



A New Cryptic Species of Fringe-Toed Lizard (*Uma*, Phrynosomatidae)

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Introduction

Fringed-toed lizards (*Uma*, Phrynosomatidae) are found in the deserts of the southwestern United States and northern Mexico and are adapted to live in wind-blown sand dunes; the fringes located on their toes increase traction when running across sand (Figs. 1,2). For decades there has been debate over the taxonomy of the *Uma notata* complex, with the number of recognized species ranging from one to four. Trepanier et al. (2001) found genetic (mtDNA) evidence that a population of *U. notata* found in the Mohawk Dunes of Arizona was a separate species in need of a formal description. The goal of this project is to compare the genetics and morphology of specimens from Mohawk Dunes to other specimens of the *Uma notata* complex in an effort to search for diagnostic characters for a formal species description.



Figure 1: Fringe-Toed Lizard in Mohawk Dunes, AZ



Figure 2: Fringed toes, full body, and gular region of a Fringe-toed Lizard from Mohawk Dunes, AZ.

Character	<i>U. sp.</i>	<i>U. notata</i>	<i>U. cowlesi</i>	<i>U. rufopunctata</i>	p-value
Ratio of Tail to Total Body Length	0.5 - 0.53 0.52 ± 0.01	0.44 - 0.52 0.5 ± 0.03	0.4 - 0.52 0.49 ± 0.04	0.46 - 0.54 0.51 ± 0.03	0.009
Fringe scales on Fourth Toe	25 - 33 28.95 ± 2.3	23 - 30 26.19 ± 2.07	22 - 32 26.82 ± 2.36	21 - 30 25.25 ± 2.56	0.000043
Number of Internasal scales	3 - 6 4 ± 1.18	1 - 5 2.88 ± 1.36	2 - 5 3.27 ± 0.79	1 - 4 2.5 ± 1.05	0.022
Percentage of specimens with broken longitudinal lines along dorsal occeli	100%	62.25%	45.45%	100%	0.021
Percentage of specimens with dark chevrons along gular fold	100%	87.50%	45.45%	66.67%	0.021
Percentage of specimens with postmental scale extending between the lateral sublabial scales to touch gular scales	81.81%	25%	45.45%	33.33%	0.011

Table 1: Characters of *Uma sp.* Compared to the rest of the *U. notata* complex. First line represents the range, second line represents the average and standard deviation.

Methods

Morphology

49 characters were compiled based on previously published research on *Uma* (Norris 1958). A total of 38 specimens were scored for these characters, including 8 *U. notata*, 11 *U. cowlesi*, 6 *U. rufopunctata*, and 11 specimens from Mohawk Dunes. The range, mean, standard deviation, were determined and significance was assessed using a t-test for measurements and scale counts and a z-test for percentages (traits with significant differences among species can be found in Table 1).

Phylogeny

Polymerase Chain Reaction (PCR) and sequencing were performed at the Smithsonian Laboratories of Analytical Biology on three different loci, cytochrome b, ATPase 6, and COI, on a total of 46 samples, including 15 from Mohawk Dunes. The editing and alignment of sequences was done using Geneious R9, and the estimation of phylogenetic trees was done in RAxML 8 using the GTR+G substitution model and 1,000 bootstrap replicates.

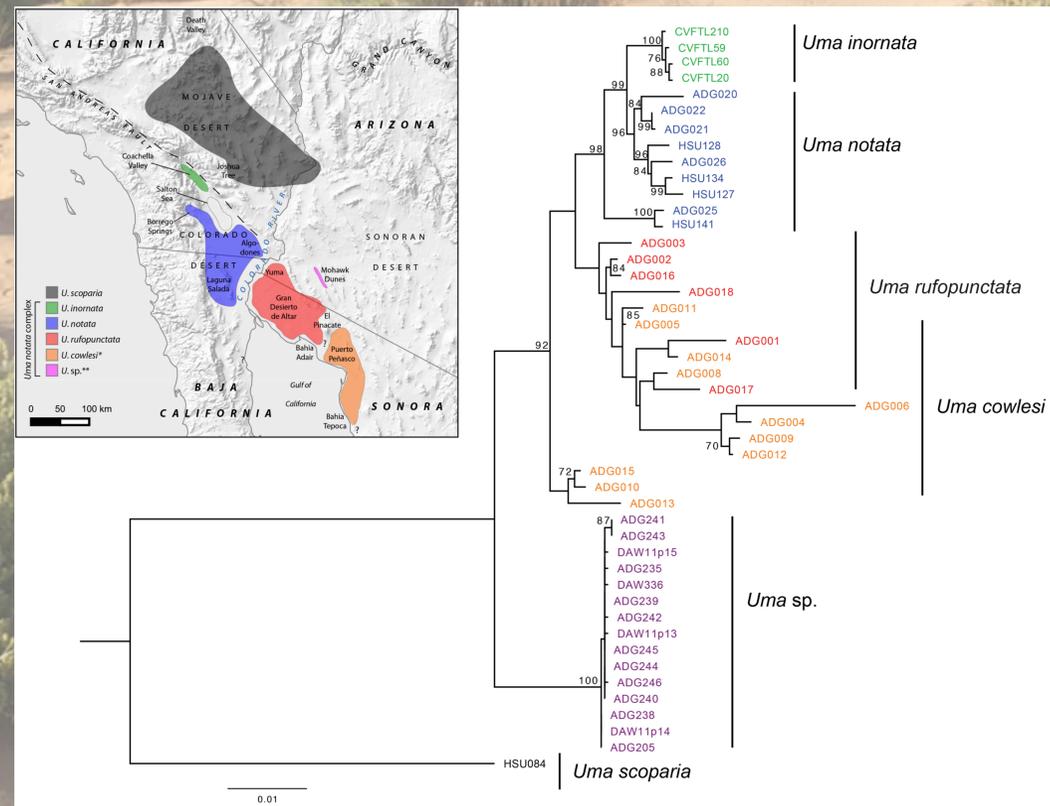


Figure 3: Phylogenetic tree of the *Uma notata* complex, and a map showing the geographic distributions of each species.

Results and Discussion

Morphology

A total of six characters showed significant differences ($p < 0.05$) when comparing Mohawk Dunes specimens to other *Uma* species, but none of these differences were fixed. However, all of these traits were informative and will be included in the formal description of the Mohawk Dunes lizard.

Phylogeny

Based on the phylogenetic analysis, 3 sites out of 667 base pairs of ATPase 6 were diagnostic for *Uma sp.*, as were 7 sites out of 657 for COI and 13 sites out of 1129 for cytochrome b. All of the Mohawk Dunes specimens formed their own clade, with a bootstrap value of 100, suggesting a separately evolving species (Fig 3).

Conclusion

Despite the lack of fixed morphological traits, the presence of six significant characters suggests that these lizards are a separately evolving population, even without diagnostic characters. This, coupled with the phylogenetic tree that shows all Mohawk Dunes specimens forming their own clade sister to the rest of the *Uma notata* complex, indicates that this is a cryptic species. Once an official species description is published, it will be easier for land managers to conserve this species and its habitat. This is important because this species is endemic to the Barry Goldwater Marine Corps Air Station where bombing exercises are regularly conducted.

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