

4. Technology

a. Biological Technology: Molecular Tools Reveal Invasive Plant Pedigree



CLASS TIME: 30 min



Objectives:

1. To direct students to recent research in invasive species biology and demonstrate the value of molecular tools to investigate plant species phylogeny.
2. To encourage critical thinking about solutions to invasive plant problems and other potential applications of biological technology.

Molecular Tools Reveal Invasive Plant Pedigree



Invasive garlic mustard has been found in Southeast Alaska and volunteers are working to control its spread. (Photo courtesy: Samia Savell, NRCS)

introduction here. It is known to readily invade understory forested areas but has not yet been detected on the Kenai Peninsula or elsewhere in Southcentral Alaska. Keep an eye out for this aggressive invader that has caused tremendous damage to natural areas by outcompeting native understory plants.

Introduction:

The Center for Environmental Research in Halle, Germany has recently published the results of a study that investigated the source of the invasive herb garlic mustard (*Alliaria petiolata*) (Durka, Bossdorf and Auge, 2005). Researchers are utilizing molecular techniques to trace the pedigree of garlic mustard in its native range in Central Europe.

A member of the mustard family, Brassicacea, garlic mustard was introduced as a garden herb and has spread throughout the Eastern US and was found near Juneau in Southeast Alaska in 2001! Land managers and invasive plant experts in Southcentral Alaska are rightfully concerned about its potential

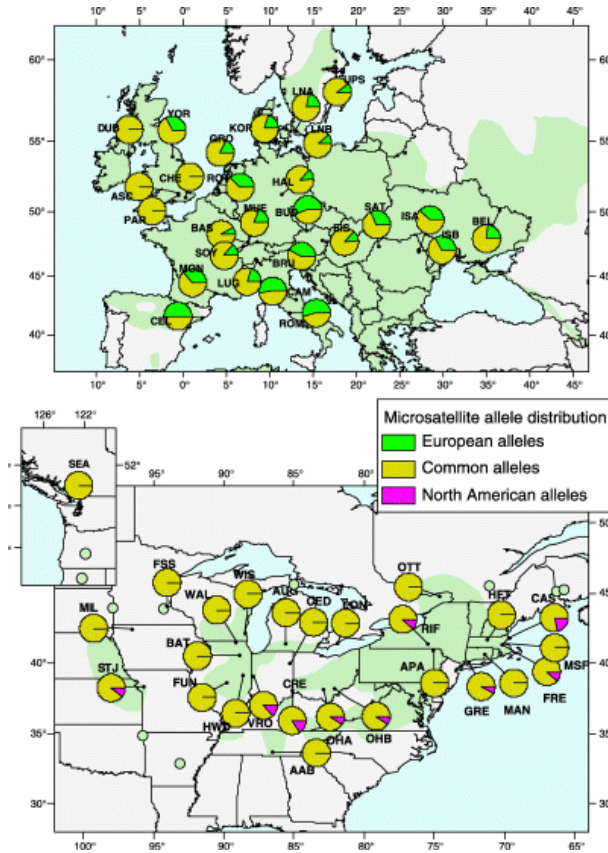
What did they do?

Researchers including Durka and his team are making use of techniques in molecular biology to understand more about the genetics of invasive weeds and their source populations within their native ranges. For this study, researchers collected seeds of garlic mustard from 27 native range plants and 26 plants from introduced populations in North America. Seedlings were grown and DNA extracted from these tissue samples.

DNA was then amplified using the standard molecular process of Polymerase Chain Reaction (PCR). Individuals were analyzed for their relatedness by looking at variation in “microsatellites”. Microsatellites are small, repeating sequences of base pairs (e.g. CACA...) within the genetic code. Within different alleles (sections of coding or non-coding DNA) microsatellites are often highly variable, or polymorphic. This is often the result of mutation during cell duplication or “slippage” that results in a unique DNA fingerprint. That means different individuals will have a different number of repeating sequences and the lineage of individuals can be traced by the variation in microsatellites. Similar techniques are being used to determine the genetic structure of invasive orange hawkweed (*Hieracium auranticum*) populations in the Western US, Canada and Alaska (Wilson, 2006). Seed samples from the Central and Lower Kenai Peninsula were submitted in the fall of 2006 by Caleb Slemmons (Homer Soil and Water Conservation District) and Janice Chumley (UAF- Cooperative Extension) to Linda Wilson at the

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University of Idaho. These samples will be included in research to study the population genetics of hawkweeds (which have quickly become a serious problem in Alaska) and their ability to hybridize.



Map of the sampled populations of garlic mustard in its native and introduced ranges in N. America (Durka, Bossdorf and Auge, 2005)

causes deleterious mutation and can cause critically endangered species to spiral into extinction. When a non-native plant is introduced in a novel environment it may have very few individuals to reproduce with. One mystery in invasive species biology has been how do introduced plants, with only a small sampling of diversity from their native range, escape inbreeding depression and become very successful colonizers?

What did they find?

The results indicate that the British Isles contributed greatly as a source for introduced populations of garlic mustard in North America. Central and Northern Europe were also linked to N. American populations by a high proportion of common alleles. The data suggest that there have actually been multiple introductions of invasive garlic mustard from different regions of Europe that ultimately led to its successful proliferation. Multiple introductions have been known from a number of other invasive species including the European starling.

One surprising result was that the N. American populations did not show evidence of reduced genetic variability when directly compared to the source populations in Europe. The phenomenon of a “population bottleneck” that occurs when the number of individual plants is critically small, typically leads to a reduction in fitness. Also known as inbreeding depression, this effect often

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What do you think?

What do you think may have allowed garlic mustard to “escape” the problems of a population bottleneck when it was introduced?

What does this study tell us about preventing a species from successfully spreading? How could knowing the source of an invasive plant help in controlling it?

Garlic mustard was introduced as a garden herb, how do you think it could be brought to Southcentral Alaska? How can we keep it out?

What other ways could molecular biology help to understand and combat biological invasions?

b. Computer Technology: Web-based Mapping Exercise

 **CLASS TIME: 50 min**



Objectives:

1. To provide students the opportunity to explore inventory data in Alaska for invasive ornamental plants including areas in their local communities.
2. To guide students comparing and contrasting regions and think about underlying causes of distribution patterns of invasive plants.

b. Computer Technology: Web-based Mapping Exercise

Computers are being used in a variety of ways to analyze and better understand biological invasions. One way that land managers and natural resource specialists utilize technology is through mapping with Global Positioning Systems (GPS). Handheld GPS units receive signals from satellites that determine the specific location where an invasive plant or plant population has been found.

Combined with specialized computer software, this allows the benefit of seeing where invasive plants are and helps to strategize about how to control them. In Alaska a statewide database called the Alaska Exotic Plant Information Clearinghouse (AKEPIC) is available for sharing recorded locations of invasive plants. A subset of this data including reported locations of 4 common invasive plants has been posted online. To get started go to <http://www.homerswcd.org/invedu>

1. First check out the statewide (All Alaska) map of the four common invasive plants: orange hawkweed, butter and eggs, common tansy and oxeye daisy. Where are most of the invasive plants recorded?
2. Now click to zoom in on each of the following regions and record or estimate how many of the four species were reported in that region.

Fairbanks:

Mat-Su Valley:

Anchorage:

What area seems to have the most records? How could you explain the pattern? What about the number of species reported?

3. Make some guesses about the Southeast. Do you think there will be all of the species recorded there? Why or why not?

Click to zoom in to the Southeast from the All Alaska map. What do you think about the distribution of the recorded locations? Are there very many?

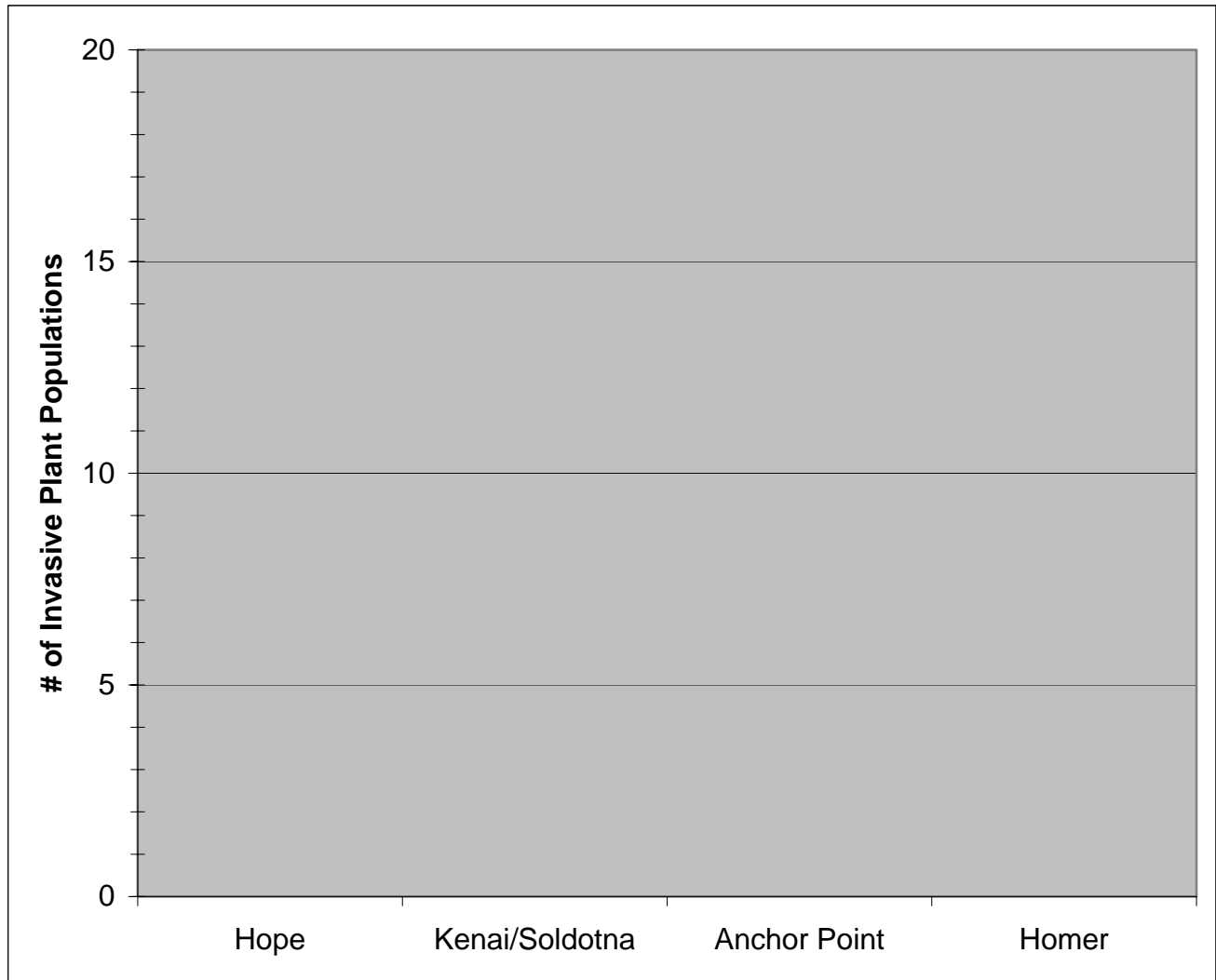
Now, you have two options - the northern section (Juneau, Haines and Sitka) or the southern section (Ketchikan and Petersburg). Compare these. Are the reported locations scattered or clustered? How does this compare with Kodiak Island?

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4. Now lets look at the Kenai Peninsula - click on it from the All Alaska map. Do you see any patterns? Let's look a bit closer. Navigate to each of the locations below and prepare a table of the # of species and graph the # of reported infestations.

	Hope	Kenai/Soldotna	Anchor Point	Homer
Orange Hawkweed				
Butter and Eggs				
Common Tansy				
Oxeye Daisy				
TOTAL				

Complete the graph by marking an (x) for orange hawkweed, (o) for butter and eggs, (+) for common tansy and (•) for oxeye daisy. Use a (*) to mark the total in each area.



Now you are on your own! Check out some of the other areas, learn about some of the other invasive plants in Alaska and what you can do to help...