



GUAM  
INANGOKKON  
PRESERVATION  
INADAH! GUAHAN  
TRUST

# GUAM PRESERVATION TRUST

P.O. Box 3036, HAGATÑA, GUAM 96932  
TEL: 671-472-9439/40 FAX: 671-477-2047

## Grant Application

**Submission Date: January 5, 2024**

**Project Title: Marianas DNA Study: Decoding Ancient Lifeways  
and Latte Period Family Trees on Guam**

**Applicant's Name: Dr. Rosalind Hunter-Anderson**

**Applicant's Address:**

**Telephone: (W) \_\_\_\_\_ (Cell) 914-400-6787 (Home) \_\_\_\_\_**

**Email: rozinabq@gmail.com**

**Duration of Project: June 2024 to: June 2025**

**Amount of Request: \$27,150**

**Project Location: Guam, Albuquerque, New Mexico, Boston MA., Vienna,  
Austria**

### Check One

☒ New Proposal

☐ Old Proposal with Changes Date of Previous Submission: \_\_\_\_\_

☐ Old Proposal without Changes Date of Previous Submission: \_\_\_\_\_

### Type of Application (Check One)

☒ New Grant

☐ Continuing Grant

☐ Supplemental Grant

I have made such steps as are necessary to verify the information given in this application package and, to the best of my knowledge and belief, all information is true, correct and accurate:

**Applicant's Signature:** Dr. Rosalind Hunter-Anderson

*\*No funds will be disbursed when the GPT is funding a partial amount for any grant proposal until the applicant has demonstrated with letter of commitment or by other acceptable means, that adequate support, financial or other, has been guaranteed for the project's completion.*

**RECEIVED**

Guam Preservation Trust

JAN 05 2024

**Budget for Marianas DNA Study: Decoding Ancient Lifeways and Latte Period Family Trees on Guam**

**Travel**

Estimated airfare	\$	4,360	RT two people ABQ Guam (based on 2024 rates. The 2025 rates may differ.)
Vehicle	\$	350	Rental vehicle on Guam
Other transport	\$	65	
Lodging	\$	1,650	Estimated 8 nights for two people for presentations and meetings on Guam
Food and incidentals	\$	1,000	Estimated 8 days for two people @ \$59/per day per person plus 2 travel days at \$39/per person per day per federal per diem rates
<b>Total Travel</b>	<b>\$</b>	<b>7,425</b>	

	<i>In-kind</i>	<b>Cost</b>
<b>DNA Sample Processing Pinhasi Lab</b>	<i>In-kind</i>	
<b>DNA Analysis Reich Lab</b>	<i>In-kind</i>	
<b>Presentation Development</b>		
Data analysis Eakin	<i>In-kind</i>	
Composition Eakin		\$ 2,000
Data analysis Hunter-Anderson	<i>In-kind</i>	
Composition Hunter-Anderson		\$ 2,000
<b>Presentations</b>		
PR and venue organization Eakin		\$ 500
PR and venue organization Hunter-Anderson		\$ 500
Estimated facilities fees		\$ 300
Interviews Eakin and Hunter-Anderson	<i>In-kind</i>	
Presentations n = 2 Eakin		\$ 1,000
Presentations n = 2 Hunter-Anderson		\$ 1,000
<b>Video Development</b>		
Video development, compilation, editing Eakin		\$ 2,500
Video development, compilation, editing Hunter-Anderson		\$ 2,500
<b>Curriculum Development Consultations on Guam and remotely</b>		
Consultations Eakin		\$ 2,500
Consultations Hunter-Anderson		\$ 2,500
<b>Project and budget management and reporting</b>		\$ 500
<b>Presentations, Video, Curriculum Development, and Management Subtotals</b>		<b>\$ 17,800</b>
<b>Travel Subtotal</b>		<b>\$ 7,425</b>
<b>Subtotal</b>		<b>\$ 25,225</b>
<b>NMGRT (7.625)</b>		<b>\$ 1,925</b>
<b>Total</b>		<b>\$ 27,150</b>

**Guam Preservation Trust Grant Application**  
**January 5, 2024**

**1. Introduction and Project Overview**

The project applicant is Rosalind L. Hunter-Anderson, Ph.D.

The project title is “Marianas DNA Study: Decoding Ancient Lifeways and Latte Period Family Trees on Guam.”

Duration of the project is one year, from June 1, 2024, to June 1, 2025.

This proposal is submitted under Guam Preservation Trust’s (GPT) Five Year Strategic Plan 2023-2027 for Fiscal Years 2024-2025 under the following grant programs:

- II. Public Interpretation and Presentation  
Publication of information regarding historic resources and their associations and  
Education tools to assist educators in presenting lessons directly related to historic properties.  
and
- VII. Archaeological Research  
Original research that addresses topics of outstanding general significance and that is well  
designed and focuses on tests of specific, well-framed research questions. Such research should  
expand existing knowledge and be of strategic importance for interpreting aspects of prehistoric  
or historic culture and society.

**Project Goals**

Our primary project goal is to enhance the public understanding of Guam's complex prehistoric past, using some of the most advanced technologies available in archaeology: ancient DNA (aDNA) analysis, radiocarbon dating, and stable isotope analysis. These tools have revealed details about Chamorro origins, ancient lifeways, family relationships, and customary practices. In addition to sharing these results with international scholars, we recognize our responsibility to make them accessible to Guam's community of teachers and learners.

**Project Objective**

Our primary project objective is to create educational products that will effectively convey the new information that has emerged about Chamorro cultural and biological heritage, in collaboration with local scholars and educators.

**Expected Outcome of the Project**

Our previous experience in presenting our results showed that aDNA analysis is of great interest locally, in part because it confirms the deep genetic heritage and cultural connections with ancient ancestors who have lived in the Marianas for thousands of years. These connections are indicated archaeologically, as well. To interpret and disseminate project results to the public, we collaborate with

our research colleagues to produce scientific reports for publication. This project will also involve collaboration with local scholars and educators to convey project results in innovative, Guam-oriented ways.

#### Project Location

Project activities will take place in Guam, with aDNA analysis conducted in Boston, MA and Vienna, Austria, radiocarbon dating and stable isotope analysis at Pennsylvania State University, and data integration and product design in Albuquerque, NM.

#### Introduction of the Proposed Project

Dr. Hunter-Anderson, archaeologist, and Joanne Eakin, osteologist, previously led an effort to collect and analyze aDNA from the Naton Beach skeletal assemblage. The resulting study compared the two burial populations from the site: the Latte Period, dating to 800 (+/- 300) years ago, and the Unai Period (Pre-Latte), dating to 2,500 (+/-300) years ago. Genomic analysis of the Naton and aDNA samples from other Micronesian islands was published in the journal *Science* in 2022 (attached). This landmark study showed continuity in the practice of matrilocality and the tendency for close relatives to be buried near one another throughout Marianas prehistory. Genetic families in Guam's Unai and Latte populations were identified to first, second, and third-degree relations. Despite differences in mortuary treatment and skeletal morphology between Unai and Latte burial populations, the study revealed a striking genetic continuity across time, confirming that the early Unai people and the later Latte people are ancestral to modern-day Chamorros.

The initial research was instrumental in our ability to reconstruct biological relatedness among Latte Period individuals at Naton Beach with a high level of detail, and even revealed a distant relative in the Naton Beach Latte pedigree among individuals excavated at the Haputo site in northern Guam. However, the geneticists' ability to draw conclusions with statistical significance was hindered by the patchiness of the obtained family trees, i.e., these trees are not completely resolved, and additional sampling was required to fully characterize them.

To that end, in 2023, we collected 33 additional Latte Period aDNA samples from the Naton collection housed at the Guam Museum, so that a more intensive analysis can be conducted to determine familial relatedness of Naton individuals. In collaboration with Kleinfelder, Inc. archaeologists during their J001B project US Marine Corps Base Camp Blas, we collected 11 samples for aDNA analysis, the first samples retrieved so far from a Guam inland burial population. These samples will provide valuable information that will expand the data base of Chamorro genetic ancestry and enable comparisons of Latte Period populations occupying the northern plateau with their contemporaries occupying coastal villages.

All samples yielding aDNA will be radiocarbon-dated, and the ratios of each individual's stable isotopes of <sup>15</sup>N (nitrogen) and <sup>13</sup>C (carbon) determined as part of the radiocarbon dating process. Stable isotope ratios indicate relative dependence on terrestrial- and marine-sourced foods, helping to characterize ancient diets at the group level. We anticipate the possibility that the inland people may have consumed a higher proportion of land foods compared with coastal groups at Naton and Haputo. Analysis of the

Camp Blas samples may find differences in diet between these inland people and those living on the coasts.

## **2. Need for Assistance**

We are requesting funding to support travel, consultations with local scholars and educators to address curriculum development, video development, preparation of in-person presentations of our project results. Our scientific collaborators, Drs. David Reich, Harvard Medical School, and Ron Pinhasi, University of Vienna, are specialists in aDNA analysis. As in previous collaborations, these world-renown geneticists have offered their expertise at no cost to this project. This level of in-kind support can be valued well beyond the cost of this grant. Additional in-kind contributions include the joint efforts of Dr. Hunter-Anderson, Ms. Eakin, and Ms. Cacilie Craft of Kleinfelder, Inc. Each provides unique expertise in specifying the appropriate archaeological and osteological contexts for interpreting the project results.

### **Long-Range Goals**

The Marianas DNA research thus far has identified five prehistoric migration streams into Micronesia and shown that the genetic heritage of present-day Chamorro directly connects them with the first human groups to enter Remote Oceania from Island Southeast Asia over 3300 years ago. The study revealed a remarkable biological continuity over millennia of cultural changes. However, the geographic range of variation in genetic heritage in Micronesia was not fully represented in our initial study. Because more ancient DNA samples were needed to better characterize the region's complex population history, in 2023 we collected aDNA samples from Palau, Guam, and the CNMI.

In Palau we collected thirty-seven samples from four sites, including two burial caves, which are likely representative of the earliest occupants. The previous study had shown that between 2400 and 1700 years ago, a 15% genetic admixture from Palau had occurred in the Marianas. The timing of this admixture falls within the Huyong Period, when Mariana Island interiors were first occupied, and the earliest known rock art on Guam, the Mahlac Cave site, was created.

On Guam, we collected additional samples from Latte Period people from the Naton Beach site. The purpose of the additional sampling was to conduct more intensive analysis and to determine the degrees of relatedness of individuals buried there. We also collected samples from individuals excavated at Camp Blas on the northern plateau. Analysis of these inland samples could reveal patterns of relatedness and social interactions among different ancient communities on Guam, helping to demonstrate the enormous potential of ancient DNA to illuminate Guam's prehistoric past within an archaeological context.

In addition, we collected 260 samples from skeletal remains housed at the CNMI historic preservation offices on Saipan, Tinian, and Rota. By analyzing additional aDNA from the CNMI individuals, we expect to describe in greater detail the migration patterns and biological relationships among the people who were once traders and later settled in the Marianas.

All these recently collected samples are currently undergoing processing and analysis by our research

colleagues in Vienna and Boston. The results, expected in early to mid-2024, will significantly expand the genetic database and allow researchers to more clearly define ancient migration patterns and biological relationships throughout the Remote Pacific and nearby regions.

Our long-range goals include incorporating the old and new data into comprehensive, archaeologically meaningful publications, public presentations, and educational products. Findings directly pertaining to Guam's prehistory will be highlighted in our local community presentations and video and included in our curriculum development efforts. Funding for publication and presentations pertaining to neighboring islands is being sought elsewhere.

### **3. Project Approach**

Upon completion of the genetic data analysis, expected in mid-2024, we will work with our research colleagues to produce at least one major scientific report for publication. We will incorporate the results into a PowerPoint presentation designed for local audiences at the University of Guam, the Guam Museum, or other community venues. Based on that presentation, we will develop a video for general distribution, on Guampedia, and the GPT website.

We will meet with Guam educators to brainstorm development of lesson plans such as those featured in the Teaching with Historic Places project. The initial meeting(s) can be scheduled during the week of our public presentations. Subsequent curriculum development efforts can be carried out via remote communications. We will seek guidance from GPT regarding scheduling the meetings and curriculum development.

For previous presentations conducted in person on Guam and in the CNMI, Dr. Hunter-Anderson and Ms. Eakin coordinated with local authorities with jurisdiction over the presentation venues, and we notified and conducted interviews with the press (radio, newspapers, and online news organization). For this project, we will provide our own public relations coordination, as well.

### **4. Organizational Capacity**

Applicant organization and cooperating partner organizations

Dr. Hunter-Anderson and Ms. Eakin are independent researchers with many years of experience in Mariana Islands archaeology and osteology. Stakeholders with vested interest in the project's outcome and whose formal permissions were crucial to its implementation include Mr. Patrick Lujan, Guam Historic Preservation Officer, Dr. Michael Bevacqua, Guam Museum Director, and (for Camp Blas) Ms. Carly Antone, Naval Facilities Engineering Command Pacific. Ms. Cacilie Craft of Kleinfelder, Inc., is the principal investigator for the Camp Blas project. Community stakeholders include local archaeologists, historians, educators, and students, many of whom are indigenous to the Mariana Islands.

Applicant organizational structure

Dr. Hunter-Anderson and Ms. Eakin are co-principal investigators for the project.

Project staff biographies and position descriptions

Project research participants and associates are Dr. Rosalind Hunter-Anderson, Pacific archaeologist, and Joanne Eakin, Pacific osteologist. Expertise in aDNA analysis and interpretation will be provided by Dr. David Reich and his technical staff at the Reich Lab at Harvard Medical School and Drs. Ron Pinhasi and Olivia Cheronet and associates at the Pinhasi Lab, Department of Anthropology, University of Vienna. Dr. Hunter-Anderson and Ms. Eakin are coordinating the research in all phases. Ms. Eakin collected the 2023 samples. Dr. Hunter-Anderson and Ms. Eakin will design and produce the local presentations and video and contribute archaeological and osteological expertise to all project reports and publications. Their professional resumes are attached.

Program and fiscal management capacity

Dr. Hunter-Anderson and Ms. Eakin are both veteran archaeology program and project directors skilled in scheduling and coordinating large projects and budgets.

Partnership agreements, letters of commitment, etc.

Agency documents are attached.

## **5. Project Impact and Evaluation**

Expected project impact

The recent study of the Naton Beach site skeletal collections using modern methods of radiocarbon dating, advanced analyses of ancient DNA, and studies of stable isotopes revealed a more detailed picture of Marianas cultural and biological history than had been known before. While confirming direct genetic connections between the oldest and the most recent prehistoric occupants of Naton Beach and modern Chamorros, new questions have emerged from that analysis which we will address during the current project. For example, why was the site unoccupied for nearly 1500 years between the older Unai population and the Latte population? Archaeologists call this little-known period the Huyong, marked by a settlement expansion into upland, interior habitats used for small gardens and managed forests for tree fruits and building materials. What happened during that multi-century occupation gap at Naton, and is it found elsewhere in Tumon and in Guam generally? Did new people arriving complicate the subsistence system? Or did the local population increase and thus require more food to be produced?

This phase of our project promises to investigate these and other intriguing questions. We expect to derive important new information about the Huyong Period cultural systems from the analysis of aDNA from Naton and Camp Blas as we continue to build our contextual knowledge of ancient Chamorro land use, settlement patterns, and community interactions.

Evaluation and monitoring process

Chains of custody will be maintained for all aDNA samples, and complete lists of the samples by site and burial number were provided to the Guam State Historic Preservation Office prior to their removal from Guam for laboratory study. These lists will serve as a check on the number of samples when they are returned. As in previous projects, the samples collected during this project were transported to Dr. Pinhasi's lab for sample preparation, where a very small amount of powder (50 mg) was drilled from

each tooth or petrous bone using precise and delicate procedures that minimize damage to the original sample. They will be retained in Dr. Pinhasi's lab in Vienna and returned to Guam when the project is finished. The powders have been sent to Dr. Reich's lab, where he oversees their sequencing, library preparation, statistical analyses, testing, and interpretation. All samples yielding aDNA will be dated by AMS (Accelerator Mass Spectrometry) at the Radiocarbon Dating Laboratory at the Pennsylvania State University.

We will devise a schedule for curriculum development during our initial meeting with educators. Remote meetings, drafts, reviews, and final product completion will be scheduled over a period of six months.

We provide periodic updates on the progress of the analysis of our samples at the Reich lab to the Guam Historic Preservation Office, the Guam Museum, and Kleinfelder, Inc. (who coordinates with NAVFAC PAC). Proposed publications resulting from the research will be available for review by the Historic Preservation Officer. These communications will be provided to GPT, as well, along with timely interim progress and financial reports (usually quarterly). A complete final and narrative report will be submitted sixty (60) days after the project's completion.





January 15, 2023

Carly Antone  
Archaeologist  
Naval Facilities Engineering Command Pacific  
carly.r.antone.civ@us.navy.mil

**SUBJECT: Permission to Collect Samples from Human Skeletal Remains from the J001B Project for the Purpose of Ancient DNA Study.**

Håfa adai Ms. Antone,

This memorandum is a formal request to conduct limited DNA sampling from in situ skeletons at the J001B project location (i.e., Marine Corps Base Camp Blas) and from the J001B project skeletal assemblage currently housed at Kleinfelder's Tumon, Guam office. This study will provide important data for a comparison of Latte Period populations occupying the northern plateau with each other and with their contemporaries occupying predominately seaside villages.

Cacilie Craft is Principal Investigator (PI) for the J001B archaeological investigations. Joanne Eakin and Dr. Rosalind Hunter-Anderson will be co-PIs for the DNA Research. Ms. Eakin, Senior Osteologist, will oversee and conduct sample collection. Dr. David Reich, Harvard Medical School, and Dr. Ron Pinhasi, University of Vienna, specialists in ancient DNA analysis, have offered to apply their expertise to Latte Period skeletal collections *at no cost*.

### **Background**

There are currently thirteen (13) in situ human burial features (some with multiple internments) within "Construction Area D" at the J001B project location. This area is otherwise known as Sabânan Fadang and has provided evidence of substantial Latte Period land use and occupation previously unexpected for the northern plateau of Guam. In addition to in situ burials, many comingled and fragmented human skeletal remains, collected during J001B archaeological investigations, are temporarily housed at Kleinfelder's Tumon, Guam laboratory.

Previously, Ms. Eakin and Dr. Hunter-Anderson led a study that compared the ancient DNA of two burial populations from the Naton Beach site on Guam: the Latte Period, dating to 800 (+/-300) years ago, and the Unai Period (Pre-Latte), dating to 2,500 (+/-300) years ago. The genomic analysis showed continuities in the practices of matrilocality and the tendency for close relatives to be buried near one another. Genetic families in the Unai and Latte populations identified first, second, and third-degree relatives. While differences in mortuary treatment and morphology between Unai and Latte burial populations had been noted, the study revealed a striking genetic continuity across time: the early Unai people were directly ancestral to the Latte population, and the Latte population was directly ancestral to the modern CHamoru inhabitants of Micronesia.

The Naton samples were also used in a larger study of Micronesian population origins that compared ancient and modern DNA samples came from Guam, Saipan, Chuuk, Pohnpei, and Palau and identified five migration streams into Micronesia. The results were published in the journal Science in July 2022.

### **Methods**

Ms. Eakin will select petrous bone samples, which have proven to be the most reliable for yielding DNA. A description of the procedure for processing cochlea powder for DNA study is attached. If petrous bones are unavailable, dentition will be selected. A complete list of samples by burial number will be compiled and submitted to the Navy and the Guam Historic Preservation Office prior to removal of samples from Guam. The samples will be transported to Dr. Pinhasi's laboratory and powder will be drilled from each cochlea or tooth. Precise and delicate laboratory procedures will minimize damage to the samples. The bones and teeth will be retained in Dr. Pinhasi's lab and returned to Guam when the project is finished. The powders will then be sent to Dr. Reich. He will oversee their sequencing, library preparation, and interpretation. Periodic updates on the progress of the analysis at the Reich lab will be provided. All samples yielding DNA will be radiocarbon dated. Interpretation of the project results would be a joint effort: Ms. Craft's, Ms. Eakin's, and Dr. Hunter-Anderson's contributions will be to provide the appropriate archaeological and osteological contexts, and the paleo-genetic inferences would be the responsibility of Drs. Pinhasi and Reich.

### **Schedule**

We propose conducting the limited sampling of 13 in situ burials of the J001B project human remains in late January 2023. We humbly and respectfully ask you to consider our research request to help us derive more information from these important sites to help build the contextual knowledge of Pre-Contact land use on Guam. If approved, we will initiate the sampling list for review and approval.

Saina ma'åse,

Cacilie Craft  
Principal Investigator

and

Joanne Eakin  
Senior Osteologist

**Kleinfelder, Inc.**  
1221 Kapi'olani Blvd., Suite 201  
Honolulu, HI 96814



joanne eakin &lt;jeeakin@gmail.com&gt;

**Request to conduct research**

3 messages

joanne eakin &lt;jeeakin@gmail.com&gt;

Sun, Jan 29, 2023 at 5:06 AM

To: patrick.lujan@dpr.guam.gov

Cc: Rosalind Hunter-Anderson &lt;rozinabq@gmail.com&gt;, "Reich, David Emil" &lt;reich@genetics.med.harvard.edu&gt;, Ron Pinhasi &lt;ropinhasi@gmail.com&gt;

Dear Patrick,

Attached for your review is our request to conduct additional ancient DNA research and collect samples from the Naton Beach assemblage.

Please do not hesitate to contact me with any questions or concerns.

Kind regards,  
Joanne **Request to conduct research.pdf**  
73K

Patrick Lujan &lt;patrick.lujan@dpr.guam.gov&gt;

Thu, Feb 2, 2023 at 4:11 PM

To: joanne eakin &lt;jeeakin@gmail.com&gt;

Hafa adai Joanne,

Let's proceed with this.

v/r,  
patrick

[Quoted text hidden]

--

**Patrick Q. Lujan**  
**State Historic Preservation Officer**  
Department of Parks & Recreation  
*Depattamenton Plaset yan Dibuetsion*  
Government of Guam  
P.O. Box 2950, Hagatna, Guam 96932  
Tele: (671) 475-6337 ~ Fax: (671) 477-2822

joanne eakin &lt;jeeakin@gmail.com&gt;

Thu, Feb 2, 2023 at 4:42 PM

To: Patrick Lujan &lt;patrick.lujan@dpr.guam.gov&gt;

That's great news, Patrick. Thank you. I'll include you on all relevant communications going forward.

Joanne  
[Quoted text hidden]

## HUMAN GENOMICS

# Ancient DNA reveals five streams of migration into Micronesia and matrilocality in early Pacific seafarers

Yue-Chen Liu<sup>1,2\*</sup>, Rosalind Hunter-Anderson<sup>3\*</sup>, Olivia Cheronet<sup>4</sup>, Joanne Eakin<sup>5</sup>, Frank Camacho<sup>6</sup>, Michael Pietrusewsky<sup>7</sup>, Nadin Rohland<sup>1,8</sup>, Alexander Ioannidis<sup>9,10</sup>, J. Stephen Athens<sup>11</sup>, Michele Toomay Douglas<sup>11</sup>, Rona Michi Ikehara-Quebral<sup>11</sup>, Rebecca Bernardos<sup>1</sup>, Brendan J. Culleton<sup>12</sup>, Matthew Mah<sup>1,8,13</sup>, Nicole Adamski<sup>1,13</sup>, Nasreen Broomandkoshbacht<sup>1,13</sup>, Kimberly Callan<sup>1,13</sup>, Ann Marie Lawson<sup>1,13</sup>, Kirsten Mandl<sup>4</sup>, Megan Michej<sup>1,13</sup>, Jonas Oppenheimer<sup>1,13</sup>, Kristin Stewardson<sup>1,13</sup>, Fatma Zalzal<sup>1,13</sup>, Kenneth Kidd<sup>14</sup>, Judith Kidd<sup>14</sup>, Theodore G. Schurr<sup>15</sup>, Kathryn Auckland<sup>16</sup>, Adrian V. S. Hill<sup>16,17</sup>, Alexander J. Mentzer<sup>16,18</sup>, Consuelo D. Quinto-Cortés<sup>19</sup>, Kathryn Robson<sup>20</sup>, Douglas J. Kennett<sup>21</sup>, Nick Patterson<sup>2,8</sup>, Carlos D. Bustamante<sup>10,22†</sup>, Andrés Moreno-Estrada<sup>19</sup>, Matthew Spriggs<sup>23,24</sup>, Miguel Vilar<sup>25</sup>, Mark Lipson<sup>1,2</sup>, Ron Pinhasi<sup>4,26\*</sup>, David Reich<sup>1,2,8,13\*</sup>

Micronesia began to be peopled earlier than other parts of Remote Oceania, but the origins of its inhabitants remain unclear. We generated genome-wide data from 164 ancient and 112 modern individuals. Analysis reveals five migratory streams into Micronesia. Three are East Asian related, one is Polynesian, and a fifth is a Papuan source related to mainland New Guineans that is different from the New Britain-related Papuan source for southwest Pacific populations but is similarly derived from male migrants ~2500 to 2000 years ago. People of the Mariana Archipelago may derive all of their precolonial ancestry from East Asian sources, making them the only Remote Oceanians without Papuan ancestry. Female-inherited mitochondrial DNA was highly differentiated across early Remote Oceanian communities but homogeneous within, implying matrilocality practices whereby women almost never raised their children in communities different from the ones in which they grew up.

**M**odern humans arrived in Near Oceania at least 47,000 years before present (BP) and spread through Australia, New Guinea, the Bismarck Archipelago, and the Solomon Islands (1, 2). After 3500 to 3300 BP, humans expanded into previously unoccupied Remote Oceania (Fig. 1A).

In the southwest Pacific, the earliest archaeological sites are associated with artifacts of the Lapita complex, appearing in the Bismarck Archipelago as early as ~3350 BP and reaching the unoccupied islands of Remote Oceania by 3000 to 2850 BP (3, 4). Ancient DNA from 11 individuals from Vanuatu and Tonga 3000 to 2500 BP indicates that these pioneers were related distantly to Neolithic southeastern Chinese (5), more closely related to Neolithic and Iron Age people of Taiwan (6), and most closely related to the ancestors of

present-day north-central Philippine groups such as Kankanaey Igorot (7–10). However, the primary ancestry of many southwest Pacific Islanders today is “Papuan” (our term to describe the primary ancestry of peoples of New Guinea, the Bismarck Archipelago, and the Solomon Islands), which genetic data has shown is due to a secondary expansion that began ~2500 BP (7–10).

The first people to reach the Mariana Archipelago arrived around 3500 to 3200 BP (11–14). Their material culture (15) differed markedly from the Lapita assemblages in the southwest Pacific, with Marianas Redware ceramics being more similar to those found at sites in the Philippines and at the northern tip of Sulawesi (16). This study uses a revised chronology for the archaeology of the Mariana Islands that terms the earliest three periods of occupa-

tion from 3500 to 1600 BP “Unai” (table S1). The burials that we analyze date to 2800 to 2200 BP (Middle to Late Unai) and thus may not reflect the ancestry profile of Early Unai inhabitants. After 1100 BP, distinctive megaliths (latte) began to appear in the Mariana Islands, along with other material cultural changes marking the “Latte” period. The oldest evidence of human occupation in Palau in Western Micronesia dates to ~3000 BP (17). The oldest evidence in Central Micronesia is ~2000 BP; ceramics at these sites are similar to late Lapita pottery and shell artifacts and thus could reflect roots in earlier Lapita cultures in either northern New Guinea or in the southwest Pacific (18, 19).

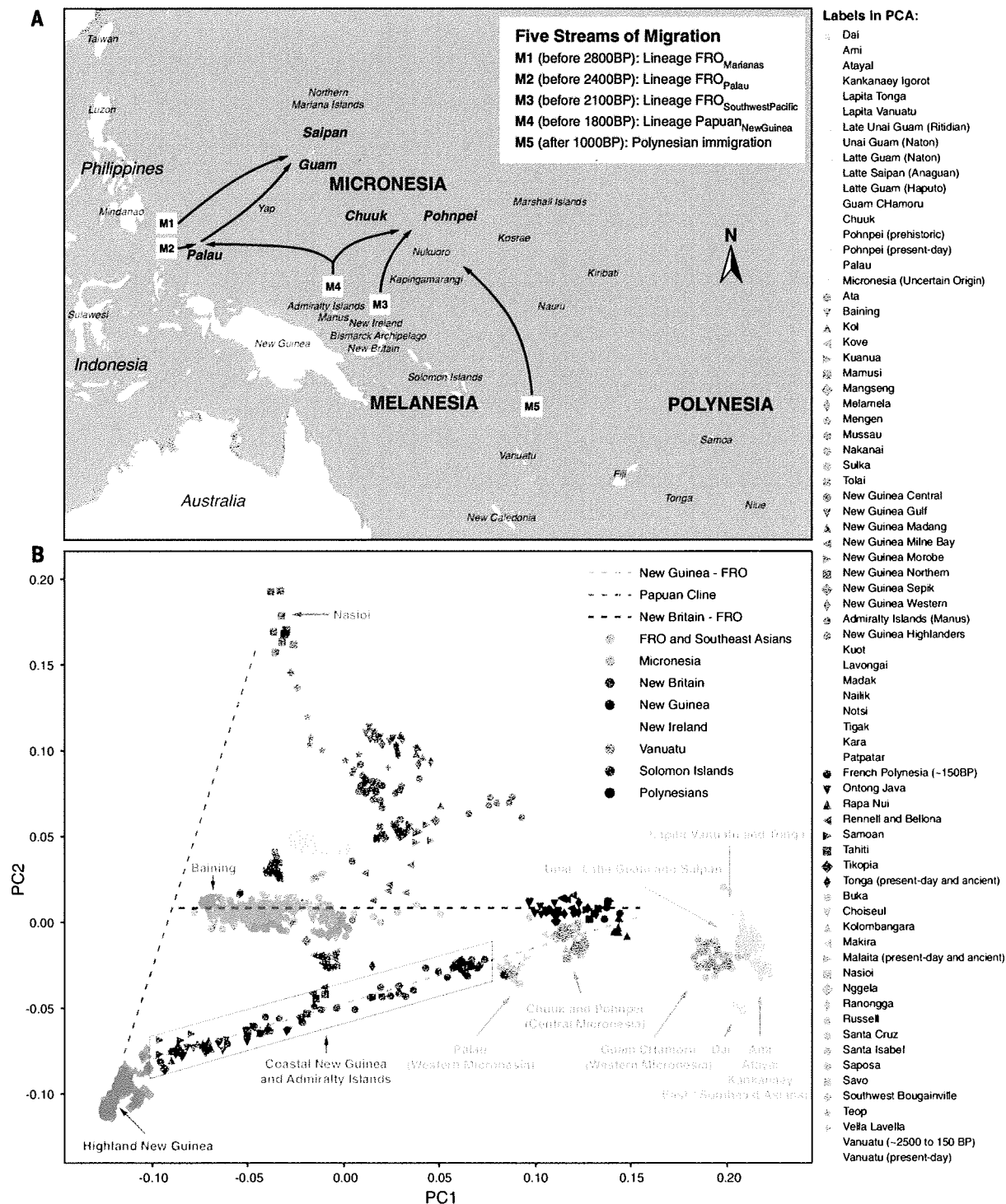
Linguistic relationships among Malayo-Polynesian (MP) languages that comprise all Austronesian languages outside of Taiwan provide an independent source of information about the cultural and geographic origins of Micronesian peoples (fig. S1). The CHamoru (20) language spoken by the indigenous people of the Mariana Islands is a first-order branch within MP; Palauan is another. All other Micronesian languages and languages of the southwest Pacific and Polynesia comprise a third major branch, Central-Eastern Malayo-Polynesian (CEMP) (21–23). Most Micronesian CEMP languages form a Nuclear Micronesian subgroup, which has been hypothesized to have developed somewhere between the Admiralty Islands and Vanuatu and to have spread near the end of the Lapita period ~2500 BP (24). By contrast, Yap’s language is believed to be an early offshoot of Proto-Oceanic derived directly from proto-languages that branched during the Lapita expansion, although Yapese was also subsequently affected by borrowings from other languages (25). The people of Kapingamarangi and Nukuoro atolls in the Caroline Islands speak Polynesian languages, suggesting replacement of the original languages by Polynesian immigration (26, 27).

To test alternative models of population history, we generated genome-wide ancient DNA data for 164 individuals from five archaeological sites and coanalyzed them with published data from two ~2200 BP individuals from

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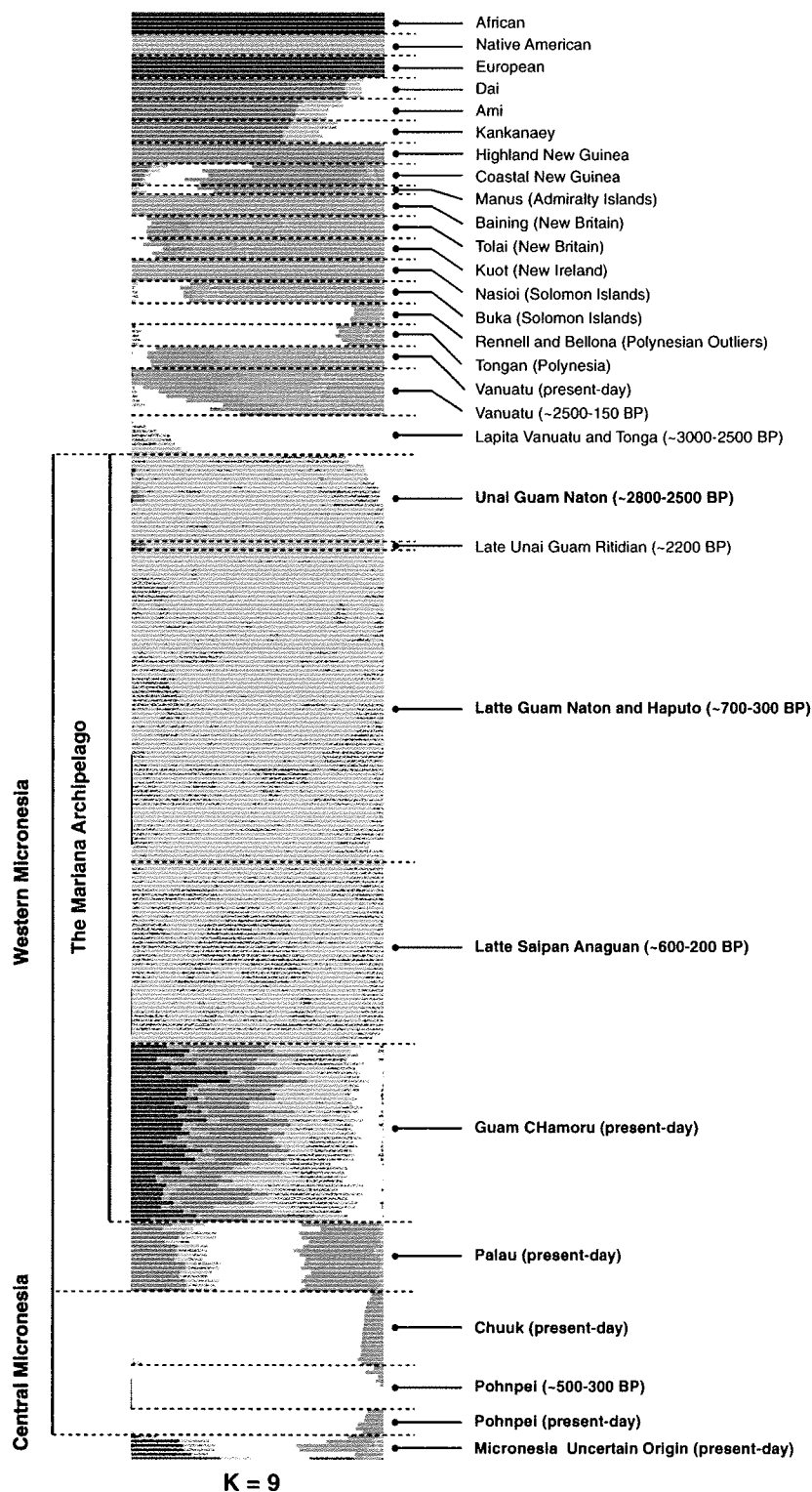


**Fig. 1 Map and PCA. (A)** Map showing five inferred streams of migration into Micronesia. **(B)** PCA results. Axes are computed with Dai, Nasioi, and Papuans; others are projected.

Guam (28). A total of 109 individuals (2800 to 300 BP) were from the Unai and Latte periods in Guam, 46 (600 to 200 BP) from the Latte period in Saipan, and 11 (500 to 300 BP) from Na Island and the nearby Nan Madol site in Pohnpei's protected lagoon in Central Micronesia (20).

We prepared samples in clean rooms, extracted DNA, built sequencing libraries, enriched for a common panel of ~1.2 million single-nucleotide polymorphisms (SNPs), and sequenced them (20). For individuals with evidence of high contamination, we restricted analysis to sequences with evidence of charac-

teristic ancient DNA damage (20). The analyzed individuals had a median of 558,971 SNPs with data (table S2). We also genotyped 112 present-day Micronesians mainly from Guam, Palau, Chuuk, and Pohnpei (tables S3 and S4). We obtained 31 direct radiocarbon dates, 30 of which were on the same samples we analyzed



**Fig. 2. Clustering analysis.** Unsupervised ADMIXTURE ( $K = 9$  clusters). New data are in boldface.

for DNA (tables S5 and S6). We coanalyzed our newly produced data with published data from 95 prehistoric individuals and 1642 present-day individuals from globally diverse populations (table S7).

#### Overview of population structure

We carried out principal components analysis (PCA) (Fig. 1B and figs. S2 and S3) by computing axes using shotgun data of present-day Dai (southern China), Nasioi (Solomon

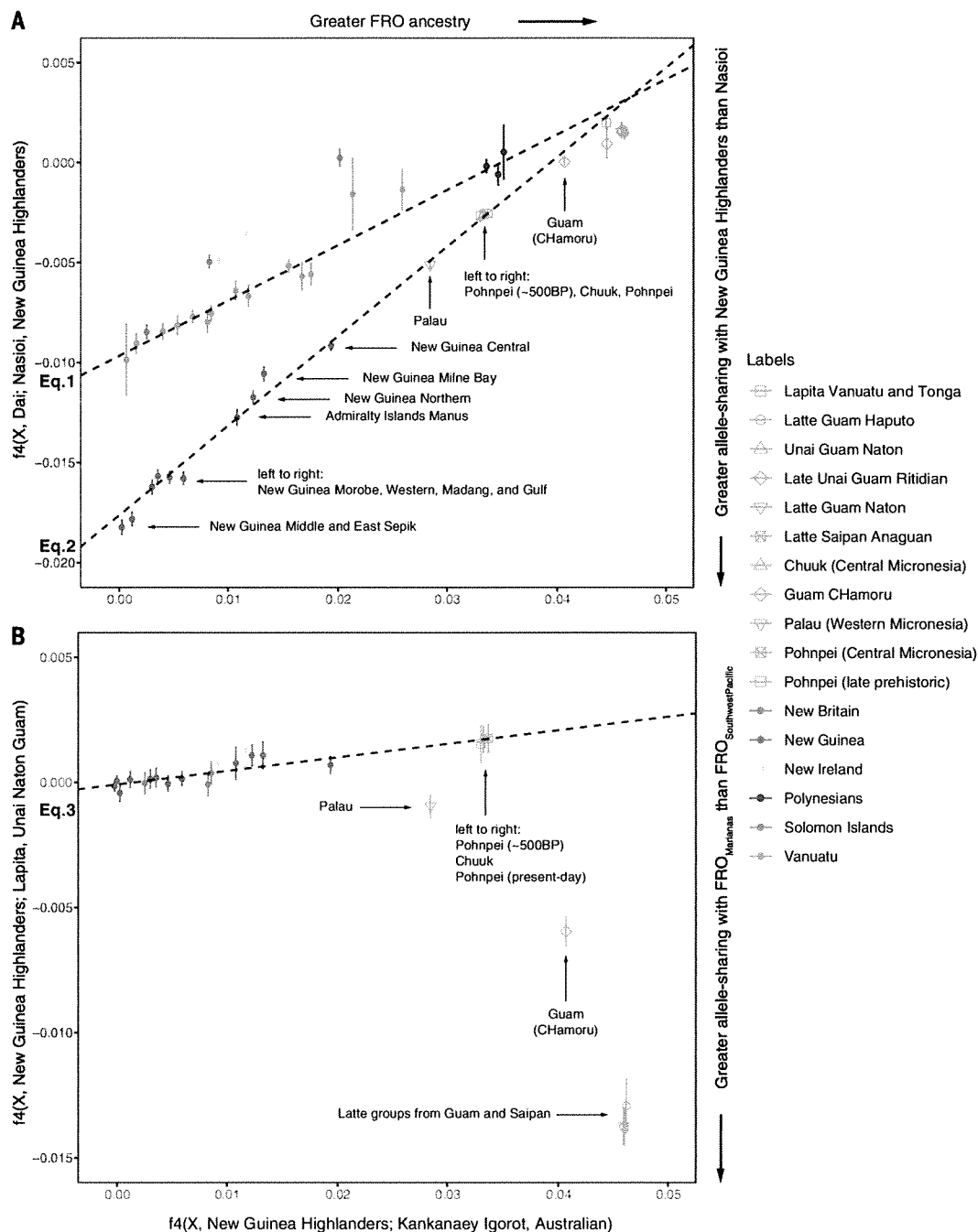
Islands), and New Guineans (from the Eastern Highlands and Middle Sepik areas) and then projecting other individuals. The first principal component (PC) corresponds to the proportion of East Asian-associated ancestry, henceforth “First Remote Oceanian (FRO)” (PC1; lower on left, higher on right); the second PC differentiates Papuan ancestry from the Solomon Islands to New Guinea (PC2; up to down). The Unai, Latte, and Lapita individuals cluster with present-day people from the Philippines (Kankanaey) and Taiwan (Ami and Atayal) on the right, corresponding to high East Asian-associated ancestry. Two clines are visible. The first (dashed blue) links groups with high proportions of FRO ancestry to New Britain, Vanuatu, and Polynesia; the second (dashed gray) links to groups from New Guinea, the Admiralty Islands, Palau, and a genetically homogeneous group of Central Micronesians (Chuuk, Pohnpei, and prehistoric Pohnpei). This suggests admixture in variable proportions between FRO and Papuan ancestry from at least two different sources—more related to New Britain in the first case and New Guinea in the second.  $f_3$ -statistics reveal patterns qualitatively similar to those shown in the PCA (fig. S4 and table S8).

We also computed the symmetry statistic  $f_4$  (X, Kankanaey Igorot; New Guinea Highlanders, Dai) to test which individuals had significant Papuan admixture (using Kankanaey as a baseline with no evidence of Papuan ancestry) (table S9). Unai and Latte individuals had little or no Papuan ancestry; except for four Latte individuals, we observed non-significant Z-tests based on the normally distributed score being  $|Z| < 3$  standard errors from zero. Lapita individuals from Vanuatu and Tonga had a small, but nonzero, proportion of Papuan ancestry (0.4 to 4.4% and 3.3 to 7.7%, respectively) (7–10). Papuan admixture was present in all prehistoric and present-day individuals from Pohnpei (~27%) and all present-day people from Chuuk (~27%) and Palau (~38%). In modern CHamoru, the inferred Papuan ancestry is consistent with zero, making CHamoru the only genetically analyzed indigenous Remote Oceanian group without evidence of such ancestry.

Unsupervised clustering using ADMIXTURE recapitulates the patterns in the PCA and differentiates the FRO components of First Remote Oceanians (we show  $K = 9$  clusters in Fig. 2; see also figs. S5 to S8). Two clusters correspond to East Asian-associated ancestry, with a light gray component maximized in Lapita individuals and a dark gray component maximized in Mariana individuals. Pohnpei and Chuuk in Central Micronesia primarily have a light gray Lapita-associated component. Modern CHamoru of Guam is the population with the highest proportion of dark gray, suggesting local continuity. Palau and Central Micronesia only have the green Papuan-associated

**Fig. 3. Different Papuan and East Asian affinities. (A**

**B)** Test for differential (A) Papuan and (B) FRO affinities using a merge of the 1240K and MEGA data (~169,000 SNPs). Equation 1 (Eq. 1) is computed with all groups from Vanuatu and Polynesians, Eq. 2 with all Micronesian and New Guinea-related groups except those from Guam and Saipan, and Eq. 3 with all present-day groups except Micronesians. We show one standard error in each direction on the y axis. We merged Lapita individuals from Vanuatu and Tonga. See fig. S9 for the same analysis performed on individuals for whom we have ~397,000 SNPs genotyped on a merge of 1240K and Human Origins data.



component maximized in New Guinea, without the orange-blue-green mixture characteristic of New Britain, the southwest Pacific, and Polynesia, suggesting previously undocumented Papuan spreads into Micronesia.

#### Evidence for at least five streams of migration into Micronesia

To determine the minimum number of migration streams into Micronesia needed to explain the data, we computed a statistic  $f_4(X, \text{New Guinea Highlanders; Kankanaey Igorot, Australian})$  proportional to FRO ancestry and

correlated it to statistics sensitive to different types of East Asian and Papuan-associated ancestry (9). We identified at least five distinct migratory streams, as follows.

(M1 to M3) Three streams of FRO migration into Micronesia including a previously unknown lineage. We plotted a statistic measuring affinity to the two previously identified (7, 28) lineages FRO<sub>SouthwestPacific</sub> and FRO<sub>Marianas</sub>, specifically,  $f_4(X, \text{New Guinea Highlanders; Lapita, Unai})$  against our statistic measuring overall FRO ancestry proportion. All populations from the southwest Pacific and Polynesia

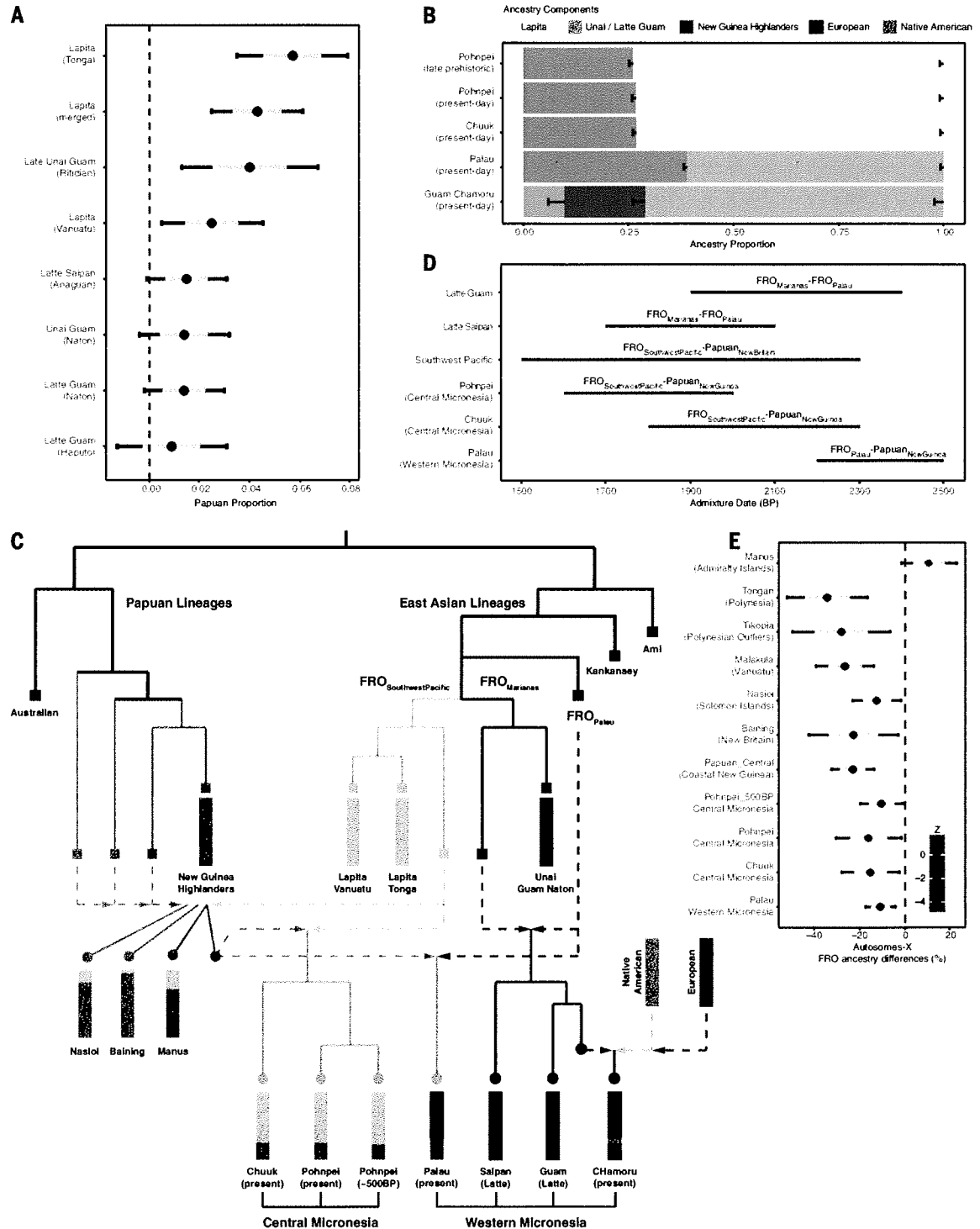
fall on a line with a positive slope, implying closer affinity to Lapita than to Unai consistent with the Lapita-associated lineage being the source of their East Asian-associated ancestry (all residuals  $|Z| < 2$  after regression; Fig. 3B and fig. S9B). Individuals from Central Micronesia (Pohnpei and Chuuk, and some other present-day Micronesians) also closely track the line (all residuals  $|Z| < 2$ ), suggesting FRO ancestry from the Lapita expansion. By contrast, present-day individuals from Palau and the Mariana Islands yield negative  $f_4$ -statistics (all residuals  $|Z| > 4$ ), implying FRO

**Fig. 4. Quantification of admixture events.**

**(A)** Proportions of Papuan ancestry in FRO and Latte groups. Thick and thin error bars show one standard error and 95% confidence interval, respectively.

**(B)** Ancestry proportions from *qpAdm*. Each group is represented by a horizontal bar and partitioned into colored segments, representing different sources of their ancestry. Error bars show one standard error.

**(C)** Admixture graphs. Arrow pairs (head to head) denote admixture events. The heights of the colored bars give mixture proportions. **(D)** Date of admixture. Ranges show one standard error in each direction. **(E)** Difference between FRO ancestry estimates on the autosomes and the X chromosome.



sources less closely related to the Lapita individuals (tables S12 and S13). We confirmed with  $f_4$ -symmetry statistics that all the pre-historic Remote Oceanian groups with nearly entirely East Asian-associated ancestry (Lapita, Unai, and Latte) descended from a common ancestral FRO population (table S22), which split earlier from the ancestors of indigenous

and Iron Age Taiwanese and even earlier from those of Kankanaey Igorot. A surprise is that despite the fact that the Latte and Unai individuals share more alleles with each other than either group does with Lapita, there is not a simple tree relating these three groups, with the statistic  $f_4$ (Latte, Unai; Lapita, diverse East Asians) yielding many significant

negative Z values (maximum  $|Z| > 4$ ; table S26). This suggests that the Latte individuals harbor remote admixture from a basal FRO lineage, which split from the lineages ancestral to Unai and Lapita before they separated from each other, a scenario that fits the data in explicit admixture graph modeling (Fig. 4C and figs. S12 to S15). We call this third lineage FRO<sub>Palau</sub>



because the proportion of this lineage is maximized in modern Palauans (where we estimate that it contributes 62% ancestry versus 15% in Latte individuals) (fig. S13A).

(M4) A previously unknown stream of Papuan migration into Micronesia. We computed  $f_4(X, \text{Dai}; \text{Nasioi}, \text{New Guinea Highlanders})$ , where the latter two populations are differentiated Papuan groups, and plotted it against our statistic measuring FRO proportion. Modern and prehistoric groups from the southwest Pacific and Polynesia fall on a line that also includes New Britain (all residuals  $|Z| < 2$ ; Fig. 3A and fig. S9A), consistent with ancestry from a New Britain-associated source we call Papuan<sub>NewBritain</sub> (8–10). By contrast, all prehistoric and present-day individuals from Micronesia with evidence of Papuan ancestry fall below the line (all residuals  $|Z| > 4$ ), mirroring the two-cline pattern in the PCA (tables S10 and S11). When we fit a separate line for Micronesians, New Guinea, and the Admiralty Islands, we observe no outliers with  $|Z| < 2$ , consistent with a previously unknown spread of Papuan ancestry from a lineage Papuan<sub>NewGuinea</sub> more closely related to New Guinea and the Admiralty Islands on its northern fringe.

(M5) Polynesian gene flow into Micronesia. We computed  $f_4(X, \text{Tolai}; \text{Kankanaey Igorot}, \text{diverse Polynesians})$  (tables S14 to S20), and plotted it against our  $f_4$ -statistic proportional to FRO ancestry (figs. S10 and S11), a procedure that provides a sensitive test of Polynesian-specific admixture. Late prehistoric individuals from Pohnpei closely track the baseline, providing no evidence of Polynesian admixture. One present-day Micronesian (Jk2812) deviates from the line (maximum  $|Z| = 3.3$ ) (table S21). We do not have a record of the island from which this individual came, so characterization of the Polynesian impact on Micronesia will require further sampling.

#### A working model for Micronesian population history

We started with a model previously used to study southwest Pacific lineages (8, 9) and then added lineages and admixture events, testing alternative models for fit (Fig. 4C and figs. S12 to S15). With so many populations, the space of possible admixture graph topologies is vast, and the topology we show is unlikely to be the only fit to the  $f$ -statistics. Nevertheless, identifying an admixture graph model is useful to demonstrate that all the features described in our analysis of individual  $f$ -statistics can jointly fit the data. We confirmed key inferences about admixture proportions and closest phylogenetic relatives of analyzed groups using *qpWave* and *qpAdm* (tables S22 to S25), which does not require making specific assumptions about deep phylogenetic relationships and allows us to test whether there are any groups that harbor genetic drift that is not present in the popu-

lations used as proxies for their ancestry (20). Finally, we used admixture linkage disequilibrium to estimate the ages of some detected admixture events with the software DATES (Fig. 4D and table S27).

(i) The Mariana Islands: Distinctive FRO ancestry without Papuan admixture. The Unai individuals from Guam whose radiocarbon dates range from 2800 to 2200 BP derive from the FRO<sub>Marianas</sub> lineage (M1) and have homogeneous ancestry. Later Latte individuals from Guam and Saipan after 700 BP derive ~85% of their ancestry from the same source (fig. S13A), with substantial continuity also confirmed by their harboring the same mitochondrial haplogroups E1 and E2 that are seen in the Unai period. The Latte individuals also derived ~15% ancestry from a previously unidentified FRO<sub>Palau</sub> lineage (M2), which we estimate mixed with FRO<sub>Marianas</sub> 45 to 50 generations before the Latte individuals lived (2400 to 1700 BP, assuming 28 years per generation). The admixture date shows that this migration and mixture process cannot be invoked to explain the origin of the Latte archaeological phenomenon in the Mariana Islands, which began much later at ~1100 BP.

The modern CHamoru from Guam are admixed with European (~19%) and Native American (~9%) ancestry (Fig. 4B), plausibly associated with Spanish colonial activities from the mid-16th century onward (29). Their remaining ancestry is entirely FRO. Although our analyses of modern CHamoru did not allow us to unambiguously determine their FRO source, they show a greater genetic affinity to FRO<sub>Marianas</sub> than to FRO<sub>SouthwestPacific</sub> (Fig. 3B), and their mitochondrial haplogroups E1 and E2 are also found in the Unai and Latte individuals, suggesting that they derived much of their East Asian-associated ancestry from earlier groups in Guam.

(ii) Palau: Mixture of FRO<sub>Palau</sub> and Papuan<sub>NewGuinea</sub> ancestry. Present-day Palauans are inferred to have ~62% FRO<sub>Palau</sub> ancestry (M2) from the same lineage that admixed in a smaller proportion into the Latte individuals (fig. S13A) and ~38% Papuan<sub>NewGuinea</sub> ancestry (M4). We estimate the date of FRO<sub>Palau</sub>-Papuan<sub>NewGuinea</sub> admixture to be ~2500 to 2200 BP, suggesting the possibility of Papuan migration into this region by this time.

(iii) Central Micronesia: Mixture of FRO<sub>SouthwestPacific</sub> and Papuan<sub>NewGuinea</sub>. We infer genetic homogeneity in central Micronesia over space and time, with Pohnpei and Chuuk having similar proportions of ~73% FRO<sub>SouthwestPacific</sub> (M3) and ~27% Papuan<sub>NewGuinea</sub> ancestry (M4) and forming a clade with the 11 individuals from prehistoric Pohnpei (Fig. 4B). FRO<sub>SouthwestPacific</sub> is a better single-source proxy for the primary First Remote Oceanian ancestry in Central Micronesia than FRO<sub>Marianas</sub>, but an entirely FRO<sub>SouthwestPacific</sub>

source fails in *qpAdm* when Unai and Latte are included as outgroups, suggesting that both FRO<sub>SouthwestPacific</sub> and FRO<sub>Marianas</sub> contributed. These findings also illuminate the origins of Nuclear Micronesian languages. Central Micronesians lack the Papuan ancestry that is predominant in the Solomon Islands, providing evidence against one of the three main candidate geographic regions (24). They also lack the Papuan<sub>NewBritain</sub> signature that was ubiquitous in Vanuatu by the time of the peopling of Central Micronesia, providing evidence against another candidate region. Instead, *qpAdm* shows that the people of Manus are a better proximate source for the Papuan<sub>NewGuinea</sub> ancestry than those of mainland New Guinea (table S24), increasing the likelihood of the third candidate—the Admiralty Islands—as the source for these languages and for the stream of migration that brought them. This should not be interpreted as implying that people specifically from Manus Island were the true source, but rather that the source was probably a genetically similar population from the Admiralty Islands or a coastal region along the northern fringe of mainland New Guinea.

We infer dates of FRO<sub>SouthwestPacific</sub>-Papuan<sub>NewGuinea</sub> mixture in Chuuk and Pohnpei of 2100 to 1800 BP, showing that these lineages came into contact at least by the time of the peopling of Central Micronesia around 2000 BP and raising the possibility that the M3 and M4 lineage expansions into Central Micronesia came as part of an already mixed stream of people speaking early Nuclear Micronesian. An alternative, however, would accommodate a different perspective on the origins of Nuclear Micronesian languages, allowing M3 to have come from a FRO<sub>SouthwestPacific</sub> group that spoke a Southeast Solomonian language (30), to be joined later by an M4 Papuan-Admiralties group that did not displace already established Nuclear Micronesian languages. Such a scenario of language continuity despite population replacement would parallel the situation posited for Vanuatu (8, 9). We do not yet have data from Yap but, given that Yapese is an earlier branching Proto-Oceanic language, we hypothesize that the indigenous Yap islanders might derive from a different mixture of source populations than other Central Micronesians.

#### Matrilocality in early Pacific islanders

We observed a notable degree of mitochondrial DNA differentiation between the FRO<sub>Marianas</sub> and the FRO<sub>SouthwestPacific</sub> lineages. All of the Unai individuals with mitochondrial haplogroup determinations and without evidence of high contamination carried haplogroups E1 and E2 (table S2), whereas all of the Lapita individuals had haplogroup B4 (7–10). All three haplogroups were found in Iron Age Taiwanese (5, 6), consistent with

the finding that the Iron Age Taiwanese were relatively undrifted descendants of a population that was also ancestral to the Unai and Lapita individuals. Such a high level of mitochondrial differentiation is surprising given the intermediate degree of autosomal differentiation as measured by  $F_{ST}$ , a standard statistic measuring population genetic differentiation, which is 0.083 between the Unai and Lapita groups. This raises the possibility of greater genetic drift on the maternal than paternal line during the early divergence and radiation of FRO lineages.

We carried out simulations to determine the probability that completely different mitochondrial macrohaplogroups spread over the two populations since they diverged, under the null assumption that males and females had the same demographic behavior and given the observed genetic drift on the autosomes (fig. S16). This null hypothesis is rejected ( $P = 0.0014$ , Fisher's exact test) (31). The  $P$  values are not sensitive to assumptions about the split time of the  $FRO_{Marianas}$  and the  $FRO_{SouthwestPacific}$  lineages (table S28). These patterns are qualitatively opposite to those in Neolithic and Bronze Age Europe, where patrilineal patterns of greater female than male mobility among households have been inferred by analyzing ancient DNA data (32, 33). Matrilocality in early Remote Oceanians has been hypothesized based on genetic and ethnographic studies of present-day communities, many of which have matrilineal practices in which women tend to raise their children in the same households in which they grew up (34, 35). Our results provide direct evidence for the practice of matrilocality among FRO populations.

These findings concerning matrilocality among the ancestors of Lapita and Unai individuals with little if any Papuan ancestry are not related to previous evidence of sex-biased admixture between Papuan and FRO ancestry in some Pacific populations (7). However, a new finding of this study does concern sex-biased mixture. Specifically, we find that the Papuan ancestry in Palau and Central Micronesia was primarily derived from male ancestors, based on significantly more Papuan ancestry on the autosomes than on the X chromosome ( $|Z| > 2.2$  to 3.3) (Fig. 4E and table S29) (7). This is notable because each of the three cases of FRO-Papuan admixture that are now documented (Palau, Central Micronesia, and southwest Pacific and Polynesia) involved a different pair of Papuan and FRO groups. These events must have been independent, and yet all share the feature of Papuan ancestry being transmitted primarily by male ancestors.

#### Family structure and population size during the Latte period

We measured runs of homozygosity (ROH) that were longer than 4 centimorgans (cM)

for 113 Latte individuals with high-enough-quality data to allow such analyses (table S30). Only two had single stretches of ROH longer than 50 cM, indicating that close-kin unions were avoided in Latte people. Nine individuals from Guam and nine from Saipan had at least one ROH longer than 20 cM, suggesting that mating pairs of close relatives such as second or third cousins on both islands were relatively common. Shorter ROH signals ( $>4$  cM) were also abundant, implying a limited pool of reproductive partners in every generation. We estimated the size of the population from which the Latte individuals in Guam and Saipan were drawing their reproductive partners to be 315 to 356 individuals in Guam and 361 to 424 individuals in Saipan (table S32).

We further analyzed long shared DNA segments [identical by descent (IBD) blocks] between the X chromosomes of male individuals (one from Guam and the other from Saipan). We identified 149 pairs of individuals who shared IBD segments longer than 8 cM (table S31). This puts an upper bound on  $N_e$ , the size of the mating population in the combined Mariana Islands, of 1203 to 1712 (95% confidence interval) (table S32). If there were restricted migration between islands, or if there were temporal variation in the dates of the individuals we compared, these numbers would be overestimates. This implies a long-term small population size or strong founder event in Latte history.

We identified 122 pairs of closely related Latte individuals (up to third-degree relatives) (fig. S17 and table S33). Eighty of 125 Latte individuals that were studied had one or several close relatives.

#### Discussion

A notable finding of this study is that the phenomenon of primarily male Papuan migrants mixing with previously resident FRO populations ~2500 to 2000 BP occurred at least three times, because the pairs of mixing sources were different in three regions (Fig. 4D). One of these migration and mixture processes occurred at an average date of ~2500 to 2200 BP, with  $Papuan_{NewGuinea}$ - $FRO_{Palau}$  mixture forming modern Palauans. A second occurred ~2300 to 1600 BP, with  $Papuan_{NewGuinea}$ - $FRO_{SouthwestPacific}$  mixture forming ancient and modern Central Micronesians. A third occurred ~2300 to 1500 BP, with  $Papuan_{NewBritain}$ - $FRO_{SouthwestPacific}$  mixture forming the ancestry of ancient and modern people of the southwest Pacific and Polynesia (7). All three mixtures were sex asymmetric, with most of the Papuan ancestry deriving from males (Fig. 4C). Even in the Mariana Islands, where there is no evidence of Papuan mixture, the inferred  $FRO_{Palau}$ - $FRO_{Marianas}$  mixture date in Latte individuals

is ~2400 to 1700 BP, providing a fourth example of migration and mixture in Remote Oceania occurring on average ~2500 to 2000 BP, well after the initial peopling events that involved entirely FRO groups.

A high-resolution ancient DNA time transect in Vanuatu has revealed the dynamics of this process in the southwest Pacific, where an initial  $FRO_{SouthwestPacific}$  migration stream likely from New Britain changed into a primarily male  $Papuan_{NewBritain}$  stream in the late Lapita period, likely deriving from the same source region and following previously established communication routes (36). Our results raise the possibility of similar processes in at least two other regions. The oldest pottery discovered in Pohnpei at ~2000 BP, which resembles that of late Lapita (19), provides an archaeological correlate for a spread of mixed  $FRO_{SouthwestPacific}$ - $Papuan_{NewGuinea}$  ancestry into this region. Parallel processes could have drawn  $Papuan_{NewGuinea}$  ancestry into Palau and  $FRO_{Palau}$  ancestry into the Mariana Islands.

Our identification of the  $FRO_{Palau}$  lineage raises the possibility that the three FRO lineages correspond to the first-order three language splits in Malayo-Polynesia:  $FRO_{Marianas}$  leading to the CHamoru language and associated with the Unai burials dated to ~2800 BP;  $FRO_{SouthwestPacific}$  leading to CEMP languages and associated with the Lapita archaeological complex and burials dating to ~3000 BP in Vanuatu; and  $FRO_{Palau}$  bringing ancestral Palauan and plausibly the first ancestry type in Palau because mitochondrial DNA of 3000 to 1800 BP remains from Chelechol ra Orrak suggests East Asian ancestry (37).

The ordering of the FRO lineage splits is also important. The fact that the  $FRO_{Palau}$  lineage split first cannot be explained by the theory that there was a single First Remote Oceanian spread into the Mariana Islands (28, 38), which then gave rise to the other lineages, because in this case,  $FRO_{Marianas}$  would have branched first. The theory of a Mariana population being ancestral to all FRO lineages is further challenged by the mitochondrial DNA evidence. If this theory were correct, the most parsimonious expectation is for the haplotypes observed in the Unai individuals from Guam at 2800 to 2200 BP (E1 and E2) also to be observed in the Lapita individuals at 3000 to 2500 BP. However, only mitochondrial haplotype B4a1a1 (the "Polynesian motif") is observed. Therefore, our results point to a scenario in which three First Remote Oceanian lineages branched from a trunk of MP speakers in Island Southeast Asia, with at least three independent streams of migrations into Remote Oceania.

Since colonial times, Pacific peoples have been divided into "Melanesians," "Polynesians," and "Micronesians," driven by theories

of shared origins (39). However, our results show that people in Micronesia have a diversity of ancestral origins even within the same geographic region, implying that the term “Micronesian” should be used as a geographic label without implying a specific biological profile.

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## ACKNOWLEDGMENTS

We acknowledge the people past and present who were the source of the samples we analyzed. We are grateful to Chamoru community members to whom we presented results on 15 October 2020 and to the Pohnpei Historic Preservation Office for review and approval of this study on 6 September 2020; we incorporated feedback from both these engagements into the final manuscript. For help in the collections of modern DNA, we thank E. Pretrick, M. Kumagai, and A. Loerzel. We also thank R. Blust, R. Chong-Cruz, P. Flegontov, E. Harney, P. John, R. Lemuel, I. Lazaridis, R. Maier, R. Palermo, T. Parks, H. Ringbauer, L. T. Souder, and L. M. Young for critical comments. **Funding:** This work was supported by grants from the National Institutes of Health (GM100233 and HG012287), the John Templeton Foundation (grant 61220), and the Allen Discovery Center program, a Paul G. Allen Frontiers Group–advised program of the Paul G. Allen Family Foundation. D.R. is an investigator of the Howard Hughes Medical Institute. T.G.S. was supported by the National Geographic Society and the University of Pennsylvania.

R.H.-A. and J.E. were supported by the Guam Preservation Trust and the National Geographic Society. **Author contributions:** R.H.-A., J.E., R.P., and D.R. conceived the project. N.P., M.L., R.P., and D.R. supervised the study. R.H.-A., O.C., J.E., M.P., J.S.A., R.M.I.-Q., and M.T.D. sampled prehistoric specimens. R.H.-A., J.E., M.P., J.S.A., R.M.I.-Q., M.T.D., and M.S. assembled archaeological and anthropological information. F.C., A.I., K.K., J.K., T.G.S., A.V.S.H., A.J.M., K.R., K.A., C.D.Q.-C., C.D.B., A.M.-E., and M.V. gathered data from present-day populations. N.R., R.B., M.Ma., K.M., M.Mi., N.B., J.O., N.A., K.S., A.M.L., F.Z., K.C., and T.G.S. conducted laboratory and/or data processing work. B.J.C. and D.J.K. performed radiocarbon dating analyses. Y.-C.L., N.P., M.L., and D.R. analyzed the data. Y.-C.L. and D.R. wrote the manuscript. **Competing interests:** C.D.B. is founder and CEO of Galatea Bio. The authors declare no other competing interests. **Data and materials availability:** Data for the prehistoric individuals are fully publicly available and have been deposited in the European Nucleotide Archive (project accession no. PRJEB51180). The informed consents for the newly genotyped present-day individuals from Guam, Palau, Chuuk, and Pohnpei are not consistent with unmediated public posting of genomic data. Researchers who wish to analyze these deidentified data can access them through the Harvard Dataverse repository (40). Data may be downloaded after registering for a Harvard Dataverse user account, providing an email address and institutional or professional affiliation, and submitting an affirmation of the following statements: (i) I will not distribute the data outside my collaboration; (ii) I will not post the data publicly; (iii) I will make no attempt to connect the genetic data to personal identifiers for the samples; (iv) I will use the data only for studies of population history; and (v) I will not use the data for commercial purposes. **License information:** Copyright © 2022 the authors, some rights reserved; exclusive licensee American Association for the Advancement of Science. No claim to original US government works. <https://www.science.org/about/science-licenses-journal-article-reuse>

## SUPPLEMENTARY MATERIALS

[science.org/doi/10.1126/science.abm6536](https://science.org/doi/10.1126/science.abm6536)  
Materials and Methods  
Supplementary Text  
Figs. S1 to S23  
Tables S1 to S38  
References (41–127)  
MDAR Reproducibility Checklist

View/request a protocol for this paper from *Bio-protocol*.

Submitted 1 October 2021; accepted 18 May 2022  
10.1126/science.abm6536



## Ancient DNA reveals five streams of migration into Micronesia and matrilocality in early Pacific seafarers

Yue-Chen Liu, Rosalind Hunter-Anderson, Olivia Cheronet, Joanne Eakin, Frank Camacho, Michael Pietrusewsky, Nadin Rohland, Alexander Ioannidis, J. Stephen Athens, Michele Toomay Douglas, Rona Michi Ikehara-Quebral, Rebecca Bernardos, Brendan J. Culleton, Matthew Mah, Nicole Adamski, Nasreen Broomandkhoshbacht, Kimberly Callan, Ann Marie Lawson, Kirsten Mandl, Megan Michel, Jonas Oppenheimer, Kristin Stewardson, Fatma Zalzal, Kenneth Kidd, Judith Kidd, Theodore G. Schurr, Kathryn Auckland, Adrian V. S. Hill, Alexander J. Mentzer, Consuelo D. Quinto-Cortés, Kathryn Robson, Douglas J. Kennett, Nick Patterson, Carlos D. Bustamante, Andrés Moreno-Estrada, Matthew Spriggs, Miguel Vilar, Mark Lipson, Ron Pinhasi, and David Reich

*Science* **377** (6601), . DOI: 10.1126/science.abm6536

### Human migrations into Micronesia

The movements of ancient humans can be difficult to ascertain from their current population genetic structure. Studying the peopling of the Micronesian islands, Liu *et al.* examined 164 ancient human remains from five different archaeological sites in remote Oceania from different prehistoric time frames, along with 112 present-day individuals from the same area. They combined these new data with the results of previous studies and also compared their results with linguistic studies. Their analysis revealed successive movements from island Southeast Asia that differ from those in the southwest Pacific. Furthermore, co-analysis of Micronesian and southwest Pacific ancient DNA indicates that the first people who colonized the Pacific islands had a population structure in which men moved to find their mates, whereas women rarely moved to join men. —LMZ

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To: Patrick Lujan, Guam Historic Preservation Officer  
From: Joanne Eakin and Rosalind Hunter-Anderson  
Date: January 30, 2023  
Cc: David Reich, Ron Pinhasi

**Subject: Permission to collect additional samples of human skeletal remains from the Naton Beach site for the purpose of ancient DNA study**

We respectfully request your approval to conduct a second phase of sampling of the Naton Beach skeletal assemblage currently housed at the Guam Museum storage facility. These new samples will allow project geneticists to generate additional genomic data to better assess family kinship practices in the Marianas during the Latte Period. These data will be available for comparison with Latte Period people occupying other parts of Guam and throughout the Mariana Islands.

Ms. Joanne Eakin and Dr. Rosalind Hunter-Anderson will be co-PIs for the DNA research. Ms. Eakin, an osteologist with expertise in ancient Marianas skeletal remains, will oversee sample collection. Dr. David Reich, Harvard Medical School, and Dr. Ron Pinhasi, University of Vienna, specialists in ancient DNA (aDNA) analysis, will analyze the samples and integrate the new data with the results of previous studies of Latte Period skeletal collections at no cost to the Government of Guam.

#### Background

Previously, Ms. Eakin and Dr. Hunter-Anderson led an effort to collect aDNA from the Naton Beach skeletal assemblages. The resulting study compared two prehistoric burial populations, one dating to the Latte Period (800 +/- 300 years ago), and one dating to the Unai (Pre-Latte) Period (2,500 +/-300 years ago). The comparative whole genomic analysis revealed long term continuity in the practice of matrilocality in the two populations and the tendency for close relatives to be buried near one another. Genetic family trees in the Unai and Latte populations were identified to first, second, and third-degree relatives. Although differences in mortuary treatment and skeletal morphology between Unai and Latte groups previously had been noted, this study documented a striking genetic continuity across more than two millennia and demonstrated that the Unai people and the Latte people are ancestral to the modern CHamoru.

The previous research was instrumental in our ability to reconstruct biological relatedness among Latte Period individuals at Naton Beach with a high level of detail, and even revealed a distant relative in the Naton Beach Latte pedigree among individuals excavated at the Haputo site in northern Guam. The geneticists' ability to draw conclusions with statistical significance was, however, hindered by the patchiness of the family trees outlined thus far. Additional sampling and analysis of Naton Latte Period remains will provide a basis for resolving the incomplete data.

#### Methods

During the previous study, all available petrous bone samples were collected because the cochlea in the petrous bone has proven to be the most reliable for yielding aDNA in fragile specimens. For the current study, we propose sampling the dentition of 48 Latte Period individuals. These

individuals were not previously sampled because their cochleae were not available. They are now candidates for testing because the relative integrity and stability of the Naton Latte Period remains have proved to be suitable for aDNA recovery via dentition.

A Chain of Custody will be maintained for all samples, and a complete list of samples by burial number will be submitted to the Guam Historic Preservation Office prior to removal of samples from Guam. The samples will be transported to Dr. Pinhasi's laboratory, where a very small amount of powder (50 mg) will be drilled from each tooth. Precise and delicate laboratory procedures will minimize damage to the samples. The teeth will be retained in Dr. Pinhasi's lab and returned to Guam when the project is finished. The powders will be sent to Dr. Reich, who will oversee their sequencing, library preparation, and interpretation. All samples yielding DNA will be radiocarbon-dated by AMS at Penn State University.

Periodic updates on the progress of the analysis at the Reich lab will be provided to the Guam Historic Preservation Office and Guam Museum. Interpretation of the project results will be a joint effort: Ms. Eakin and Dr. Hunter-Anderson will provide the appropriate archaeological and osteological contexts, and the paleo-genetic inferences will be the responsibility of Drs. Pinhasi and Reich. Proposed publications resulting from the research will be available for the Historic Preservation Officer's review.

#### Schedule

We propose conducting the limited sampling of 48 human remains in February of 2023. Preliminary results are estimated to be available in 2024, if not sooner.

We respectfully ask you to consider our research request to derive more information from this important site. Subject to your approval, we will initiate research request procedures with the Museum of Guam.

Sincerely,

Joanne Eakin

Rosalind Hunter-Anderson

**To:** Dr. Michael Bevacqua, Curator, Guam Museum  
**From:** Rosalind Hunter-Anderson and Joanne Eakin  
**Subject:** Permission to collect additional samples from the Naton Beach assemblage for the purpose of ancient DNA study  
**Date:** February 9, 2023

We respectfully request access to conduct additional sampling of the Naton Beach skeletal assemblage currently housed at the Guam Museum Flores Building storage facility. These samples will allow the geneticists to generate additional genomic data for a more complete family tree to better assess kinship practices in the Marianas during the Latte Period. The data will be available for comparison with Latte Period people occupying other parts of Guam and throughout the Mariana Islands.

Our request for a continuation of the research was reviewed and approved by Mr. Patrick Lujan, Guam Historic Preservation Officer, on February 3, 2023.

Dr. Rosalind Hunter-Anderson and Ms. Joanne Eakin will be co-PIs for the additional research. Ms. Eakin, an osteologist, will oversee sample collection. Dr. David Reich, Harvard Medical School, and Dr. Ron Pinhasi, University of Vienna, specialists in ancient DNA (aDNA) analysis, have offered to apply their expertise to Latte Period skeletal collections at no cost to the Government of Guam.

#### Background

Previously, Dr. Hunter-Anderson and Ms. Eakin led an effort to collect aDNA from the Naton Beach skeletal assemblage. The resulting study compared the two burial populations from the site: the Latte Period, dating to 800 (+/- 300) years ago, and the Unai Period (Pre-Latte), dating to 2,500 (+/-300) years ago. The genomic analysis showed continuity in the practice of matrilocality and the tendency for close relatives to be buried near one another. Genetic families in the Unai and Latte populations were able to be identified by first, second, and third-degree relatives. Despite differences in mortuary treatment and morphology between Unai and Latte burial populations, the study revealed a striking genetic continuity across time: the early Unai people and the Latte people are ancestral to the modern CHamoru.

The initial research was instrumental in our ability to reconstruct biological relatedness among Latte Period individuals at Naton Beach with a high level of detail, and even revealed a distant relative in the Naton Beach Latte pedigree among individuals excavated at the Haputo site. The geneticists' ability to draw conclusions with statistical significance was, however, hindered by the patchiness of the obtained family tree, i.e., the tree is not completely resolved, thus the request for additional testing.

#### Methods

Previously, petrous bone samples were collected because the cochlea in the petrous bone has proven to be the most reliable for yielding aDNA in fragile specimens. We now propose sampling

of the dentition of 48 Latte Period individuals. These individuals were not previously sampled because their cochleae were not available but are now candidates for testing because the stability of the Latte Period remains proved to be suitable for aDNA recovery via dentition.

Chain of custody will be maintained for all samples, and a complete list of samples by burial number will be submitted to the Guam Historic Preservation Office and Guam Museum prior to removal of samples from Guam. The samples will be transported to Dr. Pinhasi's laboratory, and a very small amount of powder (50 mg) will be drilled from each tooth. Precise and delicate laboratory procedures will minimize damage to the samples. The teeth will be retained in Dr. Pinhasi's lab and returned to Guam when the project is finished. The powders will then be sent to Dr. Reich, who will oversee their sequencing, library preparation, and interpretation. All samples yielding DNA will be radiocarbon dated.

Periodic updates on the progress of the analysis at the Reich lab will be provided. Interpretation of the project results would be a joint effort: Ms. Eakin and Dr. Hunter-Anderson will provide the appropriate archaeological and osteological contexts, and the paleo-genetic inferences would be the responsibility of Drs. Pinhasi and Reich.

#### Schedule

We propose conducting the limited sampling of 48 human remains in February of 2023.

Thank you for considering our request.

Sincerely,

Rosalind Hunter-Anderson and Joanne Eakin





**Lourdes A. Leon Guerrero**  
Governor  
**Joshua F. Tenorio**  
Lt. Governor

**Department of Parks and Recreation**  
*Dipattamenton Plaset yan Dibuetsion*  
Government of Guam

Director's Office, Parks and Recreation Divisions  
#1 Paseo de Susana, Hagåtña, Guam 96910  
P.O. Box 2950, Hagåtña, Guam 96932  
(671) 475-6288; Facsimile (671) 477-0997  
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490 Chalan Palasyo, Agaña Heights, Guam 96910  
(671) 475-6294/6355; Facsimile (671) 477-2822



**Warren Pelletier**  
Acting Director  
**Jack Hattig III**  
Deputy Director

December 15, 2023

Cacilie Craft  
45-224 Haunani Place, Apt A  
Kāneʻohe, Hawaiʻi 96744

**Subject: Permission to Sample Human Skeletal Remains from the J001B Project for the Purpose of Ancient DNA Study**

Håfa adai Ms. Craft,

I received your request, dated December 8, 2023, to conduct limited DNA sampling from in situ skeletons from the J001B project location (i.e., Marine Corps Base Camp Blas) and from the J001B project skeletal assemblage currently housed at Kleinfelder's Tumon, Guam office. I understand this study will provide important data for a comparison of Latte Period populations living on the northern plateau with each other and with their contemporaries living in coastal villages.

It is my understanding that there are currently thirteen (13) in situ human burial features (some with multiple internments) within "Construction Area D" at the J001B project location. This area is otherwise known as Sabānan Fadang and has provided evidence of substantial Latte Period land use and habitation previously unexpected for the northern plateau of Guam. In addition to in situ burials, many comingled and fragmented human skeletal remains, collected during J001B archaeological investigations, are temporarily housed at Kleinfelder's Tumon, Guam laboratory.

I am also aware that Dr. David Reich, Harvard Medical School, and Dr. Ron Pinhasi, University of Vienna, specialists in ancient DNA analysis, have offered to apply their expertise to Latte Period skeletal collections at no cost if working in direct collaboration with Ms. Eakin and Dr. Hunter-Anderson.

I approve conducting the *limited* sampling of 13 in situ burials of the J001B project human remains and request that it be completed as soon as possible so as not to delay their reinterment. We look forward to learning more about this significant CHamoru community from your analysis.

Sincerely,

Patrick Lujan  
State Historic Preservation Officer



joanne eakin &lt;jeeakin@gmail.com&gt;

**Request to collect additional samples from the Naton Beach assemblage**

10 messages

joanne eakin &lt;jeeakin@gmail.com&gt;

Thu, Feb 9, 2023 at 1:26 AM

To: Michael Bevacqua &lt;michael.bevacqua@dca.guam.gov&gt;

Cc: Rosalind Hunter-Anderson &lt;rozinabq@gmail.com&gt;, "Reich, David Emil" &lt;reich@genetics.med.harvard.edu&gt;, Ron Pinhasi &lt;ron.pinhasi@univie.ac.at&gt;, "patrick.lujan@dpr.guam.gov" &lt;patrick.lujan@dpr.guam.gov&gt;

Dear Dr. Bevacqua,

We respectfully request access to the Museum of Guam storage facility in the Flores Building to collect additional samples from the Naton Beach skeletal assemblage. Attached you will find a letter explaining the request, our original Guam Museum research agreement, and updated loan and research requests. Also attached is an inventory of the burial numbers to be sampled.

Mr. Patrick Lujan, Guam Historic Preservation Officer, approved our request on February 3, 2023.

Please let me know if I can provide additional information or address any questions or concerns. I anticipate requiring two days to conduct the sample collection and hope to schedule it at your staff's convenience sometime between February 15th and 28th.

Thank you very much for considering our request.

Sincerely,  
Joanne Eakin

**6 attachments** **Request to Collect Additional Naton Samples 2023.pdf**  
139K **Guam Museum Research Agreement 03 06 2019.pdf**  
180K **Pinhasi Lab Outgoing Loan Request 2023.pdf**  
256K **Reich Lab Outgoing Loan Request 2023.pdf**  
256K **Research or Destructive Sample Request 2023.pdf**  
157K **Additional Naton sample request.xlsx**  
11K

Michael Bevacqua &lt;michael.bevacqua@dca.guam.gov&gt;

Sun, Feb 12, 2023 at 4:53 PM

To: joanne eakin &lt;jeeakin@gmail.com&gt;

Cc: Rosalind Hunter-Anderson &lt;rozinabq@gmail.com&gt;, "Reich, David Emil" &lt;reich@genetics.med.harvard.edu&gt;, Ron Pinhasi &lt;ron.pinhasi@univie.ac.at&gt;, "patrick.lujan@dpr.guam.gov" &lt;patrick.lujan@dpr.guam.gov&gt;, Leona Young &lt;leona.young@dca.guam.gov&gt;, Colasita Gumabon &lt;colasita.gumabon@dca.guam.gov&gt;

Håfa Adai Joanne,

Si Yu'os Ma'ase for submitting your request. We can definitely set up a window of time for late next week, after the 21st which is the date we are scheduled to open a new exhibit here at the museum. I'm cc'ing on this email our admin here at the museum Leona and Colasita who coordinates the staff schedules. We'll work this week to figure out when we can best accommodate your two day window request at the Flores Building. I'll be in touch soon with updates.

[Quoted text hidden]

joanne eakin <jeeakin@gmail.com>

Sun, Feb 12, 2023 at 5:26 PM

To: Michael Bevacqua <michael.bevacqua@dca.guam.gov>

Cc: Rosalind Hunter-Anderson <rozinabq@gmail.com>, "Reich, David Emil" <reich@genetics.med.harvard.edu>, Ron Pinhasi <ron.pinhasi@univie.ac.at>, patrick.lujan@dpr.guam.gov, Leona Young <leona.young@dca.guam.gov>, Colasita Gumabon <colasita.gumabon@dca.guam.gov>

Good morning, Michael,

Thank you very much, and thanks to Leona and Colasita! I'll wait to hear from you about next week's schedule.

Joanne

[Quoted text hidden]

Michael Bevacqua <michael.bevacqua@dca.guam.gov>

Thu, Feb 16, 2023 at 11:50 PM

To: joanne eakin <jeeakin@gmail.com>

Cc: Rosalind Hunter-Anderson <rozinabq@gmail.com>, "Reich, David Emil" <reich@genetics.med.harvard.edu>, Ron Pinhasi <ron.pinhasi@univie.ac.at>, patrick.lujan@dpr.guam.gov, Leona Young <leona.young@dca.guam.gov>, Colasita Gumabon <colasita.gumabon@dca.guam.gov>

Håfa Adai Joanne, I think we should be able to accommodate you on February 27th and 28th. Let's check in next week though so I can get more details about what you might be needing from the museum beyond just access to the Flores Building.

[Quoted text hidden]

joanne eakin <jeeakin@gmail.com>

Fri, Feb 17, 2023 at 4:22 AM

To: Michael Bevacqua <michael.bevacqua@dca.guam.gov>

Cc: Rosalind Hunter-Anderson <rozinabq@gmail.com>, "Reich, David Emil" <reich@genetics.med.harvard.edu>, Ron Pinhasi <ron.pinhasi@univie.ac.at>, patrick.lujan@dpr.guam.gov, Leona Young <leona.young@dca.guam.gov>, Colasita Gumabon <colasita.gumabon@dca.guam.gov>

Michael,

Thank you for setting aside those days. I'll touch base with you next week to solidify plans. Have a great weekend.

Joanne

[Quoted text hidden]

Rosalind Hunter-Anderson <rozinabq@gmail.com>

Fri, Feb 17, 2023 at 8:51 AM

To: joanne eakin <jeeakin@gmail.com>

It seems you may not be home till March. I hope you can get some snorkeling in, despite the rainy weather. Got that new bag yet?

[Quoted text hidden]

joanne eakin <jeeakin@gmail.com>

Fri, Feb 17, 2023 at 3:16 PM

To: Rosalind Hunter-Anderson <rozinabq@gmail.com>

I missed Wednesday again, so no new bag. I still don't know what day it is and I tend to fall asleep at 5pm (my ABQ bedtime) so readjusting when I get home should be easy. I got in some excellent snorkeling time while on Palau--walls of bright, colorful coral and jellyfish. It was quite magical. Maybe this afternoon. I think today is supposed to be sunny but the rest of the week looks rainy again. What happened to the dry season? I love this rain but my tan is fading.

We had a delay in sending the Palau samples. I packaged and left the samples for Jolie to send because Fed-ex needed a day to figure out the cost. It was \$959 to ship to Vienna!!! So the samples are being carried to me next Tuesday by two of Cacilie's people. I'll send them and the new Naton samples from here via USPS because Fedex from here would still \$700+. I was considering changing my flight to return via Vienna and hand deliver them and now I really do have to change my flight to accommodate collecting at the Guam museum. I don't remember why I wrote that I'd be available through Feb. 28--that's the day I was scheduled to leave. What was I thinking? There is plenty to keep me busy with Cacilie's bones, though, so costs can be covered one way or the other.

I'm going to lunch with Darlene today so I will hug her for you. It's just the two of us, going to Jeff's. Any messages?

[Quoted text hidden]

**Rosalind Hunter-Anderson** <rozinabq@gmail.com>

Fri, Feb 17, 2023 at 3:50 PM

To: joanne eakin <jeeakin@gmail.com>

I imagine the reefs are extraordinary in Palau, compared with Guam but hey who is complaining about that? It may rain on you (it is what happens during La Nina, even in winter). Here it was 15 F this morning.

Have a nice lunch at Jeff's, always good, especially the kelaguen. Yes, tell Dar I am on the trail of Reinman's collections at the Chicago Field Museum, also other collections from Micronesia that they have there. The curator sent me a huge spreadsheet of what they have from Fred including the Nomna Bay finds. I asked him to look for Jane Underwood's detailed report on the human remains Reinman dug up. There is only a short summary in his 1977 monograph, and it says the remains and her full report is at the Field Museum. He said it could be in any number of places and hasn't got back to me yet about it. I have been helped with getting this far at the museum by the touchy John Terrell, who wants me to write a little book about ancient DNA.

[Quoted text hidden]

**joanne eakin** <jeeakin@gmail.com>

Fri, Feb 17, 2023 at 3:56 PM

To: Rosalind Hunter-Anderson <rozinabq@gmail.com>

You've been busy. I'll pass this along. You have to write your Marianas prehistory book first!

Off for a walk and a swim while the sun is out--visibility is better then.

[Quoted text hidden]

**Rosalind Hunter-Anderson** <rozinabq@gmail.com>

Fri, Feb 17, 2023 at 4:00 PM

To: joanne eakin <jeeakin@gmail.com>

That is what I told him. Ancient Micronesia Reframed comes first.

[Quoted text hidden]

## CURRICULUM VITAE

Rosalind L. Hunter-Anderson, Ph.D.

1513 Wellesley Dr. NE, Albuquerque, NM 87106

[rozinabq@gmail.com](mailto:rozinabq@gmail.com) US telephone +1-505-232-9702

### DEGREES

B.A. (Anthropology) 1969 U.C.L.A. *magna cum laude*

M.A. (Anthropology) 1971 U.C.L.A.

Ph.D. (Anthropology) 1980 Univ. of New Mexico

### AWARDS

Maga'lahi Award for the Arts, Governor of Guam, 2000

Dean's List, College of Letters and Science, U.C.L.A., 1967

Entered Honors Program, College of Letters & Science, U.C.L.A., 1967

N.S.F. Undergraduate Research Fellow, Field Museum Natural History, 1968

Jean C. Cook Undergraduate Scholarship, U.C.L.A., 1968-1969

Phi Beta Kappa, U.C.L.A. Chapter, 1969

### RESEARCH INTERESTS

human and cultural evolution, biogeography and human niche construction, climate and culture, vernacular architecture and stonework, settlement systems, prehistoric rock art, ancient DNA, population origins and demography

### GEOGRAPHIC AREAS

Insular Pacific (Micronesia); U.S. Southwest

### ACADEMIC APPOINTMENTS

Visiting Research Fellow, Univ. of Huddersfield, 2016-2021

Adjunct Associate Professor, Univ. of New Mexico, 2003-2005, 2007-2014

Visiting Associate Researcher, Univ. of Calif. Irvine, 1989-1991

Research Associate, Univ. of Guam, 1986-1989

Visiting Assistant Professor, Univ. of Guam, 1984-1985

Instructor, Eastern New Mexico State Univ., Portales, 1979

Teaching Associate, Univ. of New Mexico, 1974-1976

Graduate Assistant, Univ. of New Mexico, 1973-1974

Teaching Assistant, U.C.L.A., 1969-1972

### UNIVERSITY COURSES TAUGHT

**U.C.L.A.:** general cultural anthropology, principles of human evolution, evolution of man, introductory cultural anthropology (principles), introductory cultural anthropology (culture history)

**Univ. of New Mexico:** human osteology, introductory anthropology, Southwest peoples

**Eastern New Mexico State Univ.:** graduate seminar, archaeological method and theory

**Univ. of Guam:** archaeological field methods; Micronesian archaeology

**Univ. of Calif., Irvine:** Pacific prehistory

### EMPLOYMENT

2013-2014 Principal Investigator, Yap Malal Study, Yap State Historic Preservation Office

2011-2019 Principal Investigator, grant for Chemical Analysis of Guam Pictographs, Ancient

CHamoru DNA sampling, Guam Preservation Trust

1990-2006 Vice President and founder, Micronesian Archaeological Research Services, Guam

1990-1991 Principal Investigator, Southern Guam Paleoenvironmental Study, Office of Graduate School and Research, Univ. of Guam and Guam Historic Preservation Trust.  
1989-1991 Principal Investigator, NSF, Microneisan Horticultural Systems, Univ. of Calif. Irvine  
1989-1990 Archaeologist, Manenggon Hills survey, D.R. Moore, Mangilao, Guam  
1986-1989 Principal Investigator, USGS grants, Micronesia, WERI, Univ. of Guam  
1984-1985 Research Archaeologist, MARC, Univ. of Guam  
1983-1984 Principal Investigator, Agat excavations, Guam. Pacific Studies Institute, Guam  
1980-1982 Principal Investigator, Yap Islands Settlement Patterns, Pacific Studies Institute, Guam.

#### CONSULTANCIES

2019-present: David Reich Laboratory, Harvard Medical School, Boston.  
2006-present: Guam Historic Resources Division, Dept. of Parks and Recreation  
2005-present: Guampedia, an online encyclopedia.  
2002-present: UNESCO Paris. Local and Indigenous Knowledge Systems (LINKS).

#### RECENT GRANTS, CONTRACTS, HONORARIA

2022 Honorarium, Pacific Preservation Summit, Session 2-4, Guam Preservation Trust, \$250  
2018 Travel stipend, honorarium, Stone Fish Weirs Symposium, Taiwan Ministry of Culture, Taipei \$2000.  
2017 Phase 2, Pilot Study of Ancient mtDNA in Skeletal Samples from the Naton Beach Site, Guam. Grant GPT-17-01 from Guam Historic Preservation Trust \$4336.  
2015-2016 Phase 1, Pilot Study of Ancient mtDNA Dentitions from the Naton Beach Site, Guam. Grant GPT-16-03 from Guam Historic Preservation Trust \$3028.  
2013-2014 Archaeological Survey and Inventory of Yapese Stone Money Banks. Grant 64-11-31969 Yap State Historic Preservation Office. \$38,274.  
2013 Geochemical Characterization and Radiometric Dating of Pictographs at Mahlac Pictograph Cave, Guam. Grant GPT-13-08 from Guam Historic Preservation Trust. Phase III, \$4997.  
2012 Geochemical Characterization and Radiometric Dating of Pictographs at Mahlac Pictograph Cave, Guam. Grant GPT-12-05 from Guam Historic Preservation Trust. Phase II, \$4629.  
2012. Honorarium, First Mariana Islands History Conference, Saipan. \$300.  
2011. Geochemical Characterization and Radiometric Dating of Pictographs at Mahlac Pictograph Cave, Guam. Grant GPT-11-04 from Guam Historic Preservation Trust. Phase 1, \$4134.  
2011. Contract to prepare Inventory Site Forms and Nominations to the Guam and National Registers for Mahlac Pictograph Cave and Litekyan Pictograph Cave. Guam Historic Preservation Division. \$9999.  
2009 Airfare, per diem and registration for attending and presenting a paper at the Pacific Island Archaeology in the 21st Century: Relevance & Engagement Conference held in Koror, Palau, July 1-3. Guam Preservation Trust, Guam. \$900.  
2007 Two-Phase Academic and Technical Skills Training in Historic Preservation, for Guam Historic Preservation Office, Government of Guam. \$13,200.  
2005-2006 (with J. Amesbury): Baseline Description of Environmental Cycles, Resource Rhythms and Human Use Patterns in the Mariana Islands. Micronesian Archaeological Research Services contract with Western Pacific Regional Fisheries Management Council, Honolulu. \$50,000.  
2004-2006 (with J. Amesbury): An Analysis of Archaeological and Historical Data on Fisheries for Pelagic Species in Guam and the Northern Mariana Islands. Micronesian Archaeological Research Services contract with Joint Institute for Marine and Atmospheric Research (JIMAR), School of Ocean and Earth Science and Technology, University of Hawaii. \$59,997.25

## PROFESSIONAL MEMBERSHIPS

Fellow, American Anthropological Association  
Society for American Archaeology  
Indo-Pacific Prehistory Association

## RECENT ETHNOGRAPHIC & ETHNO-HISTORICAL PROJECTS

2014 Oral history interviews regarding construction and traditional uses of Yapese dancing grounds (*malal*; "stone money banks"). Yap State Historic Preservation Office, Colonia.  
2005-2006 Oral history interviews and archival research regarding post-World War II population resettlement in eight Guam villages. Dept. of Parks and Recreation, Historic Resources Division, Guam.  
2005-2006 Oral history interviews and archival research regarding the five houses in the Agana Historic District, Guam. Dept. of Parks and Recreation, Historic Resources Division, Guam.  
2004-2006 Compilation of baseline information for the Mariana Archipelago Fishery Ecosystem Plan. Western Pacific Fishery Management Council, Honolulu.  
2004-2006 Analysis of archaeological, historical, and oral history data on pelagic fisheries in Guam and the Northern Mariana Islands. Joint Institute for Marine and Atmospheric Research (JIMAR), School of Ocean and Earth Science and Technology, University of Hawaii.

## RECENT MEDIA PROJECTS

Contributor to Guampedia 2012: Current understandings of ancient Marianas pictographs, pp. 49-88, proceedings, First Mariana Islands History Conference. Online:  
[https://issuu.com/guampedia/docs/ancient\\_marianas\\_history/1?e=1294219/5854867](https://issuu.com/guampedia/docs/ancient_marianas_history/1?e=1294219/5854867)

Contributor, Guampedia 2009: interpretive essay on tattooing in the Marianas. Online:  
<http://guampedia.com/on-the-question-of-tattoo-by-ancestral-chamorro-2/>

Contributor to Guampedia 2006: interpretive essay on *latte*: Online  
<http://www.guampedia.com/category/22-ancient-guam/entry/7>.

Scientific advisor, "Becoming a Navigator, Becoming a Priest," a 41 min. film (DVD, VHS) by Jerome Blumberg, Rosalind Hunter-Anderson and Rosemary L. Apusa, filmed in Satawal Island, Yap State, Federated States of Micronesia. LINKS – UNESCO, Paris. 2002-2006. See  
[http://www.lussasdoc.org/film-becoming\\_a\\_navigator\\_becoming\\_a\\_priest-1,19845.html#contact](http://www.lussasdoc.org/film-becoming_a_navigator_becoming_a_priest-1,19845.html#contact)

Scientific advisor, "The Canoe is the People: Indigenous Navigation in the Pacific" Interactive CD-ROM produced by UNESCO-LINKS 2002-2005: Online  
<http://www.unesco.org/new/en/natural-sciences/priority-areas/links/knowledge-transmission/publications/multimedia/canoe-is-the-people2/>

Co-producer (with R.K Olmo), "Island Archaeology," a weekly radio series aired on Guam Public Radio KPRG-FM. Volunteered. 1997-2003.

Producer, "Island Archaeology: Reports from the Field," a weekly radio series aired on Guam Public Radio KPRG-FM. Volunteered with support from Guam Humanities Council, 1996.

Producer, "Image and Experience: Women Scientists in a Man's World," a 19 min. video tape (VHS). Supplement to N.S.F. Visiting Professorship for Women in Science and Engineering, Univ. of Calif. Irvine, 1989-1992.

## PAPERS PRESENTED AT SCHOLARLY MEETINGS

2022 (with J.E. Eakin) Ancient DNA Confirms Biological and Cultural Continuities the Marianas for over 2,500 Years. American Memorial Park Theater, May 27, 2022, Saipan.

2022 (with J.E. Eakin) Ancient DNA, CHamoru Origins and Cultural Continuity at the Naton Beach Site, Guam. 2nd Annual Pacific Preservation Summit May 24-26, Hagatna.

2019 Paleo-sediment Coring in Micronesia: A Very Brief Review & Critique. In Symposium, Research and CRM Are Not Mutually Exclusive: J. Stephen Athens—Forty Years and Counting. 84th Annual Meeting, Society for American Archaeology, Albuquerque, NM, April 10-14, 2019.

2018 (with M. George B. Foody, Peter W. Ditchfield, Stanley H. Ambrose, Joanne E. Eakin, Mafalda Almeida, Daniel Vieira, Andreia Brandão, Teresa Rito, James O.S. Hackland, Lynda B. Aguon, Raymond F.Y. Blas, Maria Pala, Martin B. Richards, Stephen J. Oppenheimer, Pedro Soares & Ceiridwen J. Edwards) Ancient DNA and Isotopic Analysis of Archaeological Remains from Guam. Poster, 8th International Symposium on Biomolecular Archaeology. 18–21 September 2018, Friedrich-Schiller-University Jena, Germany.

2018 Guam Archaeology Today: Two Recent Projects Funded by the Guam Preservation Trust, 2011-2018. Special Exhibit Tuesday Feb. 27: Chemical and Dating Analyses of Paint Samples from Mahlac Pictograph Cave, Guam. 1st Annual Pacific Preservation Summit, Feb. 26-28, 2018, Hagatna, Guam.

2018 Yapese Stone Fish Traps Revisited and Reframed. International Symposium on Protection of Fishing Weirs, Bureau of Cultural Heritage, Ministry of Culture, Taipei, Taiwan.

2017 Two Approaches to Marianas Rock Art: Culture History & Anthropology. Third Mariana Islands History Conference Sept. 1-3, Saipan, Commonwealth of the Northern Mariana Islands. Online: [https://issuu.com/guampedia/docs/mhc\\_iii\\_2017\\_2/9](https://issuu.com/guampedia/docs/mhc_iii_2017_2/9)

2015 (with J. Eakin) Chamorro Origins and the Importance of Archaeological Context. Prepared for the Third Mariana Islands History Conference, Sept. 4-6, 2015, Saipan, Commonwealth of the Northern Marianas. Conference canceled due to Typhoon Soudelor. Online: <https://issuu.com/guampedia/docs/mhc3/76>

2015 (with A.L.W. Stodder, E.M. Ryan, M.T. Douglas, and R. Ikehara- Quebral) Under the *latte*: Osteobiography and social context of a burial assemblage at Tumon Bay, Guam. Western Bioarchaeology Conference: Human Evolution and Social Change, October 15-16, 2015, Univ. of Arizona, Tempe.

2014 Learning from the Lab: Elemental Analysis and Dating of Ancient Pigments at Mahlac Pictograph Cave, Guam. Presented at the Annual Research Conference, College of Liberal Arts & Social Sciences, March 8, 2014, Univ. of Guam.

2014 Settlers or foragers? An ecological context for initial human presence in the Marianas c. 3500 years ago. 20<sup>th</sup> Congress of the Indo-Pacific Prehistory Association, Apsara-Angkor Resort and Conference Hotel, January 12-18, 2014, Siem Reap, Cambodia.

2014 (with A.L.W. Stodder, E.M. Ryan, M.T. Douglas, and R. Ikehara- Quebral) Under the *latte*: Osteobiography and social context of a burial assemblage at Tumon Bay, Guam. In session “Bio-Social Adaptation in Southeast Asia and Oceania” 20<sup>th</sup> Congress of the Indo-Pacific Prehistory



Association, Apsara-Angkor Resort and Conference Hotel, January 12-18, 2014, Siem Reap, Cambodia.

2013 (with Mohammad Yousuf and Marvin W. Rowe) Pictographs from Mahlac Cave, Guam: Radiocarbon Dating and Chemical Studies. XVII International Congress of the International Federation of Rock Art Organisations (IFRAO) in conjunction with the American Rock Art Research Association (ARARA) Conference, May 26-31, Albuquerque, NM.

2013 Migration for settlement or home range expansion: What caused people to first come to the Marianas? Second Mariana Islands History Conference, August 30-31, 2013, Univ. of Guam. Online: [https://issuu.com/guampedia/docs/mhc\\_history\\_bookpft/11](https://issuu.com/guampedia/docs/mhc_history_bookpft/11)

2013 Niche dynamics in late-Holocene ISEA and the Mariana Islands, Micronesia. 78<sup>th</sup> Annual Meeting of the Society for American Archaeology, April 3-7, 2013, Honolulu.

2012 Discussant in session, Processual Archaeology beyond Binford: Current and Future Directions. Symposium organized by Amber Johnson and John Hays: 77<sup>th</sup> Annual Meeting of the Society for American Archaeology, April 18-22, Memphis.

2012 Current understandings of ancient Marianas pictographs. First Mariana Islands History Conference, June 14-16, Saipan, Commonwealth of the Northern Mariana Islands. Online: [https://issuu.com/guampedia/docs/ancient\\_marianas\\_history/55](https://issuu.com/guampedia/docs/ancient_marianas_history/55)

2009 Last Millennium Climate Changes and evolution of the Ancestral Chamorro Culture in the Mariana Islands, Micronesia. Session C11 The Last 1000 Years, Emergence, Development and Archaeological Signatures of the Traditional Indigenous Societies in the Western Pacific. 19<sup>th</sup> Congress of the Indo-Pacific Prehistory Association, Vietnam Academy of Social Sciences, Nov. 29-Dec. 5, Hanoi, Vietnam.

2009 The Latte Period in Marianas Prehistory: Who is Interpreting It and Why? Paper presented at the Pacific Island Archaeology in the 21st Century: Relevance & Engagement Conference, July 1-3, Koror, Palau.

2008 (with D. R. Moore) Documenting the Other Spanish *Entrada*: Archaeology at Old Pago Village, Guam, Mariana Islands, Micronesia. Society for Historical Archaeology annual meetings, Jan. 8-10, Albuquerque, NM.

2008 Cultural Responses to Late Holocene Climatic Oscillations in the Tropical Northwestern Pacific: A New Interpretation of the Prehistoric Latte Period of Guam, Mariana Islands, Micronesia. XVI International Conference of the Society for Human Ecology, September 10-13, 2008, Bellingham, Washington.

2006 Climatic significance of savanna endemics and pre-human charcoal particles in paleosediment cores in the southern Marianas. 18<sup>th</sup> Congress of the Indo-Pacific Prehistory Association, March 20-26, Manila.

2002 Effects of Holocene climatic oscillations upon human population radiations into Remote Oceania, and consequences for cultural variation in the Marianas. Presented at the 17th Congress of the Indo-Pacific Prehistory Association, Sept. 9-15, Academia Sinica, Taipei.

2001 (with D.R. Moore) The Marianas Pottery Sequence Revisited. Presented at the International Symposium on Austronesian Cultures: Issues Relating to Taiwan, December 8-12, Academia Sinica, Taipei.

2001 Bare skin and social identity in Micronesia: variation in the incidence of tattooing among the coralline and high islands of the Carolines, Marshalls, and Marianas. Presented at the 10th Pacific Science Inter-Congress, June 1-6, 2001, Univ. of Guam.

2001 The anthropological meaning of latte stones: diffused architectural form or local symbol? Presented at the 10th Pacific Science Inter-Congress, June 1-6, Univ. of Guam.

2001 Toward an explanation of diversity in Latte Phase burials on Guam. Presented at the 66th Annual Meeting of the Society for American Archaeology, April 18-22, New Orleans, LA.

1999 A cultural ecological explanation of the role of giant swamp taro (*Cyrtosperma chamissonis*) in the evolution of Yapese culture. Presented via video tape at the XIX Pacific Science Congress, July 4-9, Sydney, Australia.

1998 From Palau to Rapanui, are the Pacific island grasslands recent "artifacts" or natural formations? Presented at the 63rd Annual Meeting of the Society for American Archaeology, March 25-29, Seattle, WA.

1997 Human vs. climatic impacts at Rapanui or, Did the people really cut down all those trees? Presented at the South Seas Symposium, Easter Island in the Pacific Context, Aug. 5-10, Univ. of New Mexico, Albuquerque, NM

1996 (with D.R. Moore) Pots and Pans in the Intermediate Pre-Latte (2500-1600 BP), Mariana Islands, Micronesia. Presented at the Vanuatu National Museum/Australian National University ORSTOM Conference, July 31-August 6, 1996, Port Vila, Efate, Vanuatu.

1995 Explaining diversity in Latte Phase burials on Guam. 8th annual meetings of the Society for Hawaiian Archaeology, Apr. 8-9, Honolulu, HI.

1995 Toward an explanation of diversity in Latte Phase burials on Guam. Symposium on the Prehistoric Skeletal Biology in an Island Ecosystem: Current Status of Bioarchaeological Research in the Marianas Archipelago. Annual meetings of the Amer. Assoc. of Physical Anthropologists, Mar. 29-Apr. 1, Oakland, CA.

1995 (with S. Ambrose, B. Butler, and D. Hanson) Stable isotopic analysis of human diet in the Marianas archipelago. Symposium on the Prehistoric Skeletal Biology in an Island Ecosystem: Current Status of Bioarchaeological Research in the Marianas Archipelago. Annual meetings of the Amer. Assoc. of Physical Anthropologists, Mar. 29-Apr. 1, Oakland, CA.

1994 (with D. Moore) Retreat or expansion: Tracking prehistoric settlement in Guam's interior. Paper presented at the Australian Archaeological Assoc. Annual Conference, Nov. 24-26, 1994. La Trobe Univ., Bundoora, Victoria, Australia.

1994 (with S. Ambrose, B. Butler, D. Hanson, and H. Krueger) Stable isotopic analysis of human diet variation in Micronesia. Fryxell Symposium, 59th Annual Meetings of the S.A.A., April 20-24, 1994, Anaheim, CA

1994 (with J.R. Amesbury and D.R. Moore) Living on the edge: Cultural adaptations to changing shoreline habitats in the Marianas, 3500-900 years BP. 15th Indo-Pacific Prehistory Association Congress, Jan. 5-12, Chiang Mai, Thailand.

1994 (with D. Moore and G. Thompson) The adaptive context for the prehistoric use of rice in the Marianas. 15th Indo-Pacific Prehistory Association Congress, Jan. 5-12, Chiang Mai, Thailand.

1992 An ecologically based explanation-sketch for differences in the ancient built environments of Yap and of the southern Mariana Islands, Micronesia. Third International Conference of the International Association for the Study of Traditional Environments, Oct. 8-11, Paris, France.

1992 Tracing the patterns of early permanent human occupation of the western Pacific atolls by radiometric dating of non-carbonate carbon in the basal soils of the central taro patches of large atoll islets. Poster presented at the 7th International Coral Reef Symposium, June 22-26, Guam.

1989 (with S. Khosrowpanah) Using the USLE to discuss the causes of sedimentation in Guam, Mariana Islands. Headwaters Hydrology Symposium, American Water Resources Association, June 27-30, Missoula, MT.

1989 (with J.S. Athens, J.V. Ward, and D.J. Welch) Landscape Change, Agriculture, and Complex Societies on Tropical Pacific Islands. Circum-Pacific Prehistory Conference, Aug. 2-9, Seattle, WA.

1989 (with J.R. Amesbury and D.R. Moore) Cultural implications of grave goods from a Spanish Period Carolinian burial from Guam, Mariana Islands, Micronesia. Joint Archaeological Congress, Jan. 5-9, Baltimore, MD.

1988 (with M. Montvel-Cohen) Sign and symbol: visual enhancement in Yapese meeting houses. 18th Waigani Seminar, Theme 6, Environmental Design, Architecture and Technology in the Pacific. Sept. 4-11, Univ. of Papua New Guinea, Pt. Moresby, PNG.

1988 The demystification of the *sawei*: understanding an inter-island exchange/help system in the tropical western Pacific. XII International Congress of Anthropological and Ethnological Sciences, July 24-31, 1988, Zagreb, Yugoslavia.

1987 (with S. Khosrowpanah) Socio-political impacts on the water distribution system of Kolonia, Pohnpei, capital of the Federated States of Micronesia. A.S.C.E. International Conference on Resource Mobilization for Drinking Water Supply and Sanitation in Developing Nations, May 26-29, 1987, San Juan, Puerto Rico.

1987 Above paper also presented at 7th Annual Research Conference of the College of Arts and Sciences, Univ. of Guam, Mangilao.

1987 (with Y. Zan) On the Origins of the Micronesian 'Savannahs': An Anthropological Perspective. Third Annual Soil Management Workshop, Management and Utilization of Acid Soils of Oceania, Feb. 2-6, Palau.

1987 (with S. Trowbridge) Indigenous Fresh Water Management Technologies in Truk, Pohnpei and Kosrae States, F.S.M., and in Guam. 7th Annual Research Conference of the College of Arts and Sciences, Univ. of Guam, Mangilao.

1987 The Changing Role of Small Structural Anasazi Sites in the Northern Rio Grande Valley, A.D.1175-1450. 52nd Annual Meetings of the S.A.A., May 6- 10, Toronto, Canada.

1986 An Ecological Approach to Understanding Inter-island Exchange and Social Ranking in the Western Carolines, Micronesia. Symposium on Social Complexity and Its Archaeological Correlates in Micronesia, 51st Annual Meetings of the S.A.A., New Orleans. LA.

1986 Report on Research into Prehistoric Fresh Water Management Technology in Yap, Western Caroline Islands. 7th Annual Research Conference of the College of Arts and Sciences, Univ. of Guam, Mangilao.

1986 The Magnetic Mogollon, or, Why are the Early Cultigen Sites in the Mountains? 4th Mogollon Conference, Univ. of Arizona, Tucson, AZ.

1983 Yapese Social Stratification and its Archaeological Consequences for the Study of Fishing Adaptations. Symposium on Micronesian Archaeology, XVth Pacific Science Congress, Dunedin, NZ.

1983 Recent Observations on Traditional Yapese Settlement Patterns. Symposium on Settlement Patterns in Oceania, XVth Pacific Science Congress, Dunedin, NZ.

1983 From Variety to Redundancy in House Types and Other Changes in the Use of Site Space among Prehistoric Horticulturalists in the U.S. Southwest. 48th Annual Meetings of the S.A.A., Pittsburgh, PA.

1983 The Role of Swamp Taro (*Cyrtosperma chamissonis*) in Yapese Cultural Evolution. XIth I.C.A.E.S., Vancouver, Canada.

1982 Proving the Moon is Made of Cheese: The Structure of Recent Research in the Mogollon Area. 3rd Mogollon Conference, Las Cruces, NM.

1978 The selective context for unilineality in the prehistoric Southwest. 43rd Annual Meetings of the S.A.A., Tucson, AZ.

1978 Use of a Matri-idiom in the Social Organization of the Western Pueblos. Symposium on the Status of Women in Prehistory, 43rd Annual Meetings of the S.A.A., Tucson, AZ.

1978 Matrification in Residence and Descent in the Western Pueblo Region. Woman the Gatherer Symposium, Annual Meetings of the A.A.A., Los Angeles, CA

1977 Comments on the Symposium, The Northern Rio Grande, Views from Its Periphery. 50th Anniversary Meeting of the Pecos Conference, Pecos, NM

1972 An Explanation for the Cochise Culture Materials. Annual Meetings of the S.W.A.A., Long Beach, CA.

1970 (with Y. Zan) The Recent History of New Archaeology: New Categories or New Explanations? 31st Annual Meetings of the S.A.A., Mexico City, Mexico.

1968 (with C. Vanasse and M. Schiffer) Population growth and land use diversity. Pecos Conference, El Paso, TX.

## PUBLICATIONS

2022 (with Yue-Chen Liu, Olivia Cheronet, Joanne Eakin, Frank Camacho, Michael Pietrusewsky, Nadin Rohland, Alexander Ioannidis, Rebecca Bernardos, Matthew Mah, Kirsten Mandl, Nicole Adamski, Nasreen Broomandskhoshbacht, Kimberly Callan, Ann Marie Lawson, Megan Michel, Jonas Oppenheimer, Kristin Stewardson, Fatma Zalzala, Kenneth Kidd, Judith Kidd, Theodore G. Schurr, Douglas J. Kennett, Nick Patterson, Carlos Bustamante, Andres Moreno-Estrada, Matthew Spriggs, Miguel Vilar, Mark Lipson, Ron Pinhasi, and David Reich) Ancient DNA reveals five streams of migration into Micronesia and matrilocality in early Pacific seafarers. *Science*, 377 (6601) 72-79, DOI: 10.1126/science.abm6536.

2021 When the European Old World met the CHamoru Old World in 1521: An archaeological Perspective from Guam's Latte Period. Contribution to the exhibition "BIBA CHAMORU: Culture and identity in the Mariana Islands," Nov. 18, 2021-March 6, 2022, Museo Nacional de Antropología, Madrid, Spain. In exhibition catalog *I estoria-ta: Guam, the Marianas and Chamorro Culture*, pp. 47-55. Spanish Ministry of Culture and Sport and Cultural Action, 2021 Edition.

2021 Micronesia. In *Encyclopaedia of Vernacular Architecture of the World*, 2<sup>nd</sup> Edition. Paul Memmot, Editor for Australasia and Oceania and Marcel Vellinga, Editor-in-Chief. Bloomsbury Publishing, PLC, London, UK.

2021 Yapese. In *Encyclopaedia of Vernacular Architecture of the World*, 2<sup>nd</sup> Edition. Paul Memmot, Editor for Australasia and Oceania and Marcel Vellinga, Editor-in-Chief. Bloomsbury Publishing, PLC, London, UK.

2016 (with A.L.W. Stodder, E.M. Ryan, M.T. Douglas, and R. Ikehara- Quebral) Under the *Latte*: Osteobiography and social context of a burial assemblage at Tumon Bay, Guam, Chapter 24 In Marc Oxenham and Hallie Buckley, Eds., *Routledge Handbook of Bioarchaeology in Southeast Asia and the Pacific Islands*, pp. 527-568. Taylor & Francis Group, New York, NY.

2014 (with D. R. Moore) Archaeological investigations of a Japanese-era lighthouse at Yap, Caroline Islands. *Pan-Japan* 10(1&2):57-93 In B. Dixon and D. Tuggle (eds), *The Japanese Diaspora in Micronesia: Its Archaeological Context*, Part 2.

2013 (with M. Yousuf and M. W. Rowe) Pictographs from Mahlac Cave, Guam: Radiocarbon dating and chemical studies. *American Indian Rock Art* 40: 995-1016.

2012. Running to stay in place: An adaptive escalation model for the Latte Period. *Micronesica* 42(1, 2):152-188.

2011. The Latte Period in Marianas Prehistory: Who is interpreting it and why? In J. Liston, G. Clark, and D. Alexander, Eds., *Terra Australis 35: Pacific Island Heritage: Archaeology, Identity, and Community*, pp. 17-29. Australian National University, Canberra, Australia.

2011 (with L. Straus, L.A. Borrero, W. Longacre, D. Meltzer, D. Read, J. Sabloff, and F. Wendorf). Lewis Roberts Binford (1931-2011), Lew Binford deserves more than the usual obituary. *Journal of Anthropological Research* 67 (3):321-331.

2011. Review of "Lines that Connect: Rethinking Pattern and Mind in the Pacific" by Graeme Were. *Journal of Anthropological Research* 67 (3):469-471.
2010. Cultural Responses to a Late Holocene Climatic Oscillation in the Mariana Islands, Micronesia: Lessons from the Past. *Human Ecology Review* 17(2):148-159.
- 2010 (with P. D. Nunn). Defending the Defensible: A rebuttal of Scott Fitzpatrick's (2010) critique of the AD 1300 Event model with particular reference to Palau. *Journal of Pacific Archaeology* 2(1):1-8.
- 2009 (1986) *Prehistoric Adaptation in the American Southwest*. New Studies in Archaeology, Cambridge Univ. Press, New York.
- 2009 Savanna anthropogenesis in the Mariana Islands, Micronesia: Re-interpreting the paleoenvironmental data. *Archaeology in Oceania* 44:125-141.
- 2007 (with P. D. Nunn, M. T. Carson, F. Thomas, S. Ulm, and M. J. Rowland). Times of plenty, times of less: Last-millennium societal disruption in the Pacific Basin. *Human Ecology* 35 (4):345-401.
- 2006 Review of "Island at the End of the World: The Turbulent History of Easter Island" by Steven Roger Fischer. Reaktion Books. *Pacific Affairs* 79(2):361-363.
- 2006 Review of Integrating Archaeology and Ethnohistory: The Development of Exchange between Yap and Ulithi, Western Caroline Islands by Christophe Descantes, BAR International Series 1344, 2005, Archaeopress, Oxford. *Asian Perspectives* 45(2):295-299.
- 2005 An anthropological perspective on the prehistory of the Mariana archipelago with special reference to Guam. In *Guam History: Perspectives, Vol. Two*, edited by Lee D. Carter, William L. Wuerch, and Rosa R. Carter, pp. 20-59. Richard Flores Taitano Micronesian Area Research Center, Univ. of Guam, Mangilao, Guam.
- 2005 Contextualizing our past: P-M lite comes to Micronesia. Review of The Archaeology of Micronesia by Paul Rainbird, Cambridge Univ. Press. *Journal of Micronesian Humanities and Social Science*; Electronic document. [http://marshall.csu.edu.au/MJHSS/Issue2005/MJHSS2005\\_106.pdf](http://marshall.csu.edu.au/MJHSS/Issue2005/MJHSS2005_106.pdf)
- 2004 Review of On the Margins of Sustainability, Prehistoric Settlement of Utrok Atoll, Northern Marshall Islands by Marshall I. Weisler. BAR International Series 967, 2001, Archaeopress, Oxford,. *Asian Perspectives* 43(1):158-162.
- 2003 Review of *Easter Island: Scientific Exploration into the World's Environmental Problems in Microcosm*, John Loret and John T. Tancredi (eds.). Anthropology Review Database. December 17. Electronic document. <http://wings.buffalo.edu/ARD/showme.cgi?keycode-2261>.
- 2000 Ethnographic and archaeological investigations in the Southwest Islands of Palau. *Micronesica* 33(1/2):11-43.
- 1999 (with D. Moore) Pots and pans in the Intermediate Pre-Latte (2500-1600 BP), Mariana Islands, Micronesia. In J.-C. Galipaud et I. Lilley (eds) *Le Pacifique de 5000 à 2000 avant le*

*Présent, Suppléments à l'Histoire d'une colonisation, The Pacific from 5000 to 2000 bp, Colonisation and Transformations*, pp. 487-503.

1997 Micronesia. In *Encyclopedia of Vernacular Architecture of the World*, 3 vols, ed. by Paul Oliver. Cambridge Univ. Press, Cambridge. Vol. 2, II, 5, B:1151-1153.

1997 Yapese. In *Encyclopedia of Vernacular Architecture of the World*, 3 vols, ed. by Paul Oliver, Cambridge Univ. Press, Cambridge. Vol. 2, II, 5, S:1170-1171.

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1983 Yapese Settlement Patterns: An Ethnoarchaeological Approach. Pacific Studies Institute, Agana, Guam.

## Joanne Eakin

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### Education

University of New Mexico, MA, Anthropology, specializing in Bioarchaeology

University of Maryland, BA Anthropology

### Experience Summary

Joanne Eakin, MA, has managed projects of all types pursuant to federal, state, and local laws and regulations, including Section 106 of the National Historic Preservation Act; the Archaeological Resource Protection Act (ARPA); the Native American Graves Protection and Repatriation Act (NAGPRA); and the National Environmental Policy Act (NEPA). Ms. Eakin is an osteologist who has conducted excavation and analysis of multiple large human skeletal assemblages. Her work includes skeletal inventories and analyses of large populations in Guam and the CNMI, recovery of WWII Japanese and American remains in Kiribati and Saipan, and DNA research into the early population history of Micronesia.

### Bioarchaeology Projects and Research

2023-present Osteological analysis of human skeletal remains at US Marine Corps Camp Blas on Guam's northern plateau. In progress.

2023 (with R. Hunter-Anderson) *Healing History through Science: How Ancient and Modern DNA Analysis Confirms Chamorro Authenticity in the Mariana Islands*, Marianas History Conference, Garapan, Saipan.

2022 (with R. Hunter-Anderson) *DNA Analysis Reveals a Complex Population History of Prehistoric Micronesia*, 22nd Congress of the Indo-Pacific Prehistory Association, Chiang Mai, Thailand.

2022 *Ancient DNA reveals five streams of migration into Micronesia and matrilocality in early Pacific seafarers*. Liu et al., *Science* 377, 72–79. Research funding through the National Geographic, Reich Lab, Harvard Medical School, and the University of Vienna.

2022 (with R. Hunter Anderson) *Ancient DNA Confirms Biological and Cultural Continuities the Marianas for over 2,500 Years*. American Memorial Park Theater, May 27, 2022, Saipan.

2022 (with R. Hunter Anderson) *Ancient DNA, CHamoru Origins and Cultural Continuity at the Naton Beach Site, Guam*. 2nd Annual Pacific Preservation Summit May 24-26, Hagatna.

2021 (with R. Hunter Anderson) *Origins of the People of the Mariana Islands: Ancient DNA Research and Archaeological Context*. Presentation to the 5th Marianas History Conference.

2020 Embassy Ocean Front Archaeological Testing, San Roque, Saipan, CNMI. NV5 Project Supervisor, Osteologist.

2018 *Ancient DNA and Isotopic Analysis of Archaeological Remains from Two Individuals from Guam*. M. G. Foody, P. Ditchfield, S. Ambrose, J. Eakin, M. Almeida, D. Vieira, A. Brand, T. Rito, J. Hackland, L. Aguon,

R. Blas, M. Pala, R. Hunter-Anderson, M. Richards, S. Oppenheimer, P. Soares, and C. Edwards: 8th International Symposium on Biomolecular Archaeology.

2017 Saipan Surfrider Testing and Excavation: archaeological testing and excavation of multi-component site on Saipan, CNMI, Principal Investigator, Osteologist.

2015-2017 *A Pilot Study of Ancient mtDNA and Stable Isotopes in Teeth and Temporal Bones from the Naton Beach Site, Tumon, Guam* (with R. Hunter Anderson). Funding through Guam Preservation Trust.

2015-2016 *Archaeological Testing and Data Recovery to Repatriate WWII Human Remains from the Gyokusai Battle, Saipan*. Principal Investigator, osteologist. Client: Kuentai, Tokyo, Japan.

2016 *Data Recovery at the Tkachev Property, Lot 014B08, Achugao, Saipan*. Consulting Osteologist. Client: Kuentai, Tokyo, Japan.

2015 *Chamorro Origins and the Importance of Archaeological Context* (with R. Hunter Anderson). Marianas History Conference, Saipan, CNMI.

2014 *Osteological Analysis in Rota Oil Site Excavations, CUC Rota Power Plant, Songsong Village, Island of Rota, Commonwealth of the Northern Mariana Islands*. Prepared for US EPA Region 9 and Environmental Quality Management, Inc.

2013 *Battle of Tarawa Data Recovery, Tarawa, Kiribati*. Excavation and osteological analysis: Consulting archaeologist and osteologist, History Flight.

2011 *Analysis of Human Skeletal Remains in Data Recovery Excavations at Lizard Site, LA 32078, White Sands Missile Range, New Mexico*. Prepared for Zia Environmental and Engineering Consultants Las Cruces, NM.

2012 *Possible Cases of Molar Incisor Hypomineralization (MIH) In Subadults from Guam in the Mariana Islands* (with Julie Euber). Presented at the Paleopathology Association North American Meeting, Portland, Oregon and the Marianas History Conference, Saipan, CNMI.

2011 Ancient Chamorro Burial Practices. URL: <http://guampedia.com/ancient-chamorro-burial-practices>

2009 *Preliminary Findings from the Naton Beach Burial Site, Guam*. Pacific Island Archaeology Conference, Republic of Palau.

2007 Excavation and Analysis of Human Skeletal Remains, Archaeological Data Recovery at the Naton Beach Site. Osteologist for Paul H. Rosendahl, Ph.D., Inc. Western Pacific Division Office, Guam.

2007 *Analysis of Human Skeletal Remains, Archaeological Data Recovery at Guam Dai-Ichi (Fiests) Hotel Improvements Project, PHRI 2451*. Prepared for Paul H. Rosendahl, Ph.D., Inc. Western Pacific Division Office, Guam.

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1991 *Analysis of Human Skeletal Remains, Cuchillo Reservoir Excavations*, Office of Contract Archaeology, UNM.

1989 *Analysis of Human Skeletal Remains from Rivers Edge, Rio Rancho, NM* for Rio Grande Consultants.