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Movement and habitat use by adult and juvenile Toad-headed Agama lizards (*Phrynocephalus versicolor* Strauch, 1876) in the eastern Gobi Desert, Mongolia

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Introduction

Phrynocephalus versicolor Strauch, 1876 is a small lizard (Agamidae) found in desert and semi-desert regions of China, Mongolia, Kazakhstan and Kyrgyzstan (Zhao, 1999). The species inhabits areas of sparse vegetation and can be relatively common, with reported densities of up to 400 per hectare (Zhao, 1999). In spite of its wide distribution and local abundance, relatively little detailed ecological information is available, particularly in the northern areas of its range. We report our ecological observations on a population of *P. versicolor* in the Gobi Desert of Mongolia with regard to their movement and habitat use.

Materials and Methods

We collected data 25–26 August 2018 in the Gobi Desert, approximately 5 km east of Khanbogd, Ömnögovi, Mongolia (43.18°N, 107.26°E; datum = WGS84). The study site was a large area (ca. 12 ha) of desert steppe habitat, located in the Eastern Gobi Desert Steppe phytogeographic region, containing patches of open sand interspersed with vegetation cover consisting of herbaceous plants (primarily grasses Poaceae) and leeks (Amaryllidaceae: *Allium mongolicum* & *A. polyrhizum*), and four shrubs: Mongolian Potanin (Rosaceae: *Potaninia mongolica*), Winterfat (Amaranthaceae: *Krascheninnikovia ceratoides*), Boyalych Saltbush (Amaranthaceae: *Salsola laricifolia*), and Siberian Nitrebush (Zygophyllaceae: *Nitraria sibirica*) (Tungalag, pers. comm.).

From 0700–1900 h we walked slowly throughout the study area in search of Toad-headed Agama lizards (*Phrynocephalus versicolor*). When a lizard was sighted, we captured the animal by hand or noose. We then measured the lizard (snout-to-vent length (SVL; mm) and mass (g) and sexed adults by probing. Juveniles were too small to sex. Using non-toxic paint pens, we marked each lizard with a unique colour code for later identification and to avoid recapture or repeat observations.

All focal observations occurred on one day (26 August). When an animal was sighted, we positioned ourselves 3–5 m from the lizard, waited 5 min for the lizard to acclimate to our presence, and then we began a 10-min observation period. At the start of the observation and at each 1-min increment, we noted the habitat that the lizard occupied and counted the number of moves the lizard made, as well as the number of times it ate or dug in the sand. One person (MAE) recorded data and the other (DAE) counted moves made. A move was defined as the displacement of the focal individual by at least 1 body length. We defined the habitat for a lizard, with reference to the patch centred on the lizard that was 1 body length in diameter, as either "open" (i.e., devoid of any vegetation), "grass" (i.e., containing only herbaceous vegetation), or "shrub" (i.e., containing one of the shrub species). In practice, the habitat categories were mutually exclusive and exhaustive. At the end of each observation we captured the lizard to mark and measure. No lizard was observed more than once, and all lizards were replaced at their capture site, usually within minutes.

We analysed data using Minitab 18 (College Station, Pennsylvania, USA). We used nonlinear regressions to analyse the scaling relationship in our morphometric data, non-parametric tests for the observational data because movement data were not normally distributed, and chi-square tests to compare patterns of habitat use between adults and juveniles. We considered results

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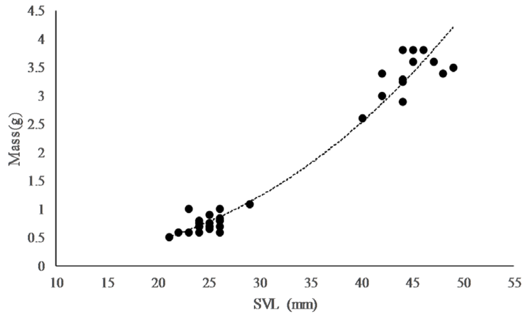

Figure 1. SVL-mass relationship for *Phrynocephalus versicolor* juveniles and adults. Regression relationship: mass = 0.00035(SVL)$^{2.41264}$; $F = 3.13$, $P = 0.01$.

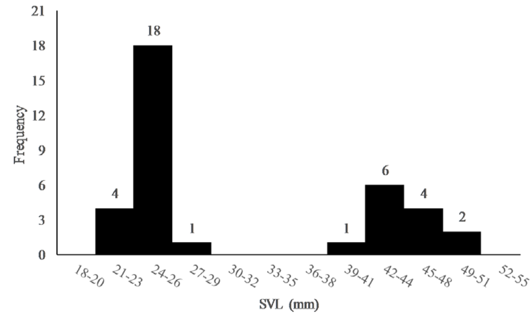

Figure 2. Size distribution for captured *Phrynocephalus versicolor*; note the two distinct size classes, which we refer to as adults (right bars) and juveniles (left bars).

significant when $P < 0.05$ and present descriptive statistics as mean ± SE.

Results

We captured 37 *P. versicolor* and collected observational data on 15 lizards. Lizards clearly fell into two size-classes (adults and juveniles; Figure 1); at the time of sampling juveniles were approximately twice as common as adults (23 juveniles vs. 13 adults; Figure 2) and adult females were more common than males (11 vs. 2, respectively). Adult SVL's were almost twice as long and their mass several times heavier than juveniles (SVL: 44.6 ± 0.69 mm (adults) vs. 24.6 ± 0.34 mm (juveniles); mass: 3.38 ± 0.10 g (adults) vs. 0.74 ± 0.03 g (juveniles); Figure 1).

We conducted focal observations on ten juvenile and five adult (female) lizards. Juveniles moved more frequently than adults (Mann-Whitney test: $W = 20.5$, $P = 0.02$; median moves per minute (MPM) = 1.05 vs. 0.00; Figure 3).

In addition, half the juveniles (5/10) but none of the adults (0/5) ate during observations. The two classes also differed in their use of habitat ($X^2 = 93.06$, df = 2, $P < 0.001$); juveniles spent more than 80% of their time in grass while adults spent most of their time in the open (Figure 4).

Discussion

Our very brief study points to several aspects of *P. versicolor*'s ecology worth consideration. Assuming that hatchling lizards occur in equal sex proportions, the strong female bias among adults could signify that males experience heavy mortality. A strong female bias has been observed for other populations of *P. versicolor* (Qu et al., 2011). Not enough is known about the behaviour of the species to suggest the source of the sex bias.

During our study, the two size classes preferred different microhabitats, with larger adults spending more time in the open whereas juveniles spent more time in the herbaceous vegetation (Figure 4). Habitat differences among size or age classes of lizards has been observed previously, but the reasons can be varied and require further inquiry. Smaller individuals may be more susceptible to thermal conditions and the grass habitat may provide a less stressful thermal environment, or the size classes could differ in food preferences or predation risk (Wang et al., 2013).

As with habitat use, the observed differences in movement rates indicate that the two size classes are pursuing fundamentally different strategies. The timing of our study corresponded to the post-breeding season (Terbish et al., 2013) during which movement was most

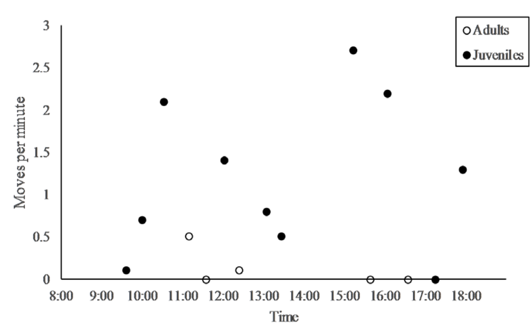

Figure 3. Levels of activity (MPM) for juvenile and adult *Phrynocephalus versicolor*.

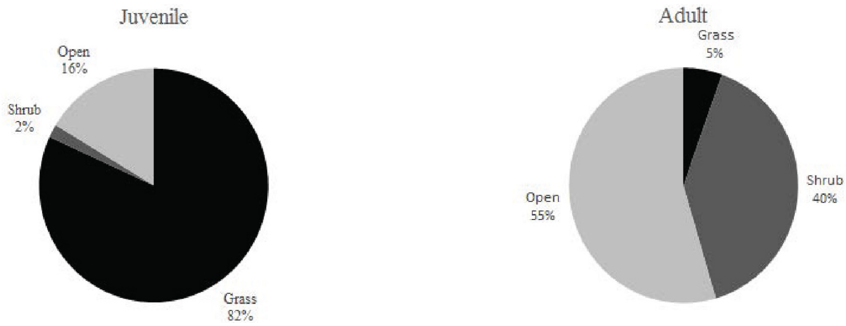

Figure 4. Habitat use for juvenile (left) and adult (right) *Phrynocephalus versicolor*.

likely to be foraging-related for both size classes. The smaller lizards are likely to be looking for smaller prey; more frequent movement might be associated with shorter detection distances for their prey items.

Phrynocephalus versicolor can occur in quite high densities and are sufficiently common to be one of the "symbols" associated with the Mongolian Gobi (Terbish et al., 2013). Our brief study points out that there is much to be learned about the ecology of the species, particularly with regard to intraspecific variation in behaviour.

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