

# Qualitative Genetics of Mountain Pine Beetle in Central Oregon<sup>1</sup>

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The mountain pine beetle (MPB), *Dendroctonus ponderosae*, is a predator of all native and many introduced pines in western North America (Furniss and Schenk 1969, McCambridge 1975, Smith and others 1981, Wood 1982). The most important hosts of MPB are ponderosa, lodgepole, sugar, and western white pine. Although these pine species occur sympatrically throughout portions of their ranges, MPB are rarely found in more than one host species in any given locality. Along the Front Range in the Colorado Rockies, this bark beetle is found primarily in ponderosa pine, but throughout the northern Rockies, its preferred host is lodgepole pine. In Oregon, the major hosts are both ponderosa and lodgepole pines, but in California, the major host is sugar pine. Nevertheless, small areas can be found in which this beetle has colonized two or more hosts at the same time.

No factor in the insect/host interaction influences the life of an endoparasitic phytophagous insect more than its host (Diel and Bush 1984). Because plant species differ chemically, physically, and biologically, they can present markedly different selective environments to insects feeding on them (Bush 1969, Wood 1980). Differential selection pressures provided by different host species can cause genetic differentiation of an insect species along host lines. Significant genotype variation in forest trees (the hosts) have been identified for bark beetles (Berryman 1972, Smith 1963, Smith 1972). Host species affect emergence, egg gallery characteristics, fecundity, development, and mortality of MPB (Amman 1982, Amman and Cole 1983, Amman and Pasek 1986, Schmid 1972).

Sturgeon and Robertson (1985) measured microsomal polysubstrate monooxygenase (PSMO) activity in western pine beetle from ponderosa pine and in MPB from both lodgepole and ponderosa pines. Although they detected no significant difference in the PSMO activity between the two beetle species, PSMO activity in MPB from ponderosa pine was significantly lower than in MPB from lodgepole pine. These results suggest that MPB in the two different host species might have qualities that vary with respect to their ecological genetics.

Isozyme electrophoresis is another means that can be used to track changes in beetle quality; in such studies, the genetic structure of insect populations is used to measure genetic variation. Data from electrophoretic surveys have provided direct measures of genetic variation within and genetic similarity among populations (Stock and others 1978). Stock and associates (1984) have surveyed much of the northern range of the MPB for electrophoretically detectable genetic variation. Beetles collected from populations in Oregon, Washington, Idaho, and Montana could be differentiated at two enzyme loci, although

similarity coefficients suggested that they were closely related (Stock and Guenther 1979). Coastal and inland populations of MPB collected from varieties of lodgepole pine showed significant differentiation (Stock and others 1978). In Utah, geographically separated populations of MPB from the same host were more similar than adjacent populations of MPB in different hosts (Stock and Amman 1980). These studies showed that there is great genetic variation within and among the populations of MPB in the same host in addition to variation due to geography. Host tree species is implicated as a factor in maintaining differences among the MPB populations (Stock and Amman 1985). However, the different host trees were not sampled at the same site, so the significance of host variation as a factor cannot be separated from natural variation and geographic variation.

Studies by Sturgeon and Mitton (1986) and Langor (1989) indicate that significant genetic divergence does exist in co-occurring populations of MPB in different hosts at the same locality. These differences, they conclude, can be attributed to either selection, substructuring populations of MPB according to host, or nonrandom mating in the hosts' population. Either of these events could lead to host-race formation, and ultimately, to speciation.

To gather more information to clarify insect/host interactions, we initiated a 10-year project on the Deschutes National Forest in central Oregon in 1985. One of our objectives is to determine the effects of secondary plant chemicals on MPB infesting five host trees over time and space. This should aid in developing a basic understanding of host-induced genetic changes in bark beetles. Our long-term study will enable us to monitor changes in allelic frequencies and genotype structuring of populations for trends that indicate changes in the population status (endemic to epidemic).

At present, we are analyzing data from the first five years of our study. Esterase enzymes are involved in the insect's ability to withstand toxins in its environment and its ability to survive. The esterase enzymes reveal four loci and show the most genetic variation. At the beta-esterase 1 locus, there is decided preference for heterozygotes, with one heterozygote genotype having a frequency that ranges 0.720 to 1.00 in 3 out of 39 samplings. This locus seems promising as a diagnostic indicator of host preference and perhaps, population status.

Although our present focus is on MPB, information gained can provide insights for research into other polyphagous insects and other insects that persist at low levels for long periods of time and suddenly explode to devastate entire forests.

No one biotechnology investigatory tool presently available can provide all of the information required to satisfy the needs of entomologists, population geneticists, and systematists, but several used in concert can validate or bring a greater degree of credibility to the information obtained through their use.

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