

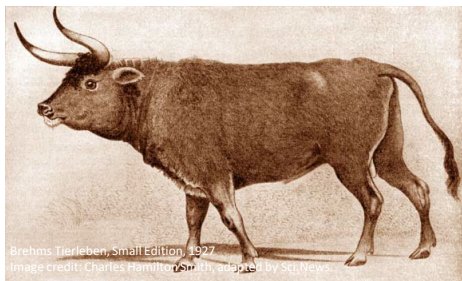
Differential trajectories of the annual reproductive cycle in sheep and cattle from Neolithic to modern times

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(1) AASPE, CNRS MNHN, Paris, France; (2) PRC, CNRS INRAE Univ de Tours, Nouzilly, France; (3) Dept de Prehistoria, Universitat Autònoma de Barcelona, Barcelona, Spain; (4) ARCHIMEDE, CNRS Université de Strasbourg, Strasbourg, France; (5) Institute of Archaeology 'Vasile Parvan', Romanian Academy, Bucharest, Romania; (6) Archaeological Museum of the Republic of North Macedonia, Skopje, North Macedonia; (7) CEPAM, CNRS Université Côte d'Azur, Nice, France; (8) Independent researcher, Athens, Greece; (9) Museum of the City of Skopje, North Macedonia; (10) TRACES, CNRS Université Jean Jaurès, Toulouse, France; (11) Arbeitsbereich Vor- und Frühgeschichtliche Archäologie, Institut für Altertumswissenschaften Johannes Gutenberg-Universität Mainz, Germany; (12) Kanton Thurgau Amt für Archäologie & Leiter Museum für Archäologie, Frauenfeld, Switzerland; (13) Università di Pisa, Italy



10 500 years
ago



Seasonally breeding
wild ancestors



Domestication

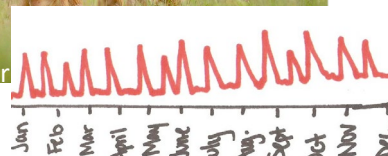
Zooarchaeology



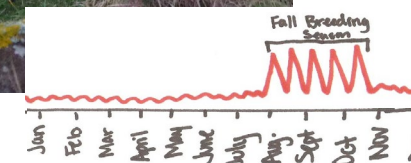
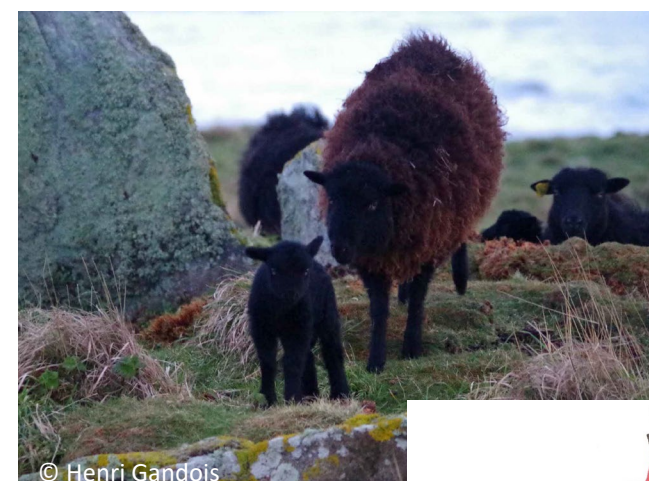
Prehistoric cattle and sheep (Europe) ?



Year-round breeders



Seasonal breeders (out-of-season
breeding possible)



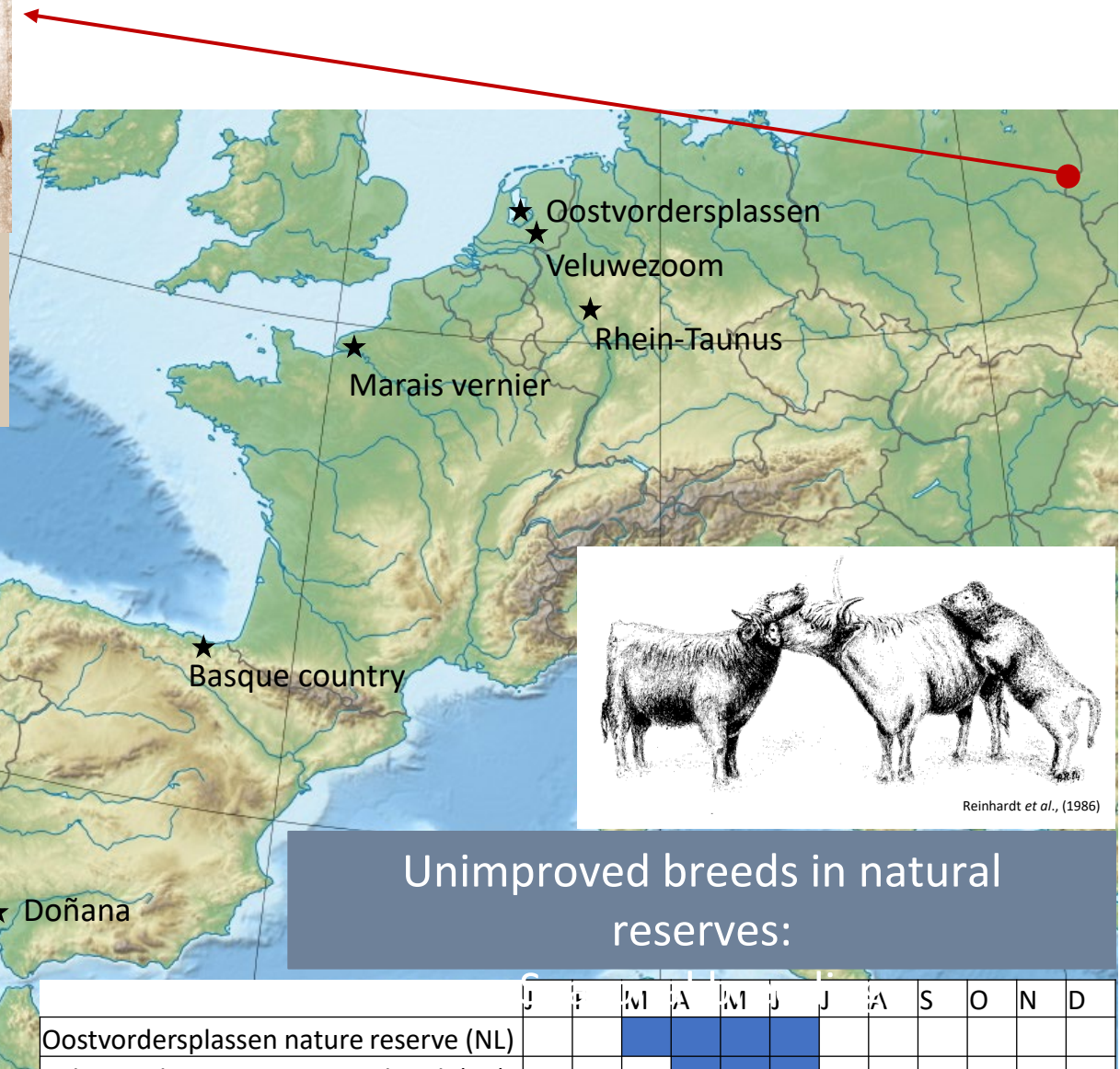
Today

Aurochs

16th c Aurochs:
Seasonal breeding



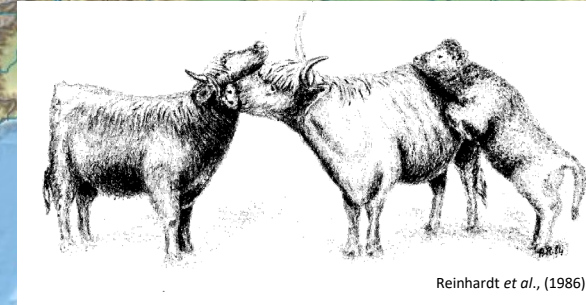
- In the 16th c Białowieża forest (Van Vuure, 2005)
- Females and males live separately
 - Mating in August-Sept, calving in May-June



Modern cattle

Modern cattle:
Year-round breeding

Year-round / seasonal breeding
(local conditions/orientation of
production)



Reinhardt et al., (1986)

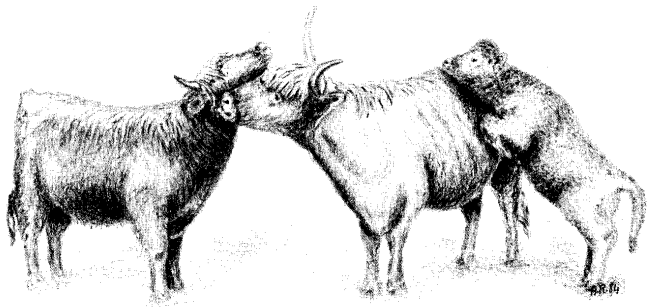
Unimproved breeds in natural
reserves:

	J	F	M	A	M	J	J	A	S	O	N	D
Oostvordersplassen nature reserve (NL)												
Imbos, Veluwezoom National park (NL)												
Rhein-Taunus Naturpark (Germany)												
Marais Vernier reserve (France)												
Basque country (Spain)												
Donana nature reserve (Spain)												

Feral cattle



Aurochs :
Seasonal breeding (?)



Reinhardt et al., (1986)

Unimproved breeds in natural reserves:
Seasonal breeding

Prehistoric cattle?

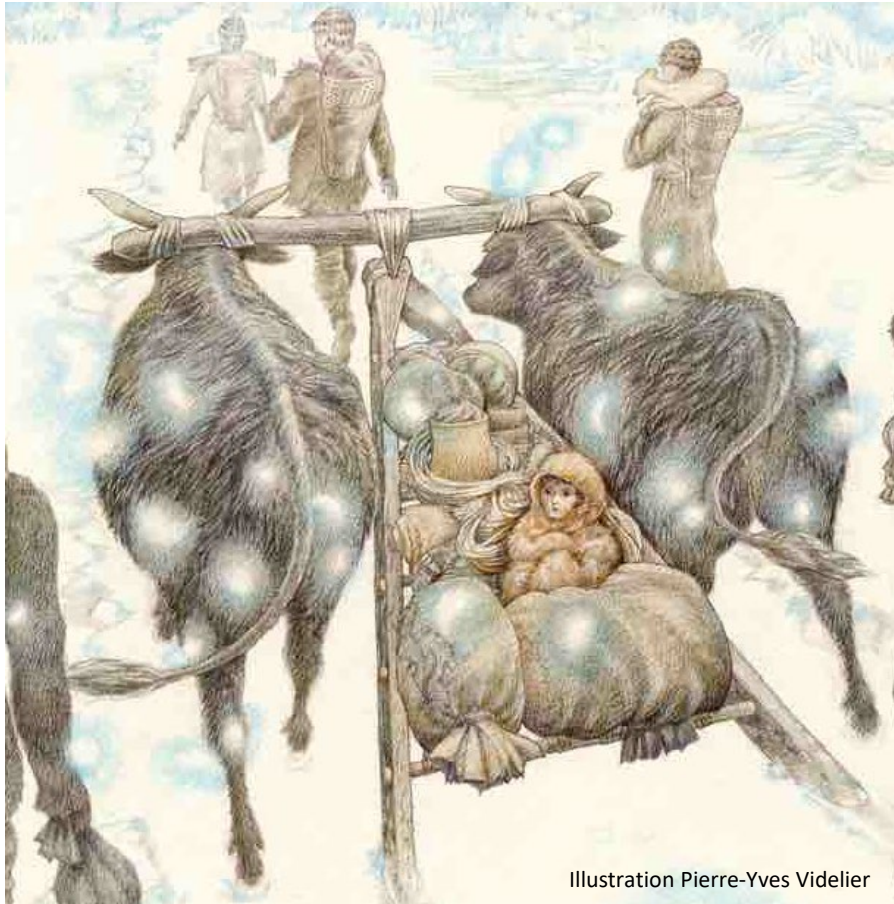


Illustration Pierre-Yves Videlier

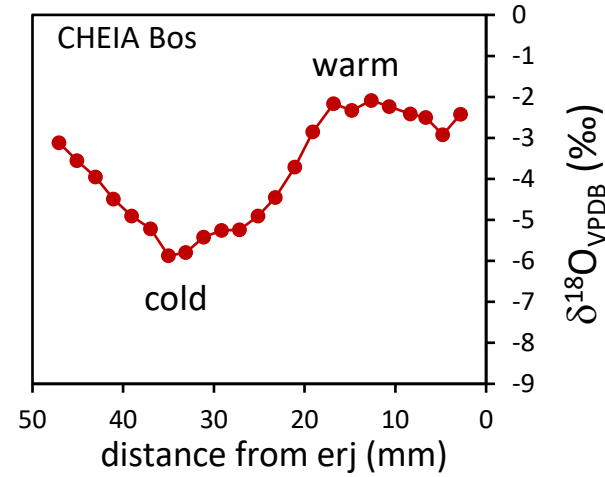
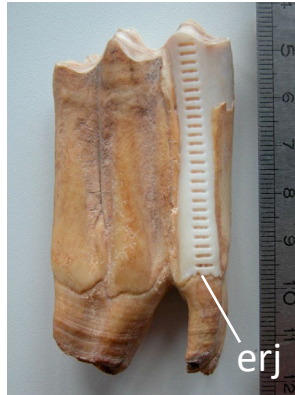


©Louis Echampard

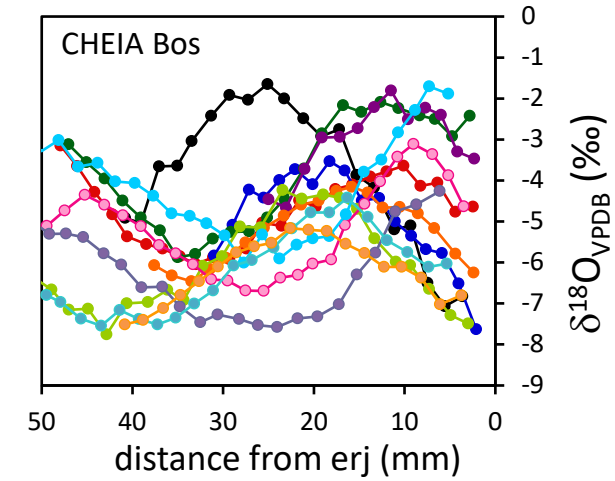
Modern cattle:
Year-round breeding

Reconstructing cattle birth seasonality in the past

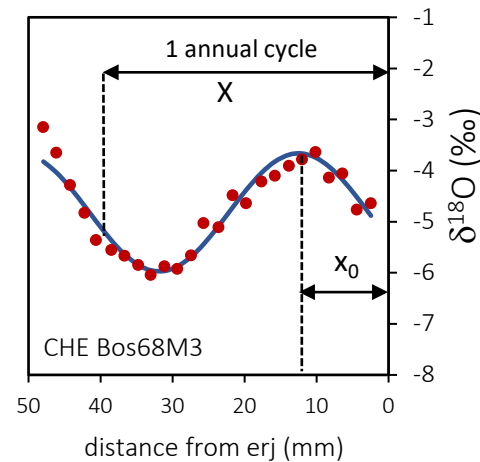
Sequential analysis of enamel $\delta^{18}\text{O}$



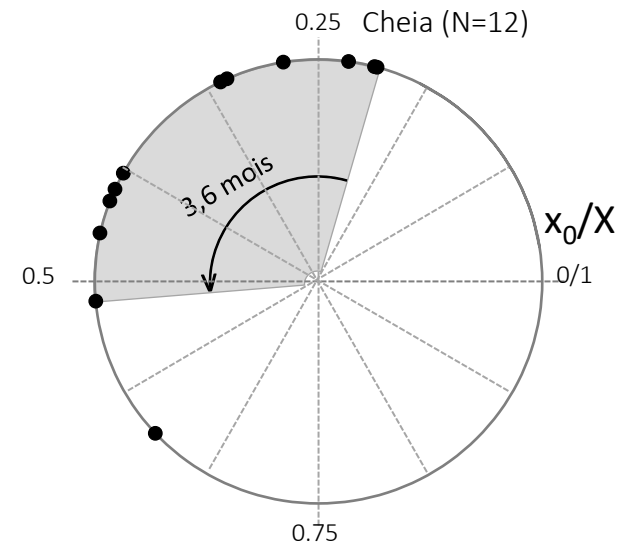
Inter-individual variability



Modelling



Birth seasonality

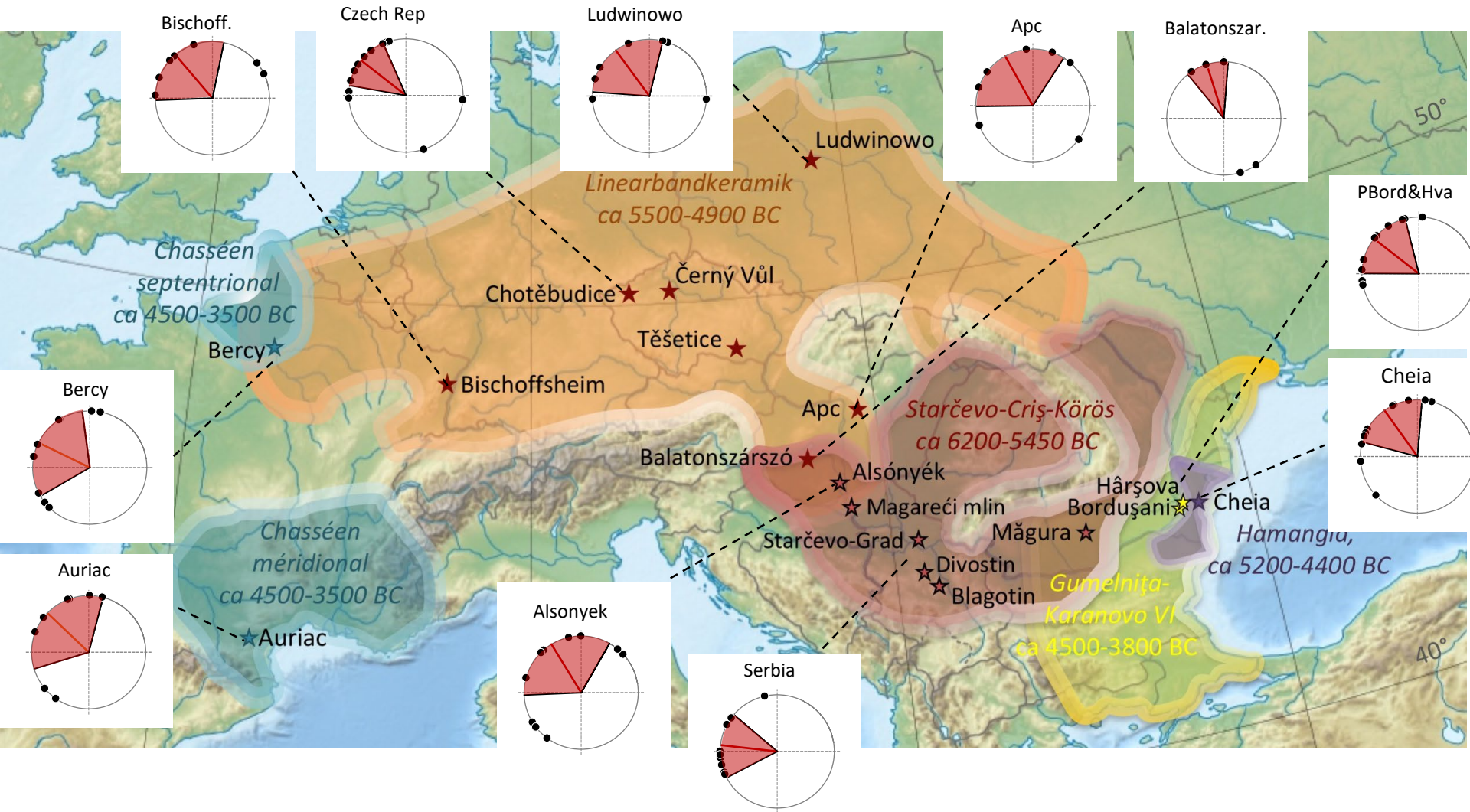


Cattle birth seasonality (6th-4th mill BCE): corpus of study



Dates cal BCE

Seasonal reproduction in cattle lasted over the first millennia of domestication



Seasonal calving on the site scale

Seasonal reproduction in cattle lasted over the first millennia of domestication

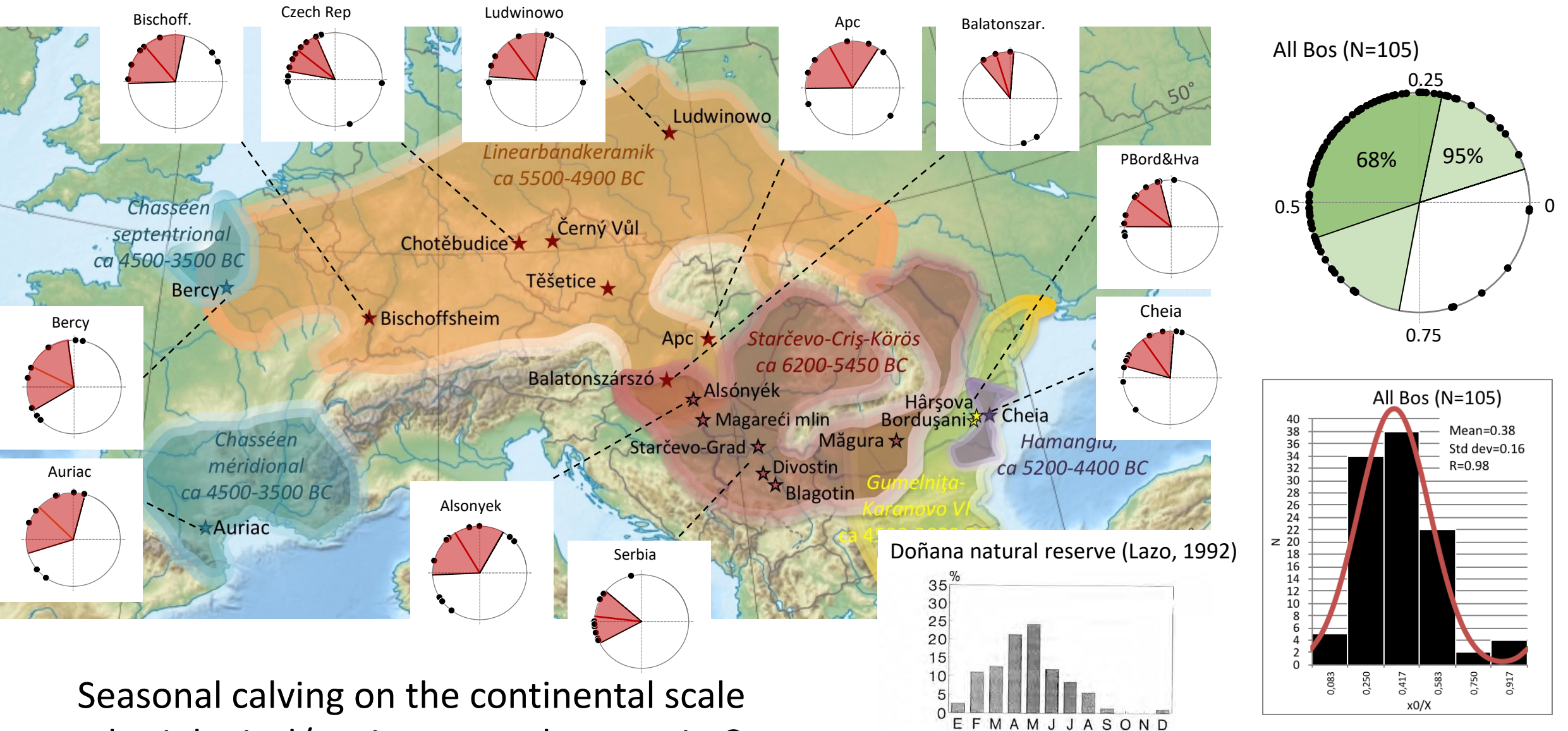


Figura 2. Distribución mensual de los nacimientos a lo largo del período de estudio (porcentaje medio de nacimientos en cada mes).
 Monthly distribution of births during the study period (mean percentage of births in each month).



Today's Europe

Husbandry:

Year-round breeding



Natural reserves:
Seasonal breeding

Seasonal anoestrus in harsh conditions?

Prehistoric Europe (6th-4th mill BCE)

Seasonal breeding

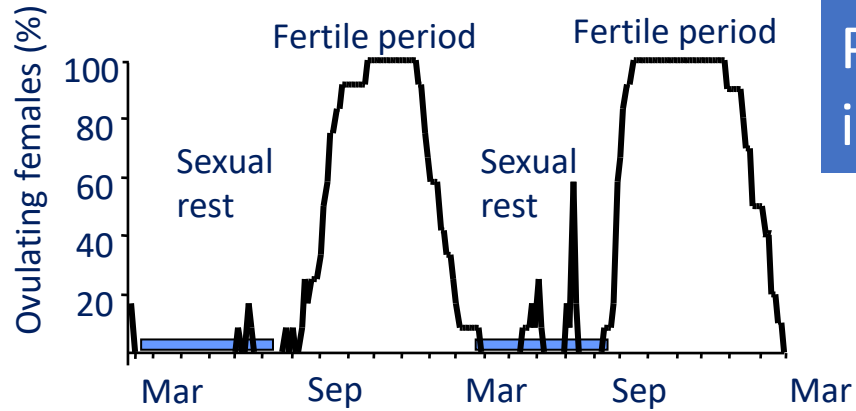


16thc in Białowieża forest
Seasonal breeding

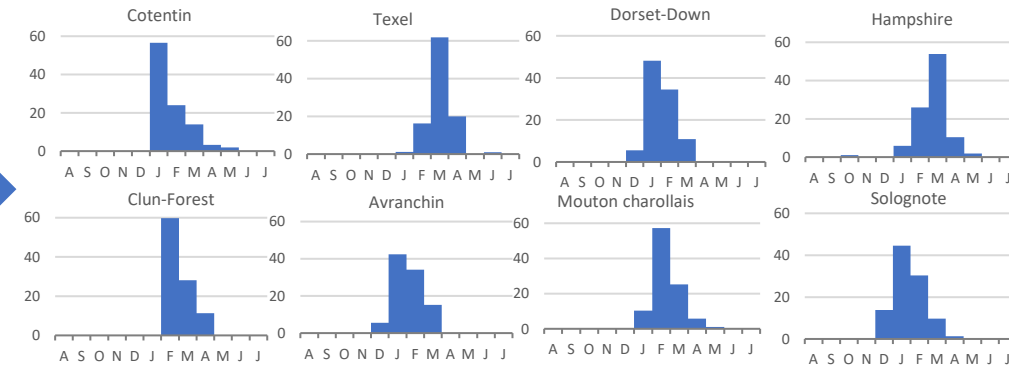


Wild ancestor
True seasonal anoestrus ?
Unexpressed capacity for
year-round breeding?

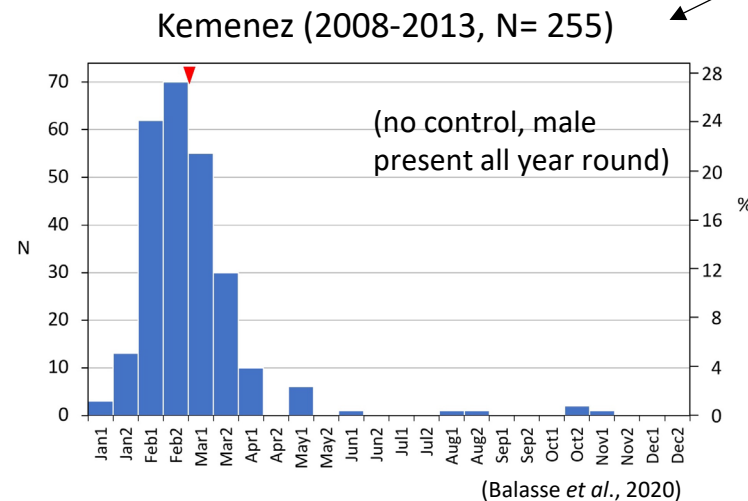
Sheep birth seasonality



Predominant pattern in continental Europe

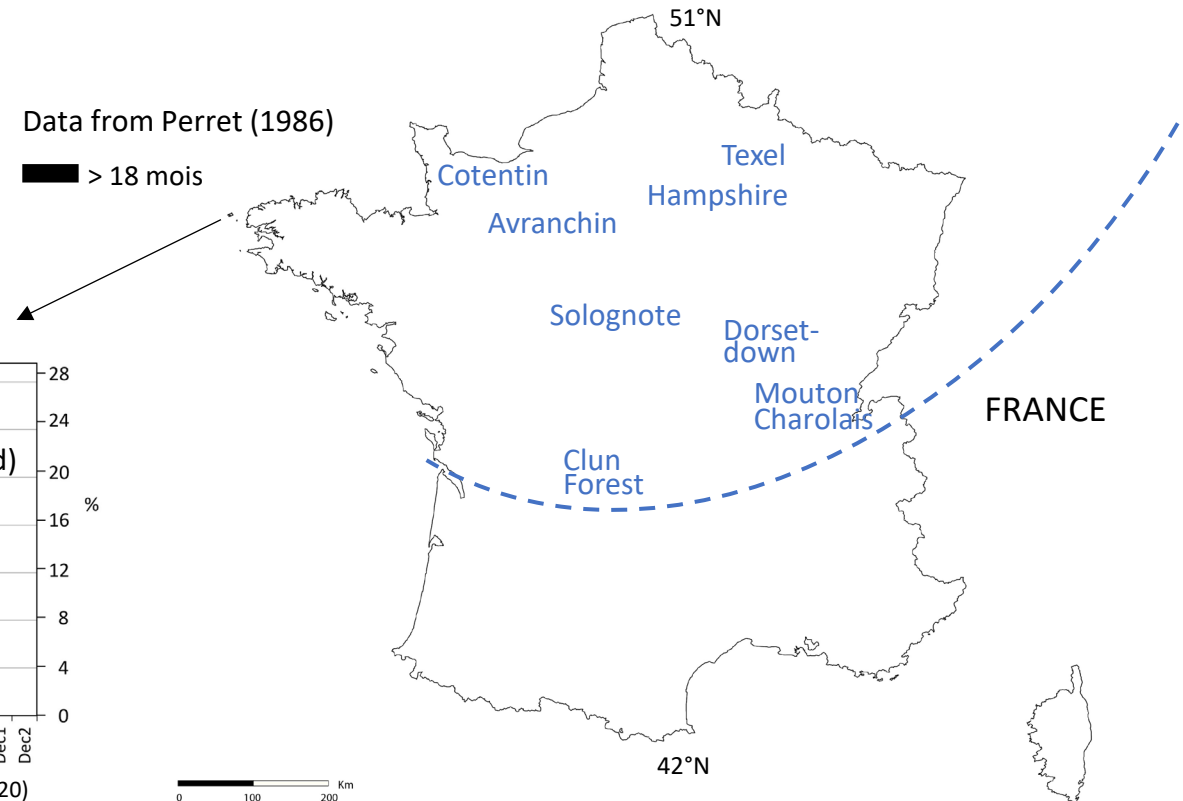


Landes de Bretagne x Ouessant cross breed

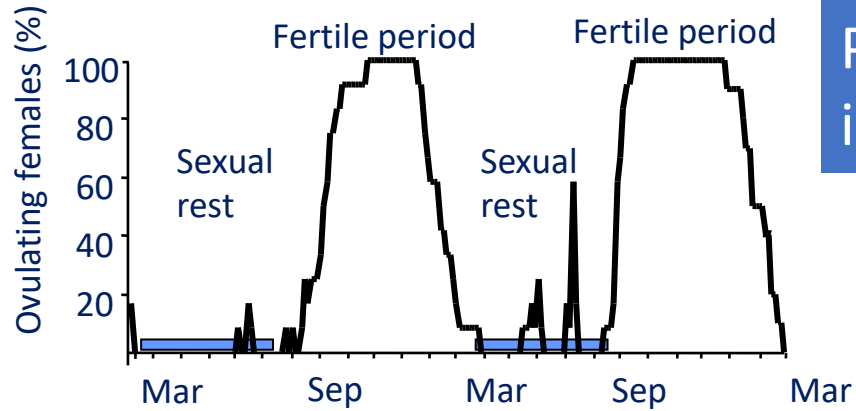


Data from Perret (1986)

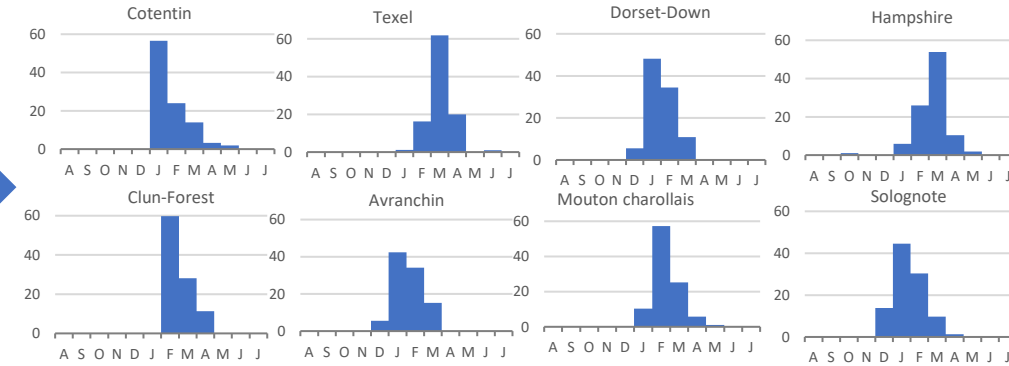
■ > 18 mois



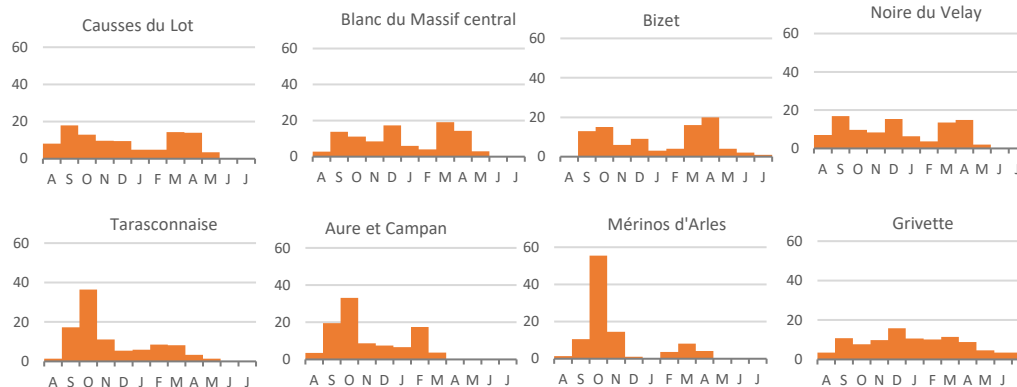
Sheep birth seasonality



Predominant pattern
in continental Europe

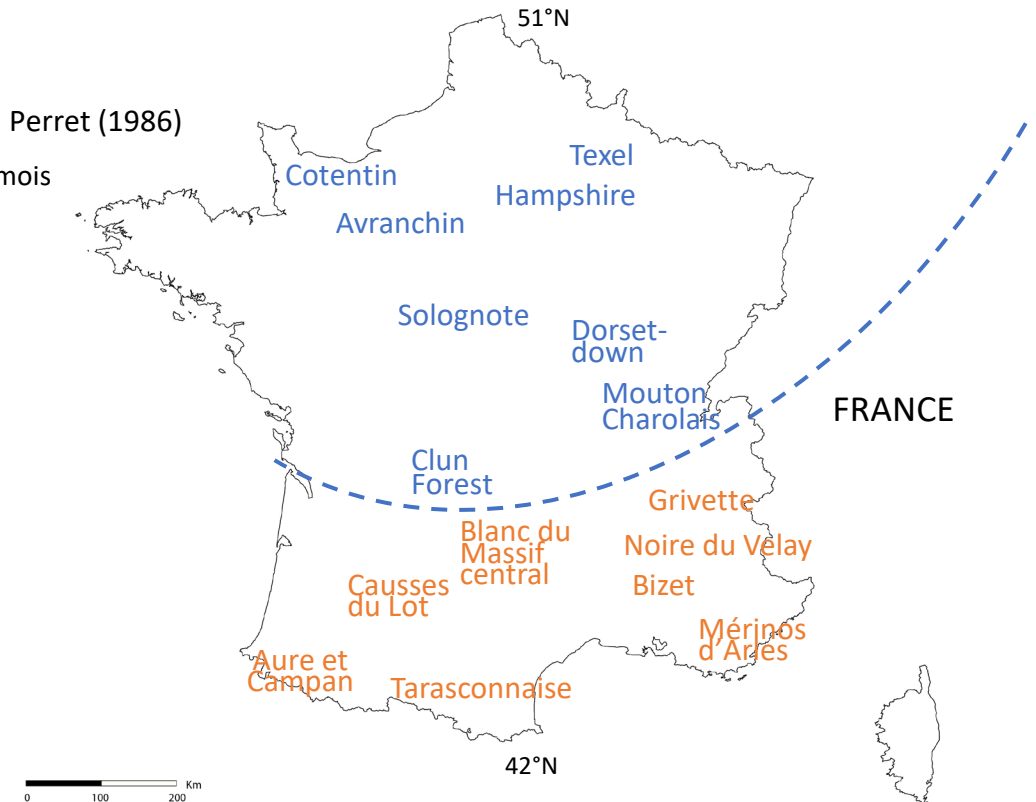


In the Mediterranean

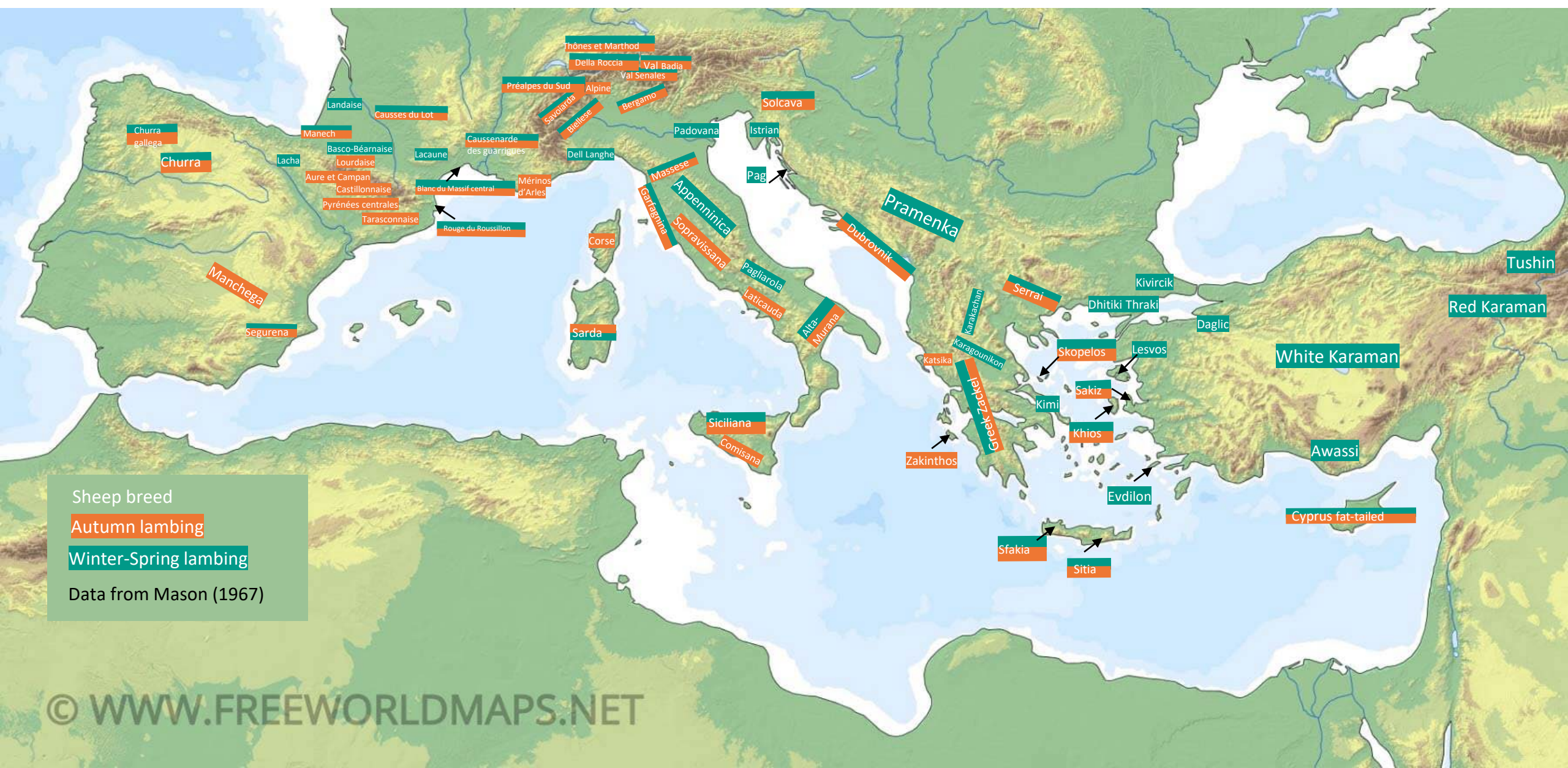


Data from Perret (1986)

■ > 18 mois

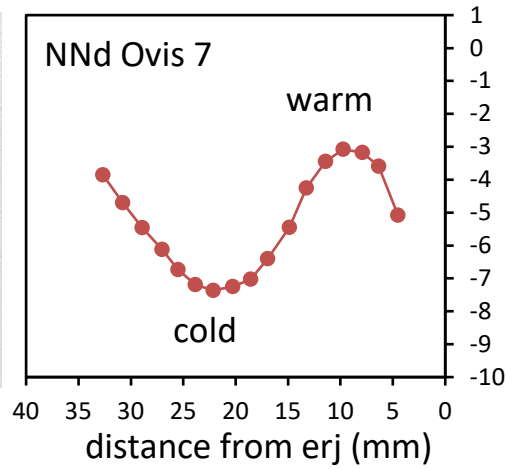


Autumn lambing, a widespread practice in the Mediterranean area

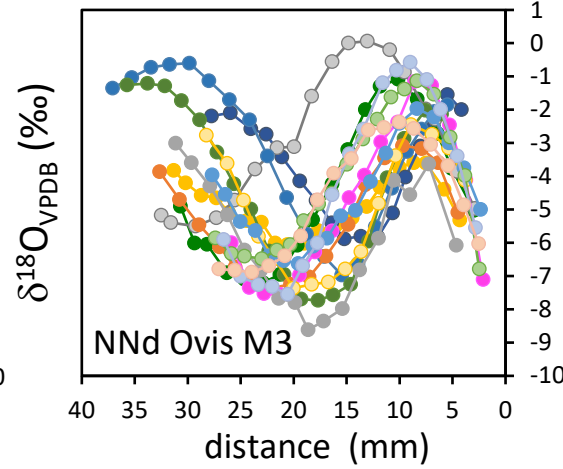


Reconstructing sheep birth seasonality in the past

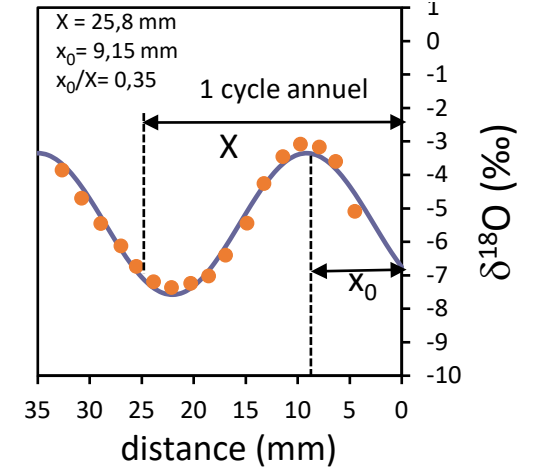
Sequential analysis of enamel $\delta^{18}\text{O}$



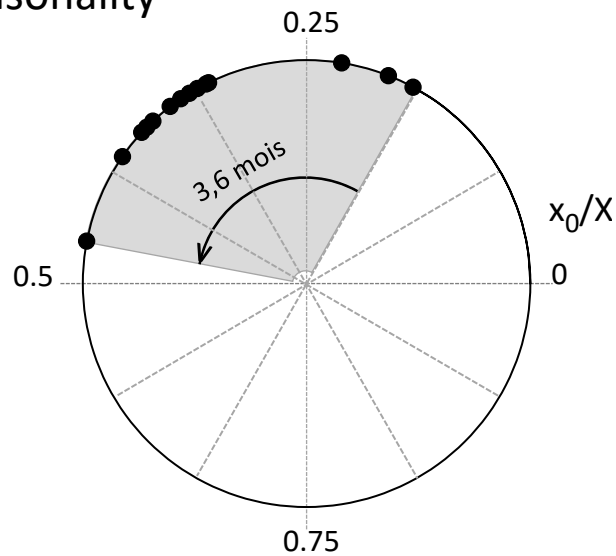
Inter-individual variability



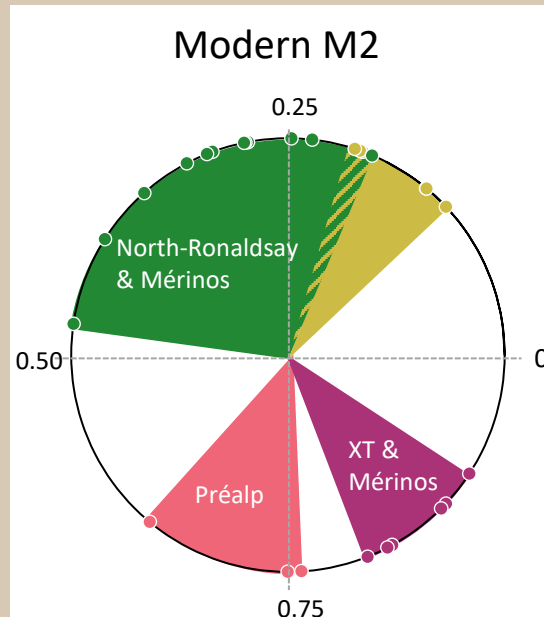
Modelling



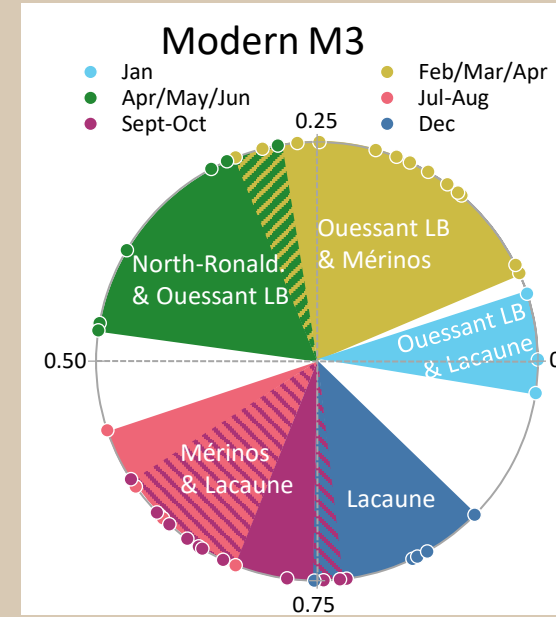
Birth seasonality



Modern M2

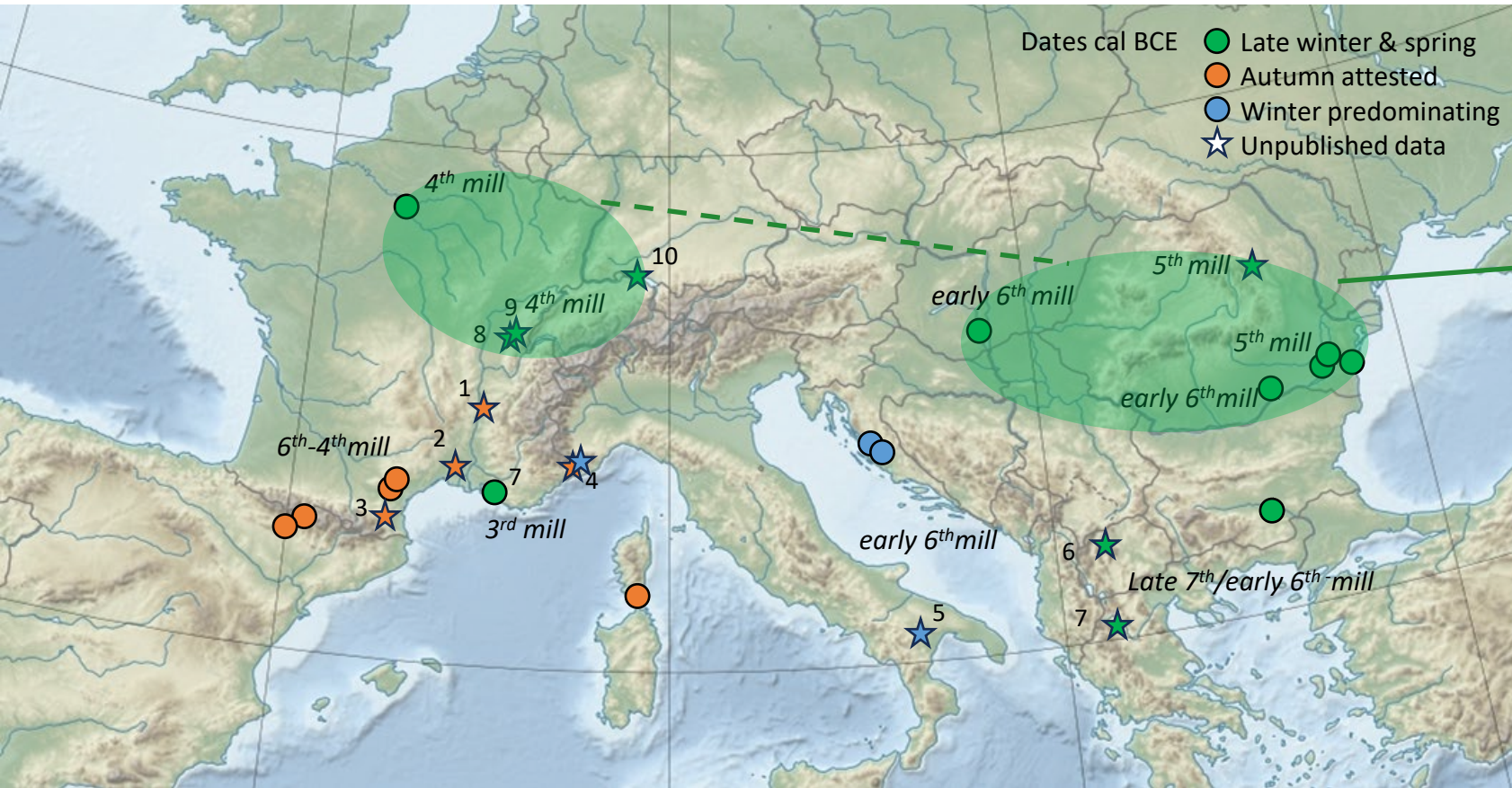


Modern M3

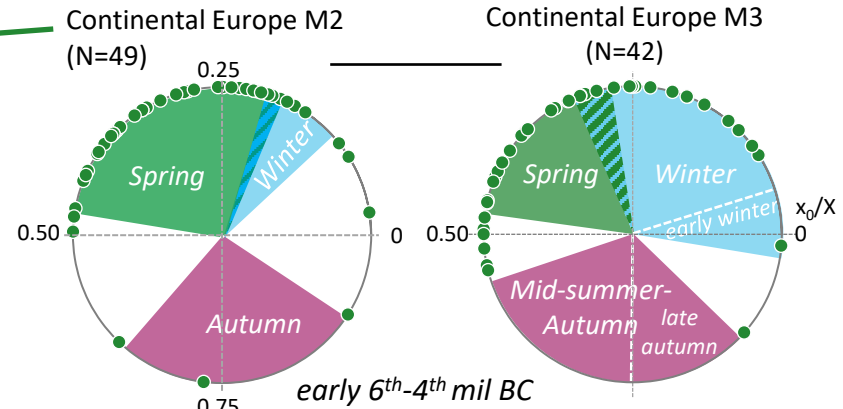


Birth season

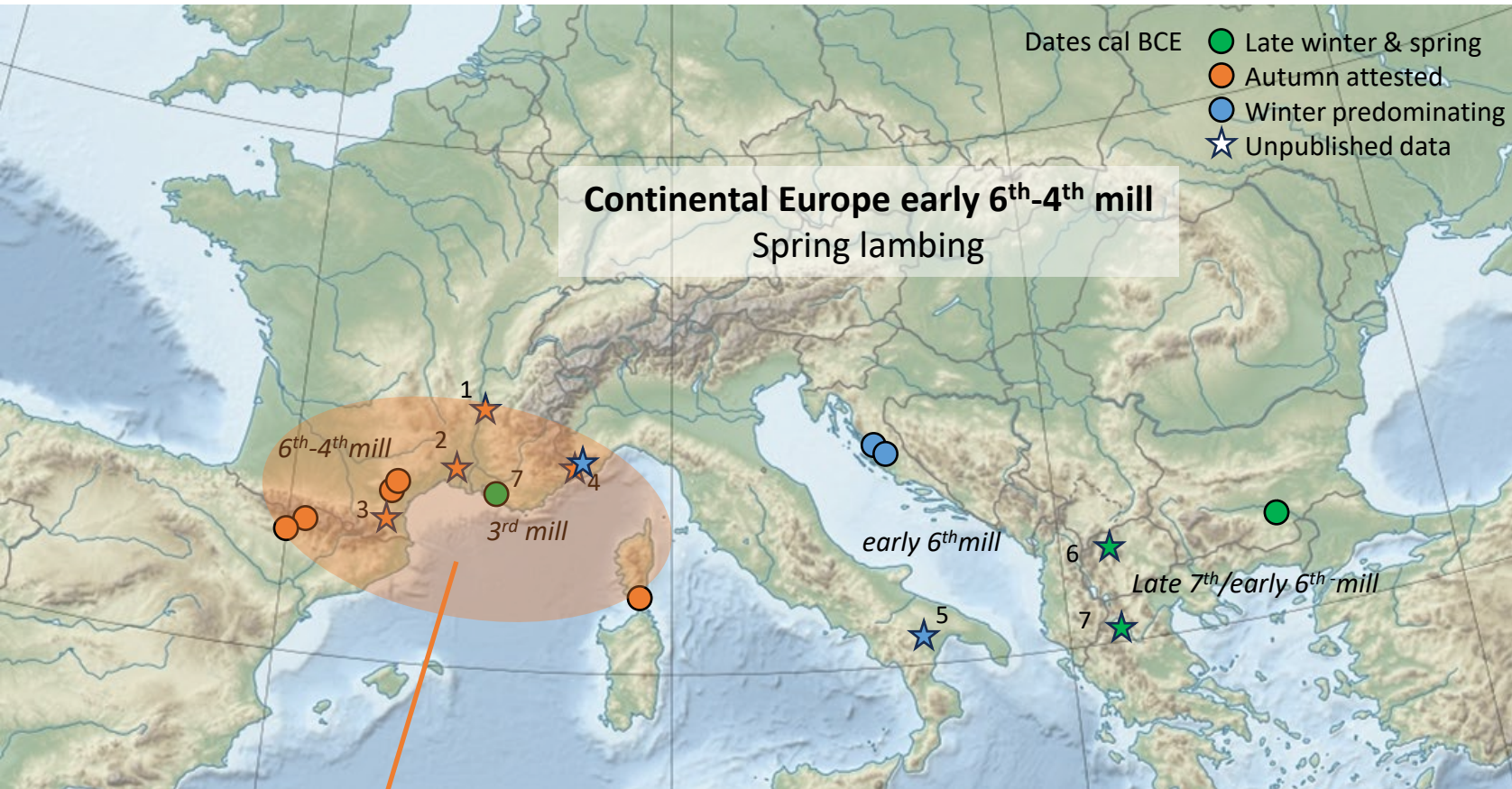
Present state of knowledge



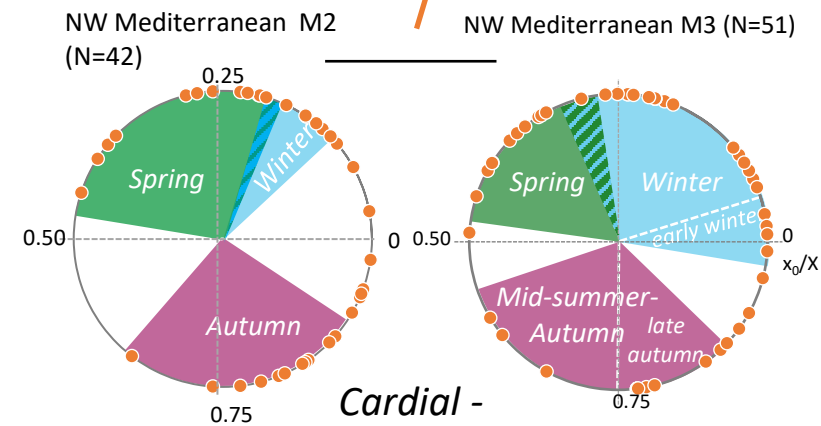
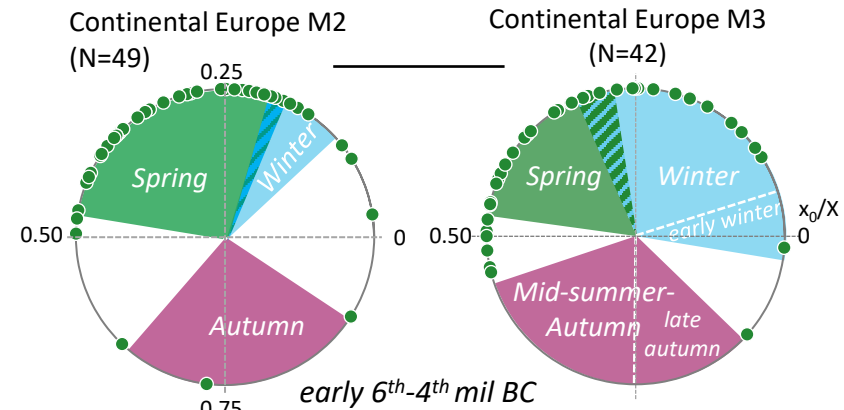
(Balasse *et al.*, 2012; 2013, 2017, 2020; Blaise & Balasse, 2011; Fabre *et al.*, 2021, 2023; Sierra *et al.*, 2021; Tornero *et al.*, 2013, 2020; Tejedor-Rodriguez *et al.*, 2021)
 ☆ **this study**)



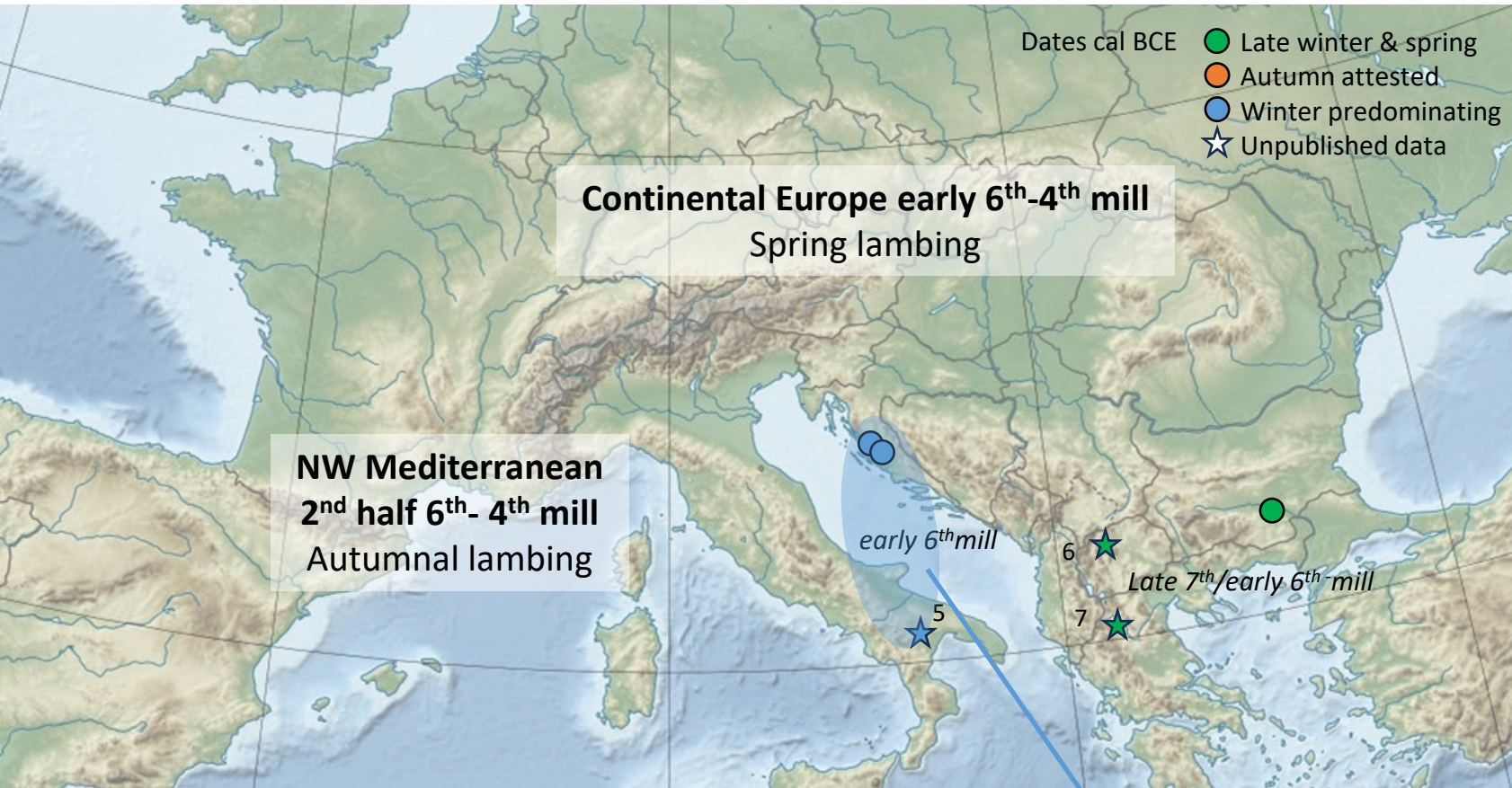
Present state of knowledge



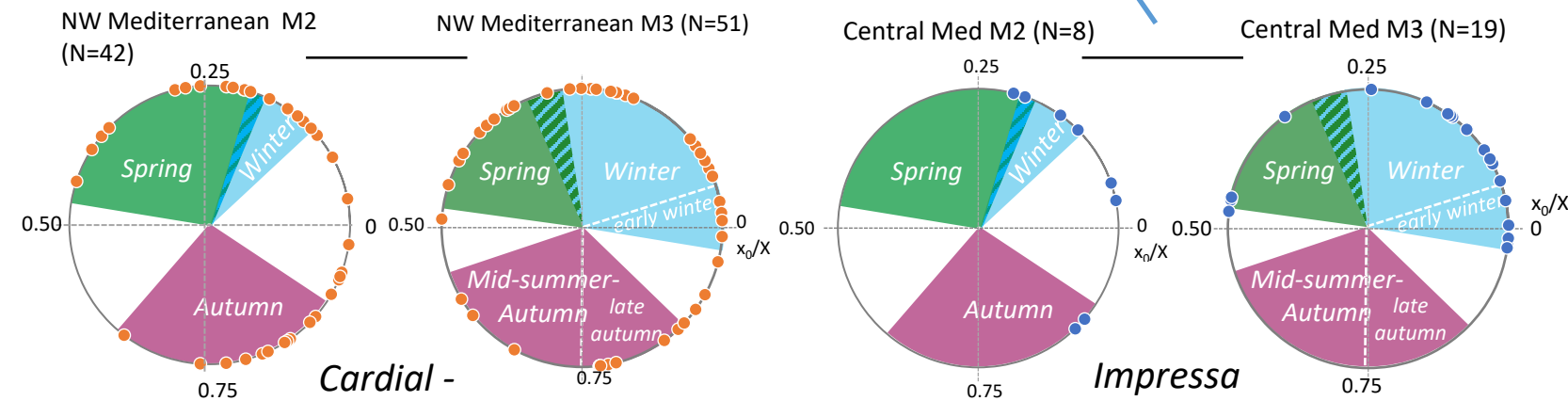
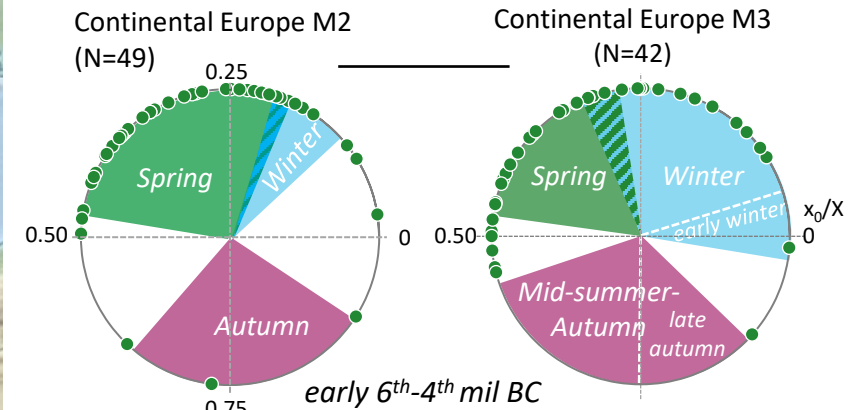
(Balasse *et al.*, 2012; 2013, 2017, 2020; Blaise & Balasse, 2011; Fabre *et al.*, 2021, 2023; Sierra *et al.*, 2021; Tornero *et al.*, 2013, 2020; Tejedor-Rodriguez *et al.*, 2021)
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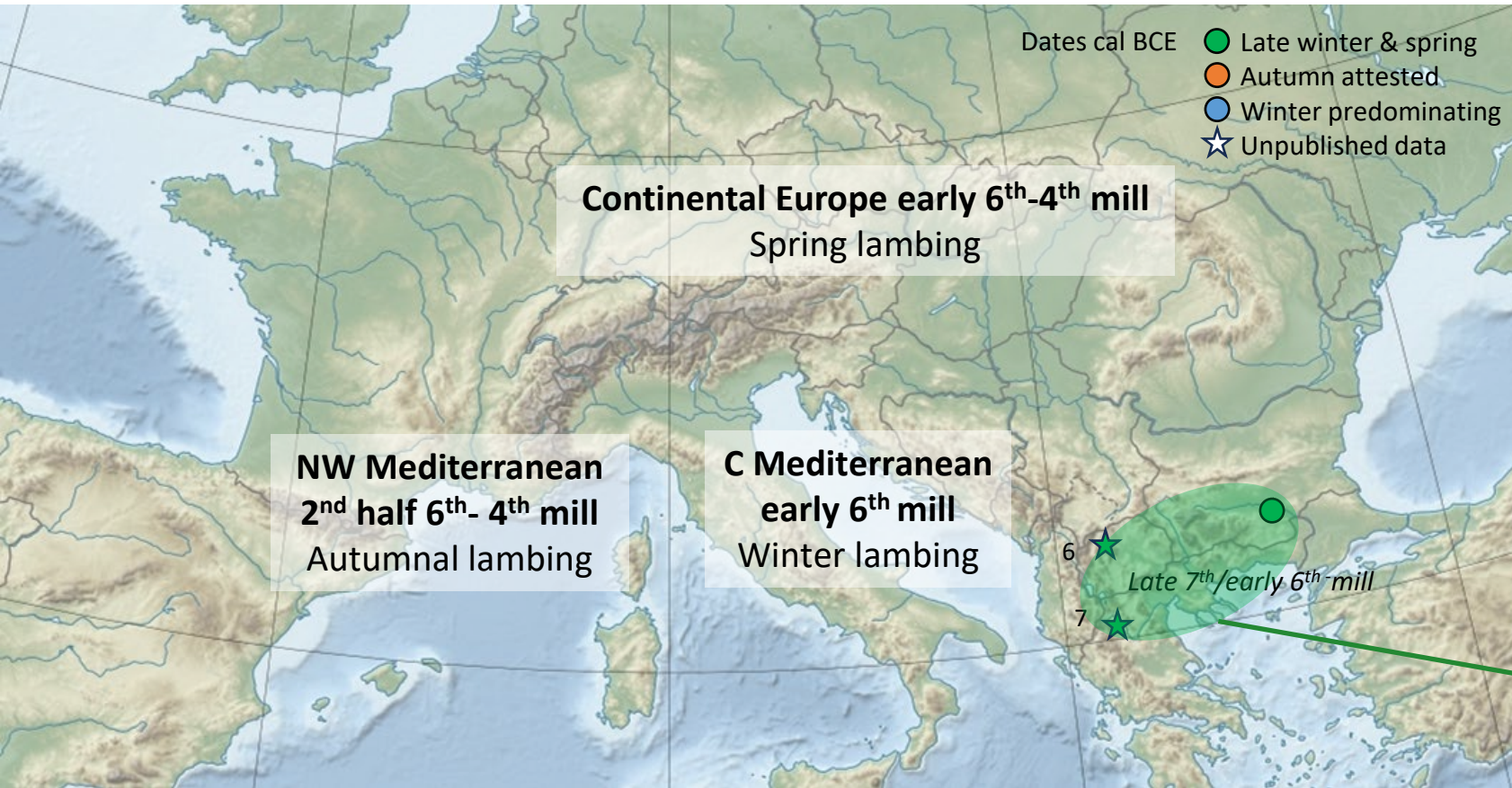
Present state of knowledge



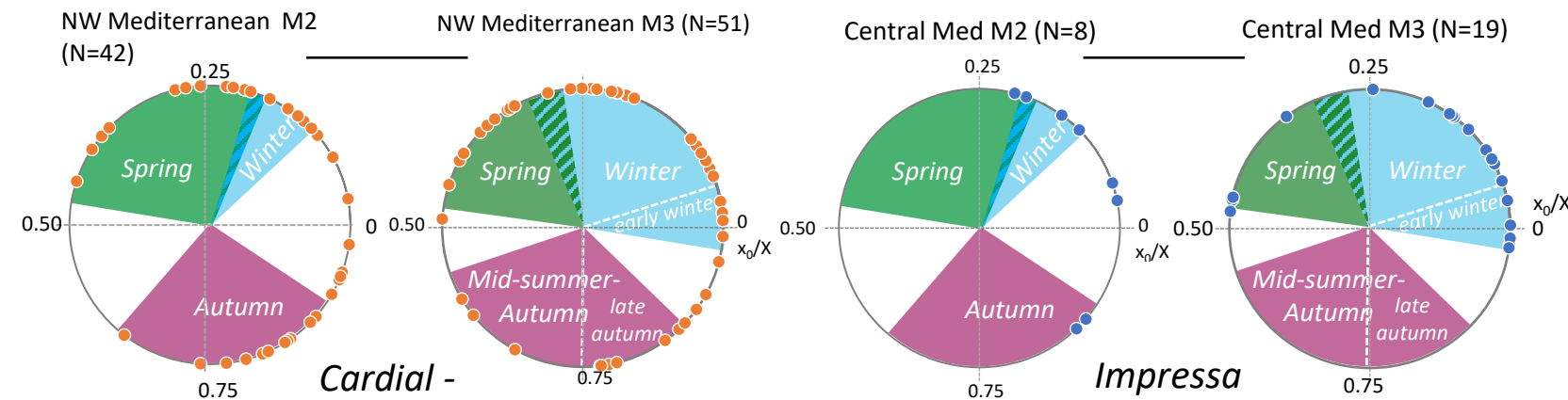
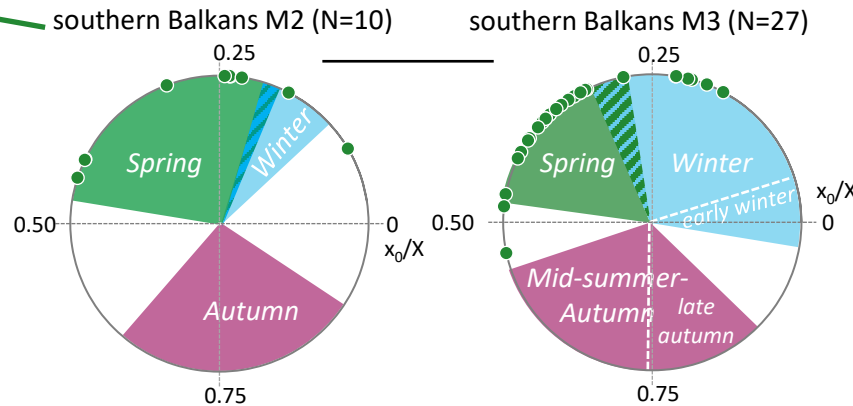
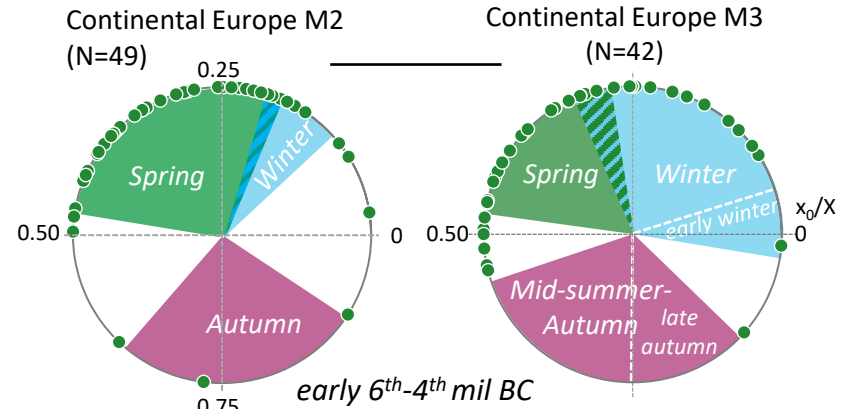
(Balasse *et al.*, 2012; 2013, 2017, 2020; Blaise & Balasse, 2011; Fabre *et al.*, 2021, 2023; Sierra *et al.*, 2021; Tornero *et al.*, 2013, 2020; Tejedor-Rodriguez *et al.*, 2021)
☆ **this study**)



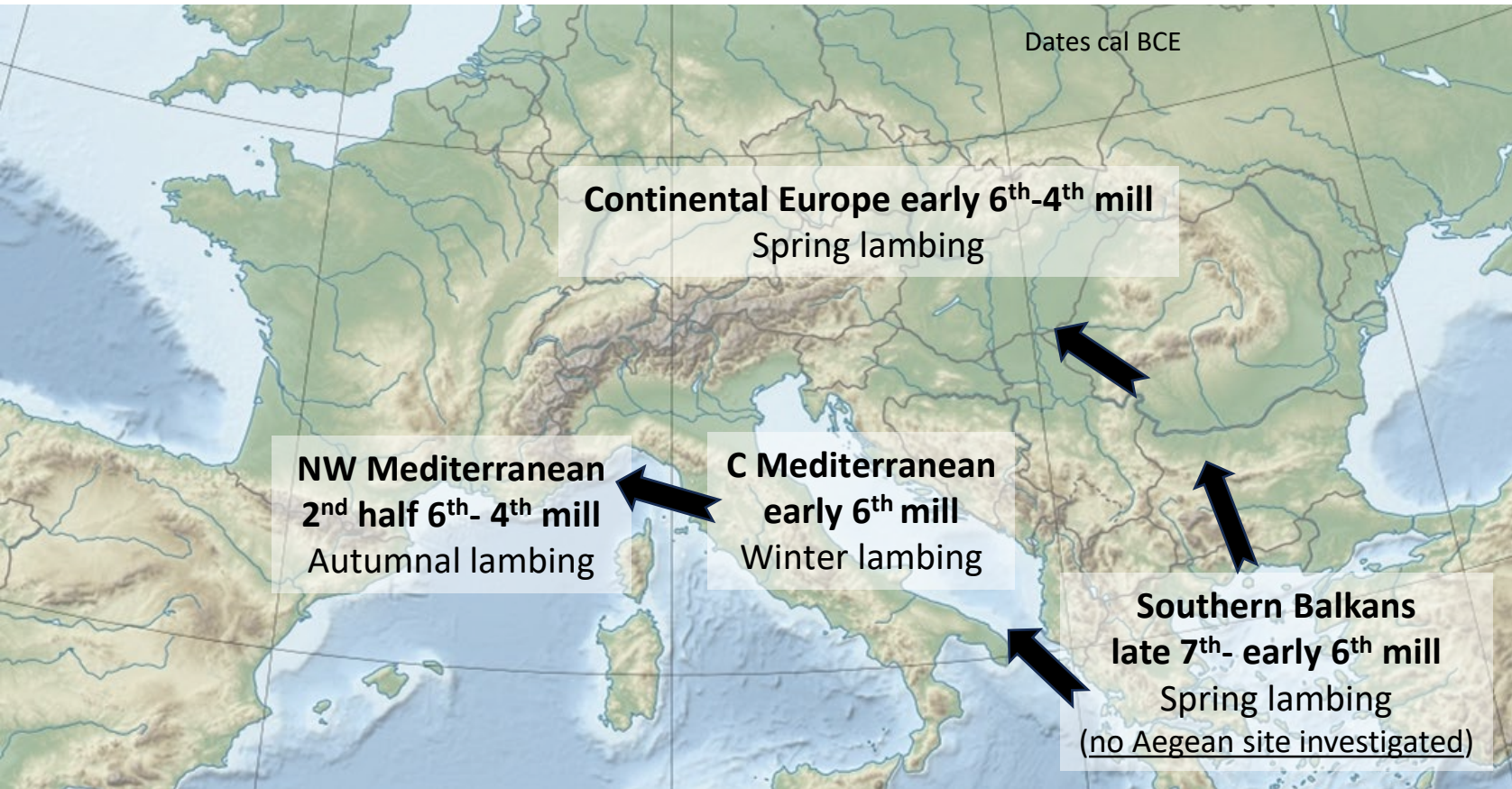
Present state of knowledge



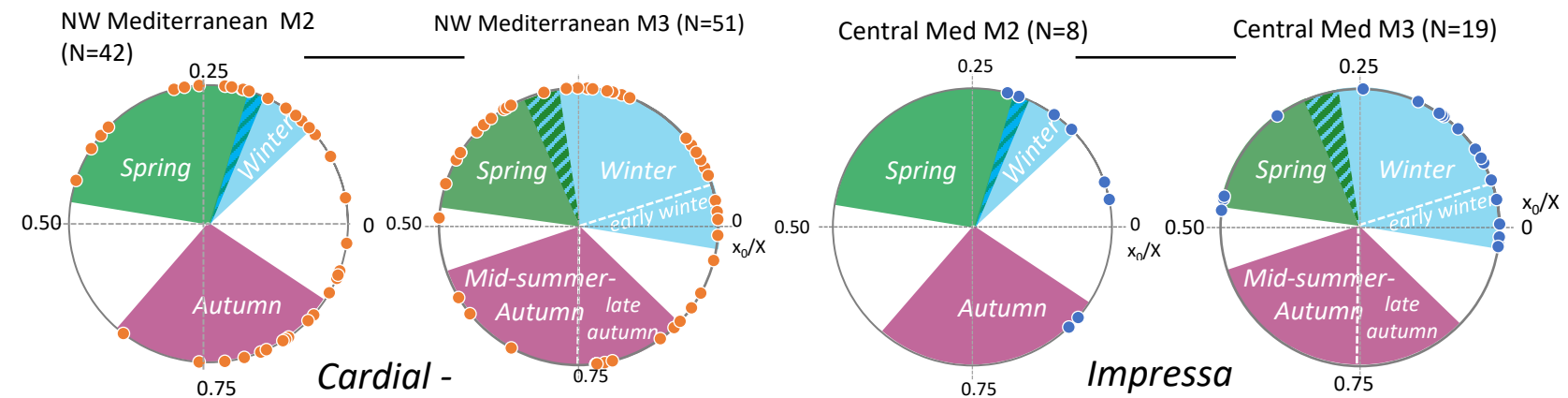
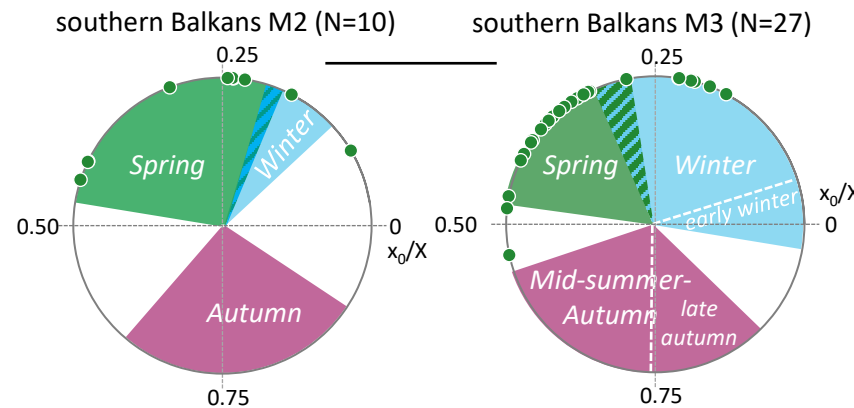
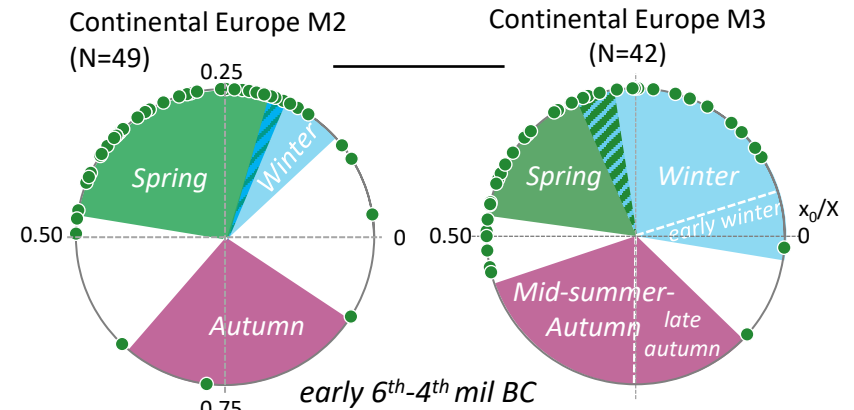
(Balasse *et al.*, 2012; 2013, 2017, 2020; Blaise & Balasse, 2011; Fabre *et al.*, 2021, 2023; Sierra *et al.*, 2021; Tornero *et al.*, 2013, 2020; Tejedor-Rodriguez *et al.*, 2021)
☆ **this study**)



Present state of knowledge



(Balasse *et al.*, 2012; 2013, 2017, 2020; Blaise & Balasse, 2011; Fabre *et al.*, 2021, 2023; Sierra *et al.*, 2021; Tornero *et al.*, 2013, 2020; Tejedor-Rodriguez *et al.*, 2021) + **this study**)

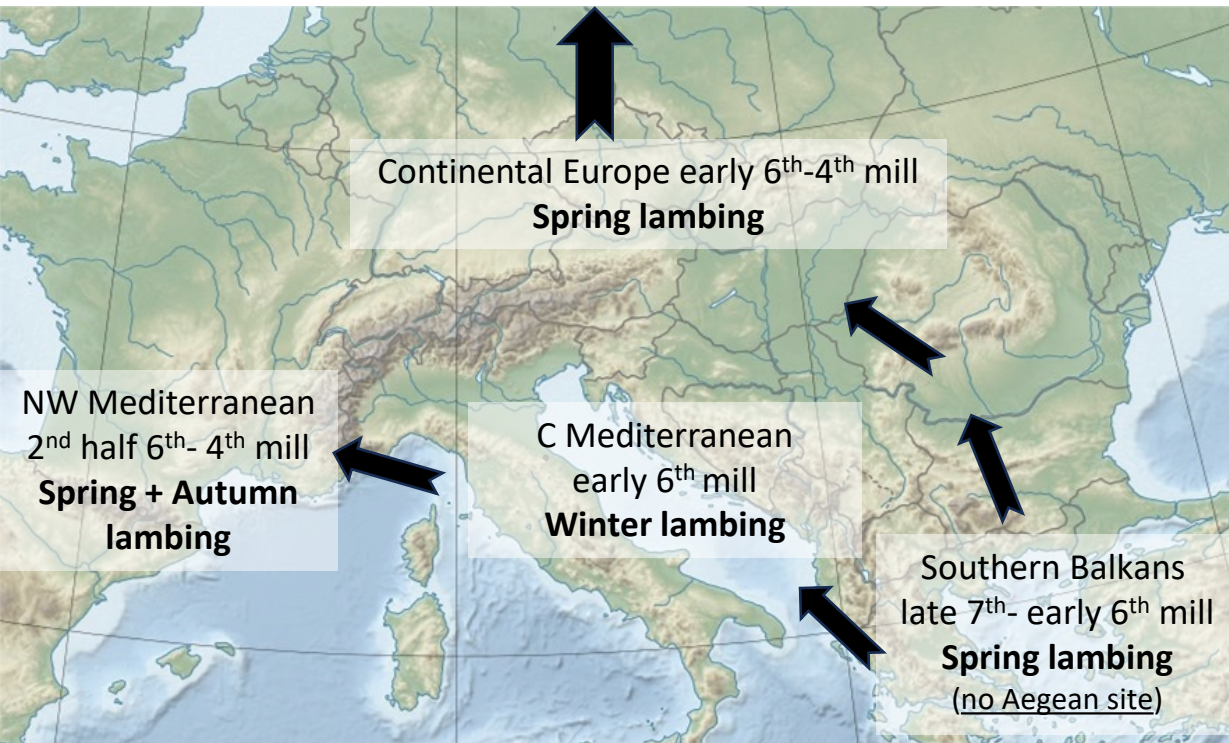




Today's Europe

Seasonal (spring) lambing
Autumn lambing in the Mediterranean

Dates cal BCE



Today's Europe

Husbandry:
Year-round breeding



Selection in favor of an initially rare ability for deseasoning?
(*favorable environmental conditions in the Mediterranean area*)

or

Selection against an initially widespread ability for deseasoning?
(*unfavorable environmental conditions at higher latitudes*)

Latent capability for year-round breeding
Unexpressed in the wild ancestor (?)
Unexpressed in Neolithic cattle (feeding conditions not met)

Funding

AUTUMN LAMBS - *Autumnal lambing in the Mediterranean area: the history of complex interactions between biology, paleoenvironments and technical systems* (ANR 2022-2026; PI M. Balasse)

FARMERS WITHOUT BORDERS - *Ecological perspectives on the spread of animal husbandry from the Mediterranean to southeast Europe (6500-5500 BC)* (Fritz Thyssen Stiftung, 2020-2024, PI M. Ivanova, Mainz University)

SUSTAIN - *Sustainability of Agriculture in Neolithic Europe* (ERC, 2021-2026, PI M. Ivanova, Mainz University).

AGROPALEOREPRO - *Reproduction animale, calendrier pastoral et disponibilité saisonnière des aliments : une problématique plurimillénaire* (CNRS MITI-INRAE, 2019-2020, PI M. Balasse)

AUTUMN LAMBS



Fritz Thyssen Stiftung
für Wissenschaftsförderung

