Diving Deeper into Ancient Hunter Gatherer Diets

Amino Acid Stable Isotope Approaches

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Ancient Diets and Radiocarbon Dating

Radiocarbon dating measures the amount of radioactive isotope carbon-14 (^{14}C) that remains in an organic sample. However, there are sources of carbon that enter freshwater environments (rivers, lakes, etc.) that have less ^{14}C than the contemporary atmosphere. These older carbon sources create reservoir effects that artifically increase the radiocarbon age of people who ate freshwater foods, making them appear to be older than they are.

The Upper Lena River and Lake Baikal have well documented reservoir effects that have impacted the accuracy of radiocarbon ages for hunter-gather-fishers that consumed freshwater fish or Nerpa, Lake Baikal seals (Schulting et al. 2022). Current corrections for this reservoir effect rely on bulk collagen stable carbon and nitrogen isotope values ($\delta^{13}C$, $\delta^{15}N$) as a proxy for the proportion of freshwater foods in an individual's diet. Unfortunately, there is a large overlap in the $\delta^{13}C$ values of terrestrial and freshwater animals in the Cis-Baikal region that has limited the precision of these corrected dates.

Figure 1. Baikal seal, Pusa sibirica

(Illustration by Pieter Folkens).

Baikal Seal
Nobuyuki Miyazaki, in Encyclopedia of Marine Mammals (Third Edition), 2018

Amino Acid Specific Approach

Bone collagen is the organic component of bone that is regularly analysed for stable carbon and nitrogen isotope analysis. Collagen is a protein made up of many individual amino acids. The benefit of analysing these individual amino acids is that they can provide isotopic signatures from the base of their foodwebs as well as the diet of the human or animal.

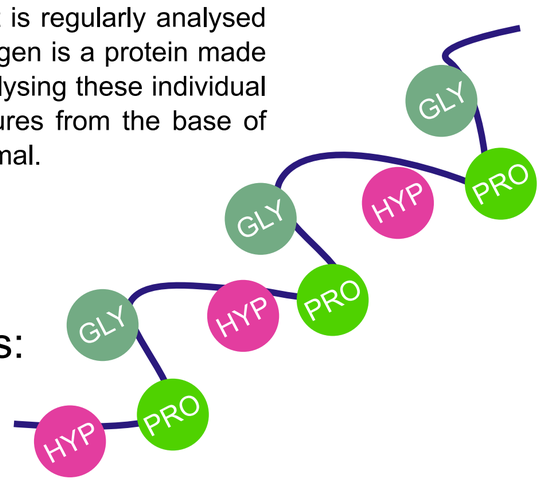
Essential vs Non-essential – $\delta^{13}C$

Source vs Trophic – $\delta^{15}N$

Metrics to identify Freshwater foods:

$\Delta^{13}C_{Val\text{-}Phe}$ $\Delta^{13}C_{Gly\text{-}Phe}$

$\Delta^{15}N_{Glx\text{-}Phe}$ $\delta^{15}N_{Leu}$



Research Questions

→ Determine if amino acid $\delta^{13}C$ or $\delta^{15}N$ values can identify the amount of freshwater protein in the diet of Cis-Baikal hunter-gatherer-fishers.

→ Identify amino acid metrics that can correct for the freshwater reservoir effect.

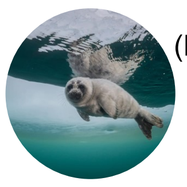
Samples

Human remains were selected from the Upper Lena (riverine fish) and Little Sea (nerpa) archaeological micro-regions to compare how different freshwater resources were identified by amino acid stable isotope analysis. Burial objects, such as animal tooth pendants, made from the bones of terrestrial animals provide a local signature of terrestrial resources.

Archaeological Humans

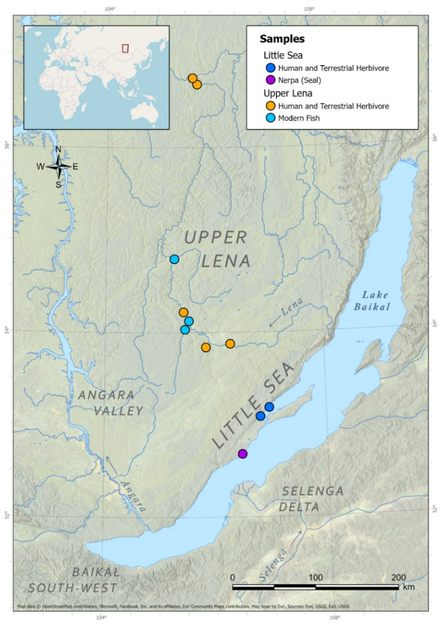
Terrestrial Animal Tooth Pendants

Nerpa seal bones from archaeological sites and the bones of modern fish caught from the Upper Lena were also analysed to determine which amino acid markers could distinguish between these freshwater and terrestrial resources.

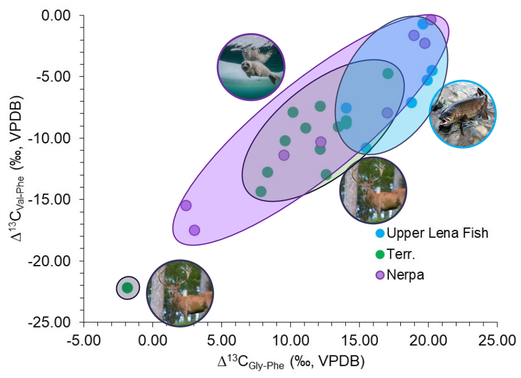


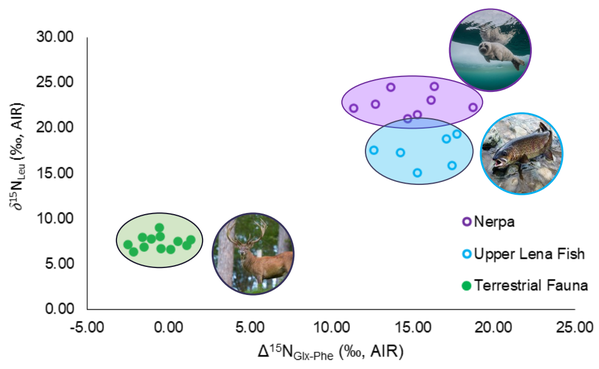
Nerpa (Lake Baikal Seal)

Upper Lena Freshwater Fish



Distinguishing Food Sources





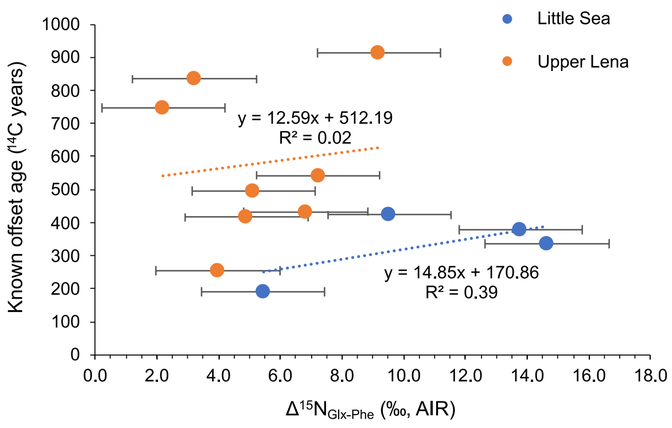
→ Amino acid $\delta^{13}C$ values of the nerpa overlapped those of the terrestrial animals and the freshwater fish.

→ Amino acid metrics specific to freshwater resource consumption in ancient populations were unable to distinguishing the freshwater resources of the Cis-Baikal region.

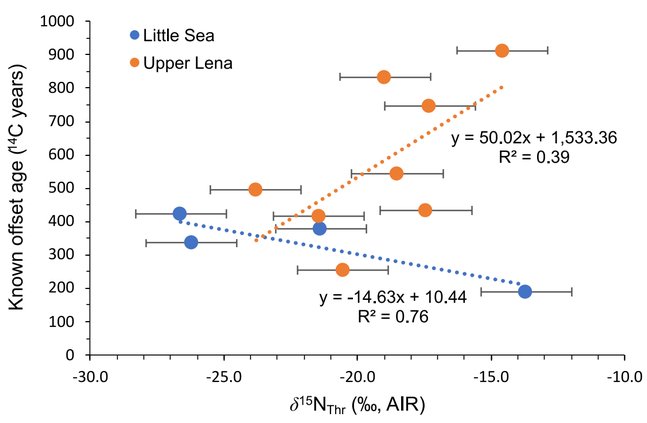
→ Amino acid $\delta^{15}N$ values were able to distinguish all three of the analysed food sources.

→ These amino acid stable nitrogen isotope metrics provided a better distinction between the freshwater fish and the nerpa than bulk collagen $\delta^{15}N$ values.

Reservoir Corrections



When the $\Delta^{15}N_{Glx\text{-}Phe}$ value was compared to known radiocarbon offset ages it proved to be more successful in accounting for the reservoir effect of the Little Sea population which had greater access to nerpa, than it was for the Upper Lena population which had greater access to fish from the Upper Lena.



The $\delta^{15}N_{Thr}$ values provided the strongest correlations against known offset ages for both micro-region populations. The stable isotope values of threonine have a complex relationship to the trophic level of diet and the mechanisms driving this are currently poorly understood.

Conclusions

→ There is no "freshwater" amino acid that completely overrules the overlap in baseline bulk stable isotope values.

→ Faunal baselines greatly assist in interpreting variation in amino acid stable isotope values.

→ Amino acid stable isotope analysis can be useful for reservoir effect corrections when regional-specific variation between the freshwater and terrestrial systems is well characterized.

Citations and Acknowledgements

Schulting, R. J., et al. (2022). "Freshwater reservoir effects in Cis-Baikal: An overview." Archaeological Research in Asia 29.

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