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*The Native Orchid Conference Journal* 9(4). October-December 2012.

# A New and Rare *Spiranthes* from the Sierra Nevada

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For 30 years I've puzzled over a highly variable complex of *Spiranthes* ranging through much of montane California and southwestern Oregon. Combining features of *S. romanzoffiana* Cham. and *S. porrifolia* Lindl., they suggest a hybrid complex, yet they exhibit distinctive features as well. My initial collections in 1983 showed the bulk of the problem to be at the tetraploid level, thereby suggesting an allotetraploid origin and simultaneously introducing considerable difficulty in interpretation of morphology. The complexity seen in the field and disclosed in cultivation and the lab dictate a population-based approach that cannot be adequately addressed from the other side of the continent. Accordingly, I have been reluctant to publish fragmentary and tentative results. The recent description of *Spiranthes stellata* P.M.Br., Dueck, & K.M. Cameron and accompanying discussions (Brown, Dueck, & Cameron 2008; Dueck & Cameron 2008) focus on only a limited portion of this broader and more complex problem. Nonetheless, they have provided important new data; with the publication of *S. stellata*, it seems both possible and necessary to refine the newly established picture with the present contribution.

In their publication of S*piranthes stellata*, the authors unknowingly included two elements within the proposed species. A widespread member, as represented by the holotype (*Colwell 07-279 et al.* [UC]), is tetraploid[1]. A second, very rare component is diploid. Field evidence supplemented by herbarium work suggests that these represent distinct populations; their similar, yet distinctive morphology indicates a close relationship and suggests recognition as subspecies.

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[1] The original description of *S. stellata* reported a chromosome count of "$n$ = 22 (preliminary)." The specimens on the holotype sheet and the published photographs are clearly comparable to plants I have counted and found to be tetraploid, with $n$ =44. To further delimit the concepts, I designate the central, complete specimen of *Colwell 07-279 et al.* [UC] lectotype.

## *Spiranthes stellata* subsp. *perexilis* Sheviak, *subspec. nov.*

**Type:** U.S.A.: California: Plumas Co. Along small tributary to Butterfly Creek, 0.3-0.5 mi N of Butterfly Valley, N edge Sec. 28, N of Quincy. Open springy fen meadow with scattered small Pinus; plants commonly in and along small rivulets, very rare in dense sod. Fls. pure white. 21 Aug 1983. *C.J. Sheviak 2500* [NYS]. (Figure 1, page 16).

A subsp. *stellata* floribus quarta parte minoribus, pallidioribus inflorescentia tenuissimi differt.

Plants very slender, 200-370 mm tall. Leaves 3-4, basal, 1 or 2 on the very base of the stem, linear to linear-oblanceolate, 30-85 [-130] mm long, 2-5 [-7] mm wide, abruptly reduced to bracts upward. Inflorescence slender, secund to openly spiraled, 41-99 mm long (mean 62 mm) with 10-44 (mean 22) flowers. Flowers white, not significantly yellow, lateral sepals 5.0-7.0 mm (mean 5.8 mm) long x 0.6-2.3 mm (mean 1.5 mm) wide, lip 4.4-6.3 mm (mean 5.3 mm) long. ($2n = 44$ [66])

**Etymology:** "very slender," *exilis* denoting in particular thin, meager, feeble, etc., in keeping with the exceptionally narrow and delicate aspect of the plants.

**Specimens examined:** California: Fresno Co.: wet meadow above Mono Crossing, 15 Aug 1918, *A.L. Grant 1510* [JEPS]; Plumas Co.: common on sunny wet soil in marshy meadow. Butterfly Valley, near Quincy. 4000 ft. 21 Jul 1930. *R.J. Weatherby 1480* [UC]; bog and marsh at Butterfly Valley, 19 Aug 1949. *M.A. Nobs & S.G. Smith* 1445 [UC, DAV]; Tulare Co.: Giant Forest. 4 Aug 1919. *L.M. Newlon* 60 [JEPS].

*Spiranthes stellata* subsp. *perexilis* occurs in wet sites at moderate elevations. It is known from only a few collections and may be limited to the Sierra Nevada. I was fortunate to locate a large population in a sloping, spring-fed meadow. Two years later I studied the population in greater detail, but in subsequent visits, I found the site to have dried out and no plants could be found. I have not seen the plant again, despite repeated visits to the site, most recently in 2004. Presumably it occurs elsewhere in the immediate vicinity, but it has been absent from other nearby spring-fed meadows that I have investigated.

*Spiranthes stellata* subsp. *perexilis* shares with subsp. *stellata* an openly spiraled inflorescence and lateral sepals that do not form the hood of *S. romanzoffiana*, their apices instead free and straight to spreading widely. Nonetheless, it is very distinctive in the field and herbarium. The inflorescence is very long and exceptionally slender, and together with the very numerous, smaller flowers held well above the basal rosette of disproportionately small leaves, the aspect of the plants is very different from the stouter subsp. *stellata*, which is more typical of other *Spiranthes* of the region. The lip is entirely characteristic of *S. romanzoffiana* in shape and often also in venation. In contrast, that of subsp. *stellata* is highly variable, ranging from lanceolate to ovate and subpandurate; only rarely is it as strongly pandurate as in subsp. *perexilis* and *S. romanzoffiana*. The subapical adaxial surface of the lip of subsp. *perexilis* is distinctive in a low cushion of very short, but stout trichomes. The length of the trichomes varies, but they are a consistent feature. In contrast, this patch is more variably and weakly expressed in subsp. *stellata*, and is sometimes wholly lacking. The flowers are white to ivory in color, paler than the more generally yellowish flowers of subsp. *stellata*.

For many years the status and rank of *S. stellata* and its subspecies have been problematical due to evidence for gene flow in the larger *S. romanzoffiana* complex in the region and the floral similarity of subspecies *perexilis* to *S. romanzoffiana.* When I first studied extensive herbarium material from the region around 1982, I noted an abundance of collections of plants with yellowish flowers in mostly open spirals. The variable lip shape and development of a subapical trichome cushion suggested hybridization of *S. romanzoffiana* and *S. porrifolia*, and I annotated them as such. An openly spiraled inflorescence, too, is often a product of hybridization in the genus, even between densely-flowered species (*e.g.*, in *S. cernua* and *S. diluvialis*). The recent sequence data of Dueck & Cameron (2008) does not support this interpretation, however. That focuses attention on the similarities of subsp. *perexilis* and subsp. *stellata*. Indeed, the subspecies are so similar in most respects that the diploid subsp. *perexilis* is presumed to have been a progenitor of the tetraploid subsp. *stellata*. The question then is whether the greater variation in the tetraploids, their yellower color, and commonly stouter habit with larger flowers and broader leaves is a direct consequence of their polyploid condition or denotes a hybrid origin. It may be significant that Dueck & Cameron found different sequences in Oregon and California populations of *S. stellata s.l.* On the other hand, the salient features of subsp. *stellata*, including stouter growth, larger leaves and flowers, more intense yellow color and variable expression of lip characters are all of the sort that are commonly found in horticultural tetraploid breeding of diverse plants and hence might be the direct result of the tetraploid condition itself.

Of particular significance here is a single triploid individual that was found in the studied population of subsp. *perexilis* (Figure 2, page 17). The flowers of this plant were slightly larger, but the only notable difference was their greater dorsi-ventral dimension. This contributed a stouter aspect and perhaps suggests an approach to the flowers of subsp. *stellata*. The two ploidy levels might then merely represent population-level variation within the species. Arguing against this is the lack of integration of the diploid population within the tetraploids when various character traits are examined (Figure 3, page 4); the triploid ap-

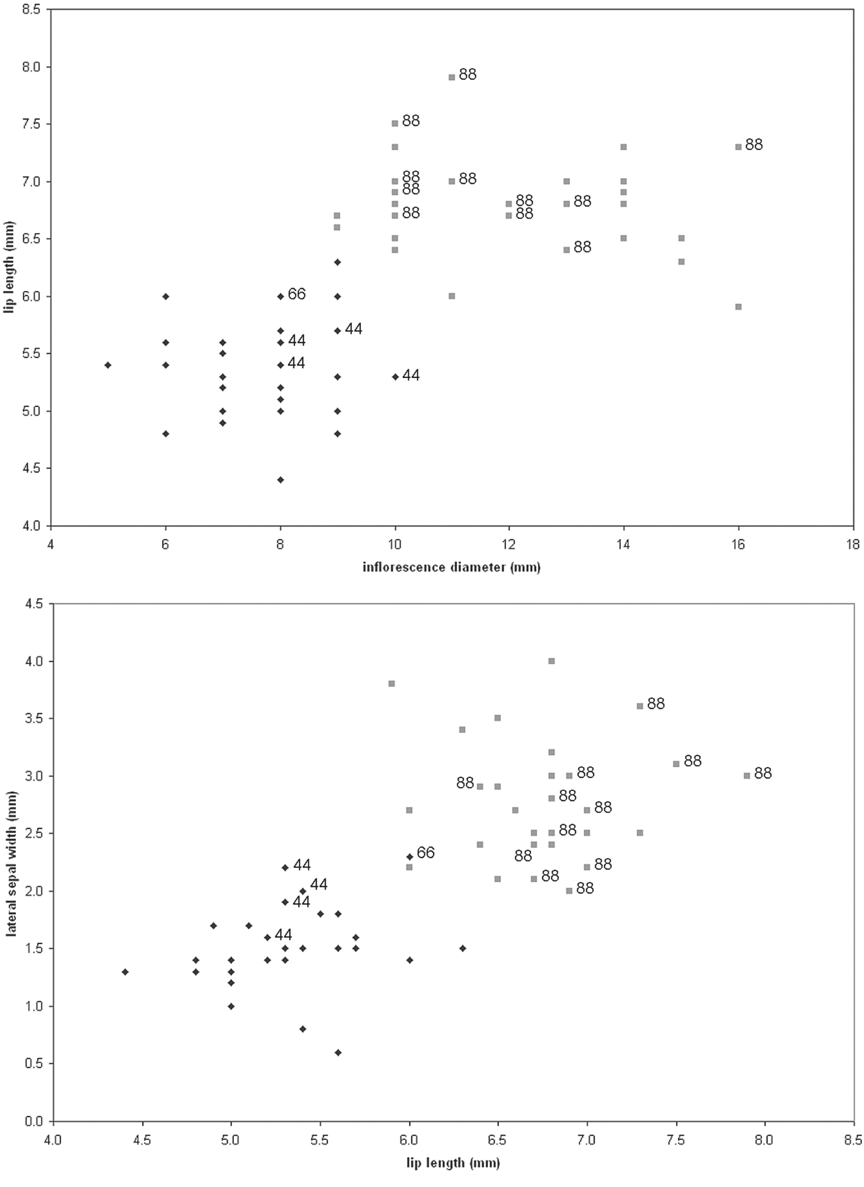

Figure 3. Scatterplots illustrating differences between and variation within *Spiranthes stellata* subsp. *perexilis* (black diamonds) and subsp. *stellata* (gray squares). Somatic chromosome numbers plotted for counted specimens. Note generally smaller flowers and more slender habit of subsp. *perexilis*. Note too the generally intermediate position of the triploid individual, but that it is not larger in all characters than normal diploid plants, and that there is no indication of an integration of subsp. *perexilis* into the domain of subsp. *stellata* that might indicate higher-level ploidy within the population of subsp. *perexilis*.

pears to be a very rare, perhaps unique, individual. Most significantly, with the exception only of the stout floral base, its characteristics do not predict those of the tetraploids; in all other respects it is merely slightly larger than the diploids, and not even in all characters. Its lip is identical to that of the diploids; it does not show the reduction of the apical dilation that is common in subsp. *stellata*. The characteristics of subsp. *stellata* and especially its extreme variability cannot be predicted from those of subsp. *perexilis* (Figure 4, page 5). Whether those features derive from a hybrid ancestry or through some other means, they suggest that the two taxa are distinct and subsp. *stellata* is not repeatedly generated from subsp. *perexilis*. Hence, they warrant formal recognition.

*Spiranthes stellata* subsp. *perexilis* appears to be related to the Central American *S. graminea* Lindl. and *S. nebulorum* Catling & Catling. All three share very small flowers in an openly spiraled inflorescence atop a very tall, slender, bracted scape and disproportionately small basal leaves. They comprise a distinct cordilleran component of the $n$ =22 based lineage. Beyond that, it appears to be related to *S. romanzoffiana* and *S. porrifolia*. Flower shape is virtually identical to that of *S. romanzoffiana*, lacking only the appressed sepal

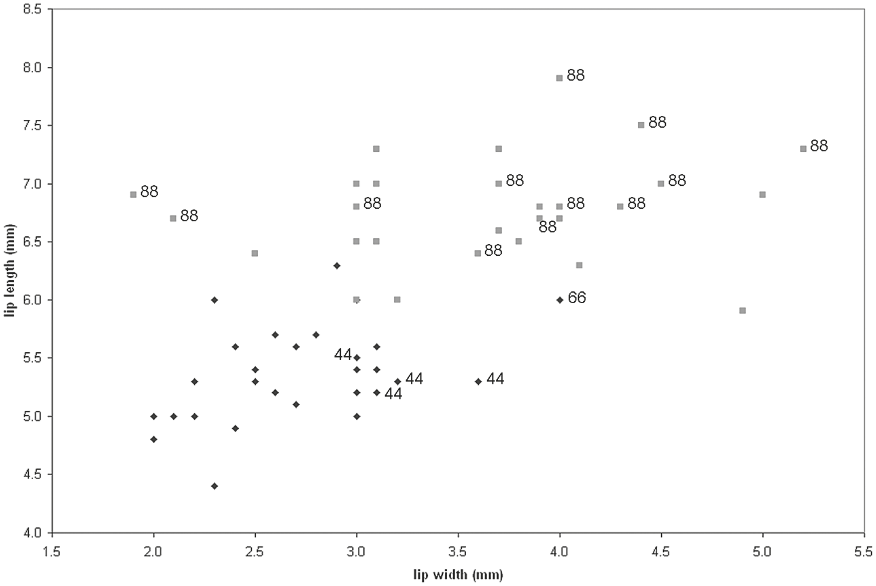

Figure 4. Scatterplot illustrating greater variability of *Spiranthes stellata* subsp. *stellata* (gray squares) than of subsp. *perexilis* (black diamonds). Somatic chromosome numbers plotted for counted specimens. Lip width, a component of shape, of subsp. *stellata* encompasses the range of subsp. *perexilis* and greatly exceeds it. This could result from recombination within a hybrid genome, but might instead result directly from the tetraploid condition. Its origin and significance are unknown.

apices and floral hood development of *S. romanzoffiana*, a condition that in fact is not always expressed in that species. Additionally, the pandurate lip of *S. romanzoffiana* is duplicated, along with, in many individuals of subsp. *perexilis*, the characteristic reduced venation with three veins, the lateral with a few branches diverging at wide, often right, angles. With *S. porrifolia* it shares a cushion of stout trichomes on the subapical adaxial surface of the lip. This combination of features suggests some relationship between these three species, despite the very dissimilar plant habits and flower sizes.

*Spiranthes stellata* subsp. *stellata* is quite variable in lip characters, and especially in habit. Much of this variability is a product of phenotypic plasticity. In part, though, there appears to be a merging of *S. stellata* subsp. *stellata* and *S. romanzoffiana* in complex populations. Given the very similar flowers of *S. romanzoffiana* and *S. stellata* subsp. *perexilis*, however, what is this variation between? The situation is complex and not unambiguous. It will be discussed further in a subsequent article.

## Acknowledgements

This work would not have been possible without the support of the curators and staffs of a number of herbaria who loaned material or accommodated my visits, including ARIZ, ASU, BRY, CAS/DS, COLO, CS, DAV, FSC, ID, JEPS, K, LA, MICH, MO, MONTU, MSC, NEB, NY, OGDF, OSC (including WILLU), RENO, RM, RSA/POM (including LAM), SD, UBC, UC, UCR, UNLV, US (including NTS), UT, V, WANF, WS, WTU. I am grateful to Amy Kasameyer, UC/JEPS Archivist, for her detailed response to my inquiry regarding the locality of the Fresno County collection and for providing a copy of Grant's field notes. Richard Mitchell's intimate knowledge of California botany is finely woven throughout the fabric of this work. The contributions of William Jennings, a colleague of long-standing, can scarcely be enumerated. Ronald Coleman generously shared field and herbarium knowledge of critical localities. Initial field work, including study at the type locality, was funded by grants from the Denver Botanic Gardens.

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# Observations on the Discreteness of *Platanthera aquilonis* and *P. hyperborea* Across Canada

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Recently much of what was called *Platanthera hyperborea* (L.) Lindl. became *P. aquilonis* Sheviak (Sheviak 1999, 2002; Sears 2008). *Platanthera huronensis* (Nutt.) Lindl. was already established as the hybrid involving *P. dilatata* (Pursh) Lindl., but Sheviak's work required us to take a closer look at the other two. To help with this he (Sheviak 2011) recently characterized the three "Leafy Green" orchids, the "*P. hyperborea* complex" (*P. aquilonis, P. huronensis* and *P. hyperborea*) in North America, and he provided a useful key, as well as noting that all three taxa have a widespread distribution. Sheviak's proposed three taxa made a lot of sense because: (1) the plants with large whitish-green flowers referable to *P. huronensis* that occur occasionally with *P. dilatata,* or as populations far removed from any putative parent, are quite distinct; (2) there are numerous occurrences that include substantial variation and appear to contain two taxa neither of which is *P. huronensis* in the sense of a spontaneous intermediate hybrid involving *P. dilatata.* Here data is presented that is relevant to the extent to which *P. aquilonis* and *P. hyperborea* are distinct and which characters may be most useful in distinguishing them. Although *P. huronensis* would have been included, it was not found in any locations studied.

## Methods

Data were collected on one or a few morphological variables and grouping variables such as odor, flower color and flowering time from four regions ranging from Nova Scotia to Alberta. Latitude and longitude in decimal degrees is given in brackets. In all cases plants were selected at a site to include variation in plant size and recorded features.

1. Northern Alberta: Data were collected on connective length (*i.e.*, the separation of the anthers at their tips in mm), flower odor (using a scale with 1 = pleasant, strong, and vanilla-like; 2 = none or intermediate and not able to be classified; 3 = unpleasant, weak and reminiscent of cat urine) and color (using a scale with 1 = pale green, 2 = intermediate, 3 = green with dull yellow-green lip) from a single flower near the base of an inflorescence. The data were col-

lected on 1-4 July 2010. The locations were centered around Fort Fitzgerald and High Level. There were seven locations with a flower from each of 11-58 plants sampled per location, and a total of 200 plants: (1) 21.8 km N of High Level, (2) dirt road to Fort Fiztgerald, 11.1 km N of Fitzgerald, (3) gravel road to Camp Hay S of Fitzgerald, (4) Peace Point Road A, (5) Pine Lake, (6) Peace Point Road B, and (7) road from Karstland Loop. Exact GPS coordinates are on file.

2. Northern Ontario: Data were collected on flower color (as above), connective length, spur length, lip length, and lip width, on 1-3 July 2011. There were nine locations with a flower from each of 2-14 plants sampled per location: (1) N end of Angus Lake, (2) Cobalt Truck Stop, (3) S of Kenogami, (4) remnants of fen shore on the E side of Gillies Lake, Timmins, (5) Roblin Road, (6) Cedar Meadows Parking lot, (7) Matagami River on S side of Timmins, (8) NE of Cobalt A, and (9) NE of Cobalt B.

3. Eastern Quebec: Data were collected on flower color (as above) connective length, spur length, lip length, and lip width on 11 July 2011. There was a single location with a flower from each of 30 plants near Cabano.

4. Nova Scotia: Data were collected on flowering time (early or late) and connective length, spur length, lip length, and lip width on 16 July 2011. The single location was a roadside ditch on highway 254 near Minasville.

Measurements were made using a WILD M3B binocular microscope with a graticule. Data are presented as multiple dot diagrams (showing numbers of occurrences for a particular range of values as a vertical accumulation of symbols), or as 3-dimensional plots made using Statgraphics software (version 15, www.statgraphics.com).

## RESULTS

### 1. Northern Alberta and southern Northwest Territories: Distinctive flower odor and color groups correlated with connective length

Plants with connectives over 0.26 mm had 94.6% of flowers with pleasant odor, 4.5% were without an odor or had an intermediate odor and 0.9% had an unpleasant odor. Also 85.6% of these flowers were whitish green, 12.6% were intermediate and 0.9% were green with a yellowish-green lip.

In plants with connectives less than 0.26 mm long, 91.1% of the flowers had an unpleasant odor, 7.8% were without an odor or had an intermediate odor, and 1.1% had a pleasant odor. Of these plants 92.2% had flowers that were green, often with a yellowish-green lip, and 7.8% were intermediate in color.

At least 100 sites in northern Alberta and southern Northwest Territories, where data was not collected exhibited a similar situation. The conclusion is that there are clearly two kinds of plants (Figures 1 and 2, pages 11 and 12). Some, referable to *P. aquilonis*, have short connectives, foul odor, and yellow flowers with a yellowish-green lip. Others, referable to *P. hyperborea*, have a broader connective, a pleasant odor, and pale or whitish-green flowers. Both kinds occur at many locations, yet they are mostly distinct at any location and overall (Figures 1 and 2).

### 2. Northern Ontario: Flower color groups well separated by morphology

In the northern Ontario sites there were collectively two kinds of plants that were well separated by morphological features (Figure 3, page 12). One group had short connectives, spurs and lip, and had green flowers with a yellowish-green lip. These were referable to *P. aquilonis*. The others with flowers with larger floral parts and pale green flowers are referable to *P. hyperborea*. As with locations in Alberta, both kinds of plants often grew within a few cm of each other, but those referable to *P. aquilonis* did sometimes occur in drier sites than *P. hyperborea* nearby and in some cases *P. aquilonis* flowered earlier. One plant with the flower color of *P. aquilonis* had the morphological features of *P. hyperborea* and one plant morphologically referable to *P. aquilonis* had flowers of intermediate color. Regardless of close proximity potentially allowing hybridization and introgression, the two remained largely distinct.

### 3. Eastern Quebec: Flower color groups in one population separated by three morphological characters

In southern Quebec, locations of leafy green orchids often include two kinds of plants, frequently growing side by side and interspersed. These are referable to *P. aquilonis* and *P. hyperborea*. The two kinds are quite distinct although the differences require close examination. Plants with green flowers with yellowish-green lips have shorter connectives, shorter spurs and shorter lips, than plants with pale green flowers with pale green lips. Figure 4, page 13, provides a typical example. This single site of data collection appeared to be representative of at least 20 sites in southern Quebec in the general region of the south shore of the Gulf of St. Lawrence and Gaspé.

### 4. Nova Scotia: Flowering time groups in one population separated by floral morphology

In Nova Scotia *P. aquilonis* and *P. hyperborea* are also present and mixed occurrences of these are not unusual, although both are rather restricted in the province. At one location here the two taxa were well separated by morphological features that corresponded to easily established flowering time groups (Figure 5, page 13). Although the flower color and odor may have been correlated, it was too late in the flowering period to enable an appropriate evaluation.

## Discussion

At a time when *P. aquilonis* and *P. hyperborea* were not clearly separated, Sears (2008) study suggested that herbarium specimens of two green orchids could be differentiated and he supported their recognition. Although this study is based on fresh flowers, it seems likely that herbarium specimens of the three taxa now recognized, could be identified correctly much of the time because of the morphological discontinuity suggested here, especially if flowers were softened for careful examination under a microscope.

If there are three kinds of leafy green orchids, this should have been revealed in any previous studies of variation in the group, but those studies concentrated on differentiating 2 taxa rather than questioning the occurrence of three. Nevertheless two groups are suggested between *P. aquilonis* (*sub P. hyperborea*) and *P. dilatata* in the PCA diagram demonstrating variation in the Canadian Rocky Mountains (Catling & Catling1997).

The two species, *P. aquilonis* and *P. hyperborea*, differ in many ways, as indicated by Sheviak (2011), and the two appear to be quite distinct over broad geographic areas based on the work reported here. Flowering time, flower odor and flower color are all useful in determination but are somewhat subjective so that the morphological characters may be the best. Of these connective length is perhaps the most useful but is difficult to measure. The following key takes the results of this study into account as well as a few hundred random measurements from across Canada and is only slightly modified from the excellent key provided by Sheviak (2011).

**1a.** Flowers whitish-green or pale green; odor pleasant, vanilla-like; connective length 0.3-0.6 mm; spur length (2.5) 3-6 mm; lip length (4) 4.5-6.8 mm …. ***P. hyperborea***

**1b.** Flowers green with a dull yellowish-green lip; odor unpleasant, reminiscent of cat urine; connective length 0-0.3 mm; spur length 2-5 mm; lip length 2.5-5(6) mm …. ***P. aquilonis***

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## Cover photos:

*Platanthera hyperborea*. (left) Photographed on the alpine limestone barrens of the Port au Port Peninsula, Newfoundland at 48.4944, -59.22171 on 7 July 2012.

*Platanthera aquilonis*. (right) Photographed at Lower Cove on the Port au Port Peninsula, in dry, open limestone gravel at 48.5176, -58.9765 on 8 July 2012.

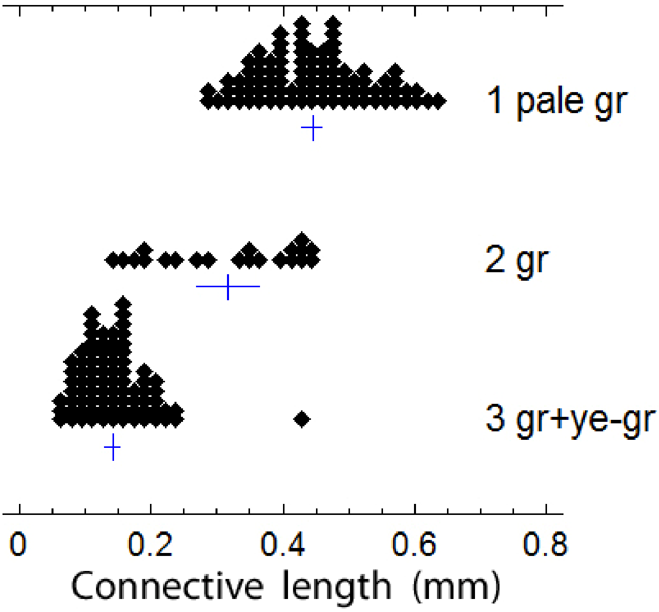


Figure 1. Multiple dot diagram showing connective length in relation to flower color in *Platanthera* (*P. aquilonis* and *P. hyperborea* ) from northern Alberta. gr = green, ye = yellow. Group 3 is *P. aquilonis* and group 1 is *P. hyperborea*.

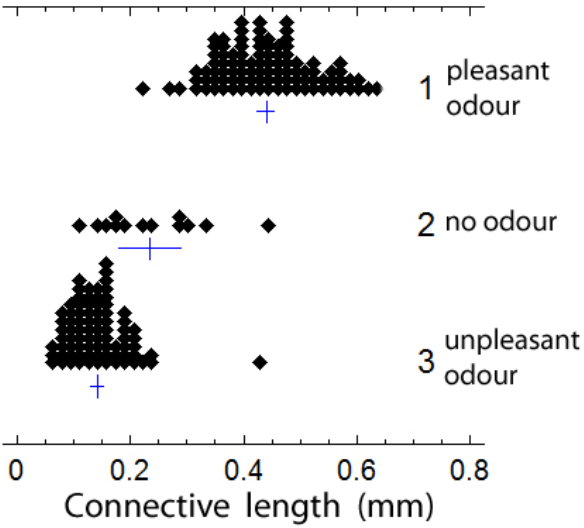


Figure 2. Multiple dot diagram showing connective length in relation to flower odor in *Platanthera* (*P. aquilonis* and *P. hyperborea*) from northern Alberta. Group 3 is *P. aquilonis* and group 1 is *P. hyperborea*.

Figure 3. Plot of lip length, spur length and connective length for occurrences of *P. aquilonis* and *P. hyperborea* in northern Ontario (Cobalt-Timmins area). gr = green, ye = yellow. Pale green = *P. hyperborea*. Green and Yellow-green = *P. aquilonis*.

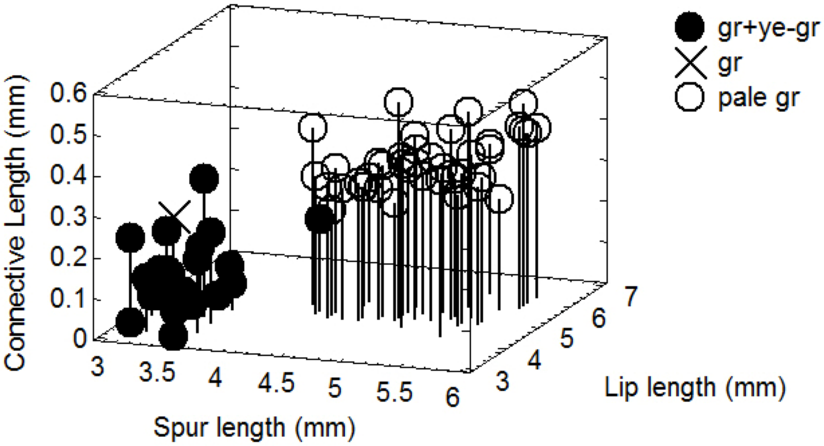


Figure 4. Plot of lip length, spur length and connective length for an occurrence of *P. aquilonis* and *P. hyperborea* in Quebec near Cabano. gr = green, ye = yellow. Pale green = *P. hyperborea*. Green and Yellow-green = *P. aquilonis*.

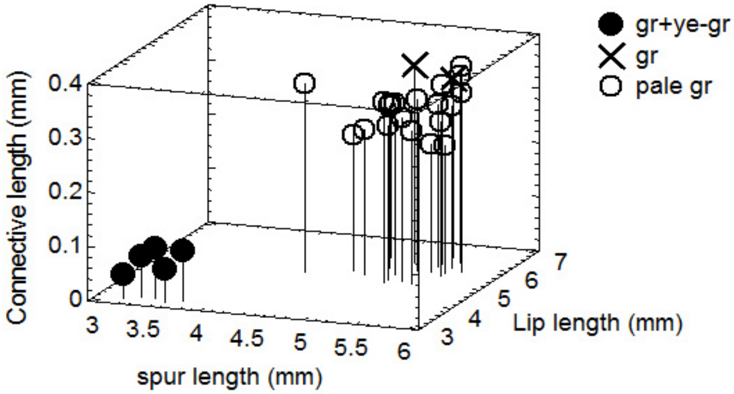
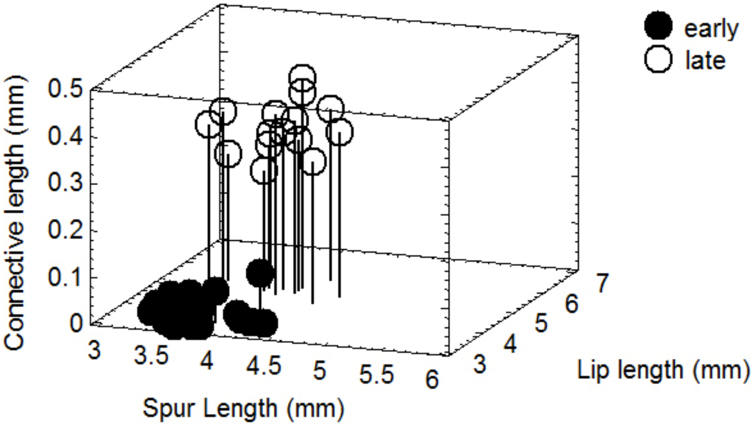


Figure 5. Plot of lip length, spur length and connective length for an occurrence of *P. aquilonis* and *P. hyperborea* in Nova Scotia near Minasville. The early plants are *P. aquilonis* and the late plants are *P. hyperborea*.



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# Using The Complexities Of Orchid Life Histories To Target Conservation Efforts

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While some orchids have likely always been rare, many orchid species that were once widespread are now also found in small fragmented populations. Declines of once widespread species are, in most cases, attributed to habitat loss and sometimes poaching (*e.g.*, Krupnick *et al*., 2012). However, many of the very characteristics that make so many members of the Orchidaceae prone to being rare (and also so fascinating) may also be driving some of their susceptibility to decline. This is especially true among temperate orchids. Approximately 28% of the estimated 25,000+ species of orchids worldwide grow in the temperate zone and are terrestrial (*i.e.*, live in the soil rather than on trees; Gravendeel *et al*., 2004). Conservation of these terrestrial species has proven to be especially challenging (*e.g.*, Swarts and Dixon, 2009; Stewart and Hicks, 2010). No terrestrial orchid has ever been de-listed as a result of conservation efforts and restoration is notoriously challenging (Stewart and Hicks, 2010; Zettler *et al*., 2005).

Far from being overwhelming, we suggest that a better understanding of these challenges can be used to more clearly identify the threats to orchids and improve conservation and restoration success. Among the challenges represented by orchid biology is their dependence on other species. Orchids require two, often very specific, types of symbiotic associations to complete their lifecycle: association with pollinators to set seed and association with mycorrhizal fungi for seedlings to develop from those seeds (*e.g.*, Waterman and Bidartondo, 2008). These dependencies add to the complexity of orchid conservation, as orchid declines may be caused not by direct effects of any environmental factors on orchid growth, but rather by effects of those factors on one of the other species on which orchids depend (*e.g.*, Swarts and Dixon, 2009). Dependence on other species, each of which has its own set of required conditions, also means that orchids are particularly sensitive to a wide range of habitat changes (those that affect either set of associated species plus those that affect the orchid directly) and so are often among the first to disappear when the environment changes or is degraded. For this reason, orchids make excellent indicators of ecosystem health. This integration of many aspects of ecosystem health also means that it is necessary to broaden the scope of factors considered to affect orchid populations to include both pollinator and mycorrhizal species and the factors that affect them in order to develop effective conservation and restoration plans.

The intricate and often very specialized relationships between orchids and their pollinators have long attracted attention. More than any other group of plants, orchids have evolved complex, often deceptive, systems to attract and interact with pollinators (*e.g*., Waterman and Bidartondo, 2008). Although some orchids are pollinated by many species, a side effect of pollination system complexity has been to limit the number of pollinator species that can successfully accomplish pollination. For example, the threatened cowhorn orchid (*Cyrtopodium punctatum*) in Florida requires a particular native bee (*Centris errans*) to successfully form seeds (Pemberton and Liu, 2008). However, *C. errans* requires host plants, which the orchid flowers mimic, that no longer co-occur with the few remaining wild populations. As a result, the orchids rarely produce seeds. Although the extensive over collection that made this once-common orchid rare is no longer such a threat, unless remaining plants can produce seeds, their recovery is unlikely. This finding led Pemberton and Liu (2008) to recommend that pollinator host plants, which grow nearby in different habitats, be planted in the vicinity of remaining native *C. punctatum* populations. This offers an excellent example of how the complexities of orchid biology can produce unique solutions for their conservation.

In addition to often depending on specific pollinators for successful seed set, all orchids also require fungi, often specific fungi, in order for their seeds to germinate. Orchid seeds are minute and include little or no nutrient reserves to support seedling development, so they require an external source of nutrients to support early development (Rasmussen, 1995). During the protocorm stage (from seed germination until they produce their first leaf), orchids rely entirely on mycorrhizal fungi, which they digest, for all nutrition. While many epiphytic orchids produce leaves very soon after germination, the protocorm stage of terrestrial orchids often lasts from several months to several years before a first leaf is produced (*e.g*., Rasmussen and Whigham, 1998). Without appropriate host fungi, orchid populations cannot recruit new members. Because the fungi most orchids associate with are almost invisible and require DNA sequencing for identification, the fungi needed by many orchids are unknown (*e.g*., McCormick *et al*., 2012). Even when host fungi have been identified, the conditions needed for them to persist and flourish are almost never known. It is clear that some orchids are dependent upon fungi that are free-living decomposers in the soil, while others associate with fungi that are also connected to other plants, especially trees, and still others associate with plant pathogens or parasites of other fungi (Rasmussen, 1995). As habitats change, fungal com-

*(Continued on page 18)*


a
b
c
d
e

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Figures to accompany "A New and Rare *Spiranthes* from the Sierra Nevada" by Charles J. Sheviak, page 1. Photos by author.

Figure 1. (left page) *Spiranthes stellata* subsp. *perexilis.* Plants at the type locality, including specimens from the holotype sheet, Plumas County, California. a: Plant in habitat. *Sheviak 2500a* [NYS] 2*n*=44. b: Inflorescence with flowers typical of the subspecies. Note the close similarity to *S. romanzoffiana*. Same plant as "a", in cultivation. c: Flowers without hood, the long slender lateral sepals directed forward and slightly spreading. *Sheviak 2500c* [NYS] 2*n*=44. d: Field-grown plant, the flowers with variable hood development, the short lateral sepals adnate to slightly spreading. *Sheviak 2500d* [NYS] 2*n*=44. e: same plant as "d" in cultivation, now with longer, strongly outward curving lateral sepals.

Figure 2. (this page) *Spiranthes stellata* subsp. *perexilis.* Left: triploid plant in the field at the type locality, Plumas County, California, with flowers somewhat broader-based and stouter than in the diploids. *Sheviak 2500b* [NYS] 2*n*=66. Right: same plant in cultivation, now with lateral sepals more generally spreading and more slender floral tube.

*(Continued from page 15)*

munities also change and orchids may lose fungi upon which they depend for their survival, but what drives changes in fungal communities is often unknown. McCormick *et al*. (2006) found that drought can cause orchids to lose their host fungi, forcing them to switch to new fungi when wetter conditions return, suggesting that future climate change scenarios that include increased frequency and duration of drought may bode poorly for orchids. Partly because the conditions that support mycorrhizal fungus growth are poorly understood, no orchid conservation plans to date include improvement of conditions for growth of host fungi. However, this is poised to change.

McCormick *et al*. (2012) found that orchids require not just that their host fungi be present, but also that they be abundant. This is the first time it has been shown that the abundance of host fungi is important for their ability to support orchids and leads to several possibilities for environmental modifications that support host fungi to help conserve orchid populations. While it seems obvious that host fungus abundance would have implications for orchid growth, it is very difficult to figure out how abundant particular fungi are when an amount of soil the size of a lima bean can contain 150 or more species of fungi. McCormick *et al*. (2012) also found that amendments of chipped wood increased the abundance of some (though not all) orchid host fungi and in some cases host fungi collected locally could be introduced with seeds to support germination. While this has been informally tried for many years, such as when orchids are transplanted with a block of surrounding soil, it often fails when fungi are introduced to an environment where they cannot thrive (such as a garden). This emphasizes that knowledge about the ecological requirements of orchid host fungi is as important as knowledge about the fungus itself. Both elements need to be known to efficiently conserve orchids.

In addition to fungi required for seed germination, many orchids supplement their nutrition throughout their lifecycle by digesting their mycorrhizal fungi, especially in times of stress (McCormick *et al*., 2006). However, all species except those that have no green leaves also fix carbon through photosynthesis. The life cycles of many terrestrial orchids also include periods lasting for one to several years when the plants are physiologically active but do not produce any aboveground tissues during an entire growing season. These periods are referred to as vegetative dormancy and high rates of dormancy have been associated with declining populations in many orchids (*e.g*., Mehrhoff, 1989; Shefferson *et al*., 2003). While dormant, orchids are thought to rely completely on their mycorrhizal fungi for nutrition (*e.g*., Wells, 1967; Shefferson *et al*., 2001; Reintal *et al*., 2010), though this has not yet been demonstrated. The fungi used by many orchids for support during dormancy and times of stress may be the same as those needed for germination or they may involve other species, as McCormick *et al*. (2004) found for *Tipularia discolor* and Zettler and Piskin (2011) found for *Platanthera leucophaea*.

Determining which factors are acting on partner species in addition to those factors directly affecting orchids may seem daunting. However, direct effects, pollinators, and mycorrhizal fungi influence orchid population dynamics by acting primarily at different stages in orchid life histories (Figure 1, page 19). Therefore observing orchid population dynamics can be used to determining where conservation efforts could most effectively be focused. For example, pollinators affect seed set, but have limited or no effect on other life stages so to conserve an orchid that had healthy plants that flowered frequently but rarely set seed, mangers might need to determine whether pollinator services were sufficient and possibly work to increase pollinator abundance. In contrast, mycorrhizal fungi dominate in determining the transition from seeds to protocorms and in support of dormant plants. Some direct factors also disproportionately affect different life stages. For example, light availability may strongly affect success of emergent, photosynthetic plants, but have little effect on protocorms or dormant plants. If an orchid produces numerous seedlings but adult plants grow slowly or many have extended dormant periods, light may be a limiting factor at the population level.

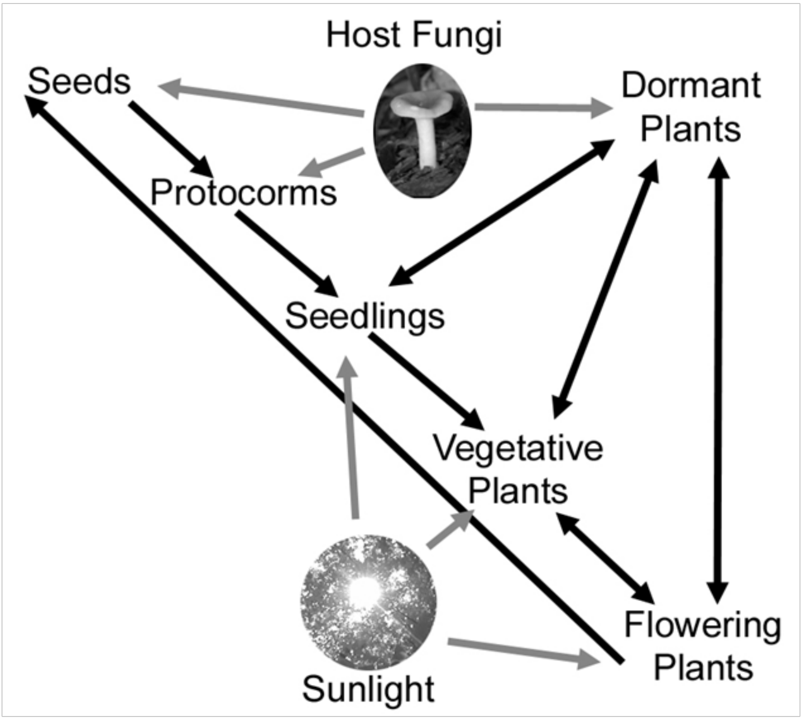

Figure 1. Diagram of a typical terrestrial orchid life history showing factors that predominantly influence different stages.

We decided to use the extent to which different life stages contribute to population decline in a threatened orchid to try to identify the most critical factors driving decline of *Isotria medeoloides* in the mid-Atlantic area. *Isotria medeoloides*, the small-whorled pogonia (back cover), is considered one of the most endangered orchids in the United States. Originally distributed up and down the east coast of the U.S., it is now restricted to a few moderate size populations in New England and widely scattered, very small, populations running south to northern Georgia, with a couple of very small outlier populations as far west as Missouri and Ontario, Canada. This distribution is thought to represent a northern migration since the retreat of glaciers approximately 18,000 years ago (Stone *et al*., 2012) and so might suggest a decline of southern populations as a simple result of climate warming since the last glacial maximum, but even many northern populations seem to be declining. We have examined 14 *I. medeoloides* populations at two sites in the mid-Atlantic area since 2007, documenting emergence or dormancy, size, and reproductive status of all plants each year. In these populations, we found that high rates of plants entering dormancy, combined with low rates of re-emergence after dormancy, were the main drivers of population decline. We also observed low rates of fruit production, though these are most likely also driven by plant nutrition, rather than lack of pollinators, because *I. medeoloides* is largely self pollinating and is able to form fruit even in the absence of pollinators. Each year, approximately half of all vegetative plants and 1/3 of flowering plants that had emerged the previous year failed to appear above-ground, presumably entering dormancy. These rates of dormancy were similar to those found by Mehrhoff (1989) in declining populations and were much higher than he found in populations characterized as stable. Likely drivers of plants entering dormancy are factors that affect plant condition and nutrition, such as decreased light availability, altered hydrology, or insufficient fungal contribution to plant nutrition. We found that *I. medeoloides* that became dormant were very likely to remain so for multiple years, much longer than the dormancy duration observed in a stable population in New Hampshire (Cairns, 1999). This suggested that multiple stages in *I. medeoloides*' life history (nutrition of both emergent and dormant plants) were driving population declines so we focused on identifying factors disproportionately affecting those stages.

In a recent study, Brumback *et al*. (2011) found that increasing available light increased *I. medeoloides* seedling persistence and also decreased the likelihood of plants becoming dormant. This suggested that light might have a strong effect on nutrition of photosynthetic plants. However, other studies that attempted to increase light availability to *I. medeoloides* have met with either population declines or crashes. A possible explanation for why some canopy thinning attempts successfully increase population growth, while others have the opposite effect, might be the impact of thinning on the mycorrhizal fungi hosting *I. medeoloides*.

While most orchids associate primarily with decomposer fungi belonging to the genera *Tulasnella* and *Ceratobasidium* (*e.g*., McCormick *et al*., 2004), we have identified *I. medeoloides* mycorrhizal host fungi as members of the genera *Russula* and *Lactarius* in the Russulaceae, a family of obligately ectomycorrhizal fungi. These fungi all require associations with trees and their abundance is likely driven by the health of their host trees. In the mid-Atlantic, the major potential host trees for ectomycorrhizal fungi are oaks (*Quercus* spp.), hickories (*Carya* spp., and beech (*Fagus grandifolia*), along with pines (*Pinus* spp.). We are currently working to determine exactly which of the potential host trees support the mycorrhizal fungi needed by *I. medeoloides* and what factors affect their abundance. This implies that management to conserve *I. medeoloides* may need to promote trees that host the mycorrhizal fungi needed by the orchids. It also implies that canopy thinning will need to target shrubs and trees that are not supporting the orchid host fungi. Removal of host trees could have disastrous effects on *I. medeoloides* populations.

While light is likely to be the primary supporter of emergent plants, mycorrhizal fungi are the primary supporters of seed germination, protocorms, and dormant plants and also increase stress tolerance of emergent plants. A deficit of mycorrhizal fungi would result in low seed germination and longer dormancy durations. We have observed no seed germination in seed packets over the five years of our study. However, population modeling indicates seedlings are being recruited into the populations, albeit at low rates, suggesting that either our current seed packet design in some way prohibits formation of mycorrhizal associations, that seed germination is episodic and we have not yet observed the appropriate conditions, or that years of seed weathering are required before germination can occur. We are currently working to solve this mystery.

Eighty-five percent of individuals that were dormant remained dormant the following year. This finding is nearly identical to the percentage of plants that Mehrhoff (1989) found remained dormant in declining populations. We have identified two possible causes for plants remaining dormant, one of which involves interactions with mycorrhizal fungi and the other is a direct effect on the plant. First, plants might fail to initiate an emergent bud as a result of insufficient nutrition. Second, they might initiate a bud that was subsequently damaged and unable to recover. Individual plants nearly always produce only one bud per year so the loss of a bud that had formed should result in dormancy the next growing season. To distinguish between these two factors, we tracked bud development and emergence in all emergent and a subset of dormant plants in our study populations. We found that 99% of plants that produced an overwintering bud emerged the following year, suggesting that persistent dormancy resulted from failure to initiate a bud, rather than bud damage. This, in turn, pointed to insufficient nutrition during dormancy as the cause of protracted dormancy in our study populations, as few of the plants that entered dormancy have re-emerged during our study. Because dormant plants are thought to rely almost exclusively on their fungi for nutrition, factors that negatively influence either fungi or the interaction between the orchid and its fungi could influence both high rates of entering dormancy and also low rates of re-emergence after dormancy. It is also possible that plants we have identified as being dormant for extended periods of time have died. Five years of observation is not long enough to distinguish dead and dormant plants, but even plants that we have seen re-emerge have been dormant for longer than average in a stable New Hampshire population (Cairns, 1999).

Results from our study of *I. medeoloides* suggest that differentiating between factors affecting different parts of the orchid life cycle and using an analysis of which parts of the life cycle are driving population declines can be used to pinpoint conditions that need to be improved to support orchid recovery. For *I. medeoloides*, our study indicated that growing conditions, including nutritional support of emergent plants, most likely driven by light, and support of dormant plants, attributed to mycorrhizal fungi, must be examined to understand factors contributing to population declines. We are currently working to independently assess the effects of light availability and abundance of host fungi in these declining mid-Atlantic orchid populations.

## Acknowledgments

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# Conserving Our Native Orchid Heritage – The What, How and When Behind the North American Orchid Conservation Center

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## Introduction

ORCHIDS are one of — if not the most — diverse plant families on earth with an estimated 25,000+ species and orchids are in trouble all over the world (Dixon *et al*., 2003). Most orchid diversity occurs in the tropics and subtropics where the majority of species are epiphytic. If, however, you need to be convinced about the diversity and beauty of orchids in temperate climates, take a visual trip to southwestern Australia (*link to this and other web sites provided after Acknowledgments*) or the Bruce Peninsula in Ontario Canada. If you are more interested in temperate zone terrestrial orchids in a garden setting, check out the fantastic display of orchids at the Gerendal reserve in Limburg, The Netherlands. Of course, a personal visit to any of these sites and many others is far more fulfilling than the images that you will find on the links to the web sites! Numerically, the U.S. and Canada have a relatively small number of native orchid species, about 210 (Krupnick *et al*., in press), but they include a relatively large number of genera that have only 1-3 species. Not unexpectedly, Florida has the highest orchid diversity because parts of the state have a subtropical climate that enables epiphytic and hemi-epiphytic orchids to survive and prosper in addition to terrestrial orchids.

Other than the rich diversity that occurs across a wide range of habitats from Florida to Alaska, what is most important about orchids native to the U.S. and Canada from a conservation perspective is that more than half of the species are listed by one organization or another as being endangered, watch listed, threatened, etc. Figure 1, page 31, demonstrates that every state has at least one threatened orchid species; indicating that the factors responsible for their decline are widespread across a range of habitats. Clearly not everything has been going well for our native orchids. There are a variety of reasons why orchids are prone to becoming threatened. Many species have small and scattered populations and the loss of many individuals or populations through habitat loss poses a threat. Many orchids have specialized pollinators that are themselves often threatened or endangered and when they are not available to pollinate orchids, orchid population cycles are disrupted. Most important, all orchids have essential relationships with mycorrhizal fungi and when the fungi are not present, orchids cannot survive (Rasmussen 1995). These and other interrelated factors demonstrate that there is a real need for a focused and large-scale effort to conserve our native orchid heritage (Swarts and Dixon 2009).

## Orchid Conservation

Orchid conservation in the U.S. and Canada has and continues to be a focus of individuals and organizations and some of the efforts are beginning to produce exciting results. For example, Larry Zettler and his colleagues and students at Illinois College have established the Orchid Recovery Program and are involved in efforts to conserve and restore native orchids from the mid-west to Hawaii and Florida. Their efforts have reached the stage where they have planted orchids that were grown in the laboratory and greenhouse into their native habitats (*e.g.*, Zettler *et al.*, 2011a, Zettler and Perlman, 2012). Michael Kane has established a facility at the University of Florida (Plant Restoration, Conservation, and Propagation Biotechnology Program) that includes orchid research and conservation. In addition to individual and university efforts to restore native orchids (*e.g.*, Kauth *et al.*, 2010), several botanic gardens (*e.g.*, Chicago Botanic Garden, Atlanta Botanical Garden – Richards and Cruse-Sanders, 2010) have started programs designed to grow and restore native orchids. A variety of public and federal programs have focused on understanding the ecology and the restoration of threatened and endangered native orchids species such as *Platanthera praeclara*, *P. leucophaea* and *Isotria medeoloides* (Alexander *et al.*, 2010a, 2010b; Zettler *et al.*, 2005; Zettler and Piskin, 2011; Brumback *et al.*, 2011).

While these and other efforts (*e.g.*, Stewart and Hicks, 2010) to conserve orchids are important and will undoubtedly continue, the individuals and organizations that are involved in orchid conservation also are engaged in other non-orchid conservation, educational, research and conservation activities. No organization is entirely focused on the conservation of native orchids in the U.S. and Canada; even though there is clearly a need to focus on a plant family in which more than half of the species are in trouble. Without a focused and large-scale effort, our native orchid heritage will be in greater and greater peril and the list of species for which there have been or are conservation efforts (Stewart and Hicks, 2010; Krupnick *et al.*, in press) will continue to be only a small percentage of the total number of species in the U.S. and Canada.

## The North American Orchid Conservation Center

In an effort to provide a national focus on the conservation of native orchids, the Smithsonian Institution (SI) and the U.S. Botanic Garden (USBG) have collaborated to establish the North American Orchid Conservation Center (NAOCC). Krupnick *et al.* (in press) have summarized the status of orchid conservation in North America, in the context of how well we are doing as per international guidelines for conservation established by the International Union for Conservation of Nature, and they have given an overview of NAOCC. In this contribution, I expand on the information about NAOCC presented in Krupnick *et al.* to provide an update on NAOCC activities and future directions. The goals of the contribution are to spread-the-word about NAOCC and, most importantly, encourage you to join NAOCC efforts individually or though one of the current NAOCC partner organizations.

## WHAT IS NAOCC?

NAOCC is a private-public partnership that was established by the Smithsonian Institution and the U.S. Botanic Garden with a mission to **conserve orchids native to North America**. NAOCC has established an initial set of long-term goals:

- Develop a national seed bank that will be representative of the genetic diversity of all native orchids in the U.S. and Canada,
- Develop a national collection of fungi that will be representative of the genetic diversity of mycorrhizal fungi required by native orchids,
- Use seed and mycorrhizal fungus banks to develop techniques for conserving, cultivating, and restoring orchids in native habitats,
- Develop techniques to conserve the genetic diversity of all native orchids by cultivating them in a national network of botanic gardens and arboreta,
- Support efforts to conserve orchid populations through habitat conservation and restoration,
- Develop web-based material that will provide up-to-date information on the ecology, conservation status, and techniques for the cultivation of native orchids.

Fulfilling the mission of NAOCC and reaching the goals will not be easy. It will take resources, both human and financial, persistence, education, and lots and lots of collaboration among and between individuals and organizations. While reaching the NAOCC goals will be difficult, success is essential if we are to conserve our native orchid heritage. Anything less than a focused and large scale national effort will assure that endangered orchids will continue to decline and disappear at a faster rate than the number of species that will be saved through the current pace of orchid conservation.

## HOW WILL NAOCC DEVELOP?

Initial funding for NAOCC came out of a new effort (Smithsonian Grand Challenges Consortia; http://www.si.edu/consortia) at the Smithsonian. I joined with SI colleagues Barbara Faust (Smithsonian Gardens), Gary Krupnick and John Kress (National Museum of Natural History), Melissa McCormick (Smithsonian Environmental Research Center) and Frank Clements (National Zoological Park) and Holly Shimizu, Director of the United States Botanic Garden (USBG), to obtain two successful grants to design and begin the initial stages of NAOCC development. Smithsonian support has been matched by the USBG and NAOCC has received the first donations from orchid groups that have learned about our intentions and efforts (Native Orchid Conference, Inc; New Hampshire Orchid Society). These initial sources of funding have allowed NAOCC to take the first small steps toward reaching our goals while also actively identifying potential sources of funding to assure success in the long-term.

I envision that NAOCC success will be assured through a combination of gifts to support specific purposes and development of an endowment that will provide basic long-term funding of essential program elements. NAOCC staff and partners will also actively seek grants to conduct research on important issues related to orchid life cycles and orchid habitats – including fungal ecology. NAOCC resources will be used to provide opportunities for collaboration and participation by individuals and organizations, and we will actively train students and educate the public. NAOCC financial resources will also support efforts to cultivate, propagate, conserve and, when appropriate, restore native orchids.

The current structure of NAOCC consists of a small volunteer group that has been guided by an internal (*i.e.*, SI and USBG) committee and by input from NAOCC partners and leading individuals in the areas of orchid ecology, propagation, and conservation. Initially NAOCC developed partnerships with a small group of botanical gardens and conservation organizations in order to proceed slowly, carefully and successfully. Initial botanical garden partners are the New England Wild Flower Society, Mt. Cuba, Duke Farms, Smithsonian Gardens, U.S. Botanic Garden, Atlanta Botanical Garden, Chicago Botanic Garden, Alaska Botanical Garden, and the Desert Botanical Garden. Over the next two years NAOCC will expand the network of partner organizations to include botanical gardens in all regions of the U.S. and Canada. In addition to botanical gardens, NAOCC has also started to develop partnerships with conservation-focused groups (*e.g.*, Center for Plant Conservation, The Nature Conservancy, NatureServe). The Nature Conservancy is also representative of organizations that own or manage large areas that serve as home to most of the native orchids. Over the next few years, NAOCC will establish working relationships with all of the large federal agencies that are obligated to manage native orchids on property that they manage (*e.g.*, Bureau of Land Management, Department of Defense, U.S. Park Service, U.S. Forest Service, U.S. Fish and Wildlife Service). Active NAOCC partnerships will also be established with the state heritage programs and equivalent organizations in Canada.

We are using initial NAOCC funding resources to develop a public NAOCC web site that will provide background information on our goals and objectives while providing up-to-date information on our activities and those of our partners. We hope that by the time this article appears, the NAOCC web site will be up and running and will become a place that you visit regularly to follow and participate in NAOCC. A second major web-based activity, to be developed over the next 2-3 years, will be an interactive web site that will be accessible through computers, tablets, and smart phones. The web site will enable anyone to identify native orchids – in the field - and be linked to all information available for each native orchid species; including what is known about their ecology, whether or not they are being cultivated, etc. If you want a preview of the types of things you will be able to do on the interactive web site, go to the orchid portion of the *Go Botany* web site. *Go Botany* was recently launched by the New England Wild Flower Society (NEWFS). The interactive NAOCC web site will be developed in collaboration with NEWFS and, when it is launched, it will initially consist of orchids of New England and the Mid-Atlantic region with orchids of Alaska and the southeastern U.S. to quickly follow.

In June (2012), NAOCC held its first workshop at the Smithsonian Environmental Research Center. The partner organizations listed above and individuals (Larry Zettler, Illinois College), organizations focused on orchids or orchid mycorrhizae (*e.g.*, Lynn Sigler, Curator of the University of Alberta Microfungal Collection and Herbarium), and organizations focused on conservation through seed and fungal banking and storage activities (*e.g.*, Megan Haidet, Bureau of Land Management, Seeds for Success; Aaron Kennedy, USDA APHIS program that maintains a national fungal collection) discussed NAOCC development and goals. One outcome of the workshop is the establishment of working groups that will set goals and procedures for the first four major activities to be initiated: seed bank, fungal bank, growing orchids, interactive web site. There is not enough space in this contribution to provide details of each of the activities but planning for the establishment and work of each committee are underway and will be the major focus of NAOCC in the remainder of 2012 and into 2013.

There are many other themes that could be included in this article as there are many compelling reasons why we need to have a national focus on native orchids. Orchids are, for example, the equivalent of the canary-in-the-coal-mine of the plant world. Most orchid species consist of small populations that are in delicate balance with other elements of the ecosystem. Especially important are the interactions that occur between orchids and fungi. Fungi are critical elements of several life history stages of orchids and orchids will not survive in nature if the appropriate fungi are not present (Rasmussen, 1995; McCormick *et al*., 2006). Orchids and their fungi are thus indicators of ecosystem health. If we are able to sustain healthy ecosystems and restore ecosystems to orchid-health we as a species will also be better sustained by the goods and services that are provided for free by those ecosystems.

### How you can help?

We seek your help and support in making the goals and objectives of NAOCC a reality. Once NAOCC is fully operational, for example, individuals and groups can assist by helping collect plant material for genetic analysis, collecting seeds for the seed bank and collecting roots for isolation and growing orchid mycorrhizal fungi for the fungal bank – as well as providing the fungal material for fungal identification. Equally important, NAOCC will provide opportunities for individuals and groups to assist in monitoring native orchids to provide important information that is rarely available. Wouldn’t it be great to say in a couple of decades that we have successfully assured the survival of our part of the most diverse group of plants on earth? You can view a video that explains much of what is written here at the following YouTube site: http://www.youtube.com/watch?v=BB0NlYvOOJM.

## Acknowledgments

I would like to acknowledge the support of NAOCC by the Smithsonian Institution, the United States Botanic Garden, the Native Orchid Conference, Inc. and the New Hampshire Orchid Society. I also want to specifically thank my co-principle investigators on the project for their continued support and enthusiasm.

## Links to web sites listed in the text

Orchids of southwest Australia: http://images.search.yahoo.com/search/images;_ylt=A0PDoX9cEkJQQzYAmy6JzbkF?p=western+australia+orchis&fr=yfp-t-701&ei=utf-8&n=30&x=wrt&vm=r)

Bruce Peninsula: http://images.search.yahoo.com/search/images;_ylt=A0PDoX_7EkJQ_noA6G2JzbkF?p=orchids+of+the+Bruce+Peninsula&fr=yfp-t-701&ei=utf-8&n=30&x=wrt&vm )

Gerendal, The Netherlands: http://images.search.yahoo.com/search/images?_adv_prop=image&fr=yfp-t-701&va=Gerendal+orchids&vm=r

Illinois College. Orchid Recovery Program: http://www.ic.edu/orchidrecoveryprogram

University of Florida. Plant Restoration, Conservation, and Propagation Biotechnology Program: http://hort.ifas.ufl.edu/plant-restoration/kane-lab/

Chicago Botanic Garden: http://www.chicagobotanic.org/research/

Go Botany: (http://gobotany.newenglandwild.org/

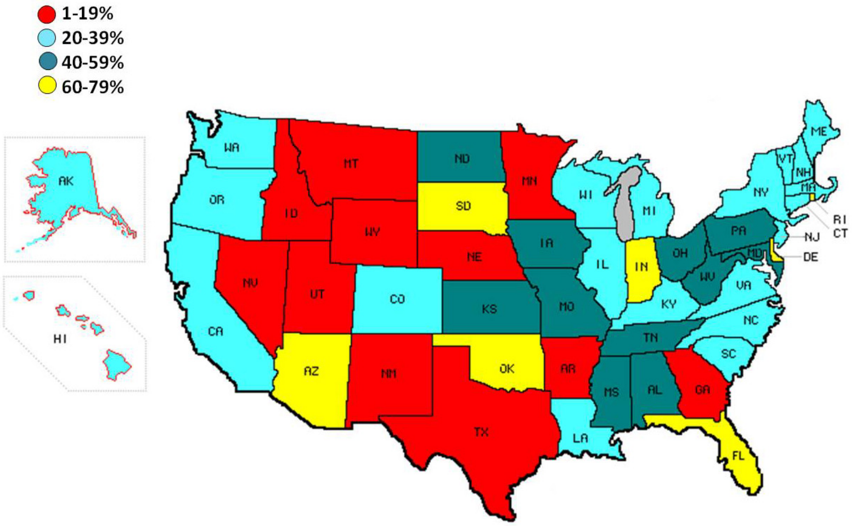

Figure 1. Percentage of orchid species, by state, that are considered vulnerable or listed as species of concern (Whigham, 2012)

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# 2013 Native Orchid Conference Annual Meeting

Plans are set for the 2013 Conference. Raymond Prothero has agreed to Chair the Conference with the help of Ron Coleman and Ben Rostron. David McAdoo and I will assist with whatever we can do. Now for some details:

**Dates:** June 10-13, 2013

**Where:** Feather Falls Casino, Oroville, CA
www.featherfallscasino.com

Lodging is available at The Lodge with rooms starting at $65.77 per night (http://www.featherfallscasino.com/the-lodge)

Meetings are in the Silver Moccasin Ballroom on June 10 & 12

This facility is pretty much self contained and, in addition to our conference, we will be able to do all our dining, drinking, and playing without our ever having to leave there.

Note we will be holding this conference during the week. We get much better rates on everything by doing this. We will have our field trips on June 11 & 13 and probably have an add-on day of field trips on Friday, June 14 for those interested. We are now in the process of securing speakers.

If you have any questions please feel free to contact Raymond [raypro64@aol.com] or me. Mark your calendars as we are already under nine months before our next conference. Registration details will be included with the first edition of the 2013 Journal.

Regards,
Mark Rose, President NOC
rmarkrose_2000@yahoo.com

**Orchids we may see in flower or spike**

*Cephalanthera austiniae*
*Corallorhiza maculata*
*Corallorhiza striata*
*Cypripedium californicum*
*Cypripedium fasciculatum*
*Cypripedium montanum*
*Epipactis gigantea*
*Goodyera oblongifolia* (in spike)
*Listera convallarioides* (in spike)
*Platanthera dilatata* var. *leucostachys*
*Platanthera sparsiflora*
*Piperia unalascensis* and *P. transversa*
(leaves with spikes just starting)

## The Native Orchid Conference, Inc.

P.O. Box 13204
Greensboro, NC 27415-3204

**Web Sites**: http://nativeorchidconference.org/
http://www.nativeorchidconference.org/NOCJournal.html
http://groups.yahoo.com/group/nativeorchidconference/

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