Marilandica

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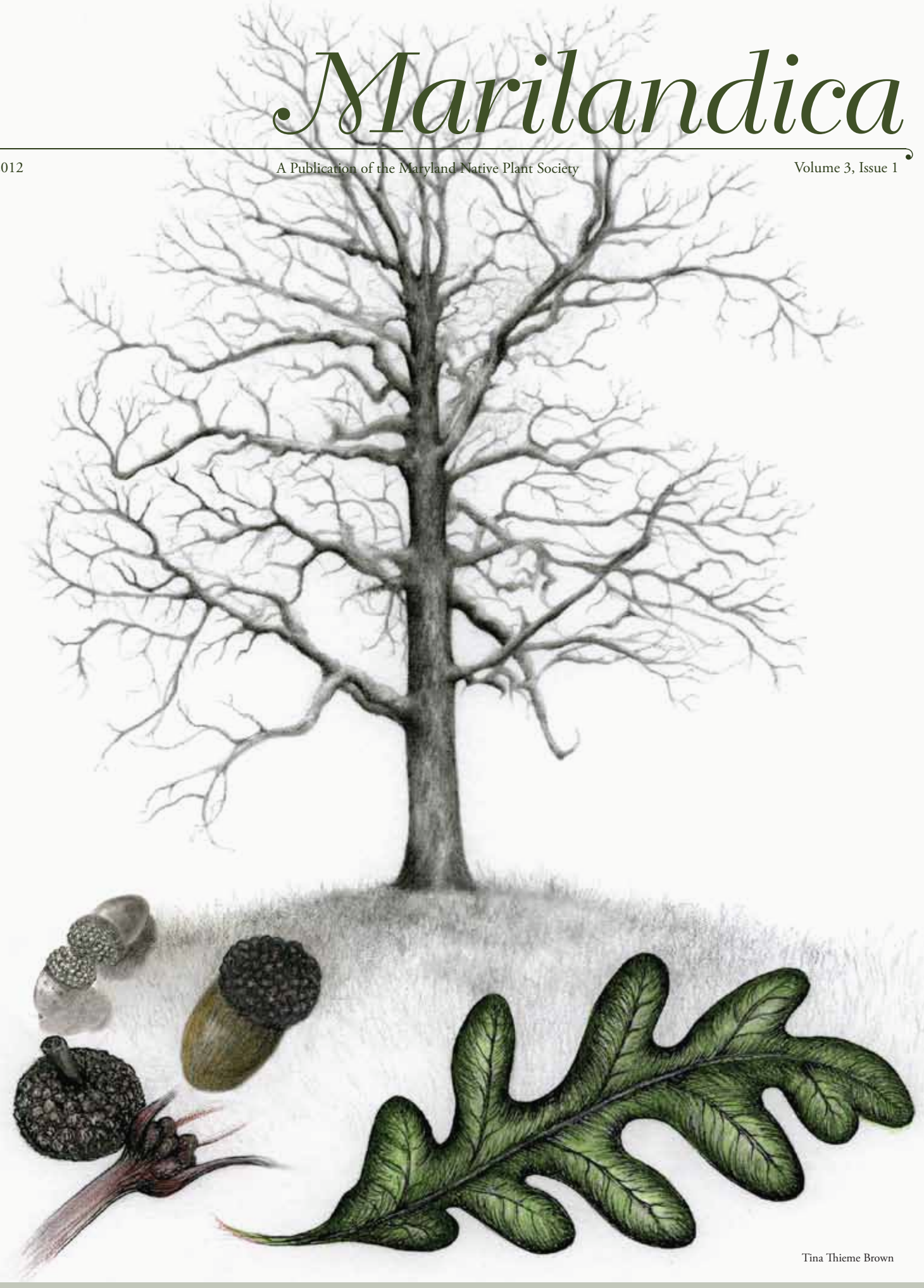

Tina Thieme Brown

Marilandica

A Publication of the
Maryland Native Plant Society

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Letter from the President

Dear Members,

For the first issue of 2012, I'll give you an overview of the Society's activities in 2011. We started what we hope will be a tradition, to focus on a single plant group for the entire year. We picked ferns, those ancient, ubiquitous, and hard-to-distinguish species. Ferns were featured in seven field trips, three monthly meetings, and two issues of Marilandica. Dwight Johnson's Key to the 25 Common Ferns of Maryland proved indispensable throughout the year; it's available on our website. Members responded enthusiastically, and for 2012 we're focusing on Oaks.

Field trips are our core activity. Last year the Society sponsored over 30 field trips, plus a field excursion to the Pocono Plateau, and additional field trips at the conference. We thus enabled hundreds of people to experience the deep satisfaction of going outside and paying close attention to what we see. Thanks to Cris Fleming and Bob Yacovissi, plant lists from many field trips are now posted on the website. Attendance at our meetings and field trips is at an all-time high. The annual fall conference is a highlight of the year. Our 2011 Conference at LaPlata in Charles County focused on Southern Maryland's rich plant communities and the urgent necessity to protect them from encroaching development. Watch for announcements of this year's Conference to be held at Towson University under the leadership of the Greater Baltimore Chapter.

We continue to advocate for conservation. Carol Jelich testified in favor of legislation (enacted) that will regulate the sale of invasive non-native plant species. Linda Keenan testified at a hearing on Prince Georges County's Preservation Area Functional Master Plan. Kirsten Johnson and Mary Pat Rowan were invited to speak at a US National Arboretum stakeholders meeting. Linda Davis, Kirsten Johnson, Eugene Meyer, Bob Stanhope and other members participated in the Coalition for Responsible Deer Management, described in the Conservation Watch section. In addition, we often cosign petitions and testimony by other organizations on conservation issues.

The Greater Baltimore Chapter welcomed Chris Partain as its new Chair. Outgoing Chair Ann Lundy, a founding member of the chapter, will continue on the chapter's board. The chapter is now holding meetings monthly in Baltimore City, Baltimore County, and Howard County. Under Liz McDowell's leadership, our Western Mountains Chapter continued its regular meetings with speakers and outreach activities. In Montgomery County, some of our monthly meetings have been standing-room-only, so please arrive early to get a seat and to socialize.

For details of all our activities in 2011, please see our 2011 Annual Report in the "About" section of our website.

~ Kirsten Johnson

Western Mountains Chapter

The Western Mountains Chapter is celebrating the Year of the Oak with assistance from Wade Dorsey, Savage River State Forest manager. Wade will lead a leisurely walk in June to highlight various oak species found in Garrett County. Then as an encore at our October meeting, he will share his presentation on Maryland's native oaks.

Our chapter meetings this year cover a range of topics. At our February meeting Liz McDowell, Chapter Coordinator, explained how gardeners can play a key role in maintaining regional biodiversity by 'going native'. In April we will focus on pawpaw, as plant breeder, R. Neal Peterson, recounts its history, biology, and his recent efforts at its domestication. At our June meeting the guest speaker will be Donna Ford-Wentz, Herbarium Curator, West Virginia University. Her main research interests include the flora of West Virginia and plant collections management. In August Stephen Keller, Assistant Professor, Appalachian Laboratory, will discuss his current research on the ecology and evolution of invasive species and the conservation genetics of rare and declining species.

Our chapter members continue to spread the word about the value of native plants by serving on Frostburg University's "Tree Campus USA" Advisory Committee and Arboretum Task Force, assisting local garden clubs with questions and representing MNPS at local native plant sales.

~ Liz Mc Dowell, Western Mountains Chapter Coordinator.

Oak in Focus–White Oak

Quercus alba L.
Beech Family *(Fagaceae)*
by Melanie Choukas-Bradley

During the "Year of the Oak," the Maryland Native Plant Society is celebrating the 21 native oaks of Maryland and we are learning all we can about their identifying characteristics and their importance to our regional ecology. Surely none of our 21 species is more beloved than the white oak (*Quercus alba*), our official state tree. Abundant in woodlands throughout Maryland, the white oak has long been a friend to humankind, both as a forest and cultivated tree. Montgomery County Forest Ecologist and MNPS board member Carole Bergmann speaks for all of us when she says: "Such a beautiful tree! The pale gray shingled bark stands out so beautifully against a bright blue winter afternoon sky. The white oak is our state tree for a reason. I love that tree and always point it out on every walk I lead!" White oak acorns are edible after treating to remove tannin. Traditionally, a protein-rich meal was made from the crushed, ground acorns and used in baked goods. The acorns are an important food source for wildlife, including squirrels, raccoons, white-tailed deer, wild turkeys, and quail. Less well-known is the importance of oaks to insects, including butterflies and moths. MNPS President Kirsten Johnson observes: "Doug Tallamy says oaks support 534 Lepidopteran species – more than any other genus in the midatlantic. Thus oaks also support insect-eating birds and animals." The white oak is, not surprisingly, in the white oak group, along with eight other Maryland oak species. Trees in the white oak group bear leaves with rounded (non-bristle-tipped) lobes or teeth (or apices in non-toothed or lobed species) and acorns maturing in one year. The acorns in the white oak group are purportedly "sweeter" than those in the red oak group.

Native Habitat and Range: A variety of habitats including upland woods; grows best in deep, rich, well-drained soils. Eastern U.S. and southeastern Canada from Maine and southern Quebec to Minnesota, south to eastern Texas and northern Florida.

Leaves: Simple, alternate, deciduous. 3 ½ to 9 inches (9-22.8 cm) long. Some leaves have narrow lobes separated by sinuses cut almost to the midrib; others have wider lobes and sinuses cut only about halfway to the midrib. Five to nine rounded lobes; lobes point upward and sometimes have one or more large, rounded teeth. Base wedge-shaped or slightly rounded. Pubescent at first, soon becoming glabrous; very pale and sometimes slightly glaucous below. Petiole ¼ to 1 inch (0.5-2.5 cm) long. Autumn color: deep wine-red some years. Dry leaves often remain on the tree through the winter.

Flowers: Male flowers in loose catkins sometimes called "aments." Female flowers are tiny, with three-lobed stigmas. Trees are monoecious and spring-blooming.

Fruit: Acorn, maturing during the first year as all acorns in the white oak group do. Sessile or short-stalked. ½ to 1 inch (1.3-2.5 cm) long, enclosed for about one-quarter of its length by a bowl-shaped cup covered with thickened nubbly scales.

Bark and Twigs: Bark pale ash-gray, with shaggy vertical scales; often slightly furrowed toward the base of the tree. Twigs reddish brown or gray, glabrous or nearly so when mature (greenish or reddish and may be hairy when young), with scaly, reddish brown, ovoid or nearly round winter buds.

Growth Habit: Large tree with a full, rounded crown. Woodland trees are tall and straight; trees grown in the open may have a short, wide trunk and broadly spreading limbs.

Similar Species: Although *Quercus alba* is by far the most common of the trees in the white oak group growing in Maryland, it could be mistaken with other species. Chestnut oak (*Q. prinus*) has more shallowly lobed leaves and bark that is dark, thick, and separated into ridges and valleys. Swamp chestnut or basket oak (*Q. michauxii*) has leaves similar to chestnut oak, and bark similar to white oak. It is largely a tree of the coastal plain although a few specimens grow at Blockhouse Point and in other piedmont locations and it is planted in the Washington, D.C. area. Swamp white oak (*Q. bicolor*) has thick leaves with felt-like pubescence below and long-stalked acorns. Post oak (*Q. stellata*) has leaves with a large pair of lobes near the apex, giving the leaf a cross-shaped look. See www.mdflora.org for a full list of oaks native to MD and other resources related to the Year of the Oak.

Locations: The white oak can be found growing in woodlands throughout Maryland and it is a favorite cultivated tree. According to Botanist, Ecologist and MNPS board member Rod Simmons: "Most of the mature White Oaks we see in yards and along old neighborhoods and sections of cities are remnants of native forested areas dominated by upland oaks that were present when the houses and streets were built."

Threats to the White Oak and other Oaks: Kirsten Johnson notes that the white oak and other oaks are threatened by deer and urbanization. On the latter, Rod Simmons agrees: "[The white oak] can tolerate the successive periods of drought and heat associated with climate change, but it cannot tolerate significant water table drops and loss of groundwater infiltration around its root zone that result from the now-constant practices of digging, trenching, paving, overbuilding, burying underground utilities, etc., that are the hallmarks of our over-developed and highly fragmented suburbs and neighborhoods." Geologist and tree enthusiast Tony Fleming adds: "I think Rod hit the nail on the head: local environmental change is a well-documented culprit in plant and animal mortality, and it comes in a variety of packages, large and small. To my thinking, the most pervasive form of local environmental change is deforestation and urbanization: the [D.C.] metro area probably has considerably fewer forested areas now than 50 or 100 years ago. Regional deforestation creates a hotter, drier, and more wind-prone microclimate, not to mention less overall soil moisture availability as forested areas are converted to urban land cover. For the large trees that remain, the cumulative effect of all these local environmental changes amounts to death by 1,000 cuts."

Oak in Focus is adapted from *City of Trees: The Complete Field Guide to the Trees of Washington, D.C.*, Melanie Choukas-Bradley with illustrations by Polly Alexander (University of Virginia Press). Carole Bergmann, Charlie Davis, Cris Fleming, Tony Fleming, Kirsten Johnson, Wesley M. Knapp, Rod Simmons, and Tina Thieme Brown contributed to this article.

On January 13, the Baltimore Sun *reported that Governor O'Malley is including in his proposed capital budget almost $24 million for much needed renovations and improvements to infrastructure in the state parks. MNPS supports this investment. The deterioration of buildings, piers, and parking lots is visible to everyone. But we wanted to call attention to another, less visible, threat to our parks and other natural areas, namely the destruction of habitat due to the overpopulation of white-tailed deer. We sent the following letter to Governor O'Malley, and we were pleased to receive this thoughtful response (facing page) from John R. Griffin, Secretary of the Department of Natural Resources.*

Sent through the Governor's website: January 21, 2012

Dear Governor O'Malley,

Maryland Native Plant Society supports your recently announced capital budget proposal to increase funds for needed improvements and maintenance in our state parks. But we want to call your attention to another, even more effective and likely less costly, way to improve Maryland's parks. Nothing is causing more harm to our state parks, forests and natural areas than the exploding population of white-tailed deer. In many parks, the native shrub and herbaceous plant layer has been virtually eliminated. When the large trees in many of our forests fall and die, they are not being replaced by younger trees because white-tailed deer eat the tree seedlings and saplings before they have a chance to mature. You can walk miles in our woods and not see a single oak, hickory or maple sapling. Our forests are dying a slow death.

The overpopulation of white-tailed deer encourages the proliferation of non-native invasive plants that the deer do not eat. These non-native plants fail to provide food for the animals, birds, amphibians, and insects that depend on native plants for food and shelter. Thus, the entire forest ecosystem is harmed. In addition, deer threaten public health and safety by carrying Lyme disease and causing thousands of vehicle collisions annually in Maryland alone.

Studies have shown that the white-tailed deer population must be reduced to fewer than 20 deer per square mile for forests to regenerate. Yet the deer population in some areas of Maryland, such as Baltimore County, is estimated at more than 80 deer per square mile.

Despite the destruction that white-tailed deer are causing, they are still protected by a regulatory system established decades ago when the deer population was sparse. State law and policy should now be updated. Park managers should be permitted — and encouraged through adequate funding — to control deer populations through managed hunting. In addition, white-tailed deer could, like the fish and crustaceans of the Chesapeake Bay, be managed as an economic resource. To this end we propose that the commercial sale of wild-hunted venison be permitted under an appropriate regulatory system that addresses public safety and balances the interests of recreational and commercial hunters. We believe this would be a practical way to reduce the deer population to a healthy level while at the same time providing revenue for our licensed hunters, and healthy high-protein, low-fat food for the people of Maryland.

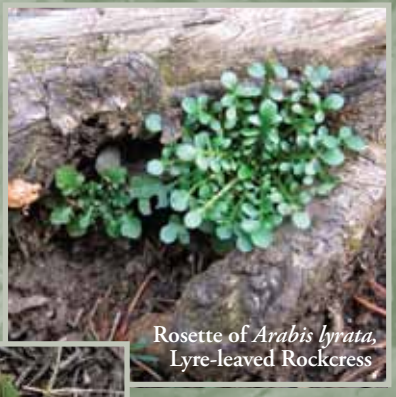
Thank you for your consideration of our view.

Yours truly,
Kirsten Johnson, President

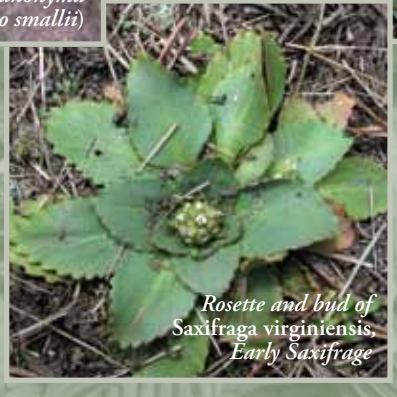
Early Spring at Robert E Lee Memorial Park


Buds of *Quercus marilandica,* Blackjack Oak


Packera anonyma (syn: *Senecio smallii*)


Rosette of *Arabis lyrata,* Lyre-leaved Rockcress


Leaves of *Quercus stellata,* Post Oak


Rosette and bud of Saxifraga virginiensis, *Early Saxifrage*

Ms. Kirsten Johnson
550 W. University Parkway
Baltimore MD 21210

Dear Ms. Johnson:

Thank you for your email to Governor Martin O'Malley regarding deer management in Maryland's State Parks. Governor O'Malley has reviewed your email and asked me to respond on his behalf.

I appreciate you taking the time to express your support for the proposed increase in capital funding for State parks. With the support of the General Assembly in approving the Governor's proposal, we will be able to address some long-standing capital improvement needs and look forward to the enhancements they will bring.

I was interested to read your description of the damage deer are doing to many of our public lands. We have been well aware of the impacts caused by too many deer and have been working very hard to address this issue for over two decades. As you may remember, some of our early efforts to control deer on State parks resulted in significant protests from the general public. We met this resistance with a goal of education and compromise and have since moved to an era where the necessity for deer control is understood, and accepted, by most citizens.

As a result, we now have managed hunting for deer in most of the parks where this activity is necessary and appropriate. While there may be the need for additional hunting on some tracts, we certainly feel our management philosophies have evolved to be consistent with the growing deer population. Consequently, the deer hunting opportunities on our State parks are very liberal, as we agree that managed hunting is the best means to manage white-tails. Gone are the days when hunting in a State park was considered an anomaly.

Looking at deer harvests across our State, it is evident that hunters are doing a good job as deer managers. That harvest now includes far more antlerless deer (does) than antlered deer (bucks), a significant change from just a decade ago. Taking more does is the most effective way to reduce the herd, and as a result, we have seen the statewide deer herd drop since peaking in 2002. Our deer managers continue to make changes to liberalize hunting regulations to increase harvest and the good news is we have turned the corner and our deer herd is no longer growing.

Your suggestion for establishing a commercial outlet for wild venison is not a new one, but it certainly is an uncommon one. As you may know, more and more people are looking at wild venison as being a healthy, sustainable and local source of food. I can point to a number of people that have taken up the sport of deer hunting, not because it was a family tradition, but because it provides an excellent source of food with an ecologically desirable outcome – fewer deer. The Department of Natural Resources has several programs in place to keep this trend growing; we look forward to adding to our deer hunting community every chance we get.

I will give your suggestion some real consideration and have passed it on to our deer managers. State park managers will continue to review their deer hunting programs with the goal of getting our herds where they belong and/or keeping them there. Healthy forests are not just pleasant places to visit, they are critical for the well being of our watersheds, wildlife, plant communities and overall ecology.

Once again, thank you for your email. Governor O'Malley appreciates hearing from you, and on his behalf, I thank you for your interest in this very important issue. If you need further assistance, please feel free to discuss this matter with Pete Jayne, Associate Director for Game Management for the Wildlife and Heritage Service, at 410-827-8612 ext 104, or email pjayne@dnr.state.md.us. He will be happy to assist you.

Sincerely,
John R. Griffin
Secretary

cc: Paul Peditto, Director, Wildlife and Heritage Service
Pete Jayne, Associate Director, Wildlife and Heritage Service
Nita Settina, Superintendent, Maryland Park Service

IQ No: 315217/CorrNo: 12777-2011

MNPS Field Trip Plant Lists: A Continuing Project

In the spring of 2007, my husband and I planned a vacation in Washington State to visit family and—of course—to do some hiking and botanizing. We had previously taken wonderful trips to Mt. Rainier and Olympic National Park, so this time we planned to take the ferry to the San Juan Islands. On a whim, I visited the Washington Native Plant Society web page and, to my delight, I found dozens of plant lists from their field trips. I printed several lists from San Juan County, and I was on my way. When we arrived, I pulled out two lists for nearby sites, and easily found many of the species listed!

On our return home, I had a plan to post lists from MNPS field trips on our web site. I thought such lists would be useful to field trip leaders and participants. I also hoped they might become valuable records for future botanists. Well, my project ran into stumbling blocks right away. The main problem was to establish a common format for the lists. People were sending many different kinds of lists: some with common names only, some with no information on who was the leader and who the recorder. Still, the project got started and we had posted ten lists by the end of 2008.

By spring 2009, it was clear there were more hurdles: 1) which authority to use for scientific names; and 2) my appalling lack of computer skills. So we established a "field trip list committee" to restart the project: Ginny and Bob Yacovissi, Heidi Pringle, Kirsten Johnson and myself. Meeting several times during the summer, the committee decided to adopt the USDA database terminology since it is an easily available and recognized authority. And my lack of computer skills suddenly didn't matter when Bob offered his expertise as well as access to a program that picks up spelling mistakes and discrepancies with USDA nomenclature.

Now we have a very smooth operation. A plant list is sent to me by the leader or the recorder soon after a field trip. I check it over and send it on to Bob, who puts it through his magical program, adding family names and footnotes with synonyms. Bob sends the list back to me to check for accuracy. I evaluate the likelihood of each species at the particular location and sometimes ask questions of the leader and/or the recorder. After several more rounds of changes, new footnoting, and other picky things, we post the list on the MNPS web site.

Some lists cannot be posted, such as those from private property or very sensitive sites. We have obtained permission to post lists from certain Nature Conservancy preserves and the Izaak Walton League property in Montgomery County.

Below is a combined list from five field trips to the Hereford area of Gunpowder Falls State Park. This area is particularly noted for species such as Hemlock, Ninebark, and Wood Betony that are typically found farther north or at higher elevations.

You can download this list and other lists from our web site. Currently, there are 45 lists posted. Go to mdflora.org, and click on "Plant Lists." Please consider volunteering to be a recorder for MNPS field trips. All you need to do is stay near the leader to get plant identifications and then check your list with the leader after the trip (don't worry about the exact spelling). It's a great way to learn the plants and help MNPS keep records at the same time. Leaders, please ask for recorders on your field trips!

~ Cris Fleming, former MNPS President, current board member, and author of *Finding Wildflowers in the Washington-Baltimore Area*

Gunpowder Falls State Park (Hereford Area) Baltimore County, MD

We offer these lists to individuals and groups to enhance the enjoyment and study of plants of different locations in Maryland and nearby states. Their accuracy has not been verified by the Maryland Native Plant Society.


Adiantum pedatum


Asarum canadense

Acer negundo	Boxelder	Aceraceae
Acer rubrum	Red maple	Aceraceae
Actaea racemosa [1]	Black cohosh	Ranunculaceae
Adiantum pedatum	Maidenhair fern	Pteridaceae
Agrimonia gryposepala	Agrimony	Rosaceae
Agrimonia parviflora	Small-flowered agrimony	Rosaceae
Agrimonia striata	Woodland agrimony	Rosaceae
Alliaria petiolata [2]	Garlic mustard	Brassicaceae
Ambrosia trifida	Giant ragweed	Asteraceae
Amelanchier sp.	Shadbush	Rosaceae
Amphicarpaea bracteata	Hog peanut	Fabaceae
Anemone quinquefolia	Wood anemone	Ranunculaceae
Antennaria plantaginifolia	Plantain-leaved pussytoes	Asteraceae
Apocynum cannabinum	Indian hemp	Apocynaceae
Aquilegia canadensis	Wild columbine	Ranunculaceae
Aralia nudicaulis	Wild sarsaparilla	Araliaceae
Aralia racemosa	Spikenard	Araliaceae
Arisaema triphyllum	Jack-in-the-pulpit	Araceae
Asarum canadense	Wild ginger	Aristolochiaceae
Asplenium platyneuron	Ebony spleenwort	Aspleniaceae
Asplenium rhizophyllum [3]	Walking fern	Aspleniaceae


Asplenium rhizophyllum


Carex pensylvanica


Cypripedium acaule


Dennstaedtia punctiloba


Dicentra cucullaria

Athyrium felix-femina	Lady fern	Dryopteridaceae
Berberis thunbergii	Japanese barberry	Berberidaceae
Betula lenta	Black birch	Betulaceae
Boehmeria cylindrica	False nettle	Urticaceae
Botrychium virginianum	Rattlesnake fern	Ophioglossaceae
Cardamine bulbosa	Spring cress	Brassicaceae
Cardamine concatenata[4]	Cut-leaved toothwort	Brassicaceae
Cardamine hirsuta	Hairy bittercress	Brassicaceae
Cardamine pensylvanica	Pennsylvania bittercress	Brassicaceae
Carex pensylvanica	Pennsylvania sedge	Cyperaceae
Carpinus caroliniana	Hornbeam	Betulaceae
Carya alba[5]	Mockernut hickory	Juglandaceae
Carya cordiformis	Bitternut hickory	Juglandaceae
Carya glabra	Pignut hickory	Juglandaceae
Castanea dentata	Chestnut	Fagaceae
Celastrus orbiculatus	Oriental bittersweet	Celastraceae
Chelone glabra	Turtlehead	Scrophulariaceae
Chimaphila maculata	Spotted wintergreen	Pyrolaceae
Circaea lutetiana[6]	Enchanter's nightshade	Onagraceae
Claytonia virginica	Spring beauty	Portulacaceae
Climacium sp.	Tree moss	Climaciaceae
Collinsonia canadensis	Horsebalm	Lamiaceae
Commelina communis	Asiatic dayflower	Commelinaceae
Cornus alternifolia	Alternate-leaved dogwood	Cornaceae
Cornus florida	Flowering dogwood	Cornaceae
Corydalis flavula	Yellow corydalis	Fumariaceae
Corylus americana	Hazelnut	Betulaceae
Cryptotaenia canadensis	Honewort	Apiaceae
Cunila origanoides	Dittany	Lamiaceae
Cypripedium acaule	Pink lady's-slipper	Orchidaceae
Cystopteris protrusa	Fragile fern	Dryopteridaceae
Dennstaedtia punctilobula	Hayscented fern	Dennstaedtiaceae
Deparia acrostichoides[7]	Silvery glade fern	Dryopteridaceae
Desmodium nudiflorum	Naked-flowered tick trefoil	Fabaceae
Desmodium paniculatum	Panicled tick trefoil	Fabaceae
Dicentra cucullaria	Dutchman's breeches	Fumariaceae
Dichanthelium clandestinum[8]	Deer tongue grass	Poaceae
Dioscorea quaternata	Wild yam	Dioscoreaceae
Dryopteris carthusiana	Spinulose wood fern	Dryopteridaceae
Dryopteris intermedia	Intermediate wood fern	Dryopteridaceae
Dryopteris marginalis	Marginal wood fern	Dryopteridaceae
Echinocystis lobata	Burr cucumber	Cucurbitaceae
Elaeagnus umbellata	Autumn olive	Elaeagnaceae
Epigaea repens	Trailing arbutus	Ericaceae
Equisetum arvense	Common horsetail	Equisetaceae
Erigeron philadelphicus	Common fleabane	Asteraceae
Erigeron pulchellus	Robin's plantain	Asteraceae
Erythronium americanum	Trout lily	Liliaceae
Euonymus alatus	Burning bush	Celastraceae
Eupatoriadelphus fistulosus[9]	Joe-Pye weed	Asteraceae
Euphorbia corollata	Flowering spurge	Euphorbiaceae
Eurybia divaricata[10]	White wood aster	Asteraceae
Fragaria vesca	Wood strawberry	Rosaceae
Galearis spectabilis[11]	Showy orchis	Orchidaceae
Galium aparine	Cleavers	Rubiaceae


Erigeron philadelphicus


Galearis spectabilis


Geranium maculatum


Helianthus divaricatus


Hydrophyllum virginianum

Galium circaezans	Wild licorice	Rubiaceae
Gaultheria procumbens	Wintergreen	Ericaceae
Gaylussacia frondosa	Dangleberry	Ericaceae
Gentiana clausa	Closed gentian	Gentianaceae
Geranium maculatum	Wild geranium	Geraniaceae
Geum canadense	White avens	Rosaceae
Glechoma hederacea	Ground ivy	Lamiaceae
Goodyera pubescens	Downy rattlesnake-plantain	Orchidaceae
Hamamelis virginiana	Witchhazel	Hamamelidaceae
Helianthus divaricatus	Woodland sunflower	Asteraceae
Hemerocallis fulva	Daylily	Liliaceae
Hepatica nobilis var. obtusa [12]	Round-lobed hepatica	Ranunculaceae
Heuchera americana	Alumroot	Saxifragaceae
Hieracium paniculatum	Panicled hawkweed	Asteraceae
Hieracium scabrum	Rough hawkweed	Asteraceae
Hieracium venosum	Rattlesnake weed	Asteraceae
Houstonia caerulea	Bluets	Rubiaceae
Huperzia lucidula [13]	Shining clubmoss	Lycopodiaceae
Hydrangea arborescens [14]	Wild hydrangea	Hydrangeaceae
Hydrophyllum virginianum	Virginia waterleaf	Hydrophyllaceae
Ilex verticillata	Winterberry	Aquifoliaceae
Impatiens capensis	Jewelweed	Balsaminaceae
Isotria verticillata	Large whorled pogonia	Orchidaceae
Juglans cinerea	Butternut	Juglandaceae
Juglans nigra	Black walnut	Juglandaceae
Kalmia latifolia	Mountain laurel	Ericaceae
Laportea canadensis	Wood nettle	Urticaceae
Ligustrum vulgare	Common privet	Oleaceae
Lilium superbum	Turk's-cap lily	Liliaceae
Lindera benzoin	Spicebush	Lauraceae
Liriodendron tulipifera	Tuliptree	Magnoliaceae
Lobelia inflate	Indian tobacco	Campanulaceae
Lonicera japonica	Japanese honeysuckle	Caprifoliaceae
Lupinus perennis	Wild lupine	Fabaceae
Lycopodium digitatum [15]	Ground pine	Lycopodiaceae
Lycopodium obscurum [16]	Tree clubmoss	Lycopodiaceae
Lyonia ligustrina	Maleberry	Ericaceae
Maianthemum canadense	Canada mayflower	Liliaceae
Maianthemum racemosum [17]	False Solomon's seal	Liliaceae
Medeola virginiana	Indian cucumber-root	Liliaceae
Menispermum canadense	Moonseed	Menispermaceae
Microstegium vimineum	Japanese stiltgrass	Poaceae
Mitchella repens	Partridgeberry	Rubiaceae
Mitella diphylla	Miterwort	Saxifragaceae
Nasturtium officinale	Watercress	Brassicaceae
Onoclea sensibilis	Sensitive fern	Dryopteridaceae
Ornithogalum umbellatum	Star-of-Bethlehem	Liliaceae
Osmorhiza claytonii	Sweet cicely	Apiaceae
Osmorhiza longistylis	Aniseroot	Apiaceae
Osmunda cinnamomea	Cinnamon fern	Osmundaceae
Osmunda claytoniana	Interrupted fern	Osmundaceae
Ostrya virginiana	Hophornbeam	Betulaceae
Oxalis violacea	Violet wood sorrel	Oxalidaceae
Packera aurea [18]	Golden ragwort	Asteraceae
Panax trifolius	Dwarf ginseng	Araliaceae


Lindera benzoin


Packera aurea


Physocarpus opulifolius


Podophyllum peltatum


Rhododendron periclymenoides

Parthenocissus quinquefolia	Virginia creeper	Vitaceae
Pedicularis canadensis	Wood betony	Scrophulariaceae
Physocarpus opulifolius	Ninebark	Rosaceae
Pilea pumila	Clearweed	Urticaceae
Platanus occidentalis	Sycamore	Platanaceae
Podophyllum peltatum	Mayapple	Berberidaceae
Polemonium reptans	Greek valerian	Polemoniaceae
Polygonatum biflorum	Solomon's seal	Liliaceae
Polygonum cuspidatum	Japanese knotweed	Polygonaceae
Polygonum perfoliatum	Mile-a-minute	Polygonaceae
Polygonum virginianum [19]	Jumpseed	Polygonaceae
Polypodium virginianum	Common polypody	Polypodiaceae
Polystichum acrostichoides	Christmas fern	Dryopteridaceae
Polytrichum sp.	Haircap moss	Polytrichaceae
Potentilla canadensis	Dwarf cinquefoil	Rosaceae
Potentilla simplex	Common cinquefoil	Rosaceae
Prenanthes trifoliolata	Tall rattlesnake-root	Asteraceae
Prunella vulgaris	Heal-all	Lamiaceae
Prunus serotina	Black cherry	Rosaceae
Pycnanthemum muticum	Mountain mint	Lamiaceae
Pycnanthemum virginianum	Virginia mountain mint	Lamiaceae
Pyrola elliptica	Shinleaf	Pyrolaceae
Quercus alba	White oak	Fagaceae
Quercus prinus	Chestnut oak	Fagaceae
Quercus rubra	Northern red oak	Fagaceae
Ranunculus abortivus	Aborted buttercup	Ranunculaceae
Rhododendron periclymenoides [20]	Pinxterflower	Ericaceae
Rosa multiflora	Multiflora rose	Rosaceae
Rubus allegheniensis	Blackberry	Rosaceae
Rubus phoenicolasius	Wineberry	Rosaceae
Rudbeckia laciniata	Tall coneflower	Asteraceae
Salvia lyrata	Lyre-leaved sage	Lamiaceae
Sambucus nigra [21]	Elderberry	Caprifoliaceae
Sanguinaria canadensis	Bloodroot	Papaveraceae
Sanicula odorata [22]	Clustered snakeroot	Apiaceae
Sassafras albidum	Sassafras	Lauraceae
Saxifraga pensylvanica	Swamp saxifrage	Saxifragaceae
Saxifraga virginiensis	Early saxifrage	Saxifragaceae
Silene caroliniana	Wild pink	Caryophyllaceae
Sisyrinchium angustifolium	Blue-eyed grass	Iridaceae
Smilax herbacea	Carrion flower	Smilacaceae
Smilax rotundifolia	Greenbrier	Smilacaceae
Solidago bicolor	Silverrod	Asteraceae
Solidago caesia	Blue-stemmed goldenrod	Asteraceae
Solidago rugosa	Rough-stemmed goldenrod	Asteraceae
Spiraea japonica	Japanese spirea	Rosaceae
Stellaria graminea	Common stitchweed	Caryophyllaceae
Stellaria pubera	Star chickweed	Caryophyllaceae
Symphyotrichum lateriflorum [23]	Calico aster	Asteraceae
Symphyotrichum novae-angliae [24]	New England aster	Asteraceae
Symplocarpus foetidus	Skunk cabbage	Araceae
Thalictrum dasycarpum	Purple meadowrue	Ranunculaceae
Thalictrum dioicum	Early meadowrue	Ranunculaceae
Thalictrum pubescens [25]	Tall meadowrue	Ranunculaceae
Thalictrum thalictroides [26]	Rue anemone	Ranunculaceae


Sambucus nigra


Sanguinaria canadensis


Silene caroliniana


Thalictrum thalictroides


Viola blanda

Thelypteris noveboracensis	New York fern	Thelypteridaceae
Tiarella cordifolia	Foam flower	Saxifragaceae
Toxicodendron radicans	Poison ivy	Anacardiaceae
Tradescantia virginiana	Spiderwort	Commelinaceae
Trillium cernuum	Nodding trillium	Liliaceae
Tsuga canadensis	Hemlock	Pinaceae
Ulmus rubra	Slippery elm	Ulmaceae
Uvularia perfoliata	Perfoliate bellwort	Liliaceae
Uvularia sessilifolia	Sessile-leaved bellwort	Liliaceae
Vaccinium angustifolium	Narrow-leaved blueberry	Ericaceae
Vaccinium corymbosum	Highbush blueberry	Ericaceae
Vaccinium fuscatum [27]	Black highbush blueberry	Ericaceae
Vaccinium pallidum [28]	Lowbush blueberry	Ericaceae
Vaccinium stamineum	Deerberry	Ericaceae
Veratrum viride	False hellebore	Liliaceae
Veronica arvensis	Corn speedwell	Scrophulariaceae
Veronica officinalis	Common speedwell	Scrophulariaceae
Viburnum acerifolium	Maple-leaved viburnum	Caprifoliaceae
Viburnum dentatum	Arrowwood	Caprifoliaceae
Viburnum prunifolium	Black haw	Caprifoliaceae
Vinca minor	Periwinkle	Apocynaceae
Viola blanda	Sweet white violet	Violaceae
Viola pubescens [29]	Smooth yellow violet	Violaceae
Viola sororia [30]	Common blue violet	Violaceae
Viola striata	Pale violet	Violaceae
Woodsia obtusa	Blunt-lobed cliff fern	Dryopteridaceae

[1] Cimicifuga racemosa
[2] Alliaria officinalis
[3] Camptosorus rhizophyllus
[4] Dentaria laciniata
[5] Carya tomentosa
[6] Circaea quadrisulcata
[7] Athyrium thelypterioides
[8] Panicum clandestinum
[9] Eupatorium fistulosum
[10] Aster divaricatus
[11] Orchis spectabilis
[12] Hepatica americana
[13] Lycopodium lucidulum
[14] Hydrangea americana
[15] Diphasiastrum digitatum
[16] Dendrolycopodium obscurum
[17] Smilacina racemosa
[18] Senecio aureus
[19] Tovara virginiana
[20] Rhododendron nudiflorum
[21] Sambucus canadensis
[22] Sanicula gregaria
[23] Aster lateriflorus
[24] Aster novae-angliae
[25] Thalictrum polygamum
[26] Anemonella thalictroides
[27] Vaccinium atrococcum
[28] Vaccinium vacillans
[29] Viola pensylvanica
[30] Viola papilionacea

This is a combined record of plant lists developed during five different field trips to Gunpowder Falls State Park (Hereford Area) in 2006, 2007, 2008 and 2009. Field trips were led by Dwight Johnson. Plant lists by Dwight Johnson, Kirsten Johnson, Jane Hill, Heidi Pringle, and Ellen Scarfutti. Nomenclature follows the USDA Plant Database at http://plants.usda.gov (January 2011). Synonyms are footnoted for some species.

Photos by Kirsten Johnson except Asplenium rhizophyllum, Adiantum pedatum a*nd* Dennstaedtia punctiloba *by Carole Bergmann.*

This is the second of a series of three peer-reviewed articles on floral visitors and phenology of three rare Potomac Gorge plant species. In supporting this project, the National Park Service hoped to learn whether pollinator limitation contributes to the rarity of these plants.

Fruit Production and Phenology of *Phacelia covillei* S. Watson (Hydrophyllaceae) in the Potomac Gorge Area of Maryland and Virginia

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Abstract

The goals of this study are to provide information on selected aspects of the phenology of *Phacelia covillei* S. Watson in the Potomac Gorge of the U.S. Mid-Atlantic Region, to ascertain whether this species requires pollination by animals in fruit production in Turkey Run Park, Virginia, and to examine this species' flower, fruit, and seed production in relation to plant size. Observations and experiments indicate that in our study area, *P. covillei* seeds sprout in September and October; plants overwinter as rosettes; and flower, fruit, and senesce in April through early June. Study plants evidently produced no nectar, and insects infrequently visited their flowers. *Phacelia covillei* sets seeds through intrafloral autogamy, but can also set seeds through interfloral autogamy and xenogamy based on our hand-pollination and pollinator-exclusion experiments. The number of branches and flowers, fruit, and seeds produced per original flower per plant varied significantly among plants in three study sites. Flower, fruit, and seed number were positively correlated with branch number. Proximal flowers on inflorescences produced more seeds per original flower than distal ones.

Introduction

Phacelia is a New World genus in the Hydrophyllaceae with over 130 annual, biennial, and perennial species, predominately in western North America (Lawrence, 1951; Stevens, 1961; Jaeger, 1969). Pollen and nectar from many species of *Phacelia* are important resources used by pollinating insects and other animals in many habitats including agroecosystems and gardens (Williams and Christian, 1991; Williams, 1997; Farkas and Zajácz, 2007). Researchers have not studied most of the species in detail to obtain a full understanding of the phenology and reproductive biology of this environmentally and economically important genus.

The herbaceous plant *Phacelia covillei* S. Watson (Buttercup Scorpionweed, Coville's Phacelia) is endemic to the United States and occurs in Maryland and North Carolina (where authorities list it as S1, endangered). In Indiana, Ohio, Virginia, and West Virginia, State Heritage Programs have not distinguished this taxon from *P. ranunculacea* (Nutt.) Constance, which they list as endangered in each state (Sewell, 2003; Sewell and Vincent, 2006). *Phacelia covillei* also occurs in the District of Columbia, Illinois, and Missouri, where officials have not assigned it a conservation status. Thus far, researchers have primarily studied this plant's morphology, taxonomy, geographical distribution, and response to day length and temperature; however, they have undertaken only limited research on its phenology and almost no research on its reproductive biology. This species (n = 14 chromosomes) is morphologically similar to *P. ranunculacea* (n = 6; Sewell, 2003).

Phacelia covillei plants are frequently winter annuals and infrequently biennials that grow in rich woods and alluvium (Allard, 1940; Fernald, 1950). *Phacelia covillei* seeds sprout in the fall and plants overwinter as rosettes. Many plants grow in areas with a layer of fallen woody-plant leaves and branches. Their stems below their cotyledons are often elongated and their cotyledons and basal, regular leaves usually have long petioles, which enable them to rise above the forest litter into the light (pers. obs.). In late winter and spring, plants develop 1–10 erect and spreading branches up to 3 dm long, and they flower in April and May. Terminal scorpioid racemes, which become recurved, each bear 1–6 flowers. The small, light blue-violet flowers are 4–5 mm long, usually five-lobed, and tubular-campanulate through almost funnelform. The flowers appear to be adapted for insect, not wind, pollination because their corollas are colorful, and mature anthers and stigmas are inside their corollas rather than far outside the perianths as occurs in wind-pollinated flowers such as some *Thalictrum* spp.

Our goals are to describe selected aspects of *P. covillei*'s phenology, determine if this species requires insect pollination in setting fruit; and to examine this species' flower, fruit, and seed production in relation to plant size.

Materials and Methods

We made observations on *P. covillei* from 2003 through 2009 in the Potomac River Gorge in Maryland, Virginia, and the District of Columbia (Cohn, 2004; Evans, 2008). Our study plants were in

seven sites in Montgomery County, Maryland and two sites in Fairfax County, Virginia, all within 2.4 km of Glen Echo, Maryland. We investigated plants in an experimental garden (Site ME) of the Wehawken Nature Preserve in Bethesda, Maryland; three island sites in the Potomac River (Sites MI-1, MI-2, and MI-3); three mainland sites (MM-1, MM-2, and MM-3) in Maryland; and two mainland sites (VM-1 and VM-2) in Virginia. Site MI-1 is a low, level island, and MI-2 and MI-3 are hilly islands. Site MM-1 is on a steep, wooded slope near the Potomac River; MM-2 is on one of its rolling banks; MM-3 is along one of its tributaries; VM-1 is on a woodland knoll; and VM-2 is on a low, flat floodplain. Study sites had from hundreds through thousands of *P. covillei* plants that grew both as isolated plants and in patches of up to thousands of often closely spaced plants. Further, all sites had many non-native, invasive plants, including *Alliaria petiolata* (M. Bieb.) Cavara & Grande, *Euonymus fortunei* (Turcz.) Hand.-Maz., and *Lonicera japonica* Thunberg. These plants are especially threatening to *P. covillei* in Sites MM-1 and MM-3.

In mid-April 2007, we transplanted nine plants that were not yet in bloom from Site MM-2 into four plastic pots, 16 cm wide x 16 cm long x 16 cm deep, and transplanted one plant into the ground in a rocky, partly sunny area in Site ME. In our investigation of *P. covillei* reproduction, we tried to choose individual flowers and plants for pollination experiments without bias, except for flowers in Site ME, from which we chose a flower from each of the 11 plants that grew in the garden in 2009. We used SPSS Statistics Version 17 to perform statistical tests.

Phenology

To learn about *P. covillei* plant development, we marked, observed, and photographed 10 plants at Site VM-1 in 2007. To determine when seeds of *P. covillei* sprout, we observed plants at Sites ME, MI-2, and MI-3. To determine the leaf number of winter rosettes, we observed plants in ME in early January 2008 and 40 plants in each of Sites MM-2, VM-1, and VM-2 in late December 2008. At Site ME, we recorded the number of cotyledons and the number of regular leaves on each of the 15 plants in three pots on an outdoor nursery table that was 1 m above the ground and on eight plants in the ground that had sprouted from seeds produced in 2007. In Sites MM-2, VM-1, and VM-2, we laid out 1.5-m-long, twine transects and counted the leaves on 40 plants along each transect. To ascertain when plants flower and when anthers dehisce, we made direct observations on plants. To learn when stigmas are receptive, we used a hydrogen-peroxide test (Kearns and Inouye, 1993) on 20 flowers. We observed 10 flowers before their anthers dehisced and 10 plants after their anthers dehisced. Each flower was on a different plant. This test assumes that peroxidase activity of a stigma indicates that it is receptive to pollen. The test involves placing a flower's stigma into a solution of 3% hydrogen peroxide in water held within a capillary tube. If oxygen bubbles arise from a stigma, it has peroxidase activity. To find out when plants set fruit, we made observations at study sites, and we defined fruit set as swelling of a flower's ovary. We scored a plant as having mature seeds when it had one or more open capsules, and we scored a plant as senesced when it was limp, brownish, and mostly or fully dry, in May.

Floral visitors and fruit set

To ascertain whether *P. covillei* produces seeds without pollination, we worked at Sites ME and VM-1. At Site ME, we obtained data from 11 plants. Because it is difficult to emasculate the tiny flowers at near-ground level, we carefully transplanted the plants into pots. The timing of bud and flower development of the plants allowed us to emasculate one test flower on each of the plants. We also chose a non-emasculated flower on each plant as a control flower. We marked the two kinds of flowers by tying color-coded thread around their pedicels. We maintained the plants in a greenhouse free of pollinators. In Site V-M1, we bagged nine individual flower buds with small gauze, pollinator-exclusion bags with 0.5-mm mesh, unbagged them when flowers opened and removed their anthers before they dehisced, rebagged the flowers, and subsequently examined their ovaries to see if they developed into fruit.

To determine if *P. covillei* sets fruit through intrafloral autogamy, we used 16 individually bagged flowers in Site VM-2, and we used test cages (pollinator-exclusion cages) and control cages in Sites VM-1 and VM-2. We enclosed entire plants in the cages. We ran the experiment with 10 pairs of plants (each with one control and one test plant) at Site VM-1 in 2007 and Site VM-2 in 2008. The paired plants were less than 0.3 m apart. We placed cages over plants before they started flowering in mid-April. Each cage was 20 cm in diameter by 35 cm high. A control cage had sides of hexagonal chicken wire with each hexagon about 2.5 wide x 3.5 cm long, and a screen top of 1-mm-mesh, gray, plastic window screen. A test cage had sides of chicken wire covered with gray, plastic window screen and a screen top. We kept a cage in place by driving three 60-cm-long, bamboo stakes into the ground around the cage, and tying twine to the stakes and against the top of each cage so that the twine held down its top and kept the cage tightly secured to the ground to stop flying pollinators from entering test cages, wind from blowing cages down, and forest vertebrates from knocking over cages. The test cages did not exclude possible pollinating ants and tiny thrips; however, we did not see these insects on or in flowers at any site. To record potential and actual pollinators of *P. covillei*, we directly observed its flowers for a total of 20 hr from 8 a.m. through 8:30 p.m. during our study period.

Flower, fruit and seed production, and plant size

To determine the number of seeds that each plant produced, we collected senesced plants and examined their capsules. We found that by examining the morphology of a dried capsule that has dropped its seeds, we could determine the number of seeds it produced. We used a 2-tailed, paired t-test to test the null hypothesis that there is no significant difference in fruit number or seed number between control and test plants. To address the question, "Does *P. covillei* produce seeds through interfloral autogamy?" we bagged nine flower buds with small gauze bags, unbagged them and removed their anthers before they dehisced; then pollinated each flower with pollen from a flower from the same plant, rebagged flowers; and subsequently examined their ovaries to see if they developed into fruit. To investigate whether *P. covillei* can produce seeds through xenogamy, we bagged 13 flower buds with small gauze bags, unbagged them and removed their anthers before they dehisced, pollinated each flower with pollen from a flower from a different plant, rebagged flowers; and subsequently examined the ovaries to see if they developed into fruit.

Results and Discussion

Phenology

In 2007 at Site ME, the soil in the ground was very dry during most of July through mid-October, and eight *P. covillei* plants sprouted from seeds in the ground on about 31 October after 2 days of rain. Fifteen seeds from plants transplanted from Site MM-1 into pots in April 2007 sprouted in continually moist soil in pots on 4 October 2007. Seeds started sprouting in outdoor pots, in which *P. covillei* self-seeded, on 30 September 2009. On 20 October 2007, we found no seedlings at Sites MI-2 and MI-3 perhaps because the soil was still too dry that autumn for seed sprouting. In contrast, Allard (1940), who studied this species in the Potomac River Gorge, reported that *P. covillei* seeds sprout in December. Seed longevity of *P. covillei* remains unstudied. Seeds of the related winter annual, *P. purshii* Buckl., germinate in their first through fourth late summers or autumns and perhaps later (Baskin and Baskin 1976). Seeds of *P. ranunculacea* sprout in their first, second, or third autumns, making this species an obligate winter annual (Baskin et al., 1993).

In the third week of December 2008, *P. covillei* plants in Site MM-3 had a mean of 1.60 ± 0.50 1 SD (range 1–2, 40); VM1, 1.40 ± 0.50 (1–2, 40); and VM-2, 2.10 ± 0.90 (1–5, 40) true leaves. VM-2 had significantly more such leaves than both MM-3 and VM-1, which did not have significantly different numbers of leaves from one another (homoscedastic data, P = 0.071, Levene Test; P > 0.05, 1-way ANOVA, Scheffé Test).

Times of early *P. covillei* flowers in the Potomac River Gorge are 12 April 2003, 17 April 2004, and 17 April 2005 for Site MI-3; 19 April 2005 and 16 April 2006, MM-2; 23 April 2007, MM-3; and 27 April 2007, VM-1; 22 April 2009, MI-3; and 23 April 2009, ME. Allard (1940), who also studied specimens of this species from the Potomac River Gorge, reported that flowers of this species usually appear after 20 April and continue through mid-May. This species may be currently blooming earlier in the Gorge due to earlier warm weather related to global climate change.

By spring 2008, 17 plants were present in Site ME, and they all descended from a single plant planted in that site in 2007. One of the plants had one tripetalous, four quadripetalous, and five pentapetalous flowers; eight plants had quadripetalous and pentapetalous flowers; and eight plants had only pentapetalous flowers on 28 April 2007. In sum, the plants had one tripetalous, eight quadripetalous, and 36 pentapetalous flowers. The flowers were sympetalous, and we saw no evidence that corolla lobes had fallen from corollas.

Anthers dehisce within flower buds up to 2 hr after flowers open, and anthers have pollen in open flowers when they are 1.09 ± 0.06 (1–2, N = 23) days old. Within buds, nondehisced anthers range from light yellow through orange. In open flowers, nondehisced anthers are orange, and dehisced ones are light brown when macroscopically examined. Corollas wilt 2.5 ± 0.11 (2–3, N = 22) days after they open.

All the stigmas from 10 open flowers with closed anthers and 10 open flowers with dehisced anthers produced oxygen bubbles in peroxide indicating that all 20 stigmas were receptive. Ovaries were initially markedly expanded 4.9 ± 0.29 (3–7, N = 21) days after anthesis.

On 22 May 2007 in Site VM-1, 28 study plants had yellowish, mature-looking capsules, and two plants each had dehisced capsules. At Site MM-2, capsules released seeds 30.8 ± 0.26 (27–33, N = 23) days after their first flowers opened.

At Site VM-1, 30 plants developed from rosettes without flower buds through senesced plants that produced seeds from 14 April through early June while other plants developed around them, and new material accumulated and changed positions in the forest litter (Figure 1). The plants quickly senesced in mid-May through early June during a hot, dry period. Allard (1940) remarked that this species is intolerant of temperatures greater than 21°C and quickly senesces in warm May weather.

Floral visitors and fruit set

During 20 hr of observation that involved all of our sites, we saw only a few insects probe *P. covillei* flowers. They were two female *Andrena* bees (Andrenidae), one female *Lasioglossum* bee (Halicitidae), two *Bombylius major* L. (Bombyliidae), and one *Toxomerus geminatus* (Say) and one *Platycheirus obscurus* Say (Syrphidae). These are taxa that are common flower visitors and presumed pollinators of many forest and other plants. These insects flew to 1–5 flowers and then left our observed plants. They appeared to be seeking nectar from the flowers, but were not obtaining any. We saw no nectar droplets in 10 flowers from different plants examined with a 20-X hand lens from 9 a.m. – 12 p.m. at Site MM-2. We did not see any insects collecting or eating pollen from the flowers. These observations suggest that the flower visitors we saw were ones that were inexperienced with *P. covillei* flowers, and after they learned that the flowers had no nectar, they no longer visited such flowers. On 25 April 2009, we watched 32 flowers on 17 plants at Site ME after night fall (8–10 p.m) when the temperature was 26°C, and the air was still. We saw no nocturnal arthropod visitors at the flowers. Microscopic examination of 10 of these flowers at up to 30-X showed that their anthers had dehisced and all stigmas had pollen on them. Nine of the flowers had two stigmas, and one flower had three stigmas. We saw no nectar droplets in the flowers.

Flower, fruit and seed production, and plant size

Phacelia covillei did not produce seeds by apomixis. At Site VA-2, none of the 10 emasculated flowers produced fruit, and at Site ME, none of the 11 emasculated flowers produced fruit. At Site VA-2, we found that flowers opened with nondehisced anthers, but at Site ME, individual flowers opened with either dehisced or nondehisced anthers, causing us to open buds and remove anthers before they opened to study possible fruit set without pollination.

Three lines of evidence indicate that *P. covillei* flowers set seeds by intrafloral autogamy. First, at Site VA-2, after we removed nondehisced anthers from each of 15 flowers, opened its anthers, and pollinated it with its own pollen, nine of the flowers produced seeds. Second, at Site ME, all 11 control flowers produced seeds. Third, the 20 test plants in pollinator-exclusion cages produced seeds.

Phacelia covillei also produces seeds via interfloral autogamy. At Site VM-2, flowers on three of nine plants that we cross-pollinated with pollen from flowers of the same plant set seeds. Further, this species also produces seeds via xenogamy. At Site VM-2, flowers of five of 15

plants that we cross-pollinated with pollen from a different conspecific plant produced seeds. Like *P. covillei*, a related species, *Phacelia purshii* Buckl. (Gillett, 1964; Baskin and Baskin, 1976), and possibly other *Phacelia* spp. are self-pollinated, self-fertile winter annuals.

In 2007 at Site VM-1, 10 control plants had a mean of 4.6 ± 2.9 1 SD (range 2–11) fruit, and 10 test plants had 5.3 ± 1.6 (3–7) fruit, showing no difference in fruit number between groups (t = –0.535; P = 0.606, 2-tailed, paired t-test). Control plants had 7.9 ± 4.9 (4–19) seeds, and test plants had 5.8 ± 4.4 (1–16) seeds, showing no difference in seed number between groups (t = 1.058; P = 0.318). Control plants had 1.8 ± 0.3 (1–2) seeds, and test plants had 1.6 ± 0.3 (1–2) seeds per fruit, showing no difference in seed number per fruit between groups (t = 1.551; P = 0.155). In 2007 at Site VM-1, both control and test plants had only 1–2 seeds per fruit, but at this location in 2008, we found plants with 1–4-seeded capsules. In 2008 at Site VM-2, 10 control plants had a mean of 7.4 ± 3.7 (2–12) fruit, and test plants had 5.3 ± 1.6 (3–7) fruit, showing no significant difference in fruit number between groups (t = 2.003; P = 0.076, 2-tailed, paired t-test). Control plants had a mean of 17.7 ± 9.1 (4–33) seeds, and test plants had 10.4 ± 3.5 (5–15) seeds showing significantly more seeds in controls (t = 2.916; P = 0.017). Control plants had 2.4 ± 0.4 (1.8–2.8) fruit, and test plants had 2.0 ± 0.3 (1.6–2.5) seeds per fruit showing more seeds per fruit in controls (t = 5.369; P = 0.016). At both sites, control plants had more seeds and seeds per fruit than test plants. Greater shading of test plants compared to control plants by the full screening of test cages may have reduced test-plant seed set.

The 120 plants from all three study sites combined had 3.3 ± 1.8 (1–10) branches, 9.4 ± 6.7 (1–37) flowers, 4.9 ± 3.8 (0–19) fruit, 12.8 ± 9.6 (0–57) seeds, 2.7 ± 0.7 seeds per fruit, and 0.3 ± 0.3 seeds per original flower. Site VM-2 plants had significantly more branches, flowers, fruit, seeds, and seeds produced per flower than plants at the other two sites (Table 1). Further, our results suggest that plants of Sites VM-1 and VM-2 had more seeds per fruit than plants of Site MM-2. Flower, fruit, and seed number are positively correlated with branch number for all sites (Table 2, Pearson's and Spearman's Rho Correlation Tests, $P \leq 0.01$, in all 18 correlations). Therefore, more branched plants have higher Darwinian fitness (measured as seed number) than less branched ones. Researchers evidently have not studied the possible effects of space and nutrient availability on branching in this species; however, Allard (1940) found that *P. covillei* rosettes under lower-light conditions branched more than plants under higher-light conditions in a greenhouse.

At all three sites, the more proximal flowers of an inflorescence, which tend to bloom earlier than the more distal ones, produced more seeds than more distal flowers (Table 3). The possible causes for this phenomenon in *P. covillei* are not yet studied, but may include decreasing nutrient and light availability for flower maturation and seed production as the flowering season progresses and forest canopies become denser.

Hydrophyllaceae evidently has a highly conserved breeding system with protandry, maximal stigma receptivity near day 3, and self-compatibility (Levy, 1988). *Phacelia covillei* is an exception to this trend in that its anthers may dehisce within buds, its flowers tend to last only 2 days, and its stigmas are evidently receptive during both days.

In conclusion, we found that in the Potomac River Gorge, the scientifically and esthetically alluring plant *P. covillei* exists as seeds from June through early October, its seeds sprout in October, rosettes overwinter, plants flower in April and May, and fruit are mature and plants senesce in May. *Phacelia covillei* plants have infrequent flower visitors, and appear to produce fruit entirely, or almost entirely, via self-pollination without animal pollinators as their pollen vectors. Plants in pollinator-exclusion cages, can produce up to 19 seeds per plant. Therefore, at least within the Gorge, *P. covillei* plants can produce many seeds without animal pollination. Many lines of research remain to be undertaken on *P. covillei* including how the reproductive biology of other populations may vary from that of the Gorge population. For example, are there populations with nectariferous flowers that are frequently visited by insect pollinators? How does the phenology and reproductive biology of *P. covillei* differ from that of the similar-looking *P. ranunculacea*?

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Aaron F. Howard, Ph.D., is a recent graduate of Georgetown University's Laboratory of Entomology and Biodiversity. He is currently on the faculty at two colleges in the Chicago area, where he teaches biology and environmental science. He is completing papers on plant clonality and the ecology and evolution of floral-display size in two North American milkweed species.

Brent Steury is the Natural Resources Program Manager for the national park known as the George Washington Memorial Parkway, where he currently oversees all aspects of the park's inventory and monitoring program. His research has focused on the distribution of threatened and endangered vascular plants on the Mid-Atlantic Coastal Plain. Brent has authored 20 journal articles, numerous technical reports, and discovered more than a dozen vascular plants that were new records for the floras of Maryland, Virginia, or the District of Columbia. In addition to his interest in plants, Brent has published papers on reptiles, amphibians, moths, bees, and land snails.

Table 1. The mean (± 1 SD) number of branches, flowers, fruit, seeds, seeds per flower, and seeds per fruit per *Phacelia covillei* plant (N = 40 plants per site)[1].

Site	Plant Characteristic					
	Branch number per plant	Flower number per plant[2]	Fruit number per plant[2]	Seed number per plant[2]	Seed number per flower number per plant[3]	Seed number per fruit[2]
MM-2	2.7 ± 1.3 (1–6)a	6.8 ± 3.9 (2–20)a	3.8 ± 2.3 (1–11)a	11.1 ± 6.30 (2–33)a	0.4 ± 0.3 (0.1–1.0)a	3.0 ± 0.7 (1.5–6.3)a
VM-1	2.6 ± 1.5 (1–7)a	6.9 ± 5.5 (1–27)a	3.2 ± 2.3 (0–19)a	8.5 ± 6.67 (0–34)a	0.4 ± 0.3 (0–1)a	2.4 ± 0.8 (0–4)b
VM-2	4.7 ± 1.6 (1–10)b	14.5 ± 7.2 (4–37)b	7.4 ± 4.4 (2–19)b	18.8 ± 11.65 (5–57)b	0.2 ± 0.1 (0.1–0.5)b	2.5 ± 0.5 (1.5–3.5)b

[1] Ranges are in parentheses after means. Within columns, means that do not share a same letter are significantly different from one another at $P \leq 0.05$ (ANOVA, Scheffé Test).
[2] We used a square-root transformation on these data to meet the homoscedasticity assumption.
[3] We used a cube-root transformation on these data to meet the homoscedasticity assumption.

Table 2. Correlations of flower, fruit, and seed number with branch number per *Phacelia covillei* plant per site. N = 40 plants per site.

Site	Correlate with Branch Number [1]		
	Flower number	Fruit number	Seed number
MM-2	0.876, 0.843	0.782, 0.702	0.673, 0.626
VM-1	0.917, 0.946	0.778, 0.879	0.827, 0.856
VM-2	0.911, 0.914	0.871, 0.881	0.814, 0.847

[1] The first coefficient in a pair is for the parametric Pearson's Correlation Test (r), and the second coefficient is for the nonparametric Spearman's Correlation Test (rho); $P \leq 0.01$ for all correlations.

Table 3. The mean number of seeds per original flower site on infructescences per *Phacelia covillei* plant[1].

Site	Inflorescence Flower Position					
	1	2	3	4	5	6
MM-2	2.21 (40)	1.80 (39)	1.40 (33)	0.64 (21)	0 (7)	0 (1)
VM-1	2.28 (40)	1.54 (39)	0.41 (30)	0 (18)	0 (2)	
VM-2	2.31 (40)	1.41 (40)	0.76 (32)	0.14 (32)	0.12 (17)	0 (3)

[1] Flower position-1 is the most proximal position; position-2 is the next most proximal position; and so forth. N = 40 *Phacelia covillei* plants in each of the three sites. The number within parentheses following a mean is the number of plants from which the mean is calculated. Each mean is an average of the mean number of seeds at each flower position for all racemes of each plant. The number of plants varies because although all plants had a flower at position-1, not all plants had flowers at position-2 and at more distal inflorescence positions.

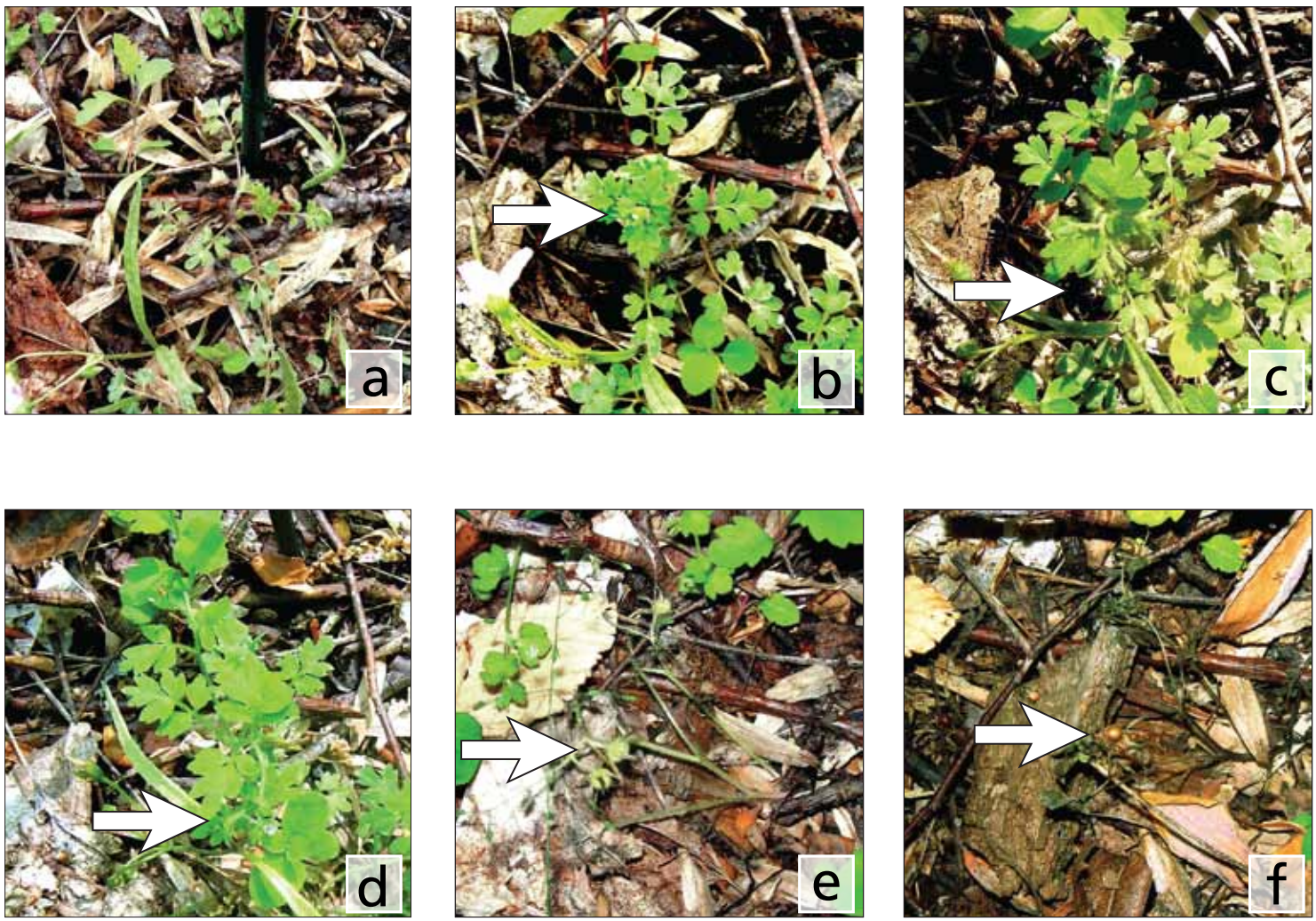


Figure 1. Development of a small plant of *Phacelia covillei* at Site VM-1 accompanied by changes in growth of other plants and in litter around it, 14 April – 24 May 2007. Photographs differ in scale so that the entire plant is shown in each photograph. Litter accumulated and moved about during the observation period. (a) 14 April, the expanding rosette of the *P. covillei* plant. A small shoot of *Lonicera japonica* Thunberg (Japanese Honeysuckle) is in the left upper corner, and its base is also in figures b–f. A second small shoot of *L. japonica* is in the lower bottom area and is also visible in figures b–d. A shoot of *Claytonia virginica* L. (Virginia Spring-beauty) is in the lower left corner, and is also visible in figures b–d before the shoot disappeared. A plant of *Veronica hederifolia* L. (Ivy-leafed Speedwell) is in the top middle area of the photograph. Seeds of *Liriodendron tulipifera* L. (Tuliptree) are in all photographs. (b) 21 April, the *P. covillei* plant with flower buds (arrow). *Claytonia virginica* (left corner) is in bloom. (c) 25 April, flowers of the *P. covillei* plant (arrow). A male inflorescence of *Fagus grandiflora* Ehrh. (American Beech) is near the lower right side of the *P. covillei* plant. (d) 2 May, small fruit of the *P. covillei* plant (arrow). (e) 17 May, large fruit of the *P. covillei* plant (arrow). A shoot of *V. hederifolia* is in the upper left corner. (f) 24 May, the totally senesced *P. covillei* plant with dehisced capsules (arrow). Two brownish petals of *L. tulipifera* are in the right side of the photograph.

Conservation Watch

Permits Denied for Charles County Connector

In late February, the Army Corps of Engineers joined the Maryland Department of the Environment (MDE) in denying a permit for the proposed Cross County Connector extension in Charles County because of its likely effect on Mattawoman Creek. The letter of denial states "the project as proposed would have direct and permanent adverse impacts on non-tidal wetlands, waterways, fish and wildlife, recreation and water quality." The Corps also found that practical alternatives to the project, such as utilizing existing roads, had not been sufficiently explored. Notably, the US Fish and Wildlife Service had urged denial of the permit, citing President Obama's May 2009 executive order for federal agencies to take a leadership role in protecting the Chesapeake Bay and its surrounding wildlife habitats. MDE denied the state Nontidal Wetlands and Waterways Permit in November.

In the Fall 2011 Marilandica, Mattawoman Watershed Society President Jim Long commented that the "Mattawoman story shows how efforts to restore the Bay and protect valuable wetlands resemble the story of Sisyphus, with two steps backward for every step forward." The recent denial of highway permits was unquestionably a step forward, but the fragile Mattawoman Watershed–so important to the health of the Chesapeake Bay–remains seriously threatened by development. For more information, please see mattawomanwatershedsociety.org.

Deer Management in Baltimore County - Update

As reported in the Spring 2011 Marilandica, a group of Baltimore County citizens petitioned the County Council to permit regulated deer hunting in the County. The petition was signed by 18 organizations representing diverse civic, environmental and recreational interests, but all concerned about the negative effects of deer overpopulation on forest health, as well as Lyme disease and highway safety. The amendment approved by the Council fell short of the petitioners' recommendation, but it permits culling of deer in County parks under Deer Cooperator Programs conducted by licensed wildlife management companies under the supervision of the Department of Natural Resources.

Coming Events

MONTHLY MEETINGS

Many MNPS members have thought of the monthly meetings in Montgomery County–usually at the Kensington Library, Knowles Avenue, in Kensington–as the regular meetings of the Maryland Native Plant Society. MNPS's other chapters hold monthly meetings as well; all the meetings known at press time are listed chronologically. Please see www.mdflora.org for details.

April 17 ~ Tuesday, 7:00 PM
A Native American Species Becomes a New Fruit Crop
Western Mountains Chapter. Location: Appalachian Laboratory, Frostburg
Speaker: R. Neal Peterson, Plant Breeder; on the pawpaw, *Asimina triloba*, North America's largest edible native fruit.

April 18 ~ Wednesday, 7:00 PM
Native Plant Nurseryman Roundtable
Baltimore Chapter. Location: Cylburn Arboretum greenhouse classroom
Participating Nurseries: Heartwood, Kollar, and American Native Plants. They will answer questions and bring plants for sale.

April 24 ~ Tuesday, 7:30 PM, doors open at 6:30
The Natural History of Oak-Feeding Insects in Maryland
Montgomery County. Location: Kensington Library
Speaker: John Lill, Assoc. Prof. of Biology, George Washington Univ.

May 16, Wednesday ~ 7:00 PM
Maryland's Orchids
Baltimore Chapter. Location: Irvine Nature Center, Owings Mills
Speaker: Carol Allen, Horticulturist and Orchid Enthusiast.

May 29, Tuesday ~ 7:30 PM, doors open at 6:30
Deer Management in Montgomery County
Montgomery County. Location: Kensington Library
Speaker: George Timko, Assistant Deer Project Manager, MD DNR.

June 19, Tuesday ~ 7:00 PM
Western Mountains Chapter
Location: Appalachian Laboratory, Frostburg
Speaker: Donna Ford-Wentz, Herbarium, West Virginia University

June 20, Wednesday ~ 7:30 PM
Saving Wild Plants at Meadowlark Garden
Baltimore Chapter. Location: Druid Hill's Rawlings Conservatory.
Speaker: Keith Tomlinson, Manager, Meadowlark Botanical Gardens.

June 26, Tuesday ~ 7:30 PM, doors open at 6:30
Oaks of the Mid-Atlantic
Montgomery County. Location: Kensington Library
Speaker: Rod Simmons

Coming Events

SPRING FIELD TRIPS

These are the field trips scheduled at press time. For up to date news of MNPS field trips and activities please see our website, www.mdflora.org and find us at meetup.com. Unless otherwise indicated, MNPS field trips are generally geared to adults. Please see the information provided for individual field trips, some of which may welcome children. If you have questions, feel free to contact the field trip leader.

April 21 ~ Saturday, 10:00 AM – 1:00 PM
Spring Wildflowers at Governor Bridge Natural Area
Leader: Karyn Molines
We'll walk through a diversity of habitats and identify abundant spring wildflowers.

April 21 ~ Saturday, Time tba
Two events at Druid Hill Park: Druid Hill Oaks and Landscaping with Native Plants to Attract Wildlife
Leaders: Chris Partain and Glenda Weber
In conjunction with Baltimore's EcoFest, MNPS will offer a tour of Druid Hill's majestic oaks.

April 22 ~ Sunday, 10:00 AM – 1:00 PM
Leakin Park
Leaders: Dwight and Kirsten Johnson
Part of Baltimore's Green Week, this walk explores spring wildflowers of Leakin Park.

April 24 ~ Tuesday, 12:00- 12:45 PM
Jones Falls at the Inner Harbor
Leader: Drew Brown
A Baltimore's Green Week event, this is a lunchtime walk along the Inner Harbor and a discussion of discussing urban stream ecology.

April 28 ~ Saturday, 10:00 AM- 2:00 PM
Carderock Recreation Area Woodlands and Tow Path
Leader: Marney Bruce
We will be walking in the woods, on the tow path, and occasionally crossing streams and climbing hills, identifying abundant wildflowers.

April 28 ~ Saturday, 10:00 AM – 12:00 PM
Herring Run Park
Leader: Vince Vizachero

April 29 ~ Sunday, 10:00 AM – 1:00 PM
Severn Run Natural Environmental Area
Leader: Chris Partain
This year we will explore the Severn Run Natural Environmental Area through the seasons. This botanically-rich spot, in northern Anne Arundel County, is an undeveloped park protecting the Severn Run Watershed.

May 1 ~ Tuesday, 6:00 PM – 8:00 PM
Near Enchanted Forest Area of Ellicott City
Leader: Heidi Pringle
This is a small stream valley, and a climb down overgrown riprap rocks is necessary to enter the forest. Please see details and register at mdflora.org. Limit of 25 participants.

May 6 ~ Sunday, 10:00 AM – 2:00 PM
Civil War Fort Sites in Washington: Fort Chaplin
Leaders: Mary Pat Rowan and Lou Aronica
Always a very special trip in May, we see wild flowers which appear only this month. We will also see a variety of native shrubs, which are unusual in a terrace gravel upland forest.

May 6 ~ Sunday, 9:00 AM – 12:00 PM
Uncultivated: Exploring Wild Urban Plants, location tba
Leaders: Lynn Cazabon and Chris Partain
Artist Lynn Cazabon will discuss her ongoing project, *Uncultivated*, while demonstrating how she chooses sites and photographs the plants.

May 19 ~ Sunday, 10:00 AM – 3:00 PM
Gunpowder State Park
Leader: Dwight Johnson
Explore oaks and late spring wildflowers on the Gunpowder in Hereford. We will explore downstream in the morning, return to lunch at our cars, then go upstream in the afternoon.

May 20 ~ Sunday, 10:00 AM – 1:00 PM
Piney Orchard Nature Preserve
Leaders: Beth Johnson and Chris Partain
Piney Orchard Nature Preserve in Anne Arundel County, the result of wetland restoration efforts, includes wetlands, woodlands, open grassy areas, sandy dry stream beds, and freshwater ponds. We will search for butterflies, dragonflies, damselflies, and plants.

June 3 ~ Sunday, 10:00 AM – 1:00 PM
Oaks of Sugarloaf Mountain
Leader: Melanie Choukas-Bradley
A leisurely hike to the summit of Sugarloaf Mountain. We will see several oak species. Mountain laurel and several early summer wildflowers will also be in bloom. Online registration is required.

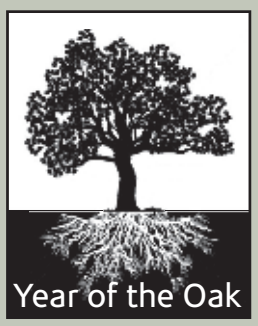
June 17 ~ Sunday, 10:00 AM – 1:00 PM
Soldiers Delight Natural Environment Area
Leader: Chris Partain
Chris Partain will lead the trip as part of the year's exploration of this special area. Serpentine barrens support a unique flora, which is adapted to low essential nutrients but high concentrations of heavy metals. Some scrubby oak species here are blackjack and post oaks.

June 23 ~ Saturday, 9:00 – 11:00 AM
Oaks Overhead, Garrett County
Leader: Liz McDowell, MNPS, and Wade Dorsey, Savage River State Forest Manager
During this leisurely walk Wade will highlight various oak species, and Liz will identify the various plants that inhabit the understory.

Become a member, join online: www.mdflora.org.

Marilandica

A Publication of the Maryland Native Plant Society



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Maryland Native Plant Society

You can also join on-line on our website www.mdflora.org

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