

# Phylogenetic position of *Kelseya* based on molecular data

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from *Kelseya*, Winter 2007

The genus *Kelseya* Rydb., namesake of this newsletter, contains a single species, *K. uniflora* (Wats.) Rydb. Members of this species are cushion-forming shrublets with solitary pink flowers; they are found on limestone in restricted areas of the mountains of Montana, Wyoming, and Idaho. *Kelseya* is a member of the rose family, Rosaceae, and recent taxonomic treatments of the family have included *Kelseya* within tribe Spiraeae, along with the largest and type genus for the tribe, *Spiraea* L., and several other small genera (Table 1). *Kelseya* is one of three genera in the tribe found in mountainous areas of western North America that are characterized by reduced growth habits; the other two are *Luetkea* and *Petrophyton*. In 1890, Sereno Watson classified these taxa in three sections, *Eriogynia*, *Kelseya*, and *Petrophytum* of the genus *Eriogynia* Hook. The type species of that genus, *E. pectinata* (Pursh) Hook., however, was determined by Kuntze in 1891 to be synonymous with the earlier-named *Luetkea siboldioides* Bongard; thus, the correct name for the taxon is *Luetkea pectinata* Kuntze. In 1900, P. A. Rydberg elevated Watson's other two sections of *Eriogynia* to generic level (but with a change in spelling in one case), thereby recognizing the three currently accepted genera.

A primary focus of research in my lab at UC Davis over the last decade has been the examination of phylogenetic relationships in Rosaceae, including family-level studies and in-depth analyses of particular genera and groups of genera. The roughly 100 genera and 3,000 species in the family have been classified in four (as in Schulze-Menz's 1964 widely used treatment) to 12 (in Takhtajan's 1997 treatment) subfamilies, many of which have been further subdivided into tribes, or alternatively, in 17 tribes which are not grouped in

subfamilies (as in Hutchinson's 1964 treatment). All of these classifications have recognized Tribe Spiraeae, with some variation in the number of genera included.

Beginning with a study of relationships across Rosaceae based on sequences of the chloroplast gene *rbcl* by David Morgan and colleagues in 1994, molecular phylogenetic analyses in several labs, including ours, have suggested that none of the previous classifications of the family accurately reflects our understanding of evolutionary relationships among the genera. For example, of Schulze-Menz's four subfamilies, which were defined primarily on the basis of fruit types, only one, Maloideae, has been supported as monophyletic, and it is consistently nested within a large group consisting of lineages formerly classified in Spiraeoideae, Amygdaloideae, and a few Rosoideae.

Over the past several years, we have collaborated with several other research groups in the US and Europe to conduct analyses of phylogenetic relationships across the families based on thorough taxonomic sampling and multiple genes, with the goal of producing a new phylogenetically based infrafamilial classification of Rosaceae. In that classification, which will be published in a forthcoming issue of *Plant Systematics and Evolution*, we recognize three subfamilies, Rosoideae, Dryadoideae, and Spiraeoideae, and within the latter we recognize seven tribes, one of which is Spiraeae as circumscribed in Table 1, although no material of the Korean genus *Pentactina* has been available for inclusion in any molecular phylogenetic studies to date.

In 2002, we initiated a phylogenetic study of Spiraeae. We obtained material of the genera listed in Table 1, except *Pentactina*, from a variety of sources, including our own field collections or those of colleagues, accessions for botanical gardens and arboreta, and, in a few cases, herbarium specimens. In September 2002, I traveled for several days to southern Montana and northern Wyoming intending to collect material of *Kelseya* and *Petrophyton*. Although I

was able to collect material from several populations of *P. caespitosum* in the Bighorn Mountains, *Kelseya uniflora* eluded me. Fortunately, shortly thereafter, Matt Lavin put me in touch with Drake Barton and Kathy Lloyd, who generously provided some material from one of Drake's collections from Trout Creek Canyon in Lewis and Clark County; that collection has represented the genus in the analyses described here. It was also at this time that I learned that the plant was the namesake for this newsletter. I therefore felt both excitement and apprehension about adding this species to our analyses; what if it turned out that our results would suggest that *K. uniflora* should be transferred to *Spiraea*?

I am happy to report that that is not what we found. Our phylogenetic analyses of this group using chloroplast *trnL-trnF* and nuclear rDNA ITS produced phylogenetic trees like the one shown Fig. 1, in which the tribe is divided into two well supported clades, one including *Aruncus*, *Luetkea*, *Holodiscus*, and *Xerospiraea*, the second including *Sibiraea*, *Kelseya*, *Petrophyton*, and *Spiraea*. The results, which will be published in the same issue of *Plant Systematics and Evolution* in which the new classification of Rosaceae will appear, support recognition of all eight of these as distinct genera: *Spiraea*, from which we sampled 24 species representing all three sections recognized by Rehder and the full geographic range of the genus, was strongly supported as monophyletic, and none of the other genera was nested within it.

Our analyses support the separation of the three genera with reduced growth habits, *Kelseya*, *Luetkea*, and *Petrophyton*, and suggest that evolution of a reduced growth habit has occurred at least twice within Spiraeaceae, with one event producing trailing subshrubs in *Luetkea*, and at least one resulting in the rosette-forming shrublets found in *Petrophyton* and *Kelseya*. Our analyses also suggest that the reduced habit may have been secondarily lost in *Spiraea*, but relationships among *Kelseya*, *Petrophyton*, *Sibiraea*, and *Spiraea* are not well supported and additional studies may reveal a sister relationship between

*Kelseya* and *Petrophyton*, as was found in the multigene analysis of Rosaceae (which, however, was based on more limited sampling within Spiraeaceae).

Our results suggest that the common ancestor of Spiraeaceae occurred in western North America, with independent migrations to the Old World occurring in *Aruncus*, *Sibiraea*, and *Spiraea*. The ancestral area for *Spiraea* could not be reconstructed unequivocally based on our results, but a complex biogeographic history of the genus, involving multiple dispersal and/or vicariant events between the Old and New Worlds, and several independent migrations between Europe, western/central Asia, and eastern Asia, with the possibility that the different events may have proceeded in different directions, are suggested. Within *Spiraea*, none of Rehder's sections, which he recognized based on inflorescence morphology, is supported as monophyletic.

We intend to continue phylogenetic analyses of this group, focusing on increasing our taxon sampling especially within *Spiraea*, from which we sampled only 24 out of an estimated 50-80 species, and sampling other genes in an effort to improve the weak support for resolution of relationships among major clades of species in our analyses. Based on the results of phylogenetic analyses of such expanded data sets, a new infrageneric classification for *Spiraea* should eventually be proposed. We also hope to obtain material of *Pentactina* to include in future studies. Finally, I hope, in the not too distant future, to be able to return to Montana and observe *Kelseya* in its natural habitat.

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Table 1. Characteristics of genera of Spiraeaceae.

Genus and Section		Number of Species	Habit	Leaves	Inflorescence	Distribution
<i>Aruncus</i> Adans.		1	perennial herb	2-3 pinnate	panicle	n temp
<i>Holodiscus</i> Maxim.		5	erect shrub	simple serrate	panicle	w N Am - n S Am
<i>Kelseya</i> Rydb.		1	cushion plant	simple entire	solitary	MT, WY
<i>Luetkea</i> Bong.		1	trailing subshrub	bternate	raceme	w N Am
<i>Pentactina</i> Nakai		1	erect shrub	simple serrate	raceme	Korea
<i>Petrophyton</i> Rydb.		4	prostrate shrub	simple entire	raceme	w N Am
<i>Sibiraea</i> Maxim.		5	erect shrub	simple entire	panicle	se Eu - w Asia
<i>Spiraea</i> L.		50-80	erect shrub	simple serrate	variable	n temp
Section	<i>Spiraea</i>	10-20	erect shrub	simple serrate	panicle	e/w N Am, Eu, Asia
	<i>Calospira</i> K. Koch	20-30	erect shrub	simple serrate	corymb	Eu, Asia, e/w N Am
	<i>Chamaedryon</i> Ser.	20-30	erect shrub	simple serrate	umbel	Eu, Asia
<i>Xerospiraea</i> Henr.		1	erect shrub	simple entire	rac./pan.	Mexico

Fig. 1. Strict consensus of 192 most parsimonious trees (I=1,007, ci excluding autapomorphies=.64, ri=.78) from phylogenetic analysis of nuclear ITS and chloroplast *trnL-trnF* sequences from representative species of Spiraeaceae. Parsimony bootstrap and Bayesian posterior probability support values are shown above and below branches, respectively.

