

Pilose *Braya*, *Braya pilosa* Hooker (Cruciferae; Brassicaceae), an Enigmatic Endemic of Arctic Canada

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Braya pilosa Hooker, Pilose *Braya*, has been poorly understood among North American botanists due to a paucity of fruiting specimens for study. This has resulted in confusion about the taxonomic position of the taxon within *Braya*, and has led to speculation about its generic status. An examination of fruiting specimens from the Royal Botanic Garden Herbarium at Kew, England reveals that *B. pilosa* is correctly placed in the genus *Braya*, and that it is a distinctive member of the genus deserving recognition at the specific level. I discuss the historical evidence that *B. pilosa* may not have been collected since 1850 due to its extremely restricted distribution on the Cape Bathurst Peninsula of the Northwest Territories of Canada. I also present evidence suggesting that *B. pilosa* is diploid and may be a parent species to some of the more widespread members of the genus, all of which are polyploid. Its closest living relative is probably *B. thorild-wulfii*.

Key Words: *Braya pilosa*, Pilose *Braya*, discovery, rediscovery, distribution, collections, rare species, Cape Bathurst, Northwest Territories, Canada.

Braya pilosa Hooker (Figure 1) is an extremely rare endemic of the Northwest Territories of Canada. It is perhaps the most distinctive and, at the same time, least understood North American member of a taxonomically difficult genus. While some botanists (Harris 1985; Argus and Pryer 1990; Rollins 1993; McJannet et al. 1995) have treated *B. pilosa* as it was envisioned and described by Hooker (1830), most have placed it into synonymy under *B. glabella* (Polunin 1959; Welsh 1974; Porsild and Cody 1980; Cody 2000; Warwick et al. 2000*) or *B. purpurascens* (Scoggan 1978). Others have reduced it to infraspecific status within *B. purpurascens* (Schultz 1924; Hultén 1970), applied the name broadly to elements of *B. glabella* (Porsild 1943, Hultén 1968), or ignored it entirely (Cody 1979; Mulligan 2002). To the best of my knowledge, there are no authentic fruiting specimens of *B. pilosa* in any North American herbarium. It is this lack of available fruiting material for study that is primarily responsible for the taxonomic confusion that has surrounded this taxon over the past 173 years.

When he described the species, Hooker (1830) had only a single collection of flowering individuals with immature silicles from which to work and he was apparently uncertain whether or not the plant was actually a *Braya*. He placed a question mark behind the genus name, lamented the lack of mature fruits that would allow unequivocal generic placement, and stated, "...in all probability, it ought to constitute a new genus." Without access to mature fruits for examination, Hooker's suggestion of a new genus would indeed seem justified. The flowers are larger than those in any other *Braya* species (the petals in some tetraploid *B. humilis* are as long but not as broad); the immature

silicles are ovoid-ellipsoid, unlike those in any other *Braya* with the exception of *B. thorild-wulfii* (which had not been discovered in 1830); and the styles are exceptionally long for a *Braya*, measuring over half the length of the ovary. In addition, Sir John Richardson (1830), who collected the type specimen in 1826 during the second Franklin expedition in search of a northwest passage, described the flowers as fragrant, with a smell similar to lilac blossoms. Fragrance has not been associated with any other member of the genus.

Murray (1983*) and Scott et al. (2000*) suggested that *B. pilosa* is a misnomer applied in error by Hooker (1830) to a *Draba*, likely *D. corymbosa*. However, Hooker's original description and accompanying illustration of the taxon indicate that he is describing something quite different from *D. corymbosa*. Hooker describes the valves of the immature silicles as "valde convexis," and again later as "remarkably convex," descriptions that do not accurately describe the distinctly flattened valves of *D. corymbosa*.

Fortunately, any doubt about the identity of Hooker's *B. pilosa* as a legitimate *Braya* rather than as a misidentified *D. corymbosa* is resolved by an examination of authentic fruiting specimens. There is a herbarium sheet at the Royal Botanic Gardens Herbarium (K) in Kew, England (Figure 2) that apparently includes specimens from three separate collections (Sea Coast, Arctic, Richardson *s.n.*, 1848; arctic coast, W. of C. Bathurst, Capt. Pullen *s.n.*, Aug. 1850; and what are likely part of Richardson's type collection of 1826). The herbarium sheet is so congested that it is impossible to be certain which individuals are part of the various collections represented, but all of them are definitely members of the same taxon. Mature silicles on

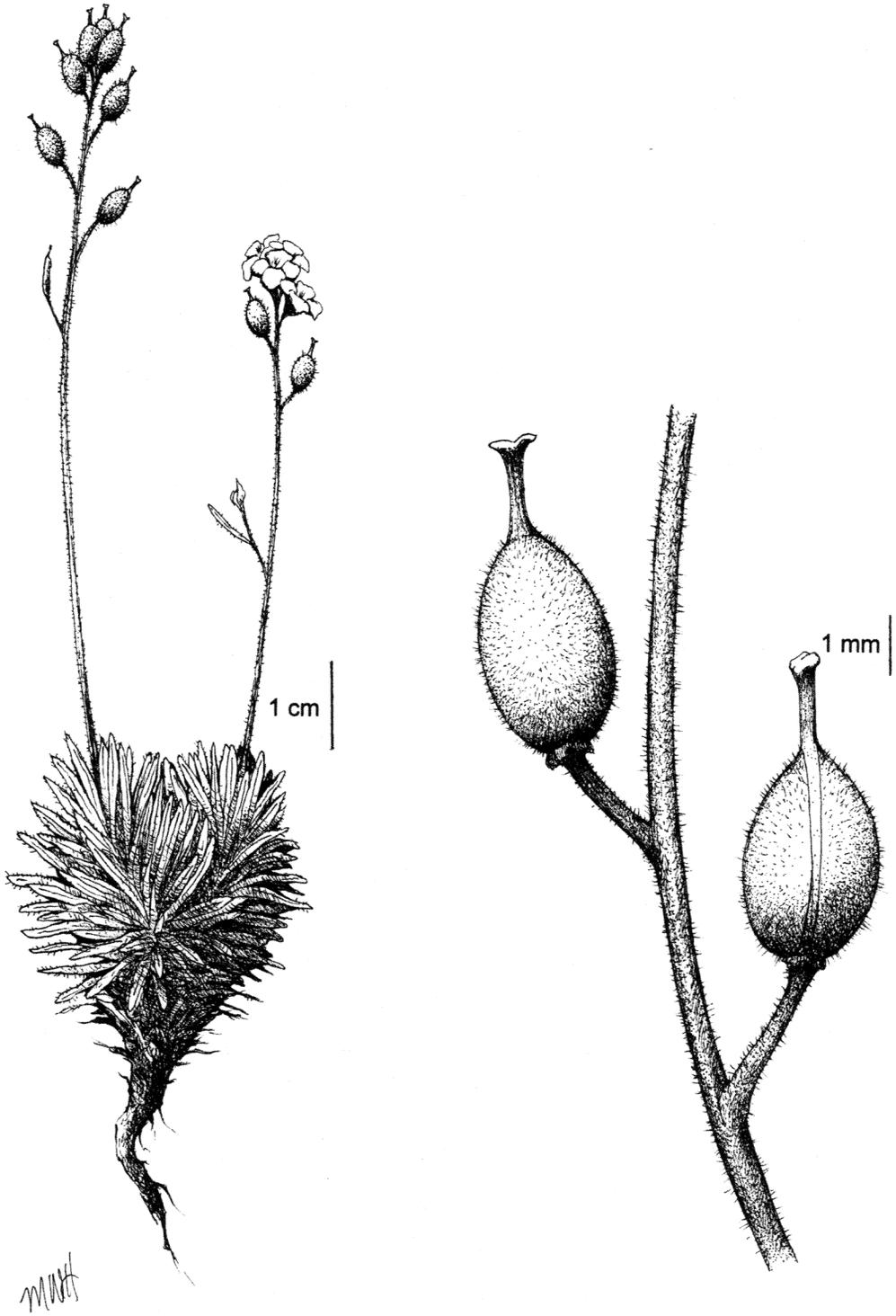


FIGURE 1: Illustration of *Braya pilosa*.

these specimens, even though pressed, are clearly ovoid-ellipsoid and perfectly match Hooker's illustrations of immature fruits of *B. pilosa*. In addition to possessing fruits that are strikingly different from those of *D. corymbosa*, the Kew *B. pilosa* specimens differ significantly from *D. corymbosa* in several other attributes. The leaves are much longer, narrower, thicker, more obtuse, and less densely pubescent than those in *D. corymbosa*; some individuals bear a single cauline leaf while *D. corymbosa* lacks cauline leaves; the styles are much longer than those of *D. corymbosa*; and most importantly, the epidermal cells of the silicle septum are typical *Braya* epidermal cells, characteristically thickened and transversely or obliquely elongated (Harris 1985, Figure 2), in stark contrast to the thin-walled, irregularly shaped, and essentially isodiametric septum epidermal cells typical of *Draba*. *Braya pilosa* is unequivocally *not* a misidentified *Draba*.

I have not seen any authentic specimens of *B. pilosa* that have been collected since 1850. It is possible that it is extinct, as Argus and Pryer (1990) and McJannet et al. (1995) have suggested, but I think it more likely that its distribution is so limited that it has simply been overlooked by botanists. Hooker's (1830) description of the type locality of *B. pilosa*, "Mouth of Mackenzie River, lat. 70°" may be somewhat misleading to those who have looked for *B. pilosa* over the last century or so. Porsild, for example, made several collections of *Braya* between the mouth of the Mackenzie River and Nicholson Island in Liverpool Bay, where Hooker's location description suggests that *B. pilosa* should be found. Although Porsild initially identified his collections as *B. pilosa* (Porsild 1943), none of them show the distinctive ovoid-ellipsoid silicles, exceptionally long styles, and large flowers of this taxon and fall instead within the normal range of diversity in *B. glabella*.

There is evidence that Hooker's description of the type locality may be his interpretation of Richardson's broad conception of the Mackenzie Delta rather than a precise description of Richardson's collection location. In his account of the 1826 journey from the Mackenzie River to Cape Bathurst, Richardson (1828) repeatedly commented on the alluvial deposits and sandbars his party encountered in the area, and correctly attributed them to outwash from the Mackenzie. He clearly viewed the entire region of the Tuktoyaktuk Peninsula, Eskimo Lakes, and Liverpool Bay as a product of a historical Mackenzie Delta. It is likely, however, that Richardson was actually very near Cape Bathurst rather than the mouth of the Mackenzie when he collected the type specimens of *B. pilosa*. In fact, there is some evidence that all three known collections of *B. pilosa* (Richardson in 1826 and 1848; Pullen in 1850) may have come from the same stretch of seashore near Cape Bathurst, roughly 200 km northeast of the mouth of the Mackenzie River.

John Richardson's original collection of *B. pilosa* almost certainly occurred on 18 July 1826, as the east-

ern detachment of Franklin's second expedition in search of a northwest passage was approaching Cape Bathurst. This eastern detachment, under Richardson's command, was assigned the task of exploring the arctic sea coast by boat from the Mackenzie River east to the Coppermine River, then traveling overland on foot from the Coppermine River to Great Bear Lake. On 18 July, Richardson (1828) records stopping for breakfast "about eight miles" from the narrow passage between Cape Bathurst and the Baillie Islands. He writes, "The air was perfumed by numerous tufts of a beautiful phlox, and of a still handsomer and very fragrant cruciform flower, of a genus hitherto undescribed." There is little doubt that the "cruciform" flower Richardson is describing is *B. pilosa*. First, 18 July is a date that an arctic *Braya* would be expected to be in a flowering rather than a fruiting condition. In addition, the dense clusters of large flowers on his type specimens would certainly be "handsome," and Richardson's description of the plant's fragrance and uncertain generic status matches perfectly with Hooker's (1830). No other cruciferous species included in Hooker's *Flora Boreali-Americana*, which treats all of Richardson's collections from this expedition, fits Richardson's 18 July plant description as well as *B. pilosa*.

Richardson collected *B. pilosa* a second time in 1848, this time when the plant was in fruit. Captain Sir John Franklin, along with his ships, the *Erebus* and *Terror*, and their crews disappeared in the Canadian Arctic in 1845. Franklin's ships carried sufficient provisions to last until the summer of 1848, but by 1847, when nothing had been heard from Franklin, the British Admiralty began mounting search expeditions. In 1848, John Rae and John Richardson were placed in command of one of these search parties. Richardson's orders were to search the arctic coast and islands east of the Mackenzie River to the Coppermine River and then travel overland from the Coppermine to Great Bear Lake, essentially retracing his 1826 journey. Unfortunately, Richardson did not mention his 1848 collection of *B. pilosa* in his published account. However, I think it is likely that this second collection was made at exactly the same place as the first. On 10 August, Richardson was approaching Cape Bathurst again, twenty-two years after his first visit there (Richardson 1851). This is exactly the right season to find *Braya* in fruit. Given Hooker's uncertainty about the generic status of *B. pilosa* due to a lack of fruiting material for examination, it is inconceivable that Richardson would not have taken the opportunity to revisit his original collection location to collect fruiting plants which would allow a definitive identification.

Braya pilosa was collected for a third and apparently last time in August of 1850 from the "arctic coast, W. of C. Bathurst" by Captain William J. S. Pullen. In 1850, Pullen, also in command of an expedition in search of Franklin, attempted to travel from Fort Simpson on the Mackenzie River to Cape Bathurst and then on to Banks Island. In mid-August he was in the vicin-

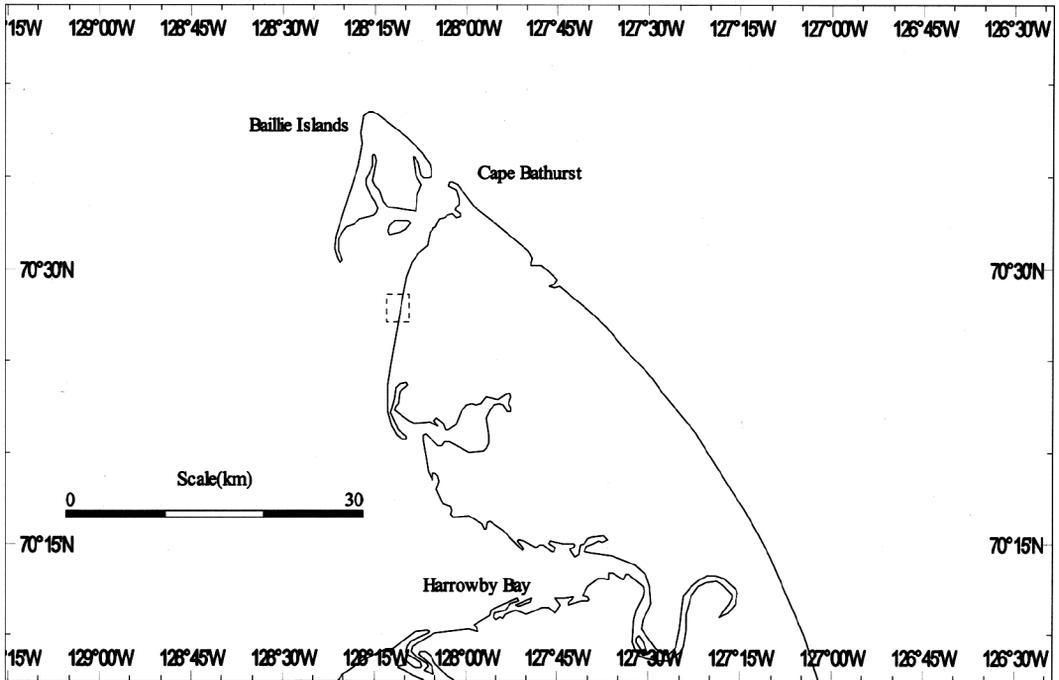


FIGURE 3: Map of Cape Bathurst Peninsula, Northwest Territories, Canada. The dashed box indicates the probable type locality of *Braya pilosa*.

ity of Cape Bathurst, but found dramatically different ice conditions there than Richardson had two years previously. The pack ice was still so thick that he was unable to proceed past Cape Bathurst, and was forced to retreat back to Fort Simpson. On 8 August, Pullen (1979) recorded that his party "landed in a small bay about 7 miles from Cape Bathurst" to eat dinner. They returned to the same bay about midnight on 10 August, after having been turned back by the pack ice at Cape Bathurst, and remained camped there until 15 August while they waited to see if ice conditions at the Cape might improve. This places Pullen within one nautical mile of Richardson's (1828) estimate of his position when I believe he made his first collection of *B. pilosa*, and at the perfect season to find the plant in fruit. He describes the small bay as being "the only place where we could conveniently land," which suggests that it is likely the same place Richardson had chosen to land for breakfast in 1826 when he discovered the plant. In addition, Pullen's steersman was Neil McLeod, a Hudson's Bay Company employee who had also accompanied Richardson in 1848. It is probable that McLeod would have mentioned Richardson's interest in the plant to Pullen and perhaps inspired him to make his own collection during the four days they were camped at the site.

If Richardson's and Pullen's *B. pilosa* collections did come from the same location on Cape Bathurst

Peninsula, the position of that location would most likely be between about 70° 27' and 70° 28' north latitude along the western coast of the peninsula (Figure 3). Or perhaps slightly farther north if their estimates of the distance to Cape Bathurst were based on the distance they actually traveled along the coastline rather than the direct straight-line distance. This section of coastline should be searched carefully for extant populations of *B. pilosa*.

While the rediscovery of *B. pilosa* would of itself be interesting botanically and historically, the availability of living plants for study would also be tremendously valuable to our understanding of *Braya*. The evolution of the genus is intimately tied to hybridization and polyploidy (Harris 1985), but that phylogenetic history is obscured by the fact that diploidy has never been reported in *Braya*. There is some evidence, however, that *B. pilosa* may be diploid and, therefore, could have played a critical role in the evolutionary history of *Braya*. Ornduff (1969) listed several attributes in flowering plants that are correlated with xenogamy and a diploid chromosome number. Among them are rotate corollas with large petals, exerted styles, scented flowers, abortive fruits, and a narrow distribution. *Braya pilosa* has the largest petals and longest styles of any *Braya*, it is the only species in the genus with scented flowers, it appears to have a fairly high frequency of abortive silicles, and it has a very narrow



FIGURE 4: Photograph of *Braya pilosa* specimen collected on 24 July 2004 (J. G. Harris and D. L. Taylor 3644).

distribution. Large, rotate flowers, allogamy, abortive fruits, and narrow distributions also have been associated with lower ploidy levels in *B. humilis* (Harris 1985), though these are tetraploids rather than diploids.

Pollen measurements also provide evidence that *B. pilosa* may be diploid. Rollins (1953) and Böcher (1956) noted a correlation of ploidy level and pollen size in *B. humilis*, with populations of lower ploidy level having somewhat smaller pollen grains than those of higher ploidy level. Pollen sizes in *B. pilosa*, *B. thorild-wulffii*, and *B. glabella* show a similar correlation. Measurements (Harris 1985) indicate that *B. pilosa* has significantly smaller pollen grains than the tetraploid *B. thorild-wulffii*, with the largest pollen grains being found in the octoploid *B. glabella*.

If *B. pilosa* is indeed diploid, its extremely limited distribution may be linked to its ploidy level. Favarger (1961) and Johnson and Packer (1967) found a correlation between plant ploidy level and habitat stability. Diploids were more likely to be found on stable habitats, while polyploids were more frequent on habitats with a history of disturbance. Areas that remained unglaciated during the Pleistocene, for example, were found to have a significantly higher percentage of diploids in their floras than areas that were glaciated (Favarger 1961; Johnson and Packer 1967). The Cape Bathurst Peninsula is known to have been unglaciated during the Pleistocene (Prest 1969) and probably served as a refugium for plants that moved back onto their former ranges as the ice receded. *Braya pilosa* likely weathered the Pleistocene on the relatively stable habitats available near Cape Bathurst, but it has apparently been unable to expand its range in recent times. It may, however, have served as a parent species to some of the more widespread polyploids in the genus. A likely candidate is *B. thorild-wulffii*, a high arctic North American endemic that shares *B. pilosa*'s ovoid-ellipsoid fruit shape and fenestrate silicle septae, and appears to be most closely related to it. *Braya thorild-wulffii* is a tetraploid ($2n=28$) (Holmen 1952; Mulligan 1965, 2002; Böcher 1966; Harris 1985), which is the lowest reported ploidy level in the genus (some populations of *B. humilis* are also tetraploid). However, Böcher (1966) observed that there appears to be only a single large pair of chromosomes in *B. thorild-wulffii*, so it is probably not simply an autotetraploid from a single diploid parent.

DNA sequence data (Harris, unpublished data) suggest that *B. thorild-wulffii* may have served as a parent to other *Braya* species of higher ploidy level. If DNA of *B. pilosa* were available, and if the species is indeed a parent to *B. thorild-wulffii*, it could provide significant insight into phylogenetic relationships within *Braya* and between *Braya* and other genera in the Cruciferae.

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Addendum

On 24 July 2004, Daniel L. Taylor and I briefly visited Richardson's presumed type locality of *Braya pilosa* near Cape Bathurst. We discovered several hundred *B. pilosa* individuals growing along the coastline on sandy, calcareous soils in an area heavily used by Caribou (*Ranifer taranclus*). The plants were limited to small, bare patches of soil disturbed by Caribou hoofs.

The plants on Cape Bathurst Peninsula (Figure 4) are perfect matches for Richardson's and Pullen's 19th Century *B. pilosa* collections (Figure 2). Specimens (J. G. Harris and D. L. Taylor 3644) are deposited in the Utah Valley State College Herbarium (UVSC), with duplicate material distributed to the following herbaria: Agriculture and Agri-Food Canada (DAO), Canadian Museum of Nature (CAN), Missouri Botanical Garden (MO), New York Botanical Garden (NY). DNA sequencing and cytological studies are currently underway (Harris, unpublished data).

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