Biocultural analyses lend insights into local population histories in ancient Fuegian-Patagonians

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Foragers in Fuego-Patagonia

- Hunter-gatherer groups in southern Patagonia and Tierra del Fuego, South America (Fuego-Patagonia), practiced subsistence strategies that relied on either marine or terrestrial resources, or a mix of both[1-4] (Fig 1)
- Some prior studies suggest that Marine and Terrestrial groups descended from the same ancestral group, while others indicate they had distinct ancestries[2,5-7]
- Little is known on the ancestries of Mixed Economy Patagonia groups who inhabited sites around the Magellan Strait[3,5]

- **Here, we take a biocultural approach to investigate the ancestries of Marine, Terrestrial, and Mixed Economy Patagonia groups, using stable isotope, paleogenomic, linguistic, archaeological, and ethnohistoric data**

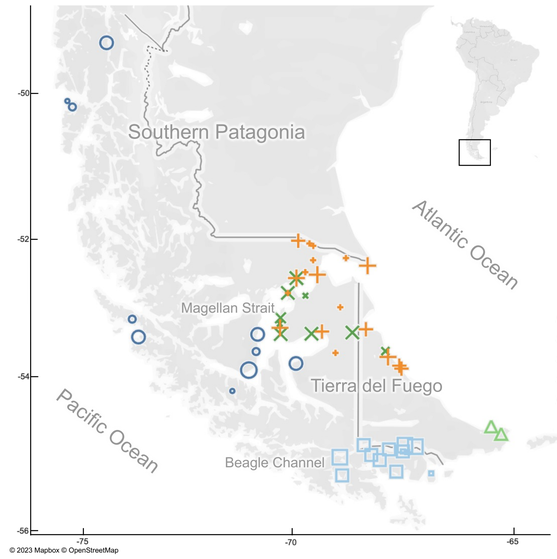

Figure 1 *Map of this study's archaeological sites, highlighting the subsistence economy found at each site.*

Inferring Groups

- Individuals[5-9] were categorized as Marine, Terrestrial, or Mixed Economy Patagonia based on archaeological context (Fig 2) and stable isotope values (carbon and nitrogen)
- Individuals with radiocarbon dates included in genomic analyses:
  - Marine N=26
  - Terrestrial N=21
  - MixedEconPat N=8

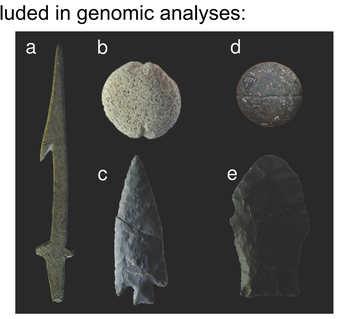

Figure 2 *Marine economy tools: (a) harpoon with cruciform base, (b) fishing weight, (c) pedunculated projectile point. Terrestrial economy tools: (d) bola, (e) fishtail projectile point. From Balentine & Alfonso-Durruty et al., 2022 (AJBA)[5]*

Finding 1: Fuegian-Patagonians Share Ancestry with Other Indigenous American Groups

- Individuals were genotyped at ~850,000 SNPs derived from ancient and present-day Indigenous populations in the Americas (N=660)[7-26]
- Principal component analysis (PCA)[27,28] places the ancient Fuegian-Patagonians with other ancient and present-day populations from the Americas (Fig 3)

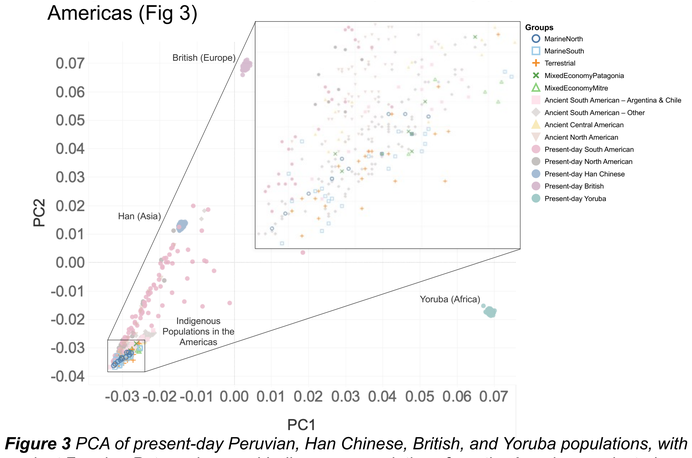

Figure 3 *PCA of present-day Peruvian, Han Chinese, British, and Yoruba populations, with ancient Fuegian-Patagonians and Indigenous populations from the Americas projected.*

Finding 2: Late Holocene Mixed Economy Patagonia Groups have Terrestrial Ancestry

- qpAdm[29,30] ancestry models suggest that Mixed Economy Patagonia diverged from Terrestrial groups in the Late Holocene (Table 1)
- Subsequent genetic drift and gene flow with neighboring Marine groups led to slight divergence between Mixed Economy Patagonia and Terrestrial groups by Historic times
- Archaeological evidence shows both marine and terrestrial resources were more equally exploited[2]
- Bioanthropological analyses suggests these individuals were intermediary in height between Terrestrial and Marine individuals[1]

Target	MarineNorth-related ancestry proportion	Terrestrial-related ancestry proportion	s.e.	p-value	Population retained in single-population model (if nested model p>0.05)
MixedEconPat_LateHolo	***0.098***	***0.902***	***0.076***	***0.904***	***Terrestrial_LateHolo (p=0.183)***
MixedEconPat_Hist	***0.282***	***0.718***	***0.088***	***0.130***	**N/A**

Target	MarineSouth-related ancestry proportion	Terrestrial-related ancestry proportion	s.e.	p-value	Population retained in single-population model (if nested model p>0.05)
MixedEconPat_LateHolo	***0.116***	***0.884***	***0.099***	***0.788***	***Terrestrial_LateHolo (p=0.222)***
MixedEconPat_Hist	***0.305***	***0.695***	***0.123***	***0.023***	**N/A**

Target	MarineSouth-related ancestry proportion	MarineNorth-related ancestry proportion	s.e.	p-value	Population retained in single-population model (if nested model p>0.05)
MixedEconPat_LateHolo	3.84	-2.84	11.837	0.131	N/A
MixedEconPat_Hist	6.338	-5.338	81.411	0.024	N/A

Table 1 *qpAdm ancestry model results for Mixed Economy Patagonia groups. Ancestry proportions are modeled from Late Holocene groups. Bolded italicized Targets are statistically likely models of ancestry proportions, while all other models are rejected.*

Finding 3: Late Holocene Marine & Terrestrial Groups Show Distinct Ancestries

- *f*-statistics[30,31] suggest that Marine groups share ancestry with a Marine individual from 4,800 BP, but not earlier Marine individuals
- Terrestrial groups, conversely, share ancestry with two older Marine individuals (6,800–6,600 BP) and a Mixed Economy Patagonia individual (5,600 BP)
- Suggests Terrestrial lineages have been in Fuego-Patagonia the longest, with a new marine-specialized population migrating into Fuego-Patagonia by ~4,800 BP
- Archaeological records show loss of green obsidian use in toolmaking at that time (ca. 5,000–3,000 BP)[4]
- Marine languages (qawasqar and yagan families) notably different from Terrestrial languages (chon-gününa küne family)[32]
- Ethnohistoric and bioanthropological records show differences in height between Marine and Terrestrial individuals, due to genetics and/or environment[1,33-35]

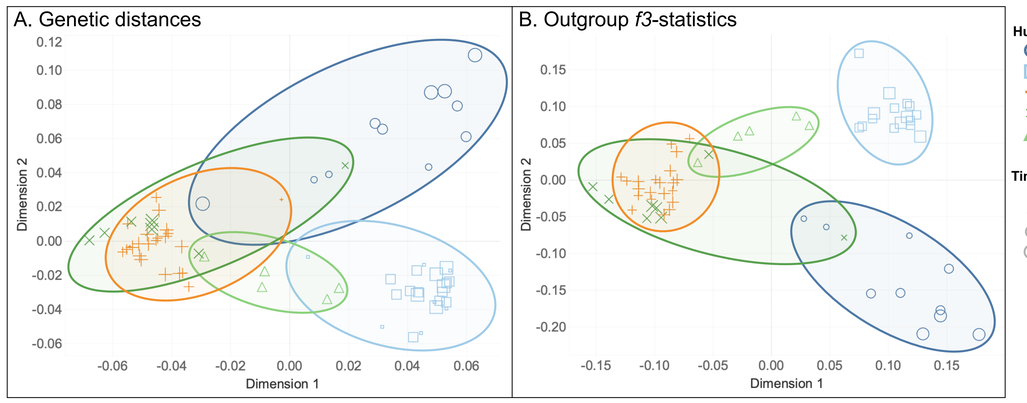

Figure 4 *Multidimensional scaling (MDS) analyses of (A) genetic distances and (B) outgroup* f3*-statistics (1-*f3*), illustrating genetic differentiation among Fuegian-Patagonian groups.*

Conclusions

- Marine and Terrestrial/Mixed Economy Patagonia groups show divergent ancestry in the Late Holocene
- Terrestrial and Mixed Economy Patagonia groups share ancestry in the Late Holocene, but diverge by Historic times
- Sociocultural evidence from archaeology, ethnohistory, and linguistics add further nuance and justification to our findings
- This study highlights the complexities of local population histories and demonstrates the importance of including sociocultural data in paleogenomic studies

Ethics Statement & Acknowledgements

The analyses conducted in this study adhere to United States and Chilean legal and ethical guidelines for ancient DNA research. Permissions to sample teeth and analyze the aDNA from the individuals in this study was obtained from the intuitions that they are curated at, the Museo Antropológico Martín Gusinde (Puerto Williams, Chile) and the Instituto de la Patagonia, Universidad de Magallanes (Punta Arenas, Chile), as well as the Consejo de Monumentos Nacionales in Chile (Ord. No. 000909/15) and the IRB at UConn (protocol #X20-0161). Descendant communities were also consulted about this research. We would like to thank and acknowledge the people belonging to the following Fuegian-Patagonian Native Groups: the Yaghan (Yámana), the Káwesqar (Alacalufe), the Selk'nam (Ona), and the Aonikenk (Southern Tehueleche). We also thank the Insituto de la Patagonia, the Museo Antropológico Martín Gusinde, and the Consejo de Monumentos Nacionales de Chile for granting permission to analyze the ancient skeletal remains in this study. This study was funded by FONDECYT 1211976 and ANID/BASAL FB210018 (Chile), National Geographic Society Genographic Grant 014, National Science Foundation 2020670, and Wenner-Gren Foundation 10095.

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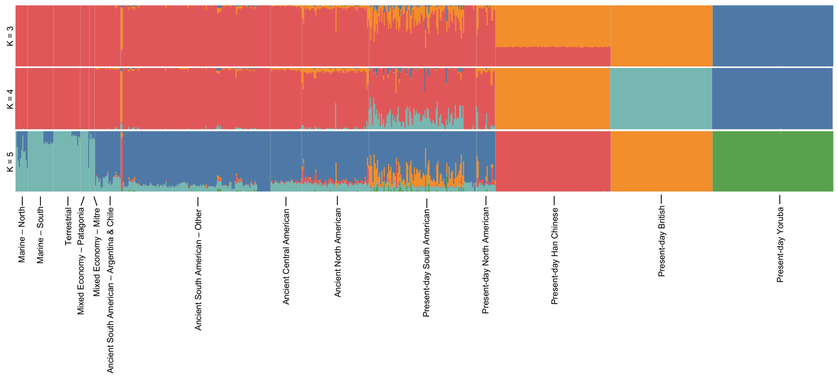

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Caption:

Modeled ancestry proportions for MixedEconomyPatagonia groups from the Late Holocene and Historic times. Ancestry proportions are modeled from Late Holocene groups. Bolded and italicized Targets are statistically likely models; all other models are rejected.