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On the origin and systematic position of the Azorean goldenrod, *Solidago azorica* (Asteraceae)

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Abstract

Goldenrods were first collected in the Azores by the German botanist Karl Hochstetter in 1838 and described as an endemic species *Solidago azorica*. In 1882, Asa Gray placed the name into synonymy of the American seaside goldenrod, *S. sempervirens*. The taxonomic position and status of the plants in the Azores remained unclear ever since but recent human-mediated introduction from the American coast seemed to be the most likely explanation. Here, I analyze molecular and morphological data and the historical record to test this hypothesis. While morphological differences are not clear and an overall similarity to some specimens from New Foundland is striking, I find that all analyzed *Solidago* plants from the Azores archipelago differ in their nuclear ITS and ETS sequences plus a number of microsatellite markers from American goldenrods. Furthermore, the historical record suggests existence of goldenrods in the Azores at the time of the arrival of the first settlers and well before Columbus' first journey. Moreover, large populations were reported from several islands in the 16th century. I conclude that the Azorean plants are native to the Azores and represent a distinct endemic species sharing a common ancestor with *S. sempervirens*. The Azorean plants represent a geographically isolated, genetically distinct population that is most likely the result of a natural colonization event from the North American coast perhaps via vagrant birds. I reinstate the name *S. azorica* and describe the morphological differences between *S. azorica* and *S. sempervirens*.

Key words: cubres, ETS, Gaspar Frutuoso, ITS, trnQ-rps16, seaside goldenrod

Introduction

The genus *Solidago* Linnaeus (1753: 878) (Asteraceae) comprises c. 84 species of perennial herbs: 77 species in North America (including Mexico) (Semple and Cook 2006), three to four in South America (Lopez Laphitz 2009), one species native to Europe and Northern Africa (Tutin *et al.* 1976), and three native to China (Yilin and Semple 2011). In general, goldenrods are well characterized and easily recognizable by their bright yellow inflorescences, perennial habit, and clonal reproduction. Species circumscriptions in the genus, however, are less clear-cut and based mainly on morphological characters with a large number of intraspecific taxa and potential hybrids. All species have a base chromosome number of x=9 and often include several ploidy levels (Semple *et al.* 1984, Peirson *et al.* 2013). Comprehensive and well-sampled molecular studies of the genus are so far lacking but the recent study of Laureto and Barkman (2011) shows that such approaches have great potential to help establish a stable classification of this problematic genus.

Solidago sempervirens Linnaeus (1753: 878), Fig. 1, is a herbaceous perennial native to sand dunes and marshes along the North American Atlantic Coast from New Foundland in the North probably south to Virginia (J. C. Semple, pers. communication 2011). The more southerly populations from Virginia to Mexico and the Caribbean are morphologically distinct and have been described as *S. mexicana* Linnaeus (1753: 879). They are currently classified as *S. sempervirens* subsp. *mexicana* (L.) Semple (2003: 1615). Much of the herbarium material labelled *S. sempervirens* or *S. mexicana* might also represent a different taxon, *S. stricta* Aiton (1789: 216) (syn. *S. virgata* Michaux (1803: 117)), or hybrids between *S. sempervirens* and *S. stricta* or *S. rugosa* Miller (1768: no. 25) (Semple and Cook 2006).

Solidago sempervirens is relatively tolerant to soil salinity and airborne salt spray and even though it does not seem to depend on salt (not a halophyte in the strict sense), it seems to be more competitive under increased salt conditions (Brauer and Geber 2002). Current deicing salt use practices therefore seem to favor its spread on roadsides and railroad tracks from the coasts further inland. Populations of *S. sempervirens* are now found throughout the Great

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