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Reconstructing the "Wood Age": Functional Morphology of Middle Pleistocene Wooden Tools from Marathousa 1, Greece

Biology * Evolution * Animals

Unearthing the Middle Pleistocene "Wood Age"

The narrative of hominin technological development has historically been skewed by differential material preservation. Because stone, bone, and antler survive over geological timescales whereas plant polymers rapidly biodegrade in aerobic soils, prehistory has been defined by lithic epochs -- despite ethnographic and primatological evidence indicating that wood formed the bulk of the Paleolithic toolkit.[1][2] The publication in PNAS of Middle Pleistocene wooden artifacts from Marathousa 1 (MAR-1) in the Megalopolis Basin of Greece fundamentally recalibrates this record.[4] Dated to approximately 430,000 years ago (430 ka), the Marathousa finds represent the earliest confirmed handheld wooden tools globally -- predating the Sch ningen spears (~300 ka) and Clacton spear (~400 ka) and differing from the structural logs of Kalambo Falls (~476 ka) or the plank fragment of Gesher Benot Ya'aqov (~780 ka) by functioning as portable, ergonomically shaped implements.[3][4]

Recovered from a waterlogged, anoxic lakeshore horizon directly associated with the butchered carcass of a straight-tusked elephant (Palaeoloxodon antiquus) and a microlithic flake industry, the assemblage includes an 81 cm alder (Alnus sp.) digging stick/lever and a 5.7 cm willow or poplar (Salix/Populus sp.) fine-retouching tool.[4][5] Synthesizing radiometric dating, taphonomy, and micro-computed tomography (Micro-CT) use-wear data, this report reconstructs the technological behavior of early Neanderthal or Homo heidelbergensis populations surviving inside a Balkan glacial refugium.[4][11]

Taphonomy, Chronology, and Glacial Refugium Paleoecology

The preservation of organic cellulose and lignin alongside calcareous bone at Marathousa 1 is owed to the structural geology of the Megalopolis Basin in the central Peloponnese -- a graben depression formed by regional plate tectonics that accumulated thick fluvio-lacustrine clays and peat-derived lignite seams across the Pleistocene.[6] Situated within the Choremi Formation between Lignite Seams II and III, the MAR-1 archaeological horizon was rapidly sealed by a low-energy mudflow along a marshy lakeshore.[6][8][9] Waterlogged, oxygen-depleted (anaerobic) pore waters suppressed wood-digesting fungi and aerobic bacteria while buffering sediment pH sufficiently to preserve both wood anatomy and vertebrate skeletal elements.[6][7]

| Chronometric / Proxy Method | | Sampled Material | | Age / Stage Determination | | Stratigraphic & Climatic Significance |

| Electron Spin Resonance (ESR) | | Mammalian tooth enamel & mollusks | | 430 - 500 ka[10] | | Measures trapped electron dose in hydroxyapatite/aragonite lattices. |

| Luminescence (pIRIR) | | Potassium-rich feldspar grains | | ~430 ka (Middle

Pleistocene)[4] | | Constrains last sunlight exposure prior to mudflow burial. |

| Biostratigraphy & Paleoclimatology | | Micromammals, megafauna, pollen | | Marine Isotope Stage 12 (~430 ka)[4][12] | | Correlates occupation with one of the severest Pleistocene glaciations. |

Placing Marathousa 1 within Marine Isotope Stage 12 (MIS 12, ~430 ka) -- an extreme glacial maximum that covered northern Europe in continental ice sheets -- underscores the Megalopolis Basin's role as a temperate micro-refugium.[11][12] Paleobotanical macro-remains and pollen document a riparian ecosystem bordered by alder (Alnus), willow (Salix), and poplar (Populus), with oak (Quercus) and maple (Acer) on surrounding slopes and edible white water lily (Nymphaea alba) and pondweed (Potamogeton) in permanent freshwater shallows.[4][9] This mild lacustrine habitat supported straight-tusked elephants (Palaeoloxodon antiquus), hippopotamuses (Hippopotamus antiquus), beavers (Castor fiber), and warm-water darters (Anhinga), alongside apex carnivores (Canis, large felids) that competed directly with hominins for carcasses.[4][12]

Functional Morphology of the Wooden Assemblage

To distinguish anthropogenic woodworking from natural drift breakage or carnivore gnawing across hundreds of waterlogged wood fragments, researchers combined macroscopic screening with non-destructive Micro-CT internal growth-ring imaging and high-magnification use-wear microscopy.[4]

| Specimen ID | | Taxonomic Wood | | Preserved Length | | Diagnostic Manufacturing & Wear Traces | | Functional Interpretation |

| MAR-1-39 | | Alnus sp. (Alder) | | ~81 cm (fragmented shaft) | | Lithic branch-chopping stop marks, stripped bark, rounded tip with crushed fibers & embedded grit.[4][5] | | Multi-purpose digging stick (tubers/aquatic rhizomes) & elephant butchery lever.[2][4] |

| MAR-1-13 | | Salix / Populus (Willow/Poplar) | | 5.7 cm (complete) | | Truncated ends; bi-directionally chamfered tip cutting across annual growth rings.[4] | | Soft-wood pressure retoucher/compressor for microlithic flake edges.[5][14] |

| Carnivore Wood | | Alnus sp. (Alder) | | Fragmentary | | Deep parallel U-shaped grooves lacking lithic V-shaped stop marks.[4] | | Taphonomic control: claw marks from large felid/carnivore on lakeshore.[4] |

Specimen MAR-1-39 (~81 cm long) demonstrates deliberate raw-material selection: alder wood resists waterlogged decay and possesses high flexural strength.[13] Micro-CT scans reveal lithic "stop marks" where lateral twigs were chopped away toward the trunk base, followed by bark scraping for an ergonomic grip and distal tip rounding. Compressive cell deformation, longitudinal striations, and embedded silt grains at the tip confirm heavy mechanical levering and digging in abrasive mud.[4]

Conversely, Specimen MAR-1-13 (5.7 cm) was carved from soft willow or poplar with truncated ends and a bi-directionally tapered point.[4] Its morphology links directly to Marathousa 1's distinctive "small tool" lithic industry -- thousands of radiolarite, quartz, and chert flakes (<3 cm) produced via bipolar anvil

percussion.[9] Experimental archaeology indicates that soft hardwood/softwood compressors effectively grip and pressure-flake diminutive stone edges without shattering them, making MAR-1-13 the earliest evidence of an organic tool crafted specifically to maintain stone tools.[5][14]

Cognitive Complexity at the Neanderthal Dawn

Chronologically aligned with the ~430 ka early Neanderthal fossils from Sima de los Huesos (Spain), the Marathousa 1 artisans -- whether late Homo heidelbergensis or early Homo neanderthalensis -- exhibited deep botanical selectivity and multi-stage operational planning (cha ne op ratoire).[4] By pairing rot-resistant alder levers with compliant willow/poplar retouchers and microlithic stone flakes, these Middle Pleistocene hominins engineered an integrated organic-lithic technology that enabled megafaunal butchery and wetland foraging during one of the coldest glacial stages of human prehistory.[4][15]

Updates... (Nov 23, 2026): Aligned Reference [8] co-author metadata with CrossRef (Bludau, Papadopoulou, Iliopoulos, et al., Jul 1, 2021) and replaced the timed-out archaeology.org URL in Reference [15] with Live Science's verified Jan 28, 2026 report; earlier Nov 20, 2026 updates standardized reference parity and DOIs.

References

* [1] Times of India. (Jan 30, 2026). World's oldest wooden tools found in Greece push early human technology history back. https://timesofindia.indiatimes.com/world/rest-of-world/worlds-oldest-wooden-tools-found-in-greece-push-early-human-technology-

* [2] Discover Magazine. (Jan 30, 2026). 430,000-Year-Old Discovery Reveals Earliest-Known Evidence of Humans Using Wooden Tools. https://www.discovermagazine.com/430-000-year-old-discovery-reveals-earliest-known-evidence-of-humans-using-wooden-tools-48

* [3] Science News. (Jan 26, 2026). This ancient stick may be the world's oldest handheld wooden tool. https://www.sciencenews.org/article/stick-oldest-handheld-wooden-tool

* [4] Milks, A., Ntinou, M., Koutalis, S., Michailidis, D., et al. (Jan 26, 2026). Evidence for the earliest hominin use of wooden handheld tools found at Marathousa 1 (Greece). Proceedings of the National Academy of Sciences, 123(6), e2515479123. https://doi.org/10.1073/pnas.2515479123

* [5] Sci.News. (Jan 27, 2026). 430,000-Year-Old Wooden Handheld Tools are Earliest Ever Found. https://www.sci.news/archaeology/earliest-handheld-wooden-tools-14512.html

* [6] Panagopoulou, E., Tourloukis, V., Thompson, N., Konidaris, G., et al. (Dec 2018). The Lower Palaeolithic site of Marathousa 1, Megalopolis, Greece: Overview of the evidence. Quaternary International, 497, 33-46. https://doi.org/10.1016/j.quaint.2018.06.031

* [7] Broda, M., & Hill, C. A. S. (Sep 2, 2021). Conservation of Waterlogged Wood -- Past, Present and Future Perspectives. Forests, 12(9), 1193. https://doi.org/10.3390/f12091193

* [8] Bludau, I. J. E., Papadopoulou, P., Iliopoulos, G., et al. (Jul 1, 2021).

Lake-Level Changes and Their Paleo-Climatic Implications at the MIS12 Lower Paleolithic (Middle Pleistocene) Site Marathousa 1, Greece. Frontiers in Earth Science, 9, 668445. https://doi.org/10.3389/feart.2021.668445

* [9] De Caro, D., Kuhn, M., Thompson, N., Panagopoulou, E., et al. (Jun 30, 2025). Small flakes for sharp needs: Technological behaviour in the Lower Palaeolithic site of Marathousa 1, Greece. PLOS One, 20(6), e0324958. https://doi.org/10.1371/journal.pone.0324958

* [10] Blackwell, B. A. B., Sakhrani, N., Singh, I. K., Gopalkrishna, K. K., et al. (Oct 15, 2018). ESR Dating Ungulate Teeth and Molluscs from the Paleolithic Site Marathousa 1, Megalopolis Basin, Greece. Quaternary, 1(3), 22. https://doi.org/10.3390/quat1030022

* [11] Roditi, E., Bocherens, H., Konidaris, G. E., & Athanassiou, A. (Jan 16, 2024). Life-history of Palaeoloxodon antiquus reveals Middle Pleistocene glacial refugium in the Megalopolis basin, Greece. Scientific Reports, 14(1), 1390. https://doi.org/10.1038/s41598-024-51592-9

* [12] Konidaris, G. E., Athanassiou, A., Tourloukis, V., Chitoglou, K., et al. (Sep 24, 2024). The Late Early-Middle Pleistocene Mammal Fauna from the Megalopolis Basin (Peloponnese, Greece) and Its Importance for Biostratigraphy and Paleoenvironment. Quaternary, 7(4), 41. https://doi.org/10.3390/quat7040041

* [13] Archaeology Magazine. (Jan 26, 2026). 430,000-year-old well-preserved wooden tools are the oldest ever found. https://archaeologymag.com/2026/01/430000-year-old-wooden-tools-marathousa/

* [14] Martellotta, E. F., Perston, Y. L., Craft, P., & Wilkins, J. (Aug 16, 2022). Beyond the main function: An experimental study of the use of hardwood boomerangs in retouching activities. PLOS ONE, 17(8), e0273118. https://doi.org/10.1371/journal.pone.0273118

* [15] Live Science. (Jan 28, 2026). 430,000-year-old wooden handheld tools from Greece are the oldest on record -- and they predate modern humans. https://www.livescience.com/archaeology/human-evolution/430-000-year-old-wooden-handheld-tools-from-greece-are-the-oldest-or