

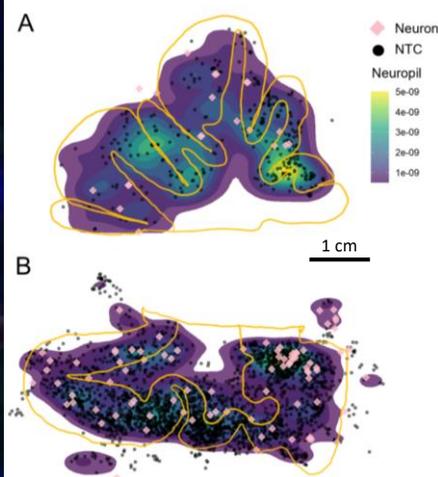
# Bull-headed: Tauopathy distribution in relation to traumatic brain injury in muskoxen

NL Ackermans<sup>1,2</sup>, B Wicinski<sup>1</sup>, TM Williams<sup>3</sup>, N Grimaldi<sup>1</sup>, M Varghese<sup>1</sup>, JS Reidenberg<sup>2</sup>, PR Hof<sup>1</sup>

<sup>1</sup>Nash Family Department of Neuroscience and Friedman Brain Institute, <sup>2</sup>Center for Anatomy and Functional Morphology, Icahn School of Medicine at Mount Sinai. <sup>3</sup>Department of Ecology and Evolutionary Biology, University of California, Santa Cruz.

- Traumatic brain injury (TBI) is one of the leading causes of death worldwide, with low success of translation from rodent models to clinical therapy.
- Muskoxen (*Ovibos moschatus*) have thick skulls and large horns, used in headbutting clashes. Bulls clash heads up to 20 times per day during the rut, at forces around 3000 N. Despite the common belief that their headgear protects their brains from extreme impacts, it have never been investigated experimentally.
- TBI can be detected in the brain by using immunohistological staining to highlight phosphorylated tau protein, which accumulates in instances of neuronal damage.

## Distribution of tau-positive structures



## Results

- TBI-like pathology is present in the form of tau-positive histological staining (C)
- Neuritic tau concentrated in layers I-III and at bottom of sulci (A, B, D)
- The middle-aged ♀ muskox (B) showed the highest amount of pathology, the male (A) showed the least (D)



## Discussion

- Muskoxen and possibly other combative bovids suffer from tauopathies related to TBI caused by headbutting
- Males may be better protected by their thick skull and horns
- Headbutting is a taxing measure of fitness for sexual selection
- Similar pathology pattern to early-stage chronic traumatic encephalopathy (CTE) in humans
- Naturally-occurring repetitive TBI and shorter lifespan presents bovids as an interesting model for human TBI and CTE

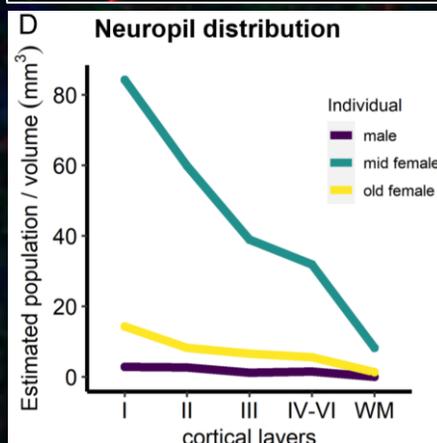
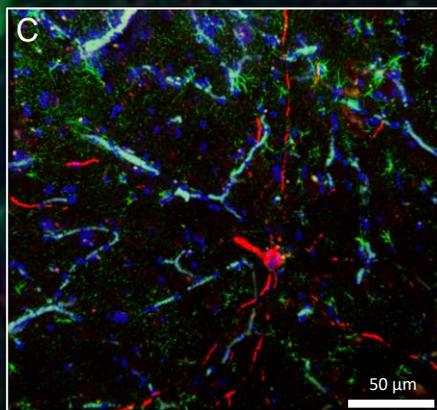
## Methods

Prefrontal cortex 10 section series from

- One old muskox ♂ brain
- One old, one middle-aged muskox ♀ brain
- 1 human brain, advanced Alzheimer's disease (positive control)

Techniques:

- Immunohistochemistry staining with CP13 (1:1000, Ser 202) antibodies highlighting phosphorylated tau protein and with glial fibrillary acidic protein (GFAP 1:1000) that highlight astrocytes. Aim to detect any chronic or acute brain trauma related to headbutting.
- Exhaustive counting of tau-positive neurites, neuropil thread clusters (NTC) and neurons using Stereo Investigator



@AckermansNicole  
Nicole.Ackermans@mssm.edu