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Challenges and opportunities offered by Scottish Freshwater Pearl Mussels as 'continuous data loggers' of environmental data

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The freshwater pearl mussel (Margaritifera margaritifera Linnaeus [1758], hereafter FPM) presents challenges and opportunities for conservation palaeobiology. FPMs preserve the whole of their life history of growth in their shells, providing an archive of time series of abiotic environmental data and the response of individual mussels to these factors. FPMs are long-lived, routinely living for 60 to 80 years, sometimes for over a century. Previous work has identified annual, seasonal and, exceptionally, daily growth increments. With careful sampling and interpretation, the shells of dead mussels have the potential to extend the records of air and water temperature, nutrient flux and flood and drought cycles for individual catchments far beyond currently available instrumental and written records. As this information is preserved in a living organism that responds to some of these variables, variation in the width of these growth increments can inform us about how these factors influence the growth of FPMs. As the species does not decouple growth and reproductive effort nor does fertility decline with age, unlike many other taxa, this allows estimation of the relative reproductive effort in a year. Such data are difficult to obtain by other means.

However, making fullest use of this significant resource presents several challenges that require co-operation between Earth scientists, conservation biologists and managers. Our present challenge of FPMs is to understand the age-profile of dead shells. The studies of the growth increments we have made to date are 'floating' chronologies. We know the age at death of the individuals, but not the absolute age of death. With common species, the issue of floating chronologies can be resolved by harvesting live individuals, which will then have a known year of death. Given the threat that FPMs are under, of both local and global extinction, this is not a viable option without demonstrating significant utility of conservation palaeobiology approaches to other stakeholders. We have begun work to build a radiocarbon-calibrated amino-acid racemization (AAR) chronological framework to date FPMs from dead individuals from the River Kerry, NW Highlands, Scotland as a means of concentrating research on individuals that died a natural death.

With an absolute chronology is in place, environmental data can be placed in an absolute temporal framework. We propose that combining data from the growth series, studies of pre-mortem taphonomic damage and analysis of trace elements will provide the capability to distinguish between the effects of drought and flood events, eutrophication in individual streams and tributaries. The availability of samples from multiple rivers with different individual ecohydraulic histories across Scotland allows the chance to disentangle the relative impact of local and regional environmental variation on FPM populations. Thus novel evidence for conservation management decisions, at a time when many new dams for hydro-electric schemes are being proposed in Scotland and other European nations with significant FPM populations, can be unlocked from these 'living data loggers'.