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Species distribution models fail to predict paleozoological occurrences during the Holocene Green Sahara phase

By Ignacio A. Lazagabaster





INTRODUCTION

BEAST Biodiversity in Egyptian Archaeology during Societal Transitions





Ignacio A. Lazagabaster

Juliet

Spedding



Irene Solano-Regadera



Chris Thomas



Salima Ikram



Steven Snape

Jakob **Bro-Jorgensen**















INTRODUCTION

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Zooarchaeological records

Faunal extinction models

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distribution models

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INTRODUCTION

Dallmeyer et al. (2020)

Climate of the Past

The end of the African humid period as seen by a transient comprehensive Earth system model simulation of the last 8000 years

Chedaddi et al. (2021 PNAS)

PNAS

Early Holocene greening of the Sahara requires Mediterranean winter rainfall

Rachid Cheddadi 💿 🖾 , Matthieu Carré 🗐 , Majda Nourelbait 💿 , 🕫 and Enno Schefuß 💿 Authors Info & Affiliations

Hopcroft and Valdes (2022)

ENVIRONMENTAL RESEARCH LETTERS

Green Sahara tipping points in transient climate model simulations of the Holocene

Peter O Hopcroft^{1,*} log and Paul J Valdes^{2,3}

Are species distribution models (SDMs) able to predict the presence of suitable habitats within the known Holocene distribution of large mammals in the Sahara?

- > SDM of a test species: the hartebeest
- Compare various SDM procedures
- Evaluate different paleoclimatic simulations
- > Integrate the zooarchaeological record

Species distribution models (SDMs), a multi-step procedure:

- 1. Download and process (paleo-) climatic data
- 2. Obtain presence data
- 3. Generate (pseudo-) absences
- 4. Select the most relevant environmental variables
- 5. Choose one or various modelling algorithms
- 6. Project onto past time periods and evaluate models

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Species distribution models (SDMs), a multi-step procedure:

Covariates	Presences	Absences	Variable selection	Algorithms	Predictions
 Climate Topography Vegetation Distance to rivers Study area 23°W to 63°E 44°S to 45°N 	iNat-GBIF	 100 km buffer PHYL exclusion Background 	 VIF (<10) BART Iterations=200 Iter	 GLM • MAX GAM • RAF GAU • GBM SVM • BART 5-kfold validation 10 replicates 	$ \begin{array}{c} \rightarrow 0 \ (ka) \\ \rightarrow 1000 \\ \rightarrow 2000 \\ \rightarrow 3000 \\ \rightarrow 4000 \\ \rightarrow 5000 \\ \rightarrow 6000 \\ \rightarrow 7000 \\ \rightarrow 8000 \end{array} $
	IUCN	 Random Background 			
	PHYL	 Random Background 			
>1	2	3	4	>5	>6

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METHODS

Paleoclimatic simulations

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Publication	Model	Timespan (yrs)	Res. (ª)	Res. (km)
Beyer et al. 2020	HadAM3H	21000	0.5x0.5	55
Krapp et al. 2021	HadCM3	800000	0.5x0.5	55
Karger et al. 2021	CCSM3	21000	0.008x0.008	1
Dallmeyer et al. 2021	MPI-ESM1.2	8000	1.8x1.8	230
Hopcroft and Valdes. 2021	HadCM3	10000	3.75x2.5	390
Hopcroft and Valdes. 2022	HadCM3+CONV+VMS	10000	3.75x2.5	390

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RESULTS

Absences

PHYL random

(presences = 639; background = 639)

PHYL background (presences = 639; background = 10000)

IUCN random (presences = 554; background = 554)

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RESULTS

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Variable selection

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RESULTS Habitat Suitability (HS) estimations at

archaeological sites with presence of hartebeest

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Generating adequate presence-absence datasets is more important than the modelling algorithm chosen

- Predictions of habitat suitability estimations at fossil sites are a critical and independent measure of SDM performance
- These predictions, combined with an understanding of species climatic requirements provide a tool to evaluate and maybe improve the fitness of paleoclimatic simulations
- Future directions: model other taxa, simulate different precipitation regimes, examine other climatic variables, include paleohydrological systems

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