Integrating palaeocology and genetics to uncover stand-scale glacial beech refugium

G. de Lafontaine, A. Ducousso, C.A. Amasifuen Guerra, S. Lefèvre, and R.J. Petit

UMR BIOGECO, INRA / Univ. Bordeaux 1, Bordeaux, France



INTRODUCTION

Glacial refugia usually refer to broad regions where boreal and temperate taxa persisted through the Last Glacial Maximum (LGM) (Bennett et al. 1991). Traditionally, such regions were defined by regional scale pollen analysis or transcontinental phylogeographical surveys. The scale at which refugia are defined might be irrelevant to determine specific stand-scale ecological or evolutionary processes.

REGIONAL-SCALE ANALYSIS

Soil macrofossil charcoal analysis including only sites from Landes de Gascogne.

SOIL MACROFOSSIL CHARCOAL ANALYSIS: a method to uncover stand-scale history of forest communities through botanical identification and radiocarbon dating of wood charcoal







 ^{14}C dating

Sampling KOH 1% Wet sieving Sorting

Weighting Taxonomic identification Drying

OBJECTIVES

Macrofossil soil charcoal analysis (de Lafontaine and Payette 2011, 2012) and SSR markers (Lefèvre et al. 2012) were used to uncover stand-scale history of isolated *Fagus sylvatica* (beech) populations at its low-elevation rear edge in Landes de Gascogne and Entre-deux-Mers, Southwestern France (Timbal and Ducousso 2010). Predictive models linked to estimates of LGM climate indicated that beech could have found suitable climatic conditions in this area during the LGM (Svenning et al. 2008).







Ciron river (whereas average pairwise distance between stands in the area is 45 km)

french lineages, following Magri et al. 2006.

beech stands in southwestern France, at the low-elevation rear edge.





REGIONAL-SCALE ANALYSIS

Genetic structure analysis including only sites from Landes de Gascogne.



STRUCTURE K = 2 groups

Beech stand at CIRON B is genetically different from nearby stands CIRON A (upstream) and CIRON C (downstream)

SOIL MACROFOSSIL CHARCOAL ANALYSIS

At CIRON B, beech dates back to 44,000 cal yr BP. By contrast, beech presence on upstream (CIRON A) and downstream (CIRON C) sites along the same valley was more recent, dated at 3800 and 900 cal yr BP, respectively.

CONCLUSION

Ц______ <u>20 km</u>

At CIRON B, radiocarbon dating of beech at c. 44,000, c. 33,000 cal yr BP and after the LGM, suggested in situ persistence of beech through Late Pleistocene but direct macrofossil charcoal evidence from the LGM are still needed to ascertain this inference. Genetic structure analyses showed a strong differentiation between CIRON B and all the other populations in the area, including the proximate CIRON A and CIRON C. Together, results of this integrated research at increasingly refined scales suggested that beech persisted through the Last Glacial Maximum in situ in at least one stand-scale refugium (CIRON B) within a regional cryptic refugium as defined by a more broad-scale analysis (Landes de Gascogne and Entre-deux-Mers).



REFERENCES Bennett et al. 1991. J Biogeog 18:103–115; de Lafontaine & Payette. 2011. Quat Sci Rev 30:867–875; de Lafontaine & Payette. 2012. Holocene 22:191–201; Lefèvre et al. 2012. Mol Ecol Res 12:484–491; Timbal & Ducousso. 2010. Bull Soc Linn Bordeaux 145:127–137; Magri et al. 2006. New Phytol 171:199–221; Svenning et al. 2008. J Ecol 96:1117–1127. ACKNOWLEDGEMENTS Experiments were funded by DGPAAT Convention E30/08, CRPF Nord-Pas de Calais-Picardie, FEDER, INTERREG IVA 2 mers, MEDDE, Conseil Général des Pyrénées Orientales, Région Languedoc-Roussillon, INRA-EFPA Projet Innovant, GdL benefited from a FQRNT postdoctoral fellowship, CAAG benefited from Erasmus Mundus BAPE and Labex fellowships.