



## **Geometric morphometrics of *Rangifer* teeth: a tool for exploring human-deer interactions during the Palaeolithic?**

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ARSCAN



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# the DeerPal project

humans and deer during the Palaeolithic,  
integrating the variability of prey ecology and ethology  
in the investigation of past human – environment interactions

## Two target species



Reindeer (*Rangifer tarandus*)



Red deer (*Cervus elaphus*)

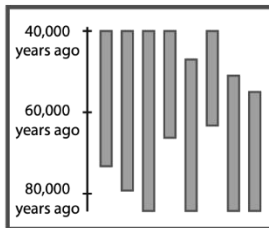
> Past variability in cervid niches and behaviours?

- Key resources for past hunter-gatherers
- Behaviourally and ecologically plastic
- Often complementary (one thrives when the other crashes)

## Two time periods

### Middle Palaeolithic

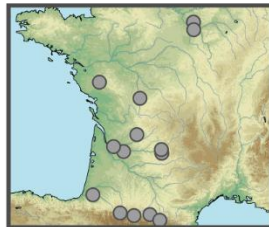
MIS 5-3, 100 to 40 ka cal. BP  
SW France



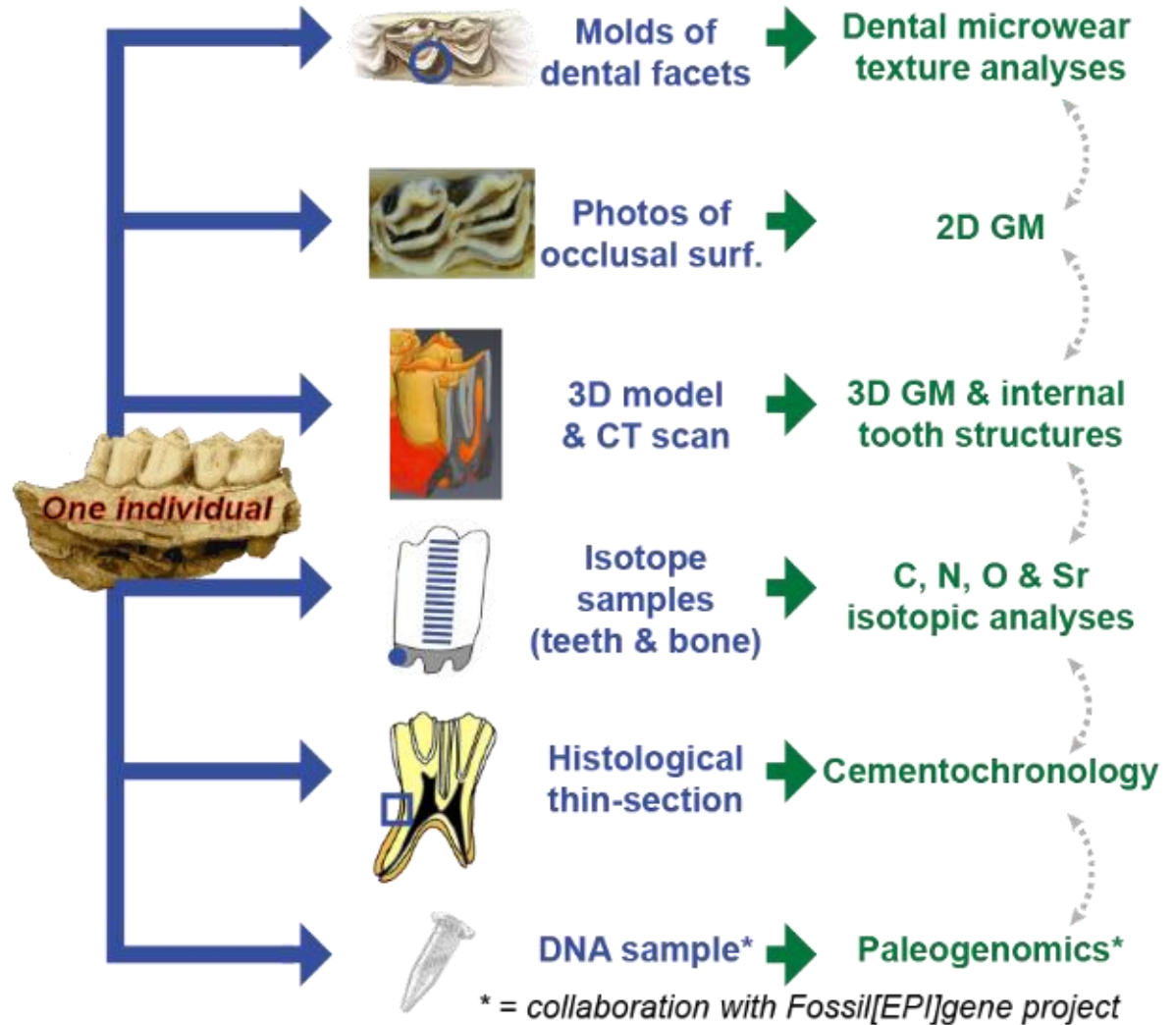
> Long stratigraphies  
A deep-time perspective

### Late Glacial

MIS 2, 16 to 12 ka cal. BP  
Paris Basin to Pyrenees



> Large geographical scale  
The last reindeer hunters



Combine methods on the same samples/collections

This presentation = first 2D GMM results on Reindeer





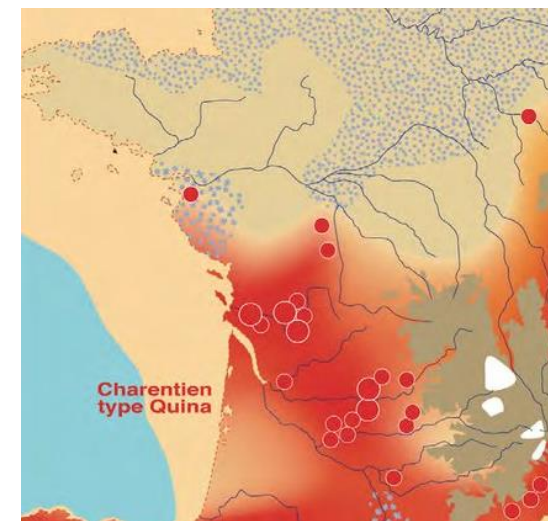
## How can 2D GM of reindeer teeth inform past human-cervid interactions?

Two examples from a Middle Palaeolithic perspective in SW France:

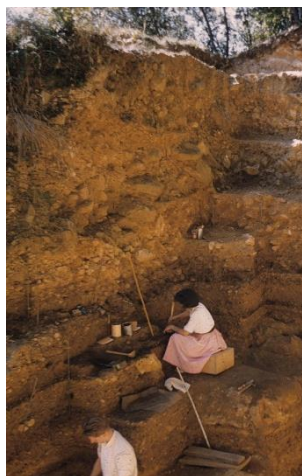


**Quina Mousterian**  
(around 60 ka cal. BP)

Reindeer mass kills (same prey), same lithic technology...  
but sites far from each other, and poor chronological  
resolution !  
> same reindeer hunted pop ?

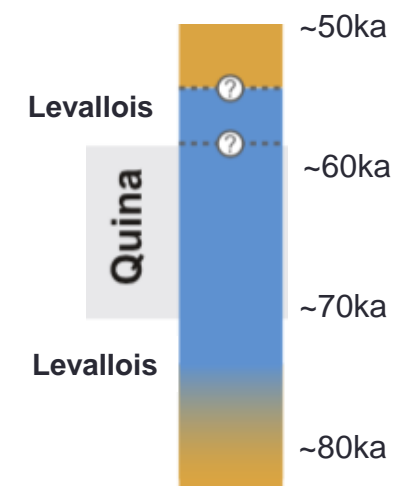


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**Transitions from  
Levallois to Quina  
Mousterian**  
(around 80 to 50 ka  
cal. BP)

In the same archaeological sequences,  
important change in lithic tech, pigment use,  
mortuary practices, subsistence strategies,  
but not in hunted prey (reindeer) = different  
or same reindeer hunted pop ?

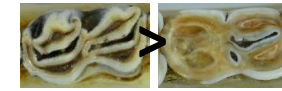


# Material & methods: 2D GM enamel folding patterns of occlusal surfaces (lower molars)

Previous work: two Master dissertations on reindeer teeth 2D GM

Gray, 2013 (lower M3, 2 populations of modern caribous)

Yu, 2019 (lower M1, 2 populations of modern Norwegian reindeer)



Sexual dimorphism?

Impact of tooth wear?

Population signal?


Ongoing work: modern reindeer (Norway, Finland, Canada, Alaska) + Mousterian and Late Glacial archaeological sites



North America	
Alaska	159
Canadian islands	56
Kaminuriak	111
Others	54
Norway	
Hardangervidda	75
Knutso	53
Finland	
wild forest reindeer	180



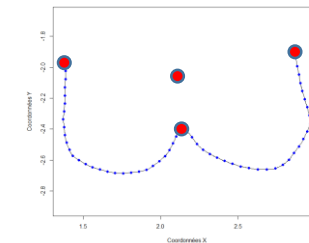
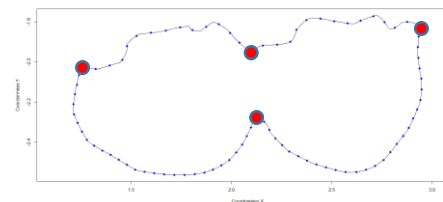
> Lower M1, M2 and M3

> Crown heights measurements

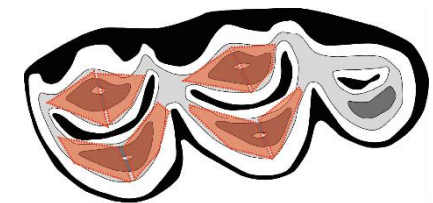
> **New tooth wear scoring system, more objective**, inspired by Brown & Chapman (1991) and Dudley (2008) works on red deer = total tooth score ranging from 0 to 18, based on 0/1 criteria (dentine exposed on each cusp slope, closing of the infundibulum, etc.).



StereoMorph: landmarks + sliding semi-landmarks

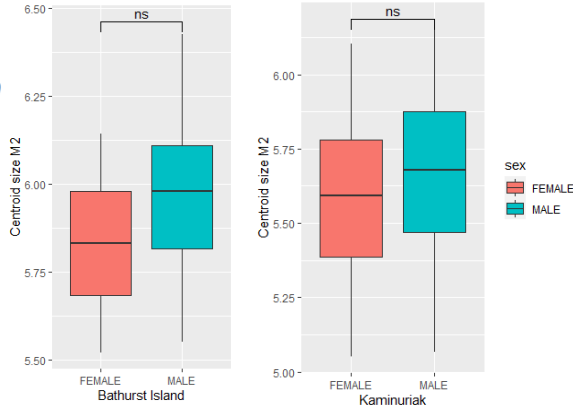


Different landmarks to test for replicability, speed & lower impact of tooth wear



# Preliminary results

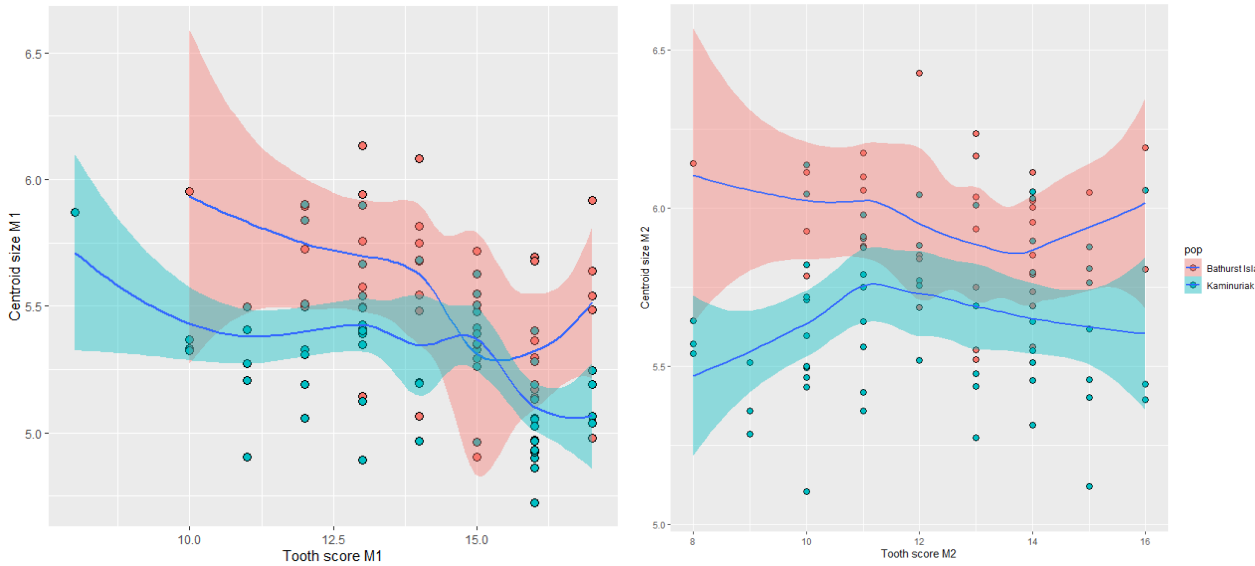
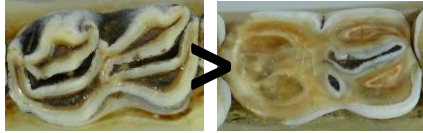
## Sexual dimorphism



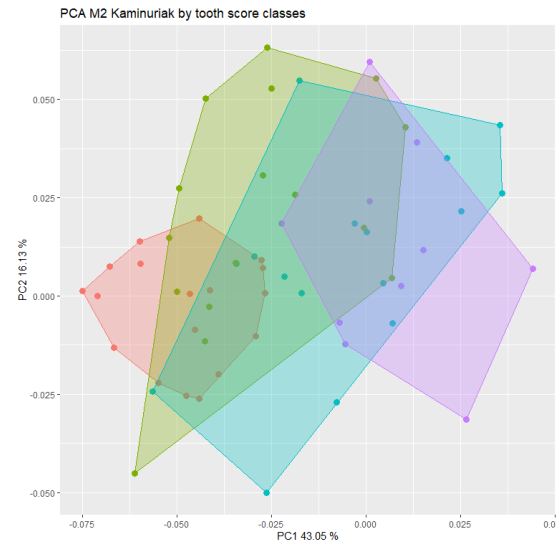
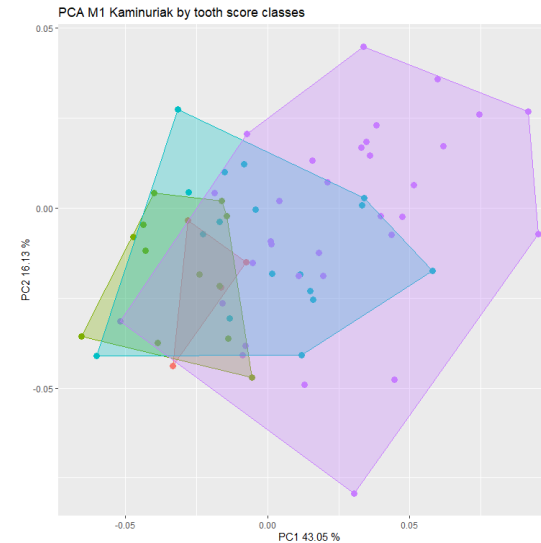
*In all populations analysed so far:  
no sexual dimorphism for M1 and M2  
> Support previous findings  
by Gray, 2013 (M3) & Yu, 2019 (M1)*

**“Good news” for archaeological applications!**  
(archeo. = little to no information on sex ratio  
+ small sample sizes...)

## Tooth wear



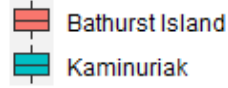
*centroid size changes according to tooth score*



*shape changes according to tooth score*

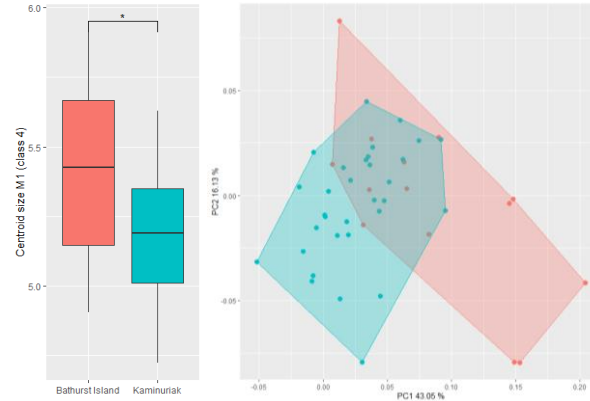
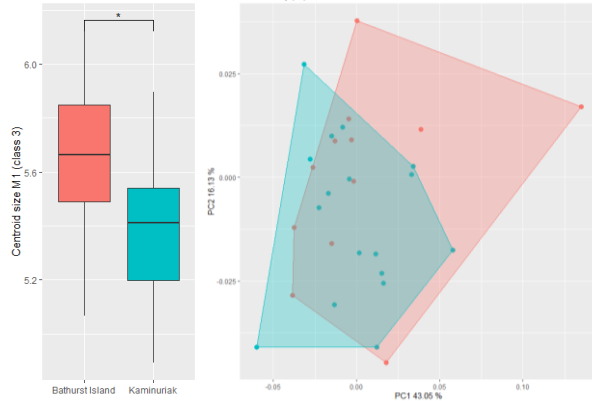
**Not unexpected, but potential “bad news”...**

## Future directions



ONLY tooth wear = class 3

ONLY tooth wear = class 4



**Despite important influence of tooth wear, still perceptible differences between populations**

*More population signal in size rather than shape?*

### Future research:

- Carry on with landmarking + statistical analysis...
- Preliminary tests = protocol well-fitted for analysis of archaeological collections
- Large modern sample (caribous + reindeer) = potential for a large-scale view on drivers of tooth morphology in *Rangifer*?
- Adapt landmark protocol depending on tooth wear classes?
- Compare with 3D GM of internal structures (no impact of tooth wear)?



**Thank you for your attention!**  
**Kiitos paljon!**



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