CONNECTICUT BOTANICAL SOCIETY
newsletter

Spring 2019 Volume 46, Number 1

# Fluorescent Lichens

**BY STEVEN MESSIER**

**LICHENS CONTAIN** over 1000 secondary compounds — chemicals not directly responsible for metabolic activities — that have a variety of ecological functions. Some thwart predation by herbivores. Others act as antioxidants, antimicrobials, antivirals, or antifungals. Some are allelopathic — inhibiting the development of competitors — while still others aid in pollution tolerance. And a large number serve to screen the photobiont (the algal component of lichen) from excess light. These molecules are the sources of lichen dyes, medicines, perfumes, and the active ingredient in litmus paper. Many are under study to battle cancer due to their anti-tumor properties. No other group of organisms is so richly supplied with secondary compounds.

One interesting feature afforded to lichens by some of these secondary compounds is the ability to fluoresce (produce light) in the presence of ultraviolet (UV) or "black" light. Fluorescence has been documented for many life forms. It is abundant in the fungal kingdom and easily observed in decaying fibers of rotting logs. Many flowers attract pollinators with fluorescent nectar guides on their petals. And marine organisms like tropical fish, jellyfish and corals often contain fluorescent proteins. Though it's rather uncommon in terrestrial vertebrates, recent discoveries uncovered fluorescence in a South American tree frog, the bony protuberances in the heads of chameleons, and puffin beaks. Even flying squirrels glow pink in ultraviolet light — who knew!

Dozens of chemicals in lichens fluoresce, providing a variety of colors visible only when illuminated by UV light (like the fluorescent pigments in DayGlo colors). *Lichens of North America* (Brodo et al. 2001) lists 32 UV-fluorescent molecules found in lichens. Undoubtedly many more exist. Lichen identification often relies upon the ability to detect these molecules, so noting the colors produced under UV light is a valuable technique. When the colors come from the outer lichen layer, the cortex, they can appear fantastically brilliant. At other times only the inner fungal medulla layer is capable of fluorescing so that this layer must be exposed by scraping away the cortex to see any response.

*Ochrolechia arborea* on red maple twigs under white light (above) and fluorescing under UV light (below).

Fluorescence in lichens occurs when light from a high-energy source, like sunshine or a UV lamp, strikes a fungal molecule capable of absorbing that energy, exciting electrons in its atoms. Molecules containing carbon rings with double bonds are often capable of this phenomenon. As the electrons de-excite they release energy of various wavelengths in the visible or infrared spectrum. Some processes produce blue light, while others emit red, orange, or yellow colors. Some lichens glow white from the combination of many colors produced all at once. However, in normal sunlight any fluorescence is masked, so the colors can only be observed when lichens are under UV light alone. Light emission continues as long as the high-energy light source remains, unlike phosphorescence, in which

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The CBS web site, created by Janet Novak, is visited by more than 1,000 people each day. The site provides an introduction to CBS and its activities, including field trips and meetings. The site also contains photo galleries, a guide to landscaping with native plants, and Newsletter articles.

We thank Janet Novak, Eleanor Saulys, Arieh Tal, and others for the excellent photos on the web site. CBS members are encouraged to submit web materials to: chris.wyse@cox.net

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# Grasses and Sedges and Rushes: Two New Guides Reviewed

**BY LAUREN BROWN**

***SEDGES AND RUSHES OF MINNESOTA.*** Text by Welby R. Smith, Photography by Richard Haug. University of Minnesota Press, 2018.

Some of us more "long-time" members of CBS might have gotten to the point where we have vowed not to buy any more botany books, as they overflow the shelves and pile up all over the house. But if that's you, and if you like the challenge of sedges and rushes, *Sedges and Rushes of Minnesota* might force you to rethink this policy. Why? First, because it includes the overlooked rushes, a family too small to warrant its own book, but one just as challenging as the sedges and the grasses. But the main reason is that this book is, overall, extraordinarily instructive. Like the ground-breaking *Sedges of Maine* (2013), it gives each species a two-page layout, with text on one side and photographs on the other. The writing is straightforward, the layout easy on the eye.

The pictures, which include whole plants, details of seeds and flowers, and habitat and growth form shots, are astoundingly clear and illuminating. Captions below each one further elucidate the descriptions on the facing page. There are also many comparative shots, for instance a whole page showing just the achenes of the different species of *Eleocharis*, laid out next to each other. That's all you need!

And even though the approach is necessarily technical, the book has many touches that can put you at ease and reduce the anxiety that some of us might feel when tackling these groups. These start with the glossary, where each term is not just tersely defined as in most manuals, but also discussed and elaborated on. (Here, the author raises a question about something that maybe you always wanted to know but were afraid to ask: what is the purpose of the ligule? It's a mystery, he says, so you still don't know, but at least you know that you aren't alone in wondering.) In distinguishing *Juncus tenuis* from a similar species, *Juncus dudleyi* (named, coincidentally, after a Connecticut boy, William Russel Dudley, who grew up in North Guilford), he explains that you need to compare the auricles, but tells you that those of *J. tenuis* are so fragile that that they often lose their distinguishing features. So if you're stymied in your identification, at least you know it's not your fault and you can wait until you find a better specimen. In the text, Smith often comes down to a relatable, conversational level, for instance, describing plants as ankle-high or knee-high. You can make the connection immediately!

Of course the book is written for Minnesota, so using the key (which I haven't tried) could be risky in that some of our CT species might not be included. Most of the species described, however, do grow in our area, making the book a potential valuable resource for confirmation of an ID. So if sedges and rushes interest you, make space on your bookshelf.

***GRASSES AND RUSHES OF MAINE.*** By Glen H. Mittelhauser, Matt Arsenault, Don Cameron, and Eric Doucette. University of Maine Press, 2019.

No sooner had I submitted the above review, than this book crossed my radar screen. The rushes are finally having their day! Three of this book's authors

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# Bringing Critically Endangered Plants Back from the Brink: A Book Review

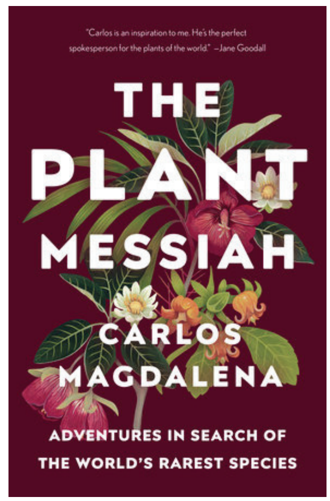
**BY DAVID YIH**

***THE PLANT MESSIAH: ADVENTURES IN SEARCH OF THE WORLD'S RAREST SPECIES***
by Carlos Magdalena. New York: Doubleday, 2017.

It may seem pretty gutsy to refer to yourself as a plant messiah, even if the title was originally bestowed upon you by a journalist. But Magdalena's enthusiasm and dedication have resulted in a number of seemingly miraculous successes in rescuing critically endangered plant species around the world. "A passion for conserving plants on the edge of extinction is infused within every molecule of my body," writes Magdalena. His credo: "Every species has a right to live without justifying its existence."

Magdalena acquired his fascination with the natural world in the verdant Asturias region of his native Spain. Jobs in Spain were hard to come by, and as a young man he emigrated to Britain. While working as a restaurant sommelier, he visited London's Kew Gardens and realized that this was where he needed to be. Competition is keen for a position at Kew, but despite his lack of professional experience, Magdalena's evident passion landed him an internship where he could develop his genius for plant propagation. From there, Magdalena's story becomes inextricably interwoven with the stories of the plants he saves from extinction.

Like many botanical gardens and arboreta around the world, Kew has long been active in conservation through cultivation - saving rare plant species from extinction through propagation and distribution. Bory's coral tree (*Chassalia boryana*), a Mauritian tree so rare it was once thought to be extinct, illustrates the crucial role cultivation plays in the preservation of some species: its seeds do not survive drying and freezing and cannot be stored in seed banks. Many other plant species no longer have extant populations in the wild and continue to exist only in cultivation. The emphasis now is on repatriating rescued species to their original wild habitats.




Returning on the train from that first visit to Kew, Magdalena had happened upon a newspaper article about café marron (*Ramosmania rodriguesi*), a species of the Mascarene Islands that was presumed extinct — until a student stumbled upon a single plant one day, in the course of a school assignment. After completing a rigorous course of training at Kew, Magdalena made it his mission to save the plant.

The Mascarene archipelago's largest islands are Réunion, Mauritius, and Rodrigues (for which *R. rodriguesi* is named). Both Mauritius and Rodrigues have been dubbed "islands of the living dead," because they are home to so many endemic species — at least thirty — that no longer reproduce in the wild. Upon the death of their last few remaining members, these species will cease to exist.

Enter the Plant Messiah. Kew propagation staff had been able to successfully root cuttings of café marron, thus producing a number of clones, but though the clones flowered profusely, none would bear fruit. How do you get the sole survivors of species whose members are self-infertile or dioecious (individuals are either male or female) to set seed? Dogged determination. By learning from his and others' failures and using creative, original approaches, Magdalena ultimately succeeded in rescuing café marron and helped restore it to Rodrigues Island. But he didn't stop there.

Subsequent challenges included the uniquely imperiled *Roussea simplex,* the only plant in the world known to depend on a single animal — the rare Mauritian blue-tailed day gecko (*Phelsuma cepediana*) — for both pollination and seed dispersal. Another oddity, *Angraecum cadetii,* is the only known plant pollinated by a cricket: the Mascarene raspy cricket (*Glomeremus orchidophilus*). Due to their reproductive reliance on a single collaborating species, such plants are especially vulnerable to extinction. As if these challenges were not enough, one of the plants Magdalena had succeeded in propagating, the rare water lily *Nymphaea thermarum*, was stolen from Kew's greenhouses, creating a media frenzy.

This engaging, breathlessly enthusiastic, and sometimes hilarious book goes on to recount Magdalena's adventures beyond the Mascarenes in Bolivia, Peru, and in Australia, where he dodges crocodiles and occasionally discovers new species or, vice versa, finds that previously separate species need to be lumped back together into one. It is filled with remarkable stories of improbable successes and provides a fascinating behind-the-scenes glimpse into the role of botanical gardens in conservation.

*David Yih is CBS president.*

## Fluorescent Lichen

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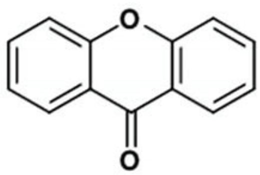
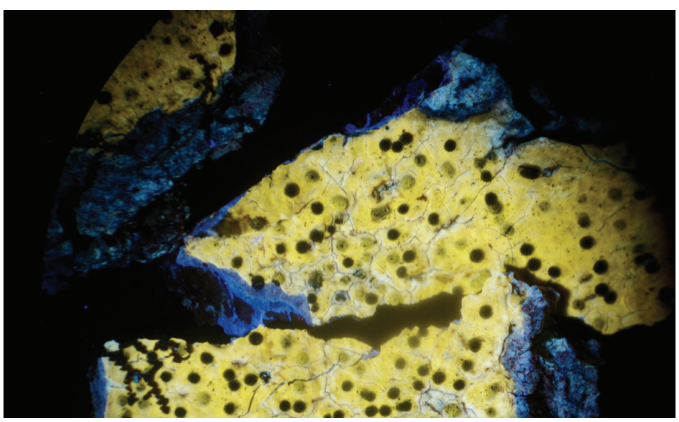
molecules continue to glow for a long time after excitation (think glow-in-the-dark frisbees).

Lichens manufacture fluorescent secondary compounds in their fungal tissues to protect the algal photosynthetic pathway from intense UV light. A common group of chemicals known to perform this function is the xanthones. Xanthone is a three-ring aromatic carbon molecule.




Xanthone

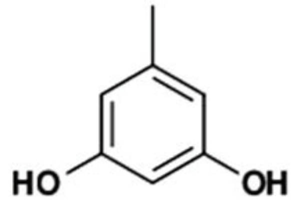
Xanthone forms the base for several yellow, orange or reddish fluorescent molecules. The most common xanthone derivative in lichens is lichexanthone, which fluoresces a bright yellow. It protects the algal cells by absorbing high intensity UV light and transforming it into harmless yellow light, which is then used for photosynthesis or emitted from the lichen. One lichen that is very common in our area, *Ochrolechia arborea,* contains lichexanthone in its thallus. This sterile crustose lichen grows on exposed twigs and branches, commonly forming thin white patches on the smooth bark of trees, especially red maple. When excited by UV light the white powdery patches suddenly glow lemon yellow.



*Pyrenula pseudobufonia* on red oak bark fluorescing under UV. The black spots are the spore-developing perithecia, which are devoid of lichexanthone.

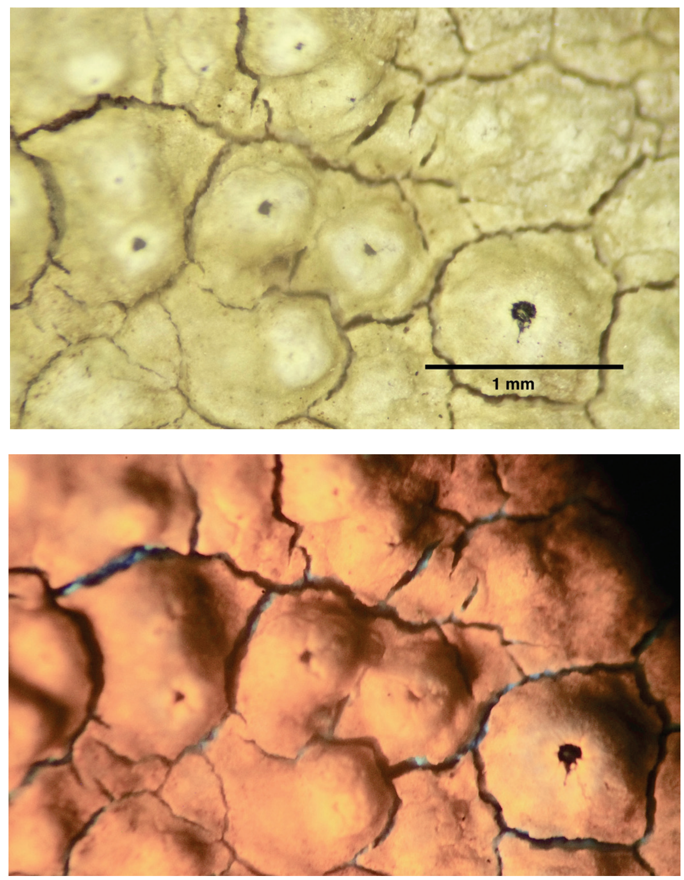
A less common crustose lichen containing lichexanthone is the eastern pox lichen (*Pyrenula pseudobufonia*), which also emits a bright yellow glow under UV. It belongs to a large group of lichens that produce perithecia — blister- or wart-like structures that produce spores. Pox lichen perithecia are not fluorescent, and therefore show up as dark spots under UV light. *Pertusaria pustulata,* one of the wart lichens common on hardwoods, contains two varieties of xanthones, in both thallus and perithecia, producing a reddish-orange fluorescent color reminiscent of some of my college DayGlo posters.

The largest group of fluorescent lichen compounds are depsides and depsidones, derived from the single aromatic ringed molecule orsinol.




Orcinol

Over half of the fluorescent molecules listed in *Lichens of North America* belong to this group. They all produce white light. Divaricatic acid, alectoronic acid, perlatolic acid, squamatic acid, and grayanic acid belong to this family of fluorescent compounds. They can be found in a wide variety of lichen genera, but are especially common in the *Cladonia* genus. *Cladonia* is a large group of fruticose lichens comprising several dozen species in our area. At least ten percent contain fluorescent chemicals, mostly orsinol derivatives.




*Pertusaria pustulata* in white light (top) and reddish orange under UV (bottom). Spores escape through ostia, small openings at the summits of the perithecia.

The very scaly dragon funnel lichen (*Cladonia squamosa*) is a common fruticose lichen found on soil and logs in shady forests. It contains squamatic acid in its cortex. When illuminated with a UV lamp this lichen presents a blue-white color.

All the lichens previously discussed produce bright colors due to fluorescent molecules in their cortex. *Usnea subfloridana* is one of the fruticose "old man's beard" lichens

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## Fluorescent Lichen

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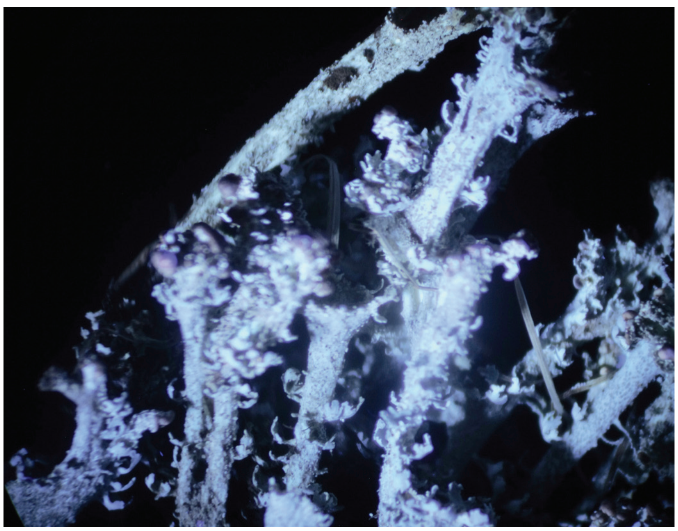


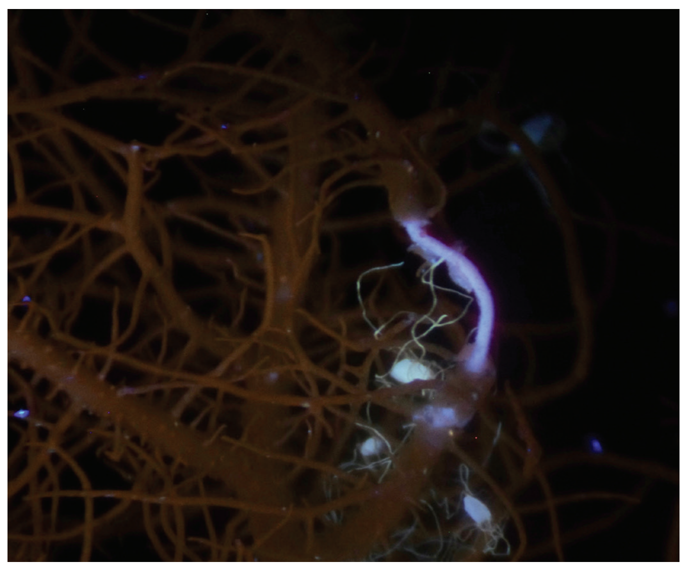
*Cladonia squamosa* fruiting structures (podecia) in white and UV light

that can be found in our area, sometimes forming tufts on branches or snags in open habitats like marshes. It also has squamatic acid— but only in its medulla and central cord. (All *Usnea* species have an elastic cord that extends throughout their thallus). The white light from the cord contrasts starkly from its dark cortex under UV light.

In its cortex, *Usnea* contains usnic acid, a compound found only in lichens. While not fluorescent, it strongly absorbs ultraviolet light. Usnic acid, in concert with other molecules like melanin can screen over 90 percent of the UV-A (long wave) and UV-B (short wave) rays. These molecules protect many arctic and alpine lichens, especially during periods of dehydration, when the underlying algal cells are most vulnerable to high-energy light radiation. They are presently being studied for potential use as a skin protectant against UV-B. Usnic acid is also the active ingredient in many herbal tinctures and decoctions used for antibacterial and antifungal remedies.

Given the prevalence of fluorescent compounds in lichens, ultraviolet lamps have become very helpful identification tools for lichens. Two *Tuckermanopsis* species provide an example. The wrinkle lichens *Tuckermanopsis americana* and *T. ciliaris* are common in forests atop evergreen branches. While they are nearly identical morphologically, the former has alectoronic acid in its medulla. Observing these lichens under a UV lamp is one way to easily separate them. *T. americana* fluoresces blue-white wherever tiny cracks in the cortex expose the inner tissues of the medulla, whereas *T. ciliaris* demonstrates no evidence of any light emission.

I often use a long wave (395 nm) UV-A light to help



*Usnea subfloridana* thallus with exposed central cord in white light and glowing under UV. Three small bright spots in the UV photo are seeds of the wooly sedge, *Scirpus cyperinus* caught in the lichen thallus, and camouflaged in daylight. The long, curly bristles that extend from the base of the seeds can also be seen.

key out lichens and always look forward to seeing what color they will produce in the dark. I recently purchased a portable 365 nm UV-A flashlight-like lamp that will let

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## Two New Guides

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were also contributors to *Sedges of Maine*, a 2013 publication that set a new bar for plant identification manuals. As in that book, each species is given two facing pages. The first is a detailed yet easily readable (big font, lots of white space) description of the plant's characteristics. The other contains several outstanding photographs that show the inflorescences, highly magnified close-up details, and sometimes habit or habitat. The text starts with the salient characteristics and also alerts you to similar species, explaining the differences.


An especially interesting feature of the book is its identification key, which is quite non-traditional. For the grasses, every manual I've ever seen starts by dividing the family into groups known as tribes. Though these divisions can be enormously helpful in the long run, the tribes are separated in some cases by obscure differences in the flower parts and this first "cut" can be a stumbling block. This book starts with a really simple character — whether the flower heads are open or closed — and sticks to easily understandable characters as long as it can. Furthermore, each line in the key is accompanied by a photograph, so that you're not left scratching your head trying to understand the meaning of the terms. Ultimately, the book is technical — you'll need to understand the names for the specialized flower parts in these two families sooner or later — but this book represents a huge contribution to our attempts to know these challenging plants.

*Lauren Brown is CBS vice-president. With Ted Elliman, co-author of* Wildflowers of New England, *she is preparing a new edition of her 1979 book,* Grasses: an Identification Guide, *scheduled for a 2020 publication by the Yale University Press.*



## Fluorescent Lichen

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me observe lichens outside during the night. The slightly shorter wavelength provides more energy to cause a brighter fluorescent response. While not to be looked at directly, it is still safer than UV-B light, and quite a bit less expensive than short wave UV lamps. Supposedly effective to a distance of 10 meters, the lamp should work well in a nearby black spruce bog. It may also locate some lichens I might have overlooked during the daylight hours, and probably many more objects than just lichens. Discovering new ways to enjoy nature is always exciting, and it is hard not to "ooh and aah" seeing the brilliant DayGlo colors lichens produce under UV light.

*Steve Messier is a retired botany and physics teacher who has been a member of the Connecticut Botanical Society for forty years. He has led numerous field trips for the Society and was the collection manager and curator of the CBS Herbarium from 1995 to 2006. He is a New England Plant Conservation Program volunteer and is presently interested in the lichen population of Connecticut. Steve is an avid hiker and loves spending his days in the woods botanizing.*

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# NEWS AND NOTES

## A New Plant Ecologist at Connecticut's Department of Energy and Environmental Protection (DEEP)

When Nelson DeBarros left Connecticut in 2017, we were saddened not only because we had enjoyed working with him, but because there was a concern as to whether or when his position would be refilled. We are pleased to say that a new Plant Ecologist/State Botanist started at DEEP in January. His name is Matthew Shannon and he comes to us from Massachusetts, where he served as the State Forester from 2009 to 2016 and then was Program Supervisor for a reforestation program in Pittsfield, MA. He has a Bachelor's degree in Natural Resource Management from Green Mountain College in Poultney, VT and a Master's degree in Environmental Policy and Management from American Public University in Charles Town, WV. Matthew's duties will focus primarily on Natural Diversity Database reviews, but he will also participate in state plant surveys on public lands and probably take on other duties as time goes on. Matthew can be reached at Matthew.Shannon@ct.gov. We welcome him and look forward to working with him to protect Connecticut's imperiled plant species.

## Governor's Proclamation Honors Edward Richardson

Ed Richardson, longtime CBS member and mainstay of the Notable Trees Committee, was honored at a gathering organized by the Connecticut Forest & Parks Association. CFPA Executive Director Eric Hammerling presented Ed with a proclamation from Governor Dan Malloy in recognition of his indefatigable volunteer efforts documenting the state's notable trees, leading tree walks, and furthering the understanding and appreciation of trees. CFPA also presented Ed with a fine hand-carved walking stick to mark the occasion. Ed was in fine fettle and reminisced about getting involved in the 1980s, when Glenn Dreyer began organizing the effort to document the trees.



Juniper Bough (*Juniperus virginiana*). Watercolor, walnut ink and colored pencil. Original artwork by Connecticut artist Nina Petrochko.

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## 2019 Summer Seminars at Eagle Hill Institute

The Eagle Hill Institute in Maine is once again offering a long list of week-long seminars in a variety of natural history topics. To see the complete calendar of 2019 Summer Seminars, visit: https://www.eaglehill.us/

## Joint Field Meeting of the Botanical Society of America, Northeastern Section, August 11-15, 2019

Each year the Botanical Society of America, the Torrey Botanical Society, and the Philadelphia Botanical Club sponsor a field meeting in an area of the northeastern United States. The 2019 meeting will explore Adams County, Ohio and will be housed at Shawnee Lodge & Conference Center. Adams County is located in the beautiful rolling hills of Southern Ohio. It is bounded on the southern side by the Ohio River. Adams County is noted for its fertile farmland, forests, wildlife, prairies and limestone deposits. For details, see: https://cms.botany.org/