RHODORA, Vol. 117, No. 969, pp. 1–40, 2015

doi: 10.3119/14-07; first published on-line March 11, 2015.

VASCULAR FLORA AND GEOECOLOGY OF MONT DE LA TABLE, GASPÉSIE, QUÉBEC

Scott W. Bailey

USDA Forest Service, 234 Mirror Lake Road, North Woodstock, NH 03262
e-mail: swbailey@fs.fed.us

Joann Hoy

21 Steam Mill Road, Auburn, NH 03032

Charles V. Cogbill

82 Walker Lane, Plainfield, VT 05667

abstract. The influence of substrate lithology on the distribution of many vascular and nonvascular plants has long been recognized, especially in alpine, subalpine, and other rocky habitats. In particular, plants have been classified as dependent on high-calcium substrates (i.e., calcicoles) based on common restriction to habitats developed in calcareous rocks, such as limestone and marble. In a classic 1907 paper on the influence of substrate on plants, M. L. Fernald singled out a particular meadow on Mont de la Table in the Chic-Choc Mountains of Québec for its unusual co-occurrence of strict calcicole and calcifuge (i.e., acidophile) plant taxa. We re-located this site, investigated substrate factors responsible for its unusual plant diversity, and documented current plant distributions. No calcareous rocks were found on site. However, inclusions of calcareous rocks were found farther up the mountain. The highest pH and dissolved calcium concentrations in surface waters were found in a series of springs that deliver groundwater, presumably influenced by calcareous rocks up the slope. Within the habitat delineated by common occurrences of calcicole species, available soil calcium varied by a factor of five and soil pH varied by almost 1.5 units, depending on microtopography and relative connection with groundwater. Variation in hydrologic delivery of weathering products leads to large variation in chemical composition of soils and waters within calcareous-influenced habitats. Here, the fine-scale variability of habitat, rather than plasticity in the plants' tolerances, appeared to be responsible for co-occurrence of taxa considered to be strict calcicoles or calcifuges. The flora in 2005–2008 was very similar to what it was in 1906, although in-filling of woody vegetation and strong chemical gradients driven by climatically controlled hydrologic processes suggest the possibility of future vegetation changes with continued climate change.

Key Words: alpine tundra, boreal forest, calcicole, Chic-Choc Mountains, climate change, floristic change, Gaspésie, geobotany, groundwater seeps, Québec, vegetation change

The preference of particular plant species for specific lithologic substrates has a long history of observation, which has proved to be very useful in understanding biogeography and vegetation ecology (e.g., Ellenberg 1988; Fernald 1907), plant physiology (McLaughlin and Wimmer 1999), and plant evolutionary processes (Shaw 1989). Early workers detected distinct floras in limestone districts in central Europe (Link 1789; Unger 1836). Fernald (1907) was probably the first to extensively study relationships between plant distribution and lithology in North America, where he classified alpine and subalpine plants occurring in New York, New England, New Brunswick, and southern Québec according to their preferences for granite, gneiss, or mica schist (Fernald's Group I), limestone or other calcareous rocks (Group II), or serpentine (or more correctly, ultramafic rocks such as peridotite and their metamorphic equivalent, serpentinite; Group III). In these early studies, the relationships were worked out in alpine to subalpine settings, and on cliffs, perhaps because of their limited soil and close or direct contact between plants and exposed rock. In contrast, in habitats with deeper soils of less obvious or mixed parentage, such as glacial till, such relationships could not be detected without specific mineralogic or chemical analyses. Although further study of plant distribution in alpine and arctic districts of North America has shown that some of the taxa Fernald designated as restricted to one group are less faithful to a particular lithologic substrate, for the most part these groups have stood the test of time (Kruckeberg 2002). Today, these species are referred to as calcifuges, acidophiles, or oxylophytes, indicative of acidic habitats with low calcium availability (Group I); calcicoles or calciphiles, confined to habitats with higher concentrations of available calcium (Group II); or serpentinicoles, indicators of habitats with higher concentrations of magnesium and heavy metals, such as chromium and nickel, coupled with low calcium concentrations (Group III; Harrison and Rajakaruna 2011).

In classifying the distribution of subalpine and alpine plants of the northern Appalachian region, Fernald distinguished plants restricted to just one of the three lithologic groups (i.e., strict indicators of substrate) from plants distributed on sites that supported two or three of the groups (i.e., plants somewhat tolerant or indifferent to a variety of substrates). Fernald noted that strict indicators of the three groups were confined to separate areas. For instance, Group I plants were common to the Adirondacks, NY; White Mountains, NH; and Katahdin, ME; but were not found with Group II plants on cliffs at Willoughby Cliffs and

Smugglers Notch, VT, or sea cliffs on the north shore of the Gaspé Peninsula, and vice versa. However, Fernald (1907) highlighted one particular site that he discovered in 1906 with his long-time field collaborator, J. Franklin Collins, which he called the Calcareous Alpine Meadow, in the Chic-Choc Mountains, Québec, as being particularly noteworthy for its diversity and unusual mingling of species otherwise considered to be strict indicators of contrasting substrates. Fernald hypothesized that this site was influenced by seepage from different directions, each associated with a different type of bedrock. The puzzle of this co-occurrence of calcicole and calcifuge plants was the impetus for the present study. We sought to re-locate this meadow to further describe the mingling of indicator plants and to evaluate Fernald's hypothesis for the origin of this remarkable site.

Near the Calcareous Alpine Meadow was a second site with many calcicoles (Group II species). Fernald and Collins called this site Marble Ridge. Together, these two sites represent extensive and floristically diverse calcareous alpine habitat that is of broad regional significance. The Appalachian region, extending from Georgia through Québec to Newfoundland, includes alpine habitats from northern New England through Newfoundland. In this region, calcareous rocks are largely confined to low-elevation, lower hillslope or valley situations, because of their susceptibility to chemical weathering and of their softness, which makes them vulnerable to fluvial and glacial erosion. True calcareous rocks at higher elevations in alpine and subalpine habitats are rare. Their influence on plant habitats may be best developed at these proximally allied sites on Mont de la Table and the nearby Mont Logan in the western portion of the Chic-Choc Mountains (Collins and Fernald 1925; Gervais 1982). These sites have unusual conservation value due to their plant diversity and the presence of rare and range-limit species and unusual communities, perhaps relict to colder portions of the postglacial period. They are also valuable as laboratories to understand mineral weathering, soil development, and water flowpaths in calcium-rich substrates within an otherwise highly acidic environment.

Despite long-standing use of lithology to characterize chemical influences on plant habitat, specific observations of rocks are rarely included in floristic studies. Using special groups of plants to characterize rocks of specific lithologic composition as calcareous or acidic is a risky venture. Calcicoles are often assumed to be restricted to calcareous rocks, which, strictly speaking, are rocks composed of calcium carbonate such as limestone and marble. Similarly, plants are classified as acidophile or calcifuge because they commonly occur on rocks such as granite, sandstone, and mica schist, which are often the source of acidic habitats. However, the relationships are less clear when strict calcicole or calcifuge plants are found on rocks whose compositions do not fit into these strict categories, or when plants of one affinity are found on rocks or soils of the putatively opposite character (Bailey 2013; DeSilva 1934).

Moreover, this classification of rocks typically leads to their characterization as basic or acidic, or as representing a particular range in pH. However, the concept of acidity, or pH, as representing the hydrogen ion activity of an aqueous solution, does not apply to a solid rock. Typically most of a rock's limited water content is tied up in the crystallographic lattices of minerals such as phyllosilicates (e.g., micas, including biotite and muscovite, clay, and serpentine minerals) and amphiboles (e.g., hornblende). Relatively little free water is present as fluid inclusions in minerals.

In fact, the acidity or calcium availability of plant habitats is not controlled by rocks themselves, but by the interactions among rocks, or rock-derived materials such as soil, and water. Mineral weathering consumes acidity and releases ions to solution, affecting the pH and dissolved nutrient concentrations in water or stored on exchange sites in soil. The classifications of Fernald and other early workers preceded the development of modern analytical techniques and widespread testing of soil and water quality. Fernald and Collins attempted to confirm plant indicator relationships by analyzing the chemistry of plant tissues that they ashed in their frying pan at their camps in the field (Fernald 1942). To objectively confirm and quantify the degree of calciphilic or acidophilic tendencies of plants, measurements of soil and water composition are warranted (DeSilva 1934) as, even today, these are rarely reported in floristic or biogeographic studies. Thus, to contribute to this literature, we sought to determine the composition of water and soil of habitats presumed to be relatively calcium-rich or calcium-poor in our study area.

The objectives of our study were to: 1) re-locate Fernald's Calcareous Alpine Meadow and Marble Ridge and inventory the flora of these sites and adjacent typical (i.e., zonal) habitats, documenting the relative separation or mingling of calcicole and calcifuge species; 2) compare the present flora and vegetation with

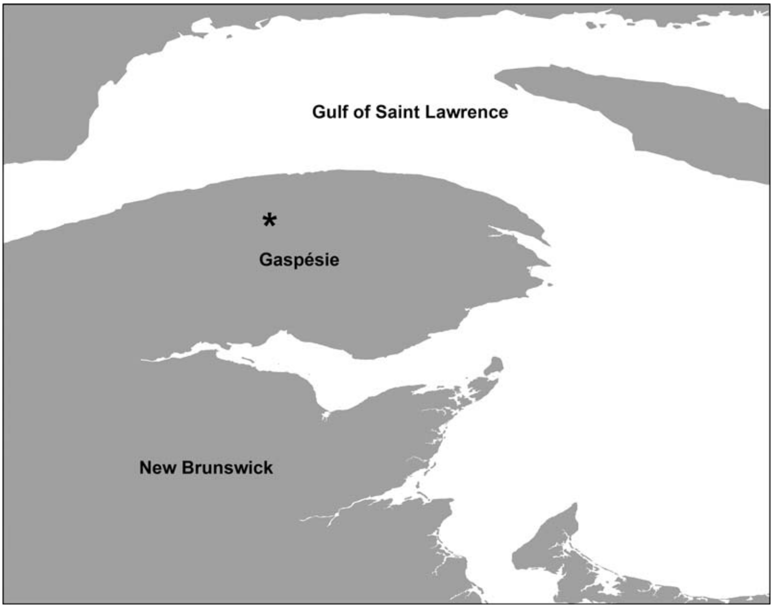

Figure 1. Location of Mont de la Table, indicated by the star, in Gaspésie, southern Québec.

that documented by Fernald and Collins one century ago and detect possible changes in the context of climate change, especially at the alpine/subalpine ecotone; 3) identify substrate conditions controlling the distribution of habitats for calcicole plant taxa on Mont de la Table; and 4) quantify chemical conditions and distinctions of the habitats of calcicole and calcifuge plant taxa at Mont de la Table, and compare them to other sites in the northern Appalachian region.

STUDY AREA

Mont de la Table (48°59′N, 66°0′W), in southern Québec (Figure 1), is a dome-like summit of 1180 m altitude rising along the western edge of a subalpine tableland that is at about 900–1100 m altitude and about 8 km wide by 12 km long. The highest summit on the tableland, as well as the highest point in southern Québec, is Mont Jacques-Cartier at 1268 m altitude, 4.3 km east of Mont de la Table. The entire tableland area, including these and several other peaks, was called Table-top Mountain (Montagnes de la Table) by Fernald and Collins and other early botanical collectors, but is now collectively known as the McGerrigle Mountains, a subdivision of the Chic-Choc Mountains in the central portion of the Gaspé Peninsula, Québec.

The bulk of the McGerrigle Mountains is underlain by a large intrusion of Devonian granitic rocks surrounded by Cambrian to Ordovician sedimentary rocks along the perimeter. Heat produced during intrusion of the granitic magmas caused contact metamorphism of the sedimentary rocks, converting siltstones and shales to pelitic hornfels, limestone to marble, and calcareous siltstones to calc-silicate hornfels. The pelitic hornfels is a dominant lithology and is exceedingly hard and resistant to erosion, thus holding up much of the escarpment bordering the McGerrigle Mountains as well as protecting the granitic core, which is relatively easily eroded and weathered. At our specific study area, previous bedrock mapping at a scale of 1:12,000 shows a contact between map unit 2cMc, which includes cordierite hornfels, spotted pelitic hornfels, and minor calc-silicate hornfels, to the west and map unit 12, consisting of red, coarse granite with minor quartz monzonite, to the east (De Römer 1977; Girard 1965). The contact between the two map units crosses the eastern flank of Mont de la Table, extending across the lower portion of the Calcareous Alpine Meadow and continuing to the eastern flank of Peak 2. No calcareous bedrock has been mapped in the vicinity of Mont de la Table.

Substrate includes fellfields, scree, and rock outcrops on upper slopes and summits; lower slopes have soils with an accumulation of fibric to sapric organic material overlying generally thin (< 1 m) glacial drift and locally derived regolith. The escarpment on the western side of Mont de la Table (Figure 2) was shaped by alpine glaciers thought to pre-date continental glaciation during the Wisconsinan era, and features two west-facing cirques with the intervening spur ("Marble Ridge") as a glacial arête. Although the region was once thought to have escaped the latest episode of continental glaciation (Fernald 1925), more recent studies have conclusively demonstrated the glaciation of the Gaspé Peninsula by the Laurentide ice sheet during late Wisconsinan time (Shaw et al. 2006), as further evidenced by erratic granite boulders observed during the present study.

Based on limited meteorological data from Mont Logan and Mont Jacques-Cartier, and extrapolation from longer monitoring

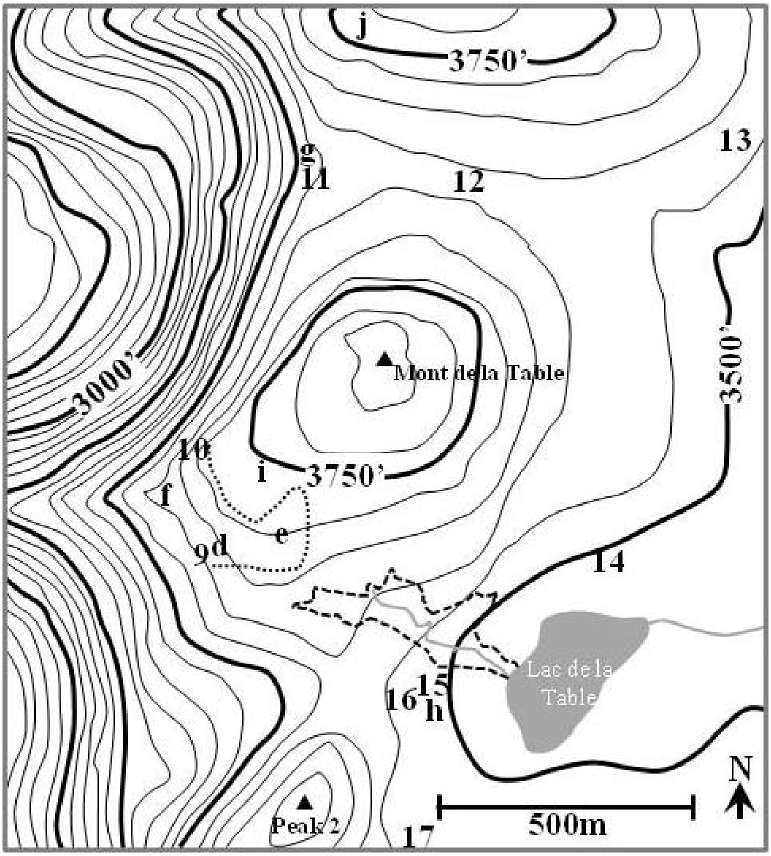

Figure 2. Vicinity map of Mont de la Table. The Calcareous Alpine Meadow is shown within a dashed line surrounding a stream that drains the south side of Mont de la Table into Lac de la Table. Marble Ridge is the prominent east-west ridge that separates the two west-facing cirques on the northwest and southwest side of Mont de la Table. The upper limit of the calcareous alpine barrens is shown as a dotted line. Soil sampling sites are shown with letters d to j. Water sampling sites are shown as numbers 9 to 17; sites 13 and 17 are located approximately 100 m to the east and south, respectively, of the map border. The base map was derived from the Canadian Department of Energy, Mines, and Resources 1:50,000 topographic map with a contour interval of 50 feet.

records along the Gaspésian coast, climate for the summits of the Chic-Choc Mountains features an estimated mean annual air temperature of -3 to -5°C, > 1600 mm of annual precipitation, and an annual snowfall of > 6250 mm (Gray and Brown 1979). Due to high winds, snow cover is limited on summits and plateau surfaces above treeline, but in subalpine habitats it lasts for 260 to 290 days, from mid-September through late June, and accumulates to > 2 m deep (Gray and Brown 1979). Conditions on the upper part of Mont de la Table are consistent with the regional relationship between latitude and treeline elevation, describing the climatic control over the upper elevation limit of spruce-fir forests (Cogbill and White 1991).

Vegetation on lower slopes and across the tableland consists of an open, boreal woodland, dominated by *Picea glauca* and *Abies balsamea* with intervening shrubby and graminoid meadows. The western escarpment and patches of woody vegetation on upper slopes and summits are characterized by krummholz dominated by *Abies balsamea*, *Picea mariana*, and *Betula cordifolia*. Most of the upper slopes and summits are composed of scree, hosting rock lichen communities, with scattered patches of shrubby and herbaceous alpine tundra composed of a variety of species.

When Fernald and Collins visited the area in 1906, the interior of the Gaspé Peninsula was an uncharted wilderness, visited only occasionally by hunters and trappers (Fernald 1942). Since then, roads were built into the interior, much logging was conducted at lower elevations, and Mines Madeleine—approximately 2.5 km north of Mont de la Table—was developed and operated for copper production during several decades of the mid-20th century. During this era of resource exploitation, broader exploration of mineral deposits left the track of a drill rig along the north shore of Lac de la Table, extending through the Calcareous Alpine Meadow to the col between Mont de la Table and the next peak to the south. A collection of abandoned bedrock core samples lay near this track, next to the shore of Lac de la Table, and two small ponds in the Calcareous Alpine Meadow appeared to be human-made, possibly as settling ponds used during drilling. This was the only evidence of direct human impact in the study area. In 1981 Parc national de la Gaspésie was established, encompassing the central Chic-Choc Mountains and including most of our study area with the exception of the western edge, which is part of the Réserve faunique des Chic-Chocs. Mont de la Table and surrounding portions of the

McGerrigle Mountains lie in a zone of strict preservation, set aside for protection of the dwindling last herd of woodland caribou south of the Saint Lawrence River, where all human access is extremely limited.

MATERIALS AND METHODS

Re-locating the Calcareous Alpine Meadow and Marble Ridge would have been nigh impossible without the detailed field notes, sketch maps with triangulation measurements, and photographs made by Collins and archived at Harvard University Botany Library. Before the first detailed maps of the region had been produced, few place-names were in common use in the Chic-Chocs. So Fernald and Collins made up many of their own place-names, which were used in their notes as well as on specimen labels and in Fernald's published writing. At first, these names were quite descriptive. Eventually, however, Fernald and Collins resorted to numbering many of the peaks and water bodies they encountered. Thus, in their nomenclature, Mont de la Table was "Peak 3," and Lac de la Table was "Pond 101." Many of these names, especially those consisting of numbers, were not adopted when topographic mapping came to the interior of the Gaspé Peninsula in the mid-20th century. Based on Collins's notes and photographs, however, we were able to locate the Calcareous Alpine Meadow and Marble Ridge on the upper slopes of Mont de la Table in the strict sense, one peak along the western portion of the much larger area Fernald and Collins called Table-top Mountain.

Our study area was chosen to include the Calcareous Alpine Meadow (note that we retain Fernald's alpine place-name, although it is more properly described as being subalpine in character), Marble Ridge, and a selection of more zonal barren and meadow habitats on the surrounding slopes. The approximate boundaries of our survey were the col between Mont de la Table and the next peak to the north, the base of the summit cone on the east side, and the south edge of the meadow bordering the south shore of Lac de la Table, all at about 1060 m (3500′) elevation (Figure 2). To the west, we surveyed the upper part of the steep escarpment, extending down to approximately 975 m (3200′) elevation. The total area covered was approximately 120 ha.

Taxonomy follows the Database of Vascular Plants of Canada (Brouillet et al. 2010+). A preliminary vascular plant list for the study area was compiled from taxa mentioned in publications by Fernald (1907, 1942), Collins's unpublished field book and journal, and an unpublished list of plants of Table-top Mountain handwritten by Fernald. The latter three documents are held in the archives of the Gray Herbarium at Harvard University. Note that Fernald's unpublished list includes taxa that he observed in other parts of the McGerrigle Mountains. For the flora presented here, we retained only taxa that we were able to document with our own collections, or with specimens collected by Fernald and Collins on August 5, 7, and 12, 1906, and clearly labeled with site descriptions that indicated they were collected in the Calcareous Alpine Meadow or habitats associated with Marble Ridge.

Herbaria at Harvard University, Université de Montréal, and Canadian Museum of Nature (GH, MT, and CAN) were searched for specimens of all species collected by us or mentioned by Fernald or Collins in published or unpublished works. In particular, we searched for herbarium specimens of several species that were distinctive to the Calcareous Alpine Meadow and Marble Ridge, but not reported elsewhere from the Mont de la Table vicinity. These included *Carex castanea*, *Dryas integrifolia* subsp. *integrifolia*, *Juncus castaneus* [= *J. leucochlamys* (Elven et al. 2010)], *Polystichum lonchitis*, *Salix vestita*, and *Saxifraga* spp. No specimens of taxa thought to be unique to the Calcareous Alpine Meadow or Marble Ridge within the broader Table-top Mountain (Montagnes de la Table; McGerrigle Mountains), other than those collected by Fernald and Collins in 1906, were found. Thus, it is likely that this site had not been visited by other collectors since its original discovery. A few specimens collected by Père Louis-Marie and companions on August 6–9, 1934, are labeled Montagnes de la Table. These are mostly of relatively common taxa, however; it is uncertain how close their travels may have taken them to Mont de la Table, *sensu stricto*.

Scoggin (1950) discussed calcareous cliffs on the western part of Table-top Mountain, but it is not clear whether he was referring to our specific study site or not. He erroneously labeled a photograph of cliffs east of Lac aux Américains, approximately 3.5 km south of Mont de la Table, as calcareous. Geologic mapping shows this area to be well within the granitic pluton (De Römer 1977). Furthermore, Scoggin listed a few taxa (*Carex norvegica* Retz., *Lonicera involucrata* [Richardson] Banks *ex* Spreng.) as occurring on calcareous cliffs on Table-top Mountain that were not documented from our study area by Fernald and Collins or us. Although this lake was named for Fernald and Collins, who camped there July 31–August 3, 1906, no calcicole specimens collected on these dates were found in our herbarium searches. Furthermore, Collins, who was typically quite exuberant in noting the discovery of unusual species, mentioned only common taxa on these dates in his journal.

Based on a review of Scoggin's thesis (1942) and his specimens at CAN, he collected calcicole species on July 5, 1939, and July 27–28, 1940. Some of these specimens have only a general label of "Tabletopped Mountain," whereas the majority of them, from all three dates, list Lac aux Américains and a few of them are even more specific, listing "calcareous pockets southwest and above Lac aux Américains, Tabletopped Mountain." The latter describes a location that is mapped as having calcareous rocks (De Römer 1977; Girard 1965). Scoggin reported taxa that have not been found in the vicinity of Mont de la Table by others, and we found specimens collected by Scoggin for only a minority (eight) of the distinctive taxa found at Mont de la Table. As it would have been impossible to visit both Mont de la Table and the cliffs south of Lac aux Américains in one day, we consider it highly unlikely that Scoggin ever visited the Calcareous Alpine Meadow or Marble Ridge. Thus, we did not include in our flora the additional taxa he listed for calcareous cliffs on Table-top Mountain.

We conducted field surveys on August 2–4, 2005, July 22–23, 2006, July 29, 2007, and July 2–4, 2008, for a total of approximately 17 person-days of effort. In comparison, Fernald and Collins spent at most five person-days in our study area. We found that taxa considered to be strict calcicoles by Fernald (1907) were confined to two distinct areas, with a sharp boundary between common presence and complete absence of calcicole taxa. This boundary was mapped by recording the limits of dominant calcicole indicators (Table 1), using a handheld Garmin E-trex Summit GPS unit (Kansas City, MO). Relative frequency of occurrence of all vascular plant species encountered was rated for four areas, including 1) the Calcareous Alpine Meadow, 2) typical subalpine meadows and intervening woodland containing only calcifuge or widespread taxa, 3) calcareous alpine barrens and cliffs associated with Marble Ridge, and 4) typical alpine tundra and krummholz communities containing only calcifuge or widespread taxa.

To detect changes to the vegetation of Mont de la Table that might not be reflected in floristic inventories, we evaluated potential

Table 1. Taxa listed by Fernald (1907) for the Calcareous Alpine Meadow on Mont de la Table, in the Chic-Choc Mountains of Québec, and considered by him to be strictly controlled by one type of substrate. Common taxa, used by us as indicators to map the boundaries of calcium-enriched habitats, including a few taxa not listed by Fernald for the Calcareous Meadow, are indicated by asterisks*. Superscripts indicate species used by us as calcium-enriched-habitat indicators: [1]found in the calcareous alpine meadow only; [2]found in the calcareous barrens only; [3]used here but not considered by Fernald (1907), perhaps because of its distribution beyond alpine and subalpine habitats.

GROUP I. CALCIFUGES
Carex deflexa (Cyperaceae)
Carex echinata subsp. *echinata* (Cyperaceae)
Omalotheca norvegica (Asteraceae)
Petasites frigidus var. ×*vitifolius* (Asteraceae)
Rhinanthus minor var. *groenlandicus* (Orobanchaceae)
Vaccinium caespitosum (Ericaceae)
Vaccinium ovalifolium (Ericaceae)
Vahlodea atropurpurea (Poaceae)
Veronica wormskjoldii (Plantaginaceae)

GROUP II. CALCICOLES
Anemone parviflora (Ranunculaceae)
Arabis alpina (Brassicaceae)
Campanula gieseckeana (Campanulaceae)
Carex capillaris subsp. *capillaris* (Cyperaceae)
Carex castanea[*1,3] (Cyperaceae)
Dasiphora fruticosa[*3] (Asteraceae)
Dryas integrifolia subsp. *integrifolia*[*2] (Rosaceae)
Erigeron hyssopifolius (Asteraceae)
Juncus leucochlamys (Juncaceae)
Packera pauciflora (Asteraceae)
Polystichum lonchitis (Dryopteridaceae)
Pyrola grandiflora (Ericaceae)
Salix glauca var. *cordifolia* (Salicaceae)
Salix vestita[*] (Salicaceae)
Taraxacum lapponicum (Asteraceae)
Tofieldia pusilla[*2] (Tofieldiaceae)
Valeriana dioica subsp. *sylvatica* (Caprifoliaceae)

GROUP III. SERPENTINICOLES
Cirsium muticum (Asteraceae)
Danthonia intermedia subsp. *intermedia* (Poaceae)
Symphyotrichum novi-belgii var. *novi-belgii*[*1] (Asteraceae)

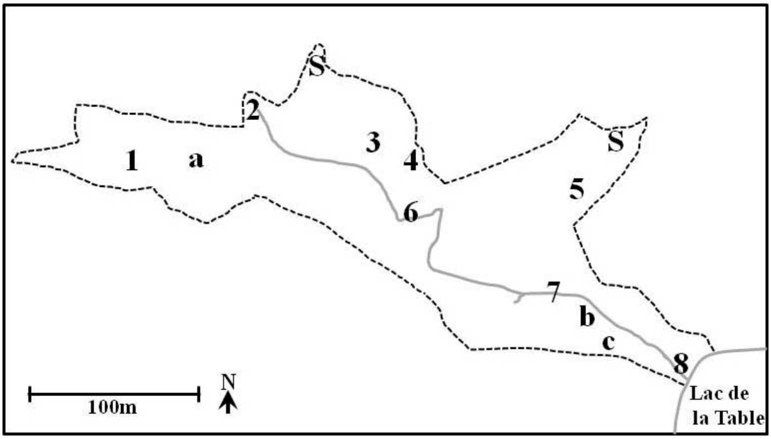

Figure 3. GPS-derived map of the Calcareous Alpine Meadow. A stream drains the meadow, flowing toward the southeast to its mouth at Lac de la Table. The upper edge of the meadow is marked by a series of springs. Unsampled springs are labeled S. Water sampling sites include springs 1–5 and the main stream at sites 6–8. Soil sampling sites are a–c.

changes in plant habitats by repeat ground photography. A panorama taken from the summit of Peak 2 (Figure 2) includes views of Marble Ridge, the summit of Mont de la Table, and the Calcareous Alpine Meadow. A copy of Collins's 1906 photograph of the same scene from the same location, obtained from the archives of the Gray Herbarium, was used to guide selection of location and to approximate focal length with a zoom lens to best match the historic image.

Water samples of approximately 60 mL were collected from streams and groundwater springs found in the Calcareous Alpine Meadow and typical subalpine meadows (see Figures 2 and 3). Samples of stream water and seepage from cliffs were collected in calcareous alpine barrens. No surface water was observed in typical alpine habitats. Water samples were analyzed for pH with a Broadley James rain probe (Irvine, CA). Concentrations of dissolved metals, including Ca, Mg, Na, K, Al, and Si, were analyzed on a Varian Vista axial indirect-coupled plasma spectrophotometer (Palo Alto, CA) at the Forestry Sciences Laboratory, Durham, NH.

Hand specimens of each bedrock lithology found in the study area were collected and sampled for preparation of thin sections (see Figure 2). Mineral content of rocks was determined by standard petrographic techniques on a polarizing microscope. Soil samples were collected from the rooting zone of representative sites in all four habitat types delineated in our flora. Soil samples were approximately 300 g each, air-dried, homogenized, and screened to remove particles > 2 mm. Soil samples were analyzed for pH in 0.01M $CaCl_2$ (Robarge and Fernandez 1987). Exchangeable cations (Ca, Mg, Na, K, and Al) were determined in 1.25 mol L^{-1} NH_4-acetate extracts buffered at pH 4.8, prepared on a mechanical vacuum extractor (Blume et al. 1990). Concentrations of cations in soil extracts were measured on a Varian Vista axial indirect-coupled plasma spectrophotometer.

RESULTS

We compiled a flora for Mont de la Table based on our collections and specimens found at the Gray and Marie-Victorin herbaria and the National Herbarium of Canada (Appendix). Herbarium searches were guided by taxa mentioned in Collins's field book, an unpublished list by Fernald, and published citations (Fernald 1907, 1942). Between the historic and recent collections, 194 taxa were included, with representatives in 45 families. The most important families, by number of taxa, were Poaceae (24), Cyperaceae (20), Ericaceae (18), Asteraceae (16), and Rosaceae (13). Together, these five families accounted for 91 taxa (47%), with the remaining 40 families accounting for the other 53%. The most speciose genera were *Carex* (18 taxa), *Salix* (10), *Poa* (6), *Vaccinium* (5), and *Epilobium* (4). Graminoids were well represented, with 50 taxa.

Relative abundances in four general habitats—calcareous meadow and woodland (Calcareous Alpine Meadow), typical meadows and woodlands (lacking calcicole taxa), calcareous alpine barrens (Marble Ridge and adjacent portion of the summit area), and typical alpine barrens (lacking calcicole taxa)—were ranked as abundant (dominant in that habitat); frequent (easy to find but not dominant); occasional (widely scattered, not difficult to find); infrequent (difficult to find); and rare (found once or twice in the habitat), following the abundance scale proposed by Palmer et al. (1995). A number of taxa were frequent to abundant throughout the study area, including in the alpine barrens, krummholz, and subalpine woodlands. These included the tree species *Abies* *balsamea*, *Picea glauca*, and *P. mariana*, and the sedge *Trichophorum cespitosum*. Another nine taxa were found throughout all portions of the study area, but varied in abundance from dominant to occasional within individual habitats. These included the shrubs *Alnus viridis* subsp. *crispa*, *Phyllodoce caerulea*, and *Vaccinium uliginosum*, and the herbs *Conioselinum chinense*, *Nabalus trifoliolatus*, *Platanthera dilatata* var. *dilatata*, *Solidago macrophylla*, *S. multiradiata*, and *Viola labradorica*.

We mapped the extent of the Calcareous Alpine Meadow (Figures 2, 3) based on the presence of several locally common calcicoles, including *Salix vestita*, *Carex castanea*, and *Dasiphora fruticosa*. The boundary between the Calcareous Alpine Meadow and the typical meadows, as defined by the presence of these taxa, was generally obvious within a 1–2 m distance where these taxa graded from being frequent or important components in the Calcareous Alpine Meadow to absent in the surrounding typical meadows. Other taxa that were restricted to the Calcareous Alpine Meadow within the subalpine portions of the study area, but were more scattered, included the willows *Salix arctophila*, *S. ballii*, and *S. glauca* var. *cordifolia*, and the herbs *Cirsium muticum* and *Packera pauciflora*. Still other taxa documented by Fernald (1907) as special components of the Calcareous Alpine Meadow, and generally considered to be calcicoles, were infrequent. These included *Anemone parviflora*, *Arabis alpina*, *Erigeron hyssopifolius*, *Juncus leucochlamys*, *Polystichum lonchitis*, and *Valeriana dioica* subsp. *sylvatica*. In contrast, a number of taxa common to calcium-poor alpine or boreal habitats, generally considered to be calcifuges, were common in the Calcareous Alpine Meadow, including *Cornus canadensis*, *Huperzia selago*, *Lycopodium clavatum*, *L. dendroideum*, *Phyllodoce caerulea*, *Solidago macrophylla*, and *Vaccinium uliginosum*.

The Calcareous Alpine Meadow, with an area of approximately 3.5 ha, had 128 taxa, or 66% of the diversity observed in the whole ~ 120 ha study area. Other subalpine meadows contained 90 taxa covering approximately 90 ha of the study area. Seventy-three taxa were common to both the Calcareous Alpine Meadow and typical meadows; 55 taxa were found in the Calcareous Alpine Meadow but not in the typical meadows; and only 18 taxa were found in the much larger typical meadows and absent in the Calcareous Alpine Meadow.

Similarly, calcium-influenced alpine barrens on Marble Ridge were distinguished from typical alpine barrens by abrupt transitions from dominance to absence of several calcicole indicators. As in the Calcareous Alpine Meadow, *Salix vestita* and *Dasiphora fruticosa* were frequent in calcareous alpine barrens. *Carex castanea* was present in calcareous alpine barrens but, unlike in the wetter meadows, its abundance was too low to be a useful indicator. Instead, *Dryas integrifolia* subsp. *integrifolia* and *Tofieldia pusilla*, both absent from the Calcareous Alpine Meadow, were important components of the calcareous barrens. Scattered within the calcareous barrens were a number of calcicoles, including *Anemone parviflora*, *Erigeron hyssopifolius*, *Pyrola grandiflora*, *Saxifraga aizoides*, and *S. paniculata* subsp. *laestadii*. All of these calcicole taxa were interspersed with frequent to occasional occurrences of calcifuge taxa typical of more acidic alpine habitats, such as *Empetrum nigrum* subsp. *hermaphroditum*, *Lycopodium annotinum*, *Phyllodoce caerulea*, *Salix uva-ursi*, and *Vaccinium uliginosum*. Many of the calcicole species were more difficult to find, with very limited populations, including *Campanula uniflora*, *Carex rupestris*, *C. vaginata*, *Parnassia kotzebuei*, *Pedicularis flammea*, *Primula mistassinica*, *Salix calcicola*, and *Saxifraga oppositifolia* subsp. *oppositifolia*, among others.

In total, 96 taxa were found in approximately 5.8 ha of calcareous alpine barrens (Figure 2), with 56 (58%) of these taxa found in alpine barrens confined to the calcareous portion. In comparison, 47 taxa, with almost no calcicole species present, were found in the remaining ~ 21 ha of alpine barrens, with 41 taxa in common between calcareous and typical alpine portions.

Only six taxa of the typical alpine barrens were absent from the calcareous area. Of these, *Poa alpina* subsp. *alpina* was widely scattered in typical alpine habitats, and the others were all infrequent to rare.

Overall, there was little evidence of change in species composition over the century that separated our work from that of Fernald and Collins. Of the 194 taxa documented between the two studies, 186 taxa were documented by us. Fernald and Collins found eight taxa that we did not locate, including *Achillea lanulosa*, *Carex lenticularis* var. *lenticularis*, *Cinna latifolia*, and *Epilobium lactiflorum*, all common boreal species that we might have overlooked. Fernald and Collins also found *Carex concinna*, *Danthonia intermedia* subsp. *intermedia*, and *Festuca prolifera* var. *prolifera*, which are calcicole taxa that are uncommon in the region, and *Cerastium cerastoides*, which is a snowbank species.

Excluded from the flora were 16 unvouchered taxa, including 14 mentioned by Fernald in his unpublished list, and two cited by him in his account of collecting on Marble Ridge (Fernald 1942; see Appendix). We were not able to locate specimens of any of these taxa definitively from Mont de la Table in our herbarium searches. However, given more general place-names on labels of early specimens, it is possible that some vouchers of common species were from our study area. Most of these taxa are common boreal species that were probably not priorities for collection by Fernald and Collins. These taxa might not have been seen by them in our immediate study area, although they would have been frequent to common in other parts of the McGerrigle Mountains. *Cystopteris fragilis*, *Festuca frederikseniae*, and *Oxyria digyna* were noted on calcium-enriched habitats and were possibly seen by Fernald and Collins in the vicinity of Marble Ridge.

We found 16 taxa not noted by Fernald and Collins. Seven of these are fairly well distributed in boreal habitats in the region and were likely not targets for collection by Fernald and Collins, including *Danthonia spicata*, *Dryopteris cristata*, *Lycopodium clavatum*, *L. dendroideum*, *Platanthera hyperborea*, *Poa pratensis* subsp. *alpigena*, and *Salix bebbiana*. Of these seven, the two lycopods were occasional and could have been overlooked by Fernald when he compiled his list, whereas the others were all infrequent to rare in our survey. Another lycopod, *Huperzia appressa*, was identified by us as a distinct taxon but would have been included in *H. selago* by Fernald and Collins. *Minuartia rubella* and *Woodsia glabella* are uncommon calcicoles previously reported from the Chic-Choc Mountains, and *Chamerion latifolium* is a regionally rare calcicole, having been reported previously from calcareous sea cliffs along the Gaspésian coast. Our report may represent the first station known from the Chic-Choc Mountains. All three of these calcicoles were rare in our survey, occurring as a small number of individuals in a single location for each. Three taxa found only by us, *Elymus repens*, *Pilosella flagellaris*, and *Tussilago farfara*, are naturalized species. They were not reported by Fernald and Collins for Table-top Mountain at the turn of the 20th century but were listed as common weeds in the region by midcentury (Scoggin 1950).

Although the floristic composition of the study area appears to have changed relatively little in one hundred years, comparisons of our photographs with those taken by Collins suggest elements of

Figure 4. Photographs of the south side of "Marble Ridge" (in the middle ground) by J. Franklin Collins, August 7, 1906 (above) and by Scott W. Bailey, July 22, 2006 (below).

both stability and change in various aspects of the vegetation. Open scree on the south-facing slope of Marble Ridge was much more prominent in 1906 (Figure 4). There appears to have been at least a 50% increase in krummholz vegetation on this slope by 2005–2008. In contrast, the line between woodland vegetation and open scree on the Mont de la Table summit cone, as well as isolated patches of

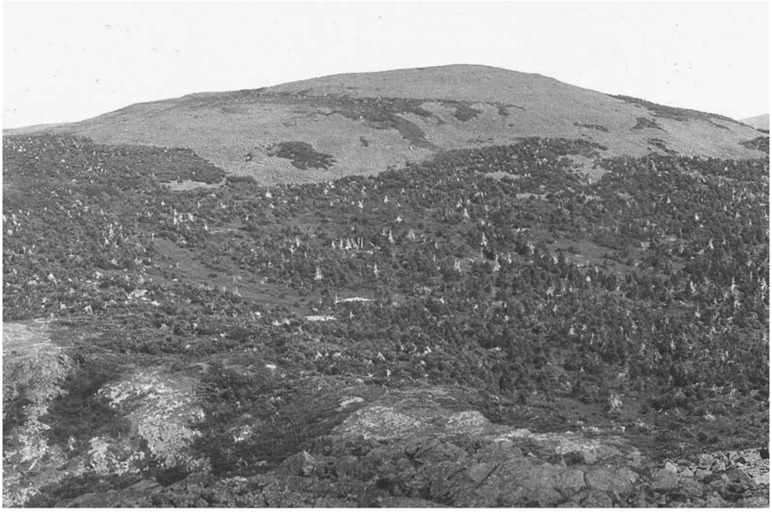

Figure 5. Photographs of the southwest side of Mont de la Table by J. Franklin Collins, August 7, 1906 (above) and by Scott W. Bailey, July 22, 2006 (below). The peak is at the upper right. The upper reaches of the Calcareous Alpine Meadow extend across the lower portion of the view, just beyond the outcrops in the foreground.

krummholz above this line, appears to be exactly the same as they were one hundred years ago (Figure 5). Open meadows on the slope where the Calcareous Alpine Meadow occurs appear to have shifted positions from 1906 to 2006 (Figures 4, 6), with some individual patches of open meadow having been completely filled in with

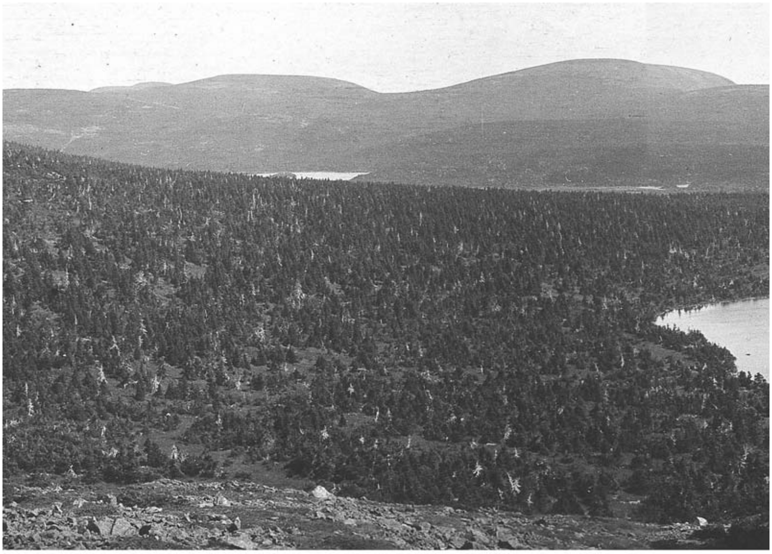

Figure 6. Photographs of a view that includes the lower portion of the Calcareous Alpine Meadow by J. Franklin Collins, August 7, 1906 (above) and by Scott W. Bailey, July 22, 2006 (below). The calcium-rich habitat extends from Lac de la Table, on the right edge, along the lower portion of the photograph, just beyond the slope of Peak 2, which is in the foreground.

coniferous vegetation, particularly in the middle portion of the slope (Figure 6). Other areas suggest an expansion of meadow, such as near the base of the slope, adjacent to Lac de la Table (Figure 6). Overall, a reduction in open meadows of approximately 25–50% is suggested by comparing these photographs. In both sets of photographs, standing spruce snags are prominent, although they may be more numerous in the 1906 views.

For the most part, our observations of bedrock were consistent with published maps (De Römer 1977; Girard 1965). Scattered small outcrops were found in the streambed within the Calcareous Alpine Meadow. These were larger and more common along the periphery of the meadow. All of these outcrops, as well as the majority of loose rocks present as boulders or on scree slopes, were of hornfels, consisting of micaceous and quartz-rich sediments that were metamorphosed by contact with the McGerrigle granite pluton. A few rounded granite cobbles and boulders were seen, which are glacial erratics since they overlie hornfels bedrock. Contrary to prior mapping, but consistent with Fernald and Collins's choice of place-names, we found that the hornfels outcrops on Marble Ridge were interbedded with a white, gray-weathering marble, with calcareous and siliceous beds alternating over 0.5–1 cm distances. Large blocks of interbedded marble and hornfels were common in the calcareous alpine barrens, either transported slightly by glacial movement, or as float from periglacial frost-shattering of bedrock underlying the scree surface. Partially calcareous outcrops and blocks were very sharp and jagged due to the preferential weathering of the marble layers. No calcareous rocks were found anywhere outside of the area delineated as the calcareous alpine barrens (Figure 2).

We sampled water from streams and groundwater springs wherever they were encountered, so as to compare vegetation patterns with spatial variation in surface-water composition. The Calcareous Alpine Meadow is an elongate area that narrowly encompasses a tributary stream to Lac de la Table (Figure 3). The northern and western edge of the calcium-enriched meadow, as denoted by distribution of indicator calcicoles, was marked by a series of groundwater springs. Two of these springs, at the northwestern end of the meadow, had the highest concentrations of calcium, 8 to almost 14 mg/L, and the highest pH, ranging from 7.4 to over 7.7, of any waters in the vicinity (Table 2). Other springs toward the northeastern border of the meadow had lower calcium

Table 2. Chemistry of surface-water samples from Mont de la Table and comparative alpine to subalpine sites from the northern Appalachian region. Chemical concentrations are in mg/L. Site numbers are shown in Figures 2 and 3. Some sites were sampled on multiple dates; individual analyses are reported to illustrate temporal variations.

Site	Date	Description	pH	Ca	Mg	Na	K	Si
CALCAREOUS ALPINE MEADOW								
1	1-Aug-05	spring near western end	7.57	12.91	0.47	0.73	0.16	2.45
1	22-Jul-06	spring near western end	7.74	13.74	0.46	0.67	0.21	2.52
2	1-Aug-05	spring at stream source	7.63	8.05	0.49	0.61	0.20	2.55
2	22-Jul-06	spring at stream source	7.71	8.66	0.48	0.72	0.22	2.59
2	29-Jul-07	spring at stream source	7.73	10.08	0.51	0.72	0.23	2.96
2	2-Jul-08	spring at stream source	7.39	10.49	0.53	0.71	0.22	2.95
3	2-Aug-05	spring, northern meadow	6.61	3.64	0.42	0.68	0.21	2.50
4	2-Aug-05	spring, northern meadow	6.56	4.10	0.50	0.70	0.28	2.41
5	3-Aug-05	spring, eastern meadow	6.21	3.72	0.43	0.63	0.13	1.67
6	2-Aug-05	stream, midmeadow	7.02	8.49	0.49	0.63	0.23	2.23
7	2-Aug-05	stream, midmeadow	7.31	8.91	0.52	0.67	0.24	2.27
8	2-Aug-05	mouth of stream	7.17	6.72	0.54	0.70	0.24	2.58
8	22-Jul-06	mouth of stream	7.16	6.51	0.49	0.80	0.25	2.46
8	29-Jul-07	mouth of stream	6.82	6.31	0.44	0.74	0.21	2.37
8	2-Jul-08	mouth of stream	6.47	5.53	0.41	0.78	0.29	2.51
CALCAREOUS ALPINE BARRENS (MARBLE RIDGE)								
9	3-Aug-05	head of alpine rill	7.17	9.08	0.33	0.48	0.37	1.77
9	22-Jul-06	head of alpine rill	7.42	9.24	0.32	0.58	0.34	1.85
9	29-Jul-07	head of alpine rill	7.32	10.11	0.32	0.51	0.27	2.06
9	3-Aug-05	cliff seep	7.56	11.36	0.37	0.52	0.36	1.91
9	22-Jul-06	cliff seep	7.39	9.49	0.29	0.54	0.29	1.87
10	29-Jul-07	cliff seep with *Salix calcicola*	7.43	13.65	0.36	0.81	0.44	2.86
11	24-Jul-06	alpine rill in calc-silicate hornfels bedrock	7.43	4.64	0.45	0.71	0.27	2.00
11	3-Jul-08	alpine rill in calc-silicate hornfels bedrock	6.66	3.75	0.36	0.58	0.19	1.76
TYPICAL MEADOWS, MONT DE LA TABLE								
12	3-Jul-08	stream draining north col	6.02	1.69	0.28	0.54	0.14	0.71
13	4-Aug-05	stream entering old mining track	6.47	1.36	0.32	1.09	0.19	3.54
13	4-Aug-05	stream entering old mining track	6.14	1.40	0.32	1.09	0.19	3.48
13	4-Aug-05	stream entering old mining track	6.53	1.33	0.30	0.91	0.17	2.97
13	4-Aug-05	stream entering old mining track	6.15	1.59	0.35	0.90	0.26	3.21
14	4-Jul-08	stream next to camp	6.18	0.68	0.21	0.78	0.09	1.89
15	2-Aug-05	southwest meadow, few indicators	6.19	7.98	0.50	1.20	0.21	2.48

Table 2. Continued.

Site	Date	Description	pH	Ca	Mg	Na	K	Si
16	2-Aug-05	upper southwest meadow	6.13	1.78	0.22	0.64	0.06	0.27
17	23-Jul-03	stream south of Pond 101	4.77	0.68	0.14	0.75	0.04	2.10
CALCIUM-ENRICHED HABITATS – VT, NH								
	29-Jun-02	Mount Pisgah, VT, cliff seep	8.75	42.07	1.36	1.40	1.90	3.56
	1-Jul-04	Bald Mountain, VT, cliff seep	7.84	32.32	0.55	6.27	0.41	2.73
	29-Jul-05	Jobs Pond, VT, cliff seep	7.88	100.22	1.58	2.92	1.82	4.80
	19-Jul-13	Smugglers Notch, VT (Easy Gully), spring	7.12	8.07	1.37	0.31	0.18	1.33
	19-Jul-13	Smugglers Notch, VT (Easy Gully), rill	7.59	12.04	2.09	0.41	0.11	0.97
	19-Jul-13	Smugglers Notch, VT (Cass's Gully), rill	7.73	24.83	4.51	0.34	0.18	1.05
	12-Aug-07	Cannon Mountain, NH, cliff seep	7.18	10.02	0.81	1.21	0.32	2.84
	18-Aug-08	Cape Horn, NH, cliff seep	7.70	19.98	1.53	4.84	0.44	10.72
BASE-POOR HABITATS – NH								
	19-Aug-05	King Ravine, southwest gully stream	5.48	0.33	0.15	0.16	0.15	0.68
	21-Jun-06	Alpine Garden, spring	5.93	0.61	0.20	0.36	0.13	1.06
	29-Jun-07	Oakes Gulf, stream, east side	5.14	0.46	0.16	0.36	0.13	1.42
	29-Jun-07	Oakes Gulf, stream, north side	4.92	0.44	0.19	0.24	0.08	1.00
ULTRAMAFIC HABITATS – QUÉBEC								
	26-Jul-06	Mont Albert, stream at edge of plateau	7.83	0.63	16.77	0.25	0.03	7.97
	26-Jul-06	Mont Albert, spring	7.78	0.43	11.87	0.34	0.05	5.23

(3.6–4.1 mg/L) and pH (6.2–6.6). Middle to lower sections of the stream had compositions intermediate between the two groups of springs, with calcium concentrations ranging from 5.5 to 8.9 mg/L and pH from 6.5 to 7.3. Repeat sampling at a few sites over two to four years showed some variability between sample dates, but maintained the gradient described above.

In comparison to the Calcareous Alpine Meadow, typical meadows in areas lacking calcicole indicators had lower calcium concentrations, ranging from 0.7 to 1.8 (except for site 15, just outside the area occupied by calcicoles, which had 8.0 mg/L calcium) and pH ranging from 4.8 to 6.5. Both the Calcareous Alpine Meadow and typical meadows had similar concentrations of other ions, including magnesium (< 0.5 mg/L), sodium (≤ 1.2 mg/L), potassium (< 0.3 mg/L), and silicon (≤ 3.5 mg/L). The calcareous alpine barrens had streams and seepage from cliffs with similar composition to samples from the richer springs on the northwestern margin of the Calcareous Alpine Meadow (Table 2). No surface waters were encountered in other alpine portions of Mont de la Table, away from the area colonized by calcicole plant taxa.

Limited soil chemical analyses suggest strong fine-scale contrasts in plant rooting environments, not seen in the water samples (Table 3). Plant-available calcium, approximated by salt extraction of a dried soil sample, and pH were similar at two sites within wetter portions of the meadow where calcicole indicators such as *Salix vestita* and *Carex castanea* were present (Table 3). However, only several meters away on a drier peaty mound, where calcifuges *Phyllodoce caerulea* and *Vaccinium uliginosum* were dominant (site c, Figure 3), available calcium levels were one-fifth the amount of the wetter sites, and pH was nearly 1.5 units lower. This sample had even lower calcium concentrations and pH than a sample from the typical meadow taken in an area devoid of calcicoles. Available calcium in the immediate vicinity of marble-bearing boulders and rocks, at sites dominated by *Dryas integrifolia* subsp. *integrifolia* and *Salix vestita*, had up to five times the calcium concentrations seen in the wetter portions of the Calcareous Alpine Meadow, and up to fifteen times higher than at nearby locations dominated by *Vaccinium uliginosum* and *Salix uva-ursi* and lacking calcicole plant taxa. Soil pH in calcareous alpine barrens was similar to the Calcareous Alpine Meadow. All samples, regardless of location, had similar concentrations of other ions measured, with the exception of magnesium, which was modestly elevated at a few of the sites in the calcareous alpine area (Table 3).

DISCUSSION

We confirmed the description of Fernald (1907) that the Calcareous Alpine Meadow contains an unusually high level of plant diversity and mingling of species considered to have calcicole

Table 3. Chemistry of soil samples from four distinct plant habitats on Mont de la Table. Exchangeable cation concentrations are in $cmol_c kg^{-1}$. Sample sites are lettered and located on Figures 2 and 3. Each analysis represents one sample of soil collected from the main rooting zone.

Site	Notes	Date	Ca	Mg	Na	K	Al	pH
CALCAREOUS ALPINE MEADOW								
a	upper meadow	2-Aug-05	27.21	0.97	0.16	0.40	26.05	4.6
b	lower meadow	2-Aug-05	30.06	1.49	0.16	0.78	48.87	4.8
c	peaty mound in meadow	23-Jul-06	6.02	1.74	0.10	0.72	14.43	3.4
CALCAREOUS ALPINE BARRENS (MARBLE RIDGE)								
d	adjacent rill	22-Jul-06	42.88	0.91	0.11	0.31	6.22	6.5
e	among marble blocks	4-Aug-05	152.76	4.73	0.13	0.26	11.93	5.3
f	alpine barren	3-Aug-05	118.60	6.48	0.18	0.30	5.24	4.3
g	head of rill	24-Jul-06	53.43	3.20	0.18	1.18	7.51	4.6
TYPICAL MEADOW								
h	matrix meadow	2-Aug-05	11.89	1.51	0.23	1.01	22.87	4.0
TYPICAL ALPINE BARRENS								
i	50 m from marble	4-Aug-05	10.40	1.57	0.06	0.27	14.94	3.7
j	alpine barren	24-Jul-06	11.56	2.46	0.08	0.30	10.34	3.3

and calcifuge tendencies. The barrens adjacent to Marble Ridge showed a similar mixture, sharing many of the same species, in a drier, more exposed alpine situation. Calcicole taxa were almost entirely confined to these two areas, covering less than 10% of our ~ 120 ha study area. And although additional small pockets of calcicole habitat were present in the area, such as the cliff overlooking Lac aux Américains sampled by Scoggin, none approaching the extent of those found on Mont de la Table are known. Thus, calcicole habitats would be expected to be present in a vastly smaller proportion of the larger McGerrigle Mountains.

The study area contains several taxa of regional biogeographic significance. Of special interest is the type locality for *Micranthes gaspensis*, a rare Gaspé endemic. Also, *Salix calcicola* was first collected by Fernald and Collins at Mont de la Table in 1906. Fernald and Wiegand later described it as a new species based on type material they had collected in Newfoundland in the1930s. The Mont de la Table station is the only one known south of the Saint Lawrence River and was re-located by us in 2007. Several other rare calcicole taxa, known only from Mont de la Table, Mont Logan, and a few other calcium-enriched sites on the Gaspé Peninsula, are southern outliers of otherwise more northerly taxa. These include *Draba lactea*, *Pedicularis flammea*, and *Salix ballii*. Other taxa reach the southern edge of their ranges in eastern North America, although they are more broadly distributed in the west in the Rocky Mountains of both Canada and the United States. These include *Campanula uniflora*, *Carex rupestris*, *Chamerion latifolium*, *Dryas integrifolia* subsp. *integrifolia*, and *Packera pauciflora* (Gervais 1982; Scoggin 1950).

No calcareous rocks were found in the Calcareous Alpine Meadow. However, partially calcareous rocks were found 150–350 m upslope on Marble Ridge, in the alpine area, with common calcicole plants. Although the calcareous component of Marble Ridge was correctly identified by Fernald and Collins, it has not been shown on subsequent geologic maps, perhaps because it is too localized relative to the scale of published maps. The upslope limit of the Calcareous Alpine Meadow coincided with a series of springs with higher pH and calcium levels, presumably derived from a fractured bedrock aquifer, with a recharge zone in the upslope alpine area where marble-containing bedrock is present. The lack of elevation of other base cation (e.g., Mg, Na, K) or silicon concentrations in soil and waters of the enriched area suggests that calcite, the dominant mineral in the marble, is the source of the enrichment. In contrast, if dolomite or a relatively easily weathered silicate mineral were the source, one would expect to see elevated concentrations of some of these other ions in enriched, relative to non-enriched, portions of the study area.

The highest exchangeable calcium concentrations in soils of Mont de la Table were found in the immediate vicinity of marble blocks in the alpine barrens. These samples showed concentrations about 5 times higher than downslope habitats in the Calcareous Alpine Meadow that were influenced by enriched groundwater, and 15–25 times higher than the most acidic habitats in noncalcareous alpine scree, or in peaty soil in mounds above the water table in the Calcareous Alpine Meadow (Table 3). These contrasts in soil quality were seen over very short distances, consistent with the notion that close proximity of actively weathering carbonate minerals and hydrologic flowpaths that deliver weathering products are both needed to boost calcium concentrations in an otherwise highly leaching environment. These results suggest that the co-occurrence of calcicole and calcifuge species may be due to fine-scale variation in habitat, driven by degree of connection to the weathering flowpath, rather than to variable tolerances of plant taxa typically considered to be strict calcicoles or calcifuges.

Calcareous minerals are mostly depleted from the rooting zone of soils after about 10,000 years of weathering of glacial deposits in the humid climate of northeastern North America, even in areas where calcareous bedrock is present (Bailey et al. 2004). Soils in the Appalachian Mountains are naturally very acidic due to accumulation and slow decomposition of heath and conifer litter and extensive leaching of weathering products, typical of humid climates. Maintenance of higher pH and available calcium concentrations, especially in upland situations, requires 1) a source of calcium carbonate so large that it has not been depleted from the weathering zone, and 2) a position relative to hydrologic flowpaths such that delivery of weathering products to the rooting zone outpaces leaching. This sets up a situation where strong contrasts in habitat are possible over short distances, depending on position relative to leaching of weathering products of calcareous materials.

Comparative chemistry data from other alpine and subalpine sites in Québec, New Hampshire, and Vermont, including several sites considered by Fernald (1907) in his development of plant lithologic groups, are provided in Table 2. Calcium-rich habitats in

VT and NH reflect a broader range in water chemistry, as well as in geologic settings, compared to Mont de la Table. Mount Pisgah and Job's Pond in VT, cliffs formed in Waits River Formation where calcite and dolomite are major components, have much higher calcium concentrations, up to 100 mg/L, and higher pH, up to 8.75, compared to Mont de la Table, where the rocks are only partially calcareous and of limited extent. Other sites with easily weathered calcium minerals, such as Easy Gully and Cass's Gully at Smugglers Notch, VT, where carbonate minerals are confined to fractures and veins within a low-calcium mica schist, have water chemistry more similar to the calcium-rich habitats at Mont de la Table. Magnesium is somewhat elevated at these VT sites, reflecting the fact that the carbonate mineral present is not just calcite (i.e., $CaCO_3$), as it is at Mont de la Table, but rather dolomite ($CaMgCO_3$) in the Waits River Formation and ankerite ($CaMgFeCO_3$) in the schist at Smugglers Notch. Cannon Mountain, NH, provides an example of a site where calcite is an alteration mineral, present in relatively small amounts in a diabase dike. It yields water chemistry similar to that of Mont de la Table. Cape Horn, NH, where several base cation concentrations and silicon are elevated compared to base-poor sites, may be an example of enhanced weathering of silicate minerals where carbonate minerals are not substantial contributors at all (Bailey 2013). This example illustrates that calcicole habitat does not always depend on a calcareous or carbonate mineral source.

As examples of Fernald's Group I habitats, alpine streams in the White Mountains, NH, show low concentrations of all base cations, as well as low pH (Table 2). In particular, the pH and calcium concentrations are lower than at the non-calcareous-influenced areas on Mont de la Table. Although these habitats were already acidic, this difference may be influenced by higher loads of acid deposition in New England, as well as by inputs of marine aerosols, which provide a slight buffering on the Gaspé Peninsula (Ouimet and Duchesne 2009). To complete the comparison, a few stream samples from Mont Albert, a mountain just to the west of Mont de la Table and underlain by partially serpentinized peridotite, show high pH, high magnesium and silicon concentrations, and very low calcium and potassium concentrations, reflecting weathering of magnesium silicates, such as olivine [$(Mg,Fe)_2SiO_4$].

The flora of Mont de la Table appears to have been very stable over the last century, within the limits imposed by the historic data, which limit comparisons to presence and absence of taxa. A total of 170 taxa, or 88% of the entire flora, were documented by both us and Fernald and Collins. Twenty-four taxa were each recorded in only one or the other of these two surveys, and these included both common boreal taxa and regionally rare calcicole taxa. The latter were hard to find in our survey as they often consisted of only a few individuals, and these might have been similarly uncommon a hundred years ago. Local extirpations or colonizations may also have occurred. The most definitive difference between the two study periods is the occurrence of three adventive taxa during our survey, whose presence would surely have attracted the attention of Fernald and Collins. It seems probable that these taxa were introduced around the time of mining exploration during the mid-20th century when drilling equipment was brought to the Mont de la Table area.

Despite directed searches, specifically for *Agoseris aurantiaca*, which was collected and lost by Fernald during a slip on loose scree (Fernald 1942), we did not find this plant. Its preferred habitat of enriched, dry scree is the habitat type that appears to have decreased most in area in the comparison of the 1906 and 2006 photographs (Figure 4). The species might have been present in very small numbers in 1906, and it may still be present in very small numbers, but overlooked by us. This could be an example of the infrequent-to-rare taxa that made up about half (49% in the Calcareous Alpine Meadow and 53% in the calcareous barrens) of the species in the calcareous habitats, and suggests the potential for greater floristic change in the future. Although differences in methods and purpose of the two studies limit our ability to make strong conclusions about past changes in the flora, it is hoped that the more detailed documentation in the present study will facilitate a resurvey of the flora in the future.

The potential for future changes is indicated by increases in krummholz on the scree slope of the south side of Marble Ridge, and by in-filling of trees in the Calcareous Alpine Meadow (Figures 4–6). Vegetative expansion on scree was also shown by Lafortune et al. (1997), who studied the dynamics of a forest-scree slope boundary at a coastal site on the northern shore of the Gaspé Peninsula. Based on dendrological evidence, the forest had advanced over the scree from about 1850 to 1950, similar to our observation on Marble Ridge. They attributed this dynamic to the warming that followed the end of the Little Ice Age in the early 19th century. Slope instability since 1950 has partially reversed this trend, however, indicating the complexity of treeline dynamics on scree slopes and warning of the dangers of inferring linear change from observations at two points in time. Similarly, Capers and Stone (2011) found increasing frequency of trees and abundance of shrubs on a series of alpine to subalpine plots on Bigelow Mountain, ME, measured in 1976 and 2009, and Beal (2009) found in-filling of krummholz in the Presidential Range, NH, by comparing photographs taken up to one hundred years apart. Carlson et al. (2011) analyzed factors controlling spatial variation in alpine tundra of the Adirondack Mountains, NY, and suggested that changes in the frequency of icing events, winter storms, or other meteorological factors could alter the boundaries of tundra patches in subalpine forests.

Payette and Boudreau (1984) suggested that continuous forest cover was present in the higher Chic-Choc Mountains earlier in the Holocene. They attributed subalpine openings in the higher summits of the McGerrigle Mountains to post-hypsithermal cooling based on reactivation of geomorphic patterns induced by gelifluction at upper elevations. Thus, the balance between forest cover and open meadow and alpine barrens has fluctuated back and forth over a longer period of time, preceding alteration of atmospheric chemistry by modern industrialization. However, the possibility that these processes have accelerated in recent years warrants more attention and increased monitoring in the future.

Sharp gradients in alpine/subalpine vegetation and substrate conditions make Mont de la Table a valuable outdoor laboratory where relationships between floristic composition, vegetation, soil development, and climate change may be studied. In addition, the interaction between chemical weathering of a limited source of calcareous rocks and the otherwise highly acidic upland environment leads to high floristic diversity and unusual co-occurrence of calcicole and calcifuge taxa. Thus, the coincidence of two sharp environmental gradients—a chemical gradient controlled by hydrology and mixing of weathering products from variably calcareous rocks, and the alpine-subalpine ecotone—might make the site a bellwether for monitoring the impacts of environmental change on vegetation and floristics in the northern Appalachian region.

ACKNOWLEDGMENTS. This study would not have been possible without the multiple talents of J. Franklin Collins in photographing, mapping, and writing his daily accounts of the 1906 botanical expedition. His records made it possible to decipher geographic name changes and variable reporting of specimen localities and details. Collins's photographs are reprinted by permission of the Archives of the Gray Herbarium. The senior author also wishes to thank Rudolf Schuster and George Newman for introducing him to the wonders of the Gaspé Peninsula. The assistance of Lisa DeCesare, Archives of the Gray Herbarium; George Argus, Canadian Museum of Nature; and Stewart Hay, Université de Montréal, is appreciated. François Boulanger and Claude Isabel, Parc national de la Gaspésie, provided permission and logistical help in accessing the study site. Jane Hislop and Jeffery Merriam conducted chemical analyses. Brett Engstrom, Gustave Goodwin, Daniel Sperduto, and two anonymous reviewers provided helpful comments on earlier versions of the manuscript.

LITERATURE CITED

Bailey, S. W. 2013. Two fern species new to New Hampshire, with comments on the generation of calcareous-like habitat by base-poor rocks. Rhodora 115: 286–289.

———, S. B. Horsley, R. P. Long, and R. A. Hallett. 2004. Influence of edaphic factors on sugar maple nutrition and health on the Allegheny Plateau. J. Soil Sci. Soc. Amer. 68: 243–252.

Beal, K. S. K. 2009. Increased tree-cover at New England treelines associated with regional warming: Evidence from historical photographs. M.Sc. thesis, University of Vermont, Burlington, VT.

Blume, L. J., B. A. Schumacher, P. W. Schaffer, K. A. Cappo, M. L. Papp, R. D. van Remortel, D. S. Coffey, M. G. Johnson, and D. J. Chaloud. 1990. Handbook of Methods for Acid Deposition Studies Laboratory Analyses for Soil Chemistry. U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Las Vegas, NV.

Brouillet, L., F. Coursol, S. J. Meades, M. Favreau, M. Anions, P. Bélisle, and P. Desmet. 2010+. VASCAN, the Database of Vascular Plants of Canada. Website (http://data.canadensys.net/vascan/). Accessed March 2014.

Capers, R. S. and A. D. Stone. 2011. After 33 years, trees more frequent and shrubs more abundant in northeast U.S. alpine community. Arctic Antarc. Alpine Res. 43: 495–502.

Carlson, B. Z., J. S. Munroe, and B. Hegman. 2011. Distribution of alpine tundra in the Adirondack Mountains of New York, U.S.A. Arctic Antarc. Alpine Res. 43: 331–342.

Cogbill, C. V. and P. White. 1991. The latitude-elevation relationship for spruce-fir forest and treeline along the Appalachian mountain chain. Vegetatio 94: 153–175.

Collins, J. F. and M. L. Fernald. 1925. The region of Mt. Logan, Gaspé Peninsula. Geogr. Rev. (New York). 15: 84–91.

De Römer, H. S. 1977. McGerrigle Mountains Area. Ministère des Richesses naturelles, Direction générale des Mines, Service des Gîtes minéraux, Québec, QC, Canada.

DeSilva, B. L. T. 1934. The distribution of "calcicole" and "calcifuge" species in relation to the content of the soil in calcium carbonate and exchangeable calcium and to soil reaction. J. Ecol. 22: 532–553.

Ellenberg, H. 1988. Vegetation Ecology of Central Europe. Cambridge University Press, Cambridge, UK.

Elven, R., D. F. Murray, and H. Solstad. 2010. To arter av kastanjesiv (*Juncus castaneus* og *Juncus leucochlamys*), begge i Europa. Blyttia 68: 128–131.

Fernald, M. L. 1907. The soil preferences of certain alpine and subalpine plants. Rhodora 9: 149–193.

———. 1925. Persistence of plants in unglaciated areas of boreal America. Proc. Amer. Acad. Arts Sci. Mem. 15: 241–342.

———. 1942. Incidents of field-work with J. Franklin Collins. Rhodora 44: 98–152.

Flora of North America Editorial Committee, eds. 1993+. Flora of North America North of Mexico. 16+ vols. New York, NY, and Oxford, UK.

Gervais, C. 1982. La flore vasculaire de la region du Mont Logan, Gaspésie, Québec. Provancheria No. 23. Mémoire de l'Herbier Louis-Marie, Université Laval, Québec, QC, Canada.

Girard, P. 1965. Mount Richardson Area. Map of preliminary report, Ministère des Richesses naturelles, Direction générale des Mines, Service des Gîtes minéraux, Québec, QC, Canada.

Gray, J. T. and R. J. E. Brown. 1979. Permafrost existence and distribution in the Chic-Choc Mountains, Gaspésie, Québec. Géogr. Phys. Quatern. 33: 299–316.

Harrison, S. and N. Rajakaruna. 2011. Serpentine: The Evolution and Ecology of a Model System. University of California Press, Berkeley, CA.

Judd, W. S., C. S. Campbell, E. A. Kellogg, P. F. Stevens, and M. J. Donoghue. 2008. Plant Systematics: A Phylogenetic Approach. Sinauer Associates, Sunderland, MA.

Kruckeberg, A. R. 2002. Geology and Plant Life. University of Washington Press, Seattle, WA.

Lafortune, M., L. Filion, and B. Hétu. 1997. Dynamique d'un front forestier sur un talus d'éboulis actif en climat tempéré froid (Gaspésie, Québec). Géogr. Phys. Quatern. 51: 67–80.

Link, H. F. 1789. Florae Goettingensis: Specimen sistens Vegetabilia Saxo calcareo Propria. Ph.D. dissertation, University of Göttingen, Göttingen, Germany.

McLaughlin, S. B. and R. Wimmer. 1999. Tansley Review No. 104: Calcium physiology and terrestrial ecosystem processes. New Phytol. 142: 373–417.

Ouimet, R. and L. Duchesne. 2009. Dépôts atmosphériques dans les forêts au Québec: Retombées actuelles en forêt et tendances au cours des 20 à 30 dernières années. Naturaliste Canad. 133: 56–64.

Palmer, M. W., G. L. Wade, and P. Neal. 1995. Standards for the writing of floras. BioScience 45: 339–345.
Payette, S. and F. Boudreau. 1984. Évolution postglaciaire des hauts sommets alpins et subalpins de la Gaspésie. Canad. J. Earth Sci. 21: 319–335.
Robarge, W. P. and I. J. Fernandez. 1987. Quality Assurance Methods Manual for Laboratory Analytical Techniques. Revision 1. Corvallis Environmental Research Laboratory, Corvallis, OR.
Scoggin, H. J. 1942. Ecological studies of the arctic-alpine flora of the Gaspé Peninsula and of Bic. Ph.D. dissertation, McGill University, Montreal, QC, Canada.
———. 1950. The Flora of Bic and the Gaspé Peninsula, Quebec. Bulletin, Canada Department of Resources and Development, National Museum of Canada, Ottawa, ON, Canada.
Shaw, A. J. 1989. Heavy Metal Tolerance in Plants: Evolutionary Aspects. CRC Press, Boca Raton, FL.
Shaw, J., D. J. W. Piper, G. B. J. Fader, E. L. King, B. J. Todd, T. Bell, M. J. Batterson, and D. G. E. Liverman. 2006. A conceptual model of the deglaciation of Atlantic Canada. Quatern. Sci. Rev. 25: 2059–2081.
Unger, F. 1836. Über den Einfluß des Bodens auf die Vertheilung der Gewächse, Nachgewiesen in der Vegetation des Nordöstlichen Tirols. Rohrmann u. Schweiger, Wein, Germany.

APPENDIX

CATALOGUE OF THE FLORA OF MONT DE LA TABLE

The list is organized in five major plant groups, following Judd et al. 2008: lycophytes, monilophytes, gymnosperms, monocots, and eudicots. Within these groups, families, genera, and species appear in alphabetical order. Specimen numbers *100–700* were collected by M. L. Fernald and J. Franklin Collins in August 1906 and are located at GH, with duplicates at MT, CAN, and elsewhere. Fernald and Collins tended to collect unusual species and specimens of value for documenting an expansion of known habitats or ranges. They did not collect many common species in this area but did make notes of their occurrence. Taxa listed as common or frequent for Table-top Mountain in an unpublished list by Fernald, as well as taxa listed specifically from Marble Ridge or the calcareous meadow, are noted with an asterisk (*). Specimen numbers *5001–8026* were collected by the present authors in 2005–2008 and are located at GH. Specimen numbers *34349–34412*, stored at MT with some duplicates at GH, were collected by Père Louis-Marie et al., 6–9 August 1934, and labeled Montagnes de la Table, 1200–1500 m. It is not certain that this expedition reached our specific study area as these collectors found no specimens of taxa restricted to the Calcareous Alpine Meadow or Marble Ridge. However, these specimens represent taxa that Fernald or Collins mentioned in unpublished notes, or that we collected. Taxonomy follows the Database of Vascular Plants of Canada (Brouillet et al. 2010+).

Four general habitats were surveyed and are listed here in the following order: calcareous meadow and woodland (Calcareous Alpine Meadow), typical meadow and woodland, calcareous alpine barrens (vicinity of Marble Ridge), and typical alpine barrens. For each species, within each of these four habitats, relative abundance, or ease of finding each taxon (Palmer et al. 1995), is ranked as: 0, not found; 1, abundant; 2, frequent (easy to find); 3, occasional (widely scattered, not difficult to find); 4, infrequent (difficult to find); 5, rare (found once or twice in a habitat); 6, found by Fernald and Collins in 1906, but not observed during the present study. Ease of finding descriptions assume an experienced plant hunter, who is familiar with the taxa and their general habitat preferences.

LYCOPODIOPHYTES

LYCOPODIACEAE

Diphasiastrum ×*sabinifolium* (Willd.) Holub * *6091*, *34392* – 3, 0, 0, 0.
Huperzia appressa (Desv.) Á. Löve & D. Löve *5147*, *6044*, *6144* – 0, 0, 3, 3.
Huperzia selago (L.) Bernh. * *5017* – 3, 0, 3, 3.
Lycopodium annotinum L. * *6059* – 4, 0, 3, 3.
Lycopodium clavatum L. *5146* – 3, 0, 0, 0.
Lycopodium dendroideum Michx. *5086* – 3, 0, 0, 0.

SELAGINELLACEAE

Selaginella selaginoides (L.) P. Beauv. * *5042*, *5056* – 5, 0, 3, 4.

MONILOPHYTES

ATHYRIACEAE

Athyrium filix-femina (L.) Roth *ex* Mert. var. *angustum* (Willd.) G. Lawson * *5059* – 3, 3, 0, 0.

CYSTOPTERIDACEAE

Gymnocarpium dryopteris (L.) Newman * *6031* – 3, 3, 0, 0.

DRYOPTERIDACEAE

Dryopteris cristata (L.) A. Gray *8019* – 0, 0, 5, 0.
Polystichum lonchitis (L.) Roth * *282*, *5015* – 4, 0, 0, 0.

EQUISETACEAE

Equisetum sylvaticum L. * *41*, *7019* – 3, 3, 0, 0.

THELYPTERIDACEAE

Phegopteris connectilis (Michx.) Watt * *6092* – 3, 3, 0, 0.

WOODSIACEAE

Woodsia glabella R. Br. *5012* – 0, 0, 5, 0.
Woodsia ilvensis (L.) R. Br. *6008* – 0, 0, 5, 0.

GYMNOSPERMS

CUPRESSACEAE

Juniperus communis L. var. *saxatilis* Pall. * *5058* – 5, 0, 3, 0.

PINACEAE

Abies balsamea (L.) Mill. * *6040* – 2, 2, 2, 2.
Picea glauca (Moench) Voss * *6065* – 1, 1, 2, 2.
Picea mariana (Mill.) Britton, Sterns & Poggenb. * *6056* – 2, 2, 2, 2.

MONOCOTYLEDONS

ASPARAGACEAE

Maianthemum canadense Desf. subsp. *canadense* * *5057*, *6084*, *7017* – 2, 2, 0, 0.
Maianthemum trifolium (L) Sloboda * *7017* – 0, 3, 0, 0.

COLCHICACEAE

Streptopus amplexifolius (L.) DC. * *5022* – 3, 3, 0, 0.
Streptopus lanceolatus (Aiton) Reveal var. *lanceolatus* * *6079* – 4, 3, 0, 0.

CYPERACEAE

Carex atratiformis Britton * *435*, *5097*, *5098*, *7022* – 4, 0, 4, 0.
Carex bigelowii Torr. *ex* Schwein. subsp. *bigelowii* * *5096*, *5099*, *5101*, *6139* – 4, 0, 4, 2.
Carex brunnescens (Pers.) Poir. subsp. *brunnescens* * *5093*, *5102* – 4, 3, 4, 0.
Carex canescens L. subsp. *canescens* * *5092* – 5, 0, 0, 0.
Carex capillaris L. subsp. *capillaris* * *5104* – 5, 0, 3, 0.
Carex castanea Wahlenb. * *5094*, *5095* – 2, 0, 4, 0.
Carex concinna R. Br. * *427* – 0, 0, 6, 0.
Carex echinata Murray subsp. *echinata* * *5103*, *6105* – 2, 2, 0, 0.
Carex lenticularis Michx. var. *lenticularis* * *434* – 6, 6, 0, 0.
Carex leptalea Wahlenb. * *5134*, *6009* – 0, 0, 5, 0.
Carex leptonervia (Fernald) Fernald * *6025* – 3, 0, 0, 0.
Carex magellanica Lam. subsp. *irrigua* (Wahlenb.) Hiitonen * *6098*, *6134*, *6135* – 4, 3, 0, 0.
Carex pauciflora Lightf. * *6019*, *6077* – 0, 3, 0, 0.
Carex rariflora (Wahlenb.) Sm. * *5088* – 4, 0, 0, 0.
Carex rupestris All. * *184*, *5091* – 0, 0, 4, 0.
Carex saxatilis L. * *5087*, *5089*, *5090*, *6106* – 3, 0, 0, 0.
Carex scirpoidea Michx. subsp. *scirpoidea* * *5100*, *6050* – 4, 0, 2, 3.
Carex vaginata Tausch * *429*, *5131*, *5132* – 3, 0, 4, 0.
Eriophorum angustifolium Honck. subsp. *angustifolium* * *8022* – 0, 3, 0, 0.
Trichophorum cespitosum (L.) Schur * *6078* – 1, 1, 1, 1.

JUNCACEAE

Juncus filiformis L. * *5108* – 3, 3, 0, 0.
Juncus leucochlamys N. W. Zinger *ex* V. I. Krecz. * *191*, *5106*, *5107* – 4, 0, 5, 0.
Luzula confusa Lindeb. * *6132*, *6133* – 0, 0, 0, 4.
Luzula parviflora (Ehrh.) Desv. subsp. *melanocarpa* (Michx.) Hämet-Ahti * *5105* – 4, 3, 0, 0.
Luzula spicata (L.) DC. * *8002* – 0, 0, 4, 4.
Oreojuncus trifidus (L.) Záv. Drábk. & Kirschner * *7018*, *8011* – 0, 0, 3, 2.

LILIACEAE

Clintonia borealis (Aiton) Raf. * *6085* – 3, 2, 0, 0.

ORCHIDACEAE

Neottia cordata (L.) Rydb. * *5037* – 5, 3, 0, 0.
Platanthera dilatata (Pursh) Lindl. var. *dilatata* * *6053*, *6083* – 2, 3, 3, 3.
Platanthera hyperborea (L.) Lindl. *5060* – 0, 0, 5, 0.

POACEAE

Agrostis mertensii Trin. * *5070*, *6111*, *6112* – 3, 3, 0, 0.
Anthoxanthum monticola (Bigelow) Veldkamp subsp. *alpinum* (Sw. *ex* Willd.) Soreng * *6109*, *6110* – 0, 4, 4, 3.
Anthoxanthum nitens (Weber) Y. Schouten & Veldkamp subsp. *nitens* * *5078* – 3, 3, 0, 0.
Avenella flexuosa (L.) Drejer * *5071* – 2, 2, 0, 0.
Bromus ciliatus L. * *6062* – 5, 3, 0, 0.
Calamagrostis canadensis (Michx.) P. Beauv. subsp. *canadensis* * *6108* – 0, 0, 4, 0.
Calamagrostis canadensis (Michx.) P. Beauv. subsp. *langsdorffii* (Link) Inman * *5072*, *6090* – 2, 2, 0, 0.
Cinna latifolia (Trevir.) Griseb. * *34349* – 0, 6, 0, 0.
Danthonia intermedia Vasey subsp. *intermedia* * *375* – 6, 0, 0, 0.
Danthonia spicata (L.) P. Beauv. *5076* – 5, 0, 0, 0.
Elymus repens (L.) Gould *6104*, *6113* – 4, 0, 4, 0.
Elymus trachycaulus (Link) Gould subsp. *trachycaulus* * *368*, *372*, *6060*, *7081* – 4, 4, 0, 0.
Festuca prolifera (Piper) Fernald var. *prolifera* *364* – 0, 0, 6, 0.
Glyceria striata (Lam.) Hitchc. * *6061*, *7083* – 4, 3, 0, 0.
Phleum alpinum L. * *5065*, *5066* – 3, 0, 4, 0.
Poa alpina L. subsp. *alpina* * *5077* – 3, 3, 0, 3.
Poa alsodes A. Gray * *5084*, *5085* – 4, 3, 0, 0.
Poa glauca Vahl subsp. *glauca* * *6049*, *7080* – 0, 0, 5, 0.
Poa laxa Haenke subsp. *fernaldiana* (Nannf.) Hyl. * *6013*, *7084* – 0, 0, 0, 5.
Poa pratensis L. subsp. *alpigena* (Lindm.) Hiitonen *8021* – 4, 0, 0, 0.
Poa saltuensis Fernald & Wiegand subsp. *saltuensis* * *336*, *338*, *374*, *6011* – 4, 0, 0, 0.
Schizachne purpurascens (Torr.) Swallen * *5074*, *6114* – 4, 4, 0, 0.
Trisetum spicatum (L.) K. Richt. * *5079*, *5080*, *7082* – 4, 0, 4, 0.
Vahlodea atropurpurea (Wahlenb.) Fr. * *5083*, *6103* – 4, 4, 0, 0.

TOFIELDIACEAE

Tofieldia pusilla (Michx.) Pers. * *196*, *5062* – 0, 0, 2, 0.

EUDICOTS

APIACEAE

Conioselinum chinense Britton, Sterns & Poggenb. * *5051* – 3, 3, 3, 3.
Heracleum maximum W. Bartram * *6146* – 3, 3, 0, 0.
Osmorhiza depauperata Phil. * *679*, *6137* – 5, 5, 0, 0.

ASTERACEAE

Achillea lanulosa Nutt. var. *lanulosa* * *770* – 6, 0, 0, 0.
Arnica lanceolata Nutt. subsp. *lanceolata* * *5020*, *5021* – 2, 4, 0, 0.
Cirsium muticum Michx. * *5027* – 3, 0, 0, 0.
Erigeron hyssopifolius Michx. * *5019* – 4, 0, 3, 0.
Nabalus trifoliolatus (Cass.) Fernald * *6002*, *6051*, *6143* – 3, 3, 3, 3.
Omalotheca norvegica (Gunnerus) Sch. Bip. & F. W. Schultz * *5014* – 3, 0, 0, 0.

Packera aurea (L.) Á. Löve & D. Löve * *260*, *6099* – 5, 0, 0, 0.
Packera pauciflora (Pursh) Á. Löve & D. Löve * *261*, *763*, *5026*, *6095* – 3, 0, 4, 0.
Petasites frigidus Macoun var. ×*vitifolius* (Greene) Chern. * *6102* – 2, 3, 0, 0.
Pilosella flagellaris (Willd.) Arv.-Touv. *5046* – 5, 4, 0, 0.
Solidago hispida Muhl. * *775*, *6075* – 0, 0, 4, 0.
Solidago macrophylla Banks * *778*, *6147* – 3, 3, 3, 3.
Solidago multiradiata Aiton * *5025*, *5034*, *5036* – 3, 3, 2, 3.
Symphyotrichum novi-belgii (L.) G. L. Nesom var. *novi-belgii* * *5048* – 2, 0, 0, 0.
Taraxacum lapponicum Kihlm. *ex* Hand.-Mazz. * *789*, *6074*, *8026* – 3, 0, 0, 0.
Tussilago farfara L. *6097* – 4, 4, 0, 0.

BETULACEAE
Alnus viridis (Chaix) DC. subsp. *crispa* (Aiton) Turrill * *6055* – 2, 3, 1, 3.
Betula cordifolia Regel * *7007* – 0, 2, 3, 3.
Betula glandulosa Michx. * *6015* – 3, 3, 0, 0.
Betula minor (Tuck.) Fernald * *6063* – 0, 0, 4, 4.

BRASSICACEAE
Arabis alpina L. * *575*, *6100* – 5, 0, 0, 0.
Cardamine bellidifolia L. * *6030* – 0, 0, 5, 5.
Cardamine pensylvanica Muhl. *ex* Willd. * *5040*, *5053* – 5, 0, 0, 0.
Draba lactea Adams * *226*, *581*, *6006*, *8008* – 0, 0, 5, 0.

CAMPANULACEAE
Campanula gieseckeana Vest * *5018*, *6037* – 2, 0, 2, 0.
Campanula uniflora L. * *736*, *7020* – 0, 0, 5, 0.

CAPRIFOLIACEAE
Linnaea borealis L. subsp. *borealis* * *6033*, *6068* – 3, 3, 3, 4.
Lonicera villosa (Michx.) Roem. & Schult. * *6088* – 3, 3, 0, 0.
Valeriana dioica L. subsp. *sylvatica* (S. Watson) F. G. Mey. * *249*, *5045* – 4, 0, 0, 0.
Viburnum edule (Michx.) Raf. * *6064* – 4, 3, 4, 4.

CARYOPHYLLACEAE
Cerastium cerastoides (L.) Britton * *222* – 0, 6, 6, 0.
Minuartia rubella (Wahlenb.) Hiern *5063* – 5, 0, 0, 0.
Silene acaulis (L.) Jacq. * *8004* – 0, 0, 0, 4.
Stellaria borealis Bigelow subsp. *borealis* * *5031*, *6010*, *6038* – 5, 0, 0, 0.

CELASTRACEAE
Parnassia kotzebuei Cham. *ex* Spreng. * *603*, *6140* – 0, 0, 5, 0.

CORNACEAE
Cornus canadensis L. * *6101* – 3, 2, 0, 0.

DIAPENSIACEAE
Diapensia lapponica L. * *6001* – 0, 0, 5, 4.

DROSERACEAE
Drosera rotundifolia L. * *6018* – 0, 3, 0, 0.

ERICACEAE

Arctous alpina (L.) Nied. * *6054* – 0, 0, 3, 3.
Empetrum nigrum L. subsp. *hermaphroditum* (Lange *ex* Hagerup) Böcher * *6041* – 0, 0, 2, 2.
Gaultheria hispidula (L.) Muhl. * *6070* – 0, 0, 4, 3.
Harrimanella hypnoides (Pall.) Coville * *5043* – 0, 0, 4, 3.
Kalmia polifolia Wangenh. * *6072* – 4, 3, 4, 3.
Kalmia procumbens (L.) Gift & Kron * *8001* – 0, 0, 0, 4.
Moneses uniflora (L.) A. Gray * *6076* – 0, *3*, 4, 0.
Orthilia secunda (L.) House * *6136* – 0, 0, 3, 0.
Phyllodoce caerulea (L.) Bab. * *6071* – 3, 3, 2, 3.
Pyrola grandiflora Radius * *239*, *5035* – 0, 0, 3, 0.
Pyrola minor L. * *5055*, *5069* – 4, 3, 0, 0.
Rhododendron groenlandicum (Oeder) Kron & Judd * *6069* – 4, 4, 3, 3.
Rhododendron lapponicum (L.) Wahlenb. * *6048* – 0, 0, 3, 3.
Vaccinium caespitosum Michx. * *6029* – 4, 4, 0, 0.
Vaccinium ovalifolium Sm. * *6027* – 5, 4, 0, 0.
Vaccinium oxycoccos L. * *6016* – 0, 4, 0, 0.
Vaccinium uliginosum L. * *6042* – 3, 3, 2, 2.
Vaccinium vitis-idaea L. * *6073* – 4, 0, 3, 2.

GROSSULARIACEAE

Ribes glandulosum Grauer * *6093*, *7025*, *8017* – 4, 0, 0, 0.
Ribes triste Pall. * *8018* – 0, 3, 0, 0.

LENTIBULARIACEAE

Pinguicula vulgaris L. * *6045* – 0, 0, 5, 0.

ONAGRACEAE

Chamerion angustifolium (L.) Holub subsp. *angustifolium* * *6023* – 4, 3, 0, 0.
Chamerion latifolium (L.) Holub *6021* – 0, 0, 5, 0.
Epilobium anagallidifolium Lam. * *667*, *669*, *34376*, *7086* – 0, 4, 0, 0.
Epilobium hornemannii Rchb. subsp. *hornemannii 236*, *663*, *5024*, *5052*, *5068* – 3, 0, 4, 0.
Epilobium lactiflorum Hausskn. * *34375* – 0, 6, 0, 0.
Epilobium palustre L. * *237*, *238*, *6141* – 0, 4, 0, 0.

OROBANCHACEAE

Castilleja septentrionalis Lindl. * *5064* – 2, 4, 4, 0.
Pedicularis flammea L. * *247*, *5033* – 0, 0, 4, 0.
Rhinanthus minor L. subsp. *groenlandicus* (Chabert) Neuman * *248*, *6034* – 2, 0, 0, 0.

PLANTAGINACEAE

Veronica serpyllifolia subsp. *humifusa* (Dicks. *ex* With.) Syme * *5032* – 4, 0, 0, 0.
Veronica wormskjoldii Roem. & Schult. * *6035* – 3, 0, 0, 0.

POLYGONACEAE

Bistorta vivipara (L.) Delarbre * *5050* – 4, 4, 2, 3.

PRIMULACEAE

Lysimachia borealis (Raf.) U. Manns & Anderb. * *6036* – 4, 3, 0, 0.
Primula mistassinica Michx. * *708*, *5061* – 0, 0, 4, 0.

RANUNCULACEAE

Actaea rubra (Aiton) Willd. subsp. *rubra* * *6026* – 5, 4, 0, 0.
Anemone parviflora Michx. * *5023*, *7021* – 5, 0, 3, 0.
Coptis trifolia (L.) Salisb. * *6032* – 3, 2, 0, 0.
Thalictrum pubescens Pursh * *6028* – 4, 3, 0, 0.

RHAMNACEAE

Rhamnus alnifolia L'Hér. * *5006*, *6058* – 5, 0, 4, 0.

ROSACEAE

Amelanchier bartramiana (Tausch) M. Roem. * *6082* – 4, 3, 0, 0.
Comarum palustre L. * *6014* – 0, 4, 0, 0.
Dasiphora fruticosa (L.) Rydb. * *6043* – 2, 0, 2, 0.
Dryas integrifolia Vahl subsp. *integrifolia* * *610*, *5013* – 0, 0, 2, 0.
Fragaria virginiana Mill. subsp. *glauca* (S. Watson) Staudt * *6096*, *7016* – 3, 3, 0, 0.
Geum rivale L. * *6094* – 3, 3, 0, 0.
Potentilla nivea L. * *609*, *6022* – 0, 0, 5, 0.
Rubus arcticus L. subsp. *acaulis* (Michx.) Focke * *6081* – 3, 3, 0, 0.
Rubus chamaemorus L. * *6020* – 0, 3, 0, 0.
Rubus idaeus L. subsp. *strigosus* (Michx.) Focke * *8025* – 0, 3, 0, 0.
Rubus pubescens Raf. * *6024*, *6080* – 3, 3, 0, 0.
Sibbaldia tridentata (Aiton) Paule & Soják * *6066* – 0, 0, 3, 3.
Sorbus decora (Sarg.) C. K. Schneid. * *6138*, *7004* – 5, 3, 0, 0.

RUBIACEAE

Galium triflorum Michx. * *7087* – 5, 0, 0, 0.

SALICACEAE

Salix arctophila Cockerell *ex* A. Heller * *522*, *6005*, *6087* – 3, 0, 4, 0.
Salix argyrocarpa Andersson * *523*, *5007*, *6089*, *8006* – 2, 2, 4, 0.
Salix ballii Dorn * *525*, *5002*, *5005*, *8010* – 3, 0, 4, 0.
Salix bebbiana Sarg. *5008* – 5, 0, 0, 0.
Salix calcicola Fernald & Wiegand * *211*, *7006*, *8007* – 0, 0, 5, 0.
Salix glauca L. var. *cordifolia* (Pursh) Dorn * *212*, *521*, *5009*, *5010*, *7005* – 3, 0, 2, 5.
Salix herbacea L. * *8005* – 0, 0, 0, 5.
Salix planifolia Pursh * *5001*, *6003*, *6086* – 4, 5, 5, 0.
Salix uva-ursi Pursh * *6057*, *8003* – 0, 0, 3, 2.
Salix vestita Pursh * *520*, *5003*, *5004*, *8012* – 2, 0, 2, 0.

SANTALACEAE

Geocaulon lividum (Richardson) Fernald * *5016*, *6052* – 0, 0, 3, 3.

SAXIFRAGACEAE

Chrysosplenium americanum Schwein. * *5054* – 4, 4, 0, 0
Micranthes gaspensis (Fernald) Small * *600*, *6145* – 0, 0, 5, 0.
Mitella nuda L. * *6067*, *7003* – 3, 4, 3, 0.
Saxifraga aizoides L. * *227*, *6046* – 0, 0, 3, 0.
Saxifraga oppositifolia L. subsp. *oppositifolia* * *601*, *6047* – 0, 0, 4, 0.
Saxifraga paniculata Mill. subsp. *laestadii* (Neuman) Karlsson * *602*, *6004* – 0, 0, 3, 0.

VIOLACEAE

Viola blanda Willd. * *8023* – 0, 4, 0, 0.
Viola labradorica Schrank * *5029*, *5039*, *8024* – 3, 3, 3, 3.
Viola macloskeyi F. E. Lloyd * *5038*, *5067* – 3, 3, 0, 0.
Viola renifolia A. Gray * *5028* – 4, 0, 4, 0.

EXCLUDED

Excluded from the flora were 16 unvouchered taxa, including 14 mentioned by Fernald in his unpublished list and 2 cited by him in his account of collecting on Marble Ridge (Fernald 1942). We were not able to locate specimens of any of these taxa from Mont de la Table in our herbarium searches.

Agoseris aurantiaca (Hook.) Greene var. *aurantiaca*. Fernald (1942) mentions collecting this plant on Marble Ridge but then losing the specimen during a fall on the scree while returning to camp. In 1923 he collected this plant on Mont Auclair, approximately 8 km from Mont de la Table. This taxon is widely distributed in western mountains, with only three eastern disjunct sites in Québec (Flora of North America Editorial Committee, eds. 1993+).
Carex aquatilis Wahlenb. "common" (Fernald, unpublished).
Carex deflexa Hornem. "frequent" (Fernald, unpublished).
Carex disperma Dewey "common" (Fernald, unpublished).
Carex limosa L. "common" (Fernald, unpublished).
Carex oligosperma Michx. "frequent" (Fernald, unpublished).
Carex rostrata Stokes "common in meadows" (Fernald, unpublished).
Carex trisperma Dewey "common" (Fernald, unpublished).
Cystopteris fragilis (L.) Bernh. "calcareous rocks, scarce" (Fernald, unpublished).
Epilobium saximontanum Hausskn. Mentioned by Fernald (1942) for Marble Ridge, but not included in his unpublished list and no voucher found. However, it was collected by Fernald et al. in 1923 on nearby Mont Auclair.
Festuca frederikseniae E. B. Alexeev "calcareous slopes" (Fernald, unpublished).
Oxalis montana Raf. "common" (Fernald, unpublished).
Oxyria digyna (L.) Hill "slaty and calcareous rocks" (Fernald, unpublished).
Ribes lacustre (Pers.) Poir. "frequent" (Fernald, unpublished).
Symphyotrichum puniceum (L.) Á. Löve & D. Löve var. *puniceum* "common" (Fernald, unpublished).
Viola palustris L. "common" (Fernald, unpublished).