Invasive plants lack natural enemies but may also have chemical weapons

by Ed Berg

I usually make a trip to Naples, Florida a couple of times a year to visit my father. In the 30 years I have been making these pilgrimages to south Florida, I have watched the human population marching across the countryside with endless residential golf course subdivisions and shopping malls. Hopefully global warming will not bring such abundance to Alaska.

In Florida, humans aren't the only invasive species; every ecosystem has its exotic invader. Many of the waterways are clogged with water thyme (Hydrilla), which was introduced as an aquarium plant in the late 1950s. The melaleuca tree—originally introduced in 1906 from Australia as an ornamental—was distributed aerially in the 1930s to dry up wetlands. It now grows in impenetrable dog-hair stands (with as many as 31,000 trees and saplings per acre) on thousands square miles of former wetlands.

Similarly, the tall willowy Australian pine (Casaurina) was introduced in the late 1800s for windbreaks and shade, but it now saturates coastal beaches above the high tide line. In shrub and forest communities the Brazilian pepper (Schinus)—an attractive shrub with bright red berries—must continually be cut back to keep it from completely crowding out native shrub species. It was originally imported in the 1840s as an ornamental from South America.

Successful invasives, be they plants, bugs, or birds, are often thought to lack natural enemies in their new environments. Importers of tropical plants, for example, are not about to import the bugs that would eat their plants. Similarly, the bird flu H5N1 virus is a very successful invader because humans don't have any antibodies for this virus. This explanation is convincing when organisms have obvious enemies, but on the flip side, it seems to imply that native organisms are in fact held in check by their own native enemies. But is this always the case?

I find it remarkable that native plants and animals the world over live in fairly stable population densities. This obvious fact only strikes you when you visit a place like Florida or Hawaii and see what happens when outsiders have arrived who don't play by the same rules as the locals.

So what then are the "rules" that normally keep native populations in check? What is the "invisible hand" that keeps a natural balance among the players? Is it a simple matter of each player having its local enemies? On the Kenai, for example, why doesn't white spruce, alder, cow parsnip, or bluejoint grass cover every square inch of dry ground? Each of these species is very competitive, and can locally exclude most other species, at least temporarily.

I think that disturbance—not enemies—is the primary reason that none of these players ever wins completely. Disturbance is the great equalizer of ecosystems that ultimately keeps life in dynamic balance. On the southern Kenai spruce bark beetles thin the white/Lutz spruce forests every 50 to 100 years, as do forest fires at intervals of 400 to 600 years. In the central and northern Kenai, forest fires are more frequent, especially in the lowland black spruce forests which burn every 80 years or so. Windstorms, floods and landslides provide more localized disturbances.

Without these disturbances, the landscape would in a few centuries converge to pure white/Lutz spruce in the uplands and pure black spruce in the lowlands. We would see few moose and snowshoe hares (and fewer still of the predators which eat moose and snowshoe hares), because moose and snowshoe hares depend on fire-generated early succession vegetation like birch, willows, and aspen.

With plants, however, there are other factors besides disturbance that control plant distribution on the landscape. Disturbance resets the clock periodically, but lifestyle factors like shade tolerance, growth rate and size determine who wins the competitive race to dominance after a disturbance event. Shade-tolerant spruce trees are the winners in our forests because they can grow up in the shade of faster growing but shade-intolerant species like grass and hardwoods; spruce trees ultimately overtop these species and shade them out, just as the slow moving tortoise overtakes the speedy hare.

Spruce also has some chemical weaponry to de-

fend its dominance, probably phenolic compounds in the needles. You may have noticed that very few plant species grow on the forest floor in a spruce forest. Gardeners know well that most domestic flowers and vegetables simply won't grow in spruce soil, especially without heavy liming to neutralize the acidity of spruce litter. From a biodiversity point of view, a spruce forest is a desert, and spruce has no doubt evolved its chemical defenses to keep it that way. The technical term for such chemical defenses is "allelopathy." The most famous example of allelopathy is black walnut—very few plants can grow under a black walnut tree because of a chemical called "jugalone," exuded by the black walnut foliage. Jugalone acts as an herbicide on would-be competitors, and spruce has analogous herbicides.

When an exotic invasive plant arrives, it can bring its own special chemical weaponry that the native plants have never seen before and for which they have evolved no immunity. Two of south Florida's nasty exotics—melaleuca and Brazilian pepper—are known to use allelopathy to inhibit their competitors. A nasty recent invasive in Alaska—spotted knapweed (*Centaurea maculosa*)—brings a chemical weapon called "racemic catechin," which is exuded by the roots. This toxin quite effectively kills the roots of native plants and gives spotted knapweed a very competitive edge; it has heavily impacted millions of acres of rangeland in the northwestern U.S. and Canada. Back on its home turf in Europe the native plants are immune to this root toxin and spotted knapweed is not such a problem.

In short, there is more to the success of exotic invasives than lack of natural enemies: invasives often bring special characteristics, such as allelopathic chemicals that make them super-competitive against naïve natives. Likewise, there are many factors besides natural enemies that keep native organisms in some kind of dynamic balance, such as disturbance and the ability to outlast one's competitors through shade tolerance, long lifespans, and—again—allelopathic chemistry.

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