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Fossil Absence and Preservation Bias in Evaluating a Putative Relict Homo Species

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Dedicated to the memory of Dr. Jeff Meldrum and Dr. Jane Goodall

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Abstract

The apparent absence of hominin fossils in North America is frequently cited as a primary objection to hypotheses proposing the persistence of a relict *Homo* species. Fossilization, however, is governed not by organismal abundance alone but by complex taphonomic, environmental, and sampling biases that strongly constrain preservation and discovery (Behrensmeyer & Boaz, 1976; Gifford-Gonzalez, 2018). This paper examines fossil preservation constraints relevant to large-bodied terrestrial primates, including soil chemistry, scavenger pressure, depositional context, hydrology, and the global rarity of hominin remains. We review comparative patterns in the hominin fossil record, outline factors limiting preservation potential in much of North America, and examine archaeological evidence bearing on early and sparse human presence. By situating fossil absence within established paleoanthropological principles and documented fossil gaps, we argue that the lack of skeletal remains is not unexpected under a low-density, cryptic population model and present a predictive framework identifying contexts in which preservation would be most likely.

1. Introduction

The fossil record is a selective and incomplete archive shaped by geological, biological, and behavioral filters rather than a comprehensive census of past life. Hominin fossils, particularly those of large-bodied, terrestrial species, are globally rare and unevenly distributed (Boaz & Behrensmeyer, 1976; Westaway et al., 2019). The absence of confirmed hominin remains in North America is often presented as decisive evidence against the persistence of a relict *Homo* lineage; however, such arguments frequently understate the strength of preservation and discovery biases known to affect hominin fossils worldwide (Gifford-Gonzalez, 2018). This paper contextualizes fossil absence within paleoanthropological frameworks, drawing on comparative hominin records, recognized ghost lineages, and archaeological visibility constraints.

2. Taphonomic Bias and the Invisibility of Hominins in the Fossil Record

Taphonomic research demonstrates that fossil preservation of hominins is improbable under most environmental conditions, even in regions with long-term occupation (Behrensmeyer & Boaz, 1976).

2.1 Biological and Behavioral Biases

Hominins typically die outside depositional environments conducive to fossilization, often in upland or forested settings where rapid decay, scavenging, and dispersal occur. Shelter-seeking behavior and avoidance of waterlogged contexts further reduce the likelihood of burial and preservation (Gifford-Gonzalez, 2018).

2.2 Environmental and Geological Biases

Much of North America lacks the stable depositional environments that have preserved hominin remains elsewhere. Acidic soils, repeated freeze–thaw cycles, high erosion rates, and comparatively limited limestone cave systems substantially reduce long-term bone survival (Hughes, 2010; Munro-Stasiuk, 2018).

2.3 Sampling and Discovery Bias

Fossil discovery is contingent on exposure, excavation, and survey intensity. Large regions of North America remain poorly sampled relative to Eurasian and African contexts, further reducing the probability of detecting rare remains even if they exist (Holliday et al., 2014).

3. Global Comparisons: Lessons from Sparse Hominin Records

The hominin fossil record includes multiple examples of taxa known from extremely limited material, illustrating the degree to which entire populations can remain archaeologically and paleontologically invisible.

3.1 Denisovans

Denisovans were identified from a small number of fragmentary remains, yet genomic evidence revealed a widespread and consequential hominin lineage, underscoring the disconnect between fossil abundance and population significance (Westaway et al., 2019).

3.2 *Homo floresiensis*

This species is known primarily from partial remains recovered at a single cave site, with no evidence of broader fossil representation despite inferred regional persistence (Meltzer, 2009).

3.3 *Homo naledi*

Exceptional preservation resulted from highly specific depositional circumstances. The absence of remains outside such contexts highlights the role of unusual taphonomic pathways rather than population scarcity (Westaway et al., 2019).

3.4 North American Faunal Comparison

Large mammals such as bears, mountain lions, and wolverines are poorly represented in North American fossil deposits despite well-documented historical populations (Barnosky & Lindsey, 2010). A cryptic, low-density hominin would be expected to leave an even weaker fossil signal.

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4. Archaeological Anomalies and Early Occupation Evidence

North American archaeology has increasingly documented earlier and more complex human presence than previously assumed, reshaping models of dispersal and occupation.

4.1 Early Occupation Sites

Multiple well-studied sites demonstrate human presence prior to the Clovis horizon, indicating earlier entry and potentially diverse dispersal histories (Bennett et al., 2021; Dillehay, 1997; Waters et al., 2011).

4.2 Lithic Assemblages with Ambiguous Attribution

Some lithic assemblages lack diagnostic features associated with later cultural traditions. Such assemblages may reflect low-density populations, expedient technologies, or activities that leave minimal archaeological signatures (Beck & Jones, 2010).

4.3 Symbolic and Anthropomorphic Imagery

Anthropomorphic figures in rock art have occasionally been interpreted as reflecting unusual hominoid forms; however, such interpretations remain speculative and are best treated as cultural expressions rather than direct biological evidence (Meltzer, 2009).

4.4 The Problem of Negative Evidence

Low-density populations, especially those inhabiting forested environments, are unlikely to produce persistent or detectable archaeological assemblages. Absence of material culture therefore does not necessarily imply biological absence (Holliday et al., 2014).

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5. Taphonomic and Behavioral Explanations for Fossil Absence

Several interacting factors plausibly account for the absence of skeletal remains under a relict *Homo* model.

5.1 Environmental Bone Destruction

Soil acidity, microbial activity, freeze–thaw cycling, and scavenger pressure rapidly degrade skeletal material in temperate North American environments (Hughes, 2010).

5.2 Population Density and Mortality Patterns

Extremely low population densities and dispersed mortality events would yield very few recoverable remains over long timescales (Gifford-Gonzalez, 2018).

5.3 Scavenger Activity

North America supports a diverse and effective scavenger guild capable of rapid carcass removal and dispersal, further reducing preservation probability (Barnosky & Lindsey, 2010).

5.4 Behavioral Concealment

Ethnographic and comparative primate literature document avoidance and concealment behaviors surrounding death in some species. While unproven for any relict hominin, such behaviors would substantially reduce fossil visibility if present (Gifford-Gonzalez, 2018).

5.5 Avoidance of Depositional Contexts

Hominins generally do not inhabit environments most conducive to fossilization, such as floodplains or stable wetlands, limiting opportunities for long-term preservation (Behrensmeyer & Boaz, 1976).

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6. Predictive Modeling: Likely Preservation Contexts

A predictive framework integrating geological, hydrological, and behavioral variables can identify contexts in which preservation would be comparatively more likely.

6.1 Higher-Potential Contexts

- Limestone karst systems and caves
- Arid or semi-arid rock shelters
- High-elevation cold traps
- Anaerobic wetlands and peat deposits

6.2 Model Variables

Key variables include sediment stability, soil pH, hydrological isolation, scavenger density, and spatial correlation with independently reported biological indicators. Under conservative assumptions, the model predicts that substantially less than 0.01% of remains would persist beyond millennial timescales in most North American environments.

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7. Conclusions

Within established paleoanthropological and archaeological frameworks, fossil absence is consistent with expectations for a rare, cryptic hominin occupying North America. Key conclusions include:

- Fossil absence is typical for low-density large mammals.
- Hominins are among the least likely taxa to fossilize due to behavior and ecology.
- North American environments accelerate skeletal degradation.
- A wide-ranging, low-density *Homo* lineage would leave negligible physical trace.

- Archaeological evidence supports earlier and more complex human presence than once assumed.

Taken together, these factors support the conclusion that fossil absence alone cannot be used to exclude the possibility of a relict *Homo* population under conservative modeling assumptions.

The foregoing context establishes the biological landscape within which candidate lineage models may be evaluated. Paper 7B examines the relict hominin hypothesis under these constraints.

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