

2021

In 2021 we watched as the pandemic brought to mind the other like (or greater) plagues from the past and made the [Science of the Human Past](#)'s work on the spread of pathogens and historical climate change a vivid reminder of the fragility and preciousness of that most important of all resources: life itself. Spurred by this urgency, our research teams worked tirelessly to discover and unfold the experiences of the past and their implications for the most pressing global issues we face today. Training the next generation of archaeoscience pioneers has, in fact, never been so important as it has become during these challenging days, and our students continue to seek opportunities at every step of the way to further—with our guidance—SoHP's collaborative mission. 2021 highlights include: new genetic evidence that the mysterious [Tarim mummies](#) of western China are descended from Indigenous people, and are *not* a remote branch of early Indo-Europeans; how a [SoHP undergraduate became first co-author](#) on a major study in *Nature* on Bronze Age migrations to Britain and the spread of Celtic languages; and [documentary filming](#) of SoHP's interdisciplinary teams' deployment of an ice core and DNA to uncover crisis and pandemic in the Roman Empire for Europe's ARTE Channel and PBS, and its innovative archaeology of Visigothic Iberia for the History Channel.

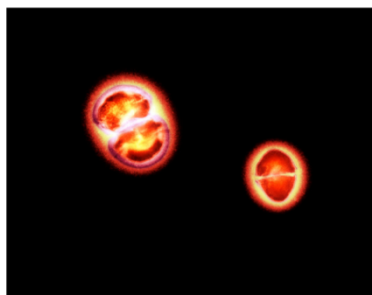
This report brings you up to date about the **Initiative for the Science of the Human Past at Harvard (SoHP)** and its activities, particularly at our [Max Planck-Harvard Research Center](#), the [Historical Ice Core Project](#), SoHP's [Educational Mission](#), its [People](#) and [Projects](#) in 2021.

The Max Planck-Harvard Research Center for the Archaeoscience of the Ancient Mediterranean (MHAAM), Cambridge and Boston, Jena and Leipzig (Germany)

RESEARCH HIGHLIGHT | 14 May 2021

Microbes in Neanderthals' mouths reveal their carb-laden diet

Gunk on ancient teeth yields bacterial DNA, allowing scientists to trace the oral microbiome's evolution.



Genomic analysis identified starch-loving *Streptococcus argentinus* bacteria (artificially coloured) in the mouths of modern humans and Neanderthals, but not in chimpanzees' mouths. Credit: National Infection Service/Science Photo Library

Nature Highlight, May 14, 2021

MHAAM's members published 28 studies in leading journals and 2 books. Global press coverage further publicized MHAAM's research spanning from food and trade to population replacement and language migration to timely discoveries about the spread of ancient pathogens.

MHAAM's great success in its first five years—with over 60 [publications](#)—prompted a five-year renewal by Harvard University and the Max Planck Society in Germany for this first-of-kind virtual transatlantic research center. The renewal for 2021–2026 *also* coincided with the move from Jena to Leipzig, Germany of the Department of Archaeogenetics (headed by MHAAM Co-Director Prof. Dr. Johannes Krause)—now based at the Max Planck Institute for Evolutionary Anthropology, where the growing research team has expanded resources and lab facilities. Access to samples for aDNA research has surged exponentially both in Germany, and at the Harvard labs of MHAAM Faculty, Professors David Reich (Human Evolutionary Biology; Harvard Medical School) and Christina Warinner (Anthropology). In 2021,



MPI-EVA in Leipzig, Germany

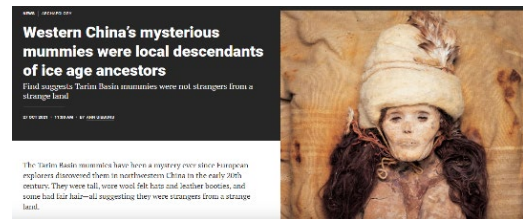


Smithsonian Magazine, December

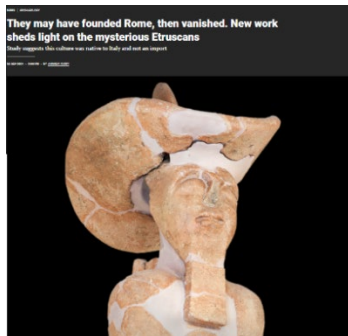
The year began with the *earliest* direct evidence in the Mediterranean for imports and the consumption of sesame, soybean, probable banana, and turmeric: the study of dental calculus—with the latest molecular and microscopic techniques—revealed the stunning complexity of [early trade routes between South Asia and the Near East](#), highlighted in [Smithsonian Magazine](#) and [National Geographic](#).

Also in January, MHAAM Co-Director Michael McCormick was featured at a special Medieval Academy webinar on “[Disease, Death, and Therapy](#)” to describe his work on [aDNA and Gregory of Tours](#)—the Bishop whose historical testimony of sixth century disease is confirmed by and integrated into the new biomolecular archaeological discoveries of early medieval plague victims in western Europe.

As the year progressed, publications on quite diverse research made global news, including fascinating new genetic evidence on the origins of the exceptionally well-preserved [Tarim Mummies](#) in northwest China, as featured in [Science](#), [Nature](#), and [Smithsonian](#).



Science, October 27, 2021



Science, September 24, 2021

Also noted: research on [African oral microbiomes](#) revealing a carbohydrate-rich diet dating back to Neanderthals and intensified in humans as highlighted in [Nature](#) and [Sci-News](#); “[Ten millennia of hepatitis B virus evolution](#)” with the earliest known ancestry of this persistent infection; and investigations towards understanding the [genetic ancestry of ancient Nubia](#). Surprising new genetic findings on the [enigmatic Etruscan civilization](#), contradicting Herodotus’ claims on their origins, were featured in [Science](#) and [Smithsonian](#). A December [Nature](#)

group publication featured analysis of dental calculus by applying thermal desorption/pyrolysis–gas chromatography–mass spectrometry and polarizing microscopy, to reveal—from smoke inhalation in both ancient men and women—that [lignite supplanted wood in Bronze Age kilns](#) more than 1000 years earlier than previously thought, and allowed Mycenaean Greeks to produce high-quality ceramic vessels and bronzes in almost unbelievable numbers.



Bronze smelting in the Aegean Bronze Age

© Nicola Ivanov

Bronze Smelting in the Aegean Bronze Age

World's oldest family tree revealed in 5,700-year-old Cotswolds tomb

DNA analysis of bodies in Hazleton North long cairn finds five generations of an extended family



© What the exterior of the Hazleton North long cairn may have looked like, taken from a Corinium

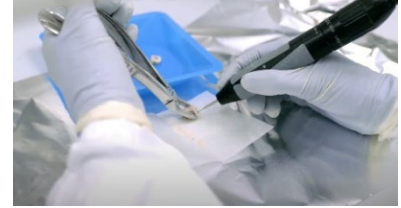
The Guardian, December 22, 2021

In another study, ancient DNA provided evidence of killing on a scale that transcended individual families in prehistory from the [victims of a 6200 year old massacre](#) in Croatia, and traced indiscriminate violence (equal numbers of male and female victims) to pre-state societies, contrary to recent arguments. In further exploration of kinship practices, the ancient DNA of a five-generation family in [Early Neolithic Britain](#) showed numerous interrelationships among men and women in this first extended pedigree reconstruction, as noted in [The Guardian](#) and [The Telegraph](#). Additionally for this productive year, MHAAM, which is committed to ethical engagement in ancient DNA research, has published guidelines for global application in [Nature](#) co-authored by its key scientists.

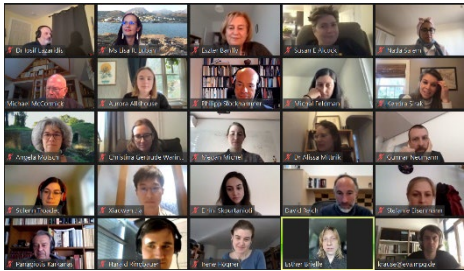


Virtual Lab Tour with Prof. Christina Warinner at Harvard

In April, MHAAM hosted a special webinar to describe its most notable discoveries of the past five years, and to share plans for future expansive research. Highlights of the webinar included virtual behind-the-scenes visits to both the remarkable new aDNA labs in Leipzig and to Prof. Tina Warinner's beautiful new proteomics and aDNA lab at Harvard. The webinar audience had the opportunity to witness, at first hand, the technological innovations allowing us to discover the pandemics of past and future—how they originate and spread—and to learn about innovations in ancient biomolecular studies yielding vivid new insights into gender and kinship, inequality, health and nutrition, mobility and migration on a global scale.

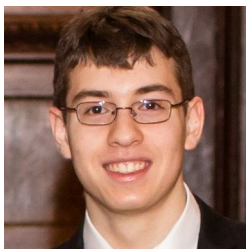


Preparation of ancient bone sample, Virtual Lab Tour in Leipzig



MHAAM Virtual Research Meeting in October

MHAAM's October research meeting included lightning presentations by team members on current research across and beyond the ancient Mediterranean. The meeting revealed new data on Nubia, Egypt, Swahili speakers, Tunisia, Cyprus, Phoenicia, Anatolia and the Aegean, Campania, Britain, and Brittany, as MHAAM's temporal and geographic reach continues to expand. Members of MHAAM's Scientific Advisory Committee were on hand to provide feedback as the transatlantic research teams discover pathways of connection and support, collaborating globally with so many archaeoscientists on sample collection, preparation, and analysis. Presentations by current MHAAM graduate students were highlights of this exciting day-long meeting featuring 16 research talks and concluding with Harvard's Justinianic Pandemic geodatabase team.



Michael Isakov

The MHAAM year drew to a close with exciting news. Michael Isakov, who as a Harvard College Sophomore excelled in McCormick's Fall 2019 undergraduate course "New Science of the Human Past: Case Studies at the Cutting Edge," is now

co-first author on the *Nature* article "[Large-scale migration into Britain during the Middle to Late Bronze Age](#)," prereleased in December and highlighted in *The New York Times*, *BBC News*, and *Science*, which confirms—plausibly—the spread of Celtic language-speaking peoples to Britain during the Late Bronze Age rather than centuries earlier or later according to prior theories. Isakov, now a senior at Harvard, discovered the existence of this momentous 3,000-year-old migration in his work alongside Harvard/MHAAM geneticists David Reich and Nick Patterson.

Ancient mass migration transformed Britons' DNA

By Brad Stone
Published online: 22 December 2021



BBC News, December 22, 2021

The New York Times

3,000 Years Ago, Britain Got Half Its Genes From ... France?

An extensive study of ancient DNA suggests that a wave of newcomers — and perhaps the first Celtic languages — crossed the English Channel three millennia ago.



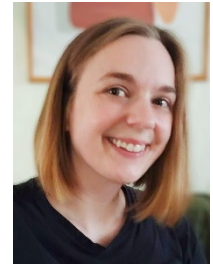
NYT, December 22, 2021



Megan Michel

MHAAM's three current graduate students have now co-authored 13 publications in major peer-reviewed journals, signaling the quality and breadth of training they are receiving both at Harvard in the aDNA and proteomic labs here, and in the array of our sister archaeoscience labs in Germany. Megan Michel's (Human Evolutionary Biology) talk on "Coevolution and Cariogenicity: Analysis of 80 Ancient *Streptococcus mutans* Genomes Spanning the Neolithic Transition" at the 9th International Symposium on Biomolecular Archaeology was a conference highlight and her current research on the global genetic evolution of infectious diseases promises even greater things.

Aurora Allshouse (Anthropology) is working with Prof. Tina Warinner on the meta-analysis of stable isotopes and diet in the Bronze Age Aegean, focusing on the varied consumption of seafood; she presented her research at the 8th Conference in Aegean Archaeology. Aurora was also Head Teaching Fellow for Anthro 1130: The Archaeology of Harvard Yard, and is currently training in shotgun proteomics for dental calculus and pottery for her dissertation research.



Aurora Allshouse



Reed Morgan at Reccopolis

Reed Morgan (History) continues to study Punic and Late Antique Tunisia, and is investigating aDNA preserved in ice cores—testifying to ways SoHP is linking its unique environmental research methods with MHAAM's genetic approach. Reed was Head Teaching Fellow this fall for *The New Science of the Human Past*: with McCormick he introduced enthused Harvard undergraduates into the way interdisciplinary archaeoscience is transforming our knowledge of the human past. Reed further collaborated in innovative archaeological research at SoHP's Reccopolis (Spain) project over the summer season.

MHAAM was awarded a Richard Lounsbery Foundation grant for work to reconstruct ancient pandemics in France: to identify and record via geodatabase the archaeological remains of victims of the Justinianic Pandemic suitable for genomic pathogen analysis in Leipzig. MHAAM postdoc Solenn Troadec (PhD, University of Nottingham) was selected to identify early medieval anomalous burials in her native France, and is making fantastic progress as she prepares for a deep research dive working closely with numerous French colleagues.



Dr. Solenn Troadec

We continue to seek resources to match, on the Harvard end, funding contributed by Max Planck in Germany for this unique and extraordinarily successful collaboration. Due to pandemic-induced financial setbacks at Harvard, this has become even more critical in order to support research and study by the new generation of archaeoscientists eager to contribute to this growing field, and our network of generous supporters is invaluable for this effort.

Historical Ice Core Project (HICP)

This year, our exploration of past climate and pollution and their relationship to ancient and medieval economies reached new milestones. Despite the challenges of lab closures due to the pandemic and costly instrumental difficulties, our colleagues led by HICP co-director Prof. Paul Mayewski at the Climate Change Institute (C.C.I., University of Maine) succeeded in producing the longest high-resolution record of pollution resulting from the smelting of metals that are key indicators of the health of ancient economies and populations. The latest advances in our analysis of

the Colle Gnifetti ice core data take the project literally deeper into the glacier's early medieval and ancient ice—promising new revelations about the Roman economy and environment as the team matches elemental analysis of ice samples with historical research in this transdisciplinary collaboration.



Dr. Alexander More

2021 also saw SoHP's Dr. Alexander More (Harvard; Long Island University; C.C.I.) complete an important study on "Climate Change at the Turn of the Millennium," to be published under the auspices of the Collège de France. Dr. More details the changes in climate around the year 1000 during the Medieval Climate Anomaly from Western Europe to East Asia, taking advantage of historical records in SoHP's *Geodatabase of Written Reports of Climate* (created by Harvard undergraduates and curated by Dr. More), as well as multiple natural climate proxy records from the glacier of Colle Gnifetti to the forests of North-West China.

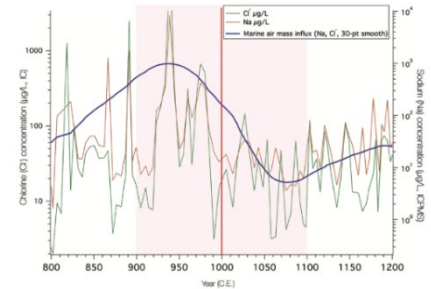


Fig. 5 - Decrease in sodium (Na) and chlorine (Cl) around the year 1000 C.E. in the Colle Gnifetti record (European Alps, Monte Rosa, 4450 meters above sea level). The pink shaded area represents the approximate boundaries of the Medieval Climate Anomaly and a red line marks the year 1000 C.E.

Decrease in sodium and chlorine, ca. 1000 CE

Teaching with research: SoHP's educational mission

In 2021, a total of 282 Harvard undergraduates participated in a broad array of SoHP courses. Our students engaged with the world-class collections of artifacts in Harvard's museums, and studied art, economics, human evolutionary biology, psychology and religion alongside archaeology and history. Dan Smail's *Deep History* exposed students to the tens of thousands of years of human existence prior to the beginning of "history" 6000 years ago, where the evidence of archaeoscience is paramount. Other SoHP courses ranged from Peter Huyber's *Paleoclimate as Prologue* and *Human Environmental Data Science: Agriculture, Conflict, and Health* (Department of Environmental and Planetary Science), to Jason Ur's *Ancient Landscapes* and *Can We Know Our Past?* and Christina Warinner's *Osteoarchaeology* (Department of Anthropology/Archaeology). Additionally,



Hands-on Roman Pottery, HU Ceramics

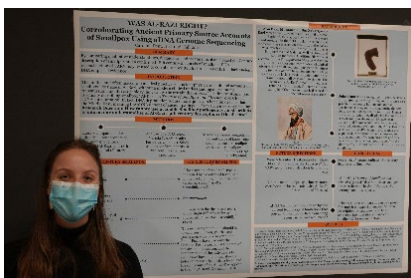
History/SoHP grad student Henry Gruber taught the new course *How Empires Fall* in Spring 2021, which focused on SoHP-relevant questions and investigations such as the impact of pandemic disease and so-called earthquake storms on empires throughout history (Hittite, Roman, Aztec).

This fall, Michael McCormick revised his *The New Science of the Human Past*. 27 undergraduates were exposed to the entire array of SoHP archaeoscience; highlights were field trips to the University's Arnold Arboretum to study tree rings' climate signals; hands-on experimental archaeology making "Roman" pottery, guided by the artists of the



Dendrochronology at Arboretum

University's Ceramics Studio; first-hand experience with Roman coins, and visits into the storerooms of Harvard's Museum of the Ancient Near East. The course culminated in student presentations of their scientific posters highlighting global archaeoscientific research ranging from medieval climate change to antique ceramic analysis to Neanderthal genetics via a proposal for computationally deciphering the unknown Minoan Bronze Age



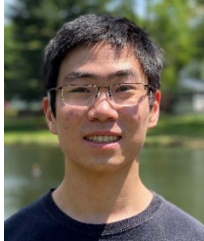
Final Poster Presentation

Linear A language. A number of these undergraduates plan to continue studying with McCormick in a specially-designed spring seminar, given their academic caliber and enthusiasm for the subject.

McCormick also taught a graduate seminar which compared more traditional archaeological surface survey techniques with the results of geomagnetics, in order to understand the relationship between what is above and below the ground. The course drew on methodological advances in the summer campaign at Visigothic Reccopolis.



Drone LiDAR Scanning Training at Reccopolis



Justin Hu, SHARP

SoHP continued to engage student Research Assistants in increasingly diverse projects (from summer 2020 to the present, 16 undergraduate students have been conducting SoHP research). Over the summer, undergrad Justin Hu ('24) was awarded a SHARP Fellowship for "Mapping the past for a better future: Next-generation research into Past Pandemics, Places, Photography, Philology" with research geared towards SoHP's geodatabase mapping project, *and* with a special, additional focus on utilizing new imaging tools that can reveal astonishing information about where historic photographs were taken and the people who took them. The summer was also highlighted by undergrad Sophia Cho's ('24) creation of a [Story Map](#) on the



Sophia Charles, HCRP

Justinianic Pandemic as witnessed by Bishop Gregory of Tours, and her research for the Harvard College Research Program (HCRP) on the movement of coins in the medieval world, creating a geodatabase of Arab and Byzantine coins in Charlemagne's Europe. Also part of the HCRP, Sophia Charles ('24) used Russian-language historical records to create a new geodatabase of written climate observations from medieval Eastern Europe. A team of students continued environmental research throughout the year for SoHP's MAPS digital humanities project; naturally, the undergrads are listed as authors of datasets for this unique geodatabase.



Sophia Cho, HCRP

People

[SoHP Steering Committee members](#) were active as always in training and research in 2021.

Peter Huybers published [Increased Sea Level Sensitivity to CO₂ Forcing across the Middle Pleistocene Transition from Ice-Albedo and Ice-Volume Nonlinearities](#), as well as [Origins of a Relatively Tight Lower Bound on Anthropogenic Aerosol Radiative Forcing from Bayesian Analysis of Historical Observations](#), and [The influence of decision-making in tree ring-based climate reconstructions](#), among many other articles.



DALME Website

The "Documentary Archaeology of Late Medieval Europe" ([DALME](#)) website, spearheaded by SoHP's Daniel Lord Smail and housed within the Harvard Department of History, continues to grow. The project assembles and synthesizes written evidence about material objects of everyday life with the help of archaeologists, art historians, data scientists, historians, and literary scholars from institutions across the US and Europe.

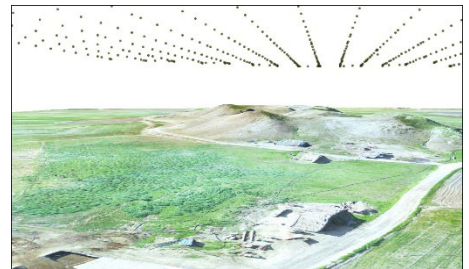
Michael McCormick presented the [New Science of the Human Past](#) to the American Philosophical Society in April, describing SoHP's range of new research approaches from ice cores to digital

humanities via medieval archaeology and migrations, as well as timely archaeogenetic research on pandemics past in order to illuminate pandemics present and future. He also lectured on the new archaeoscience at the University of Vienna and at Indiana University.

In addition to his major contributions to ancient DNA research and publications in conjunction with the Reich Lab, Nick Patterson continued to refine [admixture graphs used to represent relationships between population groups](#) and to [assess population admixture tools such as qpAdm](#). He also contributed to [“A unified genealogy of modern and ancient genomes,”](#) and towards the [effort to investigate the origins of COVID-19](#).

David Reich won the 2021 [Massry Prize for Discoveries in the Field of Ancient DNA](#). He also gave the [Simons Foundation lecture](#) on “Ancient DNA and the New Science of the Human Past.” In continued innovation in the field, his research group at the Harvard Medical School Department of Genetics published on [“Combining ancient DNA and radiocarbon dating data to increase chronological accuracy,”](#) among many other articles in prominent journals throughout the course of the year.

Jason Ur published [“The Erbil Plain Archaeological Survey: Preliminary Results, 2012-2020,”](#) which documented seven field seasons investigating settlement and land use from the Neolithic to the present in the Kurdistan Region of Iraq, which includes a large part of the core of the Assyrian Empire. Field methodology combined traditional surface collection with the use of historical aerial and satellite photographs, mobile GIS, and UAV (drone) photogrammetry. He also published research on [“Kish and the Spatial Organization of Cities in Third-Millennium BC Southern Iraq.”](#)



Drone coverage at Girdi Abdulaziz in Kurdistan



Figure 3. Dairy production begins with heating the milk in Mongolia (left) and Switzerland (right). Credit: Björn Reichardt (left) and Matthias Rest (right).

Dairy Production in Mongolia and Switzerland

While on sabbatical from Harvard during fall 2021, Tina Warinner and her group at the Max Planck Institute in Germany focused on the evolution and changing ecology of the oral and gut microbiomes, asking such questions as: *What does it mean for a human diet to be healthy or natural? Why is metabolic disease increasing so rapidly in industrialized societies? Why are some people lactose intolerant and others are not? Where do food microbes come from and are they beneficial? How did humans come to have one of the most diverse diets of any species on earth?* In addition to already-noted MHAAM publications, Prof. Warinner’s work on [“Cultures of Fermentation: Living with Microbes”](#) and [“Enduring Cycles: Documenting Dairying in Mongolia and the Alps”](#) exemplify her truly unique approach as well as her passion for global dairy production practices. In June, Tina gave the concluding keynote talk at the 9th International Symposium on Biomolecular Archaeology.

Projects

An ease in the pandemic this summer allowed the return to active excavations at the Visigothic royal capital of Reccopolis (Spain) along with SoHP’s collaborative partners at the Universidad de Alcalá de Henares (Spain) and the German Institute of Archaeology (DAI).



Reccopolis Team surveys above the Tagus River

Harvard graduate students Claire Adams, Henry Gruber, Reed Morgan and Elena Shadrina, along with MAPS Managing Editor Santiago Pardo Sánchez (Harvard College '16), worked alongside McCormick, noted Spanish archaeologist Lauro Olmo Enciso, and a team of technical wizards to recover sedimentary samples, expand instrumental survey and experiment with the newest remote

prospection techniques to reveal clues to this complex medieval urban setting on the cusp of the Visigothic/Islamic transition. This was the largest Harvard team to date, working directly with the high-tech innovation unit of the DAI (Roman-Germanic Commission). A new generation of more sensitive automated geomagnetic sensors, hand- and ATV-driven, allowed geomagnetic surveying of areas inside the city walls



Claire Adams at Reccopolis

hitherto unreachable with earlier apparatuses. This successful summer season brought the discovery of striking new features inside and outside the 44 acres of the city wall.

[Archaeology](#) magazine highlighted the team's work at Reccopolis, explaining "how an unlikely Visigothic city rose in Spain amid the chaotic aftermath of Rome's final collapse."



Santiago Pardo Sánchez: geoprospection

Mapping Past Societies (MAPS) under Managing Editors Santiago Pardo Sánchez (College '16) and Dr. Alexander More (PhD '14) will soon launch its new ArcGIS Online Platform, and has been working behind the scenes to improve the features of this free online digital atlas which serves millions of viewers annually. This year saw progress on completing a combined Oxford-Harvard shipwreck geodatabase from the Bronze Age to the Early Modern period (the largest of its kind), as well as geodatabases of coin finds, and Mediterranean travel.



MAPS Website

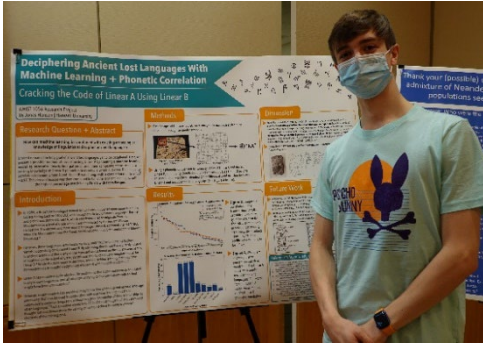


Lindsey Bouldin '23

Undergrads such as Anthropology Concentrator Lindsey Bouldin ('23) along with Isabella Gomez (Mechanical Engineering '24), Noah Dasanaik (Government and Computer Science '22), Charlotte Nickerson (Electrical Engineering '23), Sophia Charles (History and Biophysics '24) and Esteban Gutierrez Alvarez (Government and Classics '23) have worked countless hours during academic terms and summers to enlarge the geodatabases—for example, of climate records—which power the interactive maps and their numerous layers, allowing researchers across the globe, from high school students to professionals, to make new discoveries about archaeology, climate change, science and medicine, linguistics and migration, religious, artistic and economic history.

A final sign of growing awareness of SoHP's impact comes in the attention it has attracted from documentary film makers. While a British group has a film in production that features SoHP's international collaboration with the Universidad de Alcalá and the German Archaeological Institute at the extinct Visigothic royal city of Reccopolis (destined for the History Channel in the U.S.), noted French director Frédérique Wilner is producing a documentary for the Franco-German TV network ARTE about how the scientific discoveries of SoHP and MHAAM are transforming our understanding of the pandemic and climate crisis that swept across a dying Roman Empire in the 500s AD. ARTE's film is scheduled for broadcast on that network in Europe this spring; PBS has ordered an abridged version suitable for U.S. audiences. Stay tuned!

We have been able to achieve so much in difficult times thanks to the resources made available by our generous supporters, particularly the Arcadia Fund of London, Harvard's Faculty of Arts and Sciences, The Richard Lounsbery Foundation, and you, our individual supporters.



HIST 1056: Deciphering Linear A via Data Science!

The SoHP team wishes to convey to you, our supporters and colleagues, our deepest gratitude for your continued interest in the rapidly growing new discipline of the Science of the Human Past, with hopes for a healthy and even better year ahead for us all! We are heartened by the extraordinary work of our students who remain as positive and forward-thinking as ever, and who depend on the interdisciplinary nature of SoHP's unique courses, fellowship and internship opportunities. We—and they—consider this interdisciplinarity essential for a future where all is, truly, linked and where

humanities' greatest stories continue to be revealed, changing history, changing lives, and tirelessly opening new paths of discovery for the next generation. Following on the success of 2021, we wish more of the same to our intrepid students and researchers, and all that they will uncover about our human past in 2022!

On behalf of the whole SoHP team,

Lisa Ransom Lubarr, Coordinator.

SoHP Steering Committee: Thomas Benjamin (HMS Microbiology and Immunobiology, *emeritus*); Joyce Chaplin (History); Edward Hundert (HMS Global Health and Social Medicine); Peter Huybers (Earth and Planetary Sciences); Nick Patterson (Medical and Population Genetics, Broad/Harvard); David Reich (HMS Genetics; Human Evolutionary Biology); Stuart Shieber (Computer Science, SEAS); Daniel Lord Smail (History); Jason Ur (Anthro/Archaeology); Christina Warinner (Anthro/Archaeology); Walter Willett (HSPH Epidemiology and Nutrition); Michael McCormick, Chair (History).