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Global Change in Mountain Regions
The Mountain Research Initiative

Pre-adapted or plastic?

How widespread non-native plants establish in mountains around the world

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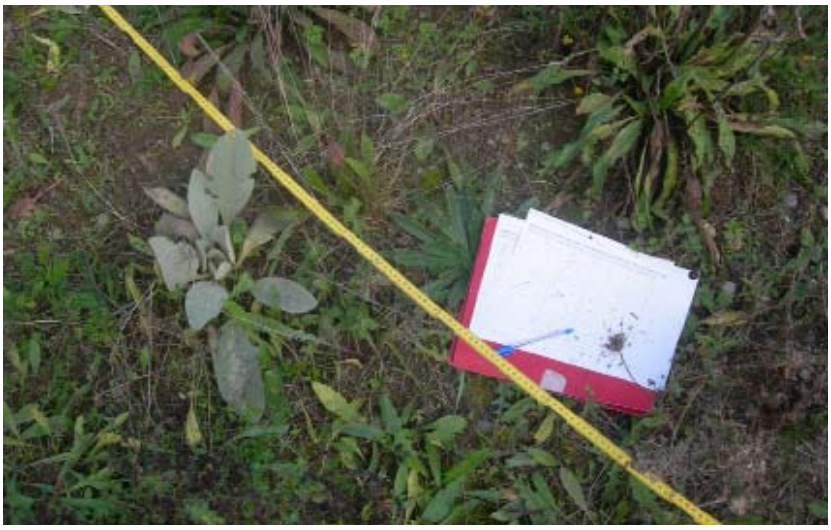
Mountain regions have the highest proportion of protected land in the world and also have fewer invasive plant species when compared to adjacent lowlands, this is because of the steep and harsh environmental conditions, and reduced human population density. Currently this provides the appearance of a decreased threat of plant invasions in mountains, in actuality global change coupled with development of human infrastructure will increase the future risk of plant invasions.

Sampling *Verbascum* rosettes growing in Morocco. © Tim Seipel



Sampling *Verbascum* rosettes growing in Switzerland. © Tim Seipel

The opportunity exists to prevent future plant invasions, which would save future resources and protect native plant diversity. So the Mountain Invasion Research Network (MIREN- http://www.miren.ethz.ch/) aims to understand the process of plant invasions into mountain areas so that the most affective prevention and management practices can be established and applied to control plant invasions. Results from the initial phase of research shows regions have been invaded to different degrees, and that global dispersal of species by humans has been an important correlate.

Non-native generalist plant species are widespread in mountains around the world. In the last MRI newsletter, Poll and Alexander explained why mountain regions are good model systems for studying the distribution of non-native plant species and widespread plant species in general. Within their PhD dissertations they argued that examining populations of the same species in different regions helps to understand the influence of environment and evolution, which in turn affects the ability of plants species to invade different regions. Poll and Alexander compared how big plants grew, the elevation ranges species occupied, and how much they varied between two regions and reported the following:

1. In multiple regions plants species had similar altitude range distributions.
2. The altitude range is mainly determined by how broadly adapted a species is to grow under a variety of environmental conditions.

3. Disturbance facilitates invasion of ruderal non-native plants in mountains.

They concluded that many of the species they measured are broadly adapted to continental and semi-arid climates and are able to grow in a wide variety of environmental conditions.

„This research will help to better understand the variation within a species, and secondly to understand why some species spread quickly and establish in some regions."

Other MIREN researchers have found non-native species at high elevations in many other mountain regions around the world (McDougall et al., submitted; Seipel et al., submitted; Alexander et al., submitted). The species that occurred at high elevations had large elevation ranges, and were generally adapted to a broad-range of environmental conditions. These generalist species were found in multiple regions studied and most originated in Eurasia, including temperate Europe. The generalist species established in parts of the New World following dispersal by immigrants (Crosby, 2004) and were adapted to continental and semi-arid habitats.

As part of the core research program of MIREN we are examining the variation and plasticity of these widespread species that originated in Eurasia and have subsequently spread all over the world. MIREN has developed a protocol (currently only available to MIREN research group) to compare plant populations and individuals of the same species in many regions. The three widespread Eurasian species being measured are Verbascum thapsus, Lactuca serriola, and Hypochaeris radicata. We wished to include as many areas as possible in the study, including those that are often underrepresented in ecological research (Khuroo et al., 2009). We

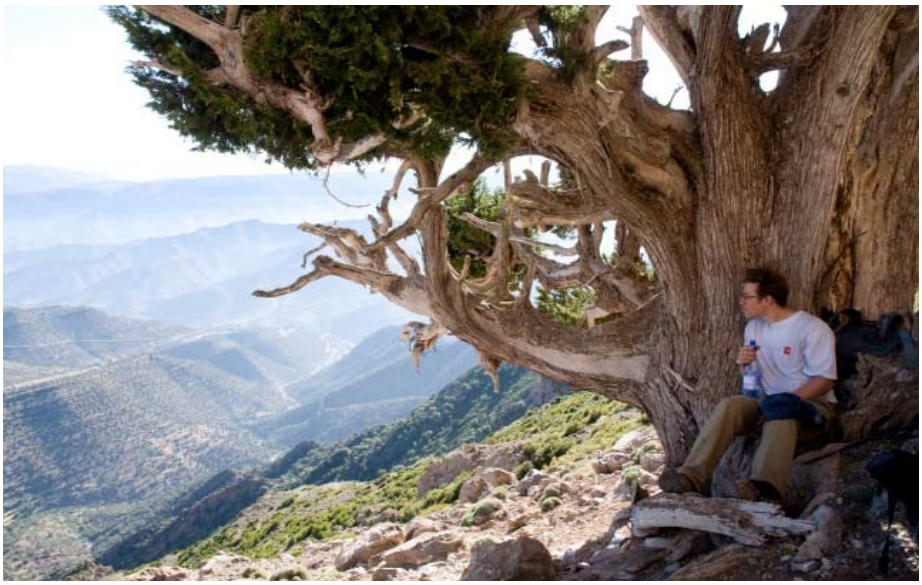
The wheat fields and the Igherm of Zawiya Ahansal in the foreground and the sunlit Jbel Aroudane in the background. © Tim Seipel

intended the protocol to be simple, not overly time consuming, so that the protocol could be easily carried out in many regions around the world. The protocol provides instructions for measures of plant size, populations, size, and the quantity of seed produced. The protocol also asks that plant material be collected for later genetic analysis. This research will help to better understand the variation within a species, and secondly to understand why some species spread quickly and establish in some regions (to the point of becoming a 'invasive weed') while in others they barely maintain populations.

MIREN started implementing this protocol in the summer of 2009. One of my first attempts to collect data was in the Zawiya Ahansal region of the Moroccan Atlas, which has a continental climate affected seasonally by the Sahara and the Atlantic Ocean. Wheat cultivation in the region is a striking example of the spread of plants from Eurasia and the similarity of many continental climates. In addition to sampling plant populations I photographed and documented the plant biodiversity. We found populations of both Verbascum sp., and Lactuca serriola at lower and higher elevations (800 and 1600 m a.s.l), but found no Hypochaeris radicata. Lactuca serriola was often found as a weed in local wheat fields. The data and plant material collected on Lactuca seriola is particularly interesting as Jake Alexander is already working on a phylogeographic analysis of specimens from many regions of the world.

Since the trip to Morocco data have been collected in many other regions including: Kashmir, La Reunion, Australia, Oregon USA, Montana USA, and the European Alps.

The final data are currently being collected and collated, and initial results will be presented in September 2010 in Perth Scotland at the conference on Global Change and the World's Mountains. The aim of the analysis is an intra-specific comparison of variation



Tim Seipel seeks relief in the shade of an old Juniper in the Atlas. © Ross Lynn.

in the measured traits, both within a region and between regions. We are doing this comparison to determine how species were able to establish and persist in so many regions and at so many different elevations. The main question is whether the plant species were already broadly adapted upon arrival in a new region, or if they have high plasticity and ability to adapt to the new conditions upon arrival. By examining the neutral genetic variation we will be able to determine if a species is more or less diverse in different regions and whether this correlates to invasion success. The null expectation is that these species are just broadly adapted to many different conditions and that the genetic diversity is less in the new non-native range because few individuals founded the new populations. If the null expectation is verified then tools such as climate matching (niche modeling) should work well at identifying potential invasive species. If, on the other hand, species have the ability to evolve rapidly simple climate matching would not identify the risk of a species becoming invasive. Through comparative study of the three model species MIREN hopes to understand better the interaction of dispersal, ecology, evolution, and human factors in the spread of non-native plants in mountains.

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