

2013-01-01

# Comparison Of Ectoparasitic Mite Loads Between Gonochoristic (*Aspidoscelis Marmorata*) And Parthenogenic (*A. Tessellata*) Syntopic Whiptail Lizards (*Teiidae*) From The Northern Chihuahuan Desert Of Trans-Pecos, Texas

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SYNTOPIC WHIPTAIL LIZARDS (TEIIDAE) FROM THE NORTHERN  
CHIHUAHUAN DESERT OF TRANS-PECOS, TEXAS

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2013

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By

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THESIS

Presented to the Faculty of the Graduate School of

The University of Texas at El Paso

in Partial Fulfillment

of the Requirements

for the Degree of

MASTER OF SCIENCE

Department of Biological Sciences

THE UNIVERSITY OF TEXAS AT EL PASO

May 2013

## **ACKNOWLEDGEMENTS**

This thesis was made possible through grant funding by the National Science Foundation for facilities development at Indio Mountains Research Station (IMRS) and support from the UTEP laboratory of Dr. Jerry D. Johnson. Additionally, I owe thanks to the following committee members, mentors, colleagues, friends, UTEP staff, and my family for assistance at every step along the way.

Professors Jerry D. Johnson, Vicente Mata-Silva, Eric A. Hagedorn, Carl S. Lieb and William P. Mackay provided valuable input for this study. Graduate students; Julia S. Alva, Ross Couvillon, Geoffrey Wisemen, Arturo Rocha, and the UTEP Field Biology and Maymester Classes Of 2010-2012 assisted during field work at IMRS. Also, the Undergraduate Research Mentoring program provided undergraduate assistance throughout the course of this study.

Most of all I would like to thank my undergraduate field assistants; Christopher Billingsley and Gabriela R. Franco, who provided much assistance and company throughout the sampling period at Indio Mountains Research Station.

Mite Identification was provided generously by Cal Welbourn- Acarologist; Division of Plant Industry, Florida Dept. Agriculture & Consumer Services, 1911 SW 34 St. Gainesville, FL 32608-1201

## ABSTRACT

The objective of this study was to compare the ectoparasitic loads between two syntopic whiptail lizard species (Teiidae) that differ in their reproductive modes; *Aspidoscelis marmorata* (bisexual) and *A. tessellata* (unisexual). The study site was located on Indio Mountains Research Station (IMRS) in a Chihuahuan Desert Scrub landscape in Hudspeth County, Texas. Previous studies conducted at IMRS showed the two species having similar diets, morphology, and reproductive characteristics, but fluctuated in nematode loads. No comparative study of ectoparasitic mites (*Eutrombicula alfreddugesi*) between the two species has ever been done.

*Aspidoscelis marmorata* (n = 141) and *A. tessellata* (n = 144) were captured during the time period of August 2010 through October 2012 in over 100 pitfall traps arranged in transects and later marked by toe clipping. The total numbers of mites (4036 mites, *A. marmorata*; 3787 mites, *A. tessellata*) were counted on the entire body of each lizard using a dissecting microscope. During the first year cycle, *Aspidoscelis marmorata* (n = 33,  $\mu = 101.8$  mites) were about half (0.531) less likely for having mites as compared to *A. tessellata* (n = 46,  $\mu = 53.9$  mites) for the first year infection cycle ( $p = 0.044$ ), but on average had significantly higher infection rates ( $p > 0.0001$ ). In the second year, a role reversal occurred, with *A. tessellata* (n = 24,  $\mu = 43.6$  mites) having a significantly higher infection rate compared to *A. marmorata* (n = 32,  $\mu = 21.7$  mites), but with no differences in prevalence ( $p = 0.181$ ). Analysis of body location of infection show *A. marmorata* (n = 97) having lower sacral loads compared to *A. tessellata* (n = 85), ( $p < 0.001$ ), but with higher infection rates on the abdominal scales ( $p < 0.001$ ). This research shows evidence

both accepting and rejecting the Red Queen Hypothesis within a single lizard community on IMRS, with variability between the two sampling years.

## TABLE OF CONTENTS

ACKNOWLEDGEMENTS .....	iv
ABSTRACT .....	v
TABLE OF CONTENTS .....	vii
LIST OF TABLES .....	vii
LIST OF FIGURES .....	x
INTRODUCTION .....	1
MATERIALS AND METHODS .....	10
RESULTS .....	16
DISCUSSION .....	35
LITERATURE CITED .....	42
APPENDIX .....	48
VITA.....	63



## LIST OF TABLES

Table 1.	Descriptive statistics of <i>Aspidoscelis marmorata</i> and <i>A. tessellata</i> throughout the study period. SVL = snout-vent length, IC = index of body condition.....	16
Table 2.	Statistics for the first sampling year (2011) for <i>Aspidoscelis marmorata</i> and <i>A. tessellata</i> using Mann-Whitney U-test for each variable with averages provided where significance occurs. Significant probability (Pr) values are bolded. ALL = cumulative data, IP = infection period, IA = infected adults, SVL = snout-vent length, IC = index of body condition, INF = infection (mite intensity), and $\mu$ = denotes mean measurements when the test statistic was shown to be significant.....	23
Table 3.	Statistics for the second sampling year (2012) for <i>Aspidoscelis marmorata</i> and <i>A. tessellata</i> using Mann-Whitney U-test for each variable with averages provided where significance occurs. Significant probability (Pr) values are bolded. ALL = cumulative data, IP =Infection period, IA = Infected adults, SVL = snout-vent length, IC = index of body condition, INF = infection (mite intensity), $\mu$ = denotes mean measurements when the test statistic was shown to be significant.....	25

Table 4.	Mite intensity analysis for <i>Aspidoscelis marmorata</i> and <i>A. tessellata</i> using Mann Whitney U-Tests. Significant probability (Pr) values are bolded. ALL = cumulative data, IP = Infection period, IA = Infected adults, with only significant mean values to the right of its probability value, SVL = snout-vent length, IC = index of body condition, INF = infection (mite intensity), and $\mu$ = denotes mean measurements when the test statistic was shown to be significant.....	26
Table 5.	General Estimating Equations analysis for presence/absence of infection as dependent variable, species and location as predictors, cumulative data.....	28
Table 6.	General Linear Mixed Model analysis for LOG (infection+1) as dependent variable, species and location as predictors, but non-normal, cumulative data.....	29
Table 7.	General Linear Mixed Model analysis for LOG (infection+1) as dependent variable, species and location as predictors, but non-normal, cumulative data.....	29
Table 8.	Linear Regression analysis of total infection to environmental variables (temperature, humidity, wind speed, air pressure, and precipitation). Significant values ( $p < 0.05$ ) are bolded in green.....	31

## LIST OF FIGURES

Figure 1.	The four representative species of the genus <i>Aspidoscelis</i> occurring syntopically on the IMRS. Only <i>A. marmorata</i> and <i>A. tessellata</i> were analyzed.....	5
Figure 2.	Larval chigger mites ( <i>Eutrombicula sp.</i> ) parasitizing a lizard's epidermal scales, and a representative adult stage is shown to the right.....	6
Figure 3.	Pitfall trap type used for lizard studies on IMRS (photo adapted from Couvillon, 2011).....	12
Figure 4.	Google Earth display showing the eight pitfall array sites used in this study on IMRS (Ranch House, Woodpecker Well, Oak Arroyo, Corral, Squaw Spring, Prospect Pit, Red Tank, and Lonely Tank); Ranch House, Prospect Pits, and Squaw Spring are the major capture sites.....	13
Figure 5.	Body positions examined for mite infections on whiptail lizards captured on IMRS.....	14
Figure 6.	Monthly counts of <i>A.marmorata</i> (n = 141) and <i>A. tessellata</i> (n = 144) throughout the sampling period (Aug. 2010-Oct. 2012) on IMRS.....	16

Figure 7.	Monthly counts of male (n = 100) and female (n = 36) <i>A. marmorata</i> throughout the sampling period (Aug. 2010- Oct. 2012) on IMRS.....	17
Figure 8.	Monthly counts of <i>A. marmorata</i> distinguished by maturity (A = adult, n = 117; J = juvenile, n = 24) throughout the sampling period (Aug. 2010-Oct. 2012) on IMRS.....	17
Figure 9.	Monthly counts of <i>A. tessellata</i> distinguished by maturity (A = adult, n = 54; J = juvenile, n = 90) throughout the sampling period (Aug. 2010-Oct. 2012) on IMRS.....	18
Figure 10.	Total monthly mite infestation (monthly sums) for <i>Aspidoscelis marmorata</i> and <i>A. tessellata</i> throughout the sampling period (Aug. 2010-Oct. 2012) on IMRS.....	19
Figure 11.	Monthly averages of mite infestation on <i>Aspidoscelis marmorata</i> and <i>A. tessellata</i> between two major infection periods (Apr. 2011-Oct. 2012) on IMRS.....	20
Figure 12.	Monthly mite infection (monthly sums) on <i>Aspidoscelis marmorata</i> and <i>A. tessellata</i> throughout the sampling period (Aug. 2010-Oct. 2012) on IMRS.....	21

Figure 13.	Monthly mite infection (monthly averages) on <i>Aspidoscelis marmorata</i> and <i>A. tessellata</i> throughout the sampling period (Aug. 2010-Oct. 2012) on IMRS.....	22
Figure 14.	Boxplots showing significant mite intensity differences ( $p = 0.0103$ ) between <i>A. marmorata</i> ( $n = 33$ ) and <i>A. tessellata</i> ( $n = 36$ ) within the infection period (IP 2011) on IMRS, with the y-axis representing the number of external mites.....	27
Figure 15.	Boxplots showing significant mite intensity differences ( $p = 0.0145$ ) between infected adult (IA 2012) <i>A. marmorata</i> ( $n = 24$ ) and <i>A. tessellata</i> ( $n = 19$ ) within the infection period (IP 2012), with the y-axis representing the number of external mites.....	28
Figure 16.	General Linear Mixed Model analysis for LOG (Infection+1) as dependent variable, with species and location as predictors, but non-normal, cumulative data.....	30
Figure 17.	Mean Temperature (daily averages, °C) throughout the two year sampling period (2011-2012) on IMRS.....	32
Figure 18.	Monthly average humidity throughout the two year sampling period (2011-2012) on IMRS.....	33

Figure 19.	Monthly average precipitation throughout the two year sampling period (2011-2012) on IMRS.....	34
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<b>APPENDIX</b>	Descriptive data for whiptail lizards examined: WDL = ID number of author; Cap = capture/recapture number; SpEp = species specific epithet; SVL = snout-vent length; Tot INF = total Infection, mite intensity; IC (index of body condition) = $\text{Mass}^{0.33} / \text{SVL}$ . Data is sorted by date, species, and sex (M = male, F = female, and J = juvenile).....	48
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## INTRODUCTION

The high prevalence of bisexual species in vertebrates, as opposed to unisexual modes of reproduction, is not well understood in evolutionary biology. Approximately 0.1% of animal species have been discovered to asexually reproduce (Vrijenhoek, 1998). The potential advantages of bisexual reproductive modes are well studied, yet the advantages of parthenogenetic methods are still questioned and difficult to recognize (Hartfield and Keightly, 2012). The assumed advantage of bisexual reproduction is greater genetic variability due to chromosomal recombination and independent assortment during gamete formation. Populations with greater genetic variability are thought to have a higher potential to adapt to biotic and abiotic limiting factors, especially when considering the constant evolutionary arms-race between parasites and hosts (Dawkins and Krebs, 1979). This arms-race between hosts and parasites has been well studied in bisexual vertebrates, including lizard hosts (e.g., Bostic, 1965, Goldberg et al., 1993, Klukowski, 2004). Conversely, investigations involving unisexual species are uncommon and are difficult to interpret. However, a few contemporary studies have compared unisexual and bisexual host-parasite interactions in different species of lizards. A study conducted by Mortiz et al. (1991) showed that unisexual geckos in the *Heteronotia binoei* species complex on average hosted more ectoparasitic mites than their bisexual counterparts in the same community. On the other hand, a study by Brown et al. (1995) inversely showed that a unisexual geckonid species, *Lepidodactylus lugubris*, had lower parasite loads and fewer parasitic species than a sympatric bisexual gecko, *Hemidactylus frenatus*. A similar study by Hanely et al. (1995) discovered that Pacific

island parthenoform geckos had a lower frequency of mite infestation than their sexual ancestors. However, both Brown et al. (1995) and Hanely et al. (1995) expressed an entirely opposite conclusion to that inferred by Mortiz et al. (1991). Those two papers contemplated that since parthenoforms resulted from hybridization, their genotypes should be highly heterozygous; suggesting a possible reason for their unisexual geckos being more resistant to parasitism. Thus, host-parasite interactions seem to be highly complex and inconsistent when comparing unisexual and bisexual species. Utilizing the “Red Queen Hypothesis” to help resolve reasons for host-parasite relationships, may be a viable way of explaining them, although the inconsistency in which reproductive system benefits the most only adds to the complexity of the problem.

The Red Queen Hypothesis concerning parasite-host relationships has been a common area of interest for some biologists (e.g., Van Valen, 1973; Bell, 1982). This hypothesis refers to a passage in Lewis Carroll’s *Through the Looking Glass* (1871) in which the Red Queen tells Alice: “it takes all the running you can do, to keep in the same place;” comparable to the negative frequency-dependent dynamics of host–parasite coevolution (Leung et al., 2012). It infers that in order for hosts to overcome their parasites, or vice versa, species must constantly maintain fitness relative to the interactions with which they co-evolve. This has been an explanation why vertebrates are predominately bisexual, in order to attain greater genetic diversity, thus higher adaptability against potential parasitic stressors. Recombination is favored in these conditions as shown by Gandon and Otto (2007), with more rapid fluctuating host and parasite genotypes as the parasitic virulence increased. In addition, with genomic recombination, sexual species are more likely to generate novel genotypes that are able to adapt not only to parasitic



pressures, but to fluctuating environmental conditions as well (Hartfield and Keightly, 2012; Hamilton et al., 1990). Four chief conditions must exist when testing the Red Queen Hypothesis: 1) genetic variation in the parasites or pathogens for infectivity or virulence; 2) genetic variation in the host population for resistance to specific strains of parasites; 3) parasites or pathogens having substantially shorter generation times than the hosts; and 4) infection by pathogens or parasites reduces the fitness of individual hosts (reviewed by Bremermann, 1985; Hamilton et al., 1990). However, May and Anderson (1983) suggest that the twofold fitness advantage of sex occurs only if the infection is near lethal to the host species.

The genus *Aspidoscelis* (formerly *Cnemidophorus*) is one of the most widely studied lizard genera in North America, partly because of its large number of inclusive species and their extensive distributions (Dunham et al., 1988; Wright, 1993). Whiptail lizard populations consisting exclusively of females were only recently discovered in natural populations by Maslin (1962), and then later confirmed in laboratory hatchlings of unfertilized eggs (Maslin 1971). This genus has been characterized by approximately one-third being parthenogenetic all-female species, which is the highest percentage of any vertebrate taxonomic group, many of which occur in the southwestern U.S. and northern Mexico (Wright, 1993). Four syntopic *Aspidoscelis* species co-occur on the Indio Mountains Research Station (IMRS), located in the northern Chihuahuan Desert of Trans-Pecos, Texas: *A. exsanguis* (Chihuahuan Spotted Whiptail), *A. inornata* (Little Striped Whiptail), *A. marmorata* (Western Marbled Whiptail), and *A. tessellata* (Colorado Checkered Whiptail) (Figure 1). These four species vary in their reproductive strategies, with *A. inornata* and *A. marmorata* being conventional gonochoristic (bisexual) diploid

species; *A. tessellata* is a diploid parthenoform; and *A. exsanguis* is a triploid parthenoform (Wright, 1993). Reeder et al. (2002) established the phylogenetic relationships between the four species. The diploid parthenoform *A. tessellata* complex resulted from hybridization between two parent gonochoristic species, *A. marmorata* and *A. septemvittata*, with *A. marmorata* confirmed as the maternal ancestor using mitochondrial DNA evidence (Densmore et al., 1989b; Dessauer et al., 1996; Dessauer et al., 2000). Dessauer and Cole (1989) showed another interesting phylogenetic relationship existing between *A. inornata* and *A. exsanguis*. This relationship infers that the triploid parthenoform, *A. exsanguis*, is the product of an ancestral diploid parthenoform backcrossing with a third gonochoristic ancestor, *A. scalaris*; however the parent ancestral diploid parthenoform was shown to be the product of two gonochoristic parent species, *A. inornata* and *A. stictogramma*. Due to their ecological similarities, co-occurrence, and phylogenetic relationships, the four species occurring at IMRS are ideal models for comparing host-parasite interactions and consequences in their natural habitat. It was originally proposed to compare parasitic mite infestations between all four species of whiptails, but because of low sample sizes for *A. inornata* and *A. exanguis*, only the two common species, *A. marmorata* and *A. tessellata* were statistically analyzed herein.



Figure 1. The four representative species of the genus *Aspidoscelis* occurring syntopically on the IMRS. Only *A. marmorata* and *A. tessellata* were analyzed.

A previous study by Mata-Silva (2006) indicated that *A. tessellata* and *A. marmorata* inhabiting IMRS are nearly similar in size and morphological shape and have similar diets, although there are slight morphological differences in males. In addition, Hotchkin and Riveroll (2005) found a difference in escape behaviors between the two species, most likely facets of their genetically controlled adaptability. Carranza (1997) completed an endoparasite survey of three species of *Aspidoscelis* (as *Cnemidophorus*) on IMRS and recorded nematodes and cestodes in bisexual *A. inornata* and unisexual *A. exsanguis* and *A. tessellata*, but didn't examine parasites in the bisexual *A. marmorata*. Mata-Silva et al. (2008) made an interesting discovery regarding nematode loads in the digestive tracts of *A. marmorata* and *A. tessellata*. In that study, on average *A. tessellata* contained about a 50% greater internal nematode load when compared to *A. marmorata*. This evidence suggests that the unisexual species being less resistant to parasitic coevolution when

compared to sexual species, since it has been verified that common host genotypes decrease over time from parasitic influences (Koskella and Lively, 2009). Even though evidence indicates that the unisexual species has a higher endoparasite infection rate than the bisexual form, there has been no evaluation of their ectoparasites, primarily larval mites (commonly referred to as chigger mites).



Figure 2. Larval chigger mites (*Eutrombicula* sp.) parasitizing a lizard's epidermal scales; and a representative adult stage is shown to the right.

The main ectoparasites that are prevalent on teiid lizards on IMRS are the larval stage of the soil mite, *Eutrombicula alfreddugesi*, Oudemans, 1910 (Acari: Eutrombiculidae) (Figure 2), a species that has been commonly cited in lizard parasite studies (Bostic, 1965; Klukowski, 2004). However, personal communications with Dr. Cal Welbourn indicated that the identity of this species is cloudy due to poor past descriptions, and that the genus complex in North America needs taxonomic revision. Frequently, chiggers are either incorrectly or not identified, such as erroneous conclusions made by Curtis and Baird (2008), who misidentified their mites to species. The post-egg life cycle of these mites begin as larvae, which attach to loose or folded areas of skin and feed by secreting digestive enzymes that dissolve epidermal tissue of the host (Goldberg et al., 1993).

Once the chiggers finish feeding, they detach from their host. Feeding duration varies between species and the body segments they are attached to allegedly fluctuate seasonally (Klukowski, 2004). Once detached, they metamorphose into adult mites and switch to a predatory mode of feeding on arthropods, arthropod eggs, and occasionally plant material.

Mite parasitism has multiple detrimental effects on lizard fitness (Kearney and Shine, 2004), including personally observed lesions and secondary infections on attachment sites. Eutrombiculids also are vectors of disease causing protozoans, including malaria that is transmitted through the blood via lesions from mite infestation (Bulté et al., 2009). These multiple negative effects, coupled with co-infection of multiple parasites, give validity to the fourth assumption when testing the Red Queen Hypothesis and may be crucial for understanding the selective advantage of sexual reproduction in the presence of parasitic stresses (Mostowy et al., 2010).

Eutrombiculid species may also prefer specific vertebrate hosts that are related by co-occurrence in particular habitats, through host population densities and characteristic behaviors, and ecological characteristics of the mite species (Shatrov and Kudryashova, 2008). However, host specificity of eutrombiculids is still questionable, but most likely they prefer particular microhabitats where they parasitize all or the majority of syntopic vertebrate species found there. In essence, the mite-host association can be established whenever spatial niches of a mite and a host overlap (Kudryashova, 1998). However, the environment can also play a role in phenological cycles, such as Wharton's (1946) ideas that habitat distribution of eutrombiculid mites is determined by environmental

requirements of non-parasitic stages, while their geographical distribution depends on larval dispersion by their vector hosts.

Potentially, comparing differences in mite loads of a parthenogenetic whiptail (*A. tessellata*) with a gonochoristic species (*A. marmorata*), will help shed light on how different sexual modes affect fitness when applied to the Red Queen Hypothesis. The Red Queen Hypothesis normally applies to bisexual species' increased genetic variability, and if the observation that unisexual species indeed have more ectoparasitism, the hypothesis will be substantiated. However, if we observe the inverse, the Red Queen Hypothesis would be refuted for explaining the difference in the ectoparasite loads between a unisexual and bisexual species. The complexity of the paradox of sex has led many to accept a pluralist approach, which considers the Red Queen and mutational deterministic processes working together to maintain the prevalence of sex (West et al., 1999), as well as Muller's ratchet effects on deleterious mutations in fixed populations (Howard and Lively, 2002). Greater genetic variability should lead to increased resistance, which bisexual species hypothetically possess compared to a unisexual form under similar parasitic conditions (Koskella and Lively, 2009). However, there is evidence that parthenogenetic species have increased levels of heterogeneity via interspecific hybridization, given possible hybrid vigor effects (Brown et al., 1995).

Comparing the locations where parasites occur on lizard bodies may also have ramifications, because differences in load frequencies may be affected by attachment sites. Although two species may have similar infection means, the distribution of parasites on lizard bodies may differ. Examining parasite loads and positions when comparing age classes (adults versus juveniles) can be used to assess intraspecific and

interspecific differences between species, as well as intraspecific sexual differences (males versus females) within the bisexual species (e.g., *A. marmorata*).

Environmental factors can also be scrutinized for correlations between parasite abundance and body positions used on a seasonal basis, especially associations with climatic parameters, such as precipitation and temperature. A study conducted by Gentry et al. (1977) showed that, when comparing increased rainfall to periods of dryness, a greater abundance of eutrombiculid mites were found in association with heavy rainfall events, and mostly absent during dry periods. They also exposed larval mites to simulated rainfall, which caused retention of mite populations for longer periods than during dry episodes. The humidity at substrate surface, temperature, and incident sunlight have been shown to be limiting factors for mite population densities; with densities being greatest in areas with high relative humidity, low incident sunlight, lower temperature, and a dense substrate vegetative canopy (Clopton and Gold, 1993). It is also possible that the positioning pattern of parasites on the lizard bodies change throughout the infection cycle and seasonally.

The primary objectives of this study were to: 1) compare the ectoparasitic mite loads (prevalence and intensity) between two syntopic whiptail lizards, *A. marmorata* (bisexual) and *A. tessellata* (diploid parthenoform) on IMRS; 2) compare mite distribution between selected body locations of mite infection on the two whiptail species on IMRS; 3) compare mite loads between phenological groups within and between the two syntopic whiptail lizards on IMRS; and 4) evaluate the influence of seasonal environmental factors affecting mite load frequencies and distribution on the two whiptail lizards on IMRS.

## METHODS AND MATERIALS

**Study Area.** - This study will be performed on Indio Mountains Research Station (IMRS), centered on 30.77688°N, 105.01617°W; 1235 m elevation, located in southeastern Hudspeth County, Texas, about 40 km southwest of Van Horn. IMRS is controlled by The University of Texas at El Paso (UTEP). The following description of IMRS is based on Johnson (2000) and Worthington et al. (2013).

Vegetation is typical Chihuahuan Desert scrub (Creosote-Lechuguilla-Ocotillo-Yucca-Acacia associations) and Tabosa-Black Gramma desert grassland. The flora is strongly influenced by the Rio Grande corridor, through which plant species otherwise characteristic of the Big Bend region, ascend northwestward along the Rio Grande Valley. Superimposed upon this pattern are remnants of widespread desert grasslands, probably infiltrators from the more typical Chihuahuan grassland areas that flank the Indio Mountains to the north and east. A floral inventory has documented about 375 species, although the overall plant diversity is expected to be closer to 500 species.

Animal life on IMRS is typical of the Chihuahuan Desert and desert grassland. Desert invertebrates are abundant, especially insects and spiders. To date, a total of 35 mammal species have been recorded on IMRS. Large mammals include Mule deer, Collared Peccary, Mountain Lions, Ringtails, Coyotes, and Gray Foxes. Smaller mammals like rodents and rabbits are common, and bats are frequently found in many of the caves and abandoned mine shafts that were previously establish on Indio Ranch. Birds are less well known, although random observations have listed about 96 species of an expected list of at least 200 resident and migrant forms. Reptiles (36 species) are also abundant



throughout the station, with several species of lizards, including the four species of whiptails to be studied herein, and three species of rattlesnakes being frequently encountered. Because of the dry environment, few amphibians (six species) occur on IMRS, although Red-spotted Toads (*Anaxyrus punctatus*) are commonly observed, especially during the summer rainy season, as well as the seemingly recent established populations of Great Plains Narrow-mouthed Toad (*Gastrophryne olivacea*).

Annual precipitation is typically less than 25 cm per year, with most falling during the summer monsoon season (June – September).

**Collecting Techniques.** - Lizards were collected during regular trips to IMRS from fall 2010 through summer 2012. Three pitfall trap arrays have been previously constructed, which consists a total of 101 buried five-gallon buckets with screw lids and wood covers, with each spaced about 20 m apart along linear transects (Figure 3 and Figure 4). The first site is located at Squaw Spring (30.79719°N, 105.01117°W; 1273 m elev.) containing a total of 20 traps located above the main pool and along the arroyo system arranged in four transects with five traps each. The second site is in the vicinity of IMRS Headquarters Compound (30.77688°N, 105.01617°W; 1235 m elevation), containing a total of 51 traps included in eight transects. The third site is located near the Prospect Pit area (30.77189°N, 105.01123°W; 1248 m elev.) and consists of five transects with six traps each, totaling 30 traps. Five other pit-fall trap arrays (Figure 4) have been placed in others areas of IMRS and they contain five pitfall traps each for a general survey study conducted at the IMRS during the first year of this study (Couvillon, 2011). Those locations are as follows: Woodpecker Well (30.814286°N, 105.048668°W; 1265 m elev.); Oak Arroyo (30.786488°N, 104.980355°W; 1319 m elev.); Red Tank

(30.731063N, 104.988238°W; 1193 m elev.); and Lonely Tank (30.727874°N, 104.972471°W; 1194 m elev.). Lizards were collected in pitfall traps throughout the day, put into plastic bags marked with bucket number and date, and then taken to IMRS laboratory for processing. GPS coordinates were recorded for hand-caught lizards found near the pitfall trap arrays. Live specimens were sexed, measured (total length [TL], snout-vent length [SVL]), and weighed, as well as individually marked via toe clippings using Tinkle's (1967) mark-recapture methods, which remains one of the most effective method for monitoring reptiles (Murray and Fuller, 2000; Ferner, 2007). SVL and weight were used to calculate body condition indices in order to evaluate potential differences for determining the overall fitness of individuals and groups, and possibly to observe any influences of mite parasitism. Body condition was calculated using Andrew's (1991) formula ( $IC = Mass^{0.33} / SVL$ ), in order to add a scale of general health for each lizard based on the relationship of two morphometric variables; body length and mass.



Figure 3. Pitfall trap type used for lizard studies on IMRS (photo adapted from Couvillon, 2011)

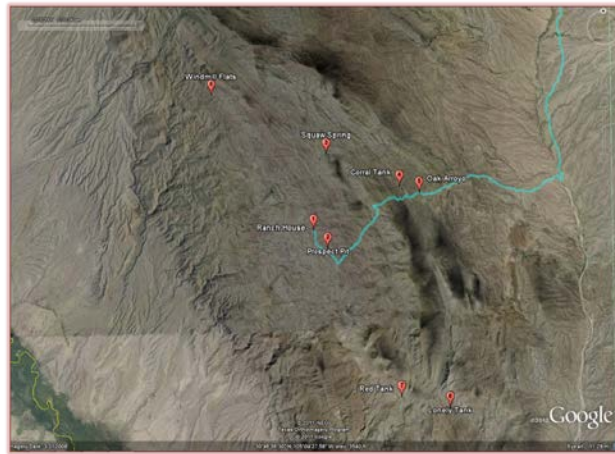


Figure 4. Google Earth display showing the eight pitfall array sites used in this study on IMRS. (Ranch House, Woodpecker Well, Oak Arroyo, Corral, Squaw Spring, Prospect Pit, Red Tank, and Lonely Tank); however Ranch House, Prospect Pits, and Squaw Spring are the major capture sites

**Mite Processing.** - Mites from infected areas of the lizard body were observed and counted using a dissection microscope and a magnifying glass. Representative mite samples were collected for each lizard species for identification. The infected positions on lizard bodies were noted for all areas. Body positions are identified as follows and depicted on Figure 5: axillary, pectoral, cervical, inguinal, sacral, and femoral, gular, abdominal (venter), and cloacal regions; the main potential sites of mite infection. The number of mites found at each body position was recorded and the sum of those (the total mite load) was calculated for each individual. Lizards were also toe clipped for later identification using the method of Tinkle (1958), which has become the most accepted method used in lizard ecology (Ferner, 2007). Recaptured lizards are important

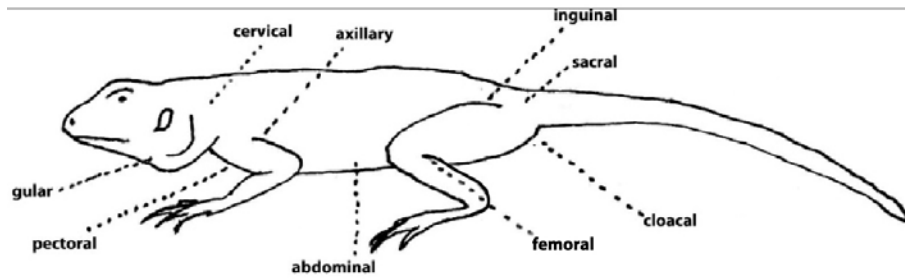


Figure 5. Body positions examined for mite infections on whiptail lizard species captured on IMRS.

for examining temporal flux in mite loads. After lizards were processed, they were released within five meters of the pitfall trap or place they were originally collected.

**Statistical Analysis.** – All statistical analyses were done using Minitab 14. The vast majority of the data displayed non-normality. As normality is an assumption for the use of parametric statistical techniques, non-parametric techniques were chosen instead. The Mann-Whitney U-test was utilized to analyze differences in parasite load frequencies between species, age classes, and sexes. The intensity of parasites, which refers to the mean number of parasites per infected host, was also examined with a Mann-Whitney U-test. When analyzing the parasitic prevalence, which is the proportion of infected individuals for each sample analyzed, a Univariate Logistic Regression was used to test differences in parasitic incidence between species. To test differences in location of body infection, the General Linear Mixed model, which is a generalization of the ANOVA, was used to analyze any differences between the particular body locations where parasites occur and their prevalence for each species. This model tests repeated

measures, different body locations, and takes into account correlations among the repeated measures within the same lizard. All statistical tests will be assumed to be significant at the alpha 0.05 level. The null hypothesis for this study will be no difference exists in ectoparasitic prevalence and intensity between species.

Environmental factors, mainly temperature and precipitation, were compared to the mite data to determine if any relationships exist, using simple linear regression analysis. These factors were then correlated to different lagged time data to compare if previous environmental variables were associated with current mite infestation rates. Time was lagged one, two, three weeks, and one month (7 day intervals) to investigate if any significant correlations interacted between previous environmental variables and subsequent ectoparasitism.

A research protocol for this study was submitted and approved (protocol A-201104-1) by UTEP's Institutional Animal Care and Use Committee (IACUC). Representative parasites were preserved in 70% ethanol and placed into the UTEP Biodiversity invertebrate collection, and also into the United States National Parasite Collection (USNPC), Beltsville, Maryland. Mites were identified by Dr. Cal Welbourn from the Division of Plant Industry, Florida Dept. Agriculture & Consumer Services.

## RESULTS

Table 1. Descriptive statistics of *Aspidoscelis marmorata* and *A. tessellata* throughout the study period. SVL = snout-vent length, IC = index of body condition.

Species	Count (n)	Range SVL (mm)	Avg SVL	Range Weight (g)	Avg Weight	Avg IC
<i>A. marmorata</i>	141	37-97	81.22	1.3-28.7	16.38	2.79
<i>A. tessellata</i>	144	30-97	68.54	0.6-26.1	9.95	2.77

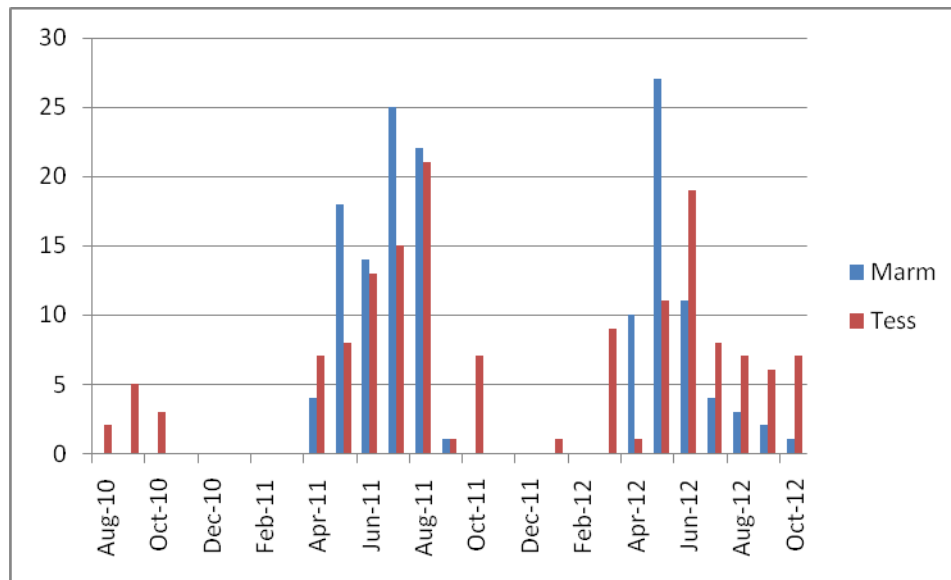


Figure 6. Monthly counts of *A.marmorata* (n = 141) and *A. tessellata* (n = 144) throughout the sampling period (Aug. 2010-Oct. 2012) on IMRS.

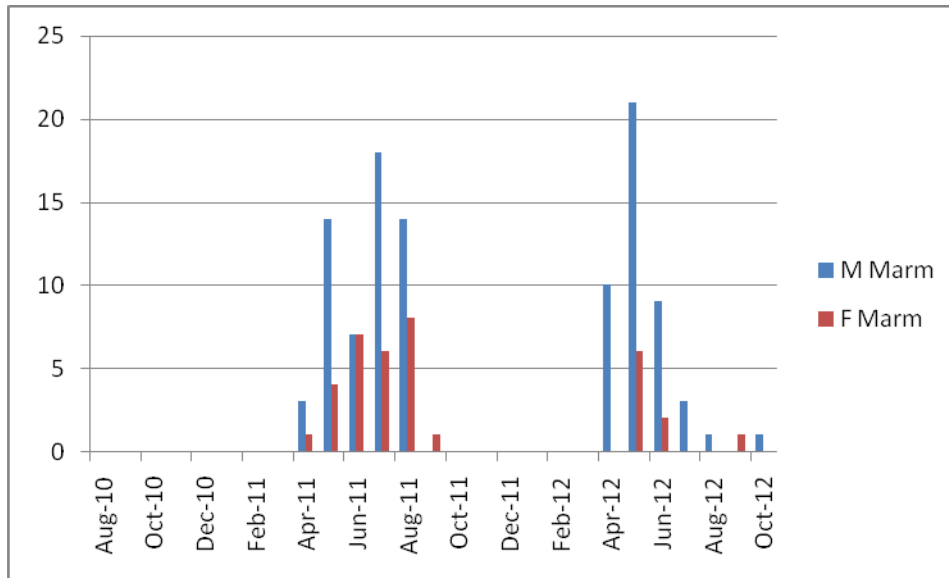


Figure 7. Monthly counts of male (n = 100) and female (n = 36) *A. marmorata* throughout the sampling period (Aug. 2010- Oct. 2012) on IMRS.

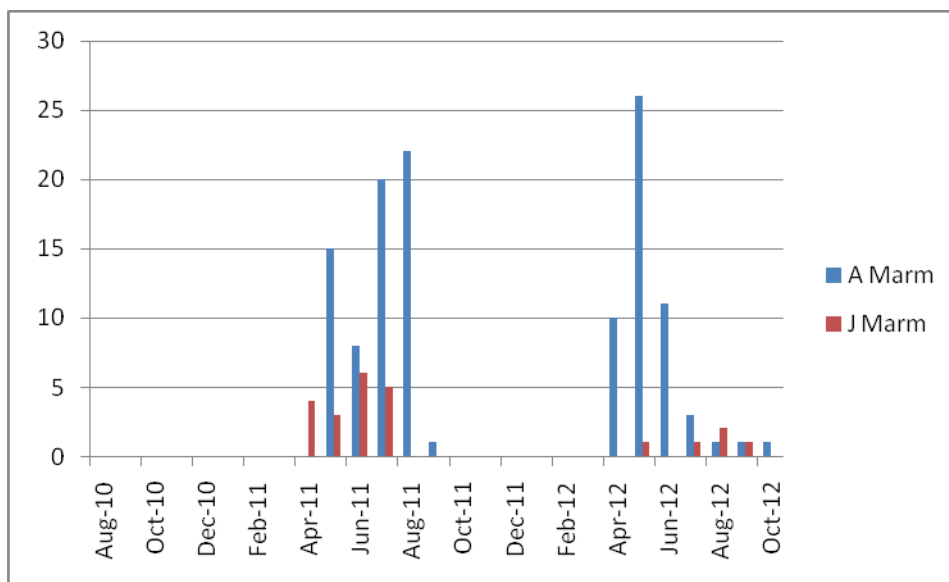


Figure 8. Monthly counts of *A. marmorata* distinguished by maturity (A = adult, n = 117; J = juvenile, n = 24) throughout the sampling period (Aug. 2010-Oct. 2012) on IMRS.

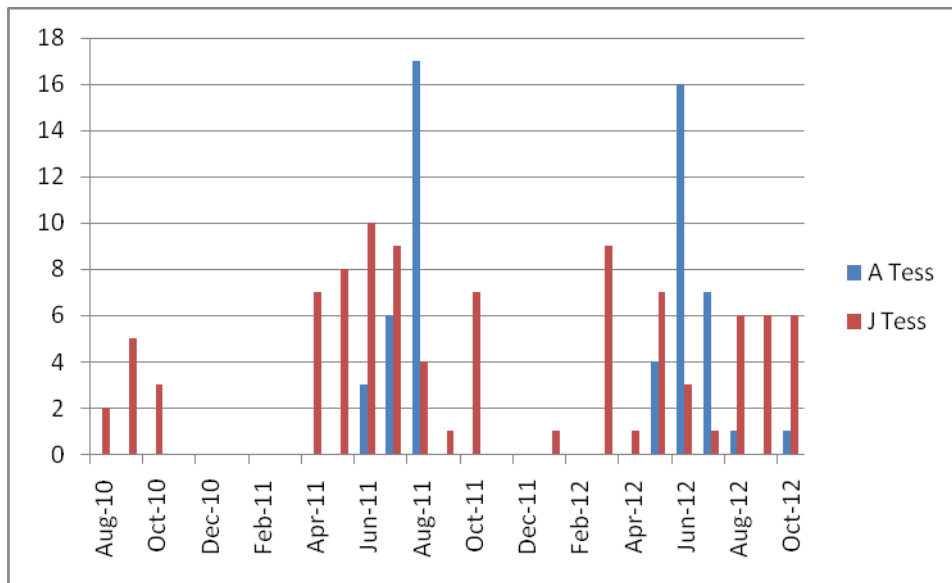


Figure 9. Monthly counts of *A. tessellata* distinguished by maturity (A = adult, n = 54; J juvenile, n = 90) throughout the sampling period (Aug. 2010-Oct. 2012) on IMRS

A total of 285 *Aspidoscelis marmorata* (n = 141) and *A. tessellata* (n = 144) specimens were captured throughout the two year (27 months) study, (Table 1, Figure 6, Appendix). *Aspidoscelis marmorata* was much more seasonal in activity compared to *A. tessellata* in both later emergence and earlier retreat during both years (Figure 6), including a lack of presence at the end of summer 2010; when sampling began in August.

Mite infestation varied much more so than compared to lizard activity, with a mite emergence population boom occurring at the end of July 2011, while the second year had early mite emergence at the end of March 2012, with a smaller population peak in July 2012 (Figures 10 and 11). Both years exhibited mite retreat by the end of October.

Observational differences were also detected between species and year, as depicted in



Figures 12 and 13, where a distinguished role reversal between species and parasitic resistance is apparent.

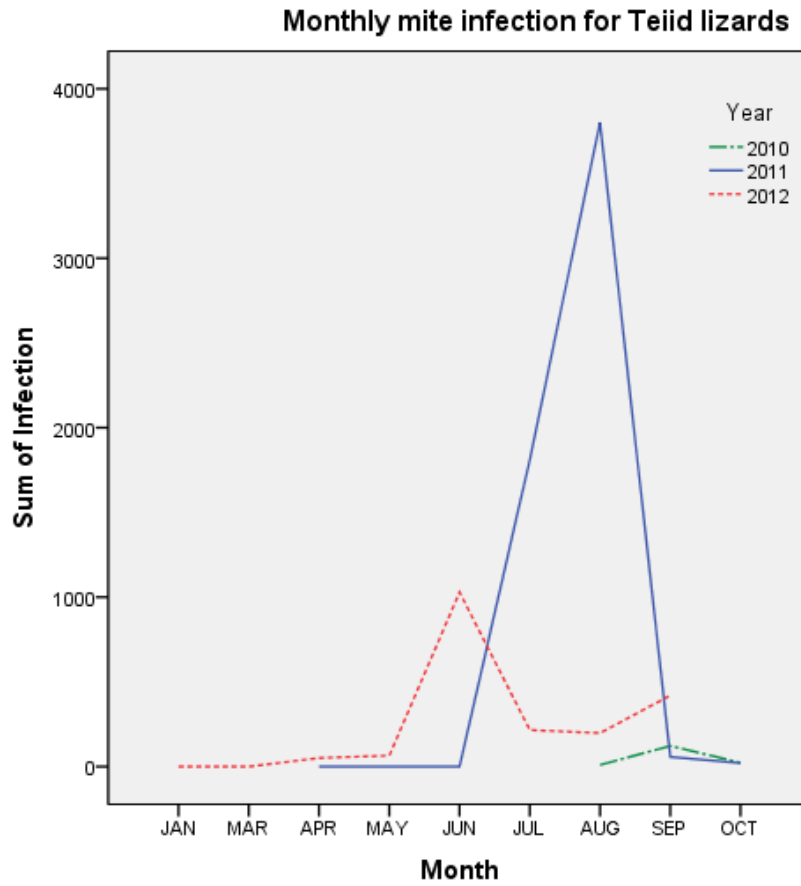


Figure 10. Total monthly mite infestation (monthly sums) for *Aspidoscelis marmorata* and *A. tessellata* throughout the sampling period (Aug. 2010-Oct. 2012) on IMRS.

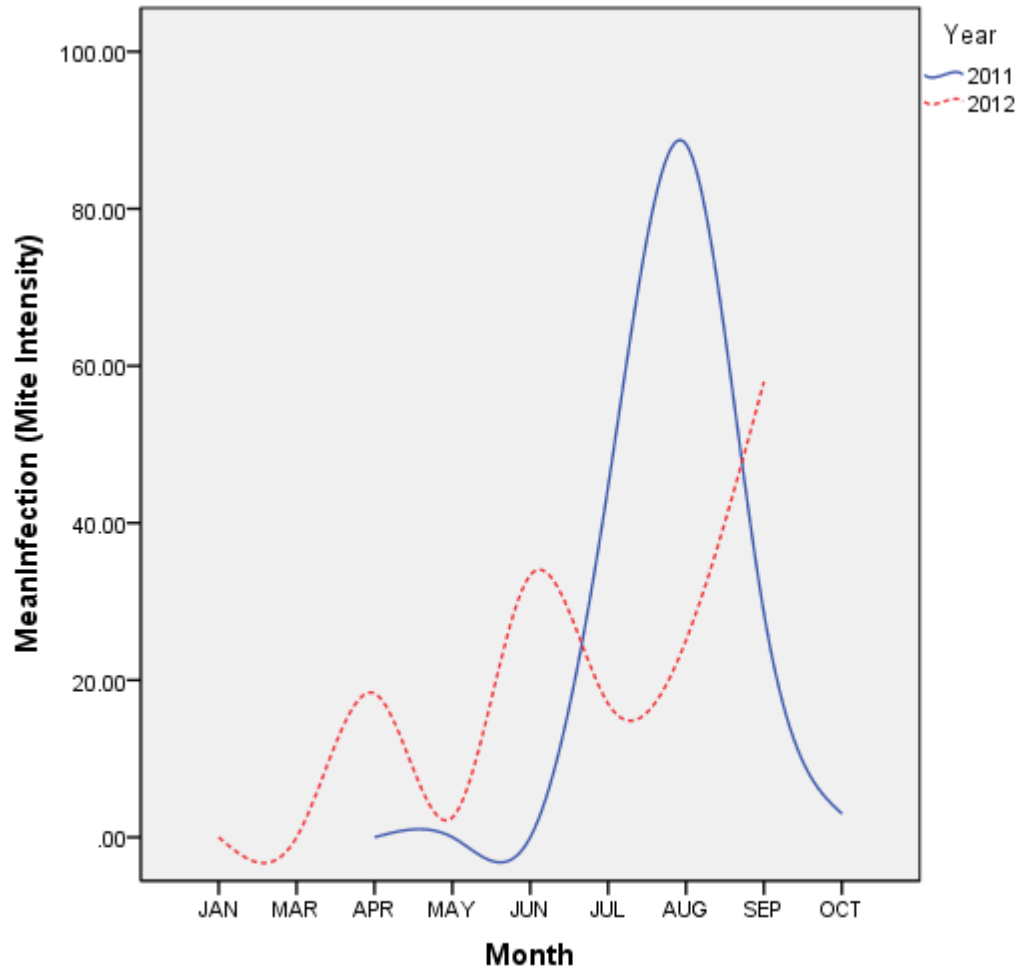


Figure 11 . Monthly averages of mite infestation on *Aspidoscelis marmorata* and *A. tessellata* between two major infection periods (Apr. 2011-Oct. 2012) on IMRS.

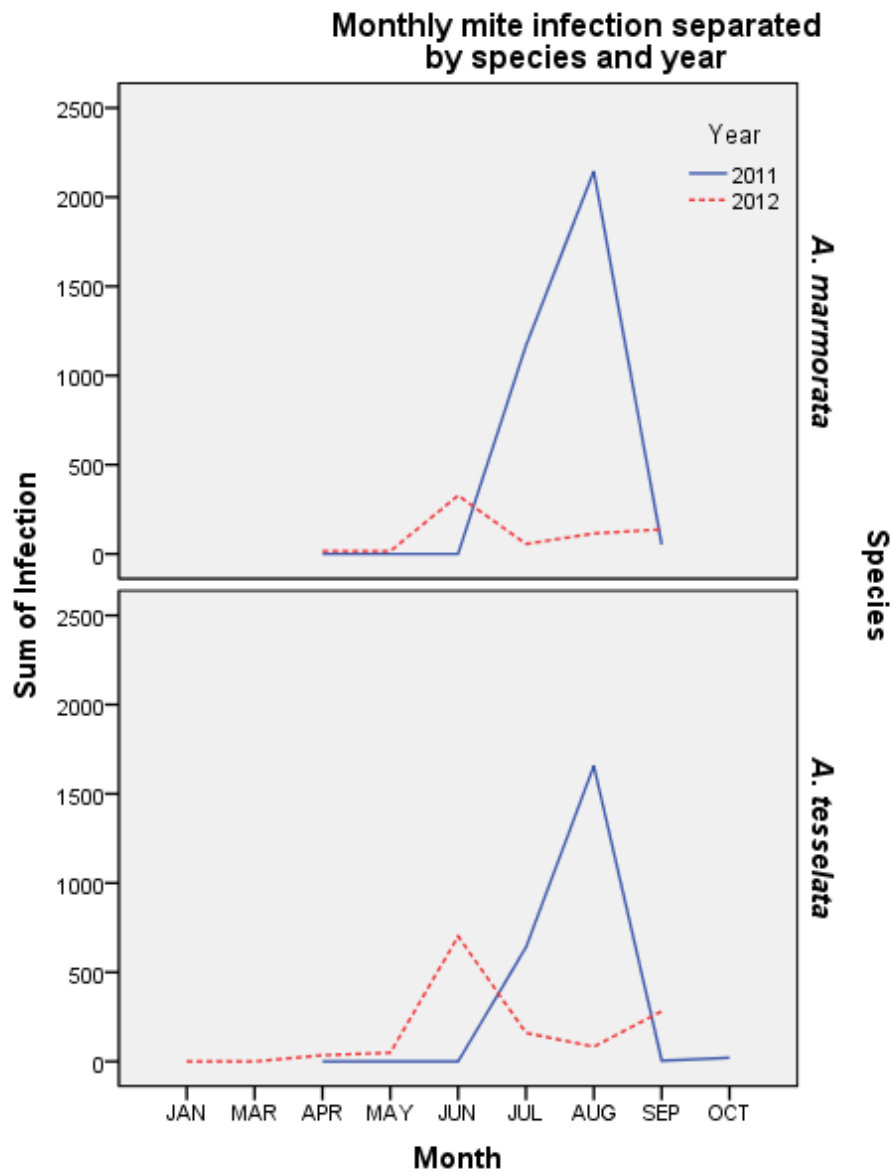


Figure 12. Monthly mite infection (monthly sums) on *Aspidoscelis marmorata* and *A. tessellata* throughout the sampling period (Aug. 2010-Oct. 2012) on IMRS.

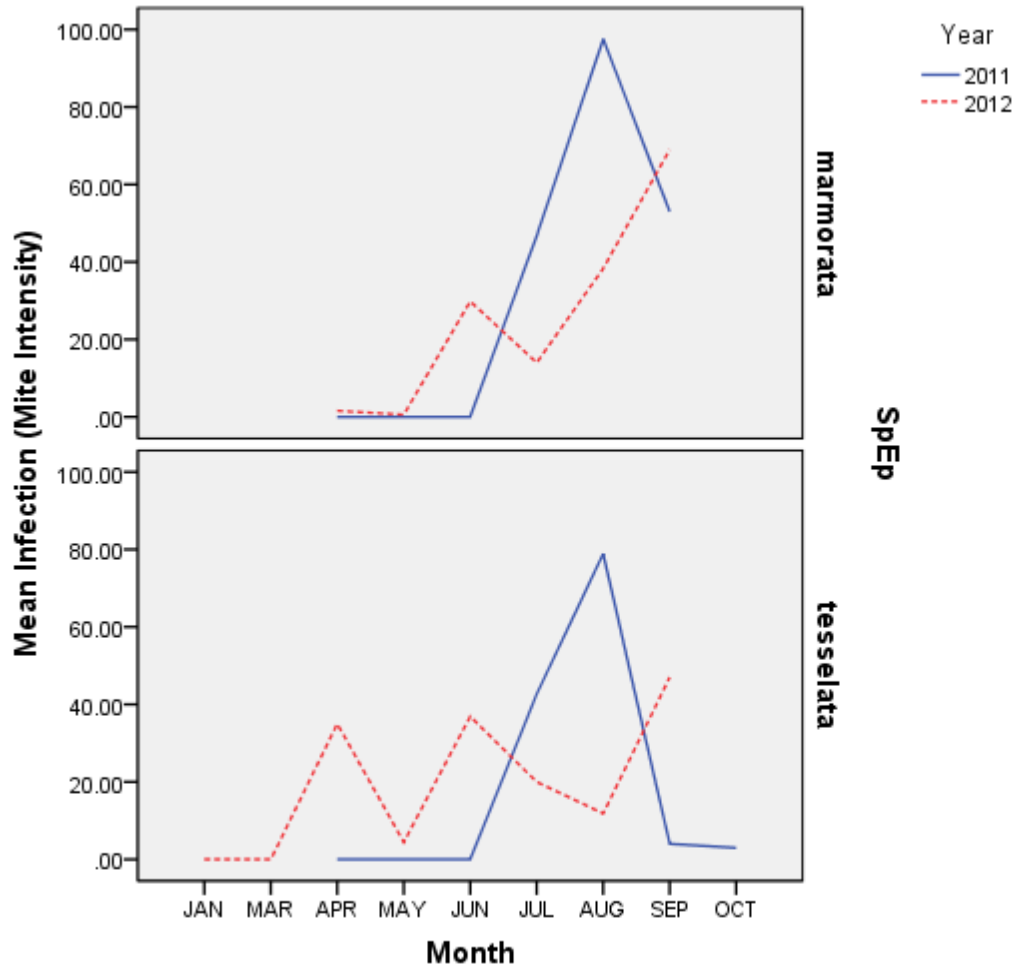


Figure 13. Monthly mite infection (monthly averages) on *Aspidoscelis marmorata* and *A. tessellata* throughout the sampling period (Aug. 2010-Oct. 2012) on IMRS.

**Year 1 (2011).** – Collection in year one yielded proper sample sizes for analysis of not only species differences, but gender and maturity factors as well. Three analyses evaluated morphological and mite infection differences between *A. tessellata* and both male and female *A. marmorata*. The analyses (Table 2) examined the entire dataset for the year 2011 (ALL), the infection period (IP); lizards captured within the time period of mite emergence and cessation, and adult lizards (Adult). Although no sexual differences

in either body condition (IC) or mite intensity (INF) were found, separate analyses revealed morphological differences between the sexes. The analysis of the entire data set shows that male *A. marmorata* (n = 56) were significantly ( $p < 0.05$ ) longer ( $\mu = 82.6$  mm) and heavier ( $\mu = 17.0$  g) than both *A. tessellata* ( $\mu = 71.0$  mm, 10.7 g) and female *A. marmorata* ( $\mu = 75.2$  mm, 11.7 g). The analysis for the infection period shows similar results with only the female whiptails not significantly differing in body size ( $p > 0.05$ ). However, when only adult lizards are examined, *A. tessellata* and male *A. marmorata* do not differ in SVL or body weight, while female *A. marmorata* are significantly smaller ( $p < 0.05$ ).

Table 2. Statistics for the first sampling year (2011) for *Aspidoscelis marmorata* and *A. tessellata* using Mann-Whitney U-test for each variable with averages provided where significance occurs. Significant probability (Pr) values are bolded. ALL = cumulative data, IP = infection period, IA = infected adults, SVL = snout-vent length, IC = index of body condition, INF = infection (mite intensity), and  $\mu$  = denotes mean measurements when the test statistic was shown to be significant.

N		Pr (SVL)	$\mu$ SVL (mm)	Pr (Weight)	$\mu$ W (g)	Pr (IC)	$\mu$ IC	Pr (INF)	$\mu$ INF
MarmF-MarmM									
27-56	All	<b>0.007</b>	<b>75.2-82.6</b>	<b>0.0008</b>	<b>11.7-17.0</b>	0.1176		0.5896	
27-56	IP	<b>0.007</b>	<b>75.2-82.6</b>	<b>0.0008</b>	<b>11.7-17.0</b>	0.1176		0.5896	
16-50	IA	<b>0.0278</b>	<b>80.6-85.0</b>	<b>0.0397</b>	<b>14.2-18.1</b>	0.1552		0.5103	
MarmF-Tess									
27-72	All	0.2087		0.2942		0.2370		0.5743	
27-64	IP	0.6514		0.8247		0.5871		0.6608	
16-26	IA	<b>0.0079</b>	<b>80.6-84.7</b>	<b>0.0063</b>	<b>14.2-16.9</b>	0.7461		0.5007	
MarmM-Tess									
56-72	All	<b>0.0001</b>	<b>82.6-71.0</b>	<b>0.0001</b>	<b>17.0-10.7</b>	0.3691		0.9254	
56-64	IP	<b>0.0001</b>	<b>82.6-74.0</b>	<b>0.0001</b>	<b>17.0-11.7</b>	0.1030		0.8850	
50-16	IA	0.6107		0.4699		0.0827		0.1515	

Prevalence (presence/absence) of mites was analyzed using a Univariate Logistic Regression analysis, with mites as the dependent variable, and species as the predictor. Results show that species is a significant predictor for the presence of mites  $\text{Pr} > \text{ChiSq}$  ( $p = 0.044$ ) with a point estimate showing that overall, *A. marmorata* is about half (0.531) less likely to having mites compared to *A. tessellata*; making unisexuals 2 times more prone to infection.

**Year 2 (2012).** - Analyses for morphometric and mite intensity differences between sexes were replicated for year two, and were shown to be not significant from year one. The index of body condition (IC) was significant throughout all comparisons, with male *A. marmorata* exhibiting healthier body condition ( $\mu = 2.83$ ) than both female comparisons, while female *A. marmorata* maintained the poorest body condition ( $p < 0.05$ ). The analysis for the entire dataset (ALL) shows similar patterns to year one, with male *A. marmorata* being significantly larger in SVL ( $\mu = 87.4$  mm) and body weight ( $\mu = 20.8$  g) when compared to the two groups of female whiptails ( $p < 0.05$ ). Analysis of adults show similar patterns with larger male lizards; however with significantly heavier ( $p = 0.048$ ) *A. tessellata* ( $n = 28$ ,  $\mu = 16.3$  g) compared to female *A. marmorata* ( $n = 7$ ,  $\mu = 14.8$  g). Within this final analysis, the only infection difference between the sexes indicated adult male *A. marmorata* ( $n = 44$ ,  $\mu = 10.5$  mites) having significantly less mite intensity ( $p = 0.017$ ) when compared to *A. tessellata* ( $n = 28$ ,  $\mu = 29.6$  mites).

Prevalence (presence/absence) of mites were identical to year one using a Univariate Logistic Regression analysis, with mites as the dependent variable, and species as the

predictor. As opposed to the prior year; 2012 results show that species is an insignificant predictor for the presence of mites  $Pr > \text{ChiSq}$  ( $p = 0.181$ ).

Table 3. Statistics for the second sampling year (2012) for *Aspidoscelis marmorata* and *A. tessellata* using Mann-Whitney U-test for each variable with averages provided where significance occurs. Significant probability (Pr) values are bolded. ALL = cumulative data, IP = Infection period, IA = Infected adults, SVL = snout-vent length, IC = index of body condition, INF = infection (mite intensity),  $\mu$  = denotes mean measurements when the test statistic was shown to be significant.

N		Pr (SVL)	$\mu$ SVL (mm)	Pr (Weight)	$\mu$ W (g)	Pr (IC)	$\mu$ IC	Pr (INF)	$\mu$ INF
MarmF-MarmM									
9-44	All	<b>0.0037</b>	<b>78.7-87.4</b>	<b>0.0004</b>	<b>12.8-20.8</b>	<b>0.0006</b>	<b>2.68-2.83</b>	0.7135	
9-44	IP	<b>0.0037</b>	<b>78.7-87.4</b>	<b>0.0004</b>	<b>12.8-20.8</b>	<b>0.0006</b>	<b>2.68-2.83</b>	0.7135	
7-44	IA	<b>0.0317</b>	<b>83.6-87.4</b>	<b>0.0039</b>	<b>14.8-20.8</b>	<b>0.0008</b>	<b>2.65-2.83</b>	0.5201	
MarmF-Tess									
9-62	All	0.054		0.3162		<b>0.0131</b>	<b>2.68-2.78</b>	0.2839	
9-61	IP	0.0605		0.3479		<b>0.0140</b>	<b>2.68-2.77</b>	0.2652	
7-28	IA	0.8852		<b>0.0478</b>	<b>14.8-16.3</b>	<b>0.0158</b>	<b>2.65-2.75</b>	0.0833	
MarmM-Tess									
44-62	All	<b>0.0001</b>	<b>87.4-67.5</b>	<b>0.0001</b>	<b>20.8-9.9</b>	<b>0.0001</b>	<b>2.83-2.78</b>	0.1118	
44-61	IP	<b>0.0001</b>	<b>87.4-67.8</b>	<b>0.0001</b>	<b>20.8-9.9</b>	<b>0.0001</b>	<b>2.83-2.77</b>	0.0926	
44-28	IA	0.0037	<b>87.4-83.9</b>	<b>0.0001</b>	<b>20.8-16.3</b>	<b>0.0001</b>	<b>2.83-2.75</b>	<b>0.0173</b>	<b>10.5-29.6</b>

**Cumulative (2011-2012).** - Cumulative analyses with entire data set show varying results within different temporal scales and adult distinction, when concentrating strictly on species differences. The three comparisons (Table 4) for all years (ALL) dataset for adult lizards caught within the infection periods (IP) for both years, and infected adults (IA), which remove lizards without mite infestation.

All three comparisons established *A. marmorata* with a higher index of body condition, except for the insignificant first infection period in 2011, which closely approached significance ( $p = 0.057$ ).

Table 4. Mite intensity analysis for *Aspidoscelis marmorata* and *A. tessellata* using Mann Whitney U-Tests. Significant probability (Pr) values are bolded. ALL = cumulative data, IP = Infection period, IA = Infected adults, with only significant mean values to the right of its probability value, SVL = snout-vent length, IC = index of body condition, INF = infection (mite intensity), and  $\mu$  = denotes mean measurements when the test statistic was shown to be significant.

N		Pr (SVL)	$\mu$ SVL (mm)	Pr (Weight)	$\mu$ W (g)	Pr (IC)	$\mu$ IC	Pr (Inf)	$\mu$ Inf
Marm-Tess									
136-144	YR	<b>0</b>	<b>82.4-68.5</b>	<b>0</b>	<b>16.9-9.9</b>	<b>0.0373</b>	<b>2.78-2.77</b>	0.1347	
33-36	IP 2011	0.0754		0.0569		0.7457		<b>0.0103</b>	<b>101.8-64.6</b>
53-61	IP 2012	<b>0</b>	<b>85.9-67.8</b>	<b>0</b>	<b>19.4-10.0</b>	<b>0.0072</b>	<b>2.81-2.77</b>	0.0665	
32-19	IA 2011	0.0829		0.2197		<b>0.0298</b>	<b>2.76-2.73</b>	<b>0.03064</b>	<b>99.4-83.2</b>
24-19	IA 2012	<b>0.0122</b>	<b>88.1-84.1</b>	<b>0.0006</b>	<b>21.1-16.6</b>	<b>0.0028</b>	<b>2.83-2.75</b>	<b>0.0145</b>	<b>21.7-43.6</b>

The cumulative mite infection (INF) was also insignificant ( $p = 0.134$ ). Cumulative data throughout both years (ALL) showed significant differences in morphology between *A. marmorata* ( $n = 136$ ) and *A. tessellata* ( $n = 144$ ), with *A. marmorata* being significantly longer ( $\mu$ SVL = 82.4-68.5 mm) and heavier ( $\mu$ W = 16.9-9.9 g) ( $p < 0.05$ ). Although the adult lizards from the first infection period did not have significant differences for length, body weight, or body condition, the infection intensity was significantly higher for *A. marmorata* ( $n = 33$ ,  $\mu$ INF = 101.8) which approached double the intensity when compared to its parthenogeny, *A. tessellata* ( $n = 36$ ,  $\mu$ INF = 64.6) ( $p < 0.05$ ). In contrast, the second infection period when analyzed yielded significant ( $p < 0.05$ ) differences, with *A. marmorata* being longer ( $\mu$ SVL = 85.9-67.8 mm), heavier ( $\mu$ W = 19.5-10.0 g), and an increased index of body condition ( $\mu$ IC = 2.81-2.77), while mite



intensity was slightly insignificant ( $p = 0.067$ ). The comparisons for the infected adults show that *A. marmorata* maintained higher body condition for both years, being significantly larger in year two ( $\mu\text{SVL} = 88.1\text{-}84.1$  mm;  $\mu\text{W} = 21.1\text{-}16.6$  g). The mite infestation for year one coincides with the infection period's results, with *A. marmorata* having significantly ( $p = 0.031$ ) higher intensity ( $\mu = 99.4\text{-}83.2$  mites) (Figure 14). However, in year two the infected adult *A. tessellata* had significantly ( $p = 0.015$ ) higher mite intensity ( $\mu = 21.7\text{-}43.6$  mites) (Figure 15).

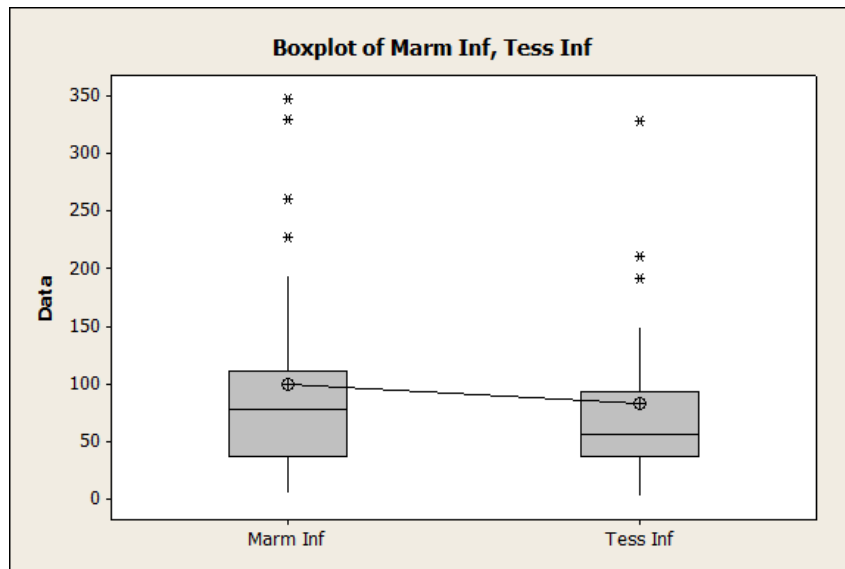


Fig 14. Boxplots showing significant mite intensity differences ( $p = 0.0103$ ) between *A. marmorata* ( $n = 33$ ) and *A. tessellata* ( $n = 36$ ) within the infection period (IP 2011) on IMRS, with the y-axis representing the number of external mites.

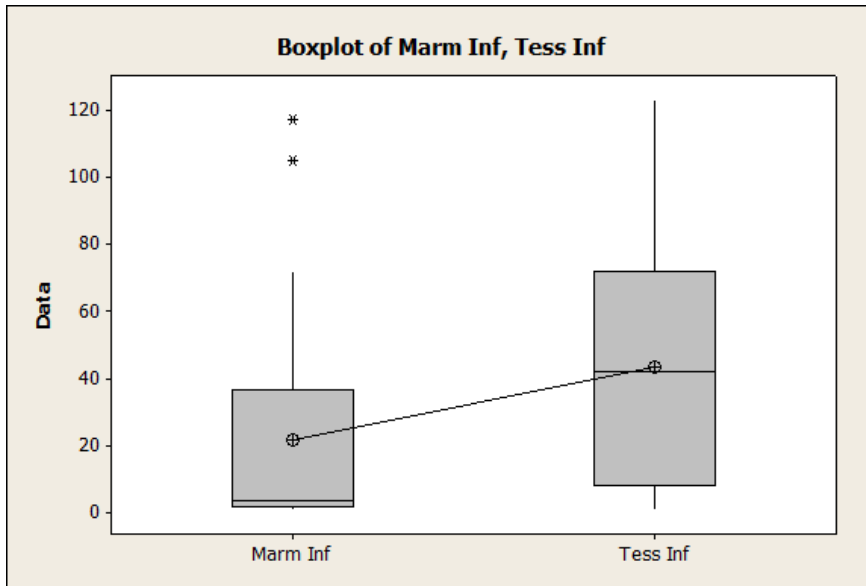


Fig 15. Boxplots showing significant mite intensity differences ( $p = 0.0145$ ) between adult *A. marmorata* ( $n = 24$ ) and *A. tessellata* ( $n = 19$ ) within the infection period (IP 2012), with the y-axis representing the number of external mites.

**Body Infection Distribution-** Cumulative analyses on body location (mite distribution) show several significant ( $p < 0.05$ ) differences between the two species (*A. marmorata*, and *A. tessellata*) through the three key body locations of infection (Abdominal, Axillary, and Sacral) in both prevalence and intensity (Tables 5, 6, & 7).

Table 5. General Estimating Equations analysis for presence/absence of infection as dependent variable, species and location as predictors, cumulative data.

Source	DF	Chi-Square	Pr > ChiSq
<b>SpEp</b>	2	14.36	<b>0.0008 *</b>
<b>Location</b>	2	43.32	<b>&lt;.0001 *</b>
<b>Location *SpEp</b>	4	57.31	<b>&lt;.0001 *</b>

Table 6. General Linear Mixed Model analysis for LOG (infection+1) as dependent variable, species and location as predictors, but non-normal, cumulative data.

Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
<b>SpEp</b>	2	315	3.82	<b>0.0229 *</b>
<b>Location</b>	2	630	62.26	<b>&lt;.0001 *</b>
<b>Location *SpEp</b>	4	630	14.55	<b>&lt;.0001 *</b>

Table 7. General Linear Mixed Model analysis for LOG (infection+1) as dependent variable, with species and location as predictors, but non-normal, cumulative data.

Tests of Effect Slices						
Effect	Location	SpEp	Num DF	Den DF	F Value	Pr > F
<b>Location *SpEp</b>		marmorata	2	630	77.40	<b>&lt;.0001 *</b>
<b>Location *SpEp</b>		tesselata	2	630	48.82	<b>&lt;.0001 *</b>
<b>Location *SpEp</b>	Abdominal		2	839	13.91	<b>&lt;.0001 *</b>
<b>Location *SpEp</b>	Axillary		2	839	0.28	<b>0.7586 ns</b>
<b>Location *SpEp</b>	Sacral		2	839	13.33	<b>&lt;.0001 *</b>

These statistics show that *A. marmorata* has significantly ( $p < 0.001$ ) higher infection rates on the abdominal scales compared to *A. tesselata* (Figure 16). However, the sacral body location is most infested in the parthenoform *A. tesselata* compared to *A. marmorata* ( $p < 0.0001$ ). Number of mites on axillary body locations wasn't significantly different between the two teiids ( $p = 0.76$ ).

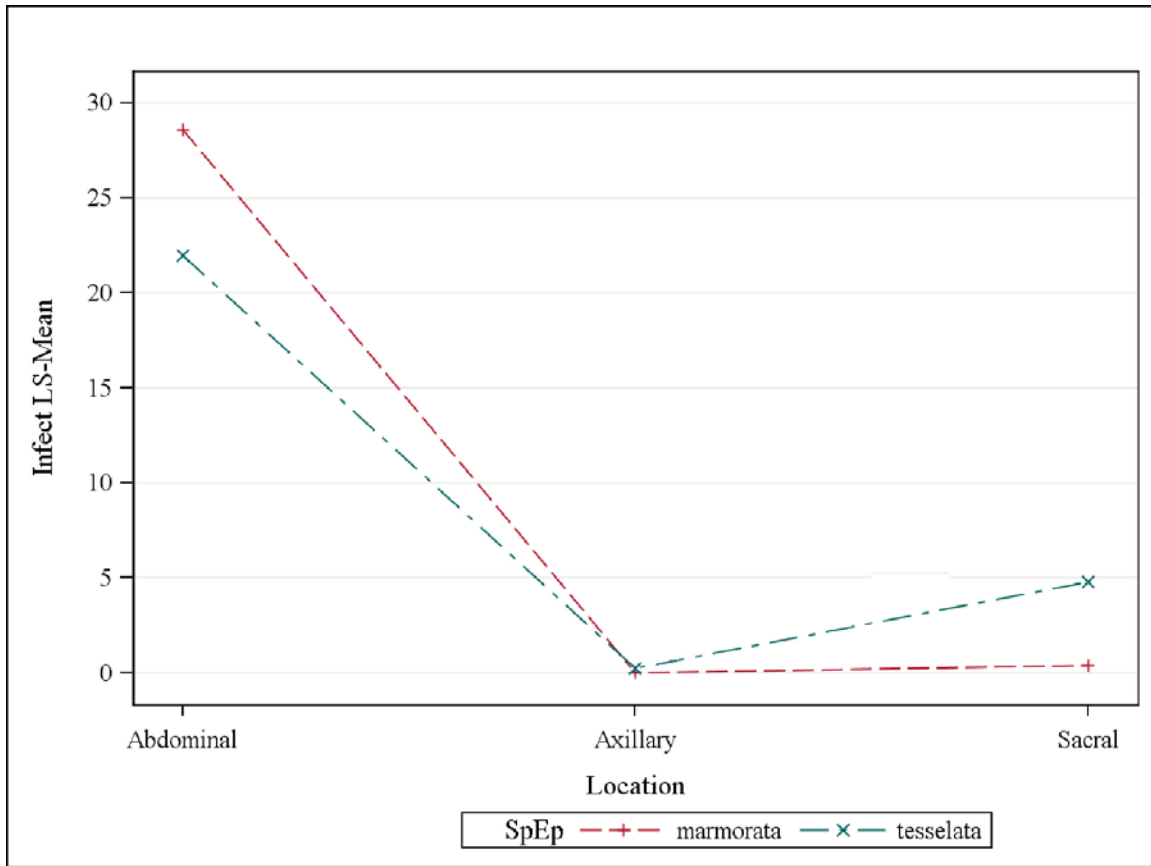


Figure 16. General Linear Mixed Model analysis for LOG (infection+1) as dependent variable, with species and location as predictors, but non-normal, cumulative data.

**Environmental Interactions-** Using simple linear regression analysis to compare monthly average (T0) environmental variables with each month's average infection (mite intensity) with incorporated lag time effects (Table 8). Lag time was tested in order to compare previous environmental variables with the subsequent infection rates by shifting the hourly variables back in 7 day intervals up to the previous monthly averages (Tmonth). Temperature was positively correlated with mite infestation rates in all temporal comparisons ( $p = 0.000$ ). Relative humidity was significant only up to the biweekly average ( $p = 0.000$ ). Lastly, rainfall was only positively correlated with mite

infestation with a lag of the previous month's average ( $p = 0.001$ ). Both wind speed and pressure were not correlated with mite infestation.

Table 8. Linear Regression analysis of total infection to environmental variables (temperature, humidity, wind speed, air pressure, and precipitation). Significant values ( $p < 0.05$ ) are bolded in green.

Variable	T <sub>0</sub>	T <sub>1week</sub>	T <sub>2week</sub>	T <sub>3week</sub>	T <sub>month</sub>
Temp °C	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>
Humidity	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	0.205	0.127
Wind Speed	0.107	0.163	0.176	0.451	0.309
Pressure	0.856	0.522	0.758	0.904	0.849
Precipitation	0.234	0.377	0.674	0.647	<b>0.001</b>

Environmental variables of temperature, humidity, and precipitation exhibited notable variability between 2011 and 2012 (Figures 17, 18, and 19). Noteworthy observations include an extended freezing episode occurring in 2011 that produced noticeable observable effects throughout IMRS. Precipitation patterns were the most apparent difference between the two years by personal observation. The first year, 2011, was void of significant rainfall until the end of June, with a typical Chihuahuan Desert summer monsoon season began. However, in 2012 significant rainfall occurred early in March while the summer season was filled with scant rain immeasurable to our weather stations.

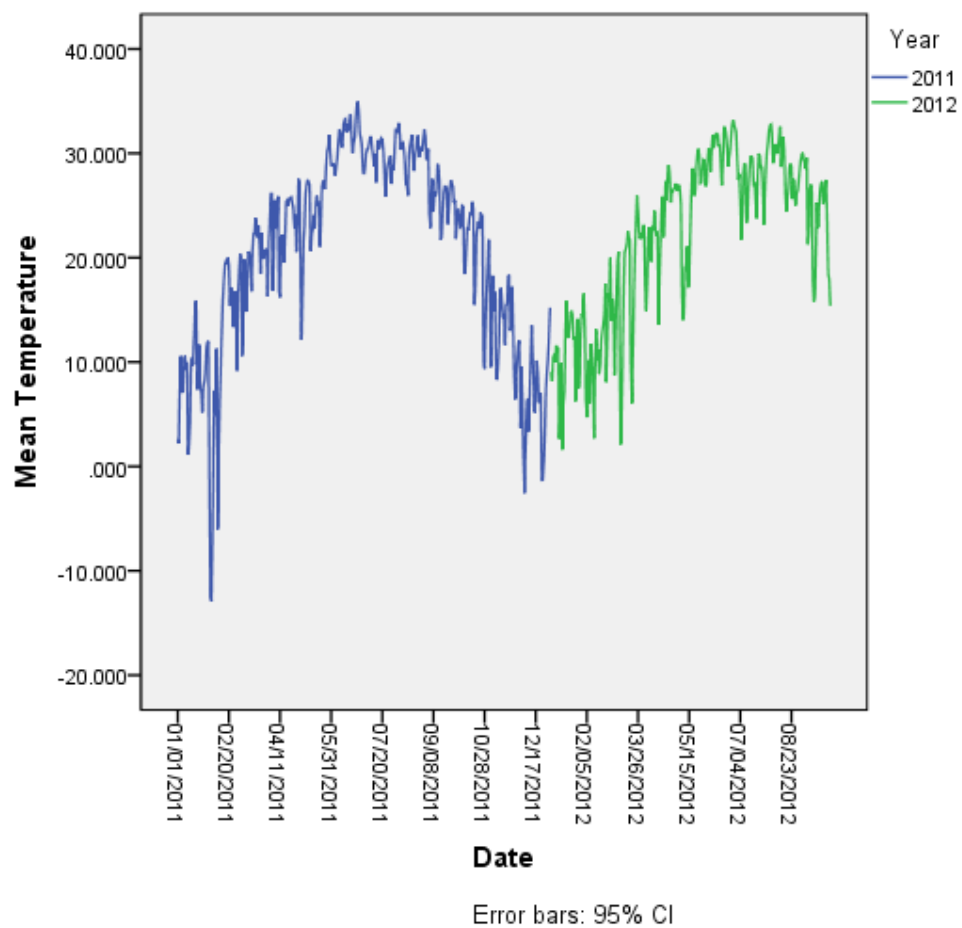


Figure 17. Mean Temperature (daily averages, °C) throughout the two year sampling period (2011-2012) on IMRS.

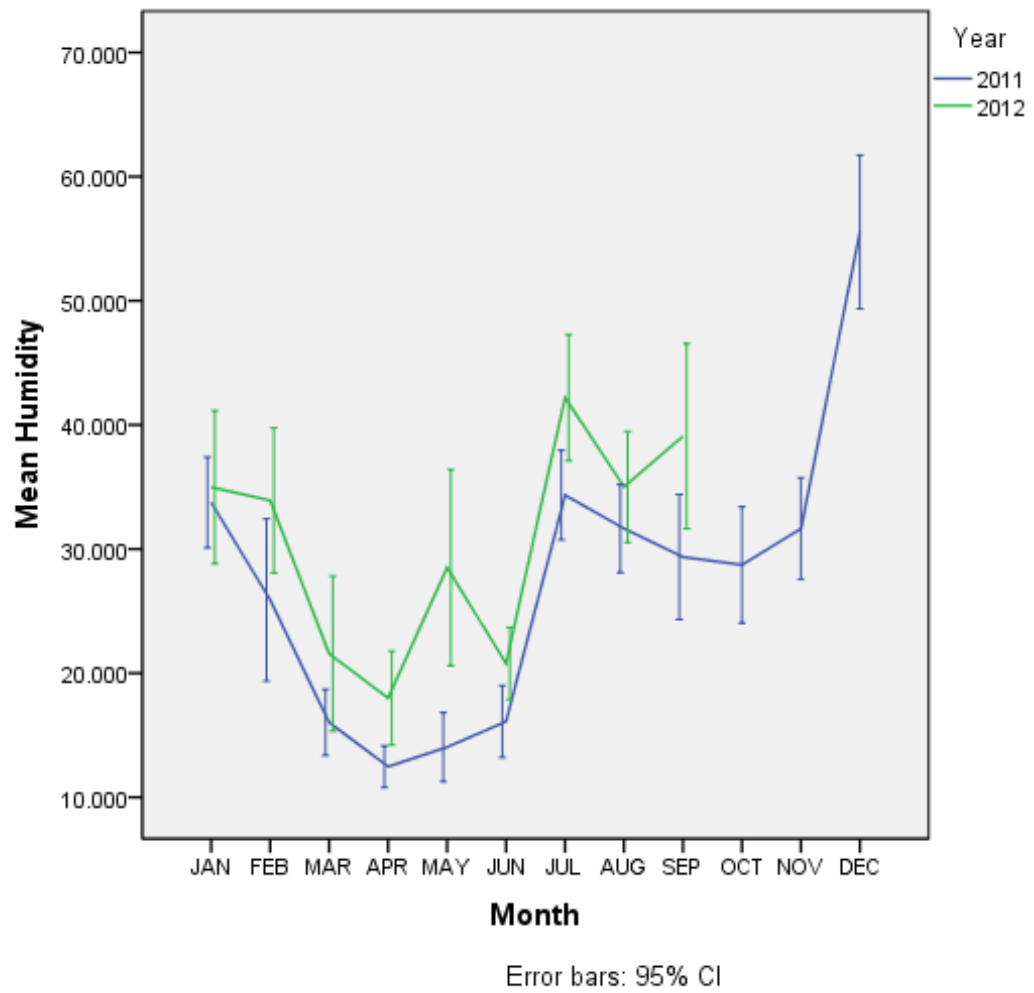


Figure 18. Monthly average humidity throughout the two year sampling period (2011-2012) on IMRS.

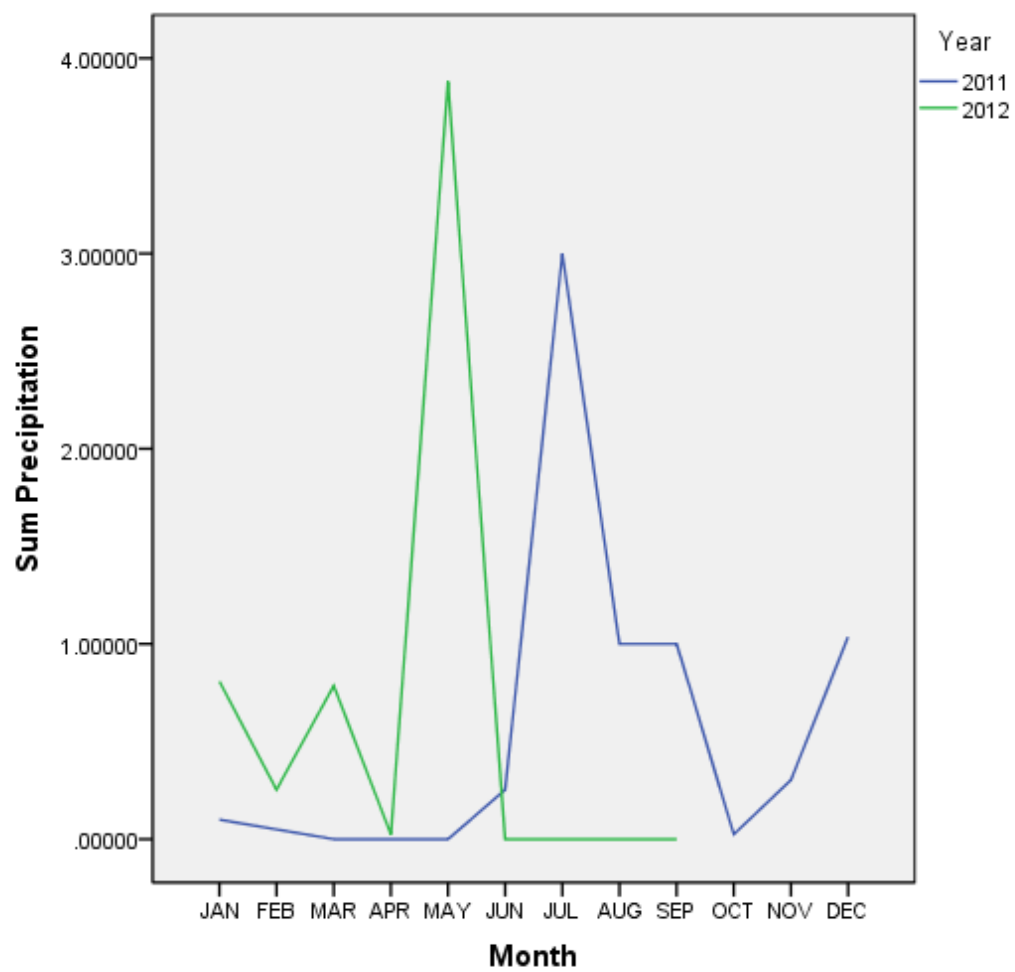


Figure 19. Monthly average precipitation throughout the two year sampling period (2011-2012) on IMRS.



## DISCUSSION

Comparing the parasitic loads between syntopic gonochoristic and parthenogenetic species has been investigated herein to test whether bisexual species in fact have higher levels of adaptability when compared to their unisexual counterparts. Utilizing the coevolutionary interactions between parasites and their host species, other studies have established support for the Red Queen Hypothesis, with bisexual species showing increased levels of parasitic resistance (Moritz et al., 1991, and Kearney and Shine, 2004) when compared to their unisexual counterpart, including earlier research performed on the internal parasites of whiptail population on IMRS (Carranza 1997, Mata-Silva et al., 2008. Carranza (1997) showed that the unisexual species, *A. exsanguis* and *A. tessellata*, had at least 50% more prevalence of endoparasites when compared to their bisexual relatives, *A. inornata* and *A. marmorata*. Mata-Silva et al. (2008) also revealed that *A. tessellata* had significantly higher intensity in parasite loads when compared to its mother species *A. marmorata*, also with 50% more nematode prevalence on unisexuals. Kearney and Shine (2004) also show evidence that parasitic mite infection only had a strong positive relationship with decreased evaporative water loss rate in the parthenoforms when comparing several physiological characters. Although finding evidence of ectoparasitism negatively affecting the fitness of their unisexual species, no relationship existed reproductive output and mite loads between the bisexual and parthenogenic species. However, additional studies have evidence to the contrary, where unisexual species are shown to have lower rates of parasitic infection (Brown et al., 1995, Hanely et al., 1995). Those two studies suggested that increased levels of unisexual heterozygosity, resulting from interspecific hybridization, could explain the increased levels of parasitic

resistance. Interestingly, the results presented here lend evidence both supporting and rejecting the Red Queen Hypothesis for bisexual adaptive superiority.

Evidence supporting the Red Queen Hypothesis was found in both sampling years (2011 and 2012). The body index condition was higher for male *A. marmorata* when compared to *A. tessellata*, as well as in cumulative analyses, which indicates an adaptive advantage for the former. During the 2012 infection period, infested adult male *A. marmorata* ( $n = 44$ ,  $\mu = 10.5$  mites) had significantly less mite intensity ( $p = 0.017$ ) when compared to *A. tessellata* ( $n = 28$ ,  $\mu = 29.6$  mites). Further analyses also show that infected adult *A. tessellata* had significantly ( $p = 0.015$ ) higher mite intensity ( $\mu = 21.7$ - $43.6$  mites) than *A. marmorata* during the second infection period in 2012. Mite prevalence in 2011 showed overall that *A. marmorata* is about half ( $0.531$ ) less prone to mite infestation when compared to *A. tessellata* ( $p = 0.044$ ), thus making unisexuals two times more vulnerable to infection. In respect to body distribution of mite infection, *A. marmorata* had significantly less parasitism on the sacral body location ( $p < 0.0001$ ).

Evidence rejecting the Red Queen Hypothesis was found during both years as well. Within the first infection period from July-Oct 2011, adult lizards did not have significant differences for body length, weight, or condition, but the infection intensity was significantly higher for *A. marmorata* ( $n = 33$ ,  $\mu_{INF} = 101.8$ ) approaching double the intensity when compared to its parthenoprogeny, *A. tessellata* ( $n = 36$ ,  $\mu_{INF} = 64.6$ ;  $p < 0.05$ ). The difference in prevalence of infection between the two species for 2012 was insignificant ( $p = 0.181$ ), displaying possible equivalent success between unisexual and bisexual parasitic resistance. The body distribution of mite infection analysis also displayed *A. marmorata* with significantly higher infection rates on the abdominal scales

( $p < 0.0001$ ), which may be more related to behavioral or locomotion differences rather than genetic.

Although there is much evidence testing the possible adaptive abilities in lizard parasite resistance, many of these relationships may be more affected by the environment rather than genetics alone. The differences observed in mite parasitism between the two years may be better understood by analyzing the environmental influences which each species is dependent on for seasonality and ecological constraints, rather than depending on the assumed genetic potentials. Environmental characteristics of the two sampling years were found to be quite different. Figures 17, 18, and 19 indicate that the extended and intensified freezing event during the first year is clearly shown with an average daily temperature peaking below 0 °C. Precipitation and humidity were also starkly different, with the first year experiencing an extended drought followed by a typical summer monsoon season with ample rainfall occurring in July. However, the second year had scattered rainfall events during winter and beginning of March while lacking the typical summer monsoon. These environmental fluctuations may help explain why mite parasitism was established much earlier in 2011 and the freeze at the end of that year may well have had an effect on the late emergence in chigger mites in 2012. Simple regression analyses showed significant interactions between environmental variables and mite infection that varied depending on the temporal scale (Table 8). Temperature, humidity, and precipitation were all shown to be significant variables when compared to monthly infection rates, although the reasons for these relationships needs further study.

This is the first study related to external mite infestation with lizard hosts that shows results both supporting and rejecting the idea of bisexual superiority in terms of

adaptability, or when applied to the Red Queen Hypothesis. The finding of differences in mite prevalence and other factors between the two years definitely indicates that variation in annual climatic events influences timing of the development of prevalence and intensity of mite infections.

Several restrictions presented themselves during the course of the study, especially those leading to the inability to fully investigate all four species of whiptails occurring on IMRS because of insufficient sample sizes of two species for statistical analyses. One such limitation was the scarcity of *A. exsanguis*, the triploid parthenogen that seemed to be restricted to the north and eastern ranges of IMRS (Couvillon, 2011). The area around Squaw Spring revealed a relatively high concentration of *A. exsanguis* based on personal observation and a few captures ( $n = 5$ ) occurring there, especially transects further away from the spring. Originally only one transect of five traps were present at Squaw Spring, but once observing the potential for capturing *A. exsanguis*, three more arrays of five traps each were constructed, raising the number of traps to 20 during the second winter season. Unfortunately, these additional traps did not capture the number of *A. exsanguis* needed for meaningful statistical analysis. The bisexual *A. inornata* was also limited in its capture rates, as only 62 individuals were recorded during the two year study. *A. inornata* is a very small species that are often observed near pitfall trap arrays. It is unknown why they do not fall into pitfall traps as often as *A. tessellata* and *A. marmorata*, but it may be related to their routine of being most active during cooler portions of the day, especially in the mornings when seeking shade is not as critical as it is during warmer midday and afternoon times. *Aspidoscelis tessellata* and especially *A. marmorata* are continually active all day, even during very warm periods when they energetically

thermoregulate by seeking shelter when overheated. Pitfall trap covers act as shading sources that attract running whiptails that unintentionally fall into the buckets.

The other pitfall trap arrays away from the three main sites (Ranch House, Prospect Pits, and Squaw Spring) used during Couvillon's (2011) study captured few whiptails during the study period, given that each of those site only possessed one transect with five traps each. Therefore, in order to better sample other regions of IMRS, it will be necessary to increase the number of pitfall trap arrays in those areas. Also, because of ecogeographic preference of *A. exsanguis* for areas that at least originally contained more desert grasslands (northern and eastern slopes), it will probably be necessary to place new pitfall trap arrays in those areas to increase collecting success. It is also possible that interspecific competition between *A. exsanguis* and the two larger whiptails species (*A. marmorata* and *A. tessellata*) is causing geographic partitioning between them on IMRS. Where *A. exsanguis* does occur in higher concentrations (Squaw Spring area) the substrate is more rocky and rugged than the alluvial fans around the Ranch House and Prospect Pits, where *A. marmorata* has historically been the most common species (Mata-Silva, 2008); *A. marmorata* is rarely found around Squaw Spring. *Aspidoscelis tessellata* is frequently found in most areas on IMRS, but its prime preference is also on the alluvial fans near Ranch House and Prospect Pits. Therefore, the presence of two large whiptail species coexisting together within the alluvial flats around Headquarters and Prospect Pits, could competitively exclude *A. exsanguis* in some way.

Another interesting finding was that juvenile *A. marmorata* were not as commonly collected as juvenile *A. tessellata*, especially in 2011. This may be due to the increased reproductive potential of the parthenogenic *A. tessellata* in which the entire population has

100% reproductive potential as opposed to 50% (male/female) for bisexual counterparts; again, perhaps behavioral differences bias capture rates in the pitfall traps. However, when referring to Figure 6, depicting species captures through time, *A. marmorata* when present during its highly seasonal activity period, is generally the most abundant species. Possible predation pressure and genetic limitations could explain the less than expected population size of the unisexual compared to its bisexual relative, generally with less adaptability which translates into lower survivorship and reduced recruitment through time. However, other studies have shown that unisexual species resulting via parthenogenesis have increased levels of heterozygosity (Brown et al., 1995, and Hanely et al., 1995), which may only be a short-lived advantage through evolutionary time, given unisexual species' only source of genetic variation is mutation. Further genetic studies are needed for both the internal (Mata-Silva, 2008) and external parasitic data to show the influence of genetic variability on parasitism, given these two different reproduction modes. The effects of shedding on mite attachment was also difficult to evaluate given the method of capture, so an insufficient numbers of shedding individuals were captured to perform meaningful statistics. However, one observation involving a female *A. marmorata* (WDL 590) was exceptional, because abdominal scales in the act of being shed were still partially attached near the base of the cloaca, which allowed for comparing numbers of mites removed from those remaining on the skin surface. That instance had 11 mites remaining attached to the abdominal region, while 44 mites were still attached to the shed fragment, indicating that 75% of the parasites were removed by shedding to that point. It is unknown if the 11 mites actively crawled from the shed back onto the lizard's body, or if the 44 others would eventually do so.

Finally, utilizing the coevolutionary relationships between hosts and their parasites can be used to explore the advantages of sexual reproduction, especially when compared with unisexual vertebrates that are heavily underrepresented in a group that is overwhelmingly bisexual. Although only 0.1% of animals have been classified as unisexual (Vrijenhoek, 1998), the lizard genus *Aspidoscelis* is nearly 33% parthenogenetic (Wright, 1993), making it a prime model for future studies examining reproductive strategies and how they affect ecological features between unisexual and bisexual forms. Studying multiple assemblages of whiptail populations in different areas may shed further light on the paradox of bisexual or unisexual advantages at the ecosystem level. Many areas possess syntopic populations of both unisexual and bisexual species that vary in relationship to each other (Reeder, 2002), with unisexuals also invading many areas uninhabited by bisexual species (Wright, 1993). The biological effects of these unisexual “weed” species (Wright and Lowe, 1968) may have potential applications for conservation biology. For example, what conservational plans can be made for the potential effects of disease transmission by unisexual species, and should special plans be made specifically for increased risks of parasitic infection spread by unisexual species? In addition, how do we properly conserve a threatened parthenogenetic versus bisexual whiptail population given their reproductive differences? Many studies like the one presented herein, can be utilized to answer these important questions, and hopefully create more questions yet to be assessed.

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## APPENDIX

Descriptive data for whiptail lizards examined: WDL# = (ID number of author; Cap = capture/recapture number; SpEp = species specific epithet; SVL= snout-vent length; Tot INF = total Infection, mite intensity; IC (index of body condition,  $IC = Mass^{0.33} / SVL$ ). Data is sorted by date, species, and sex (M = male, F = female, and J = juvenile).

WDL#	Cap	Location	Transect	Trap	Date	SpEp	Sex	SVL (mm)	Weight (g)	Tot Inf	IC
WDL 098	1	Prospect Pit	3	4	07-Apr-11	marmorata	F	64	8	0	2.92
WDL 138	1	Prospect Pit	2	6	18-May-11	marmorata	F	71	8.9	0	2.71
WDL 139	1	Ranch House	4	6	19-May-11	marmorata	F	71	9.3	0	2.75
WDL 160	1	Prospect Pit	1	1	20-May-11	marmorata	F	63	6.4	0	2.77
WDL 098	2	Prospect Pit	7	4	21-May-11	marmorata	F	79	8.3	0	2.39
WDL 160	2	Prospect Pit	2	1	10-Jun-11	marmorata	F	65	6.2	0	2.66
VMS 002*	1	Ranch House	5	5	11-Jun-11	marmorata	F	94	24.1	0	2.76
WDL 230	1	Ranch House	7	6	17-Jun-11	marmorata	F	61	6.9	0	2.93
WDL 229	1	Ranch House	6	5	17-Jun-11	marmorata	F	65	7.4	0	2.80
WDL 258	1	Prospect Pit	3	3	25-Jun-11	marmorata	F	80	12.5	0	2.67
WDL 259	1	Ranch House	2	2	25-Jun-11	marmorata	F	65	7	0	2.76
WDL 247	1	Prospect Pit	4	6	25-Jun-11	marmorata	F	74	9.5	0	2.66
WDL 311	1	Prospect Pit	3	3	23-Jul-11	marmorata	F	79	13.2	0	2.75
VMS 008*	1	Prospect Pit	3	4	23-Jul-11	marmorata	F	92	22.7	0	2.77
WDL 313	1	Ranch House	2	1	23-Jul-11	marmorata	F	73	11.4	0	2.84

WDL#	Cap	Location	Transect	Trap	Date	SpEp	Sex	SVL (mm)	Weight (g)	Tot Inf	IC
WDL 312	1	Prospect Pit	1	1	23-Jul-11	marmorata	F	69	9.1	0	2.81
WDL 258	2	Prospect Pit	3	2	30-Jul-11	marmorata	F	82	15.5	18	2.78
WDL 340	1	Ranch House	R	2	30-Jul-11	marmorata	F	79	13.2	36	2.75
WDL 353	1	Ranch House	6	5	06-Aug-11	marmorata	F	76	12.7	62	2.82
WDL 355	1	Ranch House	4	5	06-Aug-11	marmorata	F	85	16.1	5	2.71
WDL 361	1	Ranch House	7	1	07-Aug-11	marmorata	F	75	12	57	2.81
WDL 373	1	Ranch House	5	4	08-Aug-11	marmorata	F	77	12.7	227	2.78
WDL 313	2	Ranch House	3	1	10-Aug-11	marmorata	F	75	11.6	67	2.78
WDL 401	1	Prospect Pit	2	4	11-Aug-11	marmorata	F	76	11.1	75	2.71
WDL 434	1	Prospect Pit	2	5	27-Aug-11	marmorata	F	78	14.2	14	2.84
WDL 258	3	Prospect Pit	3	3	27-Aug-11	marmorata	F	85	14.1	30	2.60
WDL 436	1	Ranch House	7	6	10-Sep-11	marmorata	F	77	12.9	53	2.80
WDL 098	3	Prospect Pit	3	4	16-May-12	marmorata	F	95	27.6	4	2.85
WDL 549	1	Ranch House	7	4	17-May-12	marmorata	F	81	12.8	0	2.65
WDL 373	2	Ranch House	1	3	18-May-12	marmorata	F	83	13.8	0	2.65
WDL 259	2	Ranch House	2	1	18-May-12	marmorata	F	81	10.7	0	2.51
WDL 258	4	Prospect Pit	3	3	18-May-12	marmorata	F	83	13.4	0	2.62
WDL 573	1	Ranch House	5	3	19-May-12	marmorata	F	60	5.4	0	2.76
WDL 590	1	Ranch House	6	6	09-Jun-12	marmorata	F	82	13.8	55	2.68
WDL 229	2	Ranch House	7	6	30-Jun-12	marmorata	F	80	11.5	0	2.60
WDL	1	Prospect Pit	4	5	07-Sep-12	marmorata	F	63	6.5	65	2.78

WDL#	Cap	Location	Transect	Trap	Date	SpEp	Sex	SVL (mm)	Weight (g)	Tot Inf	IC
688											
WDL 323	1	Ranch House	R	5	29-Jul-11	marmorata	J	65	7	9	2.76
WDL 627	1	Ranch House	1	4	14-Jul-12	marmorata	J	46	2.4	0	2.83
WDL 658	1	Ranch House	2	2	04-Aug-12	marmorata	J	37	1.3	2	2.92
WDL 666	1	Ranch House	2	2	11-Aug-12	marmorata	J	48	2.7	8	2.81
WDL 687	1	Prospect Pit	5	6	07-Sep-12	marmorata	J	44	2	73	2.80
WDL 093	1	Ranch House	R	5	02-Apr-11	marmorata	M	62	6.9	0	2.88
WDL 108	1	Prospect Pit	5	3	07-Apr-11	marmorata	M	65	8	0	2.87
WDL 118	1	Prospect Pit	2	5	08-Apr-11	marmorata	M	55	4	0	2.76
WDL 156	1	Prospect Pit	2	1	19-May-11	marmorata	M	92	25.7	0	2.88
WDL 137	1	Ranch House	5	6	19-May-11	marmorata	M	96	28	0	2.83
WDL 141	1	Ranch House	7	5	19-May-11	marmorata	M	72	9.6	0	2.74
WDL 140	1	Ranch House	3	2	19-May-11	marmorata	M	90	21.8	0	2.80
WDL 157	1	Prospect Pit	5	5	19-May-11	marmorata	M	85	20.3	0	2.90
WDL 159	1	Prospect Pit	5	4	20-May-11	marmorata	M	91	22.4	0	2.79
WDL 180	1	Ranch House	7	4	21-May-11	marmorata	M	83	11.8	0	2.53
WDL 157	2	Prospect Pit	5	3	21-May-11	marmorata	M	85	20.7	0	2.92
WDL 174	1	Prospect Pit	1	5	21-May-11	marmorata	M	86	20	0	2.86
WDL 178	1	Ranch House	7	6	21-May-11	marmorata	M	68	10.3	0	2.96
WDL 166	1	Prospect Pit	2	2	22-May-11	marmorata	M	97	26.6	0	2.76
WDL 140	2	Ranch House	6	1	22-May-11	marmorata	M	88	22.4	0	2.89



WDL#	Cap	Location	Transect	Trap	Date	SpEp	Sex	SVL (mm)	Weight (g)	Tot Inf	IC
VMS 001*	1	Ranch House	5	6	22-May-11	marmorata	M	92	20.9	0	2.71
WDL 137	2	Ranch House	R	4	22-May-11	marmorata	M	93	23	0	2.75
WDL 157	3	Prospect Pit	5	6	10-Jun-11	marmorata	M	86	18	0	2.77
WDL 159	2	Prospect Pit	5	4	11-Jun-11	marmorata	M	92	27.9	0	2.95
WDL 157	4	Prospect Pit	4	6	11-Jun-11	marmorata	M	85	17.2	0	2.76
WDL 108	2	Prospect Pit	3	4	11-Jun-11	marmorata	M	66	8.2	0	2.85
WDL 108	3	Prospect Pit	5	2	18-Jun-11	marmorata	M	76	11.3	0	2.72
WDL 093	2	Ranch House	R	4	25-Jun-11	marmorata	M	88	13.2	0	2.46
WDL 246	1	Ranch House	5	5	25-Jun-11	marmorata	M	70	9.6	0	2.82
VMS 005*	1	Prospect Pit	1	1	09-Jul-11	marmorata	M	76	8	0	2.46
WDL 265	1	Ranch House	R	6	09-Jul-11	marmorata	M	85	9.8	0	2.33
WDL 264	1	Ranch House	6	6	09-Jul-11	marmorata	M	63	7.8	0	2.94
WDL 263	1	Ranch House	5	6	09-Jul-11	marmorata	M	81	17	0	2.89
WDL 137	3	Ranch House	3	3	09-Jul-11	marmorata	M	91	24	0	2.85
WDL 108	4	Prospect Pit	4	2	16-Jul-11	marmorata	M	75	12.5	0	2.84
WDL 295	1	Prospect Pit	3	4	16-Jul-11	marmorata	M	90	25.4	0	2.93
WDL 159	3	Prospect Pit	4	3	16-Jul-11	marmorata	M	93	22	0	2.72
VMS 009*	1	Prospect Pit	5	4	23-Jul-11	marmorata	M	94	28.7	0	2.91
WDL 157	5	Prospect Pit	3	4	23-Jul-11	marmorata	M	87	21.4	0	2.88
WDL 324	1	Red Tank	1	5	29-Jul-11	marmorata	M	79	13.6	330	2.77
WDL	2	Ranch	6	5	29-Jul-11	marmorata	M	67	10	177	2.98

WDL#	Cap	Location	Transect	Trap	Date	SpEp	Sex	SVL (mm)	Weight (g)	Tot Inf	IC
264		House									
WDL 339	1	Prospect Pit	2	2	30-Jul-11	marmorata	M	83	16.5	110	2.79
WDL 180	2	Ranch House	R	2	30-Jul-11	marmorata	M	85	17.8	94	2.79
WDL 159	4	Prospect Pit	3	2	30-Jul-11	marmorata	M	93	23	81	2.75
WDL 157	6	Prospect Pit	3	3	30-Jul-11	marmorata	M	88	20.5	111	2.81
VMS 011*	1	Ranch House	R	5	30-Jul-11	marmorata	M	80	13.2	103	2.71
WDL 263	2	Ranch House	1	3	30-Jul-11	marmorata	M	88	15.2	100	2.57
WDL 108	5	Prospect Pit	4	6	06-Aug-11	marmorata	M	76	8.5	41	2.50
WDL 137	4	Ranch House	3	1	06-Aug-11	marmorata	M	95	26.7	261	2.82
WDL 157	7	Prospect Pit	3	4	06-Aug-11	marmorata	M	88	22	131	2.87
WDL 354	1	Ranch House	5	6	06-Aug-11	marmorata	M	95	26.3	108	2.81
VMS 015*	1	Ranch House	2	1	07-Aug-11	marmorata	M	77	12.9	26	2.80
WDL 264	3	Ranch House	6	5	08-Aug-11	marmorata	M	73	10.3	134	2.76
WDL 159	5	Prospect Pit	3	3	08-Aug-11	marmorata	M	94	23.7	51	2.75
WDL 381	1	Prospect Pit	2	2	09-Aug-11	marmorata	M	75	11.2	32	2.75
WDL 389	1	Prospect Pit	2	1	10-Aug-11	marmorata	M	84	16.2	194	2.75
WDL 118	2	Prospect Pit	2	1	10-Aug-11	marmorata	M	79	12.6	27	2.71
WDL 141	2	Ranch House	7	4	11-Aug-11	marmorata	M	80	14.4	99	2.78
WDL 411	1	Ranch House	R	2	12-Aug-11	marmorata	M	85	15.1	347	2.66
WDL 417	1	Prospect Pit	1	5	12-Aug-11	marmorata	M	76	12.4	112	2.80
WDL 425	1	Ranch House	5	6	20-Aug-11	marmorata	M	90	22	45	2.81

WDL#	Cap	Location	Transect	Trap	Date	SpEp	Sex	SVL (mm)	Weight (g)	Tot Inf	IC
WDL 263	3	Ranch House	1	2	14-Apr-12	marmorata	M	89	20	0	2.76
WDL 524	1	Ranch House	R	4	14-Apr-12	marmorata	M	78	14.1	0	2.84
WDL 417	2	Prospect Pit	3	4	14-Apr-12	marmorata	M	78	14.4	1	2.85
WDL 263	4	Ranch House	5	5	28-Apr-12	marmorata	M	91	23	3	2.81
WDL 140	3	Ranch House	2	1	28-Apr-12	marmorata	M	92	23.8	0	2.81
WDL 528	1	Ranch House	1	2	28-Apr-12	marmorata	M	85	17.8	0	2.79
WDL 157	8	Prospect Pit	3	4	28-Apr-12	marmorata	M	92	22.5	10	2.77
WDL 137	5	Ranch House	R	4	28-Apr-12	marmorata	M	92	24.8	1	2.85
WDL 159	6	Prospect Pit	1	2	28-Apr-12	marmorata	M	95	24.5	1	2.75
WDL 529	1	Ranch House	R	3	28-Apr-12	marmorata	M	84	19.7	0	2.91
WDL 159	7	Prospect Pit	1	3	16-May-12	marmorata	M	94	25.6	1	2.81
WDL 417	3	Prospect Pit	3	3	16-May-12	marmorata	M	80	18	2	2.98
WDL 534	1	Prospect Pit	4	6	16-May-12	marmorata	M	84	17.4	0	2.80
WDL 137	6	Ranch House	R	2	16-May-12	marmorata	M	96	25.8	0	2.76
VMS 009*	2	Prospect Pit	3	3	16-May-12	marmorata	M	92	25	0	2.85
WDL 157	9	Prospect Pit	3	3	16-May-12	marmorata	M	92	24.5	2	2.84
WDL 137	7	Ranch House	6	1	17-May-12	marmorata	M	95	25.5	0	2.78
WDL 547	1	Prospect Pit	2	3	17-May-12	marmorata	M	84	21.7	0	3.00
WDL 548	1	Ranch House	5	5	17-May-12	marmorata	M	85	20.3	2	2.90
WDL 411	2	Ranch House	6	1	17-May-12	marmorata	M	81	12.3	0	2.62
WDL	1	Ranch	4	6	18-May-12	marmorata	M	85	21.4	2	2.95

WDL#	Cap	Location	Transect	Trap	Date	SpEp	Sex	SVL (mm)	Weight (g)	Tot Inf	IC
562		House									
WDL 246	2	Ranch House	7	5	18-May-12	marmorata	M	82	20.2	0	3.00
WDL 381	2	Prospect Pit	2	1	18-May-12	marmorata	M	82	18.4	0	2.92
WDL 159	8	Prospect Pit	1	1	18-May-12	marmorata	M	95	24.7	0	2.75
WDL 524	2	Ranch House	R	1	18-May-12	marmorata	M	82	16.7	0	2.84
WDL 561	1	Ranch House	6	6	18-May-12	marmorata	M	84	20.6	0	2.95
WDL 425	2	Ranch House	5	5	18-May-12	marmorata	M	87	21.8	0	2.90
WDL 265	2	Ranch House	R	5	18-May-12	marmorata	M	85	19.1	0	2.85
WDL 575	1	Prospect Pit	1	5	19-May-12	marmorata	M	82	16.2	3	2.81
WDL 534	2	Prospect Pit	4	5	19-May-12	marmorata	M	84	16.1	0	2.74
WDL 137	8	Ranch House	R	3	19-May-12	marmorata	M	94	24.3	0	2.77
WDL 411	3	Ranch House	6	5	09-Jun-12	marmorata	M	86	21.4	46	2.91
WDL 159	9	Prospect Pit	1	3	09-Jun-12	marmorata	M	95	25.3	117	2.77
WDL 141	3	Ranch House	7	5	09-Jun-12	marmorata	M	86	19.8	72	2.85
WDL 425	3	Ranch House	5	6	16-Jun-12	marmorata	M	85	18.5	13	2.82
WDL 140	4	Ranch House	2	5	16-Jun-12	marmorata	M	92	26.8	6	2.92
WDL 263	5	Ranch House	5	4	30-Jun-12	marmorata	M	91	23.3	2	2.83
WDL 561	2	Ranch House	3	7	30-Jun-12	marmorata	M	89	22.2	0	2.85
WDL 534	3	Prospect Pit	3	5	30-Jun-12	marmorata	M	88	18.9	2	2.74
WDL 613	1	Ranch House	5	5	30-Jun-12	marmorata	M	82	14.4	15	2.71
WDL 529	2	Prospect Pit	5	5	14-Jul-12	marmorata	M	85	20.3	0	2.90

WDL#	Cap	Location	Transect	Trap	Date	SpEp	Sex	SVL (mm)	Weight (g)	Tot Inf	IC
WDL 649	1	Prospect Pit	5	5	28-Jul-12	marmorata	M	85	20.6	44	2.92
WDL 093	3	Ranch House	6	2	28-Jul-12	marmorata	M	93	24.4	12	2.80
WDL 654	1	Ranch House	5	5	04-Aug-12	marmorata	M	88	17.7	105	2.69
WDL 003	1	Ranch House	2	6	27-Aug-10	tesselata	F	47	2	0	2.62
WDL 004	1	Squaw Spring	1	3	28-Aug-10	tesselata	F	59	5	10	2.75
WDL 035	1	Ranch House	2	2	11-Sep-10	tesselata	F	68	9.1	1	2.85
WDL 032	1	Ranch House	5	2	11-Sep-10	tesselata	F	72	8.8	3	2.67
WDL 004	2	Squaw Spring			25-Sep-10	tesselata	F	69	7.4	8	2.64
WDL 043	1	Ranch House	2	6	25-Sep-10	tesselata	F	60	4.4	66	2.60
WDL 044	1	Prospect Pit	3	3	25-Sep-10	tesselata	F	54	3	44	2.57
WDL 051	1	Prospect Pit	5	4	02-Oct-10	tesselata	F	46	2.4	3	2.83
WDL 058	1	Ranch House	2	6	14-Oct-10	tesselata	F	52	3.6	2	2.82
WDL 070	1	Prospect Pit	1	2	15-Oct-10	tesselata	F	50	2.9	18	2.75
WDL 092	1	Ranch House	R	2	02-Apr-11	tesselata	F	59	4.9	0	2.73
WDL 082	1	Ranch House	R	4	02-Apr-11	tesselata	F	61	5.3	0	2.70
WDL 099	1	Ranch House	R	4	07-Apr-11	tesselata	F	54	4.2	0	2.85
WDL 100	1	Ranch House	R	2	07-Apr-11	tesselata	F	65	7.8	0	2.85
WDL 109	1	Ranch House	R	3	07-Apr-11	tesselata	F	55	4.1	0	2.78
WDL 119	1	Ranch House	R	4	08-Apr-11	tesselata	F	52	3.6	0	2.82
WDL 134	1	Prospect Pit	4	6	08-Apr-11	tesselata	F	60	5.3	0	2.75
WDL	1	Ranch	2	5	19-May-11	tesselata	F	71	10.6	0	2.86

WDL#	Cap	Location	Transect	Trap	Date	SpEp	Sex	SVL (mm)	Weight (g)	Tot Inf	IC
153		House									
WDL 154	1	Ranch House	1	3	19-May-11	tesselata	F	68	7.9	0	2.73
WDL 155	1	Prospect Pit	1	5	19-May-11	tesselata	F	66	7	0	2.72
WDL 099	2	Prospect Pit	3	6	19-May-11	tesselata	F	69	8.9	0	2.79
WDL 171	1	Ranch House	5	4	20-May-11	tesselata	F	62	6.7	0	2.85
WDL 163	1	Prospect Pit	5	5	20-May-11	tesselata	F	66	7.3	0	2.75
WDL 191	1	Ranch House	6	1	22-May-11	tesselata	F	65	7.7	0	2.84
WDL 190	1	Ranch House	R	1	22-May-11	tesselata	F	68	7.8	0	2.72
WDL 109	2	Ranch House	R	3	04-Jun-11	tesselata	F	66	6.7	0	2.68
WDL 192	1	Ranch House	3	3	04-Jun-11	tesselata	F	86	14.5	0	2.59
WDL 193	1	Ranch House	1	1	04-Jun-11	tesselata	F	63	6.3	0	2.76
WDL 194	1	Prospect Pit	1	1	04-Jun-11	tesselata	F	62	6.2	0	2.79
WDL 214	1	Ranch House	3	9	11-Jun-11	tesselata	F	69	9.1	0	2.81
WDL 213	1	Prospect Pit	4	4	11-Jun-11	tesselata	F	63	6.9	0	2.83
WDL 215	1	Prospect Pit	4	4	11-Jun-11	tesselata	F	63	6.3	0	2.76
WDL 227	1	Ranch House	2	1	17-Jun-11	tesselata	F	69	8.2	0	2.72
WDL 238	1	Prospect Pit	4	2	18-Jun-11	tesselata	F	71	9.4	0	2.76
WDL 237	1	Ranch House	3	2	18-Jun-11	tesselata	F	62	6.5	0	2.83
WDL 239	1	Ranch House	4	2	18-Jun-11	tesselata	F	69	9.3	0	2.83
WDL 254	1	Oak Arroyo	1	3	25-Jun-11	tesselata	F	90	21.8	0	2.80
WDL 252	1	Ranch House	2	2	25-Jun-11	tesselata	F	85	15.6	0	2.68

WDL#	Cap	Location	Transect	Trap	Date	SpEp	Sex	SVL (mm)	Weight (g)	Tot Inf	IC
WDL 266	1	Ranch House	3	3	09-Jul-11	tesselata	F	73	9.7	0	2.71
WDL 267	1	Prospect Pit	5	6	09-Jul-11	tesselata	F	69	9	0	2.80
WDL 154	2	Ranch House	5	2	09-Jul-11	tesselata	F	74	12	0	2.85
WDL 051	2	Prospect Pit	5	4	09-Jul-11	tesselata	F	65	7.8	0	2.85
WDL 294	1	Ranch House	3	2	16-Jul-11	tesselata	F	79	16.2	0	2.92
WDL 306	1	Prospect Pit	5	2	23-Jul-11	tesselata	F	84	18	0	2.83
WDL 307	1	Ranch House	2	6	23-Jul-11	tesselata	F	83	19.7	0	2.95
WDL 305	1	Ranch House	2	3	23-Jul-11	tesselata	F	85	18.7	0	2.83
WDL 321	1	Prospect Pit	1	4	29-Jul-11	tesselata	F	90	17.3	84	2.61
WDL 171	2	Ranch House	5	6	29-Jul-11	tesselata	F	71	9.1	26	2.73
WDL 322	1	Prospect Pit	3	6	29-Jul-11	tesselata	F	65	7	8	2.76
WDL 337	1	Ranch House	2	5	30-Jul-11	tesselata	F	92	23.5	150	2.80
WDL 336	1	Prospect Pit	2	4	30-Jul-11	tesselata	F	67	8.4	115	2.83
WDL 335	1	Ranch House	3	7	30-Jul-11	tesselata	F	76	12.9	212	2.83
WDL 334	1	Prospect Pit	5	1	30-Jul-11	tesselata	F	73	10.3	45	2.76
WDL 350	1	Prospect Pit	5	2	06-Aug-11	tesselata	F	87	18.8	56	2.77
WDL 349	1	Prospect Pit	5	4	06-Aug-11	tesselata	F	80	14.9	50	2.81
WDL 351	1	Ranch House	4	5	06-Aug-11	tesselata	F	87	18.6	59	2.76
WDL 347	1	Prospect Pit	3	5	06-Aug-11	tesselata	F	76	12.5	161	2.81
WDL 348	1	Prospect Pit	3	2	06-Aug-11	tesselata	F	77	14	54	2.87
WDL	1	Ranch	4	6	06-Aug-11	tesselata	F	79	13.3	3	2.75

WDL#	Cap	Location	Transect	Trap	Date	SpEp	Sex	SVL (mm)	Weight (g)	Tot Inf	IC
352		House									
WDL 227	2	Ranch House	3	1	06-Aug-11	tesselata	F	80	16	192	2.87
WDL 362	1	Prospect Pit	1	5	07-Aug-11	tesselata	F	89	16.9	41	2.62
WDL 375	1	Ranch House	3	1	08-Aug-11	tesselata	F	79	12.6	41	2.71
WDL 380	1	Prospect Pit	2	5	09-Aug-11	tesselata	F	88	17.4	25	2.68
WDL 155	2	Prospect Pit	2	5	10-Aug-11	tesselata	F	78	13.2	328	2.78
WDL 382	1	Ranch House	5	6	10-Aug-11	tesselata	F	82	14.3	93	2.71
WDL 403	1	Prospect Pit	2	3	11-Aug-11	tesselata	F	92	20.5	211	2.69
WDL 414	1	Ranch House	R	3	12-Aug-11	tesselata	F	75	11.3	80	2.76
WDL 413	1	Ranch House	2	6	12-Aug-11	tesselata	F	80	11.7	11	2.61
WDL 412	1	Prospect Pit	1	1	12-Aug-11	tesselata	F	80	13.9	37	2.75
WDL 153	2	Ranch House	2	5	12-Aug-11	tesselata	F	83	15.5	84	2.74
WDL 415	1	Prospect Pit	3	3	12-Aug-11	tesselata	F	90	18.8	70	2.68
WDL 416	1	Prospect Pit	2	2	13-Aug-11	tesselata	F	74	11.1	15	2.78
WDL 426	1	Prospect Pit	4	1	20-Aug-11	tesselata	F	78	12	4	2.70
WDL 427	1	Ranch House	1	5	20-Aug-11	tesselata	F	97	26.1	42	2.74
WDL 459	1	Ranch House	3	1	24-Sep-11	tesselata	F	43	2	4	2.86
WDL 467	1	Prospect Pit	1	1	13-Oct-11	tesselata	F	41	1.7	3	2.86
WDL 466	1	Ranch House	3	7	13-Oct-11	tesselata	F	46	2.4	2	2.83
WDL 472	1	Ranch House	3	2	14-Oct-11	tesselata	F	50	3.9	5	3.01
WDL 473	1	Prospect Pit	1	4	14-Oct-11	tesselata	F	51	4	1	2.97



WDL#	Cap	Location	Transect	Trap	Date	SpEp	Sex	SVL (mm)	Weight (g)	Tot Inf	IC
WDL 476	1	Prospect Pit	3	3	14-Oct-11	tesselata	F	53	3.7	5	2.79
WDL 475	1	Ranch House	2	6	14-Oct-11	tesselata	F	47	3	2	2.96
WDL 474	1	Prospect Pit	3	3	14-Oct-11	tesselata	F	42	1.8	3	2.84
WDL 498	1	Prospect Pit	3	2	25-Jan-12	tesselata	F	51	3.3	0	2.81
WDL 501	1	Squaw Spring	1	2	29-Mar-12	tesselata	F	52	3.6	0	2.82
WDL 500	1	Squaw Spring	1	5	29-Mar-12	tesselata	F	54	4.4	0	2.89
WDL 499	1	Ranch House	R	2	29-Mar-12	tesselata	F	58	3.8	0	2.57
WDL 502	1	Ranch House	2	6	29-Mar-12	tesselata	F	56	4.4	0	2.79
WDL 509	1	Ranch House	R	3	30-Mar-12	tesselata	F	50	3	0	2.78
WDL 508	1	Ranch House	7	3	30-Mar-12	tesselata	F	57	4.4	0	2.74
WDL 516	1	Prospect Pit	1	1	31-Mar-12	tesselata	F	54	3.7	0	2.74
WDL 475	2	Ranch House	2	5	31-Mar-12	tesselata	F	59	4.5	0	2.66
WDL 515	1	Ranch House	R	2	31-Mar-12	tesselata	F	54	4	0	2.81
WDL 523	1	Prospect Pit	3	5	14-Apr-12	tesselata	F	56	4.5	35	2.80
WDL 533	1	Ranch House	R	3	16-May-12	tesselata	F	81	14.4	0	2.75
WDL 532	1	Prospect Pit	5	2	16-May-12	tesselata	F	61	6	2	2.81
WDL 531	1	Prospect Pit	1	5	16-May-12	tesselata	F	61	5.3	7	2.70
WDL 546	1	Ranch House	2	1	17-May-12	tesselata	F	68	7.3	1	2.67
WDL 545	1	Ranch House	R	5	17-May-12	tesselata	F	61	6.3	0	2.85
WDL 560	1	Ranch House	7	1	18-May-12	tesselata	F	70	8.7	0	2.73
WDL	1	Ranch	6	4	18-May-12	tesselata	F	90	19.2	0	2.70

WDL#	Cap	Location	Transect	Trap	Date	SpEp	Sex	SVL (mm)	Weight (g)	Tot Inf	IC
559		House									
WDL 155	3	Prospect Pit	1	5	18-May-12	tesselata	F	84	15.6	0	2.71
WDL 572	1	Ranch House	3	1	19-May-12	tesselata	F	68	8.7	0	2.81
WDL 570	1	Ranch House	1	3	19-May-12	tesselata	F	90	20.4	39	2.75
WDL 571	1	Ranch House	R	2	19-May-12	tesselata	F	69	8.3	0	2.73
WDL 582	1	Prospect Pit	5	1	09-Jun-12	tesselata	F	81	12	42	2.60
WDL 583	1	Prospect Pit	4	5	09-Jun-12	tesselata	F	76	12.5	24	2.81
WDL 589	1	Ranch House	6	5	09-Jun-12	tesselata	F	85	15.6	48	2.68
WDL 588	1	Ranch House	3	7	09-Jun-12	tesselata	F	87	17.9	95	2.73
WDL 586	1	Ranch House	5	3	09-Jun-12	tesselata	F	90	21.4	72	2.79
WDL 584	1	Ranch House	R	3	09-Jun-12	tesselata	F	79	13.7	6	2.78
WDL 585	1	Prospect Pit	4	1	09-Jun-12	tesselata	F	73	10.6	114	2.78
WDL 587	1	Jeep Trail	1	2	09-Jun-12	tesselata	F	87	20.1	123	2.83
WDL 598	1	Ranch House	R	6	16-Jun-12	tesselata	F	90	20.6	34	2.75
WDL 599	1	Ranch House	2	5	16-Jun-12	tesselata	F	80	13.2	26	2.71
WDL 597	1	Jeep Trail	1	2	16-Jun-12	tesselata	F	80	15.1	87	2.82
WDL 605	1	Ranch House			29-Jun-12	tesselata	F	78	14.1	8	2.84
WDL 003	2	Ranch House	2	5	30-Jun-12	tesselata	F	80	14.4	5	2.78
WDL 609	1	Ranch House	5	4	30-Jun-12	tesselata	F	79	13.2	2	2.75
WDL 610	1	Jeep Trail	1	2	30-Jun-12	tesselata	F	91	22.8	15	2.81
WDL 611	1	Foundation	1	2	30-Jun-12	tesselata	F	81	15.6	0	2.81

WDL#	Cap	Location	Transect	Trap	Date	SpEp	Sex	SVL (mm)	Weight (g)	Tot Inf	IC
WDL 612	1	Ranch House	R	4	30-Jun-12	tesselata	F	80	11.2	0	2.58
WDL 474	2	Prospect Pit	5	1	30-Jun-12	tesselata	F	78	13.6	0	2.81
WDL 498	2	Prospect Pit	3	1	30-Jun-12	tesselata	F	75	10.3	0	2.68
WDL 626	1	Prospect Pit	2	1	14-Jul-12	tesselata	F	94	22.3	0	2.70
WDL 623	1	Jeep Trail	1	2	14-Jul-12	tesselata	F	80	15.1	0	2.82
WDL 625	1	Ranch House	3	9	14-Jul-12	tesselata	F	82	14.9	0	2.74
WDL 624	1	Squaw Spring	1	2	14-Jul-12	tesselata	F	82	15.3	1	2.76
WDL 646	1	Prospect Pit	4	2	28-Jul-12	tesselata	F	80	13.4	43	2.72
WDL 647	1	Ranch House	5	2	28-Jul-12	tesselata	F	34	0.8	6	2.75
WDL 644	1	Prospect Pit	2	1	28-Jul-12	tesselata	F	85	15.2	65	2.66
WDL 645	1	Jeep Trail	1	3	28-Jul-12	tesselata	F	87	19.2	45	2.79
WDL 657	1	Ranch House	1	1	04-Aug-12	tesselata	F	30	0.6	0	2.86
WDL 656	1	Ranch House	1	4	04-Aug-12	tesselata	F	87	17.7	73	2.72
WDL 667	1	Squaw Spring	1	2	11-Aug-12	tesselata	F	39	1.3	1	2.77
WDL 668	1	Jeep Trail	1	2	11-Aug-12	tesselata	F	34	0.9	1	2.85
WDL 680	1	Ranch House	1	3	25-Aug-12	tesselata	F	37	1.1	2	2.78
WDL 678	1	Ranch House	2	1	25-Aug-12	tesselata	F	45	2.1	4	2.78
WDL 679	1	Ranch House	2	5	25-Aug-12	tesselata	F	44	2.2	2	2.88
WDL 671	1	Squaw Spring	1	3	07-Sep-12	tesselata	F	45	2.1	37	2.78
WDL 689	1	Prospect Pit	3	5	07-Sep-12	tesselata	F	57	5.2	72	2.88
WDL	1	Prospect Pit	1	2	07-Sep-12	tesselata	F	59	5.1	142	2.76

WDL#	Cap	Location	Transect	Trap	Date	SpEp	Sex	SVL (mm)	Weight (g)	Tot Inf	IC
670											
WDL 678	1	Ranch House	2	2	08-Sep-12	tesselata	F	34	1	3	2.94
WDL 679	1	Squaw Spring	1	2	08-Sep-12	tesselata	F	42	1.8	24	2.84
WDL 689	1	Ranch House	3	9	22-Sep-12	tesselata	F	53	3.6	4	2.77

## VITA

Interest in the biological sciences has been a fascination of mine as long as I can remember. Growing up on a family farm in a rural south Texas town provided my early years with a constant exposure to biology and nature. My parents, both with graduate degrees in science, constantly exposed me to the splendors of science, ranging from my father's artificial selection projects with domesticated plants and animals, to my mother's environmental ecological surveys of local stream systems. However, my main interests as a child were the natural processes surrounding our farm, in particular the reptiles and amphibians I could find nearly year round. I still remember the calming perplexity and curiosity I experienced whenever I would catch local herpetofauna while inspecting its unfamiliar anatomy and physiology, and yearning for understanding. This youthful curiosity for nature and science lives with me to this day. However, my interests soon focused toward conservational and ecological research while I was in middle school, when I could no longer find my favorite Texas Horned Lizard (*Phrynosomacornutum*) in my county; wanting a scientific explanation for their sudden disappearance. Once in high school, I started volunteering at the local university's Natural Toxins Research Center (NTRC), where research is conducted involving biomedical applications using snake venom. This is where I first started acquiring professional skills in herpetology. I was later employed by the NTRC when I started my undergraduate education at Texas A&M University-Kingsville as a Biology major, until I became more interested in the evolutionary biology, ecology, and physiology of herpetofauna. This is where I began my undergraduate research experiences with the department's herpetologist on a voluntary basis, as well as assisting other vertebrate researchers. This was also when I began teaching laboratories for introductory biology classes, later evolving into a TA assistantship at UTEP during my graduatedegree, where I instructed the Organismal Biology, Field Biology, and Vertebrate Zoology labs. Realizing that my scientific passion lies in herpetology, I traveled to the other tip of Texas to study whiptail ecology and evolution at UTEP, which owns the Indio Mountains Research Station, where I compared the parasitic resistance between unisexual and bisexual whiptail lizard species over two years of study. Currently receiving my Master's degree from UTEP was a major accomplishment, and now I plan to start educating my community at local colleges by securing a teaching position. This base will allow me to start exploring my options and opportunitites for conservational research both locally and abroad. I cannot see myself dedicating and developing a productive career in anything else besides herpetology and contributing to this field of science though my interest in herpetological research and conservation.

## Publications

- 1) Powell R.L., Lukefahr W.D., Moore W.L., Rabe R.W. (2010). *Sceloporus cyanogenys*(Blue Spiny Lizard). Geographical Distribution: Herpetological Review, 41(1), 108.
- 2) Powell R.L., Lukefahr W.D., Palreiro L.T., Quintanilla J.A., Villescas V.M. (2011). *Drymarchon melanurus erebennus*(Texas Indio Snake). Diet: Herpetological Review, 42(2) 289.

- 3) Lukefahr W.D., Johnson J.D., Mata-Silva V., Rocha A., Couvillon R., Del La Cerda F. (2011) *Sceloporus poinsetti* (Crevice Spiny Lizard). Ectoparasites: Herpetological Review. 42 (3): 433-434
- 4) Mata-Silva V., Johnson J.D., Couvillon R., Lukefahr W.D., Rocha A. (2011). *Crotalus atrox* (Western Diamondback Rattlesnake). Diet. Herpetological Review. 42(3): 438-439
- 5) Mata-Silva V., Johnson J.D., Lukefahr W.D., Barragan G., Rocha A., Couvillon R. (In Press) *Sonora semiannulata* (Ground snake) Predation: Herpetological Review
- 6) Mata-Silva V., Wilson L.D., Johnson J.D., Lukefahr W.D., Rocha A. (In Press) *Anaxyrus punctatus* (Red Spotted Toad) Predation (In Press). Herpetological Review
- 7) Lukefahr W.D., Powell, R.L., Baskin J.A., Thomas R. (In Press). Morphometric Analysis of Carapacial Bones of Two Genera of South Texas Giant Pleistocene Fossil Turtles. International Journal of Turtle and Tortoise Research.
- 8) Lukefahr W.D., Johnson J.D., Mata-Silva V., Rocha A., Couvillon R. (In Prep) *Thamnophis cyrtopsis* (Blackneck Garter Snake). Feeding Behavior: Herpetological Review.
- 9) Mata-Silva V., Johnson J.D., Lukefahr W.D., (In Press) *Crotalus atrox* (Western Diamondback Rattlesnake) Rain harvesting behavior. Southwestern Association of Naturalists

## Memberships

- SSAR (Society for the Study of Reptiles and Amphibians)
- SWAN (Southwestern Association of Naturalists)
- βββ (Tri-Beta: National Biological Honors Society)
- Sigma Xi (The Scientific Research Society)
- SACNAS (Society for the Advancement of Chicanos and Native Americans in Science)

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