

Course Focus

Matt Lavin - Evolution - BIOB 420



Montana harbors two kinds of ponderosa pine, the west- and east-slope forms. West-slope ponderosa pine, *Pinus ponderosa* subspecies *ponderosa*, is the important timber tree that occurs west of the continental divide (Figure 1). East-slope ponderosa pine, *Pinus ponderosa* subspecies *scopulorum*, often has a shrubby appearance and is well known from the Missouri breaks east of the divide. Knowing something about the evolutionary adaptations of these two forms of ponderosa pine, as well as the history behind how they both arrived in Montana, may be important for managing these two forms, one mostly for timber and the other mostly for wildlife habitat.

The Evolution course, BIOB 420, uses case studies like that of Montana's ponderosa pine to address the two principal areas of evolutionary biology: 1) adaptation via natural selection and 2) history. For each of these two areas of evolutionary biology, case studies are presented during the evolution course, along with data in simplified form, which is analyzed by the students so that they can reinforce their understanding of how adaptation and history are studied by evolutionary biologists.

West-slope ponderosa pine reproduces best in a wetter climate and on deeper soils compared to east-slope ponderosa, which reproduces best in the drier climates and more clayey soils east of the divide in Montana. This suggests these forms of ponderosa pine are each optimally fit to their respective environments, a fit that is explained by adaptation via natural selection. Adaptive traits are those that confer fitness, or an optimal rate of lifetime or family reproduction. During the evolution course, adaptive traits, such as the ability to respond to and grow vigorously during the short growing season east of the continental divide in Montana, can be studied by analyzing populations of individuals that vary in suspected adaptive traits. North of Helena in the vicinity of the town of Wolf Creek and the Holter Dam area, west-slope ponderosa has migrated into the habitat of east-slope ponderosa pine such that populations of hybrids and both parental species co-occur. Genetic and other evidence suggests that large-scale eastward migration of west-slope ponderosa is very limited and that east-slope ponderosa predominates east of the divide even right up to the very edge of the continental divide. East-slope ponderosa shows evidence of being best adapted to the drier conditions east of the divide. West-slope ponderosa, the evidence suggests, is not as fit in an east-slope environment.

Evolutionary history is studied most commonly with fossil and genetic evidence. During the evolution, course, however, genetic evidence is primarily analyzed for historical information. The fossil evidence for ponderosa pines, as is typical for most species, is scanty to non-existent. Packrat middens, for example, contain ponderosa pine needles and cone scales that can only suggest that this pine has been in residence in southwestern U.S.A. and adjacent Mexico for thousands of years. Genetic evidence, in contrast, suggests that the ponderosa pine has been in residence in the arid regions of south western North America for perhaps a million years. This reasoning comes from the theory that populations that persist in large sizes will accumulate genetic diversity as a function of time. Furthermore, genetic evidence reveals that during something like the post-glacial period, the ponderosa has migrated northward in two separate events. This reasoning is derived from the finding of less genetic diversity in northern compared to southern populations of



Figure 1. West-slope ponderosa (left – photo taken in Polson, Montana) is a tall-statured tree with a straight trunk that loses the lower lateral branches as the tree matures. The needle-leaves come in fascicles of usually three or more needles and the length of the needle-leaves is much longer than the length of the pinecone. East-slope ponderosa (right – photo taken south of Malta, Montana) is shorter-statured and with trunks that bear many lateral branches low on the tree even at maturity. The needle-leaves come in fascicles of usually two but sometimes three and the length of the needle-leaves is just a bit longer than the length of the pinecone.

ponderosa pine, and that the two separate northern migrations were not expected to sample the same ancestral genetic variation as they migrated north (an expectation of the theory of genetic drift). One northern migration event occurred along the Sierra-Cascade cordillera and eventually ended up in northwestern Montana. The other northern migration event occurred along the Rocky Mountain front and eventually populated eastern Montana. Each of these northern migrations carried different genetic and phenotypic signatures. See (Fig. 1).

During the evolution course, the effects of migration on the genetic variation of populations and individuals, whether recent immigration into a new area or among

populations that have been evolutionary persistent in the same region, is studied and data sets are analyzed. In the case of the ponderosa pine in Montana, data sets are analyzed to reveal how gene flow via pollen rather than seeds is responsible for some of the eastward migration of west-slope ponderosa across the continental divide near Wolf Creek. From a management perspective, the limited hybridization between these two evolutionarily distinct forms is not introducing genes from one form into populations of the other form. This is especially the case for east-slope ponderosa, which shows little if any sign of migrating west across the divide. Little concern is thus warranted from the perspective of timber management.

I chose to discuss the evolutionary perspective of Montana's ponderosa pines because it makes a good local example of a study that can be detailed and analyzed in a couple of lecture classes. Using many such case studies over the course of a semester is very effective for introducing the evolutionary concepts of adaptation and history, and detailing the evolutionary processes that shape evolving lineages, including mutation, migration, genetic drift, and natural selection.

One aspect that is not covered in this evolution course is the debate over creation science and intelligent design. This is for the same reason that a flat-earth theory is not taught in a geology course, alchemy not taught in a chemistry course, or astrology and geocentrism not taught in a physics course. Science does not cater to a particular people, place, and time, so legitimate scientific theories do not come in a Christian, Islamic, masculine, Native American, or any particular form. They come in only the form that is open to scrutiny and testing by potentially anyone.

The evolution course has been team-taught for many years. I have always instructed the history part of the course and Kevin O'Neill (from Land Resources and Environmental Sciences) has taught the part focusing on natural selection. Beginning Spring Semester 2015, a new Plant Sciences geneticist, Ryan Thum, will replace Kevin O'Neill in teaching all of the issues related to the process of adaptation via natural selection.