

Conserving Threatened Orchids: The Flower- Fungus Connection

Melissa McCormick

Smithsonian Environmental Research Center

Edgewater, Maryland



Smithsonian

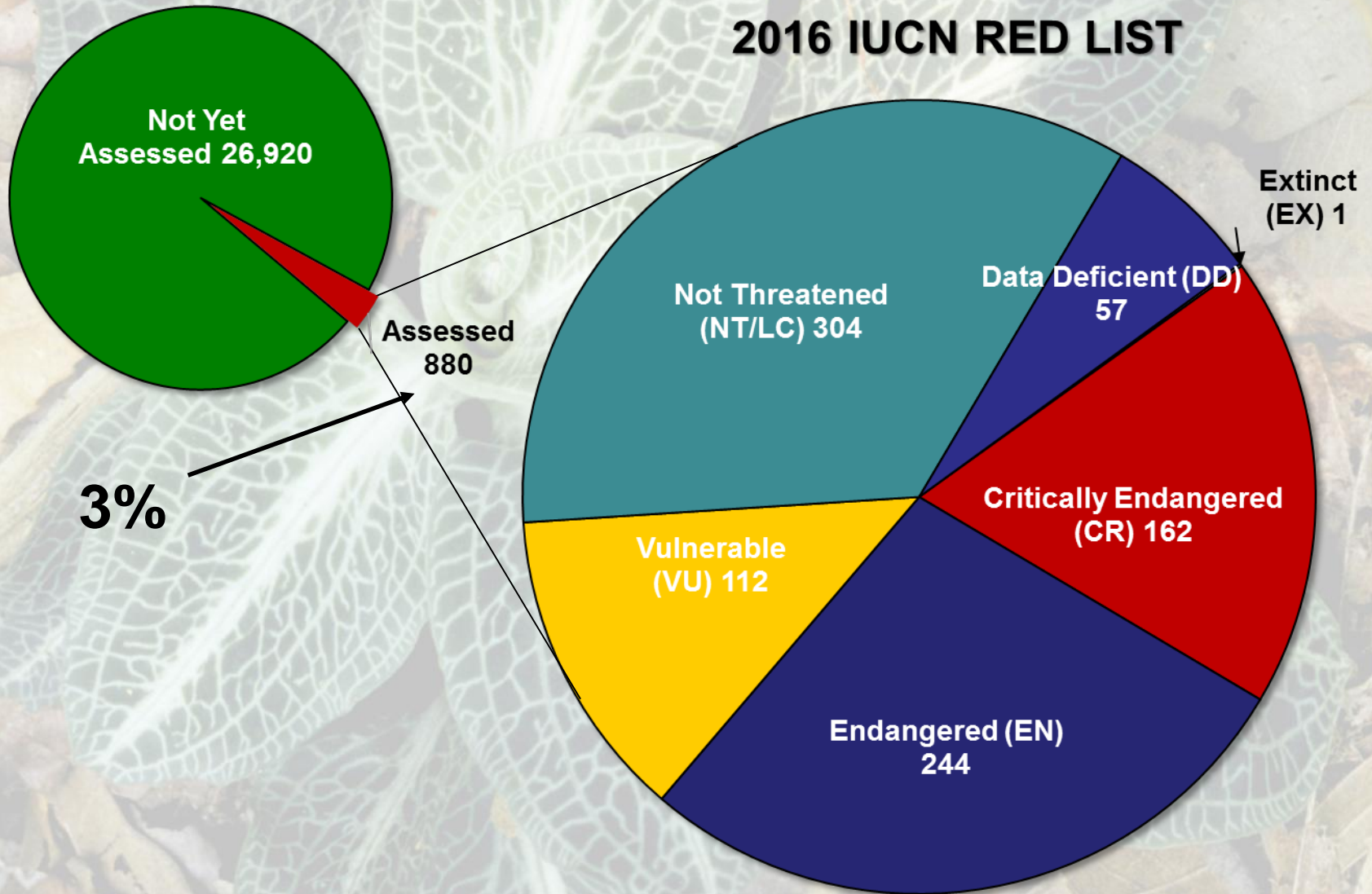
Orchids

- ~ 30,000 species (10% of all flowering plants)
- Occur on all continents except Antarctica
- Over 50 species in MD
- Widely threatened and endangered
- Complex life histories
- 'Canary in the coal mine' of the plant world



ORCHID SPECIES OF THE WORLD

2016 IUCN RED LIST





About 220 species of native orchids in the US and Canada

Cypripedium parviflorum

Spiranthes cernua

Platanthera

Goodyera

Hexalectris grandiflora

57% are threatened or endangered in some part of their range of distribution

Some of our most attractive native orchids have been declining rapidly (Knapp paper)



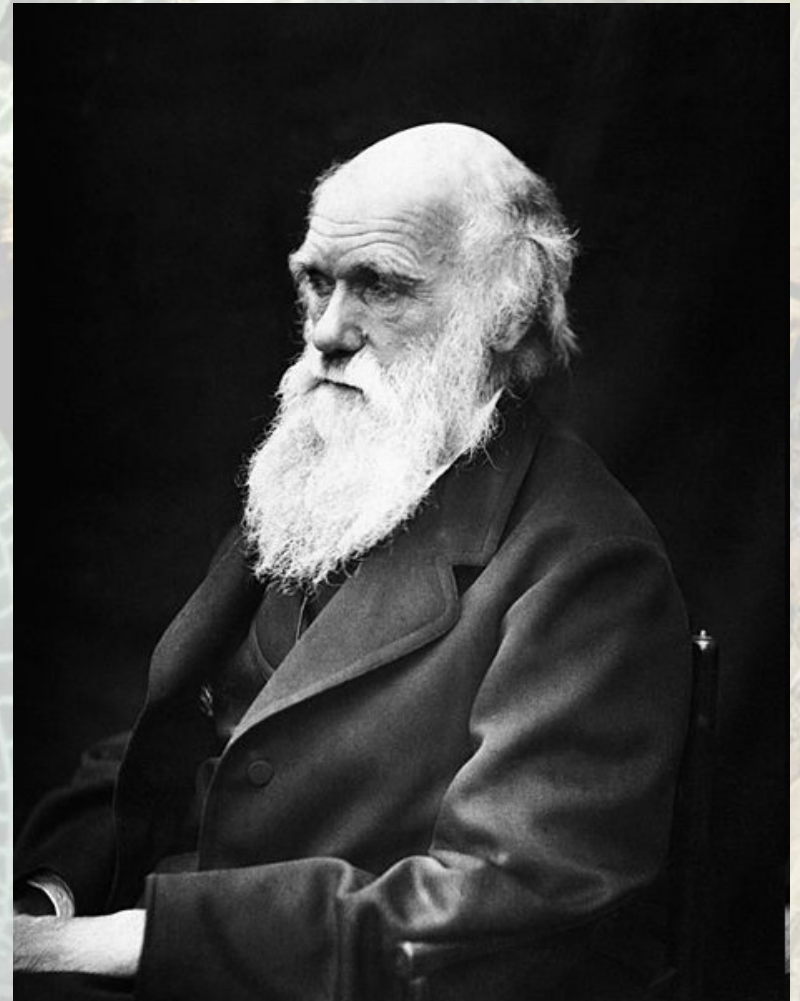
...and it hasn't been clear what we could do to help them.

Orchid conservation has been pretty much just setting aside land.



Charles Darwin

- ❖ was fascinated by orchids' elaborate pollination and by why plants that produce so many seeds are so often rare.
- ❖ calculated that if all seeds grew into plants then the great grandchildren of a single orchid would “cover the earth in one continuous green carpet”.



What is it about orchids?

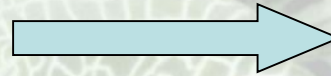
- Why are orchids so difficult to grow and preserve?
- What does orchid research tell us?
- What will it take to apply this research to native orchids in North America?
- Where does the **North American Orchid Conservation Center** fit in?



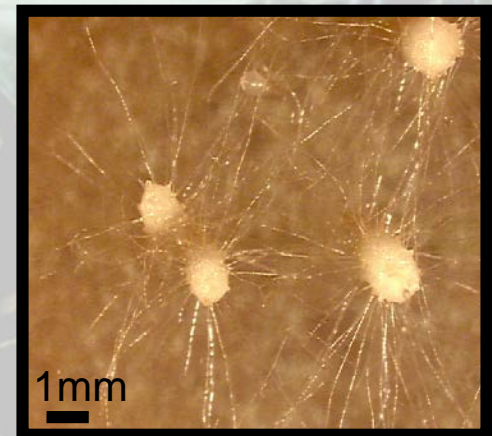
Orchid reproduction depends on other species



Pollinators



Fungi



Fungi



Pollinators



King-in-His Carriage Orchid

Drakaea glyptodon

What do fungi do for plants?

A mycorrhiza is a symbiotic association between a plant root and a fungus

- ❖ Most plants in most ecosystems
- ❖ All plant families
- ❖ Essential for access to nutrients and water
- ❖ Protect against pathogens



Read 1997



Orchids take mycorrhizae to an extreme

- ❖ Orchids cheat their mycorrhizal fungi.
- ❖ Orchids eat their fungi.
- ❖ Orchids are entirely dependent on fungi for all their nutrition at least early in life.
- ❖ This early life stage may last only a few months or many years.

Orchid mycorrhizal fungi:



❖ Ecologically diverse

Ectomycorrhizae,
Mycoparasites,
Pathogens,
Decomposers



Tulasnella violacea

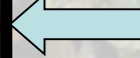
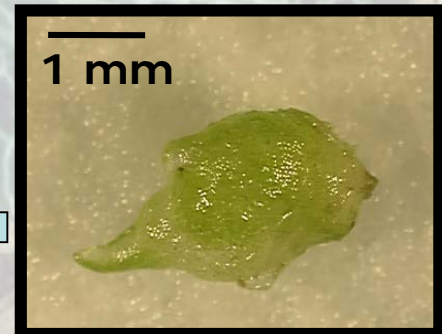
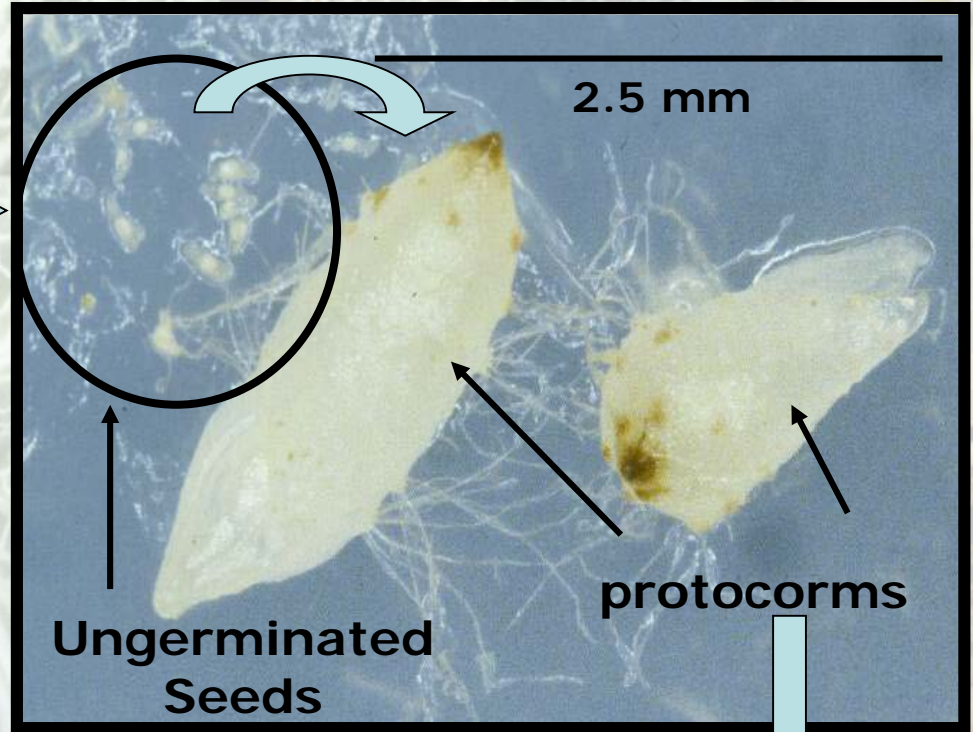
- ❖ Widespread and common
- ❖ Poorly-studied
- ❖ Morphologically indistinguishable



Tulasnella violea

Images from J. Breitenbach "Fungi of Switzerland" 1986

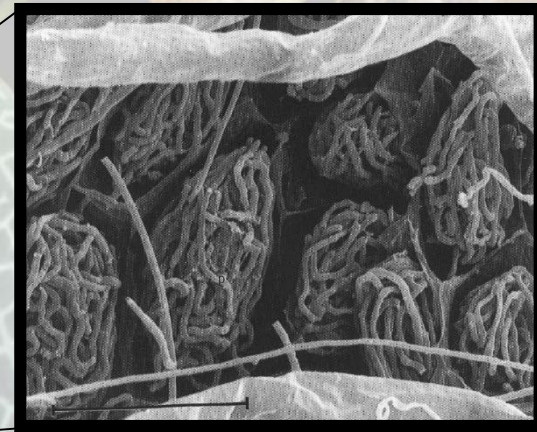
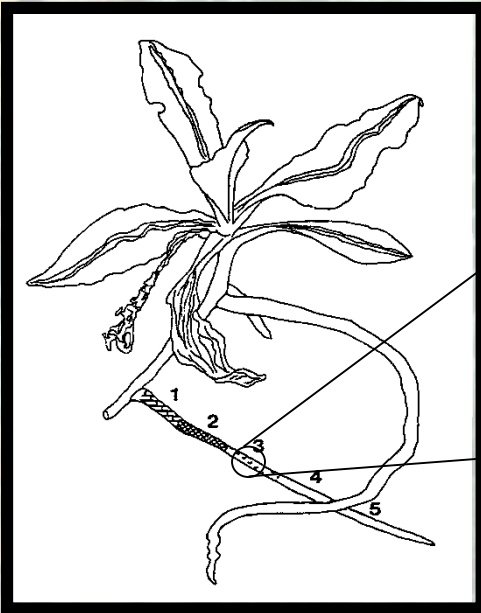
Orchid seeds and fungi:



- ❖ Seeds have no nutrients.
- ❖ Germination requires specific fungi.
- ❖ Fungi provide all nutrients, including carbon.

Adult orchids and fungi:

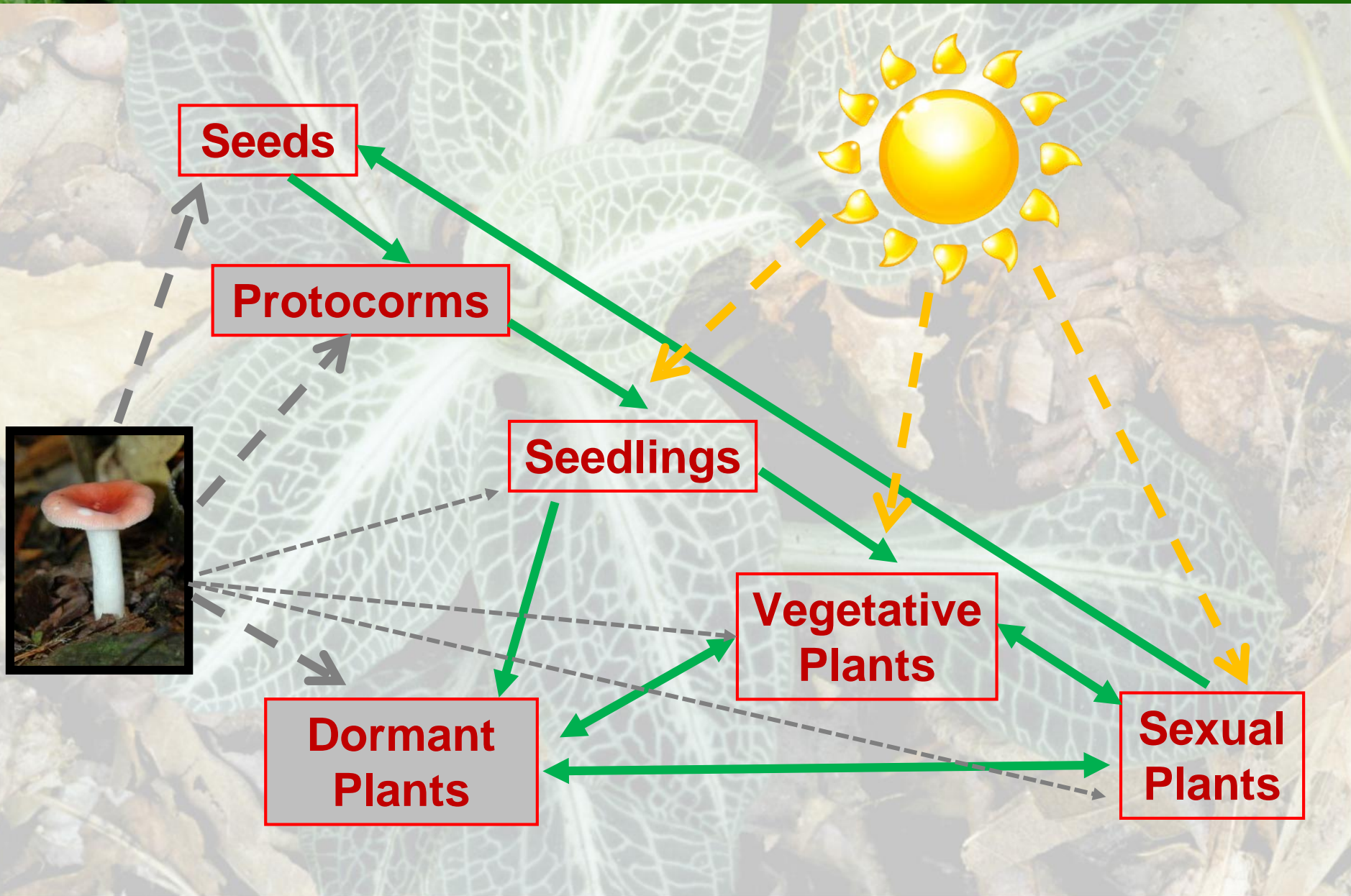
- ❖ Fungi form pelotons in root cells.
- ❖ Most orchids continue to get nutrients from fungi as adults.
- ❖ Fungi help orchids tolerate stress.



Pelotons (fungal coils) in an orchid root (Beyrle et al. 1995).

Adult *Goodyera* showing below-ground parts.
(Zelmer 1994)

Orchid life history



How do fungi affect orchid performance?



Isotria medeoloides

Where are these fungi and when do they support orchids?

- ❖ There are LOTS of fungi in the soil!
- ❖ Up to 150 species in 0.5g of soil.
- ❖ Extract DNA from soil
- ❖ 2 samples 15cm apart may share only 25% of their species.
- ❖ We design specific probes to look only at the DNA from the fungi we are interested in and tell us how much is there.



Soil core



Fungal
DNA

When do fungi support seed germination?



Seed packets tell us when conditions are right for orchids

A test with three orchids:

Liparis liliifolia
mauve twayblade



Tipularia discolor
crane fly orchid



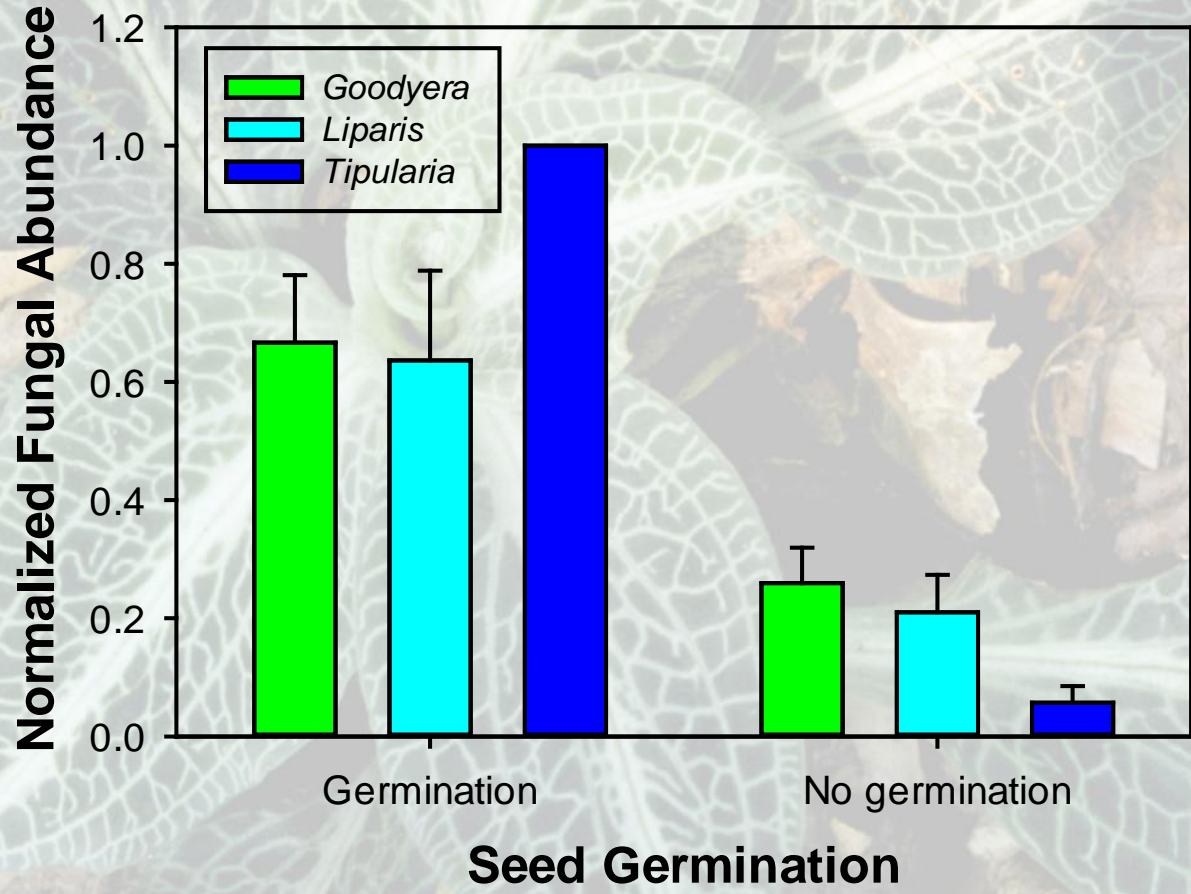
Goodyera pubescens
rattlesnake plantain



Different orchids need different fungi



More fungus more germination



Isotria fungi are all ectomycorrhizal



All *Lactarius* and *Russula* are considered obligately ectomycorrhizal (ECM)

ECM hosts we have identified are:

Fagus grandifolia

Quercus falcata

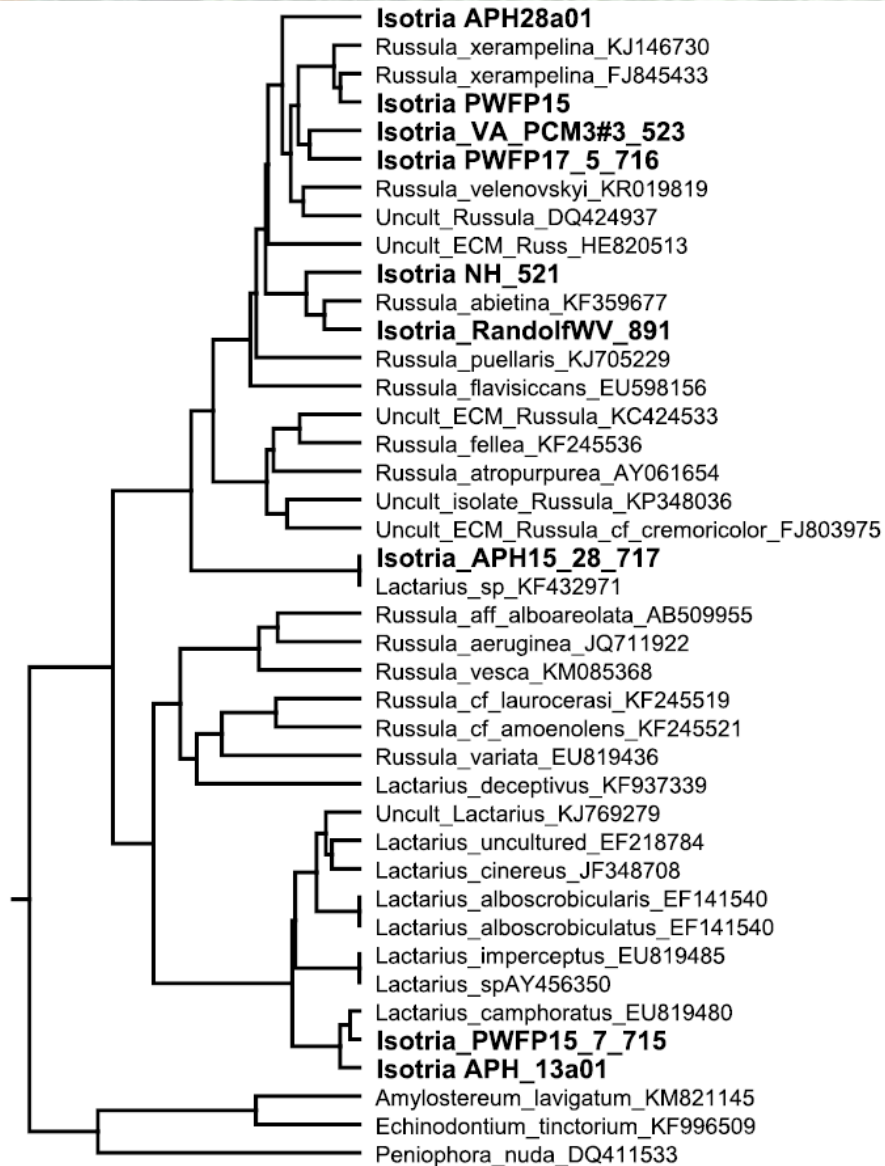
Quercus alba

Carya cordiformis

Carya ovata

Betula alleghaniensis

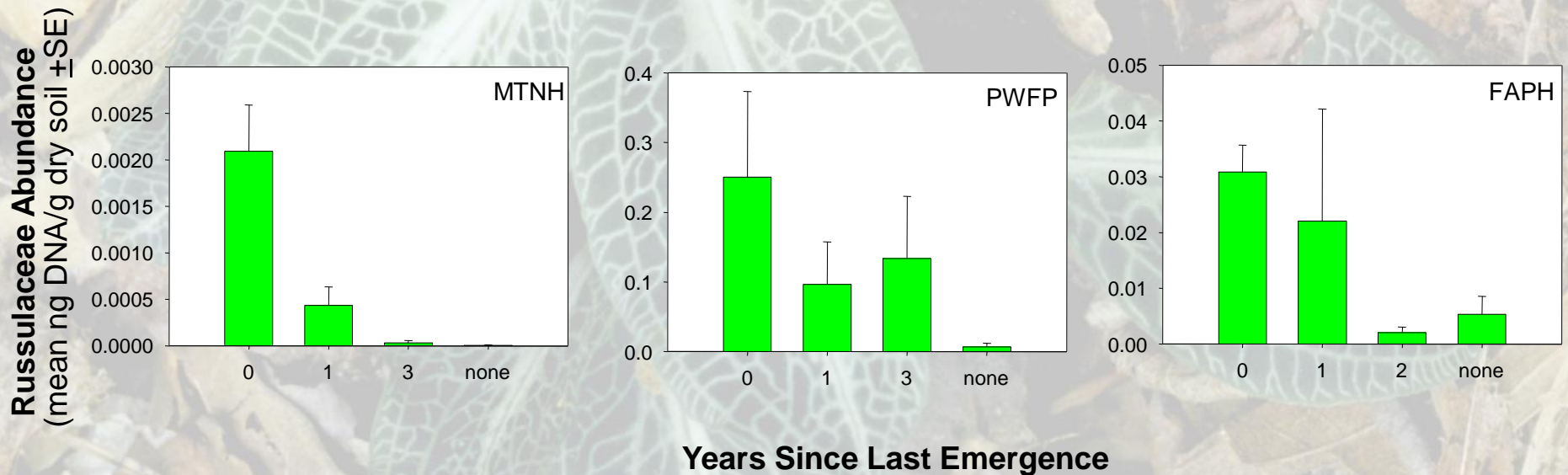
Mycorrhizal fungi



Russula xerampelina

Mycorrhizal fungus abundance

More fungus means plants are more likely to emerge and less likely to become dormant.





Field Conclusions

Some orchids need specific fungi, while others can use many different ones.

More abundant fungi are better able to support orchid seed germination and emergence from dormancy.

Maybe improving conditions for the fungi would also improve conditions for orchids.

What can we do to make fungi more abundant?

Tipularia discolor



Liparis liliifolia



Goodyera pubescens



- ❖ Seed packets of 3 species.
- ❖ With and without appropriate fungi for germination added.



What makes these fungi abundant?

6 forest sites: 3 old (150+ years), 3 young (50-70 years)

36 subplots in each: 1/3 got chipped wood, 1/3 crushed leaves, 1/3 control



wood

leaves

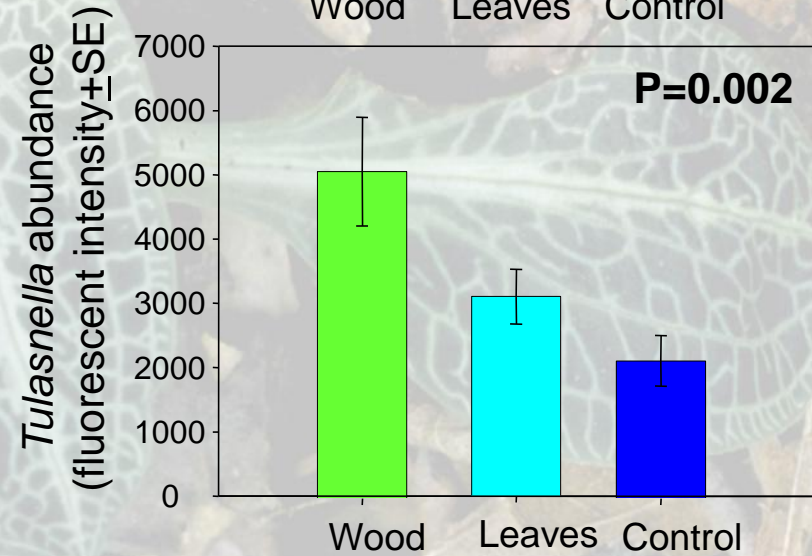
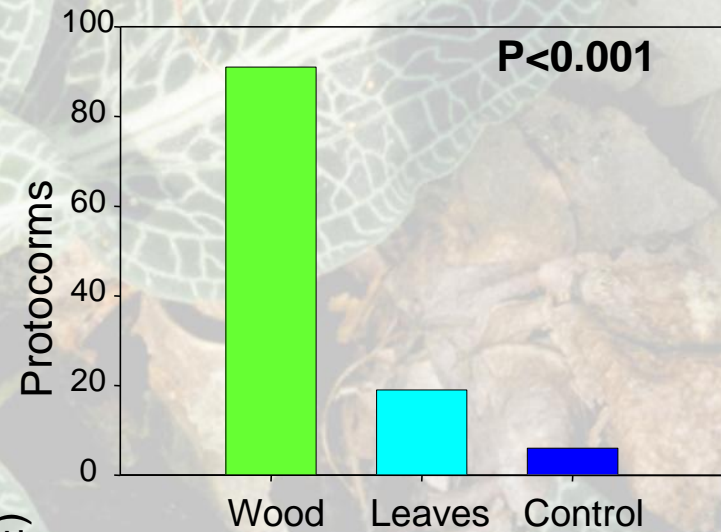
control

Goodyera pubescens
Rattlesnake plantain



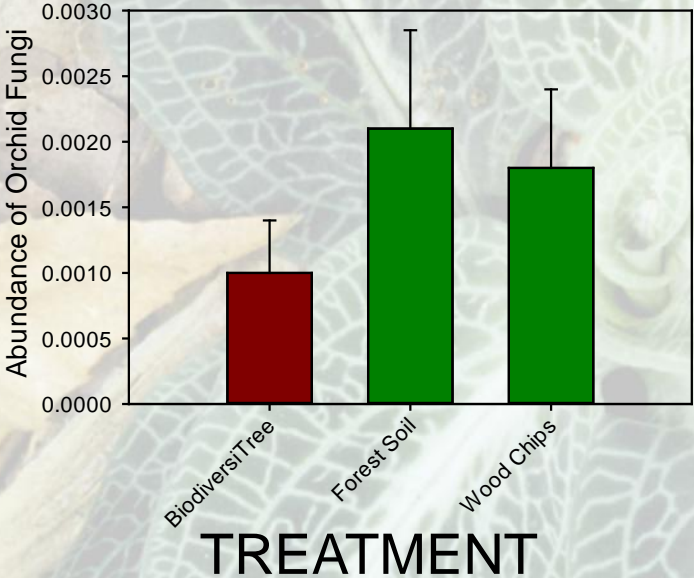


Did amendments affect host fungi and protocorm development?



Amendment treatment

Applications

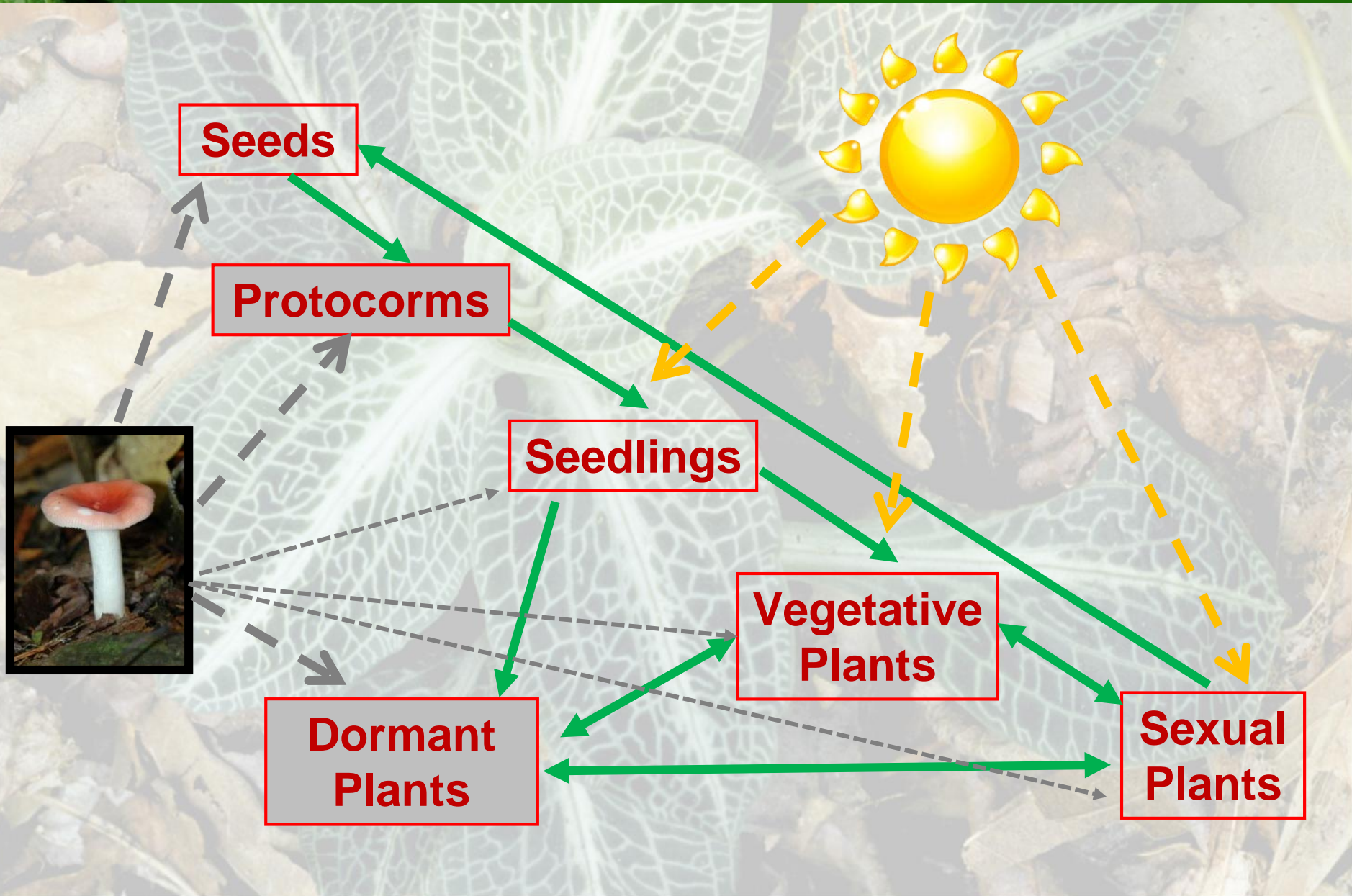




Orchids and host fungi

- ❖ All three orchids were limited by the abundance of the fungi they needed, but the fungi were all limited by different things.
- ❖ Adding wood and leaves increased host fungus abundance and germination for *Goodyera*.
- ❖ Adding wood inoculated with orchid fungi or adding forest soil that had the fungi helped to increase those fungi in new soils, but only somewhat.

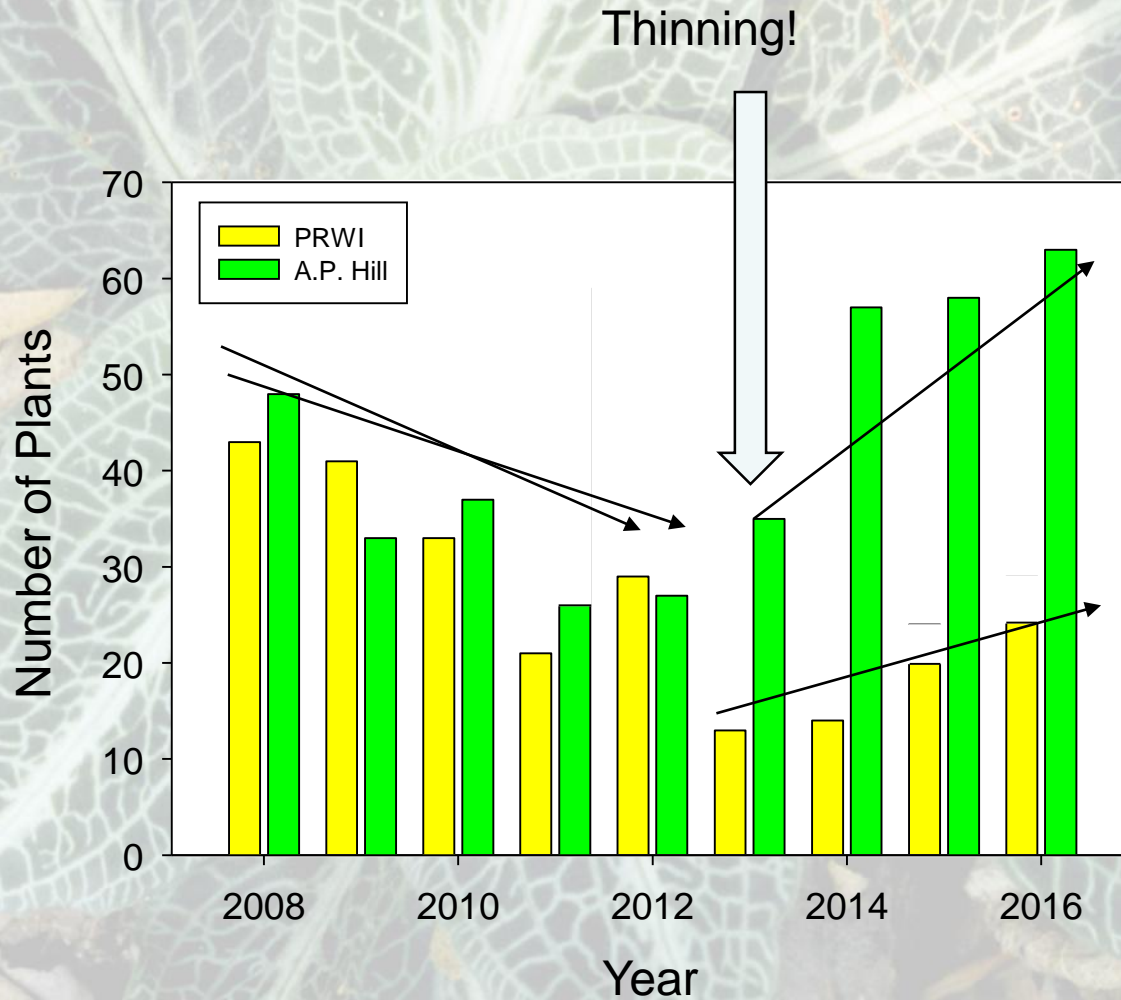
Orchid life history



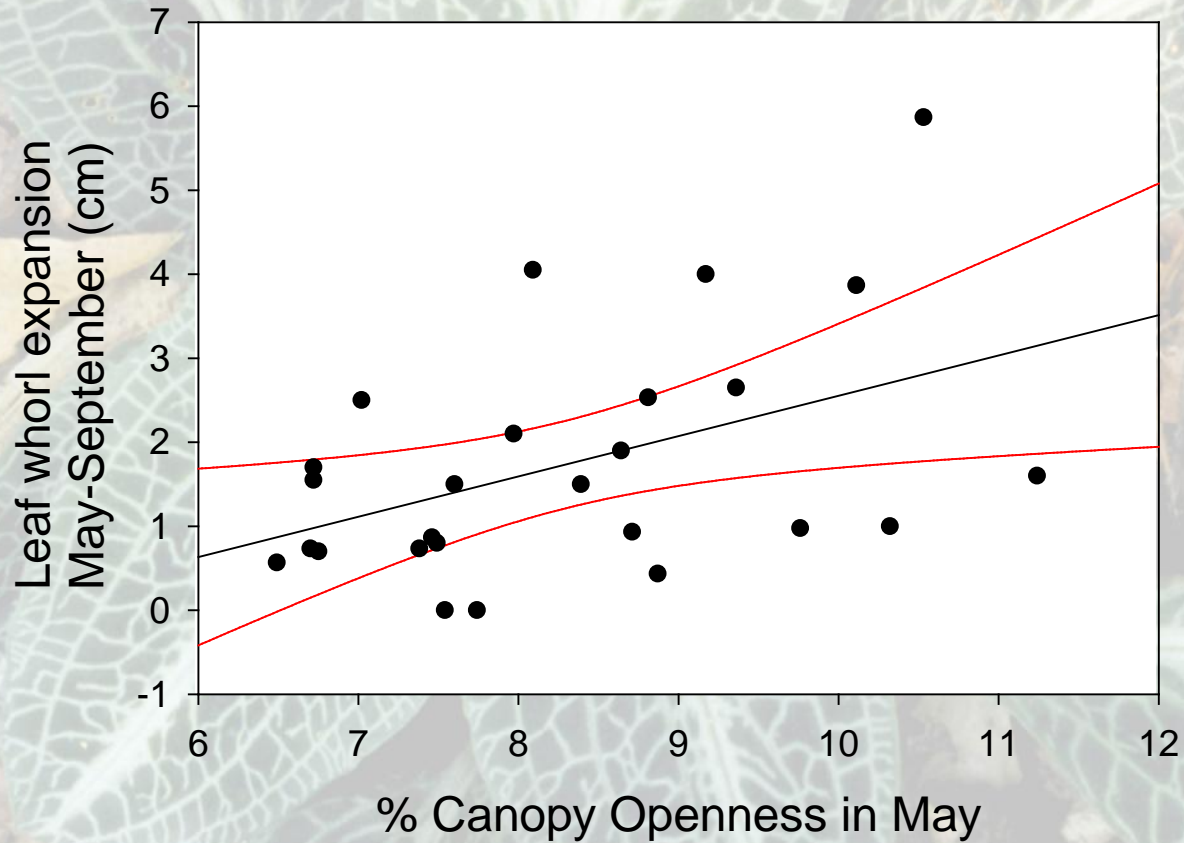
Canopy Thinning Experiment – Increase light



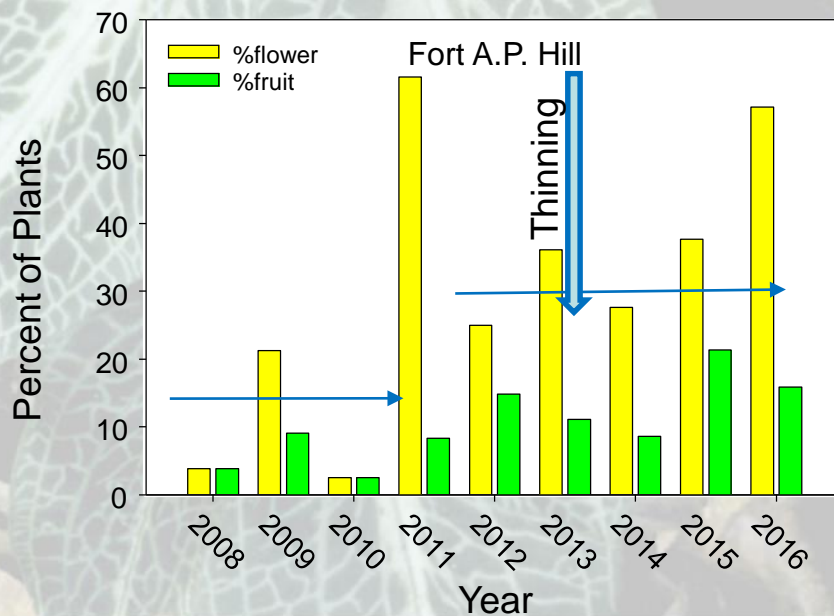
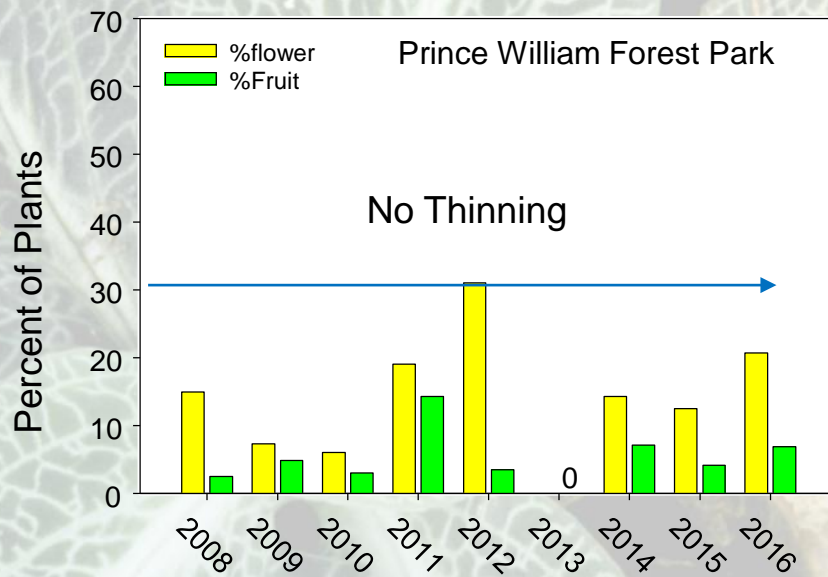
Thinning increased emergent plants



Individual plants also grew bigger



Flowering and Fruiting increased





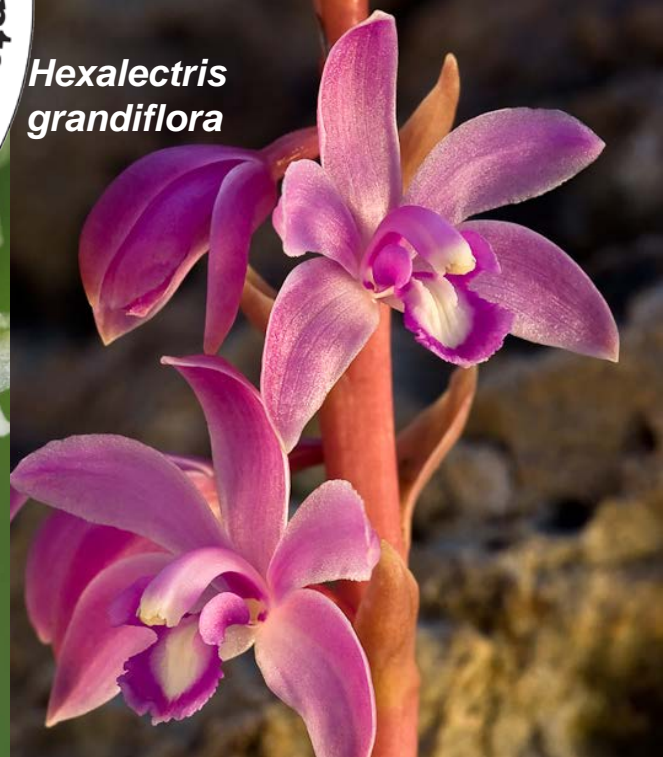
Cypripedium parviflorum



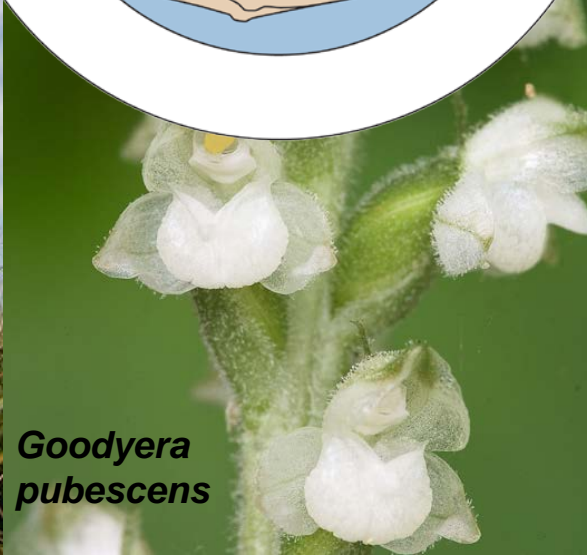
Spiranthes cernua



Platanthera praeclara



Hexalectris grandiflora



Goodyera pubescens



Our mission:

Conserve our native orchid heritage



Goodyera pubescens





Gary Van Velsir

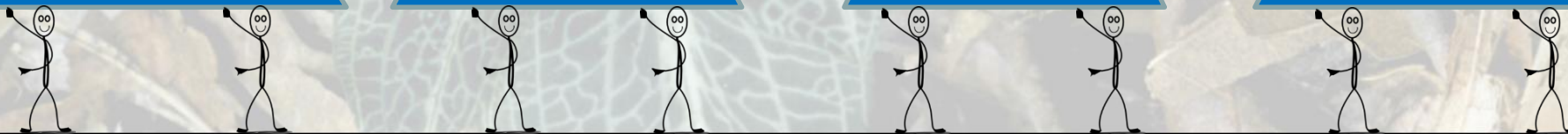
NAOCC Model

Propagation

**Fungal
Banks**

**Seed
Banks**

Education





Alaska Botanical Garden



ILLINOIS COLLEGE
FOUNDED 1829



CHICAGO BOTANIC GARDEN

Smithsonian
U.S. Botanic Garden



NEW ENGLAND
WILD FLOWER SOCIETY



Duke Farms
Living Habitats



DESERT BOTANICAL garden



ATLANTA BOTANICAL GARDEN



MT. CUBA CENTER INC.



Native Orchid Conference, Inc.
Founded 2002

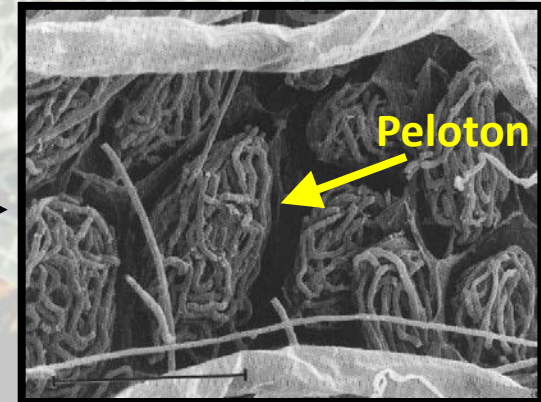
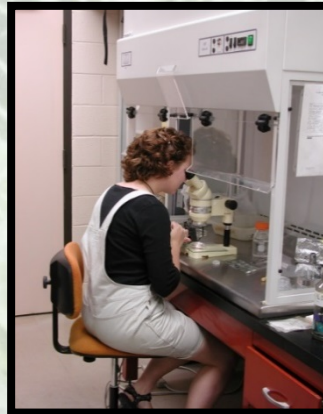
Longwood Gardens
Pollinator Partnership
UC Berkley
Virginia Native Plant Society
Minnesota Landscape Arboretum
Ridges Sanctuary

Orchid Conservation Coalition
Seeds for Success
UC Santa Cruz
Wabash College
NatureServe
University of Wisconsin-Green Bay

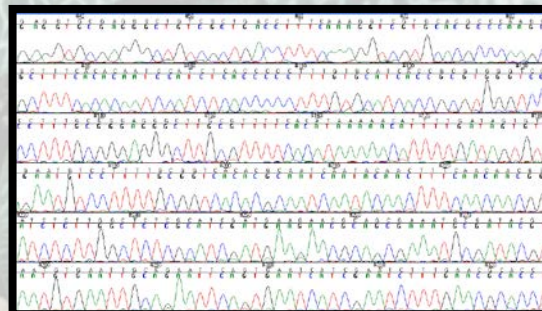
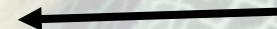
Old Dominion University
University of Florida
US Forest Service
Wintergreen Nature Foundation
Grand Traverse Regional Land Conservancy
Naples Orchid Society

Fungus banks

Conserving the diversity of fungi that orchids need



Beyrle et al. 1995



→ Cryopreservation

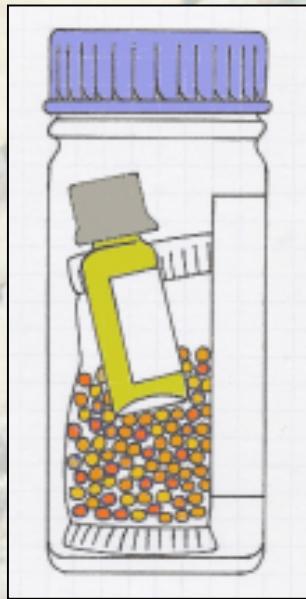
DNA
Extraction

Seed banks

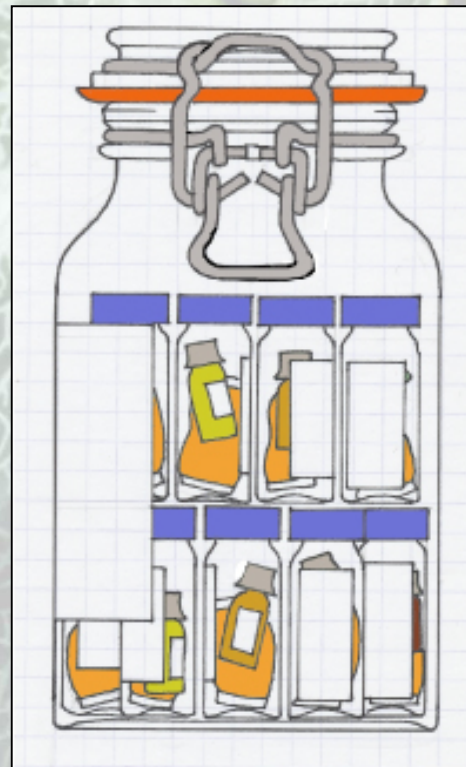
Conserving orchid genetic diversity

Regionally

- Storage in individual laboratories
- Storage in regional facilities

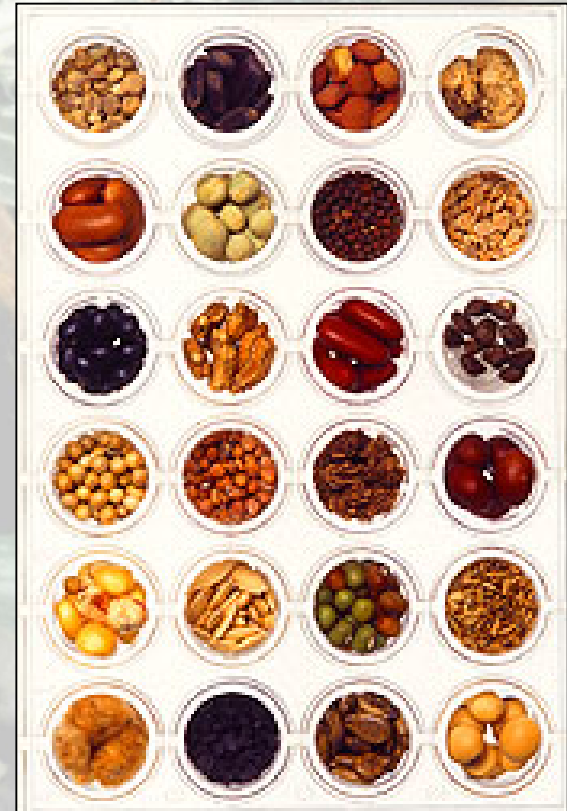


(Source: Phil Seaton)



Nationally

USDA - Agricultural Research Service
National Seed Storage Laboratory
in Fort Collins, Colorado



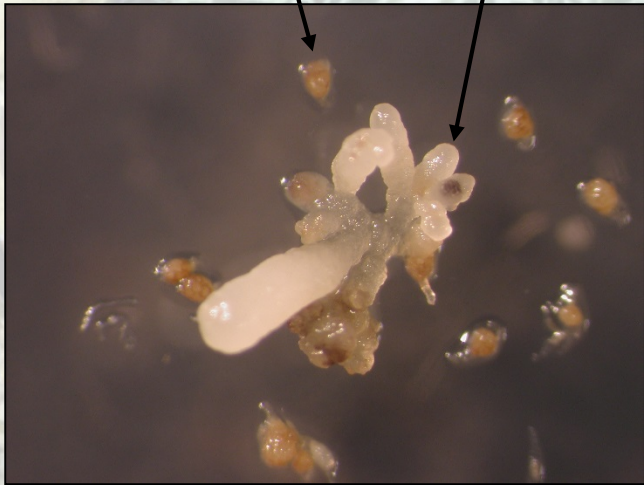
(Source: USDA Image Gallery)

Propagation to establish sustainable populations

Seeds and Protocorms

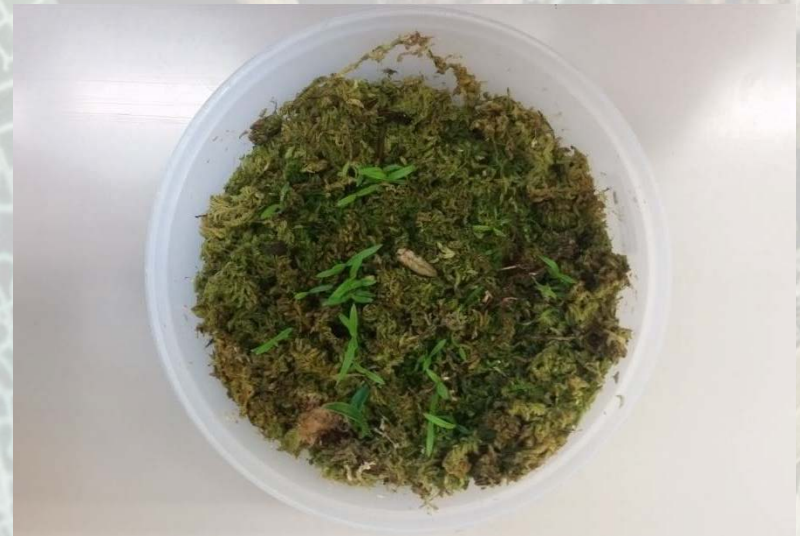


Liparis liliifolia



Corallorhiza odontorhiza

Seedlings



Education: increasing botanical literacy and engaging citizen scientists in hands-on conservation

[Home](#)[About](#)[Simple Key](#)[Glossary](#)[DONATE](#)

Go Orchids

Go Orchids is a tool to explore orchids native to the U.S. and Canada. *Go Orchids* will initially focus on orchids in New England and the mid-Atlantic. Orchids of the southeast and Alaska will be added this year and all remaining orchids in two years.

- > [Learn more about NAOCC.](#)
- > [Learn more about the Orchid Family.](#)

To explore *Go Orchids*, select one of the methods listed below. Happy orchid hunting!



Find an Orchid by Location

Find an orchid by entering your geographic location.

Find an Orchid by Name


Find an orchid by entering the scientific or common name.

Simple Key

Enter the key to narrow your orchid search by answering simple questions.

Go Orchids website

goorchids.northamericanorchidcenter.org



Home About Simple Key Glossary

Search...

Orchids

10 matching results

Show photos of:

Filter results

Habitat?

Location? Maryland

Leaf arrangement? alternate
there is one leaf per node
along the stem

Number of leaves on stem?

Form of lower petal? the
labellum does not have a
pouch-like shape

Lower petal outline? the
labellum is fringed (it may or
may not be lobed)

Add a few more questions for
narrowing your matching
species.

Already know the genus?

Genus:

Start Over:



Platanthera blephariglossis
White Fringed Bog Orchid



Platanthera ciliaris
Orange Fringed Bog Orchid



Platanthera cristata
Crested Orange Bog Orchid



Platanthera grandiflora
Greater Purple Fringed Bog Orchid



Platanthera integra
Yellow Fringeless Orchid



Platanthera lacera
Green Fringed Bog Orchid



Platanthera nivea
Snowy Orchid



Platanthera peramoena
Purple Fringeless Orchid



Platanthera psychodes
Lesser Purple Fringed Bog Orchid



Pogonia ophioglossoides
Rose Pogonia



Home About Simple Key Glossary

Search...

Cypripedium acaule Ait.

Pink Lady's Slipper



Facts About

Accepted Synonyms: *Phlogis tenax*, *Calceolaria heterodoxa*, *Cypripedium acule*, commonly called Pink Lady's Slipper. It typically grows on acidic soils, and is protected by North Carolina. Contact with the floral bract, and occasionally other parts of the plant, is known to cause skin irritation in some people.

Ecosystem Type

Anthropogenic (open roads or disturbed habitats), bog, forest edge, forest, savanna, meadow.

Characteristics

HABITAT: Terrestrial Aquatic

LEAF ARRANGEMENT: The leaves are growing only at the base of the plant. Basal

NUMBER OF LEAVES ON STEM:

FORM OF LOWER PETAL: The labellum has a pouch-like shape. Pouch-like Fringed

LOWER PETAL OUTLINE: The labellum is simple in form. Simple Fringed

BASE COLOR OF LOWER PETAL: Green Red Yellow

NETTLE SPUR: There are no nettles spurs on the flower. No Yes

INFLORESCENCE TYPE: The inflorescence has only one flower or a pair of flowers on it. Single Paired

LOWER PETAL CHARACTERISTICS: The labellum is on the edge of a pouch. Edge Center

LOWER PETAL LENGTH:

SEPAL LENGTH:

Native to North America

Yes

North American Conservation Status & Distribution

Conservation Status

Select a location to see conservation status:

Conservation and Endemic Status	Region
Endemic Range	None
US Status	N/A
Canadian Range	N/A

World America Distribution

Adapted from USDA data



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North American Orchid Conservation Center
c/o Smithsonian Environmental Research Center
P.O. Box 28, 647 Contees Wharf Rd.
Edgewater, MD 20137
Contact: naocc@si.edu

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Go Orchids and NAOCC are supported, in part, by the Smithsonian Institution and the United States Botanic Garden

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orchid-gami
NATIVE TO THE U.S. AND CANADA



Photos: Maarten Janssens and Jay O'Neill

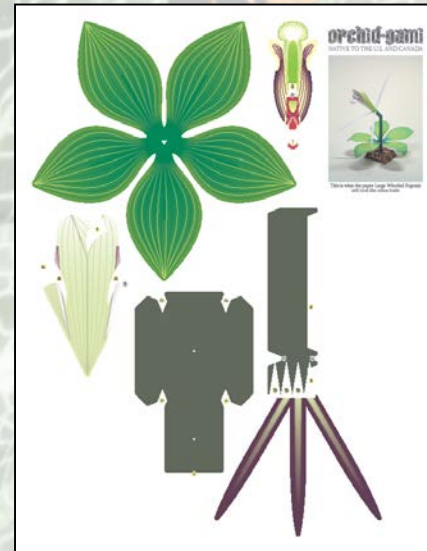
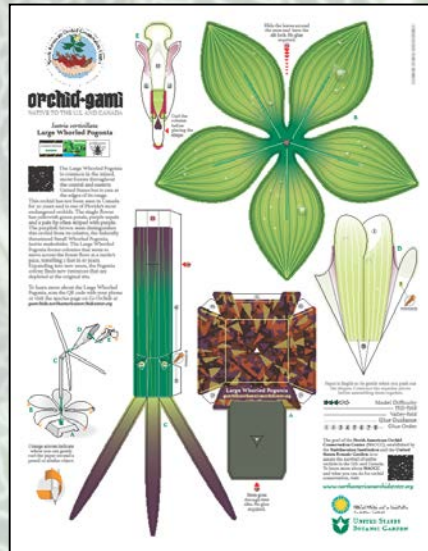


Photo: University of Wisconsin-Madison



Photo: University of Wisconsin-Madison

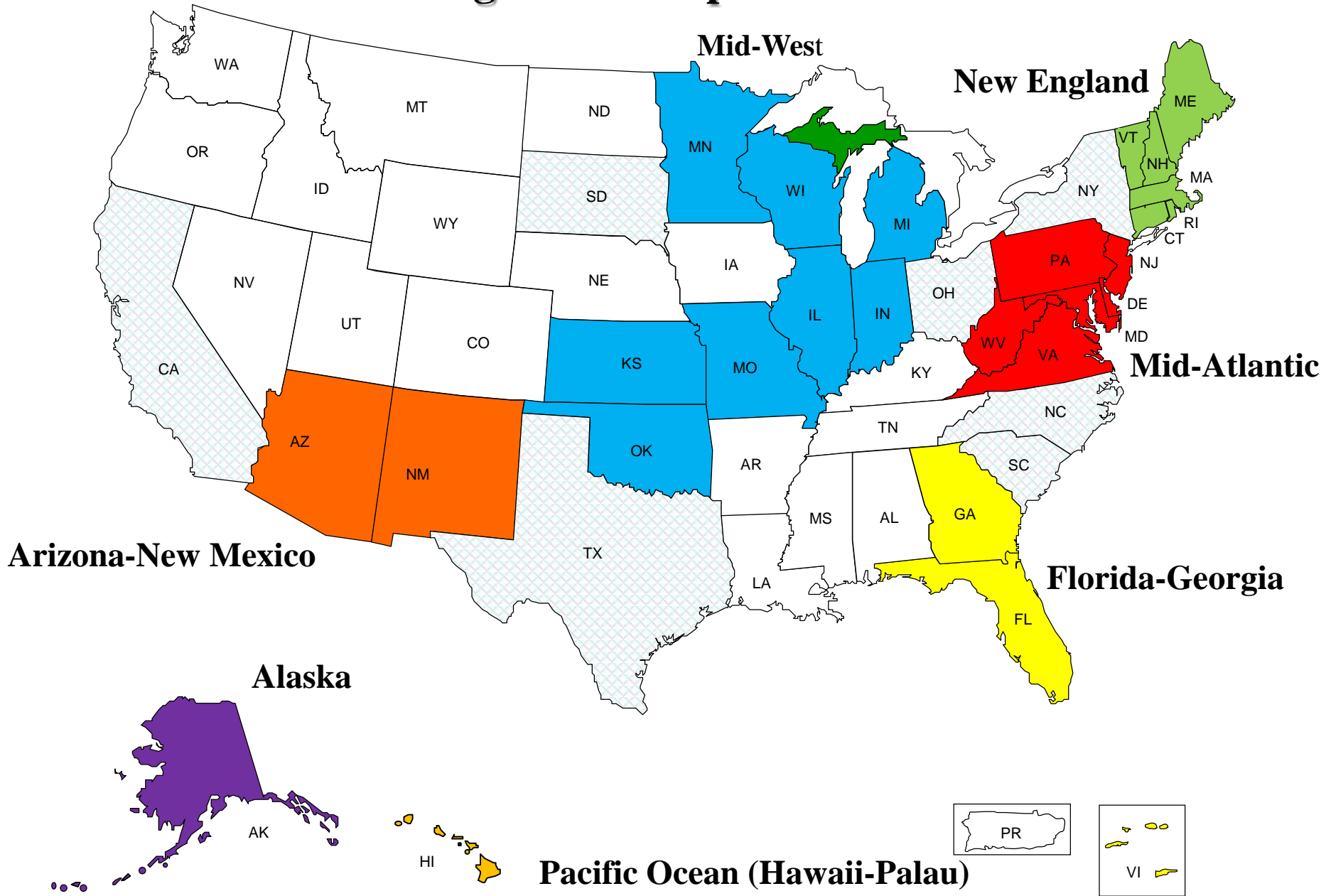
Dr. Ken Cameron – University of Wisconsin – using models with students at the Mater Grove Academy as part of “Read Across America” day

Implementing the model

Regional groups:

- **Collect mycorrhizal fungi**
- **Collect seeds**
- **Initiate propagation**
- **Initiate educational efforts**

Regional Groups – March 2017



Where the effort stands

- **More than 50% of US covered with regional groups**
- **Secured funds to support Development Coordinator**
- **First endowment received – still seeking major endowment to assure long-term success**
- **Visits to NAOCC and Go Orchids web site increasing regularly (Thanks to National Geographic for the great ‘shout-out’)**
- **Model moving beyond US (Palau – USFS, 9 western European countries, Greece-Turkey, Australia)**

Optimism abounds

- **NAOCC model based on ecological concepts and citizen science is robust and is rapidly gaining acceptance with an ever increasing number of collaborators**
- **Goal of collecting samples from all species in the U.S. and Canada in the next five years can be reached**
- **The NAOCC concept is already reaching out globally and is easily adapted to any environment/country**
- **Like all efforts of this sort, long-term success depends on development of a sustainable funding base**



Acknowledgments

- **Dennis Whigham – SERC**
- **Jay O’Neill – SERC**
- **Barbara Faust, Vicki Dibella – Smithsonian Gardens**
- **Ari Novy, Ray Mims, Susan Pell – US Botanic Garden**
- **Hanna Rasmussen – University of Copenhagen**
- **Funding: NSF, DOD, USDA, NPS, WV Department of Transportation, Contributors to SERC/NAOCC (Chicago Botanic Garden, SI Gardens, US Botanic Garden, Minnesota Landscape Arboretum, Biophilia, Hal and Helen Horwitz Orchid Conservation Fund)**

Melissa McCormick: mccormickm@si.edu

<http://northamericanorchidcenter.org/>



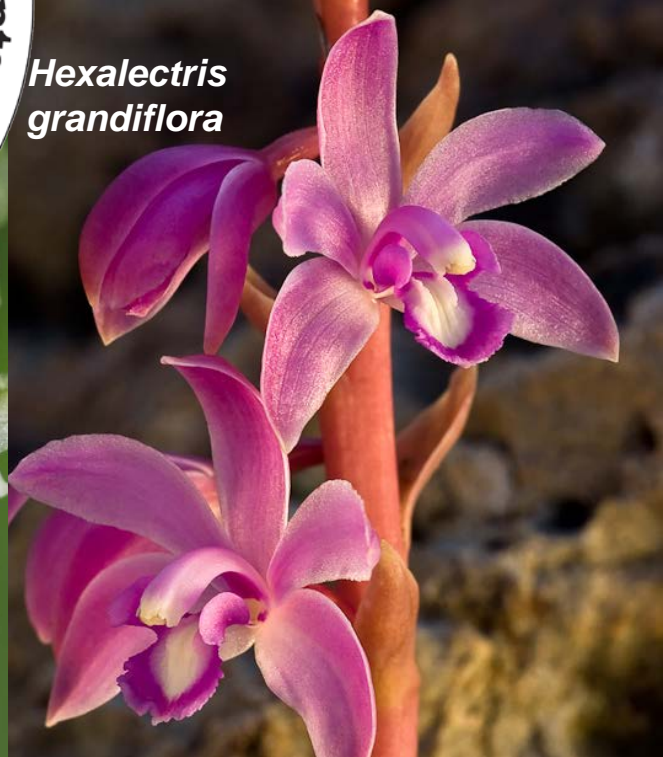
Cypripedium parviflorum



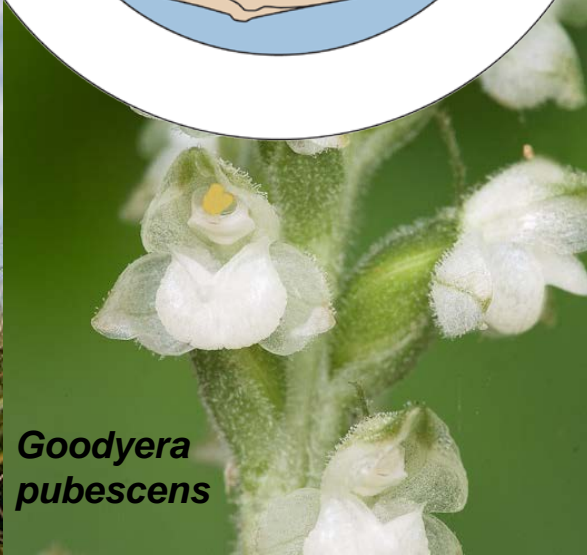
Spiranthes cernua



Platanthera praeclara



Hexalectris grandiflora



Goodyera pubescens