The Arizona Native Plant Society

The Plant Press

THE ARIZONA NATIVE PLANT SOCIETY

Volume 39, Number 2 Winter 2016

In this Issue:

Orchids in the Southwest

Plus

& Our Regular Features

Orchids — Marvels of the Plant Kingdom *by Douglas Ripley*[1]

A highlight of my summer was attending the annual meeting sponsored by the Native Orchid Conference held in August at Cochise College in Benson. The four-day meeting, which was attended by over 60 people from the U.S., Canada, and Great Britain, consisted of two days of excellent presentations on many aspects of North American native orchids and two days for field trips to several sites in the Santa Catalina and Chiricahua Mountains. The meeting organizers carefully surveyed, in advance, potential habitats to afford the participants the best opportunity to see as many native Arizona orchids as possibly during the conference. This issue of *The Plant Press* is largely devoted to the subject of Arizona's native orchids and presents some of the papers featured at the Native Orchid Conference annual meeting.

A lithographic color plate from Ernst Haeckel's *Kunstformen der Natur* of 1899 showing an artist's depiction of different species of orchids. *Public domain via Wikimedia Commons.*

It's hard to imagine any plant enthusiast who does not have at least some level of interest in the orchids. The Orchid Family (Orchidaceae), consisting of 15,000 to 20,000 species in about 1000 genera, is one of the largest families of flowering plants. Orchid flowers are strikingly irregular in their morphology and endlessly fascinating in their variety, color and beauty. Many aspects of orchid growth, reproduction, and ecology are enormously complex and in some cases little understood. For example, many orchids have evolved highly sophisticated and ingenious floral features and reproductive strategies to attract pollinators. Some rely entirely on decaying organic matter (saprophytes) for their nutrition while others are partly or entirely parasitic on other plants. Nearly all depend upon a complex symbiotic association with the mycelium of a fungus (mycorrhizal association), which assists in the absorption of minerals and water from the soil and may provide protection to the orchid root from soil organisms and other fungi.

continued next page

[1]Arizona Native Plant Society, Cochise Chapter.

President's Note *by Douglas Ripley* jdougripley@gmail.com

As the year ends, I wish to thank the members and officers of the Arizona Native Plant Society for their excellent support of the Society's various programs and projects. The Society was able to accomplish a number of worthwhile goals in 2016 thanks to your hard work and dedication. I look forward to continuing that success in the New Year as we focus on our mission to promote knowledge, appreciation, conservation, and restoration of Arizona's native plants and their habitats.

In the past year we continued the full scope of our native plant awareness and conservation programs which have been offered through our six chapters as well as through the State organization. Those have included the monthly chapter meetings and field trips, conducting botanical training through various workshops, providing research and publication grants, and formally reestablishing an active Conservation Committee under the vigorous leadership of John Scheuring. We also continued to organize, sponsor, and present the annual Arizona Botany Conference and to publish the quarterly *Happenings* newsletter and our semiannual journal, *The Plant Press*.

While we have many reasons to be optimistic about what our Society can accomplish in the coming year, it's no secret that native plant conservation faces many new challenges on many different levels. But I am confident that with the enthusiastic and imaginative support of our members, we will be able to meet those challenges while at the same time continuing to enjoy and appreciate Arizona's wonderful natural history of which we are so fond.

Present-day lifestyles seem to become busier and more hectic daily. But finding a little extra time to participate more fully in the AZNPS could make a world of difference to our Society. I therefore ask all members to consider donating some of their time to help run the Society or to ensure the success of individual Society initiatives. I think you will find it enormously gratifying to see what benefits a little of your time will yield.

This issue of *The Plant Press* is devoted largely to the fascinating subject of orchids — a theme inspired by the happy occurrence of the Native Orchid Conference's annual meeting held in August at Cochise College in Benson — papers prepared from some of the conference presentations are featured. Finally, another wonderful report from Tom Van Devender, Sue Carnahan, and Ana Lilia Reina-Guerrero, tops off the issue — on their recent Madrean Discovery Expedition to the Sierra Buenos Aires in Sonora, Mexico — as well as a note on the recognition Tom recently received for his invaluable contributions to the understanding of Sonoran natural history

Orchids — Marvels of the Plant Kingdom *continued*

The vast majority of orchids occur in the tropics where over 70 percent grow epiphytically on trees and lianas. But orchids also grow in many other habitats on every continent except Antarctica. The twenty-six species of orchids occurring in Arizona are all terrestrial and occur mainly at elevations above 5,000 feet in juniper or mixed oak woodlands and in coniferous forests. One additional Arizona orchid habitat occurs at lower elevations in riparian and wetland areas, such as the isolated freshwater *cienegas* found in some grasslands.

Commercial use of orchids is very limited, with the notable exception of the horticulture industry's hybridization and cultivation of some especially showy orchids, such as species of *Cypripedium, Cattleya*, *Cymbdium*, and *Odontoglossum*. Also, the pods of several species of the genus *Vanilla* are sources for the delicious flavoring originally discovered and cultivated by the Aztecs of Mexico.

The papers presented in this issue discuss a number of aspects of native Arizona orchids, including an update on their occurrence and nomenclature, a study to determine the best way to germinate the rare Arizona Canelo Hills Lady's Tresses (*Spiranthes delitescens*), a study to identify the pollinator for Coleman's Coral root (*Hexalectris colemanii*), and the Arizona-New Mexico regional effort of the North American Orchid Conservation Center to conserve native orchids in the southwest.

Updating the Orchid Flora of Arizona and New Mexico

by Ronald A. Coleman[1]

It has been about 14 years since the publication of *The Wild Orchids of Arizona and New Mexico* (Coleman 2002). The Native Orchid Conference held in Benson, AZ in August 2016 presented an opportunity to review the current status of our orchid flora. This article summarizes the updates to the orchid flora of Arizona and New Mexico presented at the Native Orchid Conference. The changes can be considered in two groups: nomenclature, and new discoveries. The following paragraphs address those changes, first in Arizona, then in New Mexico.

Changes to the Orchid Flora of Arizona

Nomenclature changes

Dichromanthus michuacanus is the last of our orchids to bloom. In Coleman (2002), I called this member of the Spiranthinae *Stenorrhynchos michuacanum*. Essentially in parallel, Salazar and Arenas (2002) transferred the taxon to the genus *Dichromanthus*. Therefore the correct name for our late blooming orchid is *Dichromanthus michuacanus* (Lex.) Salazar & Soto Arenas (Figure 1).

Figure 1 *Dichromanthus michuacanus.*

Three other nomenclature changes for Arizona are all in the genus *Hexalectris* based on the work of Kennedy and Watson (2010). Coleman (2002) recognized *Hexalectris revoluta* as growing in Arizona. Previously it was known in the United States only from Texas. Catling (2004) subsequently recognized differences between the Arizona and Texas plants, naming ours *H. revoluta* var. *colemanii*. Kennedy and Watson (2010) used DNA analysis to show our plant was distinct from *H. revoluta* and named it *H. colemanii* (Figure 2). *H. revoluta* is no longer considered part of our orchid flora.

In the same paper Kennedy and Watson showed that the two taxa I had identified as *H. spicata* var. *spicata* and *H. spicata* var. *arizonica* were the same and not conspecific with the *H. spicata* that grows in the Eastern United States. Our plants reverted to the specific epithet used by Watson (Watson 1882) for the original description as *Corallorhiza arizonica* and hence are now called *Hexalectris arizonica*.

New Orchids for Arizona

Hexalectris parviflora has been documented for the first time in the United States. Previously the known northern extent of this species' distribution was in the Sierra Madre Occidental in Mexico. On 1 May 2015, leading a team conducting *Hexalectris* surveys and fielded by WestLand Resources Inc., Janet Fox observed an orchid unknown to her in the Dragoon Mountains in southeastern Arizona. We subsequently identified the plant as *H. parviflora* which had never before been reported from the United States (Coleman and Fox 2009). Shortly after Fox's discovery, Teague Embrey, also working on a field team for WestLand Resources Inc., discovered an additional plant in the Peloncillo Mountains of extreme southeastern Arizona. These records increase the known number of *Hexalectris* species in Arizona to four, and in the United States to eight. These two discoveries are northern range extensions of approximately 260 miles and 220 miles respectively, from the closest *H. parviflora* records in the Sierra Madre Occidental of Mexico.

A new color form of *Dichromanthus michuacanus* (La Llave & Lex.) Salazar & Soto Arenas has been added to the Arizona orchid flora. Coleman (2009) described *Dichromanthus michuacanus* forma *armeniacus.* The flowers are a striking apricot yellow. They bloom during the same mid- to late-October as the more typical greenish flowers. Morphologically the yellow flowers are structurally identical to the traditional greenish flowers, differing only in color. The background color of the sepals, petals, and lip is a rich apricot yellow. The stripes are dark green, slightly darker than in the typical flowers. The

continued next page

[1]Tucson, AZ, ronorchid@cox.net. *Photos courtesy the author.*

From left, Figure 2 *Hexalectris colemanii*. Figure 3 *Dichromanthus michuacanus* forma *armeniacus*.

Updating Orchid Flora *continued*

throat on all yellow flowers was very dark green. In typical flowers the throat is either greenish or pale yellow, but some do have a dark green area deep in the throat. The dark green area does not approach the intensity seen in the yellow form. So far this color form has been found on only one hillside in southeast Arizona (Figure 3).

Changes to the Orchid Flora of New Mexico

Nomenclature Changes for New Mexico

Hexalectris arizonica is the correct name of plants in New Mexico previously referred to as *H. spicata* var. *spicata* and *H. spicata* var. *arizonica.* This nomenclature change is identical to that discussed for Arizona and is based on the work of Kennedy and Watson (2010).

New Orchids for New Mexico

While doing research for *The Wild Orchids of Arizona and New Mexico* I determined that all herbarium specimens in New Mexico purported to be *Platanthera dilatata* were in fact *P. huronensis*. Additionally all *Platanthera* that I observed in the field with whitish flowers were just lightly colored *P. huronensis*. I thus concluded that *P. dilatata* did not grow in New Mexico. One of the herbaria I visited to study specimens was at San Juan College in Farmington, New Mexico. Apparently I overlooked or otherwise missed two specimens from San Juan College that are clearly *P. dilatata*. One was collected from Taos County in 1976 by S. Williams and the other from Rio Arriba County in 1980 by R. Owens. Relocating the plants will be challenging because Williams simply said "wet meadow," and Owens said "mountain bog."

Hexalectris colemanii was documented in Arizona in 2010, but it was not until 2013 that it was discovered in New Mexico. Cloud-Hughes and Baker (2014) reported finding a single plant just east of the Arizona border in the Peloncillo Mountains. In subsequent years a few additional plants were found, but the number of *H. colemanii* in New Mexico remains low.

Listera borealis was known in Colorado, but had never been found in New Mexico. That changed in 2007 when Ben Legler discovered some plants along a stream in Taos County that he identified as *L. cordata*. He discovered some additional *L. cordata* plants, also in Taos County in 2009. This is the second member of the genus *Listera* in New Mexico. It is very easy to tell *L. borealis* from *L. cordata*. The lip of *L. borealis* has two

continued next page

Figure 4 *Listera borealis.*

Updating Orchid Flora *continued*

oblong lobes at the apex for about 20% of its length, with a small tooth between the lobes. The lip on *L. cordata* has two linear-lanceolate lobes for about half its length, and no tooth. Their ranges overlap, and they sometimes grow near each other (Figure 4).

Platanthera obtusata was also added to our orchid flora by Ben Legler. He found it in both Taos and Colfax Counties in 2007. Ken Heil extended the range when he found plants in Mora County in 2008. This tiny single leaf *Platanthera* grows in moist, shaded forests. The single leaf is linear-oblanceolate. On our plants, the leaf is rarely more that 6 to 8 cm long, although they can be about twice that in parts of the range. The total height of our plants is between 10 and 15 cm tall with a few whitish-green flowers. *P. obtusata* is much more common in the Northern Rockies, but should be looked for elsewhere at high elevations in the terminus of the Rockies in New Mexico (Figure 5).

Microthelys rubrocalosa (Rob. and Greenm.) Garay was discovered in 2004 growing within the Lincoln National Forest, in the Sacramento Mountains of Otero County, New Mexico, by

continued next page

Listing the Current Orchid Flora of Arizona and New Mexico

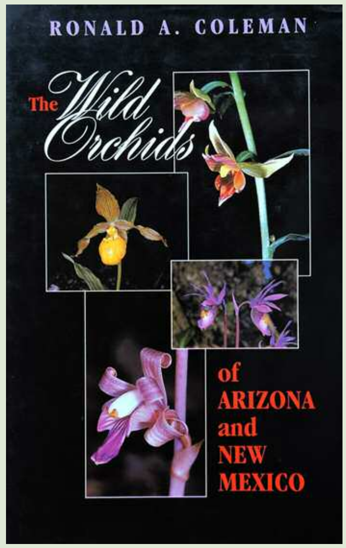
Arizona (26 species)	**Total**	**New Mexico** (32 species)
(1) Calypso bulbosa var. *americana*	1	*Calypso bulbosa* var. *americana (1)*
(2) Coeloglossum viride	2	*Coeloglossum viride (2)*
(3) Corallorhiza maculata	3	*Corallorhiza maculata (3)*
(4) Corallorhiza striata	4	*Corallorhiza striata (4)*
	5	*Corallorhiza trifida (5)*
(5) Corallorhiza wisteriana	6	*Corallorhiza wisteriana (6)*
(6) Cypripedium parviflorum	7	*Cypripedium parviflorum (7)*
(7) Dichromanthus michuacanus and *D. michuacanus* forma *armeniacus*	8	
(8) Epipactis gigantea	9	*Epipactis gigantea (8)*
	10	*Epipactis helleborine (9)*
(9) Goodyera oblongifolia	11	*Goodyera oblongifolia (10)*
(10) Goodyera repens	12	*Goodyera repens (11)*
(11) Hexalectris colemanii	13	*Hexalectris colemanii (12)*
(12) Hexalectris parviflora	14	
(13) Hexalectris warnockii	15	
	16	*Hexalectris nitida (13)*
(14) Hexalectris arizonica	17	*Hexalectris arizonica (14)*
	18	*Listera cordata (15)*
(15) Listera convallaroides	19	
	20	*Listera borealis (16)*
(16) Malaxis corymbosa	21	
(17) Malaxis porphyrea	22	*Malaxis porphyrea (17)*
(18) Malaxis soulei	23	*Malaxis soulei (18)*
(19) Malaxis abieticola	24	*Malaxis abieticola (19)*
	25	*Microthelys rubrocallosa (20)*
	26	*Piperia unalascensis (21)*
	27	*Platanthera aquilonis (22)*
	28	*Platanthera brevifolia (23)*
	29	*Platanthera dilatata* var. *dilatata (24)*
	30	*Platanthera huronensis (25)*
(20) Platanthera limosa	31	*Platanthera limosa (26)*
	32	*Platanthera obtusata (27)*
(21) Platanthera purpurascens	33	*Platanthera purpurascens (28)*
(22) Platanthera sparsiflora	34	*Platanthera sparsiflora (29)*
(23) Platanthera zothecina	35	
(24) Schiedeella arizonica	36	*Schiedeella arizonica (30)*
(25) Spiranthes delitescens	37	
	38	*Spiranthes magnicamporum (31)*
(26) Spiranthes romanzoffiana	39	*Spiranthes romanzoffiana (32)*

BOOK REVIEW *by J. Douglas Ripley, Arizona Native Plant Society, Cochise Chapter*

The Wild Orchids of Arizona and New Mexico

by Ronald A. Coleman 2002. 248 pages, 32 full-color plates, and distribution maps for all species. Cornell University Press, Ithaca and London. $35.00, hardback. *Also available at Amazon.com.*

While sometimes diminutive in their appearance, ephemeral in their flowering times, and often highly restricted in their distribution, the orchids of Arizona and New Mexico are a beautiful and fascinating component of each state's flora. Fortunately, Ron Coleman, a longtime student of native orchids in the Southwest and California, has prepared a superb guide to these remarkable plants.



The Wild Orchids of Arizona and New Mexico is a comprehensive guide to the 26 species of orchids in Arizona and the 28 orchid species occurring in New Mexico at the time of the book's publication (2002). Coleman's article in this edition of *The Plant Press* updates those numbers based on recent discoveries of new species.

The organization of this book is excellent with a succinct introduction that provides a short description of the Orchid Family, followed by a discussion of the general habitats, distribution, flowering seasons, and conservation of Arizona and New Mexico orchids.

A dichotomous key to the 14 genera included in the book is easy to use, as are several species keys provided for the larger genera. Each genus is introduced with a very informative description followed by individual treatments of each species contained within the genus. Each species' treatment contains the following information:

Nomenclature *The scientific name, etymology, synonymy, and common names*
Distribution Map
Description
Distribution Discussion
Habitat
Blooming Season
Conservation Status and Issues
Notes and Comments

Accompanying the wealth of information provided are superb color photographs taken by the author and presented in 32 separate plates. Each species' photographic treatment includes a general habitat scene, overall appearance of the plant, and flower closeups. Coleman's photography is stunning in its clarity and beauty.

The Wild Orchids of Arizona and New Mexico is the result of years of painstaking work by someone who possesses a remarkable love and understanding of native orchids. Anyone wishing to expand their knowledge of these complex and ingenious plants in Arizona and New Mexico must have this book.

From left, Figure 5 *Platanthera obtusata*. Figure 6 *Microthelys rubrocalosa*.

Updating Orchid Flora *continued*

Marc Baker (Coleman and Baker 2006). This was the first record of this species from the United States and represented a northward range extension of approximately 270 miles (436 km). The original colony of about 20 plants was badly damaged by fire. Fortunately Baker later found multiple locations in the Lincoln National Forest, so the total population of *M. rubrocalosa* in the United States is now known to be several hundred plants, all growing in Otero County.

Leaves and flowers of this species do not appear above ground until after the start of the monsoon-induced rains in July, and don't bloom until August or later. The leaves are a dark, bluish green, narrowly lanceolate, and up to 10 cm long by 1.5 cm wide. The flower spikes are up to 32 cm tall with over 30 buds and flowers. Each tubular flower is about five mm long and two mm wide. Sepals

continued next page

Volume 12 of the Flora of North America Recently Published —A major undertaking!

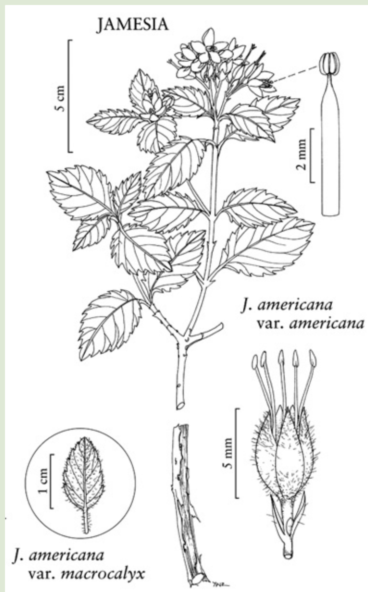
The Flora of North America (FNA) project recently published Volume 12, which adds 29 families, 122 genera, and 765 species to the impressive list of plants described so far by this ambitious botanical undertaking. FNA has now completed 20 of an anticipated total of 28 volumes.

The following information from FNA (**floranorthamerica.org**) describes the scope of this major botanical undertaking:

The Flora of North America project builds upon the cumulative wealth of information acquired since botanical studies began in the United States and Canada more than two centuries ago. Recent research has been integrated with historical studies, so that the Flora of North America is a single-source synthesis of North American floristics. FNA has the full support of scientific botanical societies and is the botanical community's vehicle for synthesizing and presenting this information.

The Flora of North America Project will treat more than 20,000 species of plants native or naturalized in North America north of Mexico, about 7% of the world's total. Both vascular plants and bryophytes are included.

Species descriptions are written and reviewed by experts from the systematic botanical community worldwide, based on original observations of living and herbarium specimens supplemented by a crucial review of the literature. Each treatment includes scientific and common names, taxonomic descriptions, identification keys, distribution maps, illustrations, summaries of habitat and geographic ranges, pertinent synonymy, chromosome numbers, phenology, ethnobotanical uses and toxicity, and other relevant biological information.



The Arizona Native Plant Society sponsored the preparation of an illustration for Volume 12 — *Jamesia americana* (Hydrangaceae) — the beautiful shrub that occurs between 5,000 and 9,500 feet elevation throughout the Rocky Mountains, and south to Southern Arizona where it occurs in several of the Sky Islands (the Huachuca, Pinaleño, Santa Rita, and Santa Catalina Mountains). The FNA provided an archive-quality print to the AZNPS of this illustration drawn by Yevonn Wilson-Ramsey.

AZNPS members can order copies of individual volumes of FNA which are now available from the Oxford University Press. One can order from **www.OUP.com/US** or telephone: 800.451.7556. Also, individual sponsorships for new illustrations for the volumes currently in preparation (Numbers 10, 11, and 17) may be purchased at the FNA website (**http://floranorthamerica.org**).

Updating Orchid Flora *continued*

and petals are greenish with white edges and formed into a tight hood around the lip and column. Two bright reddish-orange calli cover the lower half of the lip, and are visible if you look at the bottom the flower (Figure 6).

References

Catling, P. 2004. A synopsis of the genus *Hexalectris* in the United States and a new variety of *Hexalectris revoluta*. *The Native Orchid Conference Journal*. 1(2):5–25.

Cloud-Hughes, Michelle A. and Marc A. Baker. 2014. Noteworthy Collection — New Mexico. *Madroño*. 61(1):149–150.

Coleman, R.A. 2002. The wild orchids of Arizona and New Mexico. Cornell University Press. Ithaca and London.

Coleman, R.A. 2009. A yellow form of *Dichromanthus michuacanus* (La Llave & Lex.) Salazar & Soto Arenas in Arizona. *The Native Orchid Conference Journal*. pp 17–19.

Coleman, R.A. and M. Baker. 2006. *Microthelys rubrocalosa* (Rob. and Greenm.) Garay (Orchidaceae): A new orchid for the United states. *The Native Orchid Conference Journal*. 3(1):18–19.

Coleman, R.A. and Janet Fox. 2015. *Hexalectris parviflora* L.O. Williams (Orchidaceae) new to the United States flora. *The Native Orchid Conference Journal*. 12(4):15–21.

Kennedy, A. and L. Watson. 2010. Species delimitations and phylogenetic relationships within the fully myco-heterotrophic *Hexalectris* (Orchidaceae). *Systematic Botany*. 35(1):64–67.

Salazar, G., M. Chase, and M. Arenas. 2002. Galeottiellinae, A new subtribe and other nomenclature changes in *Spiranthinae* (Orchidaceae: Cranichideae). *Lindleyana*. 17:173.

Watson, S. 1882. Contributions to American botany, *Proceedings of the American Academy of Arts and Sciences*. 17:379.



From left, Figure 1 *Hexalectris colemanii*. Note the dark orange pollinia. Figure 2 Developing capsules on a *H. colemanii* spike. Figure 3 A mature, dehisced capsule (seed pod).

The Mystery Orchid Pollinator *by Eric Wallace and Teague Embrey*[1]

Orchids have long been recognized as a diverse family representing complex and divergent floral adaptations related to pollination and sexual reproduction. Charles Darwin devoted an entire treatise on this subject to further illustrate and support his theory of evolution by natural selection (Darwin 1877). Despite this long history of study, pollination systems of many species remains unknown as is the case with Coleman's Coral Root (*Hexalectris colemanii*). The primary goal of our study was to identify the potential pollinator(s) of this species.

Hexalectis colemanii — Background and Natural History

The genus *Hexalectris* currently includes nine recognized species, the majority of which occur in the southwestern U.S. and northern Mexico, including four species known to occur in Arizona. These latter species include *H. arizonica* (Arizona crested coralroot); *H. parviflora* (no apparent common name); *H. warnockii* (Texas crested coralroot), and *H. colemanii* (Coleman's coralroot) (Coleman 2002, Kennedy and Watson 2010, Coleman and Fox 2015). Coleman's coralroot (*H. colemanii*) was first described as *H. revoluta* var. *colemanii* by Catling (2004) and subsequently elevated to full species status by Kennedy and Watson (2010), although there are some who maintain that this species should be retained at the varietal rank (USFWS 2013).

This species was considered for protection under the Endangered Species Act by the U.S. Fish and Wildlife Service (USFWS), but they determined after a 12-month review that listing Coleman's coralroot as threatened or endangered was not warranted (USFWS 2013). The USFWS finding was largely based on a review of recently identified, previously unknown, populations of this species in several mountain ranges of southeastern Arizona and southwestern New Mexico (Baker 2012, WestLand 2012). Despite the USFWS determination, it is still a relatively rare species and is considered a sensitive species by the U.S. Forest Service.

[1]220 W. Franklin St., Tucson AZ 85701, batrachia@yahoo.com, teague84@hotmail.com. *Photos courtesy the authors.*

Hexalectris colemanii is a fully mycoheterotrophic orchid, meaning it lacks chlorophyll for photosynthesis and relies entirely on mycorrhizal fungal associates for nutrients (Taylor et al. 2003, Kennedy et al. 2011). In this complex relationship, fungi derive nutrients from a photosynthesizing host plant (i.e., an autotroph) that is then made available to a recipient plant (e.g., *H. colemanii*). But, because fully mycoheterotrophic species have lost the ability to function as autotrophs, they do not contribute any energy (e.g., carbon) to this energy-exchanging system and are therefore regarded as "cheater" species (Kennedy et al. 2011). Arizona white oak (*Quercus arizonica*) is suspected to be the main host plant for the mycorrhizal fungi species that support *H. colemanii*, as the majority of known *H. colemanii* colonies are associated with this species (Baker 2012, WestLand 2012), although they have also been found under Emory oak (*Q. emoryi*) (Catling 2004). Given the complexity and unknowns of these relationships, it is plausible that other plants, besides oaks, within the Madrean oak woodlands (e.g. *Rhus virens*) may act as host to the fungi species associated with *H. colemanii* (Kennedy et al. 2011).

Pollinia are cohesive packets of pollen unique to two plant families, Orchidaceae and Apocynaceae (Johnson and Edwards 2000), that are transferred from one flower to another during pollination events. *H. colemanii* has entire pollinia, as opposed to friable or agglutinated pollinia found in other orchid subfamilies, which means the unit detaches as a whole (Singer et al. 2008). The pollinia of *H. colemanii* are also relatively large (≥ 2 mm wide; Figure 1), leading us to assume that the pollinator also must be large enough to transfer this unit among flowers. However, in our experience with this species, and through discussions with Ron Coleman, we note that we have never observed larger insects visiting flowers during our daytime surveys. And yet, developing capsules (Figure 2) and in some rare cases fully dehisced capsules with seeds (Figure 3) were observed, meaning that flowers had been pollinated.

continued next page

Figure 4 (left) Malaise trap in operation.
Figure 5 (above) Sticky traps.

Mystery Orchid Pollinator *continued*

Although generally associated with tropical, moist environments, there is a surprisingly diverse group of orchids that have adapted to relatively arid environments; *Hexalectris* is one such genus (Richter et al. 2009, Kennedy and Watson 2010). In Arizona, *Hexalectris* species are typically found associated with canyon bottom environments that harbor microclimates which are more mesic than the immediately surrounding area (WestLand 2012, Cloud-Hughes and Baker 2014, Embrey and Wallace 2016).

For most of the year, *H. colemanii* plants exist as an underground, segmented corm, which is essentially an energy storage unit. However, in approximately late April, a reproductive spike emerges from the corm beneath the soil. In the ensuing weeks, these pink-hued spikes continue to grow in height with buds developing along the spike that eventually open as striking flowers. Following anthesis (the period during which a flower is fully open and functional), those flowers that are pollinated develop into seed capsules that, once mature, will dry and dehisce, thus broadcasting tiny seeds to the immediate environment or beyond. *Hexalectris* seeds are so small they are believed to be potentially distributed by wind (USFWS 2013). Based on long-term monitoring efforts of this species, we know that above-ground emergence of orchid spikes appears to be cyclical, although the driver behind these cycles is currently unknown (Coleman 2005). For example, some colonies produce flower spikes in abundance one year, while the next year only a handful of spikes may emerge (Coleman 2005, WestLand 2012, Embrey and Wallace 2016).

Current Work

Our study began as any classic natural history study does; we had observed insects associated with *H. colemanii* flower spikes and began to question what their relationship to the species might be, especially when we realized that the pollinator species of this orchid are unknown (Argue 2012, USFWS 2013). As an obligate outbreeding species, Coleman's coralroot requires one or more pollinators for successful reproduction (Catling 2004, Argue 2012). Understanding this species' pollination and reproductive biology is essential to understanding the population structure and genetic connectivity amongst the isolated mountain ranges (i.e., Sky Islands) in which it occurs. With this in mind, the objective of our study is to investigate insect-plant interactions with a focus on identifying potential pollinator(s).

We initiated work in 2014 which has continued through the 2016 field season. Typical challenges associated with the vagaries of studying a species with a relatively brief above-ground flower spike, not to mention one that has apparent dormancy cycles across years (Coleman 2005), include finding sites with enough flowers to justify study in a given year. Because of this, we opportunistically select study sites each year based on those sites that have the greatest number of flower spikes in order to maximize our chances of encountering associated insects and/or a potential pollinator.

To date, our study sites include three canyons in the Sky Island mountain ranges of southeastern Arizona, one each in the Dragoon, Santa Rita, and Whetstone Mountains. The dominant biotic communities in these canyons where we have located orchids is the Madrean Evergreen Woodland of Brown (1982). The vegetation structure generally consists of a closed-canopy overstory with an open to relatively dense understory and thick accumulations of leaf litter.

During each field season we monitor the number of plant spikes that emerge at study sites and track their flowering phenology and condition. In regards to insect-plant interactions, in 2014 we focused on diurnal observations to determine those insect species associated with flower spikes. In addition to diurnal observations, during 2015 and 2016 we initiated nocturnal observations where we observed flower spikes using flashlights with red filters; this approach reduces interference with natural behaviors of potential floral visitors (M. Irwin, University of Illinois, pers. comm.). In 2015 and 2016, we also implemented two passive trapping methods, Malaise traps and sticky traps (Figures 4 and 5), in order to sample those insect species that were moving in the vicinity of

continued next page

From left (above), Figures 6a–d Aphids, stink bug, katydid, and weevils. Inset (Figure 7, below) June beetle on a *Hexalectris colemanii* flower, seen during a nighttime observation.

Mystery Orchid Pollinator *continued*

flowering spikes and to capture insects that might have pollinia attached to their body. Insects captured were later sorted to order and relative size. Larger insects were inspected for attached pollinia and we also searched the preservative (ethanol) for pollinia that may have detached from insects' bodies during capture or transport.

Results

Insects representing three orders and seven families have been observed directly associated with flower spikes to date (Figures 6a-d):

- Order Coleoptera
  - Family Curculionidae: weevils
  - Family Scarabaeidae: June beetles
- Order Hemiptera
  - Family Aphidae: aphids
  - Family Cicadellidae: leafhoppers
  - Family Pentatomidae: stink bugs
  - Family Reduviidae: assassin bugs
- Order Orthoptera
  - Family Tettigoniidae: katydid nymph

All of these insects, with the exception of the assassin bug (a predator), are phytophagous (plant-feeding) insects with either piercing/sucking or chewing mouthparts. By far the most common insect consistently observed on flower spikes was a single weevil species; they were observed on all parts of emerged spikes including stems, buds, and flowers (Figure 6d). We observed varying degrees of insect herbivory on stems and flower buds including some herbivory that inevitably led to a reduction in successful anthesis (e.g. Figure 6c). Despite these observations, we are unable at this time to assess the potential for population-level effects of observed herbivory. Nocturnal observations at flower spikes were limited to a single, observation of a June beetle in 2015 that flew in and landed on an open flower. The beetle moved around on the flower and stem but did not appear to feed on the spike nor did it enter the floral tube (Figure 7). Following the beetle's departure, we inspected the flower and found the pollinia intact. This is the single observation we have made of an insect that we believe is large enough to transport a pollinium the size of those found in *H. colemanii*.

Results from sticky traps were relatively poor and generally only captured insects that were far too small to act as potential pollinators of *H. colemanii*; in particular, they ensnared many leafhoppers (Hemiptera) that averaged approximately 2 mm in total length. The Malaise traps were much more successful in capturing a multitude of individuals representing five families; Coleoptera, Diptera (flies), Lepidoptera (moths), Hemiptera, and Hymenoptera (wasps). By far the greatest number of individuals we captured were flies representing over 1,000 individuals. A majority of the insects captured in Malaise traps were still, by our estimation, likely too small to act as a carrier of *H. colemanii* pollinia. We did not observe any pollinia attached to insects while sorting the samples nor did we encounter any pollinia suspended in the ethanol.

Interestingly, we observed seed capsules developing on spikes at various sites during all three years indicating that pollination had occurred. Despite that, we did not observe mature capsules

continued next page

Mystery Orchid Pollinator *continued*

on any spikes at any of our study sites at the end of the season. The reason for capsule failure during our study is unknown at this time but could be related to desiccation as these are developing during the hottest, driest months in southeast Arizona (May and June) (Figure 8). These observations are congruent with those of Ron Coleman (pers. comm.) and his long-term monitoring data in that successful development of seed capsules to maturity, and thus viable seed, appears to be low in this species.

Acknowledgements

We thank the Arizona Native Plant Society (AZNPS) for providing support during the 2015 field season with a Ginny Saylor Research Grant, Ron Coleman for sharing his expertise and insights with this species, Doug Ripley for encouraging this manuscript, members of AZNPS and the Native Orchid Conference for insightful comments during presentations, and Tom Van Devender and Myles Traphagen for recommending our initial AZNPS grant.

Figure 8 A desiccated *H. colemanii* spike.

References

Argue, C.L. 2012. The pollination biology of North American orchids: Vol 2. North of Florida and Mexico. Springer. New York, New York.

Baker, M.A. 2012. Current knowledge and conservation of *Hexalectris colemanii* (Orchidaceae), Coleman's coral-root. Final Report. Cooperative Endangered Species Conservation Fund, U.S. Fish and Wildlife Service. October 30, 2012. 86 pp.

Brown, D.E. 1982. Madrean Evergreen Woodland. Pp. 59–65 *in* D.E. Brown (ed.). Biotic communities of the American southwest – United States and Mexico. *Desert Plants.* 4:1–342.

Catling, P. 2004. A synopsis of the Genus *Hexalectris* in the United States and a new variety of *Hexalectris revoluta*. *The Native Orchid Conference Journal.* 1:5–25.

Cloud-Hughes, M.A. and M.A. Baker. 2014. Noteworthy collections — New Mexico. *Madroño*. 61:149–150.

Coleman, R. 2002. The wild orchids of Arizona and New Mexico. Cornell University Press. Ithaca and London. New York. 248 pp.

Coleman, R. 2005. Population studies in *Dichromanthus* and *Hexalectris* in southeastern Arizona. *Selbyana.* 26:246–250.

Coleman, R. and J. Fox. 2015. *Hexalectris parviflora* L.O. Williams (Orchidaceae) new to the United States flora. *The Native Orchid Conference Journal.* 12:15–21.

Darwin, C. 1877. The various contrivances by which orchids are fertilised by insects. 2nd edition. John Murray, London.

Embrey, T. and E. Wallace. 2016. Insect-plant interactions of Coleman's Coralroot (*Hexalectris colemanii*). Presentation given to the Arizona Native Plant Society on May 11, 2016, Tucson, Arizona, and at the Annual Native Orchid Conference on August 1, 2016, Benson, Arizona.

Kennedy, A.H. and L.E. Watson. 2010. Species delimitations and phylogenetic relationships within the fully myco-heterotrophic *Hexalectris* (Orchidaceae). *Systematic Botany.* 35:64–76.

Kennedy, A.H, D.L. Taylor, and L.E. Watson. 2011. Mycorrhizal specificity in the fully mycoheterotrophic *Hexalectris* Raf. (Orchidaceae: Epidendroideae). *Molecular Ecology.* 20:1303–1316.

Johnson, S.D. and T. J. Edwards. 2000. The structure and function of orchid pollinaria. *Plant Systematics and Evolution.* 222:243–269.

Richter, M., K.H. Diertl, P. Emck, T. Peters and E. Beck. 2009. Reasons for an outstanding plant diversity in the tropical Andes of southern Ecuador. *Landscape Online.* 12:1–35. DOI:10.3097/LO.200912.

Singer, R.B., B. Gravendeel, H. Cross, and S.R. Ramirez. 2008. The use of orchid pollinia or pollinaria for taxonomic identification. *Selbyana*. 29:6–19.

Taylor, D.L., T.D. Bruns, T.M. Szaro, and S.A. Hodges. 2003. Divergence in mycorrhizal specialization within *Hexalectris spicata* (Orchidaceae), a nonphotosynthetic desert orchid. *American Journal of Botany.* 90:1168–1179.

Tremblay, R.L. 1992. Trends in the pollination ecology of the Orchidaceae: evolution and systematics. *Canadian Journal of Botany.* 70:642–650.

U.S. Fish and Wildlife Service (USFWS). 2013. Endangered and threatened wildlife and plants; 12-month finding on a petition to list Coleman's coralroot as an endangered or threatened species. *Federal Register.* 78:76795–76807.

WestLand Resources Inc. 2012. Rosemont copper project: Survey for *Hexalectris colemannii* and *H. arizonica* across Southeastern Arizona – 2012. Project No. 1049.35. Prepared for Rosemont Copper Company. Tucson, AZ.

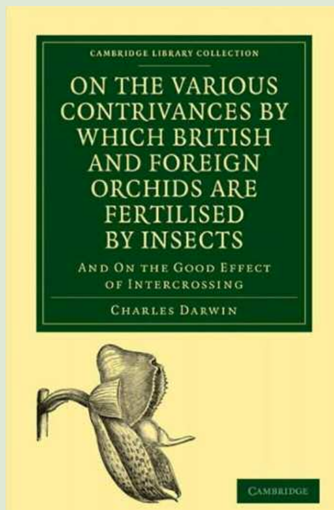
BOOK REVIEW *by Ries Lindley, Arizona Native Plant Society, Tucson Chapter*

On the Various Contrivances by which British and Foreign Orchids are Fertilised by Insects, and on the Good Effects of Intercrossing

by Charles Darwin 1862. 365 pages with 34 woodcuts. Cambridge Library Collection—Darwin, Evolution and Genetics, 1st Edition. $20.00, paperback. *Also available at Amazon.com and online at no cost, http://darwin-online.org.uk or at http://www.biodiversitylibrary.org.*

A Walk in Charles Darwin's Garden

Darwin is always a surprise. I don't know why, because he is always the same surprise. I begin reading something by Darwin, and a little voice says in one ear, with mild surprise, "Oh, he's much more readable than I expected." It should not be a surprise. It happened again with Darwin's book on orchids. The full title is certainly enough to give pause to the doughtiest reader, *On the Various Contrivances by which British and Foreign Orchids Are Fertilised by Insects, and on the Good Effects of Intercrossing*. For the orchid enthusiast, this would be the most difficult part of the book. The rest is fascinating. As the title implies, there is indeed the occasional turn of a phrase or language structure that gives a modern reader pause, but the book was written in English, and a little persistence will reward a reader with some quick learning about the nineteenth-century use of language.



Science is a cooperative project of enormous dimensions, with contributors throughout history and across vast expanses of geography contributing bits and pieces to the whole. Once in a while, a colossus comes along and knits knowledge together from many sciences and many realms. Darwin was one of those geniuses. It is a little hard to gain perspective on the magnitude of his contributions to the structure of science from reading his writings. *Orchids* is shot through with credits and asides like, "I am indebted to the Rev. B. S. Malden of Canterbury for two spikes of the Frog Orchis." It is easier to picture a hobbit in his hole writing down his thoughts on gardening than it is a man who made civilization see its entire history in a new light.

Orchids is an opportunity for anyone to walk through a really great mind and see nature from an inspiring point of view. Darwin's methods alone are thought-provoking. It is clear from the many references, like the one concerning the Rev. Malden, that Darwin did not sequester himself with a lot of like-minded university dons and speak in acronyms and inbred gibberish. The sharing of his garden was the sharing of his mind.

It is surprising how much was known about orchids in 1862, not just the taxonomy, but the gritty details of how orchids work. Darwin freely shared his methods, and the simplicity is jaw-dropping. He casually mentioned using various household items as stand-ins for insect proboscises, a human hair or a needle or a pencil used as a humblebee (today's bumblebee) head. For chemical agents to test an orchid's reactions he used spirits of wine (ethyl alcohol), chloroform, and nature's universal solvent and wetting agent, water.

What can be learned from such simple, straightforward methods? Quite a lot, it seems. Regarding *Orchis pyramidalis* (Figure 1). (This species has since been moved to *Anacamptis pyramidalis*.) Darwin worked out a logical explanation for some surprising stimulus responses in orchids. Let's take a look at one small part of the bigger process Darwin led us through. In this orchid, as in many others, pollen is collected into pollinia (*C*) comprising packets of pollen like the kernels also shown in *C*. The pollinia are attached to a sticky disc by caudicles, the stem-like structures between the hand-grenade pollinia and the sticky arched disc. When an insect, maybe a moth or butterfly, probes the flower for nectar, its proboscis ruptures a membrane exposing the sticky disc which adheres to the insect's proboscis. The end product of this simple act would look something like *F*, which is a representation of the needle Darwin used to discover this contrivance. In *F*, the disc has quickly dried into a death grip around the faux proboscis.

At this point in the process, we would expect that our butterfly would fly to another flower, and in the act of probing for nectar, it might jam the pollinia into the stigmatic surfaces there. The stigmatic surfaces are each marked as *s* in drawing *A*. Looking carefully at the height of

continued next page

Various Contrivances *continued*

the pollinia and the not-so-high stigmas, it's pretty clear the pollinia would miss. But the orchid was not through contriving. In drawing *G*, we see that the caudicles of the pollinia very quickly dry and draw the pollinia down into the position of two battering rams that are perfectly aimed to strike each of the stigmas dead center, delivering a huge load of pollen in one fell swoop. The precision of it beggars belief.

Darwin covered seven tribes defined by John Lindley (1799-1865), a number of genera in each, and several examples of species in each of the genera. His attention to detail was patient, thorough, and understandable. Each species is like a new chapter in an adventure. Orchids seem to come at us in every shape and form, and each one has some unique method of accomplishing its reproductive tasks. The outlandishly beautiful *Cypripedium* ("Ladies' slipper" in the parlance of the time) is a plodder reproductively. The anthers and stigmas are fused into a column, as in most orchids, and the labellum (lower petal) is a fusion of other plant parts, yet it appeared to Darwin that this beauty pretty much depended on the conventional methods of insect pollination. The pollen grains are not gathered into pollinia but are separate. They are picked up by an insect feeding on the plant and smeared on the stigma of the next flower in the same process. Darwin saw this as one of the oldest orchids. The more modern ones exhibit ever more exciting methods of reproductive inventiveness.

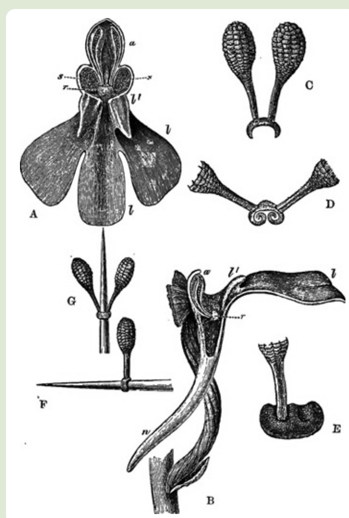
Listera ovata, tway-blade, is the most spectacular of these contrivances. When the nectar-seeking pollinator probes the flower for nectar, it will touch a structure called the rostellum (a structure that many eons ago was a stigma). The rostellum explodes and fires a sticky glue with the attached pollinia at the insect's head, where it sticks with a vengeance and can later be implanted into the stigma of the next flower.

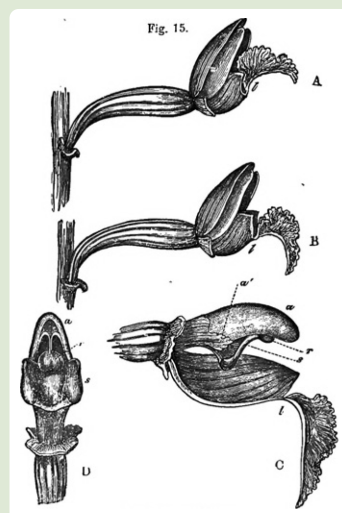
On a more sedate note, *Orchids* also covers some of the more ordinary devices orchids have developed to choreograph the work of their insect pollinators. *Epipactis palustris* has a labellum, the lowermost petal, which is hinged in the middle (Figure 2). An insect landing on the distal part of the labellum will pull the entire labellum down, revealing the nectar repository in the bowl at the base of the labellum. And what does the orchid gain from making this so easy for the nectar thief? Darwin explained:

> *Reflecting on the structure of the flower, it occurred to me that an insect in entering to suck the nectar, from depressing the distal portion of the labellum [l in drawings A, B, and C], would not touch the rostellum [r in drawing C]; but that, when within the flower, from the springing up of this distal half of the labellum, it would be almost compelled to back out parallel to the stigma [s in drawing C].*

In other words, the insect would brush the rostellum on the way out of the flower, not on the way in, and this act would cause the pollinia to be glued to its back by the sticky fluids there. This delivery of the pollen packet at the insect's exit also prevents the insect from fertilizing the flower with the flower's own pollen. The sequence is fiendishly elegant.

Darwin published this work in support of his work on the *Origin of Species*. He thought the addition of the orchid studies to *Origin* would make it too tedious. As a standalone work, it seems very approachable. It is not too long, and it has a single focus without digression. So here I must admit that there is indeed a bit of technical language in this book. But one need not read the whole book to appreciate the point of it. The book is available online at no cost, **http://darwin-online.org.uk** or at **http://www.biodiversitylibrary.org**. The book may be purchased used online for less than $20 in its most satisfying form, that is to say, hard copy. Read it in snippets if you like; it is just as enjoyable one species account at a time.





From left, Figure 1 *Orchis pyramidalis*. *a*. anther, *s*. stigma, *r*. rostellum, *l*. labellum, *n*. nectary. An original woodcut from Darwin, 1862, Cornell University Library. (**archive.org/details/cu31924084753122**) For information on the illustrator, G. B. Sowerby, visit **darwin-online.org.uk/graphics/FertilisationofOrchids_Illustrations.html**.

Figure 2. *Epipactis palustris*. *a*. anther, *s*. stigma, *r*. rostellum, *l*. labellum. An original woodcut from Darwin, 1862, Cornell University Library. **archive.org/details/cu31924084753122**

Left Growth at 20 months from sowing. Center Subsequent growth. Right Note size of roots relative to vegetative mass.
Photos courtesy the author.

Growing the Elusive Canelo Hills Lady's Tresses of Arizona's Cienegas *(Spiranthes delitescens* Sheviak*)*

by Aaron Hicks[1]

> *"You can get off alcohol, drugs, women, food, and cars, but once you're hooked on orchids, you're finished. You never get off orchids… ever."*
>
> *— Joe Kunisch, Commercial Orchid Grower*

Of the manifold wonders of the State of Arizona, that we even have orchids at all is certainly near the top of the list. Of course, given the variety of biomes found within the state, a glib assertion like that deserves some explanation, although we poor schlubs in Maricopa County who are blessed with a single occurrence of a single species in one remote canyon have to make do with the hybrid junk found at the grocery store. While the cattle-addled landscape may be otherwise bereft of orchids, we are graced with a few gems such as *Spiranthes delitescens.*

While we cannot eliminate the possibility that it is also found in Mexico, *S. delitescens* is known only from a few sites, all within Arizona. There are generally thought to be only four populations, some of which grace us with their flowers once a decade — or even less frequently. For those reasons I was fascinated with the idea of growing *S. delitescens* from seed, a process I will describe below.

It is generally thought that orchids require a fungus in order for their seeds to germinate in the wild. The embryonic orchid "harnesses" the fungus to do its bidding, and what was once thought to be a symbiotic relationship is now generally considered to be *mycotrophic,* meaning that the orchid plant lives parasitically upon the fungus. It is unclear how the fungus benefits from the relationship, or if it does so at all.

In culture, we replace the role of the fungus with sugars and starches, providing carbon in liquid form. The ubiquity of bacteria and fungi that also enjoy these carbon sources require this be done so in an axenic culture, in which everything from the media and container to the seeds are sterilized of undesirable organisms (i.e. everything but the orchid embryo itself). This works well enough for the plurality of species, although the fussy achlorophyllous orchids remain recalcitrant about this sort of thing. These techniques were developed for tropical epiphytes, plants which grow on other plants and are not parasitic on them. Over the years and with varying levels of success, there has been increased interest in how to get the temperate terrestrial species to grow in this fashion. Many platantheras, for example, continue to be stubborn and germinate sporadically if at all on synthetic media.

While *Spiranthes delitescens* is protected under federal law, provided the plants are not moved out of state, it is regulated mainly by the State of Arizona. In my efforts to cultivate this species, a permit to collect a limited amount of seed from a private landowner was secured, and the anonymous landowner was kind enough to entertain the presence of some guests for a few hours to collect some seed. 2001 happened to be an excellent year, and fruit-set was surprisingly good; plants with an inflorescence waist-high to an adult were found, much to everyone's surprise, and they were shedding dry seed, much to my amazement. A small amount of seed from two spectacular plants was secured, and transported back to the lab. Seed was refrigerated for over three months before attempting to sow it, and some was placed in liquid nitrogen for long-term storage.

So it was with some trepidation that I initially faced down the problem of trying to get *Spiranthes delitescens* into culture. With enough genera and species to entertain the most pedantic of taxonomists and collectors of plant esoterica, there are

continued next page

[1]Orchid Seedbank Project, Chandler, AZ, ahicks51@cox.net

frequently guidelines that can be followed for growing orchids *in vitro*: tropical epiphytes need *this* sort of medium, tropical terrestrials of *that* genus do well on a different medium, while a specific tropical genus might do better when sown using completely different media and techniques. For *Spiranthes*, however, there were no such guidelines. But as a group they seemed to offer no particular difficulties.

Fortunately, this premise proved to be correct, and within 20 months, healthy seedlings were to be had in the form of quickly growing plants in axenic culture. The black coloration of the medium is from the presence of activated charcoal, the precise function of which is unknown. Its presence seems to help with the growth of orchids *in vitro,* and as a darkening agent it almost certainly benefits *Spiranthes* and presumably other terrestrial orchids.

Growth *in vitro* was surprisingly fast (by orchid standards), and root development was superb. This is perhaps not unexpected for a plant that can survive underground for years at a stretch.

Symbiotic germination was also attempted. A colleague provided me with samples of Sbrev 266, a fungus isolated from *Spiranthes brevilabris* that demonstrated the unusual ability to germinate seeds of a species other than that from which it had been isolated. At the time, *Spiranthes delitescens* was the third such species, and Sbrev 266 has since been shown to work with a dozen or more species, thus putting it well ahead of the other fungal isolates known to germinate orchid seeds which can germinate only one species of orchid (to the best of my knowledge). I decided not to explant (remove living tissue from the natural site of growth and place in a medium for culture) any of these other fungal isolates as there is no guarantee that they would not be pathogenic to species endemic to Arizona.

At the time, this represented the third attempt at growing *Spiranthes delitescens* in sterile culture; Chuck Sheviak reported growing a few *in vitro,* but never deflasked them (Sheviak, pers. comm.). The Cincinnati Zoo hatched out a handful of plants, none of which survived.

Above *Spiranthes delitescens* seedlings in cultivation. Right *S. delitescens* in flower. *Photos courtesy Hope Jones.*

The efforts here described allowed us to disseminate some plants to a colleague at the University of Arizona, who grew them on to flowering within 3–4 months of deflasking them.

Of several plants deposited in the hands of a private grower, one persisted for 15 years, flowering in pot culture in 2016, but it was not self-fertile, as I had thought was the case based on the large number of fruits set when I first encountered this species in 2001. There is perhaps a pollinator in the field that is quite busy, as gauged by how many fruits set on an individual plant. Similarly, I suspect both recruitment and senescence are relatively rare events. The landowner from whom I obtained the seeds has individual plants located via a "step log," and these plants persist throughout the years with no new plants documented to the best of my knowledge. It is conceivable that individual plants within this setting are of considerable age.

The techniques used to grow this species from seed were written up, and sent to the appropriate officer at the Arizona Game and Fish Department, and my detailed methods and results were published (Hicks 2007) for anyone who wishes to replicate this work.

References

Hicks, Aaron. 2007. On the germination and subsequent culture of *Spiranthes delitescens* Sheviak in sterile culture. *Orchid Digest.* 71(3).

Figure 1 (upper left) *Cypripedium parviflorum* (Yellow Lady's Slipper). This beautiful Lady's Slipper has a broad range of distribution across the U.S. and Canada and occurs in a variety of habitats from mesic forests to wetlands (**http://goorchids.northamericanorchid center.org/species/cypripedium/parviflorum**). It reaches its western limit in Arizona (Coleman 2002). *Photo courtesy of Hal Horwitz.*

Figure 2 (lower left) *Corallorhiza striata* (Striped Coral Root) is widely distributed across central and southern Canada as well as across northern and western states in the U.S. (**http://goorchids.northamericanorchid center.org/species/corallorhiza/striata**). Like most species in the genus, the species relies on fungi for most of its nutritional requirements. In Arizona the species occurs in 8 counties and, like most orchids, at sites at higher elevation (Coleman 2002). *Photo courtesy of Hal Horwitz.*

Figure 3 (center) *Hexalectris warnockii* (Purple Spike Coral Root). This striking orchid is known to occur only in Arizona and Texas (**http://goorchids.northamerican orchidcenter.org/species/hexalectris/warnockii**), occurring in only one county in Arizona (Coleman 2002). It is considered 'imperiled' globally and listed as 'highly state rare' in Arizona. Similar to species of *Corallorhiza*, the species depends on fungi for most of it nutritional needs and individuals can remain belowground for several years between blooming events. *Photo courtesy of Hal Horwitz.*

Figure 4 (right) *Epipactis gigantea* (Chatterbox Orchid). A western U.S. species (**http://goorchids.northamerican orchidcenter.org/species/epipactis/gigantea**) that is considered to be secure globally is widespread in Arizona in wet habitats between elevations of 400-2140 meters. *Photo courtesy of Gary van Velsir.*

The Arizona–New Mexico Regional Effort of the North American Orchid Conservation Center: *Conserving Native Orchids in the Southwest*

by Dennis Whigham[1]

Orchids in the southwest where it is typically hot and dry? The answer to that questions is a resounding *Yes* (Figures 1–4) and the diversity of native orchid species in Arizona (26) and New Mexico (32) is not that different from neighboring states. An overview of orchid species and habitats in the southwest can be found in Ron Coleman's contribution to the gallery section in the North American Orchid Conservation Center website (**http://northamerican orchidcenter.org/featured-orchids-of-southwestern-us**). Regionally, California has 36 species and that big Lone Star State to the east has 56. The higher species diversity in California and Texas is mostly due to the presence of a higher diversity of habitat types. California has many mountainous areas and the northern part of the state has much more precipitation and is cooler; conditions that are ideal for many terrestrial orchids. The eastern part of Texas is much wetter than the western part of the state and orchids in that area are more similar to species that are more abundant in the southeastern part of the country. Even states to the north (Colorado = 28 and Utah = 23) have similar numbers of species and the only neighboring state with a much smaller number of species is Nevada, but even there the number (16) demonstrates that native orchids are tough and can make it in just about any landscape. What about orchid conservation

continued next page

[1]Senior Botanist, Smithsonian Environmental Research Center, 467 Contees Wharf Road, Edgewater, MD 21037, whighamd@si.edu.

Figure 5 Protocorm of *Corallorhiza odontorhiza* (Autumn Coral Root). This myco-heterotrophic species only occurs in eastern U.S. and Canada but the underground protocorm stage shown in this image would be similar for the species that occur in Arizona (*C. maculata*, *C. striata*, *C. wisteriana*). All terrestrial orchids require interactions with fungi to meet their nutritional needs at the protocorm stage (Rasmussen 1995).

Conserving Native Orchids in the Southwest *continued*

in the southwest? Is much being done to ensure that native orchids survive, especially given the extent of urban development and the possible consequences of future climate conditions?

The North American Orchid Conservation Center (NAOCC) is a coalition of collaborators that cares about native orchids and has embarked on a journey to ensure that the diversity of native orchids in the U.S. and Canada survives for the benefit of future generations (**http://northamericanorchidcenter.org**). Starting with an idea and funding from two initial partners (Smithsonian Institution and the United States Botanic Garden), NAOCC now includes more than forty partner organizations distributed across the continent and has taken the initial steps to fulfill the ecologically based conservation model developed by NAOCC. The premise behind NAOCC is that native orchids are disappearing or are moving into the threatened or endangered status in some parts of their range of distribution faster than techniques have been developed to ensure their survival. Few native orchids are grown in botanic gardens, and even in those sites, efforts to grow them are more for display than conservation.

NAOCC has developed a new paradigm for orchid conservation and the long-term focus will be to link the knowledge base that is necessary for successful conservation to involvement of individual citizen scientists as well as private and public organizations committed to conservation.

What is the NAOCC model? First and foremost, it is based on ecological principles. One objective is to conserve the genetic diversity of species by collecting and storing seeds from across the range of distribution of all species in the U.S. and Canada. Successful accomplishment of this objective will ensure that the genes that have evolved as species have migrated across the country will be secure and available to support efforts to successfully propagate native orchids. Successful propagation of native orchids is, however, not simple because it also requires that orchids are propagated alongside the fungi that they require for successful growth and reproduction. Orchids associate with fungi (they are called mycorrhizal fungi) at every stage in their life cycle. At least one stage — the stage between a seed and a seedling, called a protocorm (Figures 5 and 6) — does not have chlorophyll and baby orchids cannot become seedlings unless the protocorm becomes associated with an appropriate fungus. Some orchids, such as the species of *Corallorhiza* (Figure 5), have evolved to be so dependent on fungi that they do not have leaves and they obtain all of the resources from fungi at every stage of their life cycle. Yes, orchids 'eat' fungi! Because of the dependency of orchids on mycorrhizal fungi, similar to seeds, we need to obtain, culture, and store the genetic diversity of orchid mycorrhiza in fungal banks to support restoration and conservation efforts. The third element of the NAOCC model is to use the seeds and fungi stored in seed and fungal banks to learn how to propagate native orchids with a goal of establishing

continued next page

Figure 6 Seeds and protocorms of *Aplectrum hyemale* (Putty Root). This image of seeds and small protocorms of the Putty Root orchid are typical of all terrestrial orchids. Seeds (called 'dust seeds') are very small and when a seed germinates, the embryo needs to come into contact with an appropriate fungus to secure the resources needed to grow into and through the protocorm state. On the protocorms you see small structures that look like roots. These are not true roots but rhizoids and it is through the rhizoids that the fungi enter the cells of the protocorm — where they are digested by the orchids.

Who's Who at AZNPS

BOARD OF DIRECTORS

Anthony Baniaga
Director, Tucson Chapter President
anthony.baniaga@gmail.com

Cass Blodgett
Director at Large, Phoenix Chapter
cblodgett2@cox.net

Wendy Hodgson
Director; Education & Outreach Committee Chair
whodgson@dbg.org

Diane Kelly
State Treasurer
kelly@timdarby.net

Ries Lindley
Director; State Secretary; Co-Editor, The Plant Press
ries.lindley@gmail.com

Valerie Morrill
Director, Yuma Chapter President
bebbie@hotmail.com

Kirstin Olmon Phillips
Director, Flagstaff Chapter
kphillips@musnaz.org

Mike Plagens
Director, Phoenix Chapter President
mjplagens@arizonensis.org

Doug Ripley
President, Co-Editor, The Plant Press
jdougripley@gmail.com

Andrew Salywom
Director at Large
asalywon@dbg.org

John Scheuring
Conservation Committee Chair
jfscheuring@hotmail.com

Sue Smith
Director, Prescott Chapter President
suejs01@yahoo.com

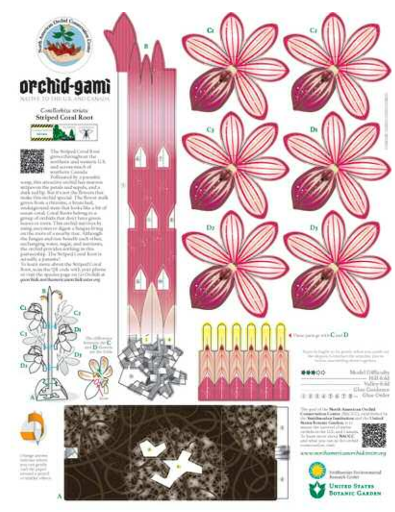
AZNPS COLLABORATORS

Cass Blodgett
Web Editor
cblodgett2@cox.net

Patricia Sanchez
Administrative Assistant
aznpsinfo@yahoo.com

Shelley Silva
Happenings *Editor*
shelley.a.silva@gmail.com

Julie St. John
The Plant Press
Layout Editor
julieStDesign@gmail.com



From left, Figure 7 Front page of the paper punch-out model of the Striped Coral Root orchid. NAOCC has developed models of 25 native orchids. For pdf versions of the models that can be printed on a two-sided printer, cut out and assembled, contact Jay O'Neill at **oneillj@si.edu**. Jay can also provide copies of the five models that have been printed.

Figure 8 Photograph of the completed *orchid-gami* model of the Striped Coral Root orchid.

Conserving Native Orchids in the Southwest *continued*

sustainable populations of native orchids. In practice, botanical gardens will be the primary focus of propagation efforts. They will learn to grow orchids using seeds and fungi collected in their regions, and once the knowledge base for establishing sustainable populations has been developed, efforts to restore orchids will be more successful. In addition, the knowledge gained will enable citizen scientists to grow native orchids in their gardens. What is the advantage of growing native orchids in people's gardens as well as in botanical gardens? First, it means that we can grow orchids in places where they may have grown in the past but were destroyed through urbanization and habitat degradation. Second, having a more sustainable population distributed across the landscape means that it increases the chances that seeds and fungi will be naturally distributed; further increasing the probability that populations will become established and species will be able to move across the landscape in response to climate change. The final element of the NAOCC model is that we want to use knowledge about native orchids to increase botanical literacy and teach concepts of ecology and conservation to current and future generations. As one example, NAOCC has developed *Go Orchids* (**http://goorchids.northamericanorchidcenter.org**), a website that has almost all of the known information about

continued next page

Announcing the 2017 Arizona Botany Meeting 13–14 May 2017

Held in Cooperation with the Prescott College Natural History Institute

Crossroads Conference Center, Prescott College, Prescott, Arizona

Please plan on attending! Presentations and poster sessions will be offered on 13 May with an optional evening dinner and program. Several field trips will be offered on Sunday, 14 May.

The conference theme is: ***Where Mexico Meets Canada — Exploring the Botanical and Ecological Significance of Arizona's Mogollon Highlands.***

Please see the AZNPS website (**AZNPS.com**) for registration information and additional details.

Photo of Crossroads Conference Center courtesy Prescott College.

Conserving Native Orchids in the Southwest *continued*

native orchids in the U.S. and Canada. The website can be used for teaching purposes and is a unique online source of information about native orchids. Another NAOCC venture into the educational area has been the development of *orchid-gami,* paper models of native orchids. Twenty-five punch-out models were developed to be representative of native orchids that occur in different parts of the U.S. and Canada, including the Striped Coral Root that occurs in the southwest (Figures 7 and 8). A few of the *orchid-gami* models have been printed and pdf files of all 25 are available. While only a few of the models have been printed, they have attracted attention and are being used in orchid shows around the country and even internationally.

The Native Orchid Conference in Benson, Arizona, was a wonderful opportunity to introduce NAOCC to people in the region. It was a success! A regional effort has been formed to collect samples of orchids and orchid mycorrhizal fungi initially from all species in Arizona and New Mexico over the next five years. Partners in the effort are the Desert Botanical Garden, the University of New Mexico, and orchid enthusiasts such as Ron Coleman (author of *The Wild Orchids of Arizona and New Mexico* and *The Wild Orchids of California*). While initial efforts will focus on two states, collaborators at Texas Tech University will also actively participate in the project with hopes of collecting materials from native orchids in western Texas. Since the Arizona-New Mexico regional effort was started at the NOC meeting in Benson, collecting efforts have already started. Andrew Salywon of the Desert Botanical Garden in Phoenix has been sending samples to the Smithsonian and several fungi from Arizona orchids are now being cultured in Maryland.

The excitement, support and enthusiasm established at the Benson meeting ensures that the Arizona-New Mexico partnership with NAOCC will result in the continued existence of native orchids in wonderful habitats such as those found in the Sky Islands. Propagation of native orchids and the involvement of citizen scientists in this effort will ensure that our native orchids continue to flourish for future generations to enjoy. How can you support the effort? Visit the NAOCC and *Go Orchids* websites and learn more about this unique conservation effort. Get engaged by financially supporting NAOCC and the regional effort and, finally, spread the word about NAOCC. You might even want to get a few of the *orchid-gami* models to test your creative skills.

References

Coleman, R.C. 2002. The wild orchids of Arizona and New Mexico. Cornell University Press, Ithaca and London.

Rasmussen, H.H. 1995. Terrestrial orchids, from seed to mycotrophic plant. Cambridge University Press, New York.


Left Rancho la Volanta. *Photo courtesy Sue Carnahan.* Right View from Sierra Buenos Aires. *Photo courtesy Luis Gutiérrez, Norte Photo.*

Madrean Discovery Expedition to the Sierra Buenos Aires

by Thomas R. Van Devender[1], Susan D. Carnahan[2], and Ana L. Reina-Guerrero[1]

The Sierra Buenos Aires is one of 32 mountain ranges (or complexes of several ranges) crowned by oak woodland or pine-oak forest in northeastern Sonora. These Sky Islands plus another 23 in Arizona are in the Madrean Archipelago between the northernmost Sierra Madre Occidental in Sonora and the Mogollon Rim in central Arizona. This area is part of the Mexican Pine-oak Woodlands Global Biodiversity Hotspot recognized by Conservation International in 2007. The Sierra Buenos Aires is just south of the massive Sierra de los Ajos. To the south, the Sierra la Púrica extends this Sky Island complex to Nacozari.

The Madrean Discovery Expeditions (MDE) program at GreaterGood.org documents the plants and animals in the Sonoran Sky Islands. Expeditions to the Sierra el Tigre in 2015 and the Sierra Elenita in 2016 were co-sponsored by Ajos-Bavispe Reserva Forestal Nacional y Refugio de Fauna Silvestre, a park in the Mexican Comisión Nacional de Áreas Naturales Protegidas (CONANP) system. The Ajos-Bavispe Reserve is the sister protected area to Coronado National Forest in Arizona. In August 2016, 49 volunteer participants, including biologists, volunteers, and photographers, converged on the Sierra Buenos Aires ("good air mountain" in Spanish) to document the biodiversity. A total of 17 four-wheel-drive vehicles met in Cananea and caravanned to base camp at El Aserradero ("sawmill" in Spanish) in the Sierra Buenos Aires.

The study area was 65 km (40 mi) south of the Arizona border, just west of Douglas in the *Municipios* ('counties') of Bacoáchi and Fronteras. The highest peak in the Sierra Buenos Aires at 2245 m is located between Fronteras (1174 m elevation) in the Río Bavispe drainage to the east and Bacoáchi (1091 m) in the Río Sonora drainage to the west.

continued next page

[1]GreaterGood.org, 6262 N. Swan Rd., Tucson, AZ 85718, [2]Herbarium, University of Arizona, Tucson, AZ 85721.



Left Cardinal catchfly. Center and Right Chain fern and closeup. *Photos courtesy Tom Van Devender.*


Left Bellflower beardtongue (*Penstemon campanulatus*). *Photo courtesy Stephen L. Minter.* Right *Limoncillo. Photo courtesy Sue Carnahan.*

Sierra Buenos Aires *continued*

The vegetation ranges from desert grassland up to oak woodland and pine-oak forest. Arroyo Agua Escondida flows westward from Puerto Mababi to Rancho la Volanta, while Arroyo San Vicente flows northward to join Arroyo Mababi. These canyons support riparian forests commonly with Arizona sycamore (*Platanus wrightii*) and locally Arizona alder (*Alnus oblongifolia*), bigtooth maple (*Acer grandidentatum*), and New Mexican locust (*Robinia neomexicana*). The spring at Aguaje de la Capilla in upper Arroyo el Mababi is a special place with a seepy slope covered with huge chain ferns (*Woodwardia spinulosa*) in a shady riparian deciduous forest. Most of the mountain is granite, with a few limestone areas.

The area is rich in history. Bacoáchi, a town 50 km (30 mi) southeast of Cananea, means "water snake" in the language of the Ópata Indians, a tribe that is now completely merged into the regional *mestizo* culture. The Spanish were in the area long before Mexico gained its independence in 1821. Until the 1880s, raids by Apache Indians were a constant threat.

The Spanish explorer Juan Bautista de Anza (1735-1788), born in Fronteras, led the first Spanish overland expedition to the Las Californias Province of New Spain in 1769, establishing the first Spanish settlement in California, the Presidio of San Diego, and

continued next page


Left Milkweed longhorn beetle (*Tetraopes femoratus*). *Photo courtesy Charles Hedgcock.* Right Milkweed (*Asclepias nyctaginifolia*). *Photo courtesy Tom Van Devender.*

Honoring Dr. Tom Van Devender

In October 2016, Dr. Tom Van Devender attended the *X Simposio Internacional sobre Flora Silvestre en Zonas Aridas* in Hermosillo, Sonora at the invitation of Dra. Magdalena Ortega-Nieblas. Tom represented GreaterGood.org with presentations on the Project WILDCAT predator protection program and the Madrean Discovery Expeditions database. After the presentation, Tom was honored by Jesús Sánchez-Escalante, Curator of the Universidad de Sonora Herbarium, with a slide show illustrating Tom's nearly 50 years of field trips in Sonora, followed by the presentation of a special recognition award for his remarkable and invaluable contributions to the understanding of Sonoran natural history.

Tom is one of the most important and accomplished biologists in Arizona. He has a long-term interest in the flora and fauna of the Sonoran Desert Region, and has collected over 20,000 herbarium specimens. Many of them are deposited into the herbaria at the University of Arizona (Tucson), Universidad de Sonora (Hermosillo), and UNAM (Cd. México). He has surveyed local floras in the Sonoran Desert in the Tucson Mountains and Ironwood Forest National Monument in Arizona. He has also studied the plants in tropical forests near Alamos in southern Sonora and Mazatlán in southern Sinaloa, and in pine-oak forests near Yécora in the Sierra Madre Occidental in eastern Sonora. He and his wife Ana Lilia Reina-G. have a special interest in the flora of La Frontera, the 100 kilometer zone in northern Sonora just south of the Arizona border — especially in Chihuahuan desertscrub on limestone, desert grassland, and tropical plants at their northern range limits. He is also a herpetologist with strong interests in the biogeography of the Sky Island Region in the Madrean Archipelago.

A charter member of the Arizona Native Plant Society, Tom has generously donated his time and efforts to many Society activities and projects over the years. He has published well over a hundred research publications including journal articles, book chapters, and six books on desert grassland, the cacti of Sonora, the Sonoran desert tortoise, packrat middens, and the paleoecology of the southwestern deserts.

Congratulations Tom on this well-deserved recognition!



Left Butterfly pea. Center Smaller parasa moth (*Parasa chloris*). Right Thurber's hoarypea. *Photos courtesy Sue Carnahan.*

Sierra Buenos Aires *continued*

was the first European to see the fog-bound San Francisco Bay. In 2010, Fronteras again gained prominence with the discovery of a rich fossil deposits, including many new species of ceratopsid, duck-billed ostrich, and therapod dinosaurs.

With the exception of a wildlife camera study by Ajos-Bavispe biologists, the flora and fauna were unknown prior to MDE Sierra Buenos Aires. This is ironic because Fronteras, Rancho Mababi, and Bacoáchi were important localities on the 1850-1854 survey which established the boundary between the United States and Mexico after the Mexican-American War and the Gadsden Purchase. American botanists and zoologists on the survey expedition made the first important collection in *la Frontera* along the Arizona-Sonora border. In 1851, George Thurber, a Rhode Island botanist, visited Rancho el Mababi, where he collected three new species — Thurber's diphysa (*Daubentonia thurberi,* now *Diphysa thurberi*), Thurber's hoarypea (*Cracca thurberi,* now *Tephrosia thurberi*), and Thurber's sedge (*Carex thurberi*). He also collected the first Sonoran staghorn cholla (*Cylindropuntia thurberi*) in Bacoáchi on the same trip.

Asa Gray, considered the most important American botanist of the 19th century, was a botany professor at Harvard University for several decades. In 1854, he published *Plantae Novae Thurberianae,* a monograph describing the new genera and species of plants collected by Thurber in New Mexico and Sonora. New species of plants named for Thurber by Gray and others in *Abutilon* and 23 other genera occur in Sonora.

The MDE Sierra Buenos Aires was a huge success. The participants from the United States (Arizona, Colorado, and North Carolina), Mexico (Sonora, Mexico City), and Canada (Alberta) went on hikes from base camp or rode in Ajos-Bavispe pickups to study areas. Cooks from Ajos-Bavispe provided delicious Sonoran breakfast and dinner to everyone. Activities included botanizing, birding, butterfly and reptile watching, photography, and always sharing discoveries. Ajos-Bavispe interns placed wildlife cameras to record nocturnal mammals. Botanists George Ferguson, Frank Reichenbacher, John Anderson, Steve Hale, Jim Malusa, Deb Sparrow, Van Devender, Carnahan, and Reina-G. combed the mountain, observing, collecting, and pressing about 400-500 species!! With every step, carpets of young limoncillo (*Dalea lumholtzii*) filled the air with a fresh lemon scent.

The Mt. Davis brickellbush (*Brickellia parvula*), seen in three different locations, was the first record for Sonora. Other noteworthy plants discovered included butterfly pea (*Clitoria mariana*), Heller's draba (*Draba helleriana*), and chain ferns. Arizona dewberry (*Rubus arizonensis*), mintleaf bergamot (*Monarda fistulosa* var. *menthifolia*), sharpglume brome

continued next page



Left Wright brachystigma. *Photos courtesy Tom Van Devender.* Center Copper fern (*Bommeria hispida*) and Right Slender sensitive pea. *Photos courtesy Sue Carnahan.* Inset George Thurber. *Photo courtesy Michigan State University.*

SPOTLIGHT ON A NATIVE PLANT *by Bob Herrmann, Arizona Native Plant Society, Cochise Chapter*

Rothrock's Knapweed (*Plectocephalus rothrockii*)

When some folks hear about knapweed, they think of it as an invasive species. But not so *Plectocephalus rothrockii*. Rothrock's knapweed is an Arizona native which can be seen blooming in the lower canyons of southeastern Arizona. The plant starts blooming as early as June and a few are still around in October. Rothrock's knapweed is one of our most colorful wild flowers and it is very popular with pollinators, thus making it a fun Arizona native plant to photograph. Two-tailed, Pipevine, and Giant Swallowtails compete for the nectar. The local Dull Firetip, the American and Painted Ladies, and even the Monarch butterfly also pollinate this plant. Sometimes you can be fooled as to whether you're seeing a hummingbird or the Hummingbird Hawk-moth on the flowers; both can be seen pollinating the same flower at the same time.

Plectocephalus rothrockii is a member of the Aster Family (Asteraceae) and was formerly classified in the genus *Centaurea*. It is a multi-stemmed hardy annual with lance-shaped leaves and grows up to 5 feet in height. It bears pale purple to pink flower heads 4 to 5 inches across, with off-white to yellow centers. In Arizona, *P. rothrockii* is restricted to moist canyons of southeastern Arizona and is known to occur only in the Huachuca and Chiricahua Mountains. There is also one record of it occurring in the Pinos Altos Mountains of New Mexico. It is much more common in the Mexican Sierra Madre Mountains to the south.

Rothrock's knapweed was named for Joseph Trimble Rothrock (1839-1922) by Jesse M. Greenman of the Missouri Botanical Garden. Dr. Rothrock was a physician, botanist, and forester. He enlisted in the Civil War and was Captain of Company E, 20th Regiment, Pennsylvania Volunteer Calvary. He later served as a surgeon and botanist under Lieutenant George M. Wheeler of the Wheeler Survey (1873-1875) for the geographical and geological exploration and survey west of the 100th Meridian. He also served as the first president of the Pennsylvania Forestry Association (PFA) in 1886.

Sierra Buenos Aires *continued*

(*Bromus mucroglumis*), and smooth sumac (*Rhus glabra*) are rare in Sonora. Sonoran birdfoot trefoil (*Hosackia alamosana*) is a perennial herb with yellow and white petals that grows at the edge of streams. It is found from Sinaloa north through Sonora, reaching Arizona in Sycamore Canyon west of Nogales. The flowers of common species such as Arizona bluecurls (*Trichostema arizonicum,* blue and white), cardinal catchfly (*Silene laciniata,* red), coralbells (*Heuchera sanguinea*, red), firecracker bush (*Bouvardia ternifolia,* red), Huachuca Mountain adder's-mouth orchid (*Malaxis corymbosa,* pale yellow), Parry's sage (*Salvia parryi,* blue), pineapple sage (*S. elegans,* red), slender sensitive pea (*Chamaecrista serpens,* yellow), and Wright brachystigma (*Brachystigma wrightii,* yellow) are always lovely.

Clitoria mariana was described in 1783 by the Swedish botanist Carl Linnaeus. It is a perennial herb with a lovely lavender flower native to the eastern and southwestern United States and Asia. Although Linnaeus is considered the father of modern taxonomy, he was an iconoclast with a rakish wit, and was despised by the church at the time. His scientific names often had earthy connotations. He named our stalked puffball *Lycoperdon* — "wolf fart" in Latin! *Cracca* was another Linnean name.

GreaterGood.org is continuing the tradition of expeditions — sending large groups of biologists to document the animals and plants in the Sonoran Sky Islands of Sonora, Mexico, for conservation, research, and education. It will take months to transcribe notes and identify unknowns. But it is clear that there will be a thousand or more records, hundreds of them with images, documenting the biodiversity of another Sky Island in the Madrean Archipelago. All of these observations and images will be publicly available in the Madrean Discovery Expeditions database (**MadreanDiscovery.org**).

Inset Carl Linnaeus. *Photo courtesy Wikipedia.*

THE ARIZONA NATIVE PLANT SOCIETY

PO Box 41206
Tucson AZ 85717
www.aznativeplantsociety.org

Nonprofit Org
US Postage
PAID
Tucson AZ
Permit #690

Address Service Requested

Printed on recycled paper.

New Members Welcome!

People interested in native plants are encouraged to become members. People may join chapters in Flagstaff, Phoenix, Prescott, Cochise County (Sierra Vista), Tucson, or Yuma, or may choose not to be active at a chapter level and simply support the statewide organization.

For more information, please write to AZNPS (see return address above), visit **www.aznativeplantsociety.org**, or contact one of the people below:

Cochise: Doug Ripley, jdougripley@gmail.com

Flagstaff: Dorothy Lamm, 928.779.7296

Phoenix: Michael Plagens, 602.459.5224

Prescott: Sue Smith, 408.507.7706

Tucson: Anthony Baniaga, anthony.baniaga@gmail.com

Yuma: Valerie Morrill, bebbia@hotmail.com

Membership Form

Name:

____

Address:

____

City/State/Zip:

____

Phone/Email:

____

Chapter preferred: ❍ State only ❍ Cochise County ❍ Flagstaff ❍ Phoenix ❍ Prescott ❍ Tucson ❍ Yuma

Enclosed:
❍ $15 Student
❍ $30 Individual
❍ $35 Family
❍ $50 Organization
❍ $75 Commercial
❍ $100 Plant Lover
❍ $500 Patron
❍ $1,000 Lifetime

Mail to:
Arizona Native Plant Society
PO Box 41206, Tucson AZ 85717