The Dense-leaved Pussy's-toes, *Antennaria densifolia* (Asteraceae: Inuleae): An Addition to the Vascular Flora of British Columbia

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The first records of *Antennaria densifolia* from southern British Columbia are cited. The identity of previous citations from Montana are questioned. The British Columbia specimens are all pistillate and as such may represent the polyploid, apomictic form of the species. Basal leaf length, involucre length, and the nature of the tips of the upper cauline leaves may best be used to differentiate between *A. densifolia* and *A. pulvinata*. Future collections may indicate that *A. densifolia* has not only a more southern distribution but that it also occurs in the intervening mountainous area between southern British Columbia and the southern Mackenzie Mountains, the latter initially considered to represent the southern limits of the species.

Key Words: *Antennaria densifolia, Antennaria pulvinata,* Dense-leaved Pussy's-toes, flora, range extension, British Columbia.

Renewed interest in conservation biology over the past two decades has resulted in the widespread recognition that the natural diversity of ecosystems must be maintained. Because rare plants and animals are an important part of this diversity, they and their habitats should be protected (Douglas et al. 1981). Proper identification of these taxa is mandatory if they are to be used to support arguments relative to the protection of an area because of its unique natural diversity.

Antennaria densifolia A.E. Porsild (Dense-leaved Pussy's-toes) was described as having minute, densely congested, obovate to oblanceolate, or obtuse basal leaves and as such was recognized as a well-marked species of the Alpinae group (Porsild 1945). Basal leaf morphology could readily be used to distinguish *A. densifolia* from both *A. compacta* Malte and *A. cana* Fernald & Wiegand. Although the arctic *A. densifolia* superficially resembles the Cordilleran *A. pulvinata* Greene, the two species differ with respect to the possession by the latter of larger heads, paler bracts, and hispid achenes (Porsild 1945). *Antennaria densifolia* was initially considered endemic to the upper eastern slope of the Mackenzie Mountains in the Northwest Territories. The species is now known to also occur in the Ogilvie Mountains and southern Richardson Mountains of the Northwest Territories and Yukon Territory (Porsild and Cody 1980). *Antennaria densifolia* was said to typically inhabit dry, turfy limestone screes (Porsild 1945).

Porsild (1975) subsequently described a second short-leaved arctic species, *A. ellyae* A.E. Porsild, which could be distinguished from *A. densifolia* by its spreading, leafy, stolon-like branches and by its twice-as-tall flowering peduncle that terminates in an elongated, cymose inflorescence. Chmielewski and Chinnappa (1990) considered *A. ellyae* to be conspecific with *A. densifolia*, noting that the minor differences in vegetative morphology merely reflected a growth response to local environmental conditions.

Using a taxonomic species concept, Bayer (1989a) concluded that *A. aromatica* Evert and *A. densifolia* could be considered discrete species because they are morphologically distinct. The two species were readily distinguished by the presence of stalked glands in *A. aromatica* and the complete lack of these glands in *A. densifolia*. Three additional characters, the presence or absence of flat, scarious, linear-lanceolate tips at the ends of the upper cauline leaves, basal leaf length, and phyllary length, could also be used in concert to separate the species, but not as reliably as the former character. The most significant aspect of this study, however, was that Montana collections were identified as *A. densifolia*, representing a disjunction of approximately 1850 km south of the nearest population in the Northwest Territories.

Chmielewski (1993) used gross morphology of type and non-type material, the Pearson product-moment correlation coefficients presented by Bayer (1988), the protologues of *A. aromatica* and *A. pulvinata*, the fallibility of using glandularity as a diagnostic character, and the results of canonical variates analysis to conclude that *A. aromatica* and *A. pulvinata* are conspecific. The latter specific epithet was deemed the legitimate name for the species.

Bearing in mind that my understanding of *A. pulvinata* has changed over the past decade to include *A. aromatica*, this investigation initially evaluates morphological affinity between *A. pulvinata* and *A. densifolia*. Conclusions based on this evaluation are then

used to reassess the identification of individuals from the single disjunct population of *A. densifolia* reported by Bayer (1989a), as well as assess the identification of several small-leaved British Columbia collections.

Materials and Methods

Mature, predehiscent specimens of *Antennaria densifolia* (N=69), *A. pulvinata* (N=153), the disjunct Montana population of *A. densifolia* (both pistillate and staminate specimens of *Bayer, DeLuca and Lebedyk, MT-725,* RM530380, and *Lackschewitz 4611,* MONTU73034) and the small leaved individuals from British Columbia (N=5) were borrowed from ALTA, CAN, CAS, CM, COLO, DAO, F, GH, LEA, MO, MONTU, MOR, MT, NDG, OS, PH, RM, SLRO, UAC, UB, UC, and US (Holmgren et al. 1990) for inclusion in the phenetic study. Qualitative characters used to identify specimens of *A. densifolia* and *A. pulvinata* prior to analysis included habit, degree and type of pubescence, color, shape, and texture of phyllaries, and the presence or absence of papillae on the achenes. These characters were not used directly in the phenetic analysis.

Character selection, and specimen selection and identification followed the methodology of Chmielewski (1993). Data were collected for 16 quantitative characters for each specimen following Chmielewski (1994a) with the exceptions that measurements were made on the middle cauline leaf as opposed to either the lower or upper-one, and that neither style length nor lobe length were included among the characters analyzed. The reasons for selecting these characters have already been stated elsewhere (Chmielewski and Chinnappa 1988a, 1991; Chmielewski et al. 1990a, 1990b; Chmielewski 1993).

The SAS (SAS Institute Inc. 1989) DISCRIM procedure (including the options list, simple, pool, slpool, crossvalidate, crosslist, and posterr) was used to perform classificatory discriminant analysis (following Chmielewski 1994a) on the specimens of *A. densifolia* and *A. pulvinata*. Rates of correct identification and Geisser classification probabilities (Pimentel and Frey 1978; Pimentel 1979) were used as indicators of separation between the species. Tests for equality of group centroids were performed as part of the analysis. The same data set was used to both define and evaluate the classification criterion. Classification through crossvalidation (SAS crossvalidate option) eliminated the problem of circularity in the analysis because each specimen was identified using a discriminant function that was computed from specimens exclusive of the specimen being classified. The classification criterion was subsequently used to classify collections from the disjunct Montana population, as well as the small leaved individuals from British Columbia, to either *A. densifolia* or *A. pulvinata*. A posteriori classification of specimens through the use of the classification criterion assumes that specimens classified in this manner do in fact belong to either *A. densifolia* or *A. pulvinata*.

Results

Evaluation of the discriminant function through the use of crossvalidation classification indicated that 98.2% (*Antennaria densifolia*, N=69, 100%; *A. pulvinata*, N=149, 97.4%) of the 222 specimens were assigned (with the highest probability) to the correct a priori species. Geisser assignment probabilities for the 218 correctly assigned specimens averaged (mean ± standard deviation) 0.9809 ± 0.0770 for *A. densifolia* and 0.9811 ± 0.0807 for *A. pulvinata*. The Mahalanobis distance between species centroids and associated F-value indicated that they were significantly different ($P < 0.0001$). The low error count in conjunction with the high Geisser assignment probabilities indicated that a posteriori classification of the Montana and British Columbia collections through the use of the classification criterion would yield acceptable results.

The five small-leaved individuals from British Columbia were consistently classified through the use of the classification criterion to *A. densifolia*. Geisser assignment probabilities averaged 0.9665 ± 0.0523 for these specimens.

Three of the four specimens from the disjunct Montana population of *A. densifolia* were classified using the classification criterion to *A. pulvinata*. Geisser assignment probabilities averaged 0.9638 ± 0.0575 for these specimens. A single staminate specimen (Lackschewitz 4611, MONTU73034) was assigned to *A. densifolia* (0.9970). If however, pistillate and staminate plants were analyzed separately and only those characters identified by stepwise discriminant analysis were subsequently used in the classificatory discriminant analysis, all five small-leaved individuals from British Columbia were assigned to *A. densifolia* (0.9812 ± 0.0331), and all four Montana specimens from the disjunct population of *A. densifolia* were assigned to *A. pulvinata* (0.9255 ± 0.1216).

Discussion

Results based on the a posteriori classification of individuals from the disjunct Montana population previously identified as *Antennaria densifolia* do not support Bayer's (1989a) view that they belong to that species, but rather that they bear morphological affinity to *A. pulvinata*. This conclusion is no doubt partly due to the very different interpretation we have relative to morphological variation within *A. pulvinata* and *A. aromatica* (Bayer 1989a, 1989b, 1991; Chmielewski and Chinnappa 1988b; Chmielewski 1993, 1994b) especially with respect to glandularity.

Bayer (1989a) stated that *A. aromatica* occurred only east of the continental divide in predominantly unglaciated areas and hypothesized that it could be restricted to the Front Ranges east of the divide as a result of climatic factors, that is, these mountains receiving less rainfall than those to the west in western Montana and Idaho. Although I agree with Bayer (1991) that two specimens cited by Chmielewski and Chinnappa (1988b) were misidentified at the time, the authors did also report a single British Columbia collection that occurs west of the continental divide in an area which was previously glaciated. Bayer (1991) did not verify the status of the latter collection. The present study also includes several additional collections of *A. pulvinata* from British Columbia as well as one from Idaho. The remoteness of the subalpine habitat in which the species occurs has likely contributed to the paucity of collections.

Although I do not agree with Bayer (1989a) that the previously cited Montana collections represent disjunct *A. densifolia*, five specimens from British Columbia were classified through the use of the classification criterion to *A. densifolia*. These specimens were all pistillate and may represent a polyploid apomictic form of *A. densifolia*. The occurrence of *A. densifolia* in southern British Columbia is not surprising, however, as Bayer (1989a) noted that a more widespread preglacial distribution was likely. As with *A. pulvinata*, the lack of previous reports may simply be a consequence of the remoteness of suitable subalpine to alpine habitat. It is possible that in the future additional collections may be found which will close the distributional gap between these southern British Columbia populations and those in the southern Mackenzie Mountains. Additionally, it is equally likely that more southern populations of *A. densifolia* will be discovered in the future.

Antennaria densifolia and *A. pulvinata* may be distinguished according to the following characteristics. Basal leaves in *A. densifolia* are typically less than 6.0 (average 5.4) mm long and the involucre less than 5.5 (average 4.9) mm long. Staminate plants are slightly smaller on average with involucres typically less than 4.5 (average 4.2) mm long. The upper cauline leaves in this species typically terminate in flat, scarious, linear-lanceolate tips. Basal leaves in *A. pulvinata* are typically greater than 6.0 (average 8.7) mm long and the involucres typically greater than 5.5 (average 6.2) mm long. The upper cauline leaves in this species typically lack the flat, scarious, linear-lanceolate tips. Staminate plants are slightly smaller on average with involucres typically greater than 4.5 (average 4.8) mm long. The foliage of *A. pulvinata* may be covered in stalked glands but this is never true of *A. densifolia*.

British Columbia Specimens:

Mount Apex, SW of Penticton, occasional in bare, gravelly-rocky areas at summit and on upper slopes, elevation 7000' and up, *J.A. Calder and D.B.O. Savile 10708,* July 18, 1953, DAO443861. Paradise Mine about 15 mi W of Windermere, occasional on bare shale summit, elevation 8500', *J.A. Calder and D.B.O. Savile 11320,* Aug 1, 1953, DAO683766. Baldy Mountain, approximately 7.5 mi ENE of Littlefort, 51°27'N and 120°03'W, occasional in rocky areas near summit, elevation 7228', *J.A. Calder, J.A. Parmelee, and R.L. Taylor 19866,* Aug 1, 1953 DAO683760. Mount McLean at Lillooet, occasional on rocky-gravelly slope, elevation 7500', *J.A. Calder, D.B.O. Savile, and J.M. Ferguson 15576,* Sept 6, 1954, DAO576733. Cathedral Lakes District, Ashnola Range, between Red Mountain and Mount Bomford, 49°04'N and 120°12'W, common in grassy rocky area at 7850', *J.A. Calder, J.A. Parmelee, and R.L. Taylor 19660,* Aug 2, 1956, DAO576739.

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