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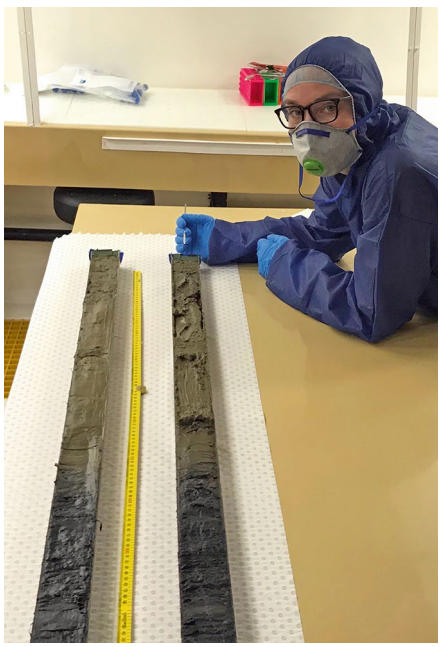
TOOLS OF THE TRADE

Sedimentary ancient DNA as a tool in paleoecology

Over a century of paleoecological investigations have been dedicated to studying the preserved hard parts of organisms contained in geological archives. Although the fossil record has revealed valuable insights into past ecosystems, the vast majority of past life has remained undetected due to a lack of preservation. Sedimentary ancient DNA (sedaDNA), DNA sourced from proximal organisms and preserved in coeval sediments, is upending that limitation in the Late Quaternary record. Owing to recent advances in sequencing technology and genetics techniques, one small sediment sample can yield a broad snapshot of a past ecosystem, indicating the presence of species from microbes to mammals.



Credit: Gifford Miller

SedaDNA analyses rely on the information contained in short DNA fragments preserved within the sediment matrix. Ancient DNA is isolated and purified from sediment core subsamples in ultra-clean, dedicated labs to minimize contamination from modern sources. This complex pool of extracted DNA can then be analysed in multiple ways: metabarcoding targets particular taxonomic groups by amplifying and sequencing short diagnostic DNA barcodes, whereas a metagenomic approach involves sequencing all genetic fragments in a sample. Emerging techniques such as target capture aim to enrich complex DNA samples for taxa of interest. Sequence data are then compared with a reference database to make taxonomic assignments, which enables inferences about what organisms lived nearby at the time the sediment was deposited.

Analyses of DNA from lacustrine, marine, and terrestrial sediments have enabled novel paleoenvironmental insights. Mammal DNA from lake cores has been used to provide tight constraints on extinction events and to reveal the timing and consequences of non-native species introductions. DNA from plants provides more spatially precise paleovegetation information than fossil pollen and is thus shedding new light on postglacial colonization patterns and species range shifts during past warm periods. SedaDNA has also been used to document how recent anthropogenic disturbances are impacting, for example, microbial communities. As ancient and environmental DNA analysis methods rapidly develop, sedaDNA will provide an increasingly clear window to the past with ecological lessons for the future.

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Competing interests
The author declares no competing interests.