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Earl Core Student Award Report

Assessing the population structure of the invasive Tree-of-Heaven (*Ailanthus altissima*) along urban and rural roadways

by Matthew S. Hansen

In the spring of 2012, I was awarded the Earl Core Student Award from the Southern Appalachian Botanical Society to support my work in assessing the population structure of the invasive Tree-of-Heaven (*Ailanthus altissima* (Mill.) Swingle) along urban and rural roadways. I was interested in observing the roles transportation corridors play in range expansion and population connectivity.

Figure 1. The author studying Ailanthus altissima

While native to Asia, *A. altissima* was first introduced to the United States in 1784 (Hu 1979) and has since been established in over 40 states, approximately 30 of which list it as invasive (Fry 2010). The tree is dioecious, insect pollinated, and its fruits are primarily wind dispersed. In addition to wind dispersion, its samaras are known to secondarily disperse via waterways (Säumel & Kowarik 2010) and motorways (von der Lippe & Kowarik 2008). Under the mentorship of Dr. Roland P. Roberts (Towson University), I devised and executed the research project to address the question: Is there a difference in population connectivity among populations found along urban and rural roadways?

Between May and August of 2011 and 2012, we collected leaflets from 776 individuals along two 1,000km transects that crossed thirteen states (ME, NH, MA, RI, CT, NY, NJ, PA, DE, MD, VA, WV, NC). The urban transect ran along Interstate 95 (I-95) and the rural transect was established parallel to and 100km west of I-95. Fifteen 10km2 sites were sampled along each transect. Within each site leaflets were collected from between 9 and 44 plants that were no closer than 25m to one another in order to limit clonal sampling. Seven-hundred sixteen samples were found to be genetically unique at nine microsatellite loci that were developed by Dallas et al. (2005). These genetically unique individuals were used in subsequent population genetic analyses.

Various software packages were used to analyze the dataset but presented here are the results from BAPS v.5.3 (Corander et al. 2008), which was used to assign groups of individuals, based on their geographic site, to a stochastic number of genetic clusters (populations), based on their allelic compositions.

Figure 2. Genetic clustering results of the urban group from 20 replicate BAPS runs assuming KMAX = 15. Each Voronoi tessellation represents one population and colors correspond to each genetic unit (K = 1) as assigned by the program. Axes represent spatial X, Y coordinates.

When the urban and rural sites were analyzed separately, the urban individuals were clustered into a single population (Fig. 2) while the rural individuals were clustered into four distinct populations (Fig. 3). However, when all thirty sites were analyzed together, the individuals were placed into five populations (Fig. 4).

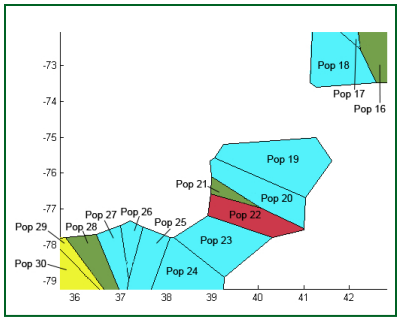

Figure 3. Genetic clustering results of the rural group from 20 replicate BAPS runs assuming KMAX = 15. Each Voronoi tessellation represents one population and colors correspond to each genetic unit (K = 4) as assigned by the program. Axes represent spatial X, Y coordinates.

Based on the BAPS findings, there appears to be more genetic relatedness among individuals located along urban roadways. Two explanations for these findings include higher volumes of traffic and more potential paths of dispersal, both of which could contribute to higher levels of population connectivity. However, the patterns we are seeing may not be due to contemporary dispersal but instead may be artifacts from historic introductions. For this reason, additional research is required to tease apart historic introductions from contemporary processes.

Funding provided by the Southern Appalachian Botanical

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From The Editor's Desk:

Joe Pollard, Newsletter Editor

The fall issue of Chinquapin includes a report by Matthew Hansen on research that was funded by the Earl Core Student Award. Students may apply to SABS for small research grants from the Core fund, with the stipulation that recipients are expected to contribute a brief summary of their research for publication in Chinquapin. For some reason, we haven't included many of these summaries in the past few years, but I'm delighted to get it going again. Three students received Earl Core Awards this year, so readers can look forward to more reports next summer and fall.

Matt reports on his master's thesis research from Towson State University, studying the effects of road corridors on the spread of an invasive species, *Ailanthus altissima*, as reflected in the genetic structure of its populations. This fascinating study also gives us pause to remember that every time we drive our cars, we are potentially transporting propagules of any number of exotic plants and animals. Many readers of Chinquapin are regular visitors to nature reserves, parks, and other sensitive areas. Perhaps we should all consider the inadvertent baggage carried in the crevices and mud on our vehicles. A trip to the car-wash before doing fieldwork seems counter-intuitive, but maybe it could help.

Returning to the issue of student research awards, I am firmly of the opinion that supporting our students is perhaps the most important business of a society like SABS, and the best possible use of our financial and intellectual resources. I know it sounds corny, but science is all about the search for new knowledge and understanding. Maybe I can personally make a small contribution to that enterprise, but in the long run the bigger contribution will be made by my academic "descendants" – the students I have taught, and their students in turn. (Sounds like an argument in exponential growth or inclusive fitness, doesn't it?) In that respect, I'm very happy that this issue includes an article by Robert Jetton, who I had the pleasure of teaching as an undergraduate. Robert has graciously agreed to share some information on his work

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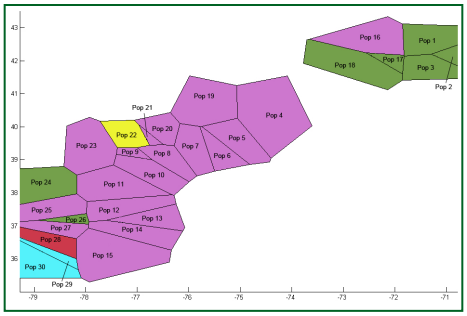

Figure 4. Genetic clustering results of the entire data set from 20 replicate BAPS runs assuming KMAX = 15. Each Voronoi tessellation represents one population and colors correspond to each genetic unit (K = 5) as assigned by the program. Axes represent spatial X, Y coordinates.

Society was used to finance a portion of the molecular reagents necessary for the completion of this research project.

The author recently completed his M.S. degree at Towson State University, and is currently working on his Ph.D. at The George Washington University. Color images can be viewed at http://sabs.appstate.edu/chinquapin-issues.

Literature Cited

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Säumel I, Kowarik I (2010) Urban rivers as dispersal corridors for primarily wind dispersed invasive tree species. *Landscape and Urban Planning*, 94, 244-249.

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What Cow? What Wheat? *Melampyrum lineare*

By Lytton John Musselman, Old Dominion University

Like bastard toadflax, the previous species in this series on parasitic plants, the "common name" of *Melampyrum lineare*, cow wheat, seems inexplicable at first. But unlike bastard toadflax there is a reason for the common name of this member of the Broomrape family. The name derives from a species weedy in British wheat fields where it was often threshed with the grain and recognized by its black seed. Our species does not occur in cultivated fields but rather in a variety of habitats usually with pines and species of the Heath family (Ericaceae).

Figure 1. The flowers are conspicuously two lipped but unlike other members of this group an overlapping upper lip, the galea, is lacking. Several sub-specific taxa have been described based on leaf characters.

The diminutive plants produce small, white and yellow flowers in mid-summer that soon develop the distinctive capsules containing two or three brown seeds, which may eventually turn black indicating that they are no longer germinable. The seeds possess an elaiosome which make them attractive to ants, which carry the seeds to their nest, eating the nutritive elaiosome and thus dispersing the seed.

Figure 2. Developing capsule.

Figure 3. Mature seeds with elaiosomes.

Studies show a higher germination rate and seedling establishment for the seeds distributed by ants. The European species have received more study than the single species of our region. There are reports that the presence of *Melampyrum pratense* and *M. cristatum* in England are indicators of old-growth forests. I know of no similar report for *M. lineare*. It is often found on rocky ledges and escarpments, places with considerable sun.

Like most root hemi-parasites *M. lineare* has high rates of transpiration aiding in the movement of materials from the host root into the parasite which could explain its rapid wilting after collecting. Haustoria, the modified roots of cow wheat that form the morphological and physiological bridge between host and parasite, are small (less than 0.5 cm) and white. They must develop soon after germination to ensure the survival and vigor of the plant. The host range is broad with attachments to trees, shrubs, herbs, ferns-- there are even reports of bryophytes being parasitized. It is possible to grow this and many related parasites in pots without hosts under a high fertilizer regimen.

Our species of cow wheat, widespread throughout most of Eastern North America as well as some western states, is a humble member of its guild of root parasites with the smallest flowers and a small stature.

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in documenting and conserving genetic diversity in hemlocks (*Tsuga* spp.), a topic which I know is of concern to many SABS members. And the fact that I recently sent another of my students to do her graduate work in Robert's lab makes the connection even more satisfying.

This issue also contains articles by regular contributors Lytton Musselman and George Ellison, along with a variety of news items. Dan Pittillo continues to provide challenging Mystery Plants. We're going to work on getting full-color versions of Chinquapin onto the website even sooner, so that you can recognize the plants better in color. Once again, that address is http://sabs.appstate.edu/chinquapin-issues.

There's a touch of cooler, crisper fall weather in the air. Enjoy!

BOTANICAL EXCURSIONS

'Simmons and the Dancing 'Possums

By George Ellison

Went up on the mountain
Just to give my horn a blow
Thought I heard my true love say
Yonder comes my beau

Bile them Cabbage down
Turn them hoecakes round
The only song that I can sing
Is bile them cabbage down

Possum up a 'simmon tree
Raccoon on the ground
Raccoon says you son-of-a-gun,
"Won't you shake them 'simmon's down?"

-- "Bile Them Cabbage Down" (traditional lyrics)

Several years ago in early autumn my wife, Elizabeth, and I were bird watching. Spotting some movement in a large tree, I focused my binoculars on what turned out to be a migrating Tennessee warbler. More interesting than the bird, however, were the plump, orange-red persimmon fruits that also came into my field of vision.

Lowering my binoculars, I could see with my naked eyes that the tree, perhaps 70 feet in height, was literally loaded with persimmons. I made a mental note to return after the first hard frosts and gather some of the fallen fruits. But I was too late. By the time I arrived the opossums had beaten me too them. Soon thereafter the tree was cut down.

'Possums are inordinately fond of the fruit--so much so that they are reputed by possumologists to dance the "Possum Circle Dance" whenever a new persimmon tree is located. Round and around they go, clasping their prehensile tails in their mouths, reversing directions periodically. But, alas, it is also true that many an old-time 'possum hunt ended at the foot of a persimmon tree.

Persimmon trees in the Smokies region where we live are fairly common at elevations below 2,500 feet, favoring well-drained sandy soils. Only the female trees bear fruit, which is famously sour until after heavy frosts. The Cherokee name for the fruit is "tsa-la-lu-i" (pucker mouth). That ever-inquisitive New World explorer and publicist Captain John Smith tried some shortly after arriving at Jamestown and declared, "If it be not ripe, it will draw a man's mouth awrie with much torment, but when it is ripe, it is as delicious as an apricot." Even after becoming fully ripe, the fruit's skin (which contains tannic acid) is best avoided.

Early settlers used the fruits for jellies, cakes, puddings, and custards. During the Civil War, Confederate soldiers boiled persimmon seeds as a coffee substitute. And they made a thick mush by mixing persimmon fruits, wheat bran, and water. This was allowed to stand for 12 hours, after which it was strained and boiled "to the consistency of molasses."

Persimmon belongs to the same genus (*Diospyros*) as ebony and displays heartwood that is so dark brown, almost black, that it resembles ebony. It is so dense and heavy (59 pounds per cubic foot) that it has been used for golf club heads and billiard cues. As such, it falls into the very hard class of woods like mountain laurel, ironwood, and black locust.

I grew up in Danville, Virginia, home of Dan River Mills. One summer, between college semesters, I got a job at Dan River Mills working as a roundabout for one of the repair crews. Our job was to repair anything that was broken.

One day, my crew's foreman, who could repair anything, pointed out that the shuttles in the textile looms were one item that almost never required his attention because they were crafted from persimmon wood. Hard, smooth, and non-warping, such shuttles could withstand thousands of hours of furious activity without cracking, splitting, or becoming roughened.

'Possums. (watercolor by Elizabeth Ellison).

Contact info: <www.georgeellison.com> or <www.elizabethellisonwatercolors.com>.

Saving Hemlocks, One Seed at a Time

By Robert M. Jetton, Research Assistant Professor, North Carolina State University

Readers of Chinquapin are likely familiar with the conifer species eastern hemlock (*Tsuga canadensis*) and Carolina hemlock (*T. caroliniana*). Both are important components of the botanical flora of the southern Appalachian Mountains and are widely recognized as keystone species in the forests they inhabit. In this region, eastern hemlock (also called Canadian or Canada hemlock) is typically found growing on the nutrient rich soils of cool moist cove and riparian forests, but its natural range extends far beyond our area and covers a number of habitat types in 24 eastern and Midwestern states and 4 Canadian provinces. Carolina hemlock, on the other hand, is a Southern Appalachian endemic whose distribution is restricted to a relatively small number of isolated populations in Georgia, North Carolina, South Carolina, Tennessee, and Virginia. It is usually found growing in dry nutrient poor soils at higher elevations along rocky outcroppings and ridge lines. By far, the largest concentration of Carolina hemlock populations occurs in western North Carolina, but the species gets its name based on the first description of the species by L.R. Gibbes at Table Rock Mountain in South Carolina in 1837 (R.L. James. 1959. Castanea 24: 112-134).

Branch of eastern hemlock infested with hemlock woolly adelgid. Photo courtesy of Camcore, Department of Forestry & Environmental Resources, North Carolina State University.

Both hemlocks are at risk of extinction across large portions of their range because of the exotic hemlock woolly adelgid (*Adelges tsugae*). This aphid-like insect is recognized by the cottony white covering that protects its body and eggs. It can be seen on the underside of hemlock boughs feeding at the base of needles where it uses its straw-like mouthparts to consume stored nutrients from within the plant. Introduced to the Richmond, Virginia area in the early 1950s on *T. sieboldii* nursery stock imported from Japan, the adelgid spread slowly west for over 30 years until reaching the Blue Ridge Mountains in the mid-1980s. At this point, the insect began a rapid range expansion and now infests hemlocks in 19 eastern states from Maine south to Georgia. Adelgid feeding, especially when combined with other environmental stresses such as severe drought, can kill trees in a few as 4 years although many survive for up to 10 years before succumbing. The result, which is readily apparent to anyone visiting the southern Appalachian Mountains today, is the widespread decline and mortality of hemlocks across much of the eastern United States in a relatively short period of time. However, hope remains that some hemlocks may endure this onslaught as there are reports of trees that have survived adelgid feeding for nearly 20 years or have escaped the infestation altogether. Similar occurrences allowed small populations of another southern Appalachian endemic, Fraser fir (*Abies fraseri*), to survive the invasion of a related exotic insect, the balsam woolly adelgid (*Adelges piceae*).

Eastern hemlock mortality caused by hemlock woolly adelgid in the Great Smoky Mountains National Park. Photo courtesy of Ben Smith, Department of Entomology, North Carolina State University.

For the past two decades, federal agencies such as the USDA Forest Service and university researchers throughout the eastern United States have been working to find solutions for mitigating the impacts of the hemlock woolly adelgid and restoring hemlock forests devastated by this insect. Research has focused on silvicultural tools, chemical insecticides, biological control (the importation and release of adelgid predators from the insect's native range in Asia), and breeding of adelgid-resistant hemlocks. Key to the success of any restoration program are efforts to save seeds from endangered populations that can then be utilized as a seed resource to support breeding and reforestation activities once conditions for the species' survival improve. Perhaps the best example of this importance is the American Chestnut Foundation's breeding program for restoring the iconic *Castanea dentata* to its native habitat. Access to a source of broadly adapted American chestnut seed has played a key role in successful development of the regionally adapted blight resistant trees being planted today (http://www.acf.org/index.php).

Efforts to save seeds of eastern and Carolina hemlock began in 2003 and are being led by Camcore, an international tree breeding and conservation progam in the Department of Forestry and Environmental Resources at North Carolina State University, and the USDA Forest Service Forest Health Protection program. Termed genetic resource conservation, the goal is to collect seeds from multiple hemlock populations across eastern United States and Canada that, as much as possible, represent the natural genetic variation and environmental adaptability present in both species. Conservation activities are guided by research studies on hemlock population genetics using DNA markers and climatic variability using climate modeling software, the results of which are utilized to target seed collections to areas that maximize the diversity captured. After collection, seeds are either placed into cold storage in seed banks for long-term preservation or are planted into seed orchards

Hemlock continued on Page 23

Mystery Plants

By J. Dan Pittillo

This year we are relating our native Southern Appalachian plants with some from elsewhere. In the first example, there was only one SA plant: Juniperus communis var. depressa. It occurs throughout most of North America (see: http://plants.usda.gov/java/nameSearch). There was only one submission for the last two issues from Georgia Hall. In the 21(2) the species were: 1) *Cymophyllus fraserianus*, 2) *Jeffersonia diphylla*, 3) *Trillium luteum*, 4) *Parnassia asarifolia*, and 5) a shrubby *Senecio* taken in Costa Rica. I hope to encourage you to and offer some more familiar Appalachian plants in this issue.


No. 1


No. 2


No. 3

In addition, there are numerous references you could consult for presence. Let's keep this to only this year's effort for the copy Judy Dumke has offered: Kristin Johannsen's Ginseng Dreams, the Secret World of America's Most Valuable Plant to the winner. Pick out the correct one (or more) species that is native to the defined Southern Appalachians. And you will have one more set to choose from by end of the contest.

[Dan is best contacted via email: dpittillo@gmail.com If you don't have computer access write to: 675 Cane Creek Road, Sylva, NC 28779]


No. 4


No. 5

"Despite the appealing, early-century presumptions of Frederick E. Clements and Lucy Braun, there is no 'climatic climax' because the climate continues to change and every species responds individually."

Roland C. Clement, quoted in
Newsletter of the Connecticut Botanical Society:
28(2&3), 2000.

Hemlock continued from Page 21

in locations where the trees can be reliably protected from the adelgid. The goal is to maintain, in perpetuity, viable seed reserves and seed orchards of both eastern and Carolina hemlock that will be available for restoration efforts once reliable hemlock woolly adelgid management strategies are identified. Another way to think of it is as an insurance policy against the "worst-case" scenario where the adelgid functionally eliminates both species from their native habitats.

Ripe seed cones of Carolina hemlock in the Cliff Ridge population along the Appalachian Trail near Unaka Springs, TN. Photo courtesy of Camcore, Department of Forestry & Environmental Resources, North Carolina State University.

Seed saving efforts for the hemlocks are ongoing, but already approximately 2.5 million seeds have been placed into conservation during this program's first 10 years. These seeds represent 451 individual mother trees from 60 populations of eastern hemlock and 134 mother trees from 19 populations of Carolina hemlock. Seed reserves have been established at the Camcore's seed bank at North Carolina State University in Raleigh, NC and the USDA Center for Genetic Resource Preservation in Fort Collins, CO. Seed orchards of both species have been establish in western North Carolina where trees are being protected from the hemlock woolly adelgid with insecticides, and in complimentary Southern Hemisphere climate zones in southern Brazil and central Chile where native hemlocks do not occur and the adelgid is unlikely to be introduced. These seeds and seed orchards represent a valuable resource that can be used to address a number of research and reforestation objectives for restoring eastern and Carolina hemlock ecosystems currently being devastated by the hemlock woolly adelgid.

Bioforest-Arauco researcher Jaime Zapata holding a Carolina hemlock he and his colleagues produced for a conservation planting in central Chile. Photo courtesy of Camcore, NC State University.

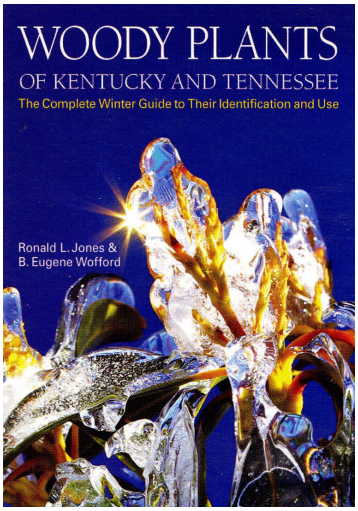
Readers interested in learning more about or assisting with the hemlock seed conservation can contact the author, Robert Jetton, via email at rmjetton@ncsu.edu or phone at 919-515-6425. For additional information on the Camcore Program and our other tree breeding and conservation activities readers can visit www.camcore.org. For more details on the biology, management, and impacts of the hemlock woolly adelgid readers are referred to http://www.na.fs.fed.us/fhp/hwa/.

SABS Welcomes Our New Members

Christopher Adams
David Adams
Rudi Boekschoten
Gwendolyn Casebeer
Clayton Costa
Theresa Culley
Ashley Egan
Susie Egan
Eyup Erdgan
Patricia Faulkner
Renee Fortner
Johnnie L. Gentry
Thomas E. Hancock
Sarah Henry
Deborah Hilbert
Yusheng Liu
DeWitt Long
Daniel McNair
Mt. Cuba Center, Inc.
Karoline Oldham
Jerald Pinson
Eric Schuettpelz
Jamie Smith
Robert Tatina
Steve Thornhill
Lisa Wallace
Willam J. Waltman
Andrea Weeks

Book Corner

New on the bookshelves is Woody Plants of Kentucky and Tennessee: The Complete Winter Guide to Their Identification and Use, by Ronald L Jones and B. Eugene Wofford. It features color images of over 400 species with full descriptions and notes on identification in the winter condition, along with a wealth of ecological, biogeographic, and ethnobotanical information. The Southern Appalachian Botanical Society provided financial support for the production of this book. Hopefully our members will find that their investment has paid dividends in a useful new reference.



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SABS Fall Council Meeting

Some readers of Chinquapin may be unaware that the SABS Council meets every fall to discuss society business. This year Richard Carter, Member-at-Large, welcomed us to his institution, Valdosta State University (Valdosta, Georgia) on 7 September. This was an unusual meeting as all Council members were present, as well as the publisher of Allen Press, Karen Ridgway! Main topics of discussion included the development of payment of dues on-line and an upcoming membership drive. Karen also presented a detailed update on the status of Castanea. We took a short break after lunch to allow time for Richard to give a tour of VSC Herbarium, and his student workers demonstrated the progress on his digitization and imaging project (a collaborative NSF grant with GA Herbarium/W. Zomlefer).

Group photo of SABS Council members. Left to right: Richard Carter, Member-at-Large; Brian Keener, Member-at-Large; John Pascarella, Editor-in-Chief, Castanea; Susan Farmer, Recording Secretary; Wendy Zomlefer, President; Kathy Mathews, President-Elect; Mac Alford, Member-at-Large; Charlie Horn, Treasurer; Joe Pollard, Editor, Chinquapin; Mike Held, Membership Secretary; and Karen Ridgeway, Publisher, Allen Press. Photo credit: Amy Vardeman.

Richard Carter giving tour of VSC Herbarium. Photo credit: W. Zomlefer

Jessica Bartek demonstrating data entry. Photo credit: W. Zomlefer

Thank you to Richard for a productive and enjoyable meeting! We look forward to next year's Council meeting with new president Kathy Mathews hosting at Western Carolina University (Cullowhee, NC).

--Wendy B. Zomlefer, President