Dating topographic evolution in New Zealand using mitochondrial DNA

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Tectonic processes and/or climate-related fluvial activity commonly cause river drainage reorientation that can affect topographic development and sedimentary depocentres on a regional scale. Drainage reorientation results from development of a physical barrier within a river valley, erosional river capture, or a combination of these. Physical barriers also separate indigenous freshwater fish, resulting in isolated populations that then evolve independently. Divergent molecular evolution of mitochondrial DNA in the separated populations results in measurable differences in DNA sequences after about 5-10 ka. We are calibrating the resultant "molecular clock" using suitable geological barrier-forming events associated with glacial and tectonic development of topography in the South Island of New Zealand. Several Holocene and late Quaternary glacial outwash and tectonic barriers have been dated by regional fluvial terrace correlation supplemented by carbon dating [1]. A middle Quaternary tectonic barrier has been dated by extrapolation of late Quaternary uplift rate estimates [2].The age of an early Quaternary barrier has been estimated from ^{10}Be and ^{26}Al dating of surface materials [3]. The resultant calibration line implies DNA divergence rates of about 10%/Ma, which is substantially faster than longer-term DNA divergence rates commonly used by biologists (typically about 2%/Ma). Further work is needed to determine if the divergence rate is linear through the Quaternary, but the method shows promise as a potential dating tool for Quaternary topographic evolution events. This method is useful in active tectonic settings where the rate of geomorphic evolution is similar to the rate of biological evolution. The method dates the last time that a "wet connection" existed between drainages that allowed genetic interchange between now-separated populations.

References

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