Gila Monsters and Urban Conflicts

Translocation as a Conservation Tool with a Large, Venomous, and Protected Reptile: Urban Gila Monsters (*Heloderma suspectum*) in Arizona

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An Urban Wildlife Program Report Submitted by:

BRIAN K. SULLIVAN, PI
Department of Life Sciences, ASUW
PO Box 37100, Phoenix, AZ 85069 USA,

MATTHEW A. KWIATKOWSKI, Co-PI
Department of Fishery and Wildlife Biology
Colorado State University
Fort Collins, CO, 80523-1474 USA
and
GORDON W. SCHUETT, Co-PI
Department of Herpetology, Zoo Atlanta
800 Cherokee Ave. SE
Atlanta, GA 30315-1440

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Abstract. *The Gila Monster (*Heloderma suspectum*) is a large, venomous lizard protected throughout its distribution in the southwestern United States and northwestern Mexico. Rapid urban growth in key areas of its range and increased encounters with humans prompted us to investigate translocation as a conservation tool with "nuisance" Gila Monsters. Twenty-five Gila Monsters reported as nuisances by residents in the northeastern Phoenix Metropolitan Area were translocated from 0 to 25,000 m from their point of capture. Subjects (N = 18) translocated less than 1000 m returned to their original site of capture within 2-30 days; none of those (N = 7) translocated more than 1000 m successfully returned, they exhibited high daily rates of speed, and were deprived the use of familiar refuges. We conclude that small distance (< 500 m) translocations within suitable habitats are ineffective in removing Gila Monsters from areas deemed unsuitable. Moreover, individuals moved significantly greater distances are unlikely to remain at a translocation site, and may experience a variety of costs (e.g., predation risk) associated with high rates of movement.*

"With the possible exception of the vampire bat, no other North American animal has been the source of more superstitions, the subject of as many legends, or the object of more exaggerated claims than the Gila monster." - Brown & Carmony (1991)

Introduction

Human populations are rapidly increasing in the American Southwest, and interactions with wildlife, especially top-order carnivores, are rising sharply. The likely outcome, especially for larger taxa, will be local extinctions due primarily to habitat loss and to a lesser extent, direct interactions with residents. One response to these threats is translocation (i.e., movement of wild individuals from one part their range to another) of individuals to protected or intact habitat patches removed from areas of common interaction with humans. Fischer & Lindenmayer (2000) reviewed translocation studies of animals, and concluded that this technique fails to solve human-animal conflicts satisfactorily. Given the widespread use of translocation as a conservation method (see reviews in Fischer & Lindenmayer 2000; Shine & Koenig 2001; Nowak et al. 2002), it warrants further scrutiny, especially for unconventional, nongame animals such as reptiles.

Translocation efforts with some species are complicated due to their potential threat to humans, such as a venomous bite (Shine & Koenig 2001; Nowak et al. 2002). One of the most notorious, large venomous reptiles encountered by residents in the southwestern United States is the Gila Monster (*Heloderma suspectum*), one of two species of helodermatid lizards and closely related to Old World varanids (Pregill et al. 1986; Schwenk 1988; Bernstein 1999). Gila Monsters are perhaps perceived as less threatening than other venomous reptiles such as rattlesnakes (*Crotalus* spp), but they remain misunderstood by the public and experience many of the same conservation issues facing rattlesnakes as a result of urbanization. Translocation of venomous reptiles is widely practiced in metropolitan regions; each year many hundreds of rattlesnakes and dozens of Gila Monsters are removed from residences and other locations in the Phoenix and Tucson metropolitan areas of Arizona, and translocated to nearby desert habitats (Hare & McNally 1997; Nowak et al. 2002; Mike Demlong, pers. comm.). Although recent reviews of results of translocation studies involving reptiles revealed consistently low success rates for snakes (Dodd & Seigel 1991; Reinert & Rupert 1999; Plummer & Mills 2000; Nowak et al. 2002), Gila Monsters remain unstudied.

The secretive habits of Gila Monsters have contributed to a lack of knowledge on the part of biologists, as well as public misunderstanding. In spite of this, the Gila Monster was one of the first venomous reptiles to receive legal protection (Brown & Carmony 1991; Bogert & Martin del Campo 1993). In response to threats of commercial overcollecting for roadside menageries, zoological supply companies, and related venues, the Arizona Game and Fish Commission provided the initial steps in 1950 to legally protect Gila Monsters in Arizona. Subsequently, other states (Nevada – 1969; Utah – 1971; New Mexico – 1975; California - 1980), as well as Mexico, provided similar legal protection to Gila Monsters. Moreover, the Gila Monster is provided international protection under CITES (Convention on International Trade in Endangered Species).

The Gila Monster is chiefly a denizen of the Sonoran Desert, and it ranges from the southwestern United States to northwestern Mexico, primarily in Sonora (Campbell & Lamar 1989; Brown & Carmon 1991; Bogert & Martin del Campo 1993). In the United States, its primary (largest) populations occur in Arizona; populations in Mojave, Great Basin, and Chihuahua deserts are both peripheral and smaller (Brown & Carmony 1991). Substantial populations likely occur in Sonora (Mexico), but their ecology is largely unstudied. Although two subspecies of Gila Monsters are currently recognized (banded race – *H. s. cinctum*; reticulate race – *H. s. suspectum*), ongoing morphological and mtDNA analyses (Douglas et al., unpubl. data) do not support this simplistic division. With the exception of introduced exotic species (e.g., *Ctenosaura pectinata*; *Iguana iguana*; Conant & Collins 1998), the Gila Monster is the largest (length and mass) species of lizard naturally occurring in the United States.

Populations of Gila Monsters persist in the vicinity of metropolitan areas experiencing rapid growth, such as Las Vegas, Nevada, USA, and both Phoenix and Tucson, Arizona, USA. Translocation of individual Gila Monsters found in or near houses is currently practiced by a variety of agencies and individuals in the Phoenix and Tucson areas, although the fate of these animals is largely unknown. Translocation of large reptiles such as Gila Monsters is of special concern because they are top-order predators, feeding primarily on birds and mammals (Beck 1990; Bogert & Martin del Campo 1993); it is conceivable that their removal and release might have negative ecological impacts (Kjoss & Litvaitis 2001; Shine & Koenig 2001). Consequently, with support from the Heritage Program of the Arizona Game and Fish Department, we undertook a study of individuals with surgically implanted radio-transmitters to ascertain the consequences of translocation of "nuisance" Gila Monsters in the northeastern Phoenix Metropolitan Area.

Methods

Subjects

Subjects were obtained through calls from the general public when a “nuisance” Gila Monster was encountered by a resident in the northern Phoenix Metropolitan area and local agency personnel were notified (e.g., Arizona Game and Fish Department). We responded to the call, obtained the Gila Monster at the residence or from the agency personnel that had removed the animal, returned it to the laboratory for processing and surgery, and then released the animal at or near the site, or at some distance from the site if translocation was deemed necessary. Animals were generally released within 72 hrs of capture. A small number (N = 3) of animals were retained in the laboratory until radio-transmitters could be obtained for implantation.

Following initial capture, subjects were transported to the Department of Life Sciences, Arizona State University West, where multiple body measurements were obtained, including length and width of head, snout-vent length (SVL), tail length and width, and body mass. Surgical implantation of radio-transmitters was performed within 48 hrs of capture (generally, procedures followed Beck 1990). Subjects were anesthetized by placing their head into a clear plexiglass chamber containing air saturated with Isoflurane. A rubber collar around the chamber opening allowed a snug fit around the neck of the subject. They were assumed to be anesthetized when they failed to exhibit reflexes to light squeezing stimulation of their feet using a hemostat. An incision approximately 2 cm long was made longitudinally through the ventral integument and peritoneum just medial to the ribs, and a temperature-sensitive radio-transmitter (Model SI-2T, Holohil Systems Ltd.,164.000 - 164.999 MHz) was placed in the abdominal cavity. Radio-transmitters implanted in adult subjects had a mass of 11.4 g (always < 10% of body mass); a single juvenile subject (# 20) was implanted with a smaller radio-transmitter (4.5 g). Radio-transmitters were anchored to a rib with a non-absorbable suture where the base of the antennae entered the transmitter case, and antennae were inserted subcutaneously from the abdominal cavity, extended anteriorly and dorsally, and anchored in the neck region. For subsequent identification, a passive integrated transponder (PIT) tag was also inserted in the abdominal cavity during surgery. The incision through the integument was closed with absorbable sutures and subjects were allowed to recover from anesthesia. Because Gila Monsters cannot be reliably sexed using external characteristics, prior to recovery from anesthesia, individuals were sexed by injection of sterile saline solution 20-30 mm posterior to the cloacal opening to evert a hemipenis. Within 48 hrs, subjects were released either at point of capture or at a translocation point. All subjects were recaptured at least once to monitor changes in mass and status of incisions. Specific details (UTM coordinates, photographs) on the capture and release location of each Gila Monster are available from the PI (BKS). These locality details are not provided here because of concerns of some residents that participated in the study and the intense interest in these animals by individuals associated with the pet-trade.

All subjects were photographed; individuals were easily recognized by matching distinctive pigment patterns on the head and body to the photographs (confirmed by PIT-tag signatures). Subjects recaptured after battery failure (8-21 months) were returned to the laboratory, the radio-transmitter was surgically removed, and the subject released following recovery (Table 1).

Translocation

Subjects were translocated when the homeowner was anxious about the safety of pets or children, or both, and requested that the Gila Monster not be returned to the immediate vicinity. Other subjects were translocated when the surrounding area was undergoing urban development

(N = 15). The remaining subjects were moved less than 200 m from their capture site, and considered "non-translocated" (N = 9). All of these individuals were observed in the vicinity of their capture site within days of release.

Nine of 15 translocated subjects were released in open habitat away from homes but in the general vicinity (200-7688 m distances) of their original capture sites. The six remaining translocated subjects were released at the primary translocation site, a large (1206 ha) area of State Trust land in the center of the study area. This site was selected because it was the largest area of continuous, relatively undisturbed Sonoran Desert habitat in this region in which surrounding residents reported observing Gila Monsters in 1999 and 2000. Despite its acceptable appearance, it was nonetheless surrounded on all sides by paved roadways that experienced significant traffic.

Data Acquisition and Analysis

Subjects with implanted radio-transmitters were located by an observer on foot using a hand-held antennae and receiver (Telonics TR-1) every 2 - 3 days from March through October, and every 3 - 5 days from November through February, 2000-2002. When an individual was located, general notes on behavior (e.g., basking, walking) and location (e.g., in a burrow) were recorded. Universal Transverse Mercator (UTM) coordinates were found for its position using a handheld Global Positioning System (GPS) unit (Garmin 12 XL). UTM coordinates were transferred into ArcView 3.2 Spatial Analysis software (Environmental Systems Research Institute, Inc), and movement patterns were analyzed using the Animal Movement extension (United States Geological Survey). Movement patterns were analyzed by year (2000, 2001) for home range area (hectares), mean distance moved (m), total distance moved (m), and mean daily speed (m/day). Home range was estimated using 100% minimum convex polygon and kernel 95% contour intervals, as determined by ArcView. For kernel estimates of home range size, smoothing values were determined using least-squares cross-validation (Seaman et al. 1999). Because both measures of home range were highly correlated, only minimum convex polygon values are provided here. Statistical tests were two-tailed with $P < 0.05$.

Results

Twenty-five Gila Monsters were processed during 2000 and 2001 (Table 1). Two of these were juveniles (# 20 & # 23), and only one (# 20) was implanted with a radio-transmitter (# 23 was released "untagged"). Of the adult subjects, eight were males and 15 were females.

All (N = 18) individuals released less than 1000 m from where they were first captured returned to the capture site vicinity in one to thirty days (Table 1). These individuals were thus classified as "non-translocated" for analysis of home range and mean daily speed parameters using movements and refuge use subsequent to successful homing. Because one individual that returned to its capture site in 2000 was translocated a second time in 2001 (female # 8), seven individuals were classified as translocated (Table 2). Because of the potential of seasonal effects on home range size and mean daily speed, comparisons were restricted to within years (2000 and 2001), and statistical analysis was only possible with data from 2001 due to sample size restrictions (e.g., only one subject in 2000 was translocated more than 1000 m). Additionally, home ranges could only be calculated for a small number of translocated individuals (N = 4) that were relocated on more than five occasions before they were "lost" (see below).

From 2000-2001 home ranges of non-translocated males (N = 4) ranged from 5.5 to 44.9 ha, and non-translocated females (N = 14) ranged from 0.25 to 67.6 ha. Many nontranslocated subjects consistently used burrows near or under homes and other structures (e.g., utility boxes; Appendix III; Fig. 1). Mean daily speed of non-translocated males ranged from 6.7 to 15.8 m/day, and non-translocated females ranged from 4.4 to 46.9 m/day. Home range and mean daily speed were not significantly correlated with body size (SVL) in either males or females that were classified as non-translocated. Given the absence of significant differences between males and females, and that sample size was small, data for the sexes were pooled for comparison of home range and mean daily speed in 2001.

The home range of non-translocated individuals ranged from 1.8 to 36.6 ha in 2001, and translocated individuals ranged from 8.4 to 190.2 ha (MWU = 14, P = 0.073, N = 21; Table 2). The home ranges of the two adult males followed for at least one month (# 1 & # 19) were especially large (95.1 & 190.2 ha in 2001; Appendix III; Fig. 2a); most translocated individuals were followed for an insufficient period (less than one month) to obtain a meaningful home range estimate before they were "lost." The fate of lost individuals could not be determined; a small plane was used in an attempt to detect signals from long distance movements but proved unsuccessful. In the absence of transmitter battery failure, it is reasonable to assume lost individuals died on roadways surrounding the translocation site and the transmitters were destroyed.

Mean daily speed (MDS) of non-translocated individuals (N = 17) ranged from 4.4 to 16.8 m/day while that of translocated individuals (N = 5) ranged from 10.4 to 120.5 m/day in 2001 (Table 2). Translocated individuals (average MDS = 60.3 m/day) exhibited a significantly higher MDS (Mann Whitney U = 8, P = 0.007) than non-translocated individuals (average MDS = 10.24 m/day). For example, female 8 was initially translocated 937 m; she returned to her capture site ("home") within one month. Over the next 11 months she exhibited a home range of

67.6 ha, and a MDS of 19.1 m/day. After being removed from a residence on two occasions in the spring of 2001, at the request of the home owner she was translocated 9,560 m to the translocation site. She was lost within one month, and during this time exhibited a MDS of 34.0 m/day.

Only two translocated individuals were followed for two seasons. Male 1 was translocated 1,657 m, and exhibited a MDS of 54.8 m/day in 2000 (Appenidx III; Fig. 2a), and 48.9 m/day in 2001 post emergence (i.e., March to June). Hence, his MDS in 2001 was not reduced relative to that exhibited in 2000 immediately following translocation. By contrast, female 20 was translocated 24,700 m; immediately after release, in late summer, she exhibited a home range of 15.4 ha, and a MDS of 38.68 m/day in the first month following release. During fall and early winter, she moved relatively little, and for all of 2001 her home range was 15.4 ha (MDS = 10.4 m/day). When she emerged in March, 2002, she exhibited a home range of only 0.01 ha, and a MDS of only 0.40 m/day. Due to her small size (SVL = 180 mm), it is possible that she had more successfully adjusted to the translocation site than the only other individual that we were able to follow after overwintering at a translocation site. However, she was the only subject under 300 mm SVL that did not gain in mass across seasons, and it is conceivable that she was declining in health as result of her initially high movements subsequent to translocation. Unfortunately, her radio-transmitter failed after two months of activity in the spring (March to May, 2002).

During this study three individuals died; two were non-translocated individuals apparently struck by automobiles (# 9 & # 15) and the other was a translocated subject. This male was found dead, apparently killed and eaten by a mammalian predator, 14 months post-release (Sullivan et al. 2002; Appendix I). Although this death can be considered "natural," it may have been related to the elevated activity levels of this subject; clearly the high mean daily speed indicate an increased level of exposure to surface active predators.

Discussion

Gila Monsters and Translocation

Our results indicate that short distance translocations are ineffective as a means of removing Gila Monsters from areas of conflict with home owners. Numerous Gila Monsters that we moved less than 1000 m were encountered (and tolerated) by homeowners, and regularly used refuges near original capture sites following translocation. Clearly, Gila Monsters can successfully return if displaced a short distance; others have documented a direct relationship between translocation distance and return rate in nuisance mammals (e.g., Blanchard & Knight 1995). If the goal of translocating Gila Monsters is their permanent removal from an area due to human conflict, translocation distance must exceed one kilometer.

Gila Monsters translocated more than a kilometer did not return to the original capture site (home), at least in the urbanized desert environment we examined. Unfortunately, all adult subjects that failed to return were lost or died, suggesting that translocated individuals do not readily tolerate a novel environment. Translocated Gila Monsters exhibited higher mean daily movements, almost five times higher than non-translocated individuals. Similarly, Reinert & Rupert (1999) found that translocated Timber Rattlesnakes moved almost three times as far each day as non-translocated individuals, and Nowak et al. (2002) documented increased movement rates for translocated Western Diamond-backed Rattlesnakes. Increased activity, especially for the typically sedentary Gila Monster (Beck & Lowe 1994; Beck et al. 1995) might entail significant energetic and thermoregulatory costs as well as predation risks. The only Gila

Monster under 300 mm SVL that did not increase in mass across seasons was a translocated female (# 20). The high activity levels of translocated Gila Monsters that we observed may have led to mortality due to predation (e.g., male # 1). Reinert & Rupert (1999), Plummer & Mills (2000), and Nowak et al. (2002) documented that translocated snakes in their respective studies differed significantly in mortality rates in relation to release status: translocated individuals had higher mortality. In our study, we suspect that the translocated Gila Monsters that were lost died on roadways surrounding the translocation sites.

Although two non-translocated Gila Monsters with radio-transmitters died as a result of being struck by automobiles, most survived for an extended period, often in close proximity to roadways and homes (Appenidx III; Fig. 1). The survivorship of the non-translocated Gila Monsters in the Phoenix urban-desert interface was somewhat surprising. Parent & Weatherhead (2000) also found that Massasauga Rattlesnakes were apparently relatively tolerant of human disturbance. Our Gila Monsters were potentially exposed to higher prey densities than might have otherwise been available in the surrounding desert environment. Quail and dove, as well as cottontail rabbits are especially abundant in many desert-urban interface environments, even in dry years in which little reproduction occurs among these species in the surrounding desert (Sullivan unpubl. fieldnotes).

Translocation as a Conservation Tool

We documented significantly increased movement rates for translocated Gila Monsters. Although high activity rates of translocated individuals in novel environments are expected, other effects of translocation require consideration. Many of the non-translocated Gila Monsters that we radio-tracked used the same refuge repeatedly over 12-18 months of observation

(Appendix III; Fig. 1, 2a). Translocation could have negative consequences depending on the degree to which individuals rely on particular refuges for escape from predators, to regulate body temperature or to maintain water balance. Thermoregulatory behavior by ectothermic vertebrates like Gila Monsters might be especially disrupted by a translocation event. Additionally, although there is a general perception that birds and mammals are more likely than reptiles to have structured or relatively complex social systems, and hence be negatively impacted by translocation, it is now appreciated that many reptiles exhibit complex social relationships (e.g., Gardner et al. 2001). Longitudinal study of translocated individuals is necessary to determine the consequences of this conservation technique, but it is clear that the notion that animals can be "rescued" by simply moving them from one area to another is naive and potentially dangerous to the individual and both resident and host populations (Pietsch 1994; Shine & Koenig 2001; Seigel & Dodd 2002).

Translocation can also have significant ecological consequences at the population and community levels. For example, Gila Monsters are one of several top-order predators (young birds and mammals are their primary prey; Beck 1990) in desert environments. The loss of but a few individuals could negatively impact ecological interactions among remaining species (Kjoss & Litvaitis 2001; Shine & Koenig 2001). Translocations also provide opportunity for disease introduction for resident populations (Cunningham 1996; Shine & Koenig 2001; Seigel & Dodd 2002). Furthermore, genetic consequences of translocation requires careful consideration (Stockwell et al. 1996; Whiting 1997), and concerns have centered on the viability of re-established populations (Stockwell et al. 1996; Madsen et al. 1999). However, most reptile translocations in urbanized desert areas occur over short distances; hence, spread of diseases or parasites is likely minimal (Cunningham 1996), as are potential negative genetic consequences.

In conclusion, our translocation study of Gila Monsters is important in that it addresses a current urban management problem of a top order reptilian carnivore that is large, dangerously venomous and protected by law. The negative results of our translocation study place time and monetary constraints on agency personnel concerned with the fate of nuisance animals; there is a clear need for a more satisfactory conservation mechanism. Despite this dilemma, we are optimistic that public education by agencies and scientists working on Gila Monsters can alter negative opinions, and that this species can be portrayed as an extraordinary low risk threat to humans and reduce the need for translocation under many circumstances. Our own interactions with homeowners, for example, demonstrated high interest in the safety and well-being of individual Gila Monsters. In Carefree we interacted with individuals at 15 residences (homeowners approached us while we radio-tracked in their "neighborhood"): all were happy to continue to coexist with Gila Monsters and felt there was no need for translocation. Importantly, natural desert habitat surrounds most houses in these regions, and there it is reasonable to imagine Gila Monsters can continue to coexist with humankind under these circumstances.

Recommendations

First and foremost, our results reveal that the current practice of short distance translocation (i.e., less than 200 m from point of capture, to nearest suitable habitat) is appropriate for a nuisance Gila Monster if the goal is simply the immediate removal of an individual from the vicinity of a home or business. Short distance translocations (less than 500 m) should be within the subject's activity or home range area; of course, such a translocation will be ineffective as a means of permanently removing the subject from the capture site. Consequently, we strongly endorse the current policy of AGFD regarding treatment of nuisance

Gila Monsters: they should be moved the shortest possible distance (no more than 500 m distant) to the nearest appropriate habitat. If suitable habitat is available in the immediate vicinity, consideration should be given to releasing the subject at the capture site (i.e., no translocation).

Second, and perhaps most significantly, if the goal of translocation is permanent removal (for whatever reason; e.g., complete lack of suitable habitat near capture site), release of the subject at distances of greater than one kilometer is likely to have negative consequences for the subject due to increased movement. The potential for negative consequences following translocation is probably higher in regions with roadways and other human activities, but also may obtain even in natural desert habitats. Disposition of nuisance individuals under these circumstances is problematic. It is also possible that individuals translocated to large areas of intact desert habitat may fare better than those we translocated to urban–desert interface habitats, even if they do exhibit high movement patterns. Retention and placement with Adobe Wildlife Center is another option that should be given consideration. At the current time, we urge that private individuals not be allowed to retain nuisance Gila Monsters given the widespread interest in these reptiles in the "pet-trade."

Additional study is necessary to determine if long distance translocation success varies with habitat, season (most Gila Monsters we translocated were moved in spring and summer), or age of the Gila Monsters. It is conceivable that translocated individuals will "adopt" a translocation site if they successfully overwinter at the new site, and this may be more likely for juveniles.

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Appendix I: text of Sullivan et al. (2002).

HELODERMA SUSPECTUM (Gila monster). **MORTALITY/PREDATION**? Little is known about potential predators of the venomous Gila monster, but they are suspected to be few (Bogert and Del Campo, 1956. Bull. Amer. Mus. Nat. His., 109:1-238). As part of a study of the activity of Gila monsters in the Sonoran Desert near Phoenix, we observed the apparent outcome of a predation event involving a male Gila monster and a mammalian carnivore.

An adult male Gila monster, 250 mm snout-vent length (294 g), was initially captured in northern Phoenix, Arizona, on 12 April 2000, surgically implanted with a small radio-transmitter (12 g), and released (1600 m from its capture site) in typical Upland Sonoran Desert dominated by creosote bush, bursage, palo verde and saguaro cacti. It was relocated once or twice a week over the next fifteen months, during which time it grew 19 mm in length and 26 g in mass. On 27 June 2001 we radio-tracked the male Gila monster, and located the exposed tag and the head and neck of the lizard. The tag was exceptionally clean and exhibited small indentations consistent with the bite marks of a canid or similar-sized carnivore. The tag was imbedded in dry grasses over which an animal had apparently rolled repeatedly. Approximately 10 m from the tag the head and neck of the Gila monster were found with evidence that tissue had been "stripped" from the ribs and vertebral column. The lizard had been radio-tracked on 23 June 2001; at that time it was in a pack rat nest approximately 125 m from the subsequent location of the tag and head.

Although we have no direct evidence, we think that a coyote is the most likely candidate as the predator responsible for killing and consuming the Gila monster. First, other carnivores (e.g., feral dogs, kit or grey foxes, skunks, badgers) have not been observed at the site, which is entirely surrounded by urbanization, over the past two years; coyotes are commonly observed at the site. Second, the radio tag was exceptionally clean (as if mouthed repeatedly) and apparently "rolled on," behaviors commonly exhibited by canid predators. Last, given the short time that had elapsed since its previous location in a traditional refuge, it seems unlikely that the Gila monster died of some other cause and subsequently was fed upon (as carrion) by a coyote.

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Submitted by **BRIAN K. SULLIVAN**, Department of Life Sciences, Arizona State University West, PO Box 37100, Phoenix, AZ 85069, USA, **GORDON W. SCHUETT**, Grand Canyon University, Phoenix, AZ, USA, and **MATTHEW A. KWIATKOWSKI**, Department of Fishery and Wildlife Biology, Colorado State University, Fort Collins, CO, 80523-1474, USA.

Appendix II: Report on secondary benefits/objectives.

Blood samples collected from all 25 Gila Monsters are currently being analyzed by Dr. Michael Douglas, Colorado State University (see attached Abstract: a presentation for the ASIH/HL/SSAR meetings this summer in Brazil). Two investigations are underway. First, a systematic account of Gila Monsters and Beaded Lizards across their entire ranges in which the 25 Phoenix area animals in our study contributed a significant sample from a single geographic area. This study, based on analysis of mitochondrial and nuclear gene sequences, is in progress, but suggests that the current taxonomy (i.e., recognition of subspecies based on color pattern) is misplaced (see Abstract). It will provide the first definitive evaluation of the systematics of these lizards. Second, Dr. Douglas is also currently undertaking an analysis of microsatellites for determination of the specific relationships among individuals (e.g., parent/offspring) found in relatively close proximity (i.e., Carefree and Pinnacle Peak). When coupled with our existing dataset on spatial relationships of individuals (e.g., home range overlap), this analysis will allow a detailed assessment of the social structure of the Gila Monster. It is important to note that this work has been funded exclusively by Dr. Douglas (funds devoted to Gila Monster analysis in excess of $20,000).

As a result of the difficulty of sampling monsters after release (i.e., because they were rarely encountered above ground to allow us to draw blood), hormone and parasite analyses were not possible (both required larger volumes of blood than we were willing to draw from an individual or repeated sampling of an individual). Additionally, because the University Institutional Animal Care and Use Committee required that radio transmitters be implanted in monsters rather than externally mounted, as originally proposed, we were able to determine the sex of individuals directly during surgery. Although this eliminated the cost of x-rays ($2000), it required the purchase of more expensive radio transmitters, and considerable surgical supplies and equipment. In the end, higher costs of radio-transmitters and surgical materials were covered by the savings in genetic analysis, absence of need for x-rays, and inability to conduct hormone and parasite analysis.

Molecular Biodiversity of Helodermatidae (Reptilia, Squamata)

Douglas, Michael E., Marlis R. Douglas, Gordon W. Schuett, Daniel D. Beck, and Brian K. Sullivan

The Helodermatidae, a broad-ranging, monophyletic and venomous clade of lizards, consists of a single genus (*Heloderma*) diagnosed by the presence of bead-like osteoderms on the dorsal surfaces of head, limbs, body and tail. The genus is comprised of two species. *Heloderma suspectum* (Gila Monster) ranges from the Mojave Desert of extreme southern NV, southwestern UT, southeastern CA and northwestern AZ, throughout the Sonoran Desert region of Arizona and Sonora, México (exclusive of Baja California), and into the Chihuahuan Desert of southeastern AZ/ southwestern NM. Two subspecies are recognized: *H. s. suspectum*(Reticulate Gila Monster, in the southern part of the range) and *H. s. cinctum* (Banded Gila Monster, northern part of the range). *Heloderma horridum* (Méxican Beaded Lizard) is distributed from sea level to 1600 m along the Pacific foothills from southern Sonora to Chiapas, along Pacific drainages in southern Guatemala, and in two Atlantic drainages of Chiapas and eastern Guatemala. Four subspecies are recognized: *H. h. alvarezi*(central Chiapas, México to extreme western Guatemala), *H. h. charlesbogerti*(eastern Guatemala), *H. h. exasperatum* (southern Sonora, northern Sinaloa), and *H. h. horridum* (western México). We examined the molecular diversity within the Helodermatidae by sequencing 840 bp of two mtDNA genes (ATP 8 and 6), from 50 *H. horridum* and 87 *H. suspectum* sampled across their respective ranges. The tree was rooted with *Elgaria* (Anguidae) and explored using Bayesian analysis. Both species are monophyletic and clearly diagnosable, but genetic diversity within *H. suspectum* is significantly reduced when compared to than found in *H. horridum*. Furthermore, our morphological, biogeographical, and mtDNA analyses provide no basis for recognizing either of the two *H. suspectum* subspecies. However, the observed mtDNA variation in *H. horridum*, while congruent with current taxonomy, questions whether these clades should instead be recognized at the specific level.

Table 1. Individual ID number (duration of tracking in months), capture date (CAPTURE), termination date (END), translocation distance (in meters), and apparent outcome (Home = returned to capture site) for all Gila monsters. Female 8 was translocated a second time (*); some animals were retained in lab prior to release (**).

ID (months)	CAPTURE	END	DISTANCE	OUTCOME
1 (14.5)	11 Apr 2000	27 Jun 2001	1,657	Death
2 (24)	12 Apr 2000	5 Apr 2002	37	Home; tag removed
3 (16.5)	13 Apr 2000	1 Sep 2001	61	Home; tag down
4 (18.5)	13 Apr 2000	31 Oct 2001	136	Home; tag down
5 (17)	19 Apr 2000	27 Sep 2001	0	Home; tag down
6 (16)	24 Apr 2000	24 Aug 2001	240	Home; tag down
7 (16)	26 Apr 2000	1 Sep 2001	360	Home; tag down
8 (11.5)	16 May 2000	30 Apr 2001	937	Home; translocated
8 (1)*	30 Apr 2001	15 May 2001	9,560	Lost
9 (19)**	31 Jul 2000	18 May 2002	169	Home; death
10 (12)**	31 Aug 2000	5 Aug 2002	136	Home; tag down
11 (13)	4 Mar 2001	12 Apr 2002	441	Home; tag removed
12 (15)	16 Apr 2001	31 Aug 2002	0	Home: end of study
13(15)	16 Apr 2001	31 Aug 2002	628	Home; end of study
14 (15)	23 Apr 2001	31 Aug 2002	582	Home; end of study
15 (2)	1 May 2001	27 Jun 2001	68	Home; death
16 (14)	12 May 2001	31 Aug 2002	49	Home; end of study
17 (1)	15 May 2001	1 Jun 2001	18,268	Lost
18 (1)	19 May 2001	1 Jun 2001	22,410	Lost
19 (3)	5 Jun 2001	1 Sep 2001	9,845	Lost
20 (9)**	4 Jul 2001	15 May 2002	24,700	Tag down
21 (1)	9 Jul 2001	29 Jul 2001	7,688	Lost
22 (11)	30 Jul 2001	31 Aug 2002	511	Home; end of study
24 (9)	26 Aug 2001	18 May 2002	270	Home; tag removed
25 (11)	31 Aug 2001	31 Aug 2002	419	Home; end of study

Table 2. Individual ID number (T = "non-homing translocation"), sex, snout-vent length in mm (SVL), home range in 2000 in hectares (HR 2000), home range in 2001 in hectares (HR 2001), and mean daily speed in meters (mds). Female 8 (*) was translocated a second time on 30 April 2001.

ID	SEX	SVL	HR 2000 (mds)	HR 2001 (mds)
1 (T)	M	250	121.9 (54.8)	95.1 (48.9)
2	F	285	3.5 (7.6)	9.2 (12.1)
3	M	300	44.9 (20.9)	6.5 (13.0)
4	F	240	4.2 (8.3)	28 (11.0)
5	F	265	3.1 (5.6)	4.2 (10.5)
6	F	335	55.9 (46.9)	36.6 (14.8)
7	F	305	6.3 (10.6)	6.7 (14.1)
8	F	308	67.6 (19.1)	7.3 (4.4)
8 (T)*	F	308	--	9.8 (34.0)
9	F	340	--	8.8 (8.4)
10	F	290	--	6.8 (7.1)
11	F	305	--	17.8 (8.1)
12	M	320	--	10.1 (6.7)
13	F	230	--	27.5 (16.8)
14	F	255	--	14.4 (9.5)
15	F	289	--	--
16	F	207	--	3.0 (5.2)
17 (T)	F	325	--	-- (33.8)
18 (T)	M	258	--	--
19 (T)	M	280	--	190.2 (88.0)
20 (T)	F	180	--	15.4 (10.4)
21 (T)	M	250	--	8.4 (120.5)
22	M	230	--	17.6 (15.8)
24	M	235	--	5.5 (8.7)
25	F	270	--	1.8 (7.8)