

Assessing Biases of Sampling and Scale in Miocene Vertebrate Assemblages from Northern Pakistan



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Background

The Y311 locality occurs on the Potwar Plateau in northern Pakistan. It lies within a thick sequence of alluvial sediments rich in fossils spanning ~16 my. (million years ago). Collections of over 4700 specimens by the Harvard-Geological Survey of Pakistan team at Y311 include surface and excavated mammals, reptiles, birds, and fish.

Two roughly adjacent excavations, West-1/West-2 and DS4/DS4-ME, were selected for analysis. These two sites are approximately the same age, 10 Ma.

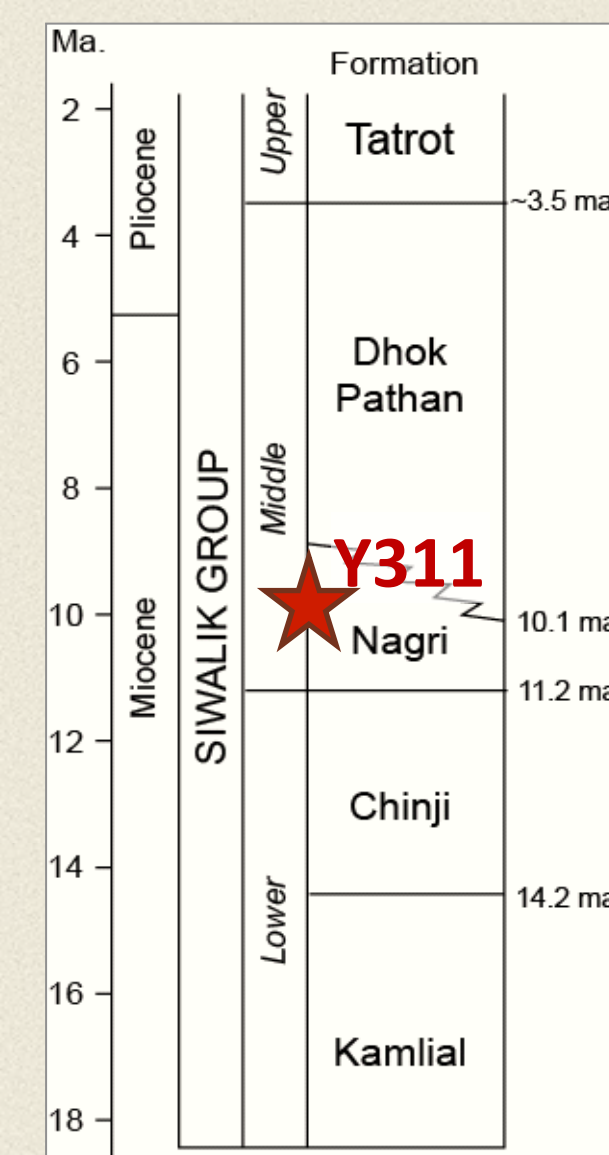


Fig. 1: Y311 in the Siwalik sequence

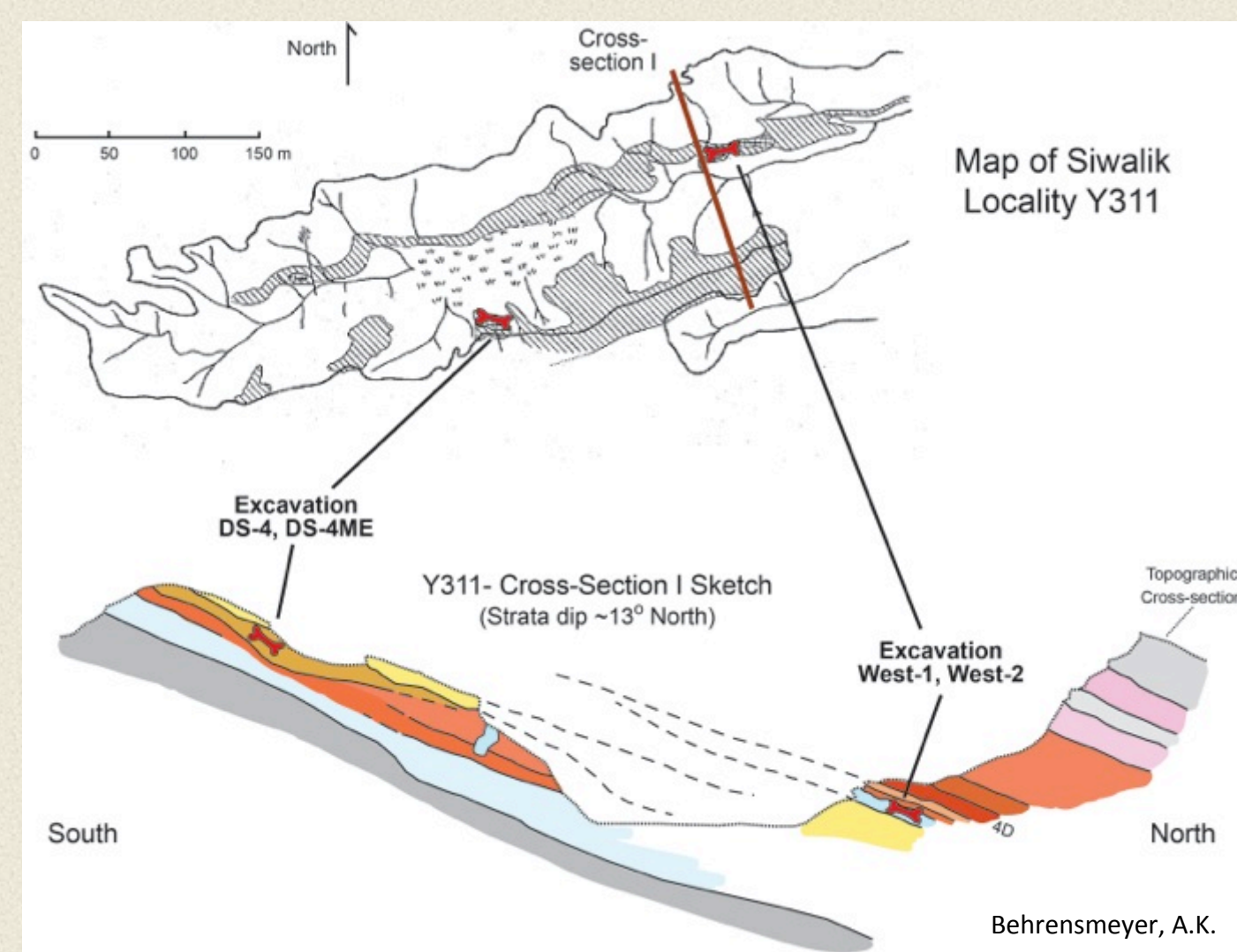


Fig. 2: Sketch Map and cross-section of Y311, showing geographic and stratigraphic relationships of the two excavation sites. Hatched areas in map indicate the fossiliferous strata.



Fig. 3: A section of the Y311 site in 1982.



Fig. 4: An artist's reconstruction of the Miocene Siwalik ecosystem. (Artwork by Mauricio Antón)

Results

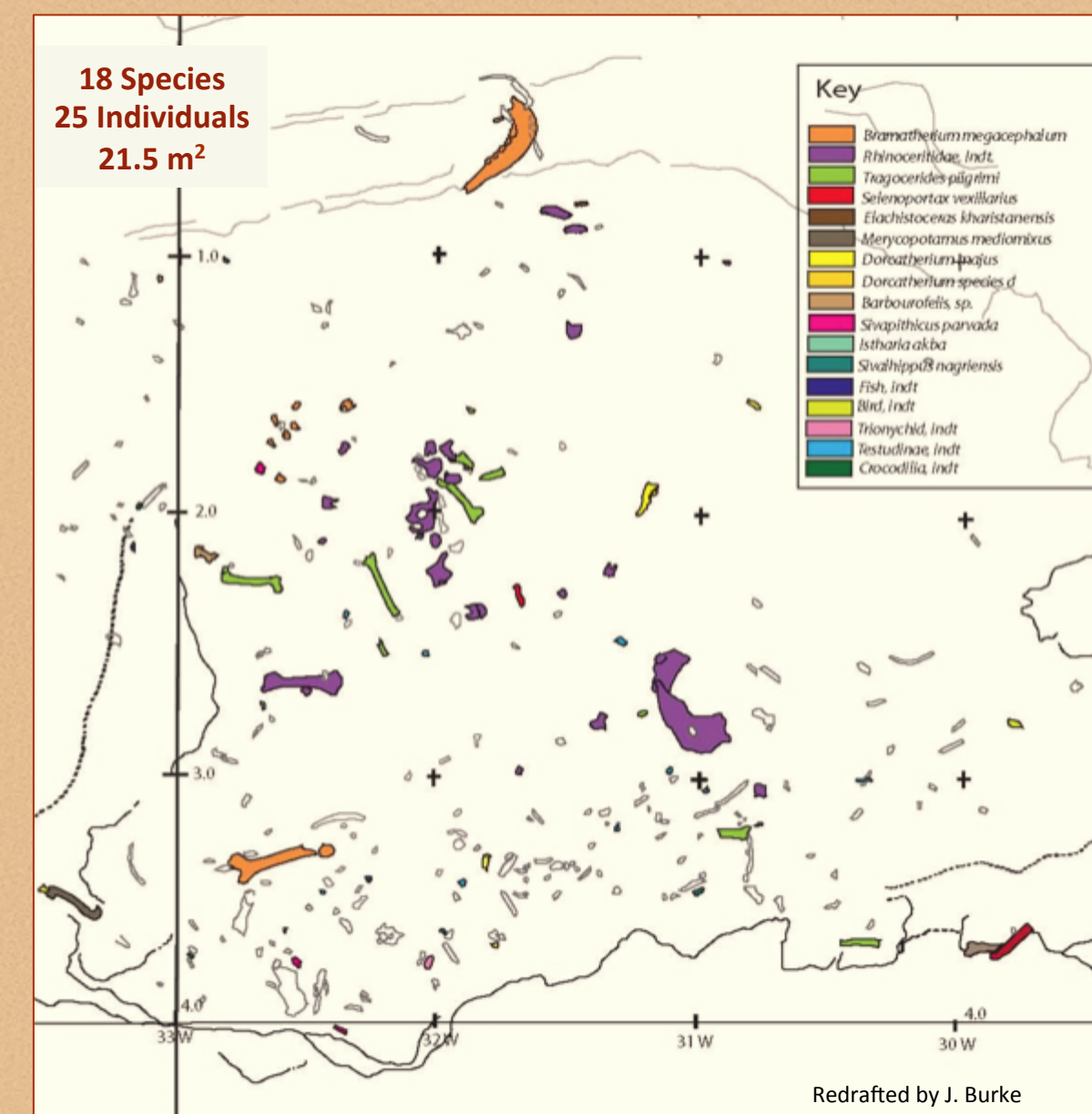


Fig. 8: Map of W-2 Excavation, 1982. Species identity indicated by color. 346 specimens excavated. Time averaging estimated to be on a scale of 10's of years (Kidwell and Behrensmeyer 1993).

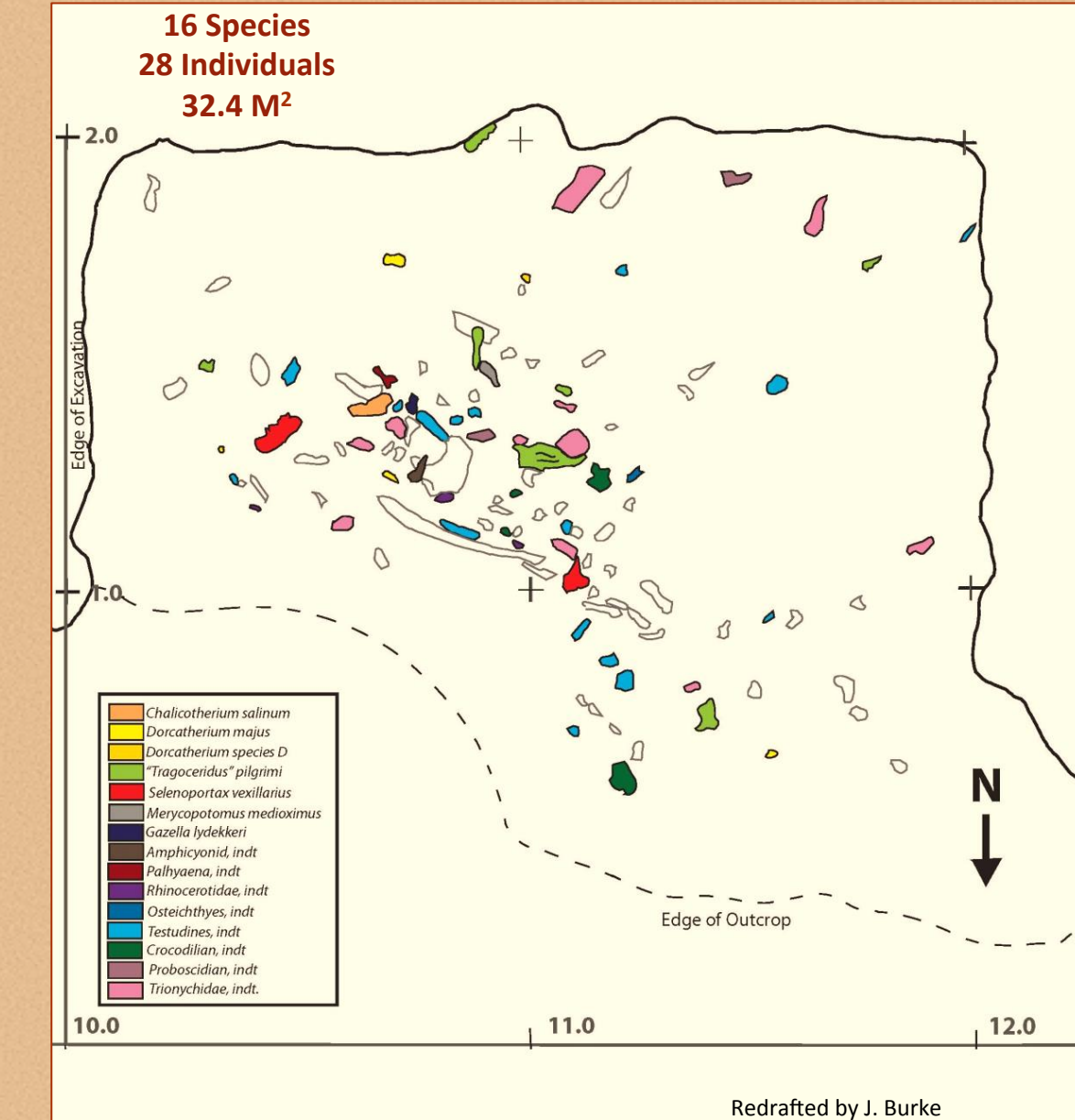


Fig. 9: Map of the Majid extension of the DS-4 Excavation, 1983. Species identity indicated by color. 176 specimens excavated. Time averaging estimated to be on a scale of 100's of years (Kidwell and Behrensmeyer 1993).

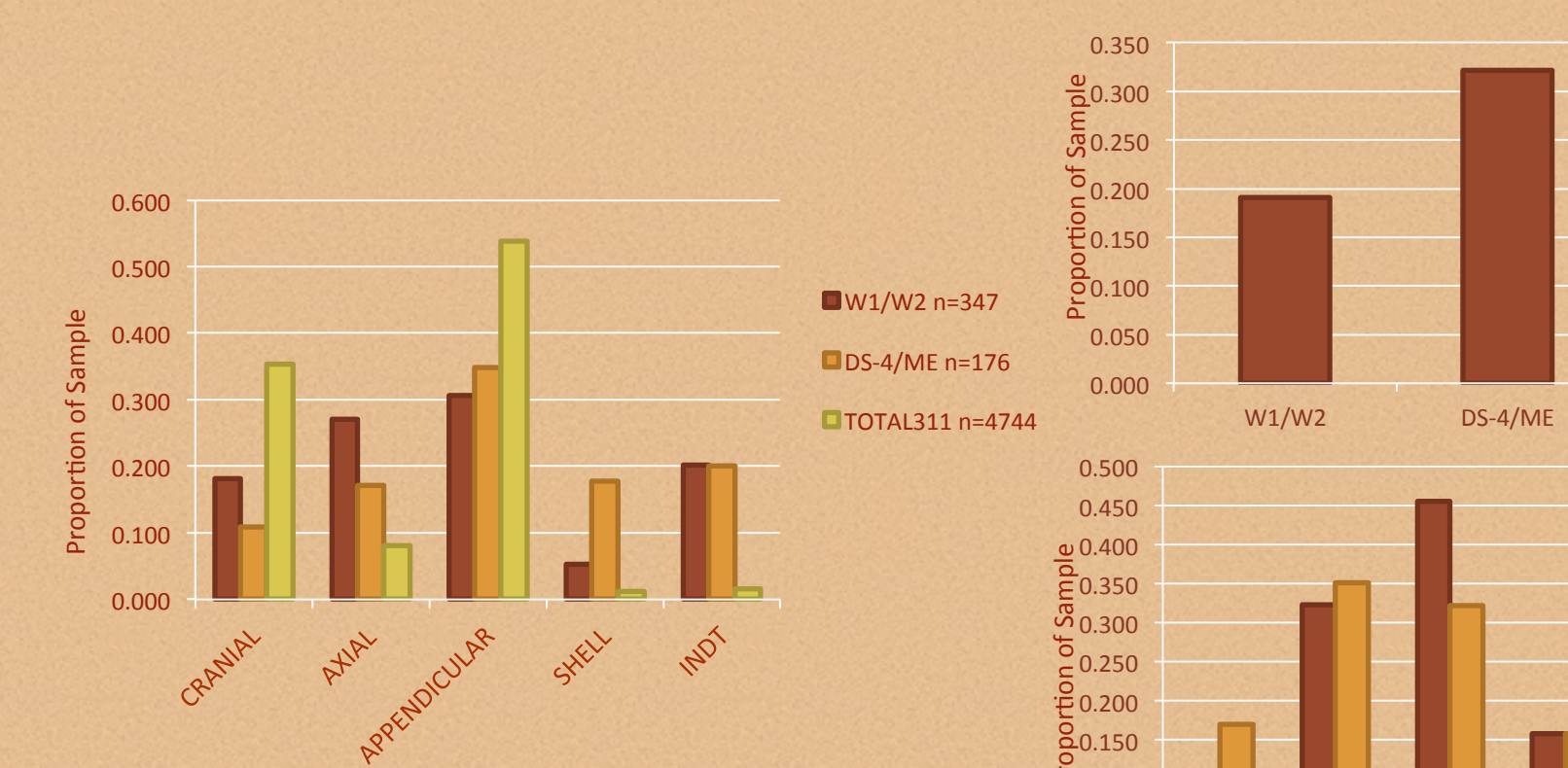


Fig. 11: Proportion of samples with surface dissolution

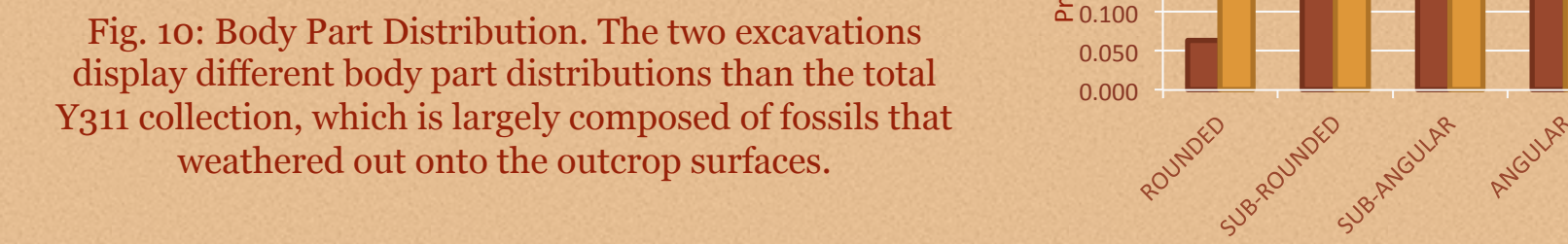


Fig. 10: Body Part Distribution. The two excavations display different body part distributions than the total Y311 collection, which is largely composed of fossils that weathered out onto the outcrop surfaces.

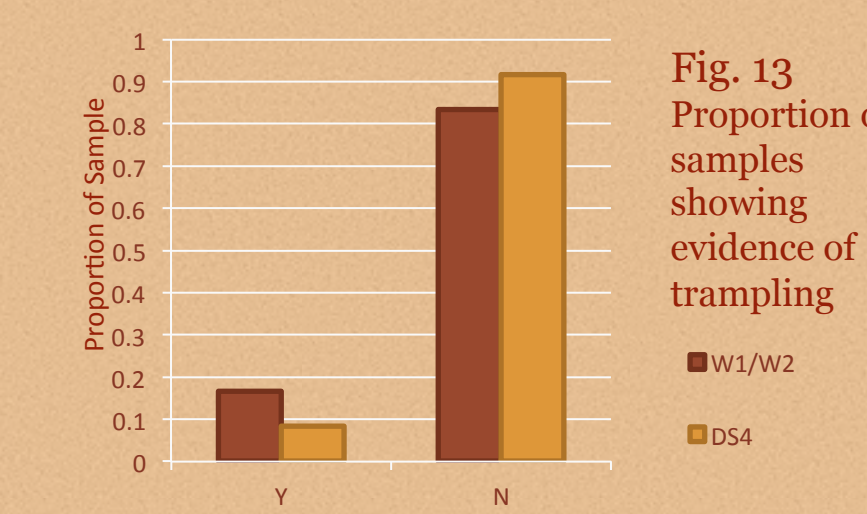


Fig. 13: Proportion of samples showing evidence of trampling

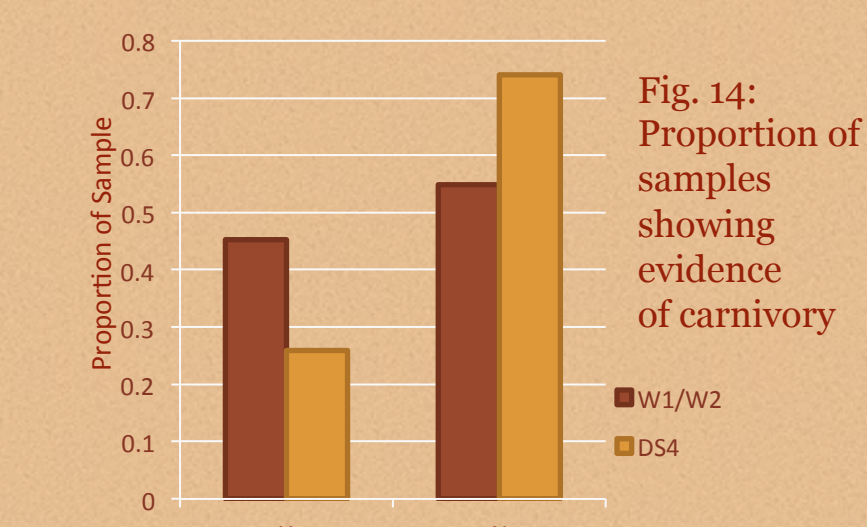


Fig. 14: Proportion of samples showing evidence of carnivory

How does Y311 compare to modern ecosystems?

Comparing the faunal information we have for the entire Y311 locality to modern ecosystems can inform us about the ancient environment, the completeness of the Y311 fossil record, and what we might be missing from our assessment of the Y311 mammal community.

Methods

Faunal lists and body size data from the Y311 locality and four modern parks in India and Southeast Asia (Kanha Park, Gunung-Leuser Park, Kaziranga Park, and Manas Park) were assembled and analyzed.

Results

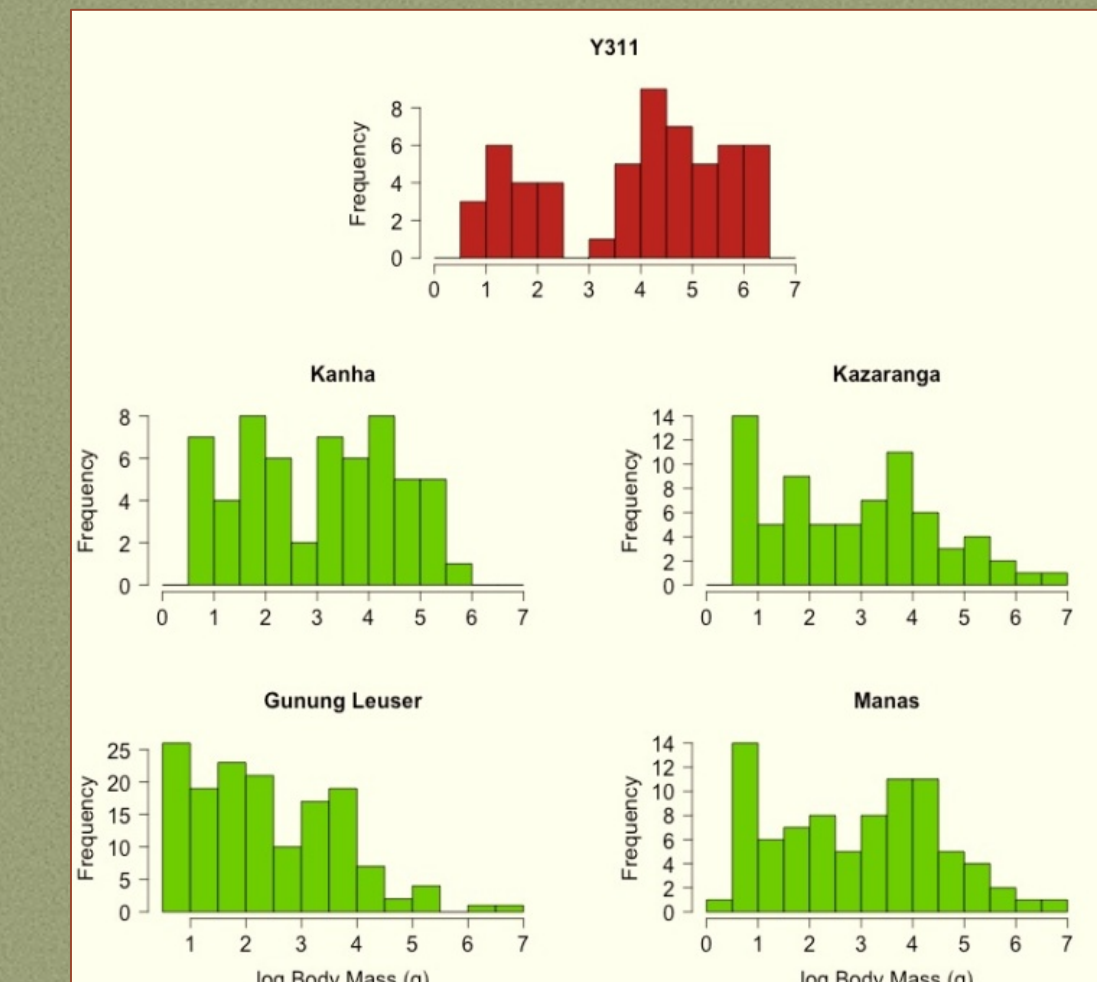


Fig. 15: Log Body Mass distributions of fauna from Y311 and modern parks

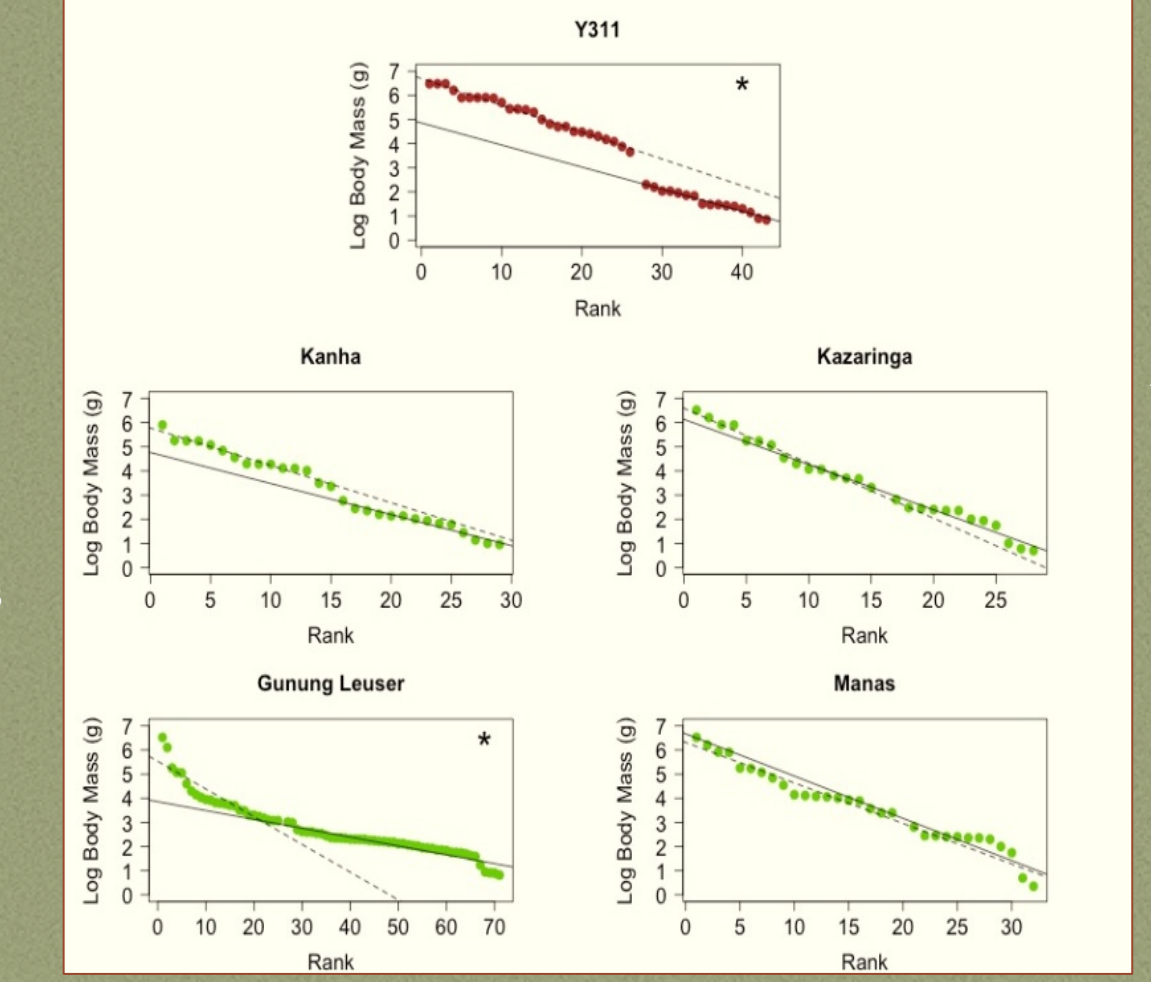


Fig. 16: Cenograms. Asterisks indicate significant interaction of regression lines and difference of slopes.

Data were compared and tested for statistical significance using Kolmogorov-Smirnov tests. All modern park faunas differed significantly from Y311, however, Kanha park was the most similar ($p = 0.012$). Log body masses were plotted on histograms for comparison (Fig. 15). A gap in the body size distribution at log body size 3 was seen in all distributions, but was more extreme at Y311, creating a bimodal distribution. The modern park histograms had right-skewed distributions, indicating that there were less large-bodied fauna at those sites than at Y311.

Cenograms of the body size distributions (Fig. 16), further show that Kanha Park is most similar to Y311. When the cenograms and log body size histograms are analyzed together as per Travouillon and Legendre (2009), the results suggest that Y311 was an open woodland with surrounding grasslands as opposed to a closed, moist forest like that found at Gunung-Leuser.

Conclusion

Y311 shows a higher number of large-bodied mammals than any of the modern sites. Additionally, small taxa <1 kg are likely under-represented in the Y311 faunal list. Kanha Park, India, is the best analog of the modern parks we analyzed.

References

Behrensmeyer, A.K. 1978. "Taphonomic and Ecologic information from bone weathering." *Paleobiology*, 4(2): 150-162.
 Kidwell, S.M. and A.K. Behrensmeyer. 1993. *Taphonomic Approaches to Time Resolution in Fossil Assemblages*. Paleontological Society.
 Travouillon, K.J. and S. Legendre. 2009. "Using Cenograms to investigate gaps in mammalian body mass distributions in Australian mammals". *Palaeogeography, Palaeoclimatology, Palaeoecology* 272: 69-84.

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1. How do two contemporaneous excavated fossil assemblages, W1/W2 and DS-4, vary in terms of taphonomy and species composition?
2. How do the two excavated assemblages compare to the overall fossil collections from the Y311 locality?

Methods

- Specimens were scored for surface weathering on a scale of 1 to 5 as per Behrensmeyer (1978).
- Surface dissolution was recorded on a scale of 0 (no dissolution) to 3 (very dissolved).
- Rounding was scored as Angular, Sub-angular, Sub-rounded, and Rounded.
- Fossils were examined for evidence of carnivory and trampling (Fig.5, Fig.).
- When possible, specimens of the same species were analyzed to establish a Minimum Number of Individuals (MNI) for the excavation (Fig.7).
- Fauna lists, specimen types and estimated body sizes for all of Y311 and the excavated sites were compared.



Fig. 5: Fossil surface with trample scratches



Fig. 6: Rib fossil with tooth mark



Fig. 7: Two *T. pilgrimi* femurs, excavated ~1m from each other, are determined to be from the same individual

Discussion and Conclusions

- W-1/W-2 does not differ significantly from DS-4 in diversity, body size distribution, completeness of bones or skeletal part representation.
- DS-4 has a significantly higher degree of rounding and dissolution than W1/W2, indicating that the deposition site of DS-4 was a more acidic, higher energy environment (Fig.11, 12).
- W-1/W-2 may be less time averaged than DS-4, based on the taphonomic evidence above; we interpret W-1/W-2 as a water-hole setting at the top of an abandoned channel, and DS-4 as a channel lag assemblage.
- W-1/W-2 had significantly more evidence of carnivory and trampling (Fig.13, 14).
- Reptiles were more abundant at DS-4 compared to both W-1/W-2 and Y311 overall.
- 18 out of the total of 58 mammal species from Y311 were positively identified at W-1/W-2 and DS-4.
- The distribution of mammal body sizes* at DS-4 and W-1/W-2 was not significantly different from the whole Y311 fauna.
- We hypothesize that the difference in body part distribution between the two excavations and the overall Y311 collection is because the latter is dominated by surface fossils, which are subject to recent fragmentation and collecting biases (Fig. 10).

*excludes mammals <1000 g not included in W-1/W-2 and DS-4 excavated samples