The predatory and antipredatory behavior of the leopard lizard *Gambelia wislizenii* in a year when food availability is exceedingly low

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A female *G. wislizenii* with a transmitter attached to the base of the tail, waits in the open, visually searching with her head up.

INTRODUCTION:

The Alvord Basin is an intricate ecosystem sensitive to variation in precipitation, temperature and timing of seasons. These environmental fluctuations affect the rates of production of flora and fauna. Therefore studying the abundance and distribution of organisms and the growth of individual organisms in a standard location over time can elucidate the intricate interplay of measured abiotic effects on trophic level interactions.

The leopard lizard *Gambelia wislizenii* is a mesocarnivore that has features of top carnivores yet it is potential prey as well. The leopard lizard eats primary consumers such as grasshoppers, secondary consumers such as the desert horned lizard *Phrynosoma platyrhinos*, and tertiary consumers such as the western whiptail lizard *Aspidoscelis tigris.* As ambush predators, *G. wislizenii* rely heavily on detecting movement of prey, and their capture success rate depends on skilled stalking, sprinting, and jumping pursuits of prey.

The 2007 season was expected to be an illuminating year for research on *G. wislizenii* because of many recent months of unusually low precipitation and a very warm early spring season was expected to severely reduce the availability of arthropods. Thus, only lizards remain as a stable prey base for *G. wislizenii.*

In a short-wait ambush mode, *G. wislizenii* move more frequently from plant to plant, and spend less being stationary as they visually search each plant (from a good vantage point just outside plant perimeter) for prey such as grasshoppers. But G. *wislizenii* uses a long-wait ambush mode when searching for *A. tigris* because *A. tigris* have a large home range and spend much of their time in mobile search for arthropods, thus *G. wislizenii* simply wait for unsuspecting *A. tigris* to approach.

Our research focus in 2007 was to document the prey availability and behavioral response of *G. wislizenii* and also to examine the antipredatory response of *G. wislizenii*, which seems to act like a fearless top carnivore, but because it is a mesocarnivore, it should also readily flee when pursued by humans.

HYPOTHESES:

1) The slow downward trend among years in the number of grasshoppers on shrubs in summer will drop precipitously in 2007, due to the very warm, dry spring of 2007.

2) The decreased availability of grasshoppers and other arthropods will cause *Gambelia wislizenii* to shift to heavier predation on *A. tigris* than in past years.

3) Thus, *G. wislizenii* will spend more time in 2007 in the long-wait ambush mode to catch *A. tigris* than in the short-wait ambush mode to catch grasshoppers.

4) As a mesocarnivore, *G. wislizenii* will display a modest antipredatory response compared to lizards that are more typically prey, such as *A. tigris*.

STUDY SITE:

The Alvord Basin of southeastern Oregon is classified as Great Basin desert scrub. The site has three mesohabitats: dune, hardpan, and sandy flats.

The vegetation in the area is predominantly comprises big sagebrush, *Artemisia tridentata* (ARTR), and greasewood, *Sarcobatus vermiculatus* (SAVE).

This *G. wislizenii* waits in the dappled shade at the base of a SAVE with its front legs partially extend and head elevated searching for prey.

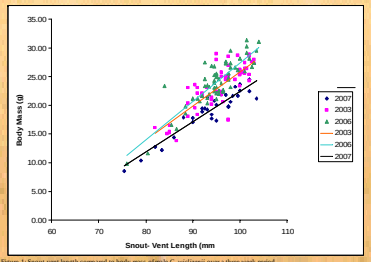

Figure 1: Snout-vent length compared to body mass of male *G. wislizenii* over a three week period.

MATERIALS AND METHODS:

Lizard Capturing and Processing: Lizards were sighted by haphazard, chance encounter, or standard plot searches and captured with lizard nooses. Captured lizards were processed by measuring snout-vent length, and tail length, noting or taking toe clips, painting them, weighing them and release back to their sighting coordinates.

Tracking and Observing *G. wislizenii*: Male and female *G. wislizenii* were radio tracked during different times of the day for eight days. When the lizard was found, we performed a ten minute focal observation via video recording, so that we would know the prevalent activity patterns and behavioral state of the lizard at that time of day. Moreover we needed to document the behavioral state of the lizard prior to our "feeding experiment." At the end of the focal observation, either cooled grasshoppers or chrome hex-nuts were tossed across the lizard's field of view to note the lizard's response to different approach patterns of prey. Field notebooks were used to record all the information.

***G. wislizenii* Field Chases:** *G. wislizenii* were chased in the three main mesohabitats to observe their behaviors and evasive strategies, routes were marked by dropping flags, and the flagged routes were mapped utilizing some vegetation maps from previous years, and hand making a few small sections this year in the field.

Raceway Runs: The raceway was a 20 meter long track with a sieved sand substrate. The finish line end and halfway point were decorated with dead wood and common desert shrubs to look shady and green. Cameras above the racetrack recorded the runs, which were reviewed later to measure the velocities of the lizards running in the track.

Grasshopper Plots: Eight 5mx 5m plots on each of three 10m x 40m plots in each of three mesohabitats were surveyed and monitored for abundance of grasshopper species, and distribution. Large grasshoppers were painted with a single paint pen dot on the thorax in reference to their quad number to determine movement patterns between the quads on repeated searches. Open areas and plants were first examined visually, then with palms up and fingers spread plants were combed from base to crown while peripheral foliage sweeps were performed to induce grasshoppers to reveal themselves. The searches were performed during three different time periods.

Pit Traps: Pit traps were laid in the ground in the three major mesohabitats. They were left under small, medium and large plants (ARTR or SAVE) and in the open for exactly seven days, then collected. Each pit trap was at least five meters from the next pit trap, and was at least 0.75m away from another plant. The contents of the pit traps were sorted down to Order, and life stage, with size categories for beetles, and ants were sorted down to Species.

Weather Station and iButtons: The weather station and Thermochron iButtons were set up and took simultaneous measurements from 7/5/2007 through 7/19/2007. The data was compared with temperature measurements with the handheld instruments used in the field. The iButtons were placed in a variety of micro- and nanohabitats to examine the temperatures of each.

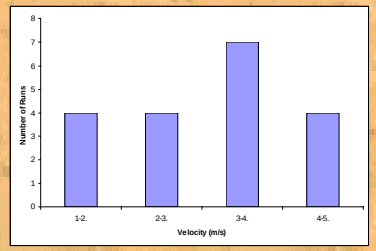

Figure 2: Velocity class attained by each *G. wislizenii* run in Raceway Trials.

A very cryptic unmarked *G. wislizenii* with its head up and partially extended front legs is displaying long-wait ambush technique by visually searching for prey in the open.

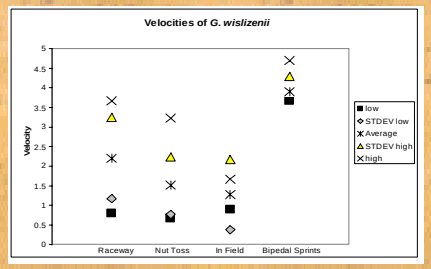

Figure 3: Velocities of *G. wislizenii* in different behaviors: quadrupedal runs on the raceway, pursuing fake prey (silvery nuts), quadrupedal "runs" to evade human pursuers in the field, and bipedal sprints on the raceway

Grasshoppers, like this captured nymph, are one of *G. wislizenii* main arthropod prey items.

RESULTS:

- ***Gambelia wislizenii* had relatively few prey in 2007 (Table 1) and were thin as a result (Figure 1).**
- **The maximum sprinting velocities, at 4m/sec (Figures 2 & 3) are about as fast as their principal lizard prey, *A. tigris.***
- **Large *ARTR* and large *SAVE* were the most common refugia of *G. wislizenii* when they were chased (Figure 4), and these plants were also the most common visited by *A. tigris* when foraging and were the most common refugia for *A. tigris* (see studies from prior years) .**
- **The average number of grasshoppers found in plot searches, although very low when compared to other years, is much higher and potentially much more informative than the grasshoppers found via pit traps (Figure 5).**
- ***Gambelia wislizenii* moved less often in 2007 than in 2006. Both moves per minute and the percent of time spent moving decreased from 2006 to 2007 (0.9 to 0.53, and 7.5 to 6.5, respectively). These movement patterns are classic for long-wait ambush predators.**
- **Habitat temperatures permit *G. wislizenii* to be on the surface throughout the morning when *A. tigris* are most active, but *G. wislizenii* can be active the entire day, on the lookout for arthropods if they retreat to the shade of SAVEs (Figure 6).**

TABLE 1

Search Year near Fields, OR	Grasshoppers per eight 5m x 5m plots	Whiptail Lizards per hectare
2003	7.7	29
2006	3	22
2007	0.5	9

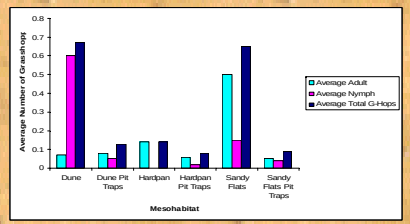

Figure 5: Average number of Grasshoppers sighted from 49 searches compared to the average number of Grasshoppers collected from 427 pit traps in the three mesohabitats.

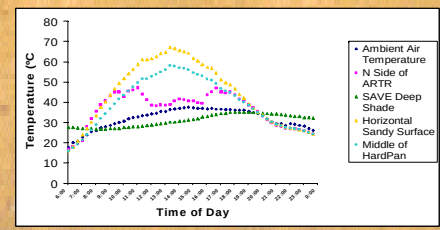

Figure 6: Average temperatures of five different nanohabitats taken every 20 minutes by Thermochron iButtons over a 14 hour period.

DISCUSSION:

The occasional observation of an *A. tigris* tail hanging out of the mouth of a *Gambelia wislizenii* (see right) is a strong indication that *G. wislizenii* successfully ambush *A. tigris*.

***Gambelia wislizenii* are capable of high sprinting velocities in a narrow raceway, but we could not get them to achieve these speeds when we chased them on plot under natural conditions. We expect that the only time they sprint fast is when they pursue *A. tigris*.**

The relative lack of grasshoppers in 2006 and 2007 may have caused *G. wislizenii* to rely more heavily on *A. tigris* as prey.

The long-wait ambush predation mode of *G. wislizenii* should be conducive to capturing *A. tigris*. If so, then heavier predation by *G. wislizenii* may have contributed to the decline of the *A. tigris* population.

The low body masses of *G. wislizenii* may be an indication that *A. tigris* were too few for effective predation by *G. wislizenii.*

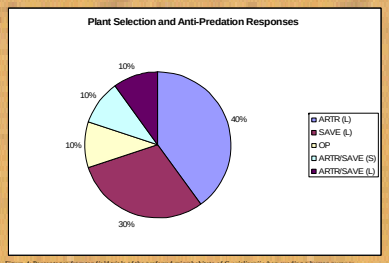

Figure 4: Percentages from ten field trials of the preferred microhabitats of *G. wislizenii* when evading a human pursuer.

A *G. wislizenii* lizard has recently swallowed an *A. tigris* lizard that weighs two thirds it's body weight.

CONCLUSIONS:

Long-wait ambush predation by *G. wislizenii* can be interpreted as visual searching for *A. tigris*, rather than some sort of antipredation behavior. It was difficult to get *G. wislizenii* to run far or fast when they were evading humans.

The relatively emaciated condition of *G. wislizenii* in 2007 is almost certainly due to low food availability, particularly the unavailability of grasshoppers.

We expect very low population density of *G. wislizenii* in 2008.

A. tigris, like the one shown above, are one of *G. wislizenii* main long-wait ambush lizard prey species.