

Leopard Gecko
Eublepharis macularius



Herpetology
December 9, 2003
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Introduction

In recent years, reptiles have become increasingly popular to have as pets. This is especially true with the leopard gecko, *Eublepharis macularius*, which has become the most popular gecko to be kept in captivity. This is because of the relative effortlessness required to care for the geckos and their bright colored pattern. They have also become primary subjects in research concerning hormones and the affected behaviors. They are a species of interest because the temperature at which the eggs are incubated determines their sexual dimorphism instead of a genetic component (Viets, Tousignant, Ewert, Nelson and Crews, 1993). This species is also unique in its moveable eyes and absence of the well-studied adhesive toe pads found in most geckos (Virtual Museum of Natural History, 2003). In all, this species can provide important insights into the physiology of geckos which will be covered in the following paper, however additionally studies are needed to comprehend the many aspects of this species..

Characteristics

The leopard gecko, *Eublepharis macularius*, belongs to the Gecko family Eublepharidae. The main defining features of this gecko family are well-developed functional eyelids. Other features include an unpaired parietal bone, absent calcified endolymphatic sacs in the neck region, and two centers of ossification present for the formation of the premaxillary bone (Szczerbak and Golubev, 1996). Members of this family also have soft small-scaled skin and do not have the adhesive toe-pads that are a feature of the geckos in the Gekkonidae family (Virtual Museum of Natural History, 2003). The prominent adaptation of adhesive toe pads found on geckos has permitted geckos to securely adhere to rock and trees for climbing. Since the Eublepharidae family lacks this feature, they are typically found on ground hidden between rocks.

Furthermore, members of this family produce soft-shell eggs unlike the other Gecko family, Gekkonidae, whose eggs are enclosed by a hard-shell. Members of this family are mainly confined to desert and dry-savanna habitats (Bartlett and Bartlett, 1995). The four genera of this family are the *Coleonyx*, *Eublepharis*, *Goniurosaurus*, and *Hemitheconyx* (Virtual Museum of Natural History, 2003).

The genus *Eublepharis* also has some overall defining characteristics that help herpetologists define the species. A unique characteristic of this genus is the fat-tail used for the storage of fat, which can be used as a valuable energy resource (Terrell, Uhl and Funk, 2003). The tail is typically shorter than the length of the head and body with a dilated middle and pointed tip (Szczerbak and Golubev, 1996). If the tail would fall off, it would regenerate with a bulbous shape, irregular scale pattern and paler coloring (Bartlett and Bartlett, 1995). Species in the *Eublepharis* genus have digits that are short, cylindrical, clawed, and have transverse lamellae underneath (Gocmen, 2003). Eight species have been identified within the *Eublepharis* genus, one being *Eublepharis macularius*, with coloration patterns and a small number of consistent scale characteristics (Szczerbak and Golubev, 1996).

The coloration of *Eublepharis macularis* is the explanation behind its common name, the Leopard Gecko. The dorsal surface of the body has a bright lemon-color surface decorated with numerous dark brown spots and occasional light thin interspaces. This pattern originates at the head with the spots becoming larger on the body set in non-distinct longitudinal rows. This pattern changes as one goes toward the tail where the spots merge to form transverse rings diminishing at the ventral surface (Szczerbak and

Golubev, 1996). The ventral surface is white with some washed-out darker spots on the main body surface.

The coloration of the leopard gecko is varied between adults and juveniles. Juveniles are generally with yellow and dark brown stripes with fade into spots as it matures (Martinez). Furthermore, young leopard geckos have a black-brown hood from the nostrils to the ears that covers the entire upper head. In the occipital region of the hood there are three light tips that are pointed to the neck in type of bird-track shape and a solid black-brown stripe on the neck (Szczerbak and Golubev, 1996). Adult males and females look alike with the only true sex differences being that males are larger. Males have an average SVL of 15.5 to 16 centimeters and the SVL of females is 14.5 to 15 centimeters (Gocmen, 2003). Males also typically have a broader head and neck (Martinez). The hemipenes can be found by comparing the undersides specifically the areas anterior and posterior to the cloaca between males and females. Males have a series of enlarged pores anterior to the anus and a globular tail base, which is absent in females (Bartlett and Bartlett, 1995).

Habitat

The Leopard gecko can be typically located in Southwest Asia. The range of *E. macularius* is from eastern Afghanistan and spreads south through Pakistan to western India (Szczerbak and Golubev, 1996). Most specimens seen in the wild were found in rocky deserts and arid grasslands (Martinez). They are most frequently located on clay-gravel soil covered by sand and rich in bushes of *Zygophyllum* (Szczerbak and Golubev, 1996). They are nocturnal animals, so during the day they can be found hidden in holes and crevices in avoid predators (Sleigh and Birchard, 2001). Their main predators are

foxes (Szczerbak and Golubev, 1996). Much is yet to be studied regarding variances between leopard geckos from different geographical areas.

Diet

Leopard geckos are found to be strictly carnivores feeding mainly upon living insects and other arthropods. The leopard gecko's prey is small, typically half the width of their skull. Their diets consist mainly of crickets, meal worms, and newly born mice (Martinez). They tend to be stealthy while hunting their prey with final acquisition of the victim being quick and certain but vary between individuals. They tend to exhibit heightened amounts of tail-writhing and postures (Bartlett and Bartlett, 1995). Deperno and Cooper studied labial-licking behaviors in 1996. Labial licking is defined as the tongue only contacting one's own labial scales along with surrounding scales of its mouth (Deperno and Cooper, 1996). It was found there is a direct relationship with this behavior decreasing as the gecko is exposed for a longer period to prey (Deperno and Cooper, 1996) The reason behind this could be that it may be a grooming function instead of a chemosensory response (Cooper, 1994). It should be studied further so one can better understand these behaviors in relation to leopard gecko's hunting behavior of prey.

In captivity, it is suggested that their diet is consistently varied. Also, it should be supplemented with calcium and vitamin D3. This is especially important during rapid growth of juveniles or egg production of females because it allocates enough calcium needed for bone growth and proper eggshell development (Bartlett and Bartlett, 1995).

Behavior

Behaviors exhibited by geckos have been well studied and documented, especially the Leopard gecko. Leopard geckos are mainly nocturnal with their main

activities taking place directly after sunset (Szczerbak and Golubev, 1996). Male leopard geckos have exhibited competitive behavior by being quite territorial and exhibiting aggressiveness towards one another. They may tear off the tail of another male or even rip off a piece of skin from the body (Szczerbak and Golubev, 1996). If aggressive, a male leopard gecko will approach by waving its tail and approaching the intruding animal in a sideways movement. It may then bite the intruder's neck or head or even flip the individual on to its back (Crews, Coomber, Baldwin, Azad, and Gonzalez-Lima, 1996). In 1990, Mason and Gutzke found that males and females recognize one another through chemoreception. Besides visual cues, an individual can detect whether another gecko is male or female through semiochemicals excreted by the skin of the neighboring gecko. The individual will thus exhibit a specific behavior towards that gecko, the behavior being aggression if the interacting individual is a male and courtship if it is a female. Males and females may excrete different semiochemicals which are believed to have evolved as water-retention mechanism (Mason and Gutzke, 1990) In this study, they looked specifically at females during the shedding of their skin to see if upon losing the skin, males would treat the female as a male. It was found males were more aggressive to females when the skin was shedding while exhibiting courtship behavior to them pre- and post-shedding, which indicate a pheromone difference between females and males.

Sakata, Gupta, Chuang, and Crews found in 2002 that social experience affects reproductive and territorial behaviors in a male leopard gecko. They looked for differences between males raised alongside females compared to those who were raised alone. They found that socially experienced males were more likely display territorial markings and to show more courtship behavior compared to that of naïve males. This

difference continued even true after both types of geckos were castrated and administered testosterone replacement therapy. This demonstrates how a gecko's social interaction in the field is important to its reproductive behavior. It may also indicate that these differences are linked to experience-dependent alterations in the metabolic activity in important limbic brain areas (Sakata, Gupta, Chuang, and Crews, 2002).

E. macularius is a lizard whose sex is determined by the temperature that its eggs are incubated. In a study published in 1993, Viets, Tousignant, Ewert, Nelson and Crews discovered that an embryonic temperature of 30 C produces a female-biased sex ratio (one male to every three females) while those with a temperature of 32.5 C produce a male-biased sex ratio (three males to every one female). With this knowledge, studies have looked to find other differences that this incubation temperature would create especially concerning behaviors that are either sexual or aggressive. In 1996, Crews, Coomber, Baldwin, Azad, and Gonzalez-Lima found that the incubation temperature is the primary factor that determines differences found between interactions of the male and female leopard. This is important because it means that incubation temperature is more important in influencing brain organization and hence behavior than gonadal sex during development (Crews, Coomber, Baldwin, Azad, and Gonzalez-Lima, 1996).

Since it was found that sociosexual behavior reflects differences in the morphology of the brain, it would be important to know how permanent is the effect of incubation temperature. Rhen and Crews published in 1999 that testosterone treatments of adult male Leopard geckos had no effect on activation of behaviors. They also uncovered that adult males from different incubation temperatures had differing responses to the same hormone treatments. This is due to embryonic temperature being

the main determinant of differences amongst behaviors of adult males from different incubating temperatures and not the hormones circulating through the body.

Testosterone's effect upon adult females was also studied. It was observed that females derived from a male-biased incubation temperature were more sensitive to testosterone than those from a female-biased incubation temperature. These females also exhibited male typical aggressive behavior after the testosterone treatments and they were typically attacked more by males which may be an indication that the testosterone changed the chemical composition of the lipids excreted by the female's skin (Flores and Crews, 1995). It was also discovered in a later study that testosterone increased and decreased female reproductive behaviors and that with long duration could allow the female to form a hemipenes (Rhen, Ross and Crews, 1999). In all, these studies have provided greater insight into the understanding of the importance of incubation temperature and its effects upon hormones, brain organization and behavior.

Reproduction

According to Crews *et al.* (1996), the courtship behavior most popularly used among geckos consists of the male approaching the female slowly using his tongue to lick the air and substrate. The chemical produced by the female's skin causes the male to vibrate the tip of his tail. If the female is receptive, then she will remain still as the male approaches. He will then lick and bite her gently prior to shaking her tail. Slowly, the male will move his grip from to the upper body and position his body parallel to hers. The females will then lift her tail and allow the male to intromit. In a study in 2003, researchers examined the receptors of androgens in female leopard geckos during their reproductive cycle. It was observed that there is a direct correlation with the expression

of androgen-mRNA in the brain during the late vitellogenesis phase and elevated concentrations of androgens found circulating the body. This in effect than creates a higher propensity for receptive behavior exhibited by the female leopard gecko. (Rhen *et al*, 2003)

Female leopard geckos lay two eggs per clutch (Bartlett and Bartlett, 1995). These eggs are hard-shelled and it takes approximately 60 days for the eggs to hatch (Szczerbak and Golubev, 1996). Sleight and Birchard found in 2001, that the amount of prenatal visual stimulation had an effect upon embryos. The more exposure to a light source, the shorter the incubation time and a higher preference exhibited by the juvenile for that same stimulation after hatching. This indicates that the nervous system is responsive to stimulations even prior to the maturity of the organism. This gives a better understanding to their development.

Conclusion

The leopard gecko, *Eublepharis macularius*, has become important in research studies looking at brain and hormones effects upon behavioral and anatomical differences between males and females. This is because it is completely reliant upon the environmental factors it is exposed to prior to hatching. Information gathered here may be a future model from which one could figure out the similar behavioral shifts found in similar species.

Another study that has been found to be important is the identification and characterization of the *GnRH-II* gene in the leopard gecko. This is the first time that this gene, which is found highly conserved in vertebrates, has been discovered in reptiles. This means that this gene may have become divergent during the amniote evolution since

the precursor sequence found in the leopard gecko is slightly variant from that found in mammalian species and more similar to that found in amphibians and fishes (Ikemoto and Park, 2003). This study has important implications considering the reptiles and their route through the evolutionary time frame.

In conclusion, these creatures have been studied for valuable insights into their physiology. Since the sexual dimorphisms is not effected by differing genes, the distinctions between males and females must be solely due to the incubation temperatures effect on the development of the brain and hormone excretion. Effects of testosterone and estrogen seen in these creatures provide a deeper understanding on their overall effect and usefulness. Future studies are needed though in studying the ecological aspects of the creature especially as the species is gaining popularity as a pet. They may hold a more important place in the ecological niches they can be found and therefore their abundance in nature may be important and they may need protection from high rates of capture just to be kept as pets.

Works Cited

- Bartlett RD and PP Bartlett. 1995. *Geckos: Everything About Selection, Care, Nutrition, Diseases, Breeding, and Behavior*. Barron's Educational Series, Inc.: New York.
- Cooper, WE. 1994. Multiple functions of extraoral lingual behavior in iguanian lizards: prey capture, grooming, and swallowing, but not prey discrimination. *Animal Behavior* **47**:765-775.
- Crews D, P Coomber, R Baldwin, N Azad, and F Gonzalez-Lima. 1996. Brain organization in a reptile lacking sex chromosomes: effects of gonadectomy and exogenous testosterone. *Hormones and Behavior* **30**:474-486.
- Deperno CS and WE Cooper, Jr. 1996. Labial-licking for chemical sampling by the leopard gecko (*Eublepharis macularius*). *Journal of Herpetology* **30**(4): 540-543.
- Flores DL and D Crews. 1995. Effect of hormonal manipulation on sociosexual behavior in adult female leopard geckos (*Eublepharis macularius*), a species with temperature-dependent sex determination. *Hormones and Behavior* **29**:458-473.
- Gocmen B. 2003. *Leopard Geckos of the World*.
<<http://bornova.ege.edu.tr/~bgocmen/home14.html>>
- Ikemoto T and MK Park. 2003. Identification and characterization of the reptilian *GnRH-II* in the leopard gecko, *Eublepharis macularius*, and its evolutionary considerations. *Gene* **316**:157-165.
- Martinez M. *Leopard Gecko*. <<http://www.whozoo.org/students/marmar/leopgeck.htm>>
- Mason RT and WHN Gutzke. 1990. Sex recognition in the leopard gecko, *Eublepharis macularius* (Sauria: Gekkonidae): possible mediation by skin-derived semiochemicals. *Journal of Chemical Ecology* **16**:27-36.
- Rhen T, J Ross and D Crews. 1999. Effects of testosterone on sexual behavior and morphology in adult female leopard geckos, *Eublepharis macularius*. *Hormones and Behavior* **36**:119-128.
- Rhen T and D Crews. 1999. Embryonic temperature and gonadal sex organize male-typical sexual and aggressive behavior in a lizard with temperature-dependent sex determination. *Endocrinology* **140**(10):4501-4508.
- Rhen T, JT Sakata, S Woolley, R Porter and D Crews. 2003. Changes in androgen receptor mRNA expression in the forebrain and oviduct during the reproductive cycle of female leopard geckos, *Eublepharis macularius*. *General and Comparative Endocrinology* **132**:133-141.

- Sakata JT, A Gupta, C-P Chuang, and D Crews. 2002. Social experience affects territorial and reproductive behaviors in male leopard geckos, *Eublepharis macularius*. *Animal Behaviour* **63**:487-493.
- Sleigh MJ and GF Birchard. 2001. Amount of prenatal visual stimulation alters incubation times and postnatal preferences in leopard geckos (*Eublepharis macularius*). *Journal of Comparative Psychology* **115**(3):233-240.
- Szczerbak NN and ML Golubev. 1996. *Gecko Fauna of the USSR and Contiguous Regions*. (Eds. AE Leviton and GR Zug) Society for the Study of Amphibians and Reptiles; New York.
- Terrell SP, EW Uhl, and RS Funk. 2003. Proliferative enteritis in leopard geckos (*Eublepharis macularius*) associated with *Cryptosporidium* sp infection. *Journal of Zoo and Wildlife Medicine* **34**(1):69-75.
- Viets BE, A Tousignant, MA Ewert, CE Nelson, and D Crews. 1993. Temperature-dependent sex determination in the leopard gecko, *Eublepharis macularius*. *Journal of Experimental Zoology* **265**:679-683.
- Virtual Museum of Natural History. 2003. *Eublepharidae*.
<http://www.curator.org/LegacyVMNH/WebOfLife/Kingdom/P_Chordata/Class/Reptilia/O_Squamata/InfraGekkota/Eublepharidae/eublepharidae.htm>