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PACHAMAMA - 101062179 — HE-MSCA-PF-2021

Career Development Plan

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Project: Paleodietary analyses of the first Andean cities: high-resolution assessment to macronutrients using a multiproxy approach - **PACHAMAMA** - 101062179 — HE-MSCA-PF-2021.

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Following the principles of the MSCA Guidelines on Supervision, my supervisory team and I have designed this Career Development Plan (CDP), which is focussed in strengthen my capabilities and acquire new ones. This CDP will be periodically reviewed (each 3 months) to meet goals and adjust my specific training to new needs.

Brief overview of Research Project and major accomplishments expected

The origin of the first urban centres and their associated social complexity are among the most debated topics in prehistoric archaeology. In the Central Andes, these processes have their antecedents in coastal settlements with impressive signs of monumentality, dating from at least the third millennium BC. According to a seminal 1975 publication, these societies would have developed complex systems of socio-political organization, which eventually led to States and Empires, sustained by the exploitation of the rich shoals of endemic marine species. On the other hand, newer archaeological evidence suggests that the adoption of plants in the region precedes in at least 3 millennia the rise of monumental architecture. Further, archaeological research conducted in the Peruvian North-Central coast (PNCC) for the last two decades has drastically changed our knowledge about the trajectory of early urban developments. At least 35 planned sites integrated into intra-valley hierarchical systems of settlements in the PNCC (i.e., Huaura, Supe, Fortaleza, and Pativilca valleys), dating between 4100-1800 BCE, came to reinforce the hypothesis that early civilization, based on powerful agricultural development, arose in the middle valleys rather than on the coastline. However, several major questions are still unanswered: 1) What food sources characterized the diets of the earliest urban populations of the Central Andes during the Initial Formative period (3000-1800 BCE)? 2) What were the roles of plant and marine resources in the diet of coastal and inland emergent urban sites? 3) How did these diets change over time? With the support of the Marie Skłodowska-Curie Actions programme, the PACHAMAMA project will analyse paleodiet using a multiproxy approach (stable isotopes, Bayesian mixing models, and palaeoproteomic analyses of dental calculus) aiming to identify the main macronutrients of the diet, to unlock diet composition among early urban groups in coastal Peru. To identify dietary food molecules, we will use stable carbon and nitrogen isotope analyses of bulk collagen from bone and teeth using gas chromatography combustion isotope ratio mass spectrometry (GC-C-IRMS), the analysis of stable carbon and nitrogen isotopes on single amino acids (AA) from bone collagen using liquid chromatograph-IRMS (LC-IRMS). Palaeoproteomics will be applied to identify specific food molecules and diet-correlated pathogens in the oral microbiome. The integration of palaeodietary isotopic reconstruction, palaeoproteomics, and other bioarchaeological (i.e., oral pathology) data is the most innovative component of PACHAMAMA.

1. LONG-TERM CAREER OBJECTIVES (over 5 years)

1.1. Goals

To get a more stable academic position at world-leading research institutions in South America and Europe (i.e., universities, museums, government research institutions). My long-

term career objectives for the next five years include a substantial improvement in my current academic skills to replace the weaknesses in my CV to enhance the career perspectives and future employability. The 24 months of training acquired thanks to PACHAMAMA will provide new skills to enhance my research profile, reinforce my project management experience, strengthen my network of scientific partners, and improve my possibilities of success to get an ERC StG or other funding applications.

1.2. Further research activity necessary to attain these goals

My academic repertoire and my future academic career should be strengthened by new skills acquired, such as:

a) Versatility and resourcefulness: The training in stable isotopes, Bayesian Mixing Models, palaeoproteomics, and bioinformatics, combined with my current expertise in palaeodietary reconstruction, palaeopathology, and other capabilities as bioarchaeologist, should improve my profile placing me in an exceptional condition to apply for permanent positions in the field of bioarchaeology.

b) Expanded research network: PACHAMAMA will allow me to be integrated within an ERC research group (TRADITION) and two departments (DP and ICTA, UAB) that have world-leading reputations in archaeology, ancient and modern environmental studies, and social sciences. Within this academic environment I will engage with researchers at the forefront of these fields, creating new opportunities to develop interdisciplinary research aiming to build a strong network of scientific collaboration.

c) Enriched professional development: PACHAMAMA will provide new opportunities for lecturing, teaching laboratory sessions, and mentoring of students and junior researchers, reinforcing my skills for a future career in academia.

d) Dissemination of the research results: Boost research excellence leadership through publication submission/publication of scientific articles in specialized peer-reviewed open-access journals, participation in academic events. PACHAMAMA results should also be disseminated through social media platforms and public engagement activities. The programmed actions figure in the Communication and Dissemination Plan (DCP).

e) Funding application: Writing of new projects to applying for funding that will put me in a better position to secure a permanent academic position (e.g., ERC StG, other funding applications).

2. SHORT-TERM OBJECTIVES (1-2 years, project length)

By learning the complete protocols of isotopic and palaeoproteomic analyses, I will be in a unique position to integrate the research results, critically evaluate them, and answer my archaeological questions. The training and accomplishment of the PACHAMAMA action will allow me to produce high-impact research articles to be submitted to prestigious peer-reviewed journals.

2.1. Research results

a) Publication of scientific articles: The main expected results from PACHAMAMA research include some anticipated publications:

1) A paper based on the wide integration of methods used (stable isotopes, amino acids analyses and proteomics), will be discussing the diets at the onset of the urbanization process in the PNCC. This paper will be submitted to wide distribution, open-access journals such as PlosOne, Nature, PNAS.

2) A methodological paper focused on the integration between proteomics of oral microbiome and oral pathology will be submitted to a more specialized journal (e.g., Journal of Proteomics, Journal of Dental Research).

3) Other results related to specific findings on lifestyle, health or archeological issues could offer other alternatives of publication. Such results will be submitted to more "archaeological" journals (e.g., Journal of Archaeological Science, Latin American Antiquity).

4) Publication of the first Proteomic Library for the North-Central Coast of Peru (i.e., bacterial metaprofiles and species identification).

All the methodological developments, datasets, and research outputs generated by PACHAMAMA will be shared with academic audiences in open access repositories (e.g., the UAB's Digital Documents Deposit, Open Research Europe-ORE and European Open Science Cloud-EOSC, Zenodo.org, etc.) following UAB's and the EU's open access policies. We also will publish research results in Research Gate, Academia and Orcid profiles, to reinforce our presence in the virtual academic sphere. A Data Management Plan (DMP), which include all the details about the protocols to be follow with the resultant data of PACHAMAMA, will be submitted to MSCA in the next weeks.

b) Participation in academic meetings: During the PACHAMAMA action I will be participating in at least 3 international conferences:

1) The 10th Paleopathology Association Meeting in South America (PAMinSA-X, 9-11 August 2023, Cochabamba - Bolivia), where we will present preliminary results of stable isotopes for dietary reconstructions in the PNCC.

2) The *X Congreso Nacional de Arqueología del Perú* (21-26 August 2023, Lima–Peru), where we will present preliminary interpretations on the relationship between diet and social complexity in the PNCC.

3) The 10th International Symposium on Biomolecular Archaeology (ISBA-10, 13-16 September 2023, Tartu - Estonia), where we will present preliminary data on proteomic analysis of dental calculus and their integration with stable isotopes and oral pathology.

We also anticipated our participation in local academic and public-engaged activities in Barcelona and the Supe Valley in Peru (see CDP for details).

2.2. Research Skills and techniques

Through a well-established training program in state-of-the-art isotopic and proteomic methods at ICTA and DP (UAB), PACHAMAMA project will allow me to improve my expertise in laboratory and protocols experimental design, quantitative and qualitative analytical methods, as well as the development of independent and critical thinking in my research field. A better background in the integration of multi-scalar biomolecular methods allow me, in turn, to deal with more complex research questions in future projects.

Several modules of training in specific new areas are expected during PACHAMAMA action:

a) Training in protocols and laboratory procedures of collagen and carbonate extraction and purification from bone and teeth.
b) Training in protocols mass-spectrometry analyses of bulk collagen stable isotopes of carbon, nitrogen, and sulfur.
c) Training in protocols and laboratory procedures of amino acid extraction from bone collagen and compound-specific isotope analyses of single amino acids.
d) Training in analytical laboratory procedures and managing of spectrometers such as Elemental Analysis-Isotope Ratio Mass Spectrometry (EA-IRMS), Gas Chromatography Combustion Isotope Ratio Mass Spectrometry (GC-C-IRMS) and Liquid Chromatograph-IRMS (LC-IRMS).
e) Training in Bayesian Stable Isotope Mixing Models (BSIMMs) for paleodietary reconstructions.
f) Training in palaeoproteomic analysis and the most up-to-date protocols for protein extraction from dental calculus (i.e., identification of specific food molecules and diet-related microbiomes) and preparation for LC-MS/MS analysis.
g) Training in Bioinformatics of Palaeoproteomics. Specific training in the use of publicly available protein sequence databases to interpret metaproteomic datasets (i.e., UniProt, NCBI, SwissProt) and bioinformatic software packages (i.e., Mascot, deamiDATE).

2.3. Research management

My past experience has given me the opportunity to gain skills in project management by being in charge of the management of four research projects on bioarchaeology, in which I have been responsible for scientific coordination, logistics, finances and development of strategies for the adequate use of resources, and time-management capabilities. PACHAMAMA will provide me extra skills related to work programming, supervision, administrative duties, financial planning, and resource management. The successful completion of the PACHAMAMA will attest to my ability to conceive, plan, and manage a large-scale research project, and also my competence to carrying out larger international projects.

Through its C&C action plan, UAB has created a Professional-Competence Model for researchers that include the development of six desirable skills to a successful academic career: interpersonal, cognitive, communication, research, organizational, and influencing and impacting skills. In the framework of this plan, the ***Unitat de Formació*** of UAB has implemented several **training events and academic courses** specially designed to improve these skills that I will **attend** as part of PACHAMAMA, among them: project management, personal motivation, adaptation to change, conflict resolution, leadership, standardization, copyright laws, data management, ISO requirements.

PACHAMAMA will provide me appropriate skills to working in teams, expand my research and collaborative networking and will provide me the ability to successfully **identify possible sources of funding** for personal and team research. The list of fellowships and funding applications that I planned to apply appear below:

1. Starting Grant of the European Research Council (ERC)
2. Consolidator Grant of the European Research Council (ERC)
3. Ayuda Ramón y Cajal – Agencia Estatal de Investigación de España (AIE)
4. Other opportunities in Europe and South America.

3. Communication skills

3.1. Communication to different target audiences

PACHAMAMA includes a well-designed communicative strategy to spread the resulting knowledge for different target audiences, that can be divided in five main fronts:

a) Expose scientific leadership to broader **scientific community through conferences, podium presentations in congresses, seminars** etc. This includes the improvement of my communicative skills in English to be able to defend research outcomes in front of big audiences.

b) The **writing and submission of academic papers and books/book chapters** followed by adequate outreach. After the publication of our scientific articles, **media releases** will be planned with the UAB's Public Information Office to be published as media reports in the Catalan, Spanish, and European media outlets. Our partner, the Caral Project, has contact with journalists of magazines, journals, and TV, in Peru and Spain, that will be contacted to prepare short journalistic reports of the results.

c) A project's **website and social media walls** (LinkedIn, Instagram, and Twitter) have been created and will be a central point for dissemination and online engagement. Simultaneously, the webpages of the *Departamento de Prehistoria* and ICTA (UAB) and the websites of the *Zona Arqueológica Caral* and *Ministerio de Cultura del Perú*, will supply additional support. The aim is to promote public understanding of our study field through an easy and non-technical way to engage the general public through the media.

d) Other activities, which aim to bring science to the community through a **series of annual events,** were mentioned above in the section 2.1.

e) Finally, to share science to the wider-public, especially students, we have projected, along with the Caral Project Direction, the publication of a divulgation book for children about bioarchaeological research in the valley (see DCP for details).

Details on the development of these communicative strategies will be submitted as a detailed Dissemination and Communication Plan (DCP) in the next weeks.

4. Other professional training (course work, teaching activity)

Apart from, scientific events such as conferences, seminars, lectures, and other academic meetings, I planned to share my background on Andean Archaeology, oral pathology, palaeopathology, and stable isotope reconstructions with students and scholars in ICTA and the *Departamento de Prehistoria*, as well as with my scientific partners in South America.

As mentioned in the original project, the idea is to impart this expertise in the mentioned matters to undergraduate and postgraduate students of the DP through two seminars in the Master of Prehistory, in the Prehistory Department of the UAB:

1) The class called "Stable isotopes for the archaeological study of weaning behaviours, childhood diets, and parental investment" in the course "Introduction to Biomolecular Archaeology" of the Master in Prehistoric Archaeology (March 2023).
2) A not yet programmed class about archaeological applications of stable isotopes in the Master in Prehistoric Archaeology (March 2024).
3) Other classes imparted as part of future invitations.

During my research field-season in July of 2023, I planned to impart some conferences for professionals and students that work in the Caral Project, to make an update of our findings in the research of stable isotopes in bones and teeth from the Formative populations.

I also expect to have the opportunity to co-supervise postgraduate dissertations (Master's in Prehistoric Archaeology), and to collaborate with members of ICTA and DP.

These activities will increase my teaching, supervision, and mentoring experience and, in turn, should strength my knowledge-transfer skills.

5. Anticipated networking opportunities

Meetings with supervisor, to supervise and adjust the appropriate development of PACHAMAMA project have been scheduled to each 15 days frequency.

I expect to develop collaborative networks with members of the ERC TRADITION, and scholars from the *Departamento de Prehistoria*, and ICTA, through weekly and monthly meetings and seminars.

On other avenues, I will reinforce my through paper publications with recognized specialists in stable isotopes and proteomics in the next months.

Finally, I expect, co-organize an international workshop in Barcelona (Ancient Proteins and the Early Globalized World) with Dr. Alice Toso in 2024 (ICTA-DP/UAB).

My participation in these events will be relevant to expand my collaborative networks with an increasingly wider research community.

6. Other activities with professional relevance

Among other relevant activities related to career management we can mention the eventual and collateral acquisition of new transferable skills. For instance, learning Bayesian Mixing Models demand the parallel learning of other additional skills such as Bayesian Statistics, R language, and the knowledge of other software packages such as IsoMemo, Stable Isotope Bayesian Ellipses in R (SIBER), Kernel isotopic niches in R (rKIN), among other statistic tools for calculation of polygon areas (convex hulls) etc.

Expansion of the array of our theoretical capabilities can be useful to get a better opportunity to be employed and the successful application for funding. In my case, for instance, the expansion to close research areas with stables isotopes, as the study of weaning behaviors in the past, could have significant academic impact. Weaning, infant health and nutrition, childcare and parental investment, are universal issues, and this theoretical expansion can attract the attention of the wide public and could have a positive social impact in health and welfare of contemporary populations. This kind of study can be important to create conscious about the importance of adequate practices of childcare and infant nutrition aiming the reduction of infant mortality and the improvement of infant-mother health, as well as promote debates and implement public policy aligned with the United Nations agenda to 2030 (ONU, 2022).

Among other tasks included in this Career Development Plant are some strategies to be aware of potential institutions to apply, considering the CV strengths, using online tools to identify the needs of potential employers and employability opportunities. The next webpages, which we are engaged, provide us for periodic communication of potential employ opportunities in the academic area:

- Research Gate (https://www.researchgate.net/).
- Academia (https://www.academia.edu).
- Google Alerts (https://www.google.es/alerts)
- Central de Concursos (https://centraldeconcursos.com.br)
- Times Higher Education (https://www.timeshighereducation.com/)
- Academic Positions (https://academicpositions.com/)

In relation to the management of own career progression, all the conditions have been stated in the previous pages and I will try to complete them as programed. However, will be the successful finishing of the PACHAMAMA project and their academic achievements (research results, publications in high impact journals, podium presentations, conferences), as well as the acquisition of new research fundings, the objective parameters to measure the progression of my academic career. The progression of my career should be, ultimately, pondered by the attaining of a more stable academic position and the recognition of my researcher quality by my peers in bioarchaeological research field.

Bellaterra, January 25th, 2023.

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