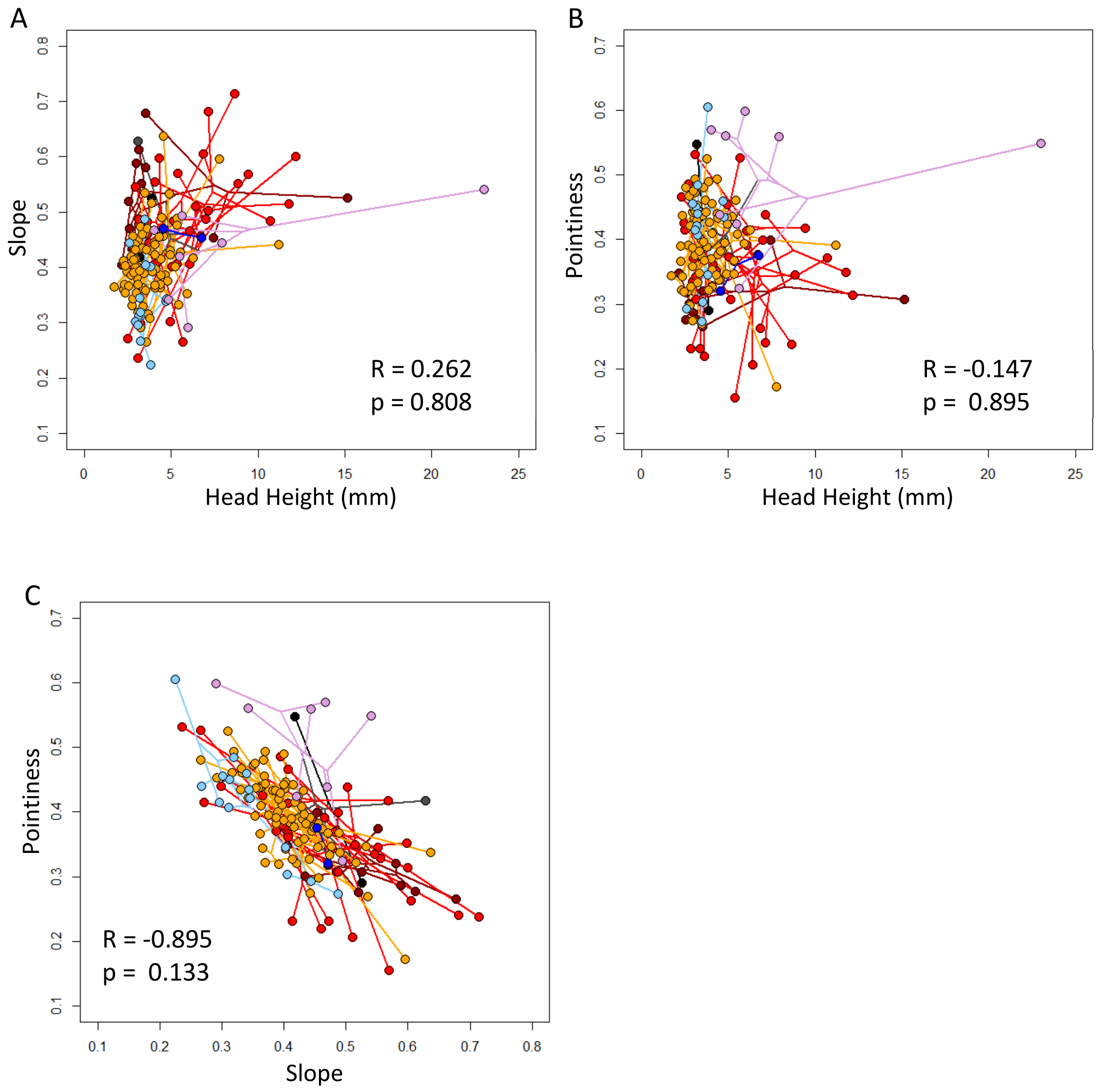

Figure S1: A phylomorphospace of burrowing lizard head shapes defined by diameter, slope, and pointiness from a lateral view. Evolutionary correlations and p-values are presented. Clades are color coded (Dibamidae: black, Acontinae: brown, Scincinae: red, Sphenomorphinae: orange, Gymnophthalmidae: light blue, Amphisbaenidae: purple, Anguidae: blue, Pygopodidae: black. n=152 species.

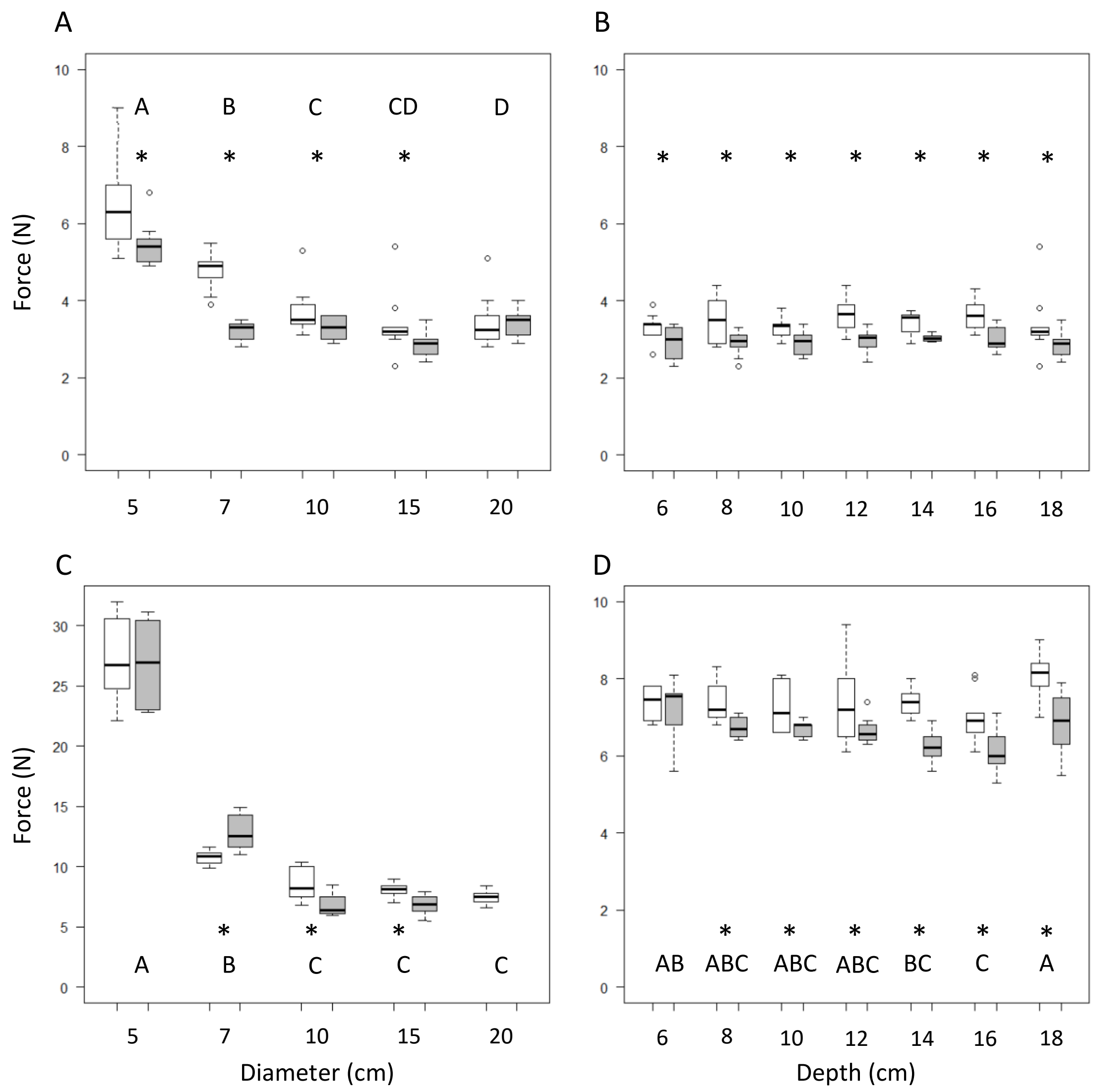

Figure S2: Penetration force into coarse (white) and fine (gray) glass bead (A, B) and rock (C, D) substrates of varying container diameters (A, C) and depths (B, D). Asterisks indicate significant differences between coarse and fine particle substrates. Capital letters indicate comparisons between diameter or depth treatments in each graph. Lack of symbols indicates no significant difference. Note that the y-axis scale for C is different and that data for the fine substrate in the 20cm diameter container do not exist because of lack of sufficient substrate. Experiments manipulating container diameters were all done with a substrate depth of 18cm, while those manipulating substrate depth used a container of 15cm diameter. All experiments use a model of 16mm diameter, 0.8 slope, and 0.6 pointiness. Ten replicates were done for every combination of container diameter, substrate depth, and type of substrate.

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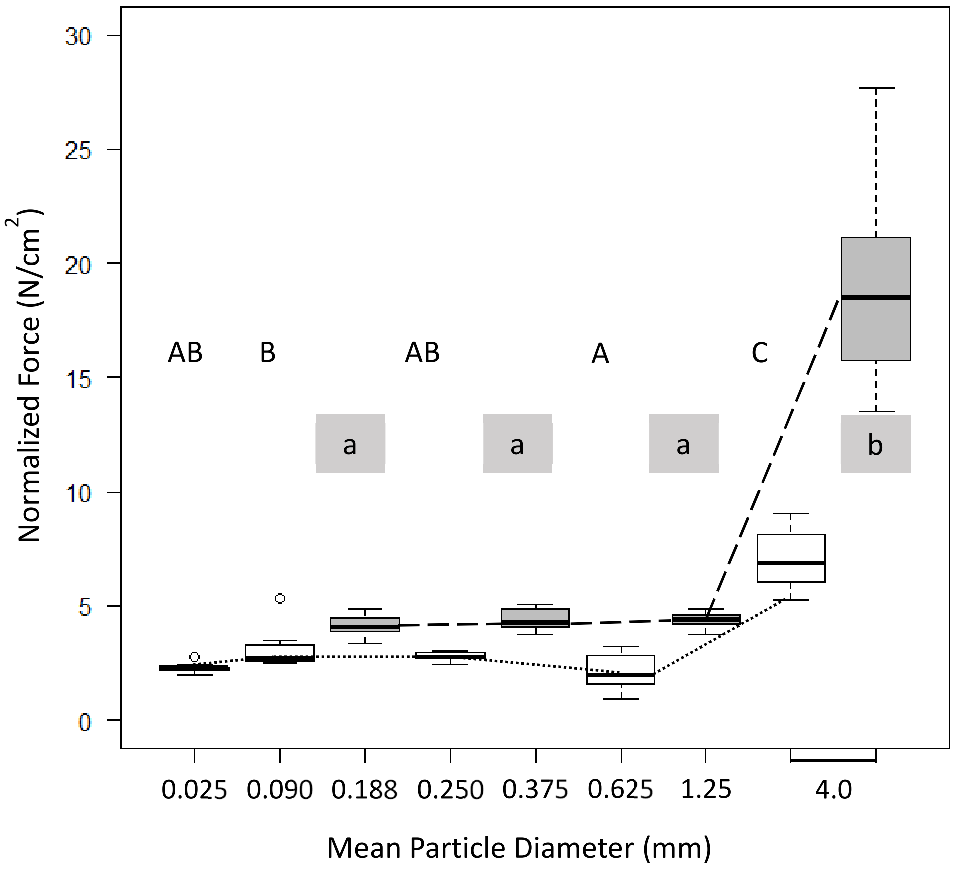

Figure S3: Penetration force into glass bead (white boxes with dotted line) and rock (grey boxes with dashed line) substrates by the average head model (diameter=5mm, slope=0.55, Pointiness=0.33). Note that most substrate particle diameters are not matched between bead and rock substrates. Capital letters indicate significant differences between glass bead substrates, and lower case letters with shading indicate significant differences between rock substrates. Particle diameter had a large effect for both types of substrate (GLM: $D^2>0.94$, Effect>0.95, $p<0.001$). Ten replicates were done on each substrate.

Table S1: Results from ANOVA and pairwise t-test analyses of clade differences in head shape variables for 151 species of fossorial lizards. For each ANOVA, the Mean Square treatment (MS), F-statistic and P-value are provided. All analyses have residual DF=144, and treatment DF=6. The Pygopodidae are excluded because only a single species was sampled. To the right of the ANOVA table are results of pair-wise t-tests with a Bonferroni correction for multiple comparisons. Clades sharing letters are not significantly different from one another for the variable identified in each row. Letters are ordered such that A represents the lowest means and B and C successively higher means.

Variable	MS	F	P	Acontinae	Aphisbaenidae	Anguidae	Dibamidae	Gymnophthalmidae	Scincinae	Sphenomorphinae
Head Width	31.221	4.26	0.0006	ABC	C	ABC	ABC	AB	BC	A
Head Height	26.607	4.61	0.0003	ABC	C	ABC	ABC	AB	BC	A
Dorsal Slope	0.050	7.71	<0.0001	B	ABC	ABC	ABC	A	C	C
Lateral Slope	0.072	7.29	<0.0001	AB	B	AB	B	A	B	B
Dorsal Pointiness	0.036	6.70	<0.0001	C	B	ABC	ABC	ABC	AB	AB
Lateral Pointiness	0.037	11.29	<0.0001	A	C	ABC	ABC	C	AB	AB

Table S2: Comparison of Generalized Linear Models (GLMs) with different error structures for the container dimension experiment for glass beads (residual degrees of freedom (DF_r=198) and rock substrates (DF_r=189), and for the experiment using different physical head models using the same substrates (glass: DF_r=1295, rock: DF_r=1032). GLMs use the quasi family with a defined link function and assumption of relationship between mean response (μ) and error variance. DEV_r is the residual deviance, Δ is the difference from the minimum deviance. Best model for each data set is in bold and shaded.

		Container Size Experiments				**Physcial Head Model Experiments**			
Model		**Glass Beads**		**Rock**		**Glass Beads**		**Rock**	
Link	**Variance**	**DEV_r**	**Δ**	**DEV_r**	**Δ**	**DEV_r**	**Δ**	**DEV_r**	**Δ**
Identity	Constant	48.6	47.7	293.4	293.2	1400.2	1380.4	12692.8	12689.9
Identity	μ	11.7	10.8	18.7	18.5	184.9	165.1	392.5	389.6
Identity	μ^2	3.1	2.2	1.7	1.5	45.4	25.6	22.0	19.1
Identity	μ^3	**0.9**	**0.0**	**0.2**	**0.0**	**19.8**	**0.0**	**2.9**	**0.0**
Log	Constant	48.6	47.7	293.4	293.2	1342.2	1322.4	12117.4	12114.5
Log	μ	11.7	10.8	18.7	18.5	178.2	158.4	378.6	375.7
Log	μ^2	3.1	2.2	1.7	1.5	45.3	25.5	22.3	19.4
Log	μ^3	0.9	0.0	0.2	0.0	20.3	0.5	2.9	0.0

Table S3: Tables of deviance for best GLMs for substrate container dimension experiments for (A) glass beads (D^2=0.752, n=220, DF_r=198, DEV_0=3.47) and (B) rock (D^2=0.955, n=210, DF_r=189, DEV_0=4.47) substrates. DEV_d is the improvement in deviance with the inclusion of each factor, DEV_r is the residual deviance for each model. Effect is the effect size described in the text, calculated from deviance. * is medium effect size, ** is large effect size. There is no Diameter:Depth interaction because experiment was not fully crossed.

A. Glass Beads

Factor	DF	DEV_d	DEV_r	F	P	Effect	
Particle Size	1	0.44	3.03	96.57	<0.001	0.339	**
Diameter	4	2.00	1.03	109.80	<0.001	0.699	**
Depth	6	0.02	1.00	0.88	0.509	0.027	
Particle:Diameter	4	0.13	0.88	7.11	<0.001	0.131	*
Particle:Depth	6	0.02	0.86	0.58	0.749	0.018	

B: Rock

Factor	DF	DEV_d	DEV_r	F	P	Effect	
Particle Size	1	0.01	4.47	7.98	0.005	0.041	
Diameter	4	4.19	0.28	985.44	<0.001	0.954	**
Depth	6	0.04	0.24	5.57	<0.001	0.151	*
Particle:Diameter	3	0.03	0.21	10.53	<0.001	0.144	*
Particle:Depth	6	0.01	0.20	1.72	0.117	0.052	