

Flowering During January in Antigonish County, Nova Scotia*

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*Contribution from the Herbarium of St. Francis Xavier University

Garbary, David J., and Barry R. Taylor. 2007. Flowering during January in Antigonish County, Nova Scotia. *Canadian Field-Naturalist* 121(1): 76–80.

Over 85 records of 23 species of blooming, herbaceous angiosperms were made at 19 sites in Antigonish County between 7 and 21 January 2006, when daytime temperatures reached 15°C. These observations followed an unusually warm fall and early winter. All species were observed on waste ground or in fields and garden plots, except for *Epigaea repens* L. which was part of ground vegetation in a sparsely wooded site. The primary families represented were Asteraceae (six species), Brassicaceae (six species) and Caryophyllaceae (four species). The most commonly observed plants were *Taraxacum officinale* (L.) Weber (11 sites), *Capsella bursa-pastoris* (L.) Medik. (nine sites), *Thlaspi arvense* L. (three sites) and *Stellaria media* (L.) Vill. (four sites). Many plants and inflorescences were conspicuously frost-damaged, and flowers were rarely fully open. In several species, e.g., *T. arvense* and *Cerastium vulgatum* L., many individual plants looked normal and there was no evidence of frost damage. These observations are the latest flowering records for Nova Scotia.

Key Words: Asteraceae, Brassicaceae, Caryophyllaceae, winter flowering, phenology, Antigonish County, Nova Scotia.

In Nova Scotia most species of flowering plants have ceased to flower by early November (Zinck 1998). Taylor and Garbary (2003) carried out an extensive survey of flowering during an unusually warm late fall in Antigonish County and found 92 species in bloom during November–December. These were the latest flowering records of all but one of these species, and extended the known flowering periods for plants in Nova Scotia by an average of 45 days. Of particular note were 15 species that were in bloom on 14–16 December 2001.

A detailed evaluation of the phenology of the entire late fall flora was again undertaken in 2005 after another warm fall in which abundant flowering was still occurring in early November. This study will be described elsewhere in the context of regional climate change (Garbary et al.). Here, we provide records of 23 species of herbaceous plants observed in flower during an extraordinary warm period in January 2006. Our observations complement those on spring phenology by Vasseur et al. (2001). They compared flowering times in 12 species in the late 1990s with dates a century earlier and showed significant changes in only two species, of which only *Syringa vulgaris* L. had earlier flowering.

Materials and Methods

Collection sites

Nineteen sites in Antigonish Town and County, northern Nova Scotia, were explored between 7 and 21 January 2006 in three collection periods. Adjacent sites were a minimum of 200 m apart, and the maximum distance between two sites was 23 km. Ten sites were visited on 7 January, 16 sites during the period 11–16 January, and seven sites on 21 January. Five sites were visited three times, and three other sites were

visited twice. Most of these sites had been previously visited by Taylor and Garbary (2003). Sites were typically highly disturbed areas of waste ground or gravel (Figure 1), or agricultural fields or garden plots. Each site was surveyed for 15–45 minutes. Notes were taken on the flowering status and plant condition of each species in bloom. Representative plants were collected; plants with cryptic flowers were dissected and examined under a stereomicroscope to ensure that flowers were intact. Voucher specimens for most species were prepared and deposited at St. Francis Xavier University. Nomenclature follows Zinck (1998).

Weather

Weather data were taken from the nearest active Environment Canada meteorological station at Tracadie, approximately 25 km from Antigonish (http://climate.weatheroffice.ec.gc.ca/climateData/canada_e.html). The first collecting period was on 7 January when daytime temperatures reached 4.3°C. This followed several days with daily maximum temperatures above 0°C and daily minimal temperatures no lower than -2.5°C. Each of the succeeding four nights had frost, although daytime maxima were always above freezing. The second collecting period, between 12 to 16 January, had minimum and maximum temperatures of 0.4°C and 15.9°C, respectively. Temperatures between 15 to 20 January were cooler and frosts occurred most nights (minimum -6.8°C) although mean daily temperatures were below freezing on only one day (-4.6°C). The final collecting day was 21 January when temperature ranged from 2.0 to 8.4°C. This was followed by at least ten days when temperatures dropped below freezing (-0.3 to -9.2°C) and conditions were more typical of the season.



FIGURE 1. Sample habitat. Waste ground on campus of St. Francis Xavier University adjacent to Trans-Canada Highway, 7 January 2006. Four species were found in flower at this site.

Results

ASTERACEAE

Taraxacum officinale (L.) Weber was the most widely distributed species, occurring at ten sites. One to four plants were observed at each site during all three collecting periods and blossoms occurred at two sites on 21 January. Each plant had one or two ragged inflorescences with short pedicels. Leaves had some frost damage and were often flattened against the substratum, although they had good colour on some individuals.

Achillea millefolium L. occurred as a single plant in a farmer's field and as six plants on waste ground (Figure 2). Plants had green leaves, but the flowering shoots were often reclining, with several to dozens of white florets. The flowering shoots observed 14 January were wilted and most of the flowers had turned brown.

Two species of *Matricaria* were found: *M. maritima* L. and *M. matricarioides* (Less.) Porter. Plants of *M. maritima* were found at two sites. A single, well-developed inflorescence was found on 7 January as well as several partially intact flower heads. By 15 Jan-

uary remaining ray florets were mostly lost; however, the disc florets on many heads remained bright yellow. The plants were often partly wilted but the leaves had healthy colour. Up to three plants of *M. matricarioides* were found at each of three sites, and it was observed during the first two collecting periods. Inflorescences typically had a mixture of dull yellow and brownish florets. The plants appeared no less viable than others observed in early December.

Leontodon autumnalis L. occurred at two sites on 7 January where single individuals were found with only one or two wilted inflorescences on each plant. Basal rosettes had good colour but were slightly wilted. Examination of both sites one week later revealed no flowering individuals.

Two plants of *Senecio vulgaris* L. occurred at one site on waste ground; a single individual was found at a second site. Florets on most inflorescences had turned brown but several had bright yellow florets. Plants were a maximum of 10 cm in height and flowering was observed only in the first two observation periods.



FIGURE 2. *Achillea millefolium* photographed *in situ* on 7 January 2006 at site shown in Figure 1. Flowering shoot is about 30 cm tall.

BRASSICACEAE

Capsella bursa-pastoris (L.) Medik. was among the most common plants flowering in January. It occurred at nine sites with one to three plants per site. Flowering individuals were up to 30 cm tall and carried a few flowers at the apex of each plant. Leaves were typically green and healthy, although larger plants had generally become decumbent. During the second week, plants were mostly very small (5-10 cm high) with only a few florets. On 21 January flowers were found at two sites.

Thlaspi arvense L. was among the most robustly flowering species observed. The plants were erect, dark green and with prominent white flowers. *T. arvense* in flower was as common in January as in any previous collecting period, and flowers were found at one site on 21 January.

Raphanus raphanistrum L. occurred at two sites where there were typically many plants. The stems and leaves of these plants were badly wilted and reclining; however a few bright yellow florets and numerous clusters of buds remained intact at many apices on many plants. In the second week only a single, badly damaged plant was found at one site.

Cardamine pensylvanica Muhl. ex Willd. was the only species clearly protected by the heat shadow of a large building. Dozens of small, prostrate plants each with one to several flowers occurred in a flowerbed along the side of a large brick building. No decline in flowering was noted in the second week and flowers persisted to 21 January.

Erysimum cheiranthoides L. was found at two sites and only in the second week. Four large plants were found along a bare concrete foundation for a house. The surrounding lot supported numerous plants of this species but all had gone to seed. A second site had a few small individuals up to 5 cm tall. Both sites were covered with snow on 7 January and so were not examined until the second week.

A single plant of *Lepidium campestre* (L.) R. Br. was found 12 January on waste ground. The plant was about 20 cm tall and had two clusters of flowers with the most vigorous close to the ground and immersed in a cluster of leaves.

CARYOPHYLLACEAE

Stellaria media (L.) Vill. was found at two or three sites in all collecting periods (four sites overall), and was among the most prominent of the plants in flower. At two locations it was found as scattered individual plants; however, at two other sites it formed large expanses of continuous ground cover with numerous inflorescences (Figure 3).



FIGURE 3. *Stellaria media* photographed *in situ* on 7 January 2006 showing part of a large colony about 1 m in diameter.

Flowering individuals of *Cerastium vulgatum* L. were few and occurred at only three sites, although many vegetative plants or plants with remains of inflorescences were present at most locations. The reproductive individuals appeared healthy and showed no signs of frost damage. They grew on loose gravel where there was no competition from surrounding vegetation. Flowering persisted at one site to 21 January.

A few flowers were present on several plants of *Spergula arvensis* L. from a farmer's field in the first two weeks. The plants showed considerable frost damage and dissection showed that very few bore intact stamens and pistils. At a second site where vegetative parts of the plants were less damaged, no intact flowers occurred.

An extensive patch of *Spergularia rubra* (L.) J. & C. Presl. occurred on waste ground. The prostrate plants were 5-10 cm diameter and showed all reproductive stages from buds to fruits. The site was only examined during the second week of observation.

OTHER FAMILIES

Euphorbia helioscopia L. (Euphorbiaceae) was present at only one of the sites. There were hundreds of individuals. Large plants (20-40 cm tall) were con-

spicuously frost damaged, with the wilted stems causing the upper parts of the plants to topple over. The terminal portions of these plants looked healthy, and subsequent dissection of inflorescences showed intact flowers. Small plants (5-15 cm tall) showed less collapse of the stems and also had numerous intact flowers. Flowering persisted until 21 January.

Individual plants of *Fumaria officinalis* L. (Fumariaceae) were found on each of the first two visits to one site. The plants had two small inflorescences in which a few flowers still retained their characteristic two-toned colour. Inflorescences on other plants at this site had been severely damaged and turned brown. On most individuals the finely dissected leaves and delicate stems showed no conspicuous wilting. At another site dozens of plants grew in soil mounds, but there were no inflorescences.

Viola tricolor L. (Violaceae) occurred at two sites. Both were in flower beds and one was adjacent to a building. Plants at both sites had leaves and stems in excellent condition and several to dozens of fully open flowers with blossoms persisting until 21 January.

There were numerous plants of *Veronica persica* Poir. (Scrophulariaceae) at one site where they grew as prostrate clumps or straggling plants over the bare soil. The bilobed fruits were conspicuous, and a single intact but only partially open flower was found on single individuals returned to the laboratory at each of the three visits.

Vegetative plants of *Polygonum arenastrum* Jord. ex Boreau (Polygonaceae) were common at most sites. Although most plants had conspicuous frost damage, a few plants had two to three white-tipped buds and open flowers that persisted until week two.

Epigaea repens L. (Ericaceae) was the only woodland plant found in the study. An extensive population occurred at one site (14 January) among other ground vegetation beneath an open, mixed forest growing on sandy soil. Although buds on many plants appeared swollen, only a single plant had open blossoms.

Discussion

That any plants should be flowering in January in northern Nova Scotia, much less 23 species, is remarkable. This late phenology may reflect the ability of plants to have late flowering strains (e.g., *Thlaspi arvense*, Warwick et al. 2002), or possibly reflect a western European origin where fall and early winter temperatures would be much milder. Zinck (1998) does not include December in the flowering periods of any of these species; November is included in the flowering periods only for *Capsella bursa-pastoris*, *Matricaria matricarioides*, *Senecio vulgaris*, *Stellaria media* and *Viola tricolor*. The region falls within plant hardiness zone 5B of Agriculture and Agri-Food Canada (<http://sis.agr.gc.ca/cansis/nsdb/climate/hardiness/intro.html>), in which harsh winters kill non-hardy species.

January is normally associated with severe winter weather; the 30-year daily average temperature at Col-

legeville (the nearest meteorological station for which climate normals are available) is -6.6°C , and the average minimum is -11.6°C . Winters here are among the coldest in the province (Davis and Browne 1997). About 50 cm of snow falls on average in January, and a heavy snowpack is common. Snowpack depths in a wooded area of the St. Francis Xavier University campus were 40-50 cm in mid-January every year but one in 1999-2005 (B. Taylor, unpublished data). In the single low-snow year, the weather was very cold and the ground was frozen.

The circumstances that led to plants blossoming in mid-January were more complex than an extended period of warm weather. While fall and early winter of 2005-2006 were unusually mild, there had been regular nights of frost since November and two major snowfalls (5 and 15 December) prior to the collection period. The sites were visited over the course of three weekends, and in the intervening periods there were frosts on most night at Tracadie. These plant species appear to be very resistant to short-term freezing, as long as warm temperatures return quickly. In addition, the most severe weather may have occurred when the plants were covered with 20 cm of snow from the 15 December snowstorm. The snow would have insulated the plants from the deep frosts, but it was subsequently washed away by heavy rain.

None of the plants in bloom was restricted to the first round of collecting; indeed, five species were found in bloom only in the second round and ten species had blossoms on 21 January. The two sites supporting *Erysimum cheiranthoides* were snow-covered on 7 January and the single specimen of *Lepidium campestre* found in week two may have been missed on the earlier visit to the site. Only one site visited in this study could be considered highly protected and influenced by radiant heat from a building, and *Cardamine pennsylvanica* was the only species unique to this site. The remaining sites were exposed to ambient air temperatures and precipitation.

Nevertheless, even though plants in bloom were found at 17 sites in mid-January, this was not a conspicuous phenomenon; surveys of additional sites revealed no plants in blossom. The sites with plants in flower comprised highly specialized habitats mostly of limited extent: land cleared for development, margins of abandoned or active agricultural fields, garden plots and soil mounds. Even within these sites, most plants of many species reported here had entirely succumbed to the rigours of winter.

The plant species in bloom were not a cross-section of the provincial flora. Most of the species reported here are opportunistic, weedy species that thrive in highly disturbed habitats, including agricultural settings (e.g., *Raphanus raphanistrum* L., Warwick and Francis 2005). Indeed many of our sites had less than 50% cover of vegetation. In addition, all species observed in flower except *Epigaea repens*, *Cardamine pennsylvanica* and *Cerastium vulgatum* are non-native

members of the flora (Zinck 1998). Most of these species are weeds that were introduced from Europe with grain. It would appear that the ability to tolerate harsh physical conditions (in contrast with competitive ability) extends to tolerance of harsh weather as well (Taylor and Garbary 2003).

Flowering in January in a cold climate would appear to be futile, and therefore likely of little evolutionary value. Excepting *Epigaea repens*, all of the species reported here are annuals or short-lived perennials (Zinck 1998). As early colonizers of disturbed ground, they would be adapted to growing and reproducing quickly in advance of competition from later species. It seems likely that these species are adapted to grow, flower and set seed as long as the weather permits (e.g., *Senecio vulgaris*, Robinson et al. 2003). This phenology contrasts with that of longer-lived perennials in which above-ground plant parts senesce in late autumn in anticipation of winter. The ruderal species observed here evidently lack this adaptation, presumably because either cold temperatures (annuals) or competition (perennials) normally curtails reproduction and kills the plant. Consequently, when those events are delayed, the plants have no physiological mechanism to end flowering, even when seed production may be impossible.

An important exception to the above is Pomquet Beach Provincial Park, an undisturbed, coastal site where *Epigaea repens* was part of a dense community of ground vegetation beneath a diffuse tree layer. Unlike the remaining fall-flowering species, *Epigaea repens* normally flowers in April and May (Zinck 1998), when it forms a conspicuous part of the spring-flowering flora. The plants in flower in January may be considered either a second, late-fall flowering, or an exceptionally early spring flowering. This phenomenon contrasts with the situation of the remaining species, in which normal late-fall flowering merely persisted for a long time. It is doubtful that new flowers were initiated among these species.

Epigaea repens was observed in flower in the Annapolis Valley, about 250 km southwest of our study area, in early November 2005 (N. Nickerson, Agriculture and Agri-Food Canada, Kentville, personal communication). Hence our flowering material from Antigonish County probably should be considered a further extension of a late fall return to flowering. The same probably applies to *Fumaria officinalis*, for which the latest flowering month given by Zinck (1998) is August. It would be of interest to determine details of plant phenology for *E. repens* and other species at the extreme southern tip of the province, where January mean temperature is only just below freezing (plant hardiness zone 6B; Davis and Browne 1997).

Changes in plant phenology are indicators of climate change and have been used as a proxy for temperature (Badeck et al. 2005; Menzel 2002; Sherry et al. 2007; Walther 2004). Consequently, the January flowering records reported here might be considered as evidence of regional climate warming. Thus, even if regional climate warming has not been demonstrated, the changes that we observed would be a natural consequence of such a warming trend.

Acknowledgments

We thank Robert Garbary and Jonathan Ferrier who assisted with field work and Nancy Nickerson for information on flowering of *Epigaea repens*. This work was supported by grants from the Natural Sciences and Engineering Research Council of Canada to both authors.

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Received 24 January 2006

Accepted 15 January 2008