



# Peninsular Thailand as a part of the Pleistocene savanna corridor: isotopic evidence of mammalian tooth enamel from the cave of Tham Phedan

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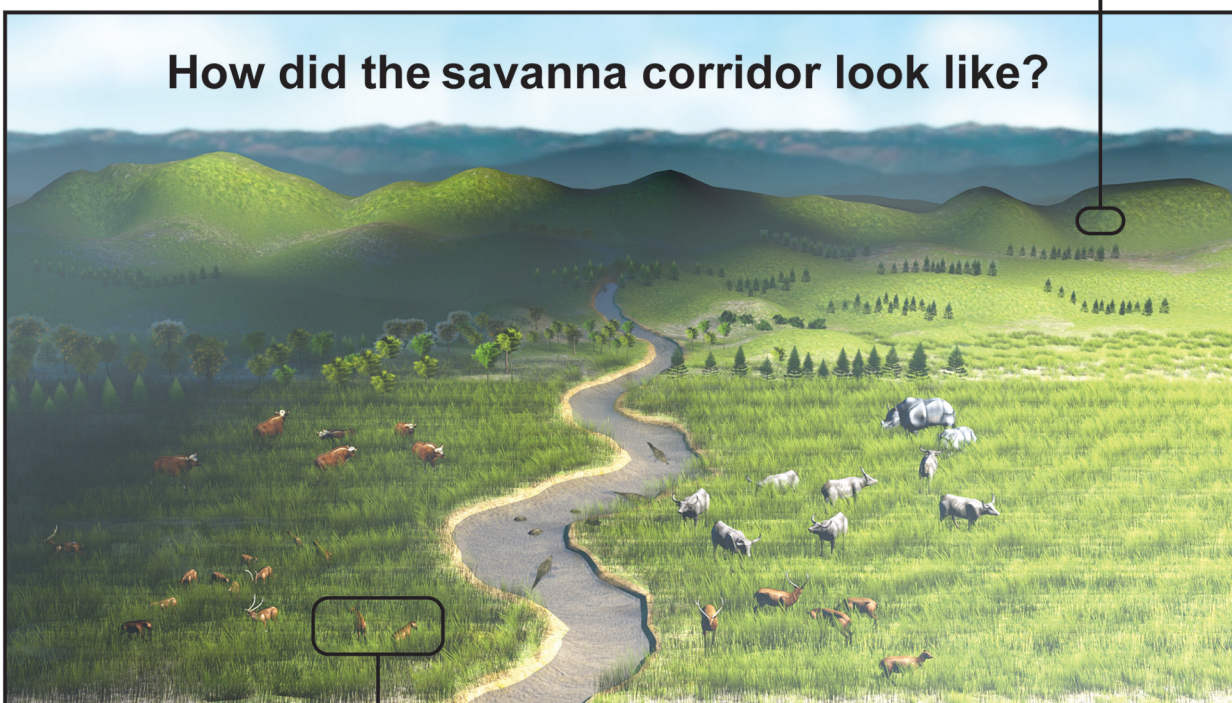
## Rationale

The hypothesis of a “savanna corridor” or a band of open vegetation (seasonal forests and grasslands), stretching from mainland Southeast Asia to Java at several periods of lowering sea level and exposed land bridges through the Pleistocene glacials, has been proposed to explain the facilitated migration route into Indonesian islands for early humans and associated large mammals.

### Closed canopy habitat



### How did the savanna corridor look like?



### Open canopy habitat

## Objectives

- 1) To reconstruct the paleoecology of mammalian fauna in Tham Phedan and the paleoenvironments of the region, using stable carbon isotope analysis of mammalian tooth enamel
- 2) To evaluate the hypothesized savanna corridor based on multi-proxy evidence

## Fossil site

**Location:** Tham Phedan Cave, Nakhon Si Thammarat Province, Peninsular Thailand

**Fossiliferous layer:** paleochaannel deposits at the cave roof

**Fossil findings:**

- 1) Malayan porcupine (*Hystrix brachyura*)
- 2) Extinct spotted hyaena (*Crocota crocuta ultima*)
- 3) Javan rhinoceros (*Rhinoceros sondaicus*)
- 4) Sambar deer (*Rusa unicolor*)

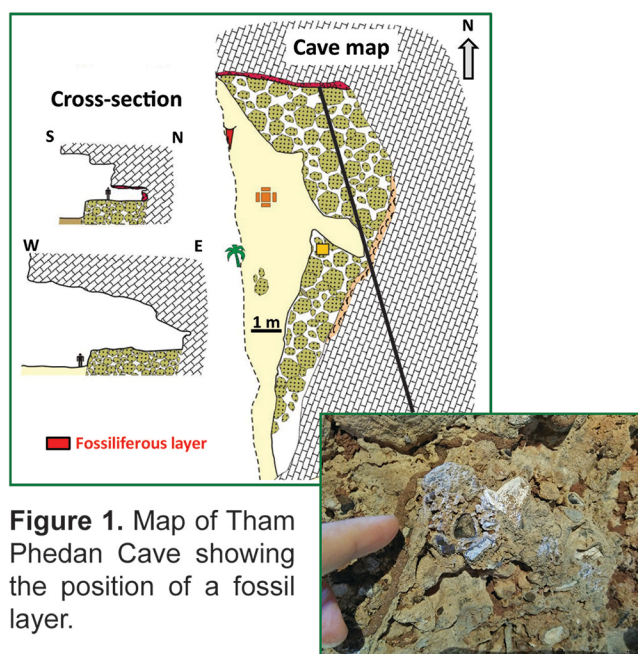


Figure 1. Map of Tham Phedan Cave showing the position of a fossil layer.

## Methodology

- Sampling: 10 analyzed tooth enamel (bioapatite) samples of 4 available taxa from the cave of Tham Phedan
- Carbonate pretreatment: removal of organic matter (by NaOCl) and non-lattice-bound carbonates (by acetate buffer solution)
- Isotope Ratio Mass spectrometry: Elementar IsoPrime 100 Isotopic Ratio Mass Spectrometer connected to a multiflow Geo at University of Tübingen

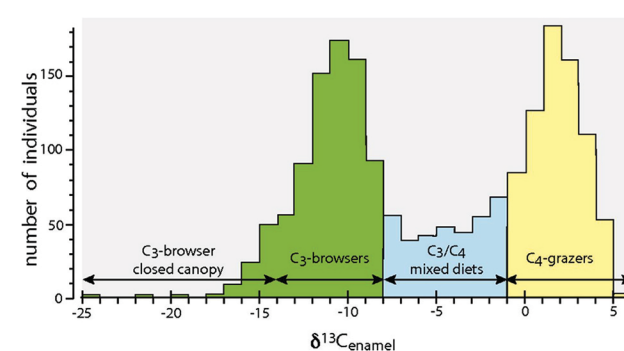


Figure 3.  $\delta^{13}\text{C}$  values for tooth enamel (or equivalent) for >1,900 mammals from East and Central Africa (from Cerling et al., 2015):

$\delta^{13}\text{C}$  for C4-grazers  $\rightarrow$   $-1\text{‰}$ VPDB  
 $\delta^{13}\text{C}$  for C3/C4 mixed feeders  $\rightarrow$  between  $>-8\text{‰}$ VPDB and  $<-1\text{‰}$ VPDB  
 $\delta^{13}\text{C}$  for C3-browsers  $\rightarrow$   $<-8\text{‰}$ VPDB

## Results & Discussion

### Diets:

- Malayan porcupines and Javan rhinoceroses  $\rightarrow$  pure C3 plants
- Spotted hyaenas  $\rightarrow$  herbivores inhabiting open environments
- Sambar deer  $\rightarrow$  pure C4 plants

### Habitats:

- Sambar deer and spotted hyaenas  $\rightarrow$  open canopy landscape or grassland ecosystems
- Malayan porcupines and Javan rhinoceroses  $\rightarrow$  closed canopy landscape or forest ecosystems

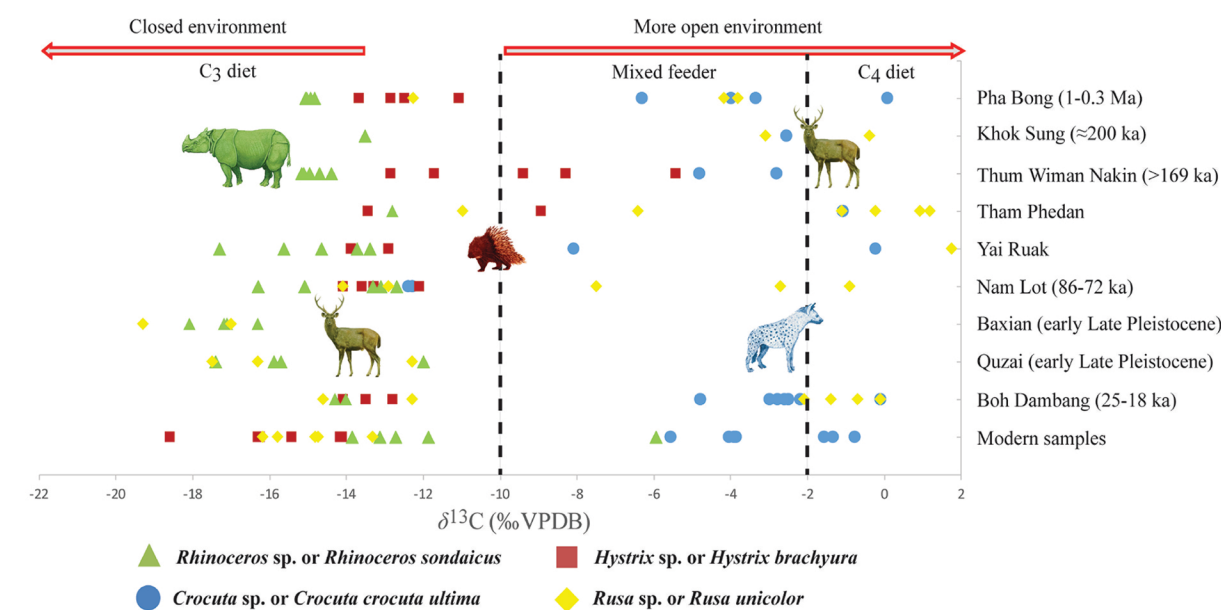


Figure 4. Bulk  $\delta^{13}\text{C}$  values of porcupines (*Hystrix*), spotted hyaenas (*Crocota*), rhinoceroses (*Rhinoceros*), and sambar deer (*Rusa*) from Tham Phedan in comparison with other Pleistocene Southeast Asian and South Chinese fossil sites.

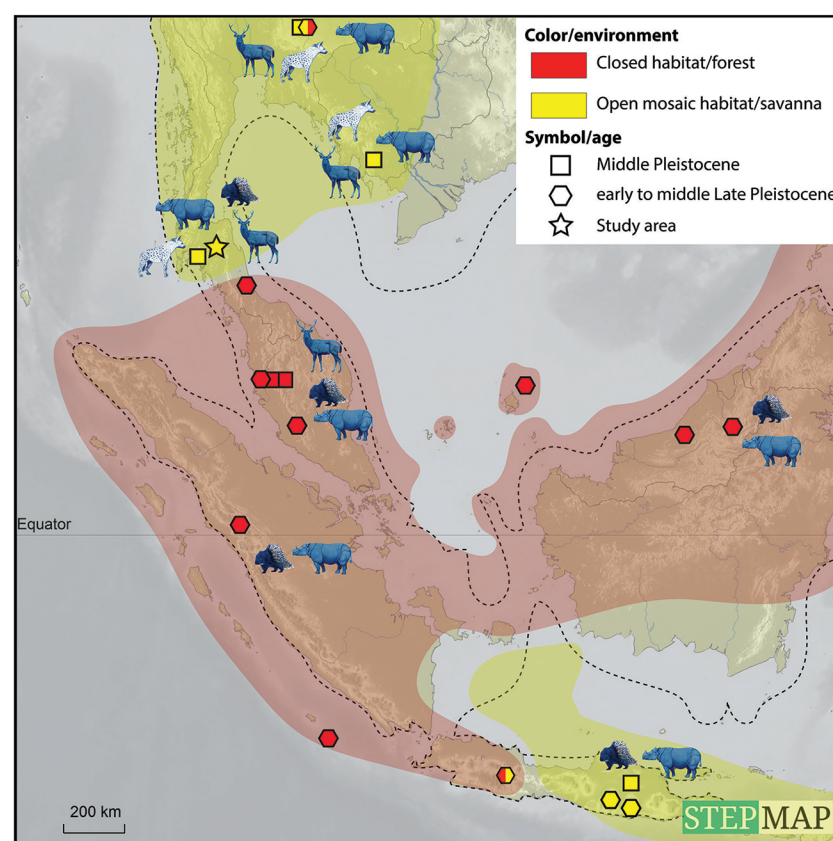


Figure 5. Map of Southeast Asia showing the fossil records of 4 mammal taxa: *Hystrix brachyura*, *Crocota crocuta ultima*, *Rhinoceros sondaicus*, and *Rusa unicolor*, and the habitat/environmental scenarios in relation to the intermediate sea level (-40 to -50 m below current sea level) during the Middle to middle Late Pleistocene and early Holocene.

## Conclusions and future plans

- 1) The open grassland environment was present in Tham Phedan, confirming a savanna corridor in Peninsular Thailand during the late Middle Pleistocene.
- 2) The continuous savanna corridor appears unlikely during the Pleistocene glacials and was latitudinally separated by a transequatorial rainforest belt, starting around the northern part of Sundaland.
- 3) Ongoing paleontological excavations at the cave of Tham Phedan and further investigations into the Pleistocene environmental conditions in Thai-Malay Peninsula are critically helpful to better identify such a corridor in relation to the early human migration route in the future.

## References

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