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Avian Taphonomy at Bluefish Caves, Yukon, Canada

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Tetraoninae taxa are good environmental proxies. Currently, seven species have been recorded in the Yukon Territory (Lepage, 2021): two from forests (*Bonasa umbellus*, *Falcipennis canadensis*), one from open grasslands (*Tympanuchus phasianellus*), and three from tundra (*Lagopus lagopus, Lagopus leucura* and *Lagopus muta*). These taxa, however, are relatively similar in size and morphology, making identifications to the species level difficult.

Watson and Ledogar (2019) propose a way to distinguish postcranial remains from gallinaceous birds using osteometrics. Following the same methods, we took measurements on the most numerous anatomical elements, i.e., the carpometacarpus and tarsometatarsus. We measured only complete specimens with fully preserved proximal and distal extremities using an electronic caliper (two decimals) according to methods presented by von den Driesch (1976). We then compared measurements from archaeological specimens with modern samples from Watson and Ledogar (2019) and Stewart (1999, 2007). We measured additional specimens from the CUMV for comparison. Because researchers do not always consider the same measurements in their studies and because the diagonal of the distal end (Did) of the carpometacarpus is not a precise measure (von den Driesch, 1976), we used only the greatest length (GL) and the proximal breadth (Bp) of this anatomical element in a bivariate scattergram. In contrast, we represented the tarsometatarsus by four variables: the greatest length (GL), the proximal breadth (Bp), the smallest breadth of the corpus (SC), and the distal breadth (Bd). We log-transformed, normalized, and displayed all four variables in a between-group principal component analysis (PCA) using the software Past v. 4.06b (after Hammer et al., 2001). In addition, to describe variation between individuals, we plotted the smallest breadth of the tarsometatarsus (SC) against the greatest length (GL). Due to the high number of bone elements in Cave I, we considered only the best represented sides in the analyses: the left side for the carpometacarpus and the right side for the tarsometatarsus. We represented both sides for caves II and III. The total number of complete carpometacarpi and tarsometatarsi recovered from Unit B (i.e., loess) of caves I, II, and III is N = 272 and N = 149, respectively. Finally, we performed Student's independent t-tests to examine the difference between the means of the ancient and modern populations with a 95% confidence interval.

The resulting graphs show no overlap with the White-tailed Ptarmigan (*L. leucura*), nor with the forested taxa (Fig. S1, S2 and S3). In contrast, the Bluefish Caves specimens clearly overlap with the Willow Ptarmigan (*L. lagopus)* and the Rock Ptarmigan (*L. muta*). Both species are easily distinguishable through graphs plotted for the tarsometatarsi (Fig. S2), allowing for the quantification of relative abundances. A minimum of N = 114 individuals can be attributed to the Willow Ptarmigan (Cave I = 105; Cave II = 3; Cave III = 6) and N = 33 individuals are attributed to the Rock Ptarmigan (Cave I = 30; Cave II = 0; Cave III = 3) (Table S1).

The osteometric analysis also indicates that the limb proportions slightly differ between ancient and modern specimens. Table S1 shows separate measurements of the tarsometatarsi for the two *Lagopus* species. Regarding the Willow Ptarmigan, the Bluefish Caves' tarsometatarsi, ranging in length from 35.6 to 42.1 mm, are shorter than the modern specimens (37.0 – 45.3 mm) (Stewart, 2007), but longer than their Siberian counterparts from the late Pleistocene–early Holocene Dyuktai Cave site (34.1 mm – 39.0 mm) (Zelenkov et al., 2008) (Fig. S4). The t-tests confirm that the Bluefish Caves specimens possess a shaft width (SC) that is like the extant species (t (75) = 1.029, p = 0.307), but the greatest length (GL) is significantly shorter (t (72) = −4.573, $p < 0.001$) (Fig. S4). As for the Rock Ptarmigan, the SC and the greatest length (GL) of the Bluefish Caves' tarsometatarsi are shorter than the modern samples (SC: t (59) = 2.302, p = 0.025; GL: t (42) = −4.324, $p < 0.001$).

Because it was not possible to distinguish the species based on the carpometacarpi, Table S2 shows the measurements of the wing bone for both *Lagopus* species together. Graphically (Fig. S4), the Bluefish Caves specimens seem to be relatively longer than the modern samples, but this was not statistically demonstrated (Bp: t (339) = 1.870, p = 0.062; GL: t (339) =1.696, p = 0.091), which may be due to the fact that the *Lagopus* species were not differentiated in the ancient sample.

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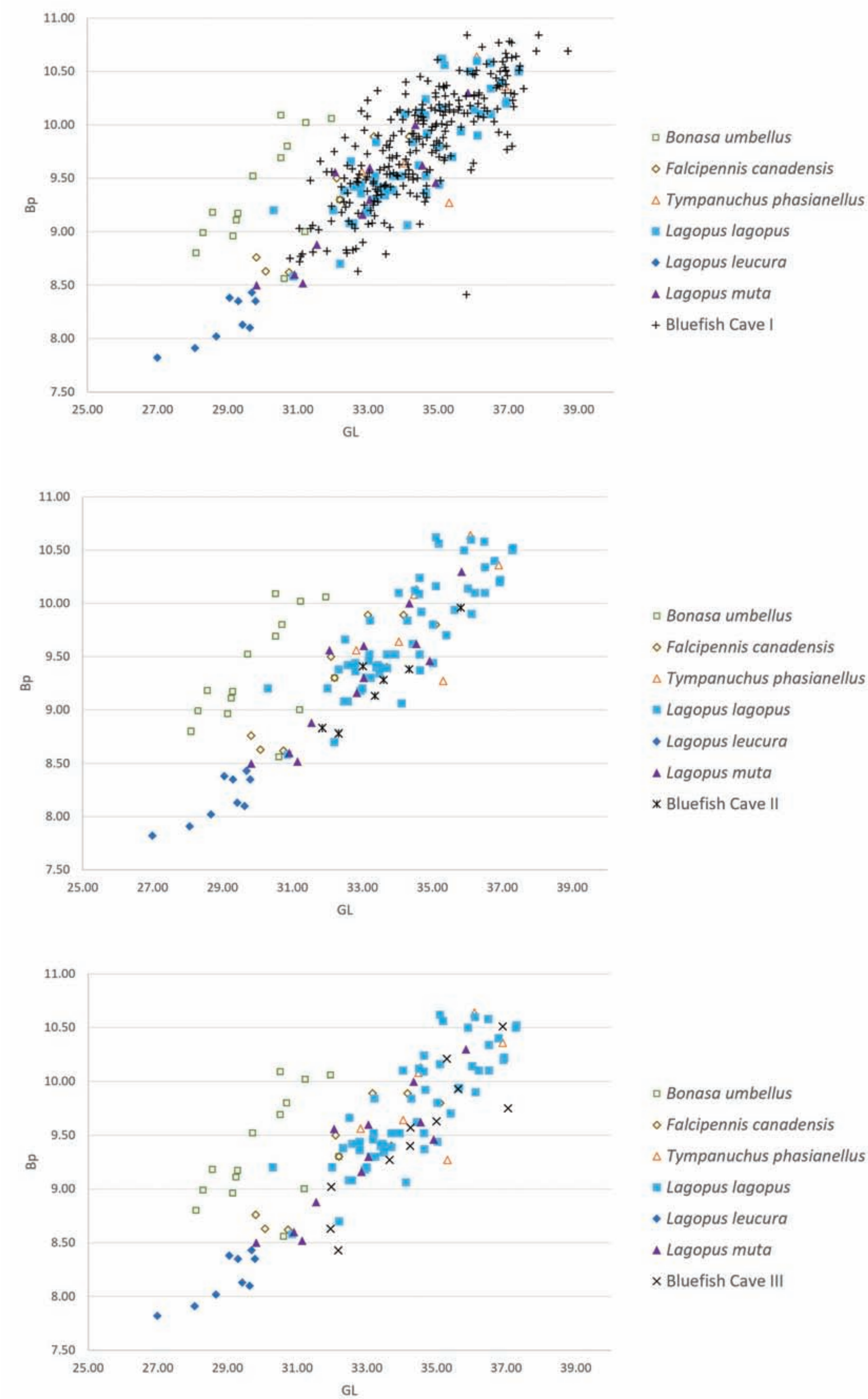

FIG. S1. The proximal breadth (Bp) of the carpometacarpus is plotted against the greatest length (GL). Comparative specimens: *B. umbellus*, N = 15; *F. canadensis*, N = 9; *T. phasianellus*, N = 8; *L. lagopus*, N = 57; *L. leucura*, N = 9; *L. muta*, N = 12. Bluefish Caves specimens, Unit B: Cave I (left side only), N = 254; Cave II, N = 7; Cave III, N = 11.

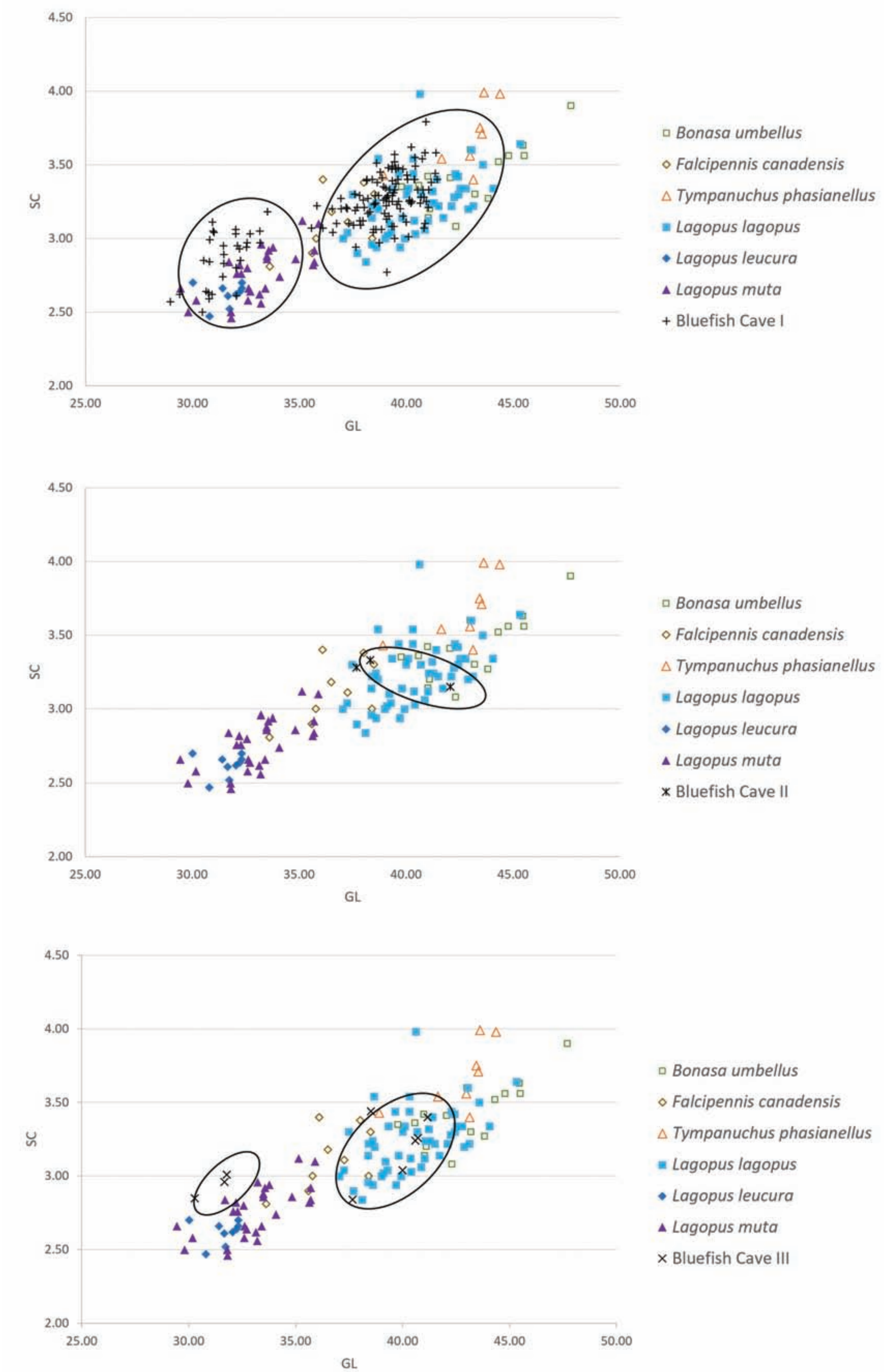

FIG. S2. The smallest breadth of the tarsometatarsus (SC) is plotted against the greatest length (GL). Comparative specimens: *B. umbellus*, N = 15; *F. canadensis*, N = 9; *T. phasianellus*, N = 8; *L. lagopus*, N = 51; *L. leucura*, N = 9; *L. muta*, N = 28. Bluefish Caves specimens, Unit B: Cave I (right side only), N = 137; Cave II, N = 3; Cave III, N = 9. Two populations (*L. lagopus* and *L. muta*) can be distinguished (black circles).

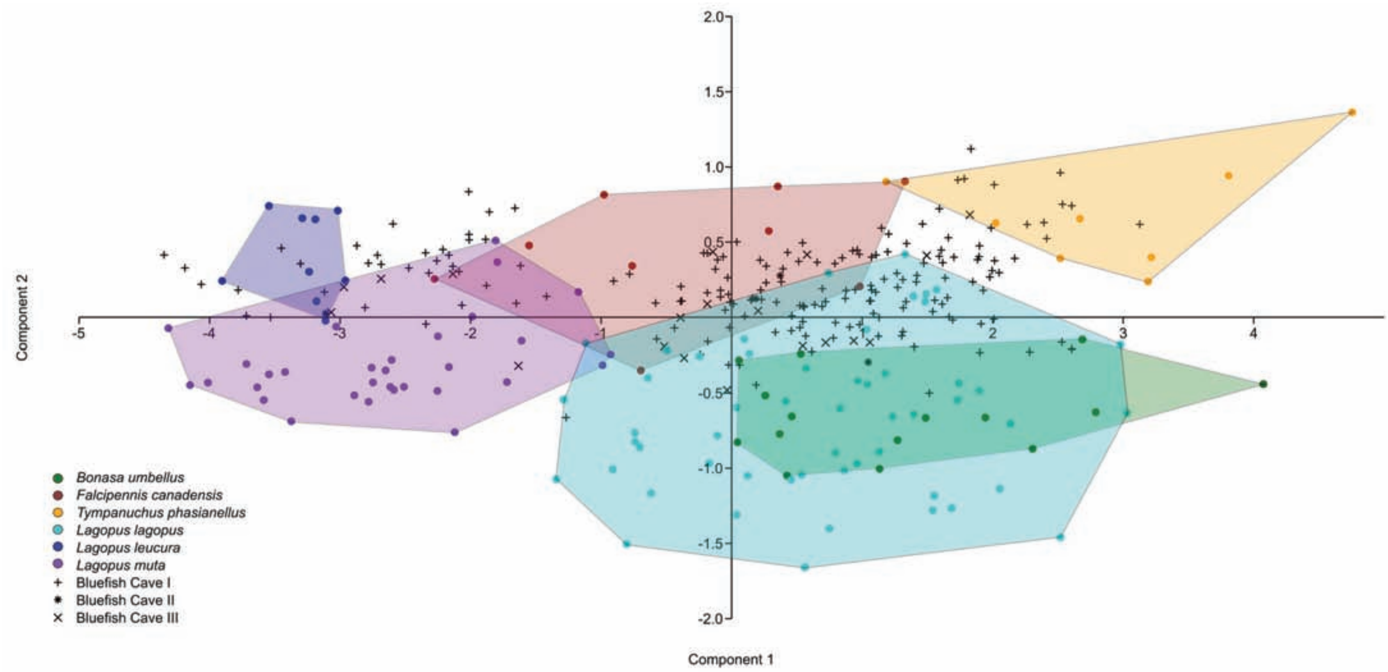

FIG. S3. PCA results for the galliform tarsometatarsus. Four variables are represented: the greatest length (GL), the proximal breadth (Bp), the smallest breadth of the corpus (SC) and the distal breadth (Bd).

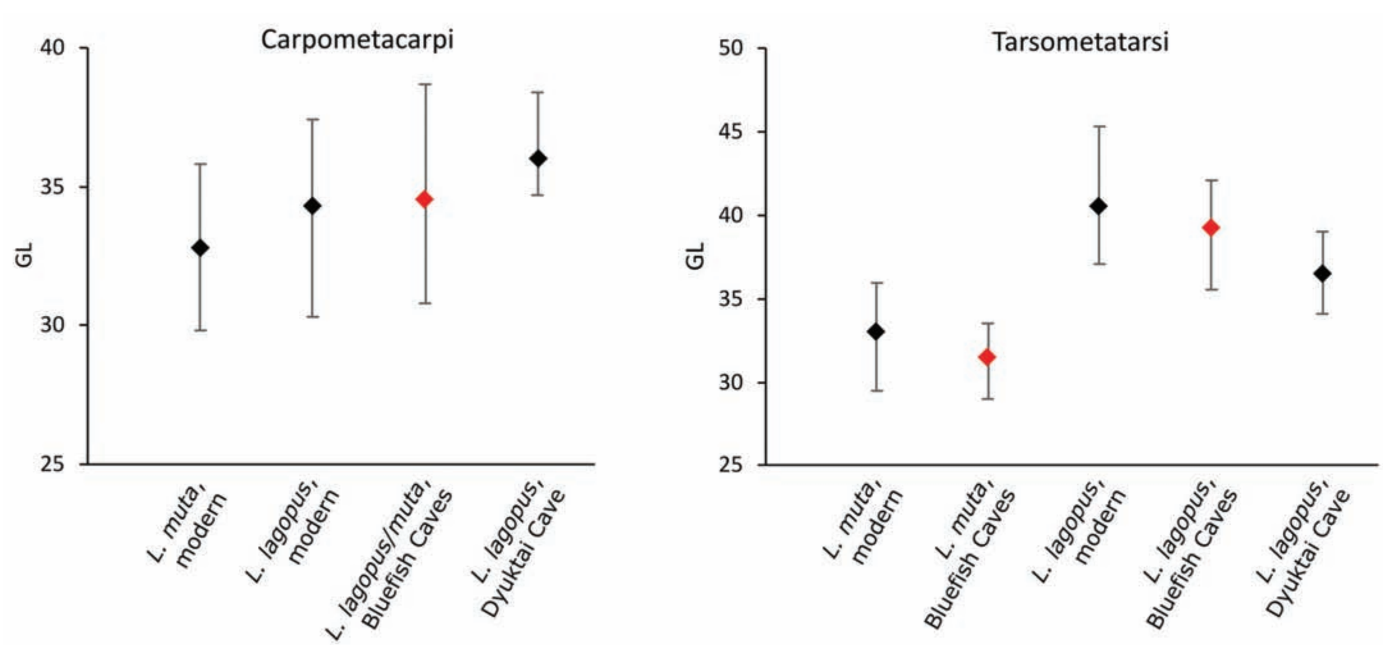

FIG. S4. Comparison of greatest length (GL) measurements. Modern data from Stewart (2007). Dyuktai Cave data from Zelenkov et al. (2008).

TABLE S1. Measurements obtained on the tarsometatarsi from Bluefish Caves (Unit B) compared with modern samples of Willow Ptarmigan (*L. lagopus*) and Rock Ptarmigan (*L. muta*). Modern data from Stewart (2007). Dyuktai Cave data from Zelenkov et al. (2008).

	GL	Bp	SC	Bd
L. muta, modern (N = 31)				
Mean	33.07	7.22	2.76	6.86
Min	29.44	6.58	2.46	6.34
Max	35.90	7.86	3.12	7.84
L. muta, Bluefish Caves (N = 33)				
Mean	31.48	7.02	2.87	7.22
Min	28.97	6.31	2.50	6.65
Max	33.50	7.63	3.18	7.84
L. lagopus, modern (N = 48)				
Mean	40.51	8.42	3.24	7.94
Min	37.04	7.50	2.84	6.92
Max	45.32	9.98	3.98	9.20
L. lagopus, Bluefish Caves (N = 114)				
Mean	39.17	8.35	3.28	8.62
Min	35.56	7.62	2.84	7.76
Max	42.07	9.03	3.79	9.66
L. lagopus, Dyuktai Cave (N = 21)				
Mean	36.50	8.00	3.20	8.00
Min	34.10	7.50	2.70	6.70
Max	39.00	8.60	3.40	9.00

TABLE S2. Measurements obtained on the carpometacarpi from Bluefish Caves (Unit B) compared with modern samples of Willow Ptarmigan (*L. lagopus*) and Rock Ptarmigan (*L. muta*). Modern data from Stewart (2007). Dyuktai Cave data from Zelenkov et al. (2008).

	GL	Bp	Did
L. muta, modern (N = 12)			
Mean	32.84	9.29	6.47
Min	29.82	8.50	5.82
Max	35.84	10.30	6.98
L. lagopus, modern (N = 57)			
Mean	34.35	9.75	6.96
Min	30.30	8.58	5.70
Max	37.42	11.32	7.86
L. lagopus/muta, Bluefish Caves (N = 272)			
Mean	34.47	9.81	6.70
Min	30.77	8.41	5.51
Max	38.69	11.12	7.83
L. lagopus, Dyuktai Cave (N = 14)			
Mean	36.00	n/a	n/a
Min	34.70	n/a	n/a
Max	38.40	n/a	n/a