Quaternary Science Reviews 120 (2015) 57–70

Contents lists available at ScienceDirect

Quaternary Science Reviews

journal homepage: www.elsevier.com/locate/quascirev

Differential insect and mammalian response to Late Quaternary climate change in the Rocky Mountain region of North America

Scott A. Elias

Geography Department, Royal Holloway University of London, Egham Hill, Egham, Surrey TW20 0EX, UK

ARTICLE INFO

Article history:
Received 7 April 2015
Accepted 30 April 2015
Available online 22 May 2015

Keywords:
Late Pleistocene
Insect fossils
Vertebrate fossils
Zoogeography

ABSTRACT

Of the 200 beetle species identified from Rocky Mountain Late Pleistocene insect faunal assemblages, 23% are no longer resident in this region. None of the 200 species is extinct. In contrast to this, only 8% of 73 identified mammal species from Rocky Mountain Late Pleistocene assemblages are no longer resident in the Rockies, and 12 species are now extinct. Since both groups of organisms are highly mobile, it would appear that their responses to the large-scale fluctuations of climate associated with the last 125,000 years have been considerably different. Most strikingly contrasting with the insects, there are no mammals in the Rocky Mountain Late Pleistocene fossil record that are found exclusively today in the Pacific Northwest (PNW) region. The PNW does have a distinctive modern mammalian fauna, but only one of these, Keen's Myotis, has a fossil record outside the PNW region, in the eastern and central United States. No modern PNW vertebrate species have been found in any Rocky Mountain fossil assemblages. Based on these data, it appears that there has been little or no mammalian faunal exchange between the PNW region and the Rocky Mountains during the Late Pleistocene or Holocene. This is in stark contrast to the fossil beetle record, where PNW species are a substantial component in many faunas, right through to the Late Holocene.

1. Introduction

The systematic study of Quaternary insect fossils began in the Rocky Mountain region in the early 1980s (Elias, 1983, 1985, 1988), and has continued since that time. To date, 122 fossil insect assemblages have been analysed from 13 sites, ranging from northern Montana to southern Colorado (Fig. 1). These sites have yielded about 300 insect taxa, predominantly beetles (Coleoptera). The sites range in age from about 125,000 years to recent (Table 1). The fossil beetle faunas include 200 taxa identified to the species level, based on the external morphology of their exoskeletons. This is roughly triple the level of diversity of identified species of mammals from Late Pleistocene assemblages in this region, based on data from Faunmap (Graham and Lundelius, 2010).

The aim of this paper is to compare and contrast insect and vertebrate distribution shifts in the Late Pleistocene for the Rocky Mountain region. The Rockies form an archipelago of boreal habitat islands, stretching from the true boreal forests of Canada south to the highlands of New Mexico. As such, these montane habitat islands have provided a series of migration corridors for cool-to cold-adapted biota, with the Great Plains on the east and various deserts and other arid regions on the west. Have vertebrates and invertebrates used these migration corridors in similar ways, in response to Late Pleistocene climate change? We now have sufficient fossil data available to begin to make comparisons.

A wealth of fossil data from Quaternary assemblages (summarized in Elias, 2010) has demonstrated that beetles (and probably many other groups of insects that lack substantial fossil records) shift their geographic ranges in response to climatic oscillations. Evidence for large-scale range shifts of this kind has been found in fossil assemblages from Europe (Coope, 1973), Australia (Porch et al., 2009), New Zealand (Marra, 2003), North America (Elias, 1991) and South America (Ashworth et al., 1989). Coupled with this phenomenon, there is little or no fossil evidence of insect extinctions due to Pleistocene glaciations, even in the more sedentary insect groups (Coope, 1978). In fact, the vast majority of species identified from Pliocene and Early Pleistocene deposits in the Arctic represent extant taxa (Elias and Matthews, 2002). Insect migration in response to climate change is not so much a deliberate act to move away from unsuitable environments. Rather, as typifies r-selected biota, most insects have large numbers of offspring, and most of these offspring move away from their point of origin, to minimize competition with their siblings and other members of

E-mail address: s.elias@rhul.ac.uk.

http://dx.doi.org/10.1016/j.quascirev.2015.04.026
0277-3791/

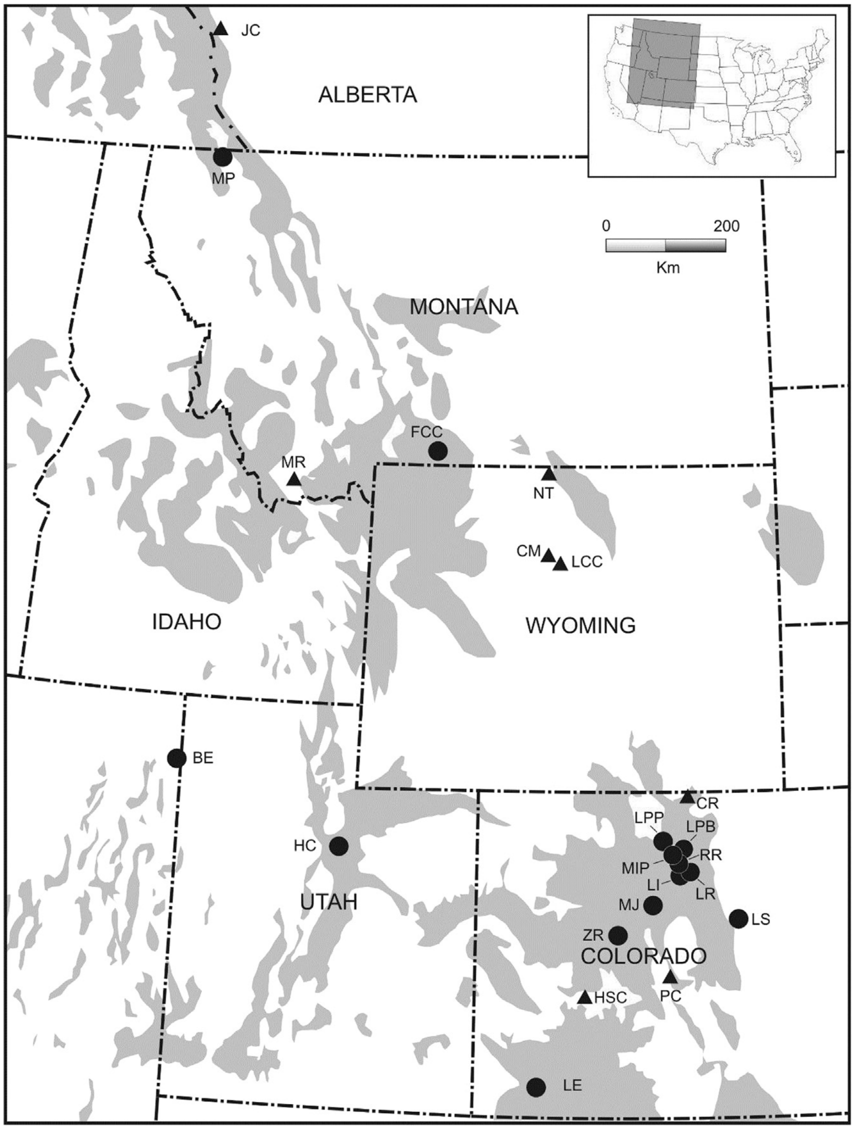

Fig. 1. Map of the Rocky Mountain region, showing locations of fossil insect sites (circles) and fossil vertebrate sites (triangles) discussed in text. Shaded areas represent mountainous regions.

their species' local population. When climatic change occurs, this habit of fanning out in all directions once insects reach maturity ensures the survival of those individuals that happen to migrate to regions that still fall within the suitable climatic envelope of their species. Over Quaternary time scales, this phenomenon has made virtual globe-trotters of some beetle species. For instance, a regular member of Pleistocene cold-period faunas in Britain was the dung beetle *Aphodius holdereri*. This species is known today from a

Table 1
Late Quaternary insect fossil localities in the Rocky Mountain region.

Site	Abbreviation in Fig. 1, Table 1	Age range of faunas (calibrated yr BP × 1000)	Reference(s)
Bonneville Estates, NV	BE	13.7 ka	Goebel et al., 2007; Elias, 2013
False Cougar Cave, MT	FCC	11.3 ka	Elias, 1995
Huntington Canyon, UT	HC	10.7 ka	Elias, 1995
Lamb Spring, CO	LS	21.7 ka, 17.6 ka	Elias, 1986; Elias and Nelson, 1989; Elias and Toolin, 1990
Lake Emma, CO	LE	10.2–8.9 ka	Elias et al., 1991
Lake Isabelle, CO	LI	11.5–9 ka	Elias, 1985
La Poudre Pass, CO	LPP	11.3–0.1 ka	Elias, 1983; Elias et al., 1986
Lefthand Reservoir, CO	LR	6.2–0.1 ka	Elias, 1985
Longs Peak Inn Bog	LPB	3.2–0.2	Elias et al., 1986; Elias, 1996
Marias Pass, MT	MP	13.4 ka	Elias, 1988, 1996
Mary Jane Ski Area, CO	MJ	16.8–14.6 ka	Short and Elias, 1987; Elias, 1996
Mount Ida Bog Pond, CO	MIP	10.2–5.3 ka	Elias, 1985, 1996
Roaring River, CO	RR	2.5	Elias et al., 1986
Ziegler Reservoir	ZR	125–77 ka	Elias, 2014