

Phylogeography of *Dendroctonus rufipennis* Based on mtDNA and Microsatellites

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Spruce beetle, *Dendroctonus rufipennis* (Kirby), is one of the most broadly distributed bark beetles in North America, extending from Alaska to Newfoundland, south to Arizona. It colonizes most species of spruce within its range. Usually it is associated with highly stressed or killed trees, but under certain conditions undergoes landscape level eruptions that kill millions of trees (Werner and others 1977), regardless of their physiological condition (Wallin and Raffa 2004). Populations may be semivoltine or univoltine, depending on temperature (Hansen and others 2001). Spruce beetles show relatively close associations with several species of fungi (Six and Bentz 2003), some of which vary in frequency with beetle population phase (Aukema and others 2005).

Adult beetles were collected from sixteen sites extending across the full range of *D. rufipennis*. DNA was extracted, and approximately 100 beetles were sequenced for mtDNA and approximately 550 beetles were genotyped for microsatellites (Maroja and others subm). Phylogenies were reconstructed by several means, including Maximum Parsimony and Bayesian Posterior approaches. We also computed isolation by distance, neutral evolution, migration and divergence time between populations, linkage disequilibrium, and deviation from Hardy-Weinberg equilibrium (Maroja and others 2007).

Three distinct clades were apparent (Maroja and others 2007). Two are northern, extending west to east from Alaska to Newfoundland, and the third extends north to south throughout the Rocky Mountains. The Rocky Mountain clade further subdivides into northern and southern clades. A zone of overlap is located in southern British Columbia, which appears to represent secondary contact between beetles that moved north along the Rocky Mountains and beetles occupying the boreal forests of Canada. There is high among-clade divergence.

Across all populations, there was a strong relationship between genetic distance and physical distance. This relationship was also significant within one northern clade. However, there was no isolation by distance effect within the other two clades, or within the pooled northern clades. There was no evidence for migration between the northern and southern Rocky Mountain clades. These same patterns segregate according to spruce species, and there is little evidence for migration between white and Engelmann spruce. However, host plant relationships cannot be teased apart from underlying geographic distribution patterns of tree species.

Based on historical records of spruce and the estimated divergence times from this study, the most parsimonious explanation is that spruce beetle

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populations were isolated during recent glaciations and have since become reconnected (Maroja and others 2007). However, initial divergence of these lineages must have occurred much earlier.

Our short-term goals include clarifying potential relationships with host tree species, including whether there may be incipient host races. Long-term goals are to develop genetic markers that could help distinguish between localized population buildup vs. eruptions due to migration, and help distinguish between eruptive and noneruptive populations.

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