

Urban behavioral ecology of the Western black widow spider: the effect of nature and nurture on development and cannibalism

J. Chadwick Johnson, Lindsay Miles, Patricia Trubl
 Dept. of Mathematical & Natural Sciences, Arizona State University at the West Campus



ABSTRACT

- Due to their potent venom, widow spiders (*Latrodectus spp.*) are medically-important pests (1).
- Black widows (*Latrodectus hesperus*) from urban habitats of Phoenix, AZ experience a drastically different environment than conspecifics from surrounding, undisturbed Sonoran desert habitats. Specifically, urban habitats are characterized by higher prey abundance, lower prey diversity, and lower enemy risk than desert populations (2).
- As a result, urban populations tend to be densely populated/infested (nearest neighbor = 1.3 m.), whereas desert populations tend to be sparsely populated (nearest neighbor = >50 m.; Johnson, unpublished data).
- Here we present data from field-collected egg sacs suggesting that females from the prey-limited, low-competition desert environment actually maintain a higher body condition and produce heavier egg sacs than females from prey-abundant, high competition urban environments.
- Desert egg sacs also proved to contain more eggs, and the average egg mass and egg size of individual eggs from desert females was significantly greater than eggs from urban black widows. Surprisingly, egg condition (egg mass/egg area) did not differ significantly across populations.
- A follow-up lab manipulation of the body condition of twenty female black widows was conducted to directly assess the extent to which food availability and maternal provisioning influence egg parameters, development rate and sibling cannibalism.
- Our results suggest that maternal condition has a marginally significant effect on egg condition, and that egg condition has a positive effect on development speed, but no effect on cannibalism rate. Instead, after controlling for egg condition, family of origin predicts a significant amount of variation in cannibalism rate—suggesting cannibalism is a heritable trait.
- We conclude by arguing that an understanding of the impact urbanization has on local fauna (including animal behavior) is required if we wish to both reduce the impact we have on other organisms and reduce the risk that dangerous urban pests have on human populations.

METHODS

- Desert widows were collected from the Peralta Trail in the Superstition Wilderness. Urban widows were collected from Marshall Ranch Elementary School in Glendale, AZ.
- Fed females made egg sacs when they were above 650 mg, whereas starved females made egg sacs when they were under 400 mg. Upon deposition of an egg sac, 25 eggs were weighed (μg) and measured (mm^2).
- For each family, five eggs were placed in each of 25 transparent boxes (4 x 4 x 5cm). Boxes were checked daily for hatching date, date mobile (development speed) and date of first cannibalism.

RESULTS

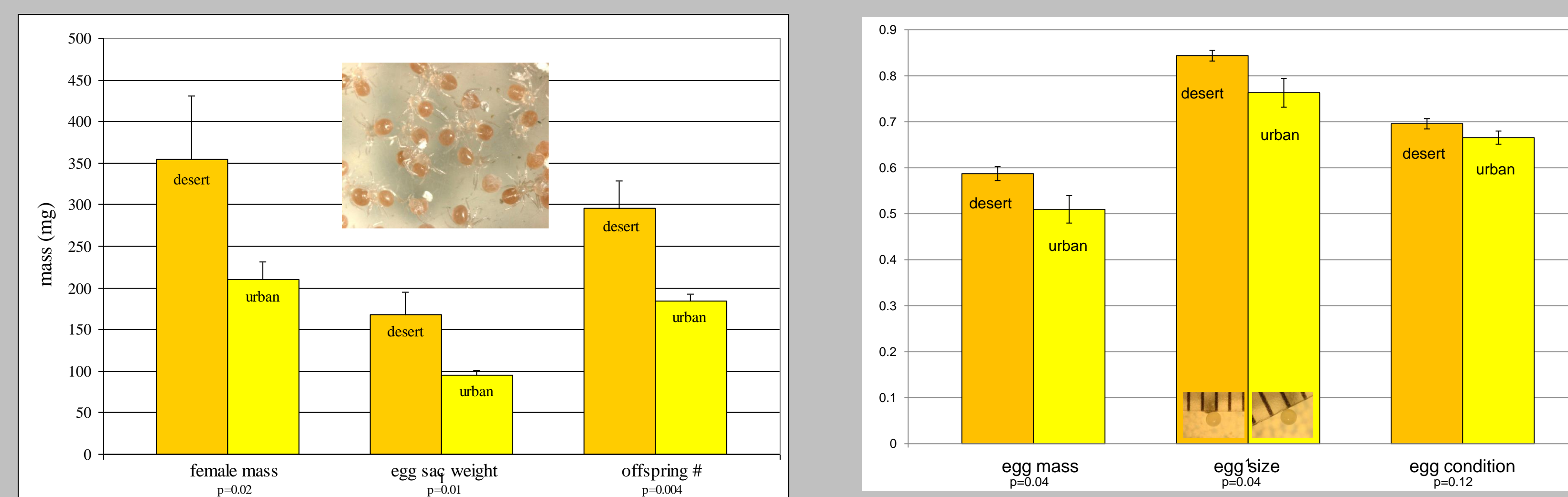


Figure 1. A field census indicates that, relative to urban females (N=8), desert females (N=8) are heavier and make heavier egg sacs that contain more eggs. In addition, eggs (N=25/female) made by desert females are, on average, heavier and larger, but do not differ in condition (mass/size).

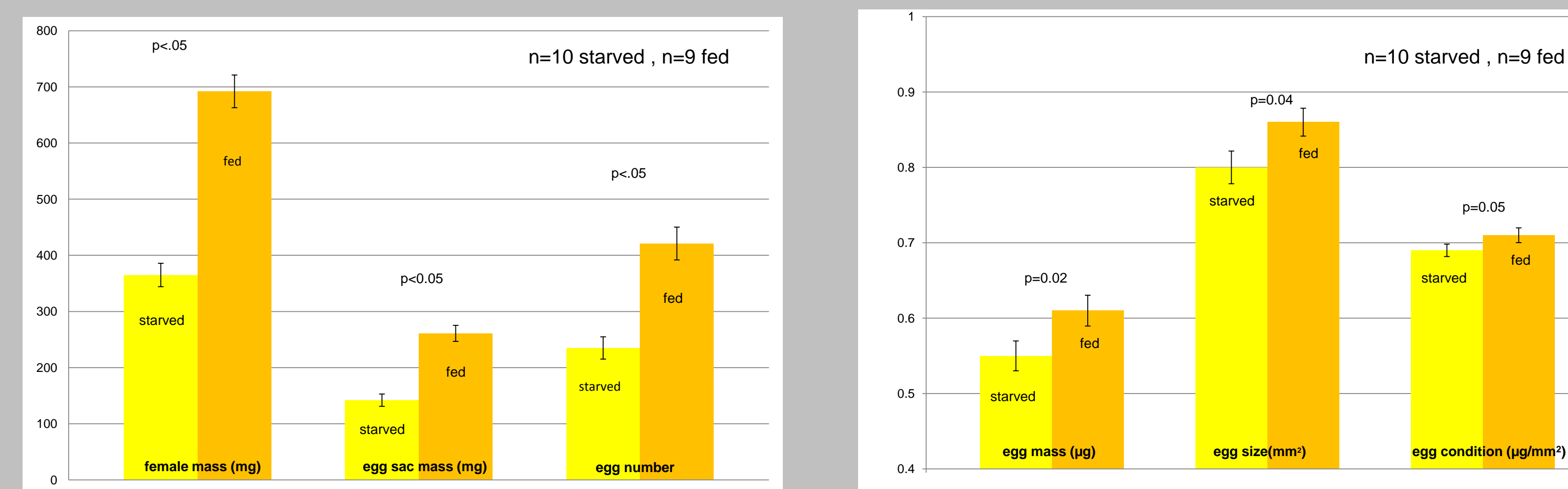


Figure 2. An experimental food manipulation indicates that, relative to starved females, fed females are heavier and make heavier egg sacs that contain more eggs. In addition, fed females make individual eggs that are, on average, heavier, larger, and in marginally better condition (mass/size).

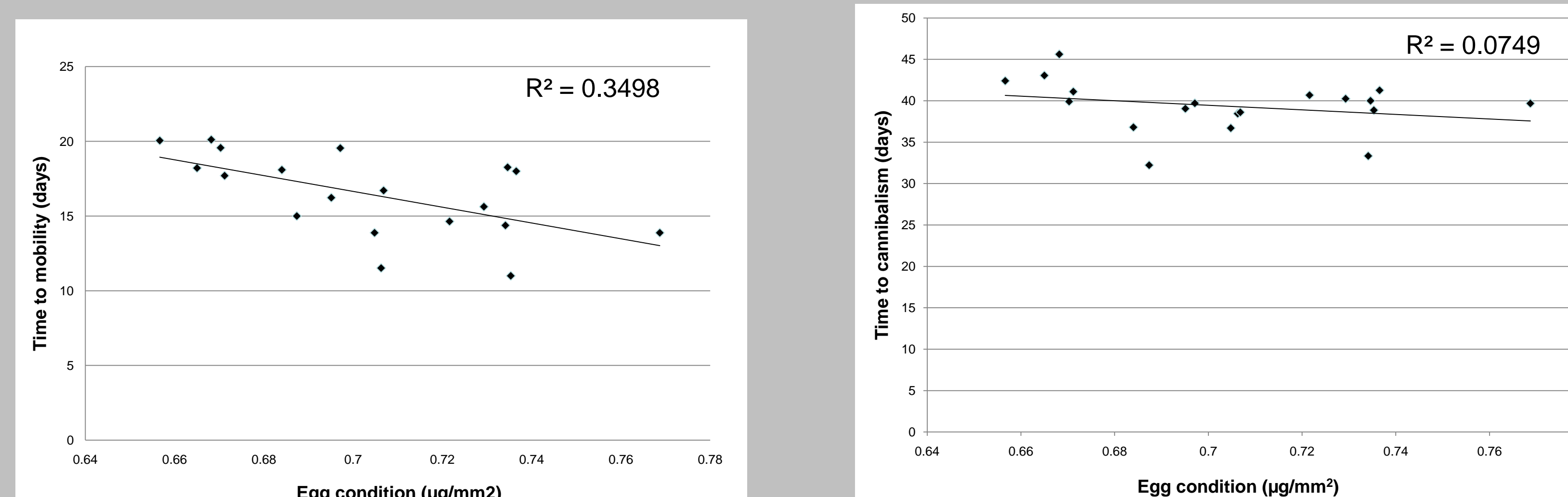


Figure 3. Egg condition (mass/size) is a good predictor of development speed, but a poor predictor of cannibalism rate (N=19 family averages).

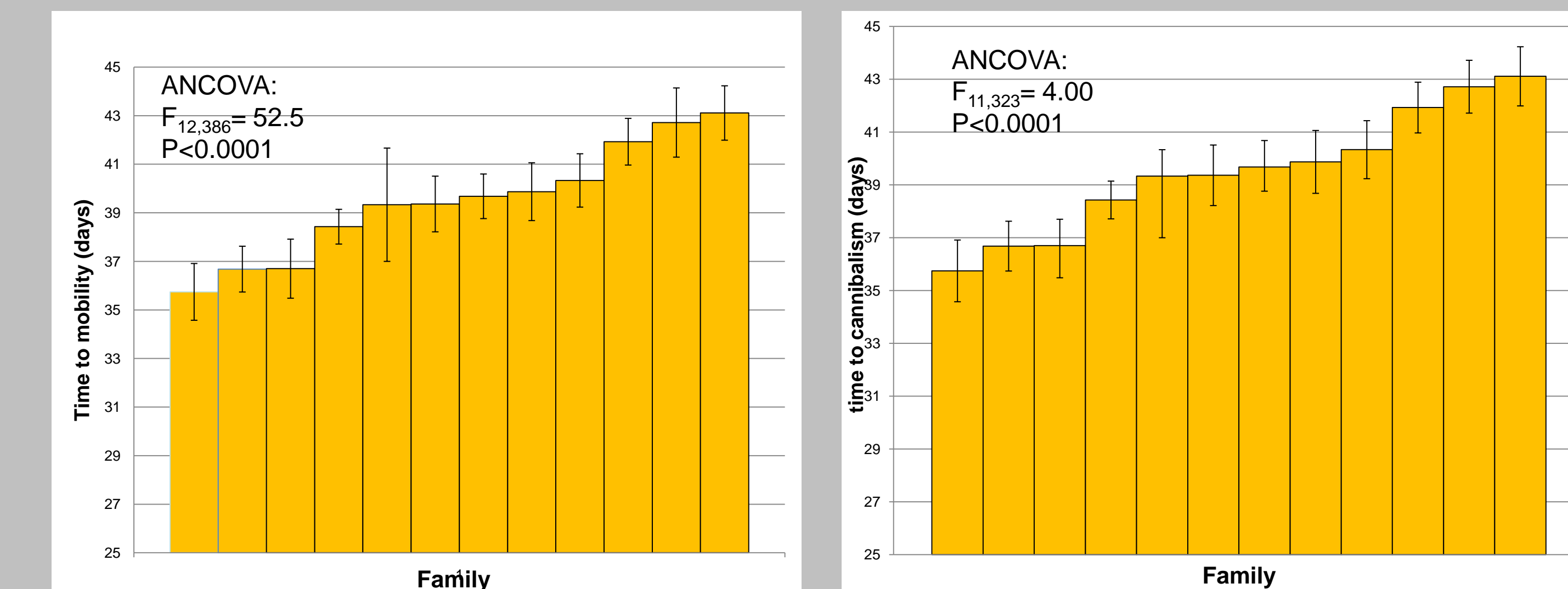


Figure 4. After controlling for egg condition, family of origin predicts a significant amount of variation in development speed and cannibalism rate.

DISCUSSION

- We were surprised to find that spiders from prey-limited, desert habitat are in better condition than urban spiders (Fig. 1). The relative poor condition of urban spiders may be explained by the high intraspecific competition encountered in infestations and/or the low prey (nutrient) diversity available in urban habitat. These data are consistent with a model developed to explain the poor condition of urban birds (3).
- Our data (field and lab) suggest that maternal mass has a large influence on egg mass and egg size (Fig. 1&2). Interestingly, maternal mass is not as strongly coupled to egg condition. Indeed, poor condition females appear reluctant to manufacture eggs below a threshold condition of $0.68 \pm 0.01 \mu\text{g}/\text{mm}^2$. Instead, poor condition females appear to curtail egg # rather than egg condition.
- Our hypothesis that poor egg condition could explain high rates of cannibalism within some clutches was refuted. Instead, after controlling for egg condition, both development speed and cannibalism rate proved to be predicted by family of origin. Thus, here we present one of surprisingly few data sets that suggest cannibalism is a heritable trait.
- Datasets such as this one illustrate the power animal behavior has to inform studies of urban ecology.

LITERATURE CITED

1. Muller GJ (1993) Black and BRW spider bites in South Africa—a series of 45 cases. *South African Medical Journal* 83: 399-405.
2. Faeth SH, Warren PS, Shochat E, & Marussich WA (2005). Trophic dynamics in urban communities. *BioScience* 55: 399-407.
3. Shochat E (2004). Credit or debit? Resource input changes population dynamics of city slicker birds. *Oikos*, 106 (3); 622-626.