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Visions of the Past – Using Microscopic Dental Wear Analysis to Reconstruct Extinct Species

Abstract

In both Japan and Germany, prehistoric animals such as dinosaurs and extinct mammoths are among the most popular exhibits in museums. But how are these vivid reconstructions of extinct animals created? How can we reveal the lifestyles of organisms for which only skeletal remains have been preserved? Paleontologists have approached these questions using a wide range of methods.

In our research, we focus on a particularly small but informative clue: microscopic wear traces preserved on tooth surfaces. Vertebrate teeth are covered with hard enamel, which makes them highly resistant to decay and therefore likely to be preserved in the fossil record. As a result, teeth provide valuable insights into the diets of extinct animals. When enamel surfaces are examined under a microscope, they reveal countless tiny scratches and pits—collectively known as dental microwear. Because these features are formed through direct contact between food items and teeth, their morphology reflects the physical properties of the consumed diet: harder foods tend to leave deeper, more pronounced marks, whereas softer foods produce finer, shallower traces.

By establishing relationships between microwear patterns and known diets in living animals, and then applying these relationships to fossil specimens, we can infer the diets of extinct species. Using this approach—Dental Microwear Texture Analysis (DMTA)—we have investigated the diets of prehistoric Japanese deer hunted by prehistoric humans, extinct deer from the Ice Age, and even dinosaurs.

Through reconstructing past ecosystems in this way, we can gain new perspectives on the ecological world we inhabit today.

CV

Education

1999/04-2003/03, Bachelor of Science in Faculty of Science, The University of Tokyo.

2003/04-2005/03, Master of Science in Graduate School of Agricultural and Life Sciences, The University of Tokyo.

2005/04-2010/03, Ph.D in Graduate School of Science, The University of Tokyo.

Professional Appointments

2010/04-2013/03, Project researcher of Museum Group for Promoting Cutting-Edge Research in Macroscopic Sciences, The University Museum, The University of Tokyo.

2013/04-2015/09, JSPS Postdoctoral Research Fellow at The University Museum, The University of Tokyo.

2015/10-2020/03, Assistant Professor, Department of Natural Environmental Studies, Graduate School of Frontier Sciences, The University of Tokyo.

2020/04-2024/01, Lecturer, Department of Natural Environmental Studies, Graduate School of Frontier Sciences, The University of Tokyo.

2024/02-present, Associate Professor, Department of Natural Environmental Studies, Graduate School of Frontier Sciences, The University of Tokyo.

Awards and Honors (Selected)

- Young Scientist Initiative Award, Society for Evolutionary Studies, Japan, 2024
 - Excellent Poster Award, The Mammal Society of Japan, 2022
 - Research Encouragement Prize, The Mammal Society of Japan, 2019
 - Morita Scientific Research Award, Japan Association of University Women, 2019
 - Best Young Presentation Award, The Anthropological Society of Nippon, 2015
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Research Grants (Selected)

- Principal Investigator, KAKENHI (B) “Ecological and anthropogenic drivers of mammalian faunal formation in the Japanese Islands” (No. 23K25981, 2023–2027)
 - Principal Investigator, KAKENHI (Young Scientists B) “Functional morphology of teeth in large herbivorous mammals” (No. 16K18615, 2017–2022)
 - Co-Investigator, KAKENHI (C) “Island adaptation processes in Ryukyu mammals” (No. 23K05910, 2023–2026)
 - Co-Investigator, KAKENHI (A) “Interdisciplinary study of Homo sapiens expansion into the Ryukyus” (No. 22H00027, 2022–2027)
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Selected Publications

1. **Kubo M.O.**, Kubo T., Schulz-Kornas E., Kaiser T.M., Winkler D.E. 2025. *Inter-microscope comparability of dental microwear texture data Part II Deriving instrument-specific correction equations for meta-analyses using published data.* **Anatomical Record**. doi.10.1002/ar.25661.
2. Winkler D.E., **Kubo M.O.** 2025. *Inter-microscope comparability Part I Reproducibility of diet inference using different instruments.* **Anatomical Record**. doi.10.1002/ar.25685.
3. Usami K., **Kubo M.O.*** 2025. *In-vitro puncture experiments using alligator teeth.* **Anatomical Record**. doi.10.1002/ar.25659 (* corresponding author)
4. **Kubo M.O.** et al. 2025. *Feeding ecology of the Amami rabbit and Ryukyu long-furred rat inferred from dental microwear textures.* **Mammal Study** **50**: 199-210.
5. Rozzi R. et al. 2023. *Dwarfism and gigantism drive human-mediated extinctions on islands.* **Science** **379**: 1054-1059.