COLLEGE OF SCIENCE DEPARTMENT OF INTEGRATIVE BIOLOGY

SEM Analysis of Digestive Wear on Rodent Bones: A comparison of modern and fossil remains

Samuel Hay-Roe and Rebecca Terry

Introduction:

When people think of fossils, they generally imagine the bones of large, charismatic animals. However, small mammals are an ecologically important group of organisms that show up frequently in the fossil record, and can frequently function as indicators for local environmental and ecological conditions (Terry, 2007, 2010). Rodent and rabbit remains are often locally concentrated and deposited around predator den and roost sites, leaving behind large deposits (Andrews, 1990). In order to determine the identity of a predator responsible for creating a prey “death-assemblage” without accompanying fecal or pellet matrix, we must look to the bones themselves. Digestive wear and pitting is an established metric for identifying predator taxa from prey remains, and is very useful in determining the taphonomic origin of microfossil deposits (Andrews, 1990, Andrews & Evans, 1983). In the John Day Fossil Beds collection there are a number of small mammal fossils that are speculated to have been deposited by predators, possibly owls, but this diagnosis has not been confirmed. Thus the primary aim of this project is to investigate patterns of wear on small mammal fossil samples from the John Day National Monument using scanning electron microscopy (SEM), with the hypothesis that they were ingested by an owl-like bird of prey. In order to do this, a metric for determining predator identity from microscopic evidence must be established.

Figure 1.

The mandibles of various rodents, genus Microtus (top) and Apodemus (bottom). Tick marks on top are 2mm.

Methods:

Raptor pellets and mammalian scats containing the remains of rodents were collected through partnership with Chintimini Wildlife Center, Turtle Ridge Wildlife Rehabilitation, and Wildlife Images, and the Hopkins paleontology lab at University of Oregon. These pellets and scat were then cleaned in the lab using water and forceps. Samples of the most complete mandibles, teeth, and long bones from each predator species were then selected and prepared for imaging by three 15 minute cleanings by sonication.

Samples were then taken to the Camcor EPMA lab at the University of Oregon, and imaged using the FEI Quanta 200 in variable pressure mode. Images were taken of each in approximately the same spot: on the ramus below the 1st molar, below the mandibular foramen, on the incisor enamel near the mandibular symphysis, and on the edge of a break (generally the coronoid process). Images were taken at scales of approximately 10, 50, 200, and 500µm

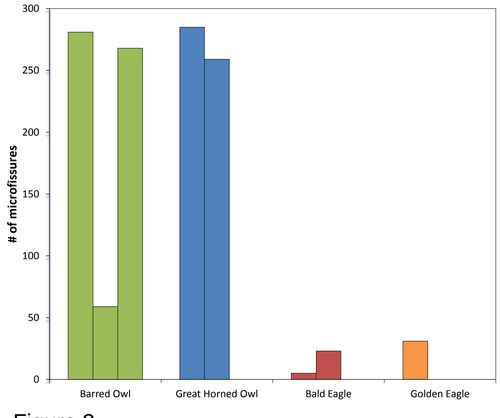

Figure 2.

Graph displaying the density of microfissures on the ramus of a mandible in a sample image scaled to 10µm. Owl digested mandibles consistently show a higher number of microfissures than bones digested by diurnal raptors.

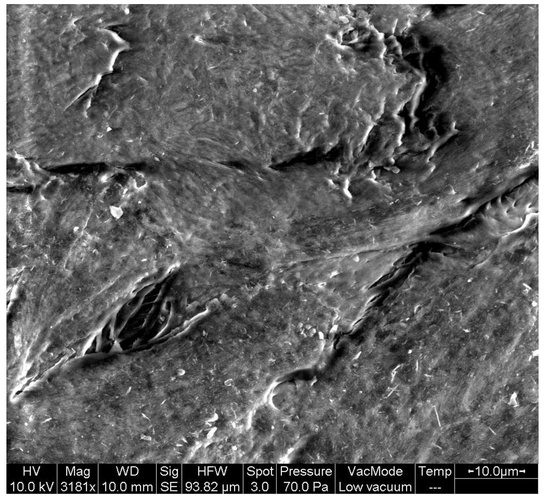

Figure 3

The mandible of a rodent digested by a Bald Eagle. Image taken on the ramus, below the first molar. Notice the large, deep fissures, and smooth bone surface. Scale bar is 10µm

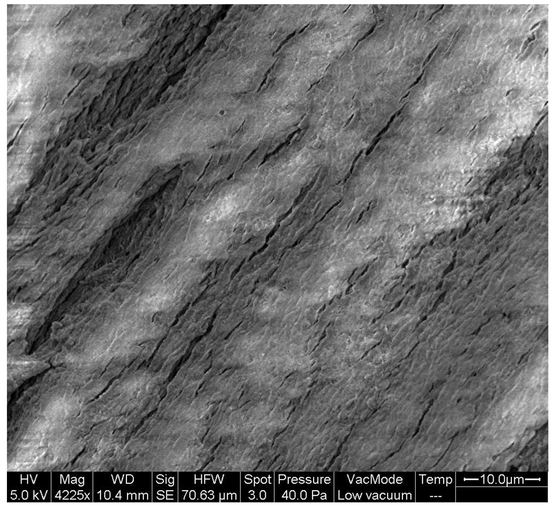

Figure 4.

The mandible of a rodent digested by a Barred Owl. Image taken just below the mandibular foramen. Notice the many small fissures, and rough bone surface. Scale bar is 10µm

Results:

Prior to image analysis, samples digested by diurnal raptors and owls display significant qualitative differences. Bones digested by owls consistently display high densities of small microfissures on the mandible. Mandibles digested by diurnal raptors show far fewer microfissures in a given area, but those fissures are significantly longer and deeper. On the ramus region of the mandibles, samples consumed by owls averaged 230.4 fissures with a standard deviation of 96.37 and diurnal raptors averaged 19.67 fissures with standard deviation of 13.32 in a 10µm scale image.

Discussion:

While preliminary visual analysis indicates distinct differences in the condition of bones digested between groups, morphometric analysis of the microfissures is still pending. Of particular interest are the surface characteristics of the bone between the fissures, as well as the erosion of enamel from the anterior surfaces of incisors. While these features may not be as easily quantifiable as microfissure morphology, they may be of use collectively in the diagnosis of predator depositors for fossil rodent bones. The next step in this study is the imaging and analysis of mandibles digested by mammalian predators, and finally the examination of fossil samples from the John Day collection.

References

1. Andrews P, Nesbit Evans EM. 1983. Small Mammal Bone Accumulations Produced by Mammalian Carnivores. Paleobiology 9:289–307.

2. Andrews, P. (1990). Owls, caves, and fossils: Predation, preservation, and accumulation of small mammal bones in caves, with an analysis of the Pleistocene cave faunas from Westbury-sub-Mendip, Somerset, UK. Chicago: University of Chicago Press.

3. Hockett BS. 1996. Corroded, Thinned and Polished Bones Created by Golden Eagles (Aquila chrysaetos): Taphonomic Implications for Archaeological Interpretations. Journal of Archaeological Science 23:587–591.

Montalvo CI, Bisceglia S, Kin MS, Sosa RA. 2012. Taphonomic analysis of rodent bone accumulations produced by Geoffroy’s cat (Leopardus geoffroyi, Carnivora, Felidae) in Central Argentina. Journal of Archaeological Science 39:1933–1941.

Montalvo CI, Fernandez FJ, Liebana MS, Santillan M, Sarasola JH. 2014. Taphonomic analysis of rodent bone accumulations produced by the White-tailed Kite (Elanus leucurus, Accipitriformes) in Central Argentina. Journal of Archaeological Science 52:354–362

Reed DN. 2005. Taphonomic implications of roosting behavior and trophic habits in two species of African owl. Journal of Archaeological Science 32:1669–1676.

Terry RC. 2007. Modeling the Effects of Predation, Prey Cycling, and Time Averaging on Relative Abundance in Raptor-Generated Small Mammal Death Assemblages. Palaios 23:402–410.

Terry RC. 2010b. The dead do not lie: using skeletal remains for rapid assessment of historical small-mammal community baselines. Proceedings of the Royal Society B 277:1193–1201.

OSU Oregon State University College of Science

SURE SCIENCE

Acknowledgements

Funding for this project was provided by Oregon State’s URISC. Many thanks to Dr. Rebecca Terry for her indispensable help and guidance, David Taylor for his insight and advice, and all of Terry Lab for their support.

Oregon State University