Culture, climate or both? 6000 years of human activity from Ireland using sedaDNA, stable isotopes, lipid biomarkers and pollen

Antony Brown[a,b], Maarten van Hardenbroek[c], Helen Mackay[d], Thierry Fonville[b], Peter Langdon[b], Nicki Whitehouse[e], Finbar McCormick[f], Emily Murray[f], Phil Barratt[f] , Maxwell McCann[b], Andy Henderson[c], Francesco Ficetola[g,h], Ludovic Gielly[h], Kim Davies[i], Anne Crone[j], Greame Cavers[j], Mikkel Winther Pedersen[k], Javier de la Casa Sánchez[l], Inger Alsos[a], Kevin Edwards[m]

[a] *Tromsø Museum, Arctic University of Norway, Tromsø, 9009 Norway*, antony.g.brown@uit.no, inger.g.alsos@uit.no
[b] *Geography and Environmental Sciences, University of Southampton, SO17 1BJ UK,* Thierry.fonville@gmail.com, p.g.langdon@soton.ac.uk,
[c]*School of Geography, Politics & Sociology, University of Newcastle, NE1 7RU UK, maarten.vanhardenbrok@newcastle.ac.uk, andy.henderen@newcastle.ac.uk*
[d]*Department of Geography, University of Durham, DH1 3LE UK, helen.mackay@durham.ac.uk*
[e] *Department of Archaeology, School of Humanities, University of Glasgow, G12 8QQ UK, nicki.whitehouse@glasgow,ac.uk*
[f]*Archaeology, Queens University Belfast, Northern Ireland, BT9 6AY UK, fmccormick@qub.ac.uk, emily@emilymurray.consulting*
[g]*Department of Environmental Science and Policy, University of Milan, 20133 Milan, Italy, francesco.ficetola@unimi.it*
[h]*Univ. Grenoble Alpes, Univ. Savoie Mont Blanc, CNRS, LECA, 38000 Grenoble, France, Ludovic.gielly@univ-grenoble.alpes.fr*
[i]*IMSET, Bournemouth University, Bournemouth, BH12 5BB UK, daviesk@bournemouth.ac.uk*
[j]*AOC Group Ltd., Edinburgh, Scotland, EH20 9SY UK, anne.crone@aocarchaeology.com, greame.cavers@aocarchaeoogy.com*
[k]*Globe Institute, University of Copenhagen, Oester Voldgade 5-7, 1350 Copenhagen K, Denmark, mwpedesen@sund.ku.dk*
[l]*Autonamous University of Barcelona, Campus UAB. Edifici C. 08193 Bellaterra, Spain, j.delacasa@creaf.uab.cat>*
[m]*School of Geosciences, University of Aberdeen, AB24 3FX Scotland, kevin.adwards@abdn.ac.uk*

In the humid-temperate western seaboard of the North Atlantic the roles of climate and culture in settlement and lake history are hard to disentangle due to multiple forcing factors. In this study a 6000 year record from a lake in Ireland (Lough Catherine) is analysed using geochemistry (stable isotopes, biogenic silica, XRF), molecular methods (sedaDNA metabarcoding and lipid biomarkers), and biological proxies (pollen and spores). We also present a collation of the archaeological data, which provides a comprehensive sequence for the major site in the catchment (Island MacHugh). Our analysis reveals close tracking of the archaeology by the molecular data from later prehistory to the modern period. The development of agriculture from the Late Bronze Age into the Iron Age is revealed by sedaDNA of the common agricultural plants and animals as well as direct evidence of site occupation in the form of fecal stanols. A second major peak of activity occurs in the early Medieval period when the island-site is converted into a defended settlement. The authenticity of the sedaDNA data is confirmed by the sedaDNA-estimated date for the introduction of exotic species (trees) into the catchment. GAM modelling reveals that the lake variables (BSi and stable isotopes) are principally driven by vegetation, which reflects human influences on land use rather than climate. The sedaDNA, biomarker and isotope data also reveal only weak correlation with climatic factors. In contrast to a deterministic view of climate being determinant the controlling factor here is human activity and subsistence culture.