intended to have contact with animals must have a guardrail/barrier that separates the two (AZA Accreditation Standard 11.3.6).

AZA Accreditation Standard

(11.2.4) All emergency procedures must be written and provided to staff and, where appropriate, to volunteers. Appropriate emergency procedures must be readily available for reference in the event of an actual emergency.

Emergency drills should be conducted at least once annually for each basic type of emergency to ensure all staff is aware of emergency procedures and to identify potential problematic areas that may require adjustment. These drills should be recorded and evaluated to ensure that procedures are being followed, that staff training is effective and that what is learned is used to correct and/or improve the emergency procedures. Records of these drills should be maintained and improvements in the procedures duly noted whenever such are identified (AZA Accreditation Standard 11.2.5). AZA-accredited institutions must have a communication system that can be quickly accessed in case of an emergency (AZA Accreditation Standard 11.2.6).

AZA Accreditation Standard

(11.2.6) The institution must have a communication system that can be quickly accessed in case of an emergency.

Chapter 3. Shipping and Transport

3.1 Shipping Preparations and Procedures

AZA Accreditation Standard

(1.5.11) Animal transportation must be conducted in a manner that is safe, well-planned and coordinated, and minimizes risk to the animal(s), employees, and general public. All applicable local, state, and federal laws must be adhered to. Planning and coordination for animal transport requires good communication among all involved parties, plans for a variety of emergencies and contingencies that may arise, and timely execution of the transport. At no time should the animal(s) or people be subjected to unnecessary risk or danger.

The most common way to move tarantulas from one zoo or breeding facility to another is shipping them through a courier service. This can be a stressful and detrimental experience if not done properly. Luckily, there are tested and tried methods that are overwhelmingly successful.

Begin by deciding on a proper courier. If shipped within the United States there are no federal regulations restricting the movement of any tarantula from state to state. *Brachypelma smithi* are a CITES II listed species so cannot be shipped internationally without special permits from Fish & Wildlife. Individual shipping companies may have issues shipping live animals however. Check with your zoo's policies and/or registrar before deciding how to ship. The most convenient way for most hobbyists to move spiders is using a third party insured company; ShipYourReptiles.com or ReptilesExpress.com use FedEx to transport packages. Follow the simple instructions on their websites to properly label your box. Always ship next day delivery, using Priority or First Class is also recommended. Do not ship after Wednesday in the week because of the chance of a delay. If you ship on a Thursday for a Friday delivery and there is a problem the spider may be stuck in a warehouse until the following week.

When preparing to package your spider keep in mind that too much space in the container can be detrimental. Keep everything snug so if the package is jarred or shaken the spider won't sustain injury. Begin by finding an appropriate sized Tupperware container. Line the interior of the container with soft paper towels, replicate a burrow. Roll lengths of paper towel into padding for the walls. Lightly mist the paper towels to keep the spider hydrated during the shipment (Figure 1, 2, 3)

Figure 1

Figure 2

Figure 3

Coax the tarantula into the container and make sure it is comfortably snug around the animal (Figure 4 & 5). Now fold another piece of paper towel to fit over the top of container before placing the hole-punched lid on (Figure 6). Tape the lid in place to ensure it won't pop off during shipment. Put the labeled container into a shipping box that is packed with newspaper or peanuts to avoid jostling (Figure 7). A Styrofoam lined shipping box keeps the interior cool in hot weather and warm in cold weather, it is worth utilizing unless the arrival and departure areas are experiencing mild climate. If you know the package is going to a location where it may be exposed to temperatures below 60F it is recommended to place a 40 hour exotic animal heating pack into the box. These can be purchased, along with other shipping needs from most exotic pet shipping companies; ShipYourReptiles.com or ReptilesExpress.com. These heat packs are oxygen activated and can reach temperatures in the triple digits. Follow the instructions on the package; generally keep a few inches of distance between the animal and the heat pack and tape the heat pack into place without covering the breathing strip.

Figure 4

Figure 5

Figure 6

Figure 7

Chapter 4. Social Environment

4.1 Group Structure and Size

Brachypelma are not considered communal and should not be kept together. Cannibalism is commonly reported even when captive reproduction is attempted.

Careful consideration should be given to ensure that animal group structures and sizes meet the social, physical, and psychological well-being of those animals and facilitate species-appropriate behaviors.

4.2 Influence of Others and Conspecifics

Brachypelma should not be kept with any other species unless possible predation isn't a worry (see "living soil").

Animals cared for by AZA-accredited institutions are often found residing with conspecifics, but may also be found residing with animals of other species.

4.3 Introductions and Reintroductions

Introductions should only be done when captive reproductions are being attempted. Introduce the male into the female's enclosure. This replicates the natural behavior of males leaving their burrows to find a suitable mate. Observe the entire courtship and reproduction with a careful eye and tweezers. If the female is aggressive or attempting to chase the male corral her away with tools or a deli cup.

Managed care for and reproduction of animals housed in AZA-accredited institutions are dynamic processes. Animals born in or moved between and within institutions require introduction and sometimes reintroductions to other animals. It is important that all introductions are conducted in a manner that is safe for all animals and humans involved.

Chapter 5. Nutrition

5.1 Nutritional Requirements

AZA Accreditation Standard

(2.6.2) The institution should have a written nutrition program that meets the behavioral and nutritional needs of all species, individuals, and colonies/groups in the institution. Animal diets must be of a quality and quantity suitable for each animal's nutritional and psychological needs.

Tarantulas are commonly referred to by the misnomer Bird Eating Spider. Although many tarantulas are capable of eating small birds or nestlings the practicality of this commonly happening in nature is relatively low. Many tarantulas are terrestrial or fossorial and would rarely come into contact with small birds. This is particularly true with the two genera that are most commonly called bird spiders the *Theraphosa* and *Lasiodora*. That being said, all tarantulas are insectivorous and occasional vertebrate carnivores. A diet that consists solely of domestic crickets (*Acheta domestica*) is common place in the hobby and has not shown ill effects. Crickets come in sizes that will satiate any life stage of most tarantulas. New born crickets, pinheads, can be consumed by first instar *Brachypelma* and are reported to be more nutritious than a diet of fruit flies (*Drosophila* sp). A diet exclusively of fruit flies can cause developmental issues in growing spiders.

Although crickets are an excellent staple there are advantages to offering a variety of prey items to your tarantula. Feeding the occasional giant cockroach or pinkie mouse is an excellent way to fatten up a female that may be a desired breeder. Vertebrates should be limited to a couple a year; they are a rich meal and can cause obesity. There is a variety of invertebrates that can be offered though. Tropical cockroaches (*Blaptica dubia*, *Blaberus discoidalis*, and *Gromphadorhina portentosa*), various orthoptera, and some lepidoptera larvae can all be potential prey items. Care must be given when considering diet. Avoid anything that has defensive spines, strong mandibles, or may be toxic. Generally, avoid feeding out Hymenoptera, Coleoptera, and Diptera. If it isn't commonly sold as a feeder insect or if you don't know; don't use it. Field collecting insects may also be detrimental because of secondary toxicity from insecticides. Any insect that can burrow should also be avoided, for example mealworms. This will eliminate any large, unwanted pests establishing themselves in the exhibit.

Tarantulas generally require live prey. They may feed on recently pre-killed animals that are fed off of forceps. They seize their prey by wrapping their front legs and pedipalps around the animal and sinking their fangs into it. They inject venom which not only kills the food but also acts as a digestive enzyme. Some large insects can take over a day to be consumed; the tarantula will hold onto it and macerate it slowly while drinking the digested fluids through their chelicerae. Because the exoskeleton isn't consumed dusting the prey with supplements isn't necessary. However, feeding the prey a nutritious meal before feeding it to the tarantula is a good vessel to deliver vitamins; this is commonly referred to as "gut-loading". During the feeding process the spider will often simultaneously wrap the meal in webbing to help contain all the pieces. When the prey is consumed the spider will drop the silk wrapped leftovers away from their burrow, this is called the bolus. Remove the bolus when seen to reduce the risk of mold or fungus growth, "living soil" may reduce a bolus before the keeper notices it even exists.

A formal nutrition program is recommended to meet the nutritional and behavioral needs of all taxa (AZA Accreditation Standard 2.6.2). Diets should be developed using the recommendations of nutritionists, the Nutrition Scientific Advisory Group (NAG) feeding guidelines: (http://www.nagonline.net/Feeding%20Guidelines/feeding_guidelines.htm), and veterinarians as well as AZA Taxon Advisory Groups (TAGs), and Species Survival Plan® (SSP) Programs. Diet formulation criteria should address the animal's nutritional needs, feeding ecology, as well as individual and natural histories to ensure that species-specific feeding patterns and behaviors are stimulated.

5.2 Diets

AZA Accreditation Standard

(2.6.1) Animal food preparation and storage must meet all applicable laws and/or regulations.

Ectotherms have vastly different dietary requirements than endotherms. Tarantulas in particular are capable of going months without a meal. Occasionally they will go off feeding even when they are offered food; this is usually because they are preparing to molt or something is wrong with the husbandry. A standard feeding regiment is to offer 1-2 appropriate sized prey items every Monday, Wednesday, and Friday. This ensures that any uneaten prey is removed after a few days. Appropriate sized prey items would be something smaller than the cephalothorax. Crickets in particular are capable of damaging tarantulas, particularly when they are molting, if they are left in the cage for too long. If the prey items are not eaten do not replace them the following feeding day, wait until the next. For example, if crickets are fed Monday but not eaten when checked on Wednesday do not offer food again until Friday. If tarantulas go off feed for a few weeks and no external factors have changed (temperature, humidity, etc) then a molt is most likely imminent. Of course, use common sense, if the spider's abdomen seems thin along the sides or if the prey is quickly consumed offer more or larger meals.

The formulation, preparation, and delivery of all diets must be of a quality and quantity suitable to meet the animal's psychological and behavioral needs (AZA Accreditation Standard 2.6.2). Food should be purchased from reliable, sustainable and well-managed sources. The nutritional analysis of the food should be regularly tested and recorded.

5.3 Nutritional Evaluations

There is anecdotal evidence that nutritionally deficit prey items may cause developmental problems in young tarantulas. This is manifested by crooked legs and poor mobility. However, this is still just a hypothesis proposed by hobbyists. It could also be caused by a myriad of other husbandry problems. More research must be done on this topic. Providing a varied diet and gut-loading the prey first is the best option.

Chapter 6. Reproduction

6.1 Reproductive Physiology and Behavior

Reproducing is one of the most stressful experiences an animal can have. However, it is also one of the most enriching. Producing offspring is the most natural behavior and many animals are so driven to do it they will sacrifice themselves in the process. This is particularly true for many arachnids. Male tarantulas grow at an accelerated rate compared to females of the same species. Usually a male will reach maturity a few molts before a female. This is an evolutionary adaptation to disperse genes. Tarantulas do not migrate far from their home range, if males and females from the same clutch matured at the same time there would be no inbreeding barrier. Once a male reaches maturity it will never molt again. The male is driven to find a willing female before it succumbs to old age. This need will drive tarantulas from the comfort of their burrow to transect over miles of harsh wilderness. Many of these males never find a willing partner and succumb to predation or the elements. Some of those males that do find a female still aren't successful in reproduction and are consumed before the deed is accomplished. Tarantulas are an R-selected organism. They produce huge litters in the hopes that a few will pass on their genetic material. Those few males that are able to breed with a female are also sometimes consumed. This is a willing sacrifice to the female, if she receives a nourishing meal while gestating the male's offspring the babies carrying his genes have a better shot in the world.

The life of any animal is much different in captivity. The male does not need to transect miles to reach a mate; he should be introduced by a keeper. Hopefully, the male won't be eaten either. Removal of the male will allow for numerous females to be bred by one male and at numerous intervals, something that probably never happens in the wild. But before captive reproduction can even begin you must first ensure that you have a male and female, that you cycle them properly, and that both parties are capable of reproducing.

Brachypelma can be sexed as early as fifth instar if using a light microscope. When a tarantula molts the abdomen of the shed exuvium can be gently separated and splayed open. Looking at the inside of this thin membrane you should notice four white patches; these are the shed flaps of the book lungs. Between the pair of book lungs closer to the cephalothorax might be a small flap. This tiny, triangular flap is only present in females and it is known as the epigastric furrow.

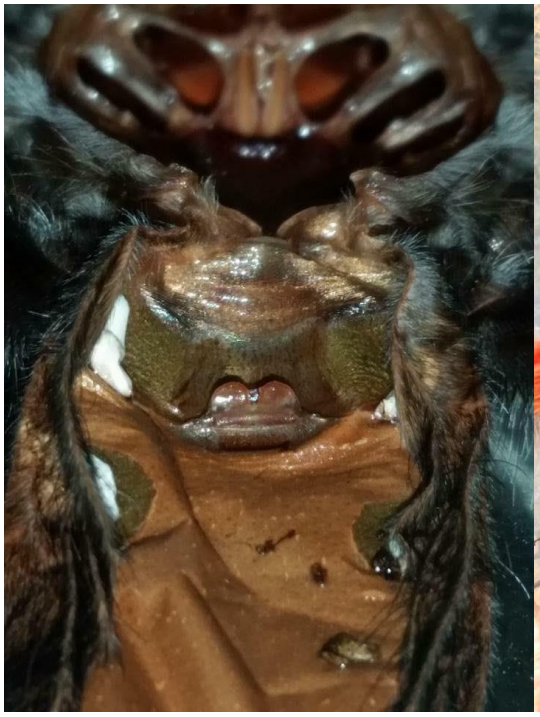

Photo Credit: Joyce Fletcher Mello Stuart

Patrick Mumford (All female spiders)

This is where the spermatophore is stored after a successful copulation. The larger the molt, the easier the epigastric furrow is to spot. Males lack this reproductive trait and their book lungs appear to be slightly closer together.

Male Brachypelma smithi usually reach adulthood in two-three seasons, or years, depending on prey availability. A male that hasn't reached sexual maturity yet is known as a penultimate male, a male that has is known as a mature male. You can tell that a male has matured by the presence of sex organs on the pedipalps and tibial

spurs on the first set of legs. The tips, tarsus, of the pedipalbs form boxing glove-looking palpal organs or bulbs. This is what is used to insert a spermatophore packet into the female.

Jen Gustason

Once the male matures he will lay a thick layer of silk down in his terrarium, occasionally this is eaten so look for remnants. This can be constructed within a week of maturity. This web is called the sperm web and after construction he will load his pedipalps with the spermatophore and go looking for a female.

The reproduction process starts when a mature male approaches a female's burrow. This is when the keeper must be most aware. The male will generally begin tapping the entrance to the burrow or around the female's enclosure with his pedipalps and front legs to notify her of his presence (Figure 8).

Figure 8

If the female isn't willing to participate she will usually either attack the male or dart away from him. This may indicate that she is either too close to a molt, not yet fully mature, or already gravid. Sometimes after a few tentative taps the male can be observed either redoubling his effort or trying to escape, he is most likely picking up on cues that the female is not interested if he tries to flee. Assist the male in escaping with forceps and capture cups if necessary, the female will not hesitate to eat him if she is hungry enough. If the female is interested she may approach the male and alternately tap her own pedipalps and legs. The courtship should be observed and it can sometimes take up to an hour, especially with inexperienced partners. The male and female will face each other and the female will left her legs up in a pseudo-threat display manner. The male will hook his tibial spurs under her fangs or front legs raising and doubling her cephalothorax back onto her abdomen (Figure 9).

Figure 9

Lifting the female up will expose the ventral side of her abdomen to the males pedipalps which he will insert into her epigynum and deposit a spermatophore packet into her epigastric fold. As quick as this happens the two will separate and the male will usually dart away. The entire process can take seconds (Figure 10 & 11).

Figure 10

Figure 11

It is important to have a comprehensive understanding of the reproductive physiology and behaviors of the animals in our care. This knowledge facilitates all aspects of reproduction, artificial insemination, birthing, rearing, and even contraception efforts that AZA-accredited zoos and aquariums strive to achieve.

6.2 Pregnancy, Egg-laying/ Parturition

Brachypelma smithi are native to the Mexican highlands; that is just north enough from the equator that the area experiences climactic changes. Mimicking these seasonal variations in captivity is key to producing a viable egg sac. In the wild the male would generally breed with a female in the fall and later summer monsoon season months. The female will spend her time gaining weight and aestivating during the cold, dry winter months. When the spring monsoon season arrives the female will produce an egg sac. This sac will hatch during a time in the habitat that is best suited for survival for her offspring; when food and moisture is plentiful. This seasonality has to be replicated in captivity. After breeding a female cool that female to a temperature in the mid to low 60F's for about two months. Do this slowly dropping the temperature ~10F once a week until you have reached the desired low 60F's and sustain that for two-three weeks. Slowly raise the temperature back up to the desired normal habitat. Do not feed her during this time and do not over water her. Keep her dry but offer her a small fresh water bowl and be aware of dehydration indicators like leg curling. After ~2 months of cooling establish the standard ~80F temperature for a few days and then feed and water heavily. Mist her daily, keep her water bowl full, and offer large prey items that will help fatten her up. Make sure she has a hiding spot where she can feel completely secure; a length of PVC pipe or terracotta pot.

Hopefully she will heavily web this area up after one month of the raised temperature. Do not disturb her if she webs the entrance to her burrow up, note the date and prepare to remove the egg sac or let her maternally incubate the eggs. Do not offer her food if she seems to have produced an egg sac. If she molts she will lose the spermatophore that she was carrying and you will have to restart the entire process. If she molts after the cooling period you could attempt to breed her again without the cooling cycle and see if that acts as a catalyst to produce an egg sac. After the egg sac has been observed the female needs to be kept in a low commotion area, do not offer food but make sure to keep the habitat moist. If there are too many disturbances the female may consume the egg sac or discard it. A general guideline is to have written records of when the exhibit was serviced somewhere near the cage. This will ensure that numerous well-intentioned keepers aren't disturbing the female unnecessarily.

From the date the egg sac is thought to exist or is observed you have a decision to make. Let the female maternally incubate her egg sac or pull it and artificially incubate it yourself. Tarantulas have been hatching eggs for millions of years; they are evolutionarily more than equipped to produce the next generation. However, this may not be true for the husbandry parameters that have been implemented for your captive. Many hobbyists opt to pull the egg sac so they can have complete control over the incubation and allow for the female to return to her routine and exhibit. If you decide to pull the egg sac you must do it after a minimum of 30 days from the original lay date. If you pull the sac too early many of the eggs could be unfertilized. An interesting behavior tarantulas do while holding their egg sac is constantly kneading and rotating the sac. Hobbyists thought that this was to keep pressure off of the eggs on the bottom of the sac. However, it appears it may also serve to help fertilize the eggs that have left the body. When the female produces the silk mat to lay her eggs on she also distributes the spermatophore packet into the webbing. As she lays the eggs they are passed through

the epigastric furrow and most are fertilized there but some are not. The unfertilized eggs will hopefully later come into contact with a sperm cell in the egg sac. Rotating the egg sac exposes all the eggs to the silk to ensure the eggs are all fertilized.

Use tongs to pull the sac away from the female, she will fight you for it. Grasp the sac by the tip of the silk; do not grab it in the middle because you may damage eggs inside. Using tweezers and a razor or small pair of scissors gently cut the sac open. Hopefully you will be greeted by ~500 yellow protonymphs or “eggs with legs”. The cephalothorax and legs will be underdeveloped and the abdomen, which is carrying the yolk, will look like a large egg.

It is extremely important to understand the physiological and behavioral changes that occur throughout an animal’s pregnancy.

6.3 Birthing/Hatching Facilities

Once the sac has been opened, gently pour the contents into a custom incubator. A tarantula incubator is a container with soft bedding and a high humidity that the protonymphs can be spread apart in. I use panty hose suspended in a delicup above wet paper towels. I seal the delicup and poke one small air hole in the lid. Make sure the spiderlings are not exposed to water; a single drop can drown them. Also, make sure they are not resting on top of each other. Allow for enough room for them to be evenly spaced in one layer. Open the container every day or two to allow fresh air flow. If any eggs turn black or look to be rotten remove them or separate them from the other protonymphs.

As parturition approaches, animal care staff should ensure that the mother is comfortable in the area where the birth will take place, and that this area is “baby-proofed.”

6.4 Assisted Rearing

When the egg sac is first produced it will spend the first 30 days as just an egg. The next 30 days will be spent as the protonymph. Then the spider will molt into its first instar. When the spider molts into the first instar you can individually bottle them into dram vials or delicups. Give the spider a bit of substrate; moss, cocofiber, or dirt mix for them to burrow into. Do not offer them a water bowl and mist sparingly as to not drown them. Offer the new spiderlings pinhead crickets or other small prey items.

Although mothers may successfully give birth, there are times when they are not able to properly care for their offspring, both in the wild and in ex-situ populations. Fortunately, animal care staff in AZA-accredited institutions are able to assist with the rearing of these offspring if necessary.

Chapter 7. Other Considerations

7.1 Additional Information

All arthropods shed their exoskeleton when growing, this process is called molting. Molting is commonly considered the most perilous time during your tarantula's lifecycle. The spider is vulnerable to attack from prey items, so ensure that they have been removed. Also, if the spider is greatly disturbed it could sustain a bad molt resulting in missing or mangled limbs or death. Generally, a keen eye can spot the signs of an impending molt. Look for thinning setae (hair) along the leg joints and the abdomen. *Brachypelma* are prone to flicking their utricating hairs which often results in a bald abdomen. If your tarantula has a bald abdomen look at the exoskeleton, if it is a fleshy-pink it is not ready to molt. However, if the exoskeleton is dark that is the newly formed setae under the "skin". The spider starts this process by going off of feed for up to a few months to a few days depending on age of the animal. Generally, the spider will molt at night at the mouth of its burrow. A thick mat of silk will be constructed before the spider flips onto its back with its legs in the air. Do not disturb the spider during this process; if the spider is doing it on display encourage visitors to not bang on the glass. The tarantula's carapace will disconnect from the cephalothorax allowing for the tarantula to escape the confines of its old exoskeleton. Once the cephalothorax has come out the pedipalps and eight legs will follow. The abdomen generally tears along the top and pulls out next, including their attached, primitive book lung flaps. If you find the molt while it's fresh it can be manipulated for educational purposes before it dries out and becomes brittle. By examining the molt you can also sex spiders that have not fully matured (see the Reproduction section). Allow the spider a few days to a week, depending on age, to harden before offering food or handling.

All tarantulas are venomous. However, some genera of only New World tarantulas have the ability to also flick urticating hairs as a secondary defense. Because of this defense New World tarantulas tend to be more docile than their Old World counterparts. The likelihood of hair flicking and the physical microscopic structure of the hairs vary from species to species. Some genera, like *Grammostola* and many *Brachypelma* tend to rarely flick hair and when they do they are generally not painful. On the contrary, *Theraphosa* won't hesitate to unleash clouds of intensely burning hairs at the slightest provocation. If a *Brachypelma* quickly scrapes its hind legs against the top of its abdomen that indicates that it has released an airborne puff of hairs. If you are performing maintenance on the exhibit and would not like to be itchy quickly vacate the area until the cloud settles, then lightly mist the surrounding area to wash the still volatile hairs into the substrate. If you get the hairs on your skin lightly wash the area with cool water if it becomes more than an annoyance.

References

Attard, L., Sherberger, F., & Mason, T. (2008, July). Tarantula Sexing. Workshop conducted at the Invertebrates in Education and Conservation Conference, Nogales, AZ.

Bitgood, S., Patterson, D., & Benefield, A. (1986). Understanding your visitors: ten factors that influence visitor behavior. *Annual Proceedings of the American Association of Zoological Parks and Aquariums* (pp. 726–743).

Bitgood, S., Patterson, D., & Benefield, A. (1988). Exhibit design and visitor behavior. *Environment and Behavior*, *20*(4), 474–491.

Churchman, D. (1985). How and what do recreational visitors learn at zoos? *Annual Proceedings of the American Association of Zoological Parks and Aquariums* (pp.160–167).

Conway, W. (1995). Wild and zoo animal interactive management and habitat conservation. *Biodiversity and Conservation*, *4*, 573–594.

Davison, V. M., McMahon, L., Skinner, T. L., Horton, C. M., & Parks, B. J. (1993). Animals as actors: take 2. *Annual Proceedings of the American Association of Zoological Parks and Aquariums* (pp. 150–155).

de Vosjoli, P. (1997). *Arachnomania: The general care and maintenance of tarantulas and scorpions*. Lakeside, CA: Advanced Vivarium Systems.

Gurley, R. (1994). *A color guide to tarantulas of the world: I*. Ada, OK: Living Art Publishing.

Johnston, R. J. (1998). Exogenous factors and visitor behavior: a regression analysis of exhibit viewing time. *Environment and Behavior*, *30*(3), 322–347.

Locht, A., Yanez, M., & Vazquez, I. (1999). Distribution and natural history of Mexican species of Brachypelma and Brachypelmides (Theraphosidae, Theraphosinae) with morphological evidence for their synonymy. *Journal of Arachnology*, *27*(1), 196-200.

MacMillen, O. (1994). Zoomobile effectiveness: sixth graders learning vertebrate classification. *Annual Proceedings of the American Association of Zoological Parks and Aquariums* (pp. 181–183).

Morgan, J. M., & Hodgkinson, M. (1999). The motivation and social orientation of visitors attending a contemporary zoological park. *Environment and Behavior*, *31*(2), 227–239.

Povey, K. D. (2002). Close encounters: the benefits of using education program animals. *Annual Proceedings of the Association of Zoos and Aquariums* (pp. 117–121).

Povey, K. D., & Rios, J. (2002). Using interpretive animals to deliver affective messages in zoos. *Journal of Interpretation Research*, *7*, 19–28.

Sherwood, K. P., Rallis, S. F., & Stone, J. (1989). Effects of live animals vs. preserved specimens on student learning. *Zoo Biology*, *8*, 99–104.

Wolf, R. L., & Tymitz, B. L. (1981). Studying visitor perceptions of zoo environments: a naturalistic view. In P. J. S. Olney (Ed.), *International Zoo Yearbook* (pp. 49–53). Dorchester: The Zoological Society of London.

World Conservation Monitoring Centre. (1996). *The IUCN red list of threatened species*. Retrieved from http://www.iucnredlist.org/details/8152/0

Yerke, R., & Burns, A. (1991). Measuring the impact of animal shows on visitor attitudes. *Annual Proceedings of the American Association of Zoological Parks and Aquariums* (pp. 532–534).

Yerke, R., & Burns, A. (1993). Evaluation of the educational effectiveness of an animal show outreach program for schools. *Annual Proceedings of the American Association of Zoological Parks and Aquariums* (pp. 366–368).

Zhong, Y., Song, B., Mo, G., Yuan, M., Li, H., Wang, P., ... Lu, Q. (2014). A novel neurotoxin from venom of the spider, *Brachypelma albopilosum*. *PLoS ONE*, *9*(10), 1-6. doi:10.1371/journal.pone.0110221