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Committee
on the Status
of Endangered
Wildlife
in Canada

Comité sur le
statut des espèces
menacées
de disparition
au Canada

Ottawa, Ont. K1A 0H3
(819) 997-4991

STATUS REPORT ON THE VAN BRUNT'S JACOB'S-LADDER

POLEMONIUM VAN-BRUNTIAE

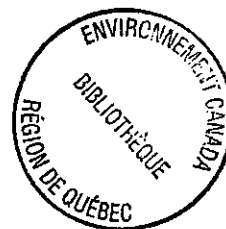
IN CANADA

BY

ANDRÉ SABOURIN

AND

DENIS PAQUETTE



**STATUS ASSIGNED IN 1994
THREATENED**

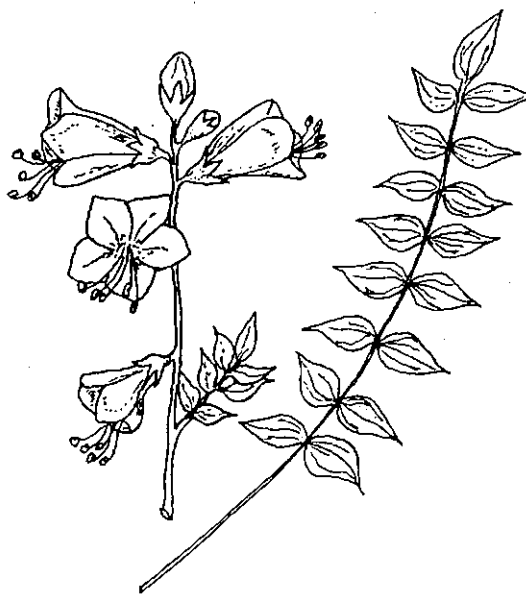
REASON: **HIGHLY RESTRICTED RANGE OF ONLY A FEW SITES, ALL LOCATED ON PRIVATE LANDS, WITH THREATS TO MOST FROM AGRICULTURAL EXPANSION, ROAD BUILDING AND NATURAL SUCCESSION.**

OCCURRENCE: **QUEBEC**

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573
Vol. 8

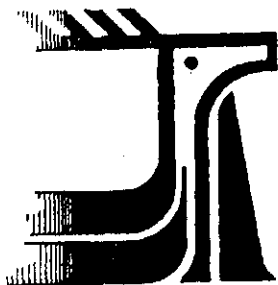
STATUS REPORT ON ENDANGERED WILDLIFE IN CANADA

van Brunt's Jacob's-ladder



**COMMITTEE ON THE STATUS
OF ENDANGERED WILDLIFE
IN CANADA**

COSEWIC



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au Canada

JUNE 1990

Ottawa, Ont. K1A 0S7 (613) 997-4991
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STATUS REPORT ON THE VAN BRUNT'S JACOB'S-LADDER

POLEMONIUM VAN-BRUNTIAE

IN CANADA

BY

**ANDRÉ SABOURIN
LES AMIS DU JARDIN BOTANIQUE DE MONTRÉAL
34-84TH AVENUE WEST
BLAINVILLE, QUÉBEC**

AND

**DENIS PAQUETTE
LES AMIS DU JARDIN BOTANIQUE DE MONTRÉAL
1478 LÉVEILLÉE STREET
P.O. BOX 483
PRÉVOST, QUÉBEC
JOR 1T0**

**STATUS ASSIGNED IN 1994
THREATENED**

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R É S U M É

La Polémoine de van-brunt, *Polemonium van-bruntiae*, est une plante herbacée vivace confinée aux clairières humides et aux prairies riveraines des Appalaches. Elle ne se trouve que localement, de la Virginie occidentale au Québec. Au Canada, elle n'est connue que d'une station historique au Nouveau-Brunswick et de onze stations au Québec, dont deux historiques, toutes restreintes aux régions de l'Estrie et des Bois-Francs. Bien que nous croyons que la majorité des populations soient vulnérables à des activités humaines, du moins en partie, la disparition n'est pas appréhendée à court terme, sauf pour une population. De plus, les sites et les populations étant restreints, nous recommandons de lui attribuer le statut d'espèce *vulnérable* au Canada.

ABSTRACT

Van Brunt's Jacob's-Ladder, *Polemonium van-bruntiae*, is a perennial herbaceous plant confined to humid glades and riparian meadows in the Appalachian mountains. It is found from West Virginia to Quebec. It is known in Canada only from eleven sites in the Eastern Townships and the Bois-Francs region of Quebec, two of which are only known historically, and at another historic site in southwestern New Brunswick. Most of the populations are, in part, vulnerable to human impact, however, extinction is not imminent, except for one population. However, having restricted populations and sites, we give it the status of *vulnerable* in Canada.

[Note: The species has been designated as threatened in Canada by COSEWIC because of the following reasons: the species has a restricted range, there are only 9 confirmed populations, 5 sites are susceptible to human activities, 1 site is in danger of being lost, all sites are on private lands and the plants are reproductively constrained by reproducing to a large extent only by vegetative means. E. Haber, Chairman, Plants Subcommittee, July 1994]

I INFORMATION RESPECTING THE SPECIES

1. Classification and nomenclature

Scientific name: *Polemonium van-bruntiae* Britton

Original publication: Britton, N.L. 1892. Bulletin of the Torrey Botanical Club, 19:224.

Type specimen: New York State, Balsam Lake, Ulster County, Catskill Mts., 1890, C. Van Brunt (N.Y.)

Relevant synonyms:

- *Polemonium vanbruntiae* Britton. Wherry, E.T. 1935
Proc. Pa. Ac. Sci, 9:151; 1936. Bartonia 17:6
- *Polemonium caeruleum* L. subsp. *VanBruntiae* (Britt.)
Davidson, J.F., 1950, University of California Publications in Botany, 23:221.

Common names: Polémoine de Van Brunt, Polémonium de Van Brunt (named for Mrs. Cornelius Van Brunt, who collected the type specimen); Eastern Jacob's Ladder, Jacob's-ladder, Tall Polemonium, American Jacob's Ladder.

Family name: *Polemoniaceae*

Common family
name: *Polemoniaceae*

Genus: *Polemonium* [Tournefort] L. Genera Plantarum: 46, 1737.
The origin of the name has never been clearly explained. It appears either to have been named for Polemon, an Athenian philosopher, or to have been derived from the Greek word "polemos", meaning war or battle.

Plant group: Spermatophyta, Angiosperms, Dicotyles, Polemoniales.

Other taxonomic treatments

Until it was recognized taxonomically by Britton (1892), the plant was not differentiated from *Polemonium caeruleum*, a species introduced from Europe. E. Wherry was very familiar with *P. van-bruntiae*, having published a photograph of it (Wherry, 1935). However, he was doubtful that it was a distinct species owing to its small number of distinctive characters (leaflets and stamens). Nonetheless, he maintains the name *P. van-bruntiae* in subsequent studies (Wherry, 1942, 1945).

Davidson (1950) reduced *P. van-bruntiae* to a subspecies of *P. caeruleum* (*P. caeruleum* ssp. *van-bruntiae*) after observing the extensive morphological diversity of Eurasian specimens of *P. caeruleum*. Grant (1950) supported this view, and stated that the genus was still poorly understood and required further study. It should be noted that these authors never observed *P. van-bruntiae* in the field.

Hultén (1970) was also doubtful that it was a species. He felt it was possible that the taxon was simply a variation of *P. caeruleum* originating from introduced specimens. Although he felt the plant was related to this species complex, he nonetheless used the name *P. van-bruntiae*.

Most contemporary American and Canadian authors (Argus and Pryer, 1990; Scoggan, 1979; Thompson, 1991), recognize *P. van-bruntiae* as a distinct species. The characters presented in Table 1 (p. 9) support this view, although a genetic study could help dispel any remaining doubts regarding the taxonomy.

The written form of the species name has varied considerably (one word, two words, unhyphenated, capitalized). Nonetheless, the form commonly used today in Canada is *P. van-bruntiae*. In the United States, some authors (Johnson and Murray, 1988; Thompson, 1991) use *P. vanbruntiae*.

Phylogenetic aspects

Except in Quebec, the distribution of *P. van-bruntiae* coincides almost perfectly with that of *P. reptans*, the only other species native to eastern North America. (According to Davidson (1950), the northeastern part of Cain's map (1944) is incomplete for *P. reptans*.) The phylogenetic history of *P. van-bruntiae* has not yet been carried out, but a study of it could reveal whether *P. van-bruntiae* is most closely related to *P. caeruleum* or to *P. reptans*.

Davidson (1950) and Grant (1959) believe it is most closely related to *P. caeruleum*. However, cytological studies show that the three species have the same chromosome number, $2N = 18$ and rarely $2N = 36$ for *P. van-bruntiae* (Cain, 1944; Grant, 1959; Wherry, 1945). *P. caeruleum* was introduced from Europe, although this Eurasian species probably originated in western North America, where the large majority (20 out of approximately 29) of the species of *Polemonium* are found (Davidson, 1950; Wherry, 1942), and then migrated to Eurasia via the Bering Strait. *P. van-bruntiae*, *P. caeruleum* and *P. reptans* belong to the same taxonomic group, Grant's section *Polemonium* (1959) or Wherry's group *Eupolemonium* (1942). *P. caeruleum* and *P. van-bruntiae* belong to the same subgroup (Davidson, 1950; Grant, 1959; Wherry, 1942). As a result, the two species would have the same ancestor but *P. van-bruntiae* may very well have evolved separately from *P. caeruleum*, and not have derived from it through recently introduced Eurasian populations. We feel, rather, that *P. van-bruntiae* became established in eastern North America as a result of populations that migrated from the west long ago.

According to Grant (1959, p. 195), the genus *Polemonium* bears the most primitive characters of the tribe *Polemonieae*: perennial habit, alternate leaves, open corolla, equal stamens, many-seeded fruits, the only genus of the tribe to be related by several characters with the tropical genus *Cobaea* of the same family. For instance, the narrowly winged seeds (like those of *P. van-bruntiae*) may be vestiges of the wings on the seeds of the genus *Cobaea*. Moreover, the genus *Polemonium* is by far the best represented of the tribe in Mexico, where it is well developed in the mountains and where the most morphologically primitive species occur. In conclusion, the genus is believed to have originated in subtropical-warm temperate environments and, since it is the oldest of the tribe, the tribe is believed to have the same centre of origin.

2. DESCRIPTION

Herbaceous caespitose plant, perennial with horizontal branched rhizome, 4–10 cm long, 2–10 mm wide, with several fibrous roots. Stems erect 40–140 cm tall, robust, glabrous, simple and branched only in the slightly pubescent-glandular inflorescence (Figure 1).

Leaves alternate, glabrous, ranging from 50 cm long (basal) to 2 cm long at base of inflorescence, 1.5–10 cm wide, composed of distant leaflets. Leaflets are entire, acuminate, usually opposite or almost; basal, lower leaves with 11–21 short-petioled, ovate to oblong leaflets, 15–60 mm long, 5–25 mm wide, (5) 10–35 mm apart; upper leaves with 7–15 sessile, oblong to lanceolate leaflets, 5–30 mm long and 2–12 mm wide. Bracts of inflorescence vary from entire to pinnately compound and are glabrous or pubescent-glandular, particularly at margins; they are 5–30 mm long and 2–30 mm wide.



Figure 1:

Polemonium van-bruntiae Britton

a, Habit, x $\frac{2}{3}$

b, Dissection of flower, x 2

c, Calyx, x 2

Drawing taken from Davidson (1950, p. 220)

Inflorescence paniculate, sometimes corymbiform, rather slender with few flowers; axes 5–50 mm long, shortly and slightly pubescent-glandular, terminating in 2–8 flowers. Flowers odourless with blue-violet corolla, yellowish-green at base, 15–25 mm in diameter, glabrous, open, campanulate, tubular at base and the 5 lobes (petals) fused near the centre, rounded and flared near apex, 12–20 mm long and 7–10 mm wide.

Calyx with 5 lobes (sepals) oblong-lanceolate, acute and fused near the centre, ranging from purplish-green at anthesis to yellowish-green at maturity, persistent, slightly glandular and pubescent, sparsely covered with long (up to 2 mm) hyaline hairs; lobes 8–12 mm long at anthesis, 4–6 mm wide, grow to 17 mm at maturity.

Pedicels shortly and densely pubescent-glandular, 2–15 mm long, often slightly curved downward on flowering but rather erect or divergent at fructification.

Stamens 5, well exserted, 12–18 mm long and longer than corolla by 4–7 mm; anthers yellow-orange, 2–5 mm long; white filaments with a tuft of white villous hair at the base. Style much exserted, blue-violet, slightly longer than the stamens; stigma 3-lobed, rarely 4-lobed.

Capsule ovoid, 5–7 mm long and 3–4 mm wide, chiefly 3-locular, sometimes 4-locular and even up to 7-locular. Seeds 1–10 per locule, brownish black, narrowly winged at tips, oblong-reniform, 2–3 mm long and approximately 1 mm wide.

There are several partial descriptions of this species, which are often found in the keys. The most complete are those of Britton (1892) and Thompson (1991).

Differentiation and field characters

Polemonium van-bruntiae can be confused with *P. caeruleum* and *P. reptans*, two species introduced into Quebec, the first from Europe and the second from eastern United States. These two species are cultivated and occasionally escape near gardens, vacant lots, fields near residential areas, cemeteries, the edges of ditches and woods. These habitats are less humid, better drained and less wild than the habitat of *P. van-bruntiae*, which consists rather of riparian meadows, shrub fens, swamps and moist clearings (CAN, DAO, MT, MTMG, NBM, QFA, QK, QUE, SFS). According to our own observations and those of several authors (Britton, 1892; Cox, 1885; Davidson, 1950; Fernald, 1949, 1950; Gleason and Cronquist, 1963; House, 1923; Klimas and Cunningham, 1981; Newcomb and Morrison, 1977; Peterson and McKenny, 1968; Scoggan, 1979; Seymour, 1969; Strausbaugh and Core, 1958; Wherry, 1935, 1942) and on the basis of specimens from the above-mentioned herbariums, the main morphological differences among the three species are as given in Table 1.

Table 1: Main morphological differences among *P. caeruleum*, *P. reptans* and *P. van-bruntiae* (*): Taxon described by Davidson (1950) as *P. caeruleum* ssp. *vulgare* and by Scoggan (1979) as *P. caeruleum* ssp. *caeruleum*.

<i>P. caeruleum</i> (*)	<i>P. reptans</i>	<i>P. van-bruntiae</i>
1. Stamens and style slightly exerted or equal to the corolla.	1. Stamens and style inserted or equal to the corolla.	1. Stamens and style well exerted.
2. Stem erect, 20–90 cm tall.	2. Stem diffuse-arcuate, 15–45 cm tall.	2. Stem erect, 40–140 cm tall.
3. Lower leaves serrated, with 19–29 lanceolate to oblong sessile leaflets.	3. Lower leaves rather spaced, with 7–17 lanceolate to ovate leaflets.	3. Lower leaves spaced, with 11–21 ovate to oblong short-petioled leaflets.
4. Inflorescence densely pubescent-glandular.	4. Inflorescence slightly pubescent-glandular to glabrous.	4. Inflorescence slightly pubescent-glandular.
5. Calyxes 5–9 mm long at flowering.	5. Calyxes 5–7 mm long at flowering.	5. Calyxes 8–12 mm long at flowering, (– > 17 mm at maturity).
6. Flowering: late May to early July.	6. Flowering: May to June.	6. Flowering: late June to late July.

Illustrations

- **Figure 1** shows *P. van-bruntiae* and is taken from Davidson (1950, p. 220). Other illustrations can be found in Britton (1892), Strausbaugh (1958), Peterson and McKenny (1968) and Newcomb and Morrison (1977). Wherry (1935) published a photograph, and Fernald (1949) published a photograph of specimens.
- **Figure 2** is a photograph of inflorescences; it was taken in Ham-Nord (No. 6).
- **Figure 3** is a photograph of the habit and leaves; it was taken in Stoke (No. 2).

3. BIOLOGICAL AND ECONOMIC IMPORTANCE

Polemonium van-bruntiae is endemic to eastern North America. We have observed that, except for the fact that the plant is smaller in size in less humid, marginal habitats, populations of *P. van-bruntiae* observed in Quebec are morphologically stable. Davidson (1950, p. 217) states that *P. caeruleum*, of which he believes *van-bruntiae* is a subspecies, is stable and constant in North America. Generally speaking, however, the biological importance of *P. van-bruntiae* has not been studied and would appear to be negligible in Quebec, particularly because there are only a small number of populations with few individuals in each population in their

habitat where associated species play a more obvious environmental role. In fact, only the Ham-Nord population (No. 6) is large enough to have an impact on soil retention.

With respect to its economic importance, the potential of van Brunt's Jacob's-ladder as an ornamental in water gardens is obvious. It also attracts butterflies, many types of insects and even hummingbirds. However, we found nothing in the literature on this aspect. *P. caeruleum* is widely used and sold in garden centres in Quebec. With respect to the medicinal properties of *P. van-bruntiae*, Klimas and Cunningham (1981) state that the Indians used a decoction from its leaves as a hair rinse. Cox (1985) states that the rhizome of *P. reptans* and *P. caeruleum* is reported to have astringent properties and to cause sweating, and that it has been recommended for diarrhea, snake and insect bites, inflammations and lung problems. Grant (1959) states that *P. caeruleum* was used as an antisyphilitic by European peasants and Siberians.

4. DISTRIBUTION

Biogeographic summary

Polemonium van-bruntiae is endemic to the central Appalachians, in eastern North America, in a relatively small area extending from eastern West Virginia to southeastern Quebec (Eastern Townships and Bois-Francs regions) and southwestern New Brunswick, where a historical population (1885) was observed. Figures 4, 5 and 6 show the distribution of the species in North America, Canada and Quebec, respectively (Britton, 1892; Cain, 1944; Davidson, 1950; Hultén, 1970; Johnson and Murray, 1988; Rousseau, 1974; Strausbaugh and Core, 1958; Wherry, 1935; CAN, DAO, MT, MTMG, QFA, QK, QUE, SFS). Davidson published a map (1950, p. 273) which shows a collection in the Gaspé-Bassin region in Quebec. However, in our view, this record is based on an misidentification (see p. 18).

P. van-bruntiae is believed to have found refuge during the last ice age in regions south of its current range, namely in West Virginia, western Maryland and southern Pennsylvania. Shortly after the retreat of the glacier, it is believed to have migrated northeastward (Cain, 1944; Wherry, 1935). Some authors state that this taxon currently occurs in two disjunct areas, separated by central-south Pennsylvania. This is believed to have resulted from a warm, dry postglacial period (Cain, 1944; Grant, 1959).

P. van-bruntiae reaches its northern limit in Quebec. It likely reached the Eastern Townships and Bois-Francs after the deglaciation of these regions in about 12,000 BP, and prior to their colonization by spruce and fir forests in about 9,500 BP (Richard, 1987). Given that *P. van-bruntiae* occurs in open areas, we can assume that the establishment of coniferous forests caused a large number of populations to disappear and that those that still exist today are relic populations. Moreover, owing to the dispersal difficulties of the species, it has been unable to invade the new open environments created by recent deforestation.

Background

The taxon is believed to have been first observed in 1860 by a Dr. E.C. Howe, in Schoharie County, in the northern Catskill mountains, New York (Wherry, 1935). It was included in the addenda to the fourth edition of Gray's Manual (1863) under the name *Polemonium coeruleum*. It was subsequently observed in most of the states in which it is presently known to occur until 1892, in which year Britton named it *P. Van-Bruntiae*, after the type specimen collected by Mrs. C. Van Brunt at Balsam Lake, New York, in 1890.

It was first collected in Canada in 1885 by J. Brittain, at Trout Brook, probably near Trout Lake, Charlotte County, in southwestern New Brunswick (QK, DAO). It was not observed again until July 2, 1937, this time in Quebec, by Brother Allyre and Brother Lorenzo in Arthabaska, in the Bois-Francs region (QFA). Subsequent collections were made in Arthabaska in 1942 and 1943. Since then, none of these Canadian stations had been rediscovered (CAN, DAO, MT, MTMG, NBM, QFA, QK, QUE, SFS, UNB; Hinds, 1986).



Photo D. Paquette ©

Figure 2 (above)

Inflorescences of
Polemonium van-bruntiae
 Ham-Nord, Arthabaska Regional
 County Municipality,
 Quebec

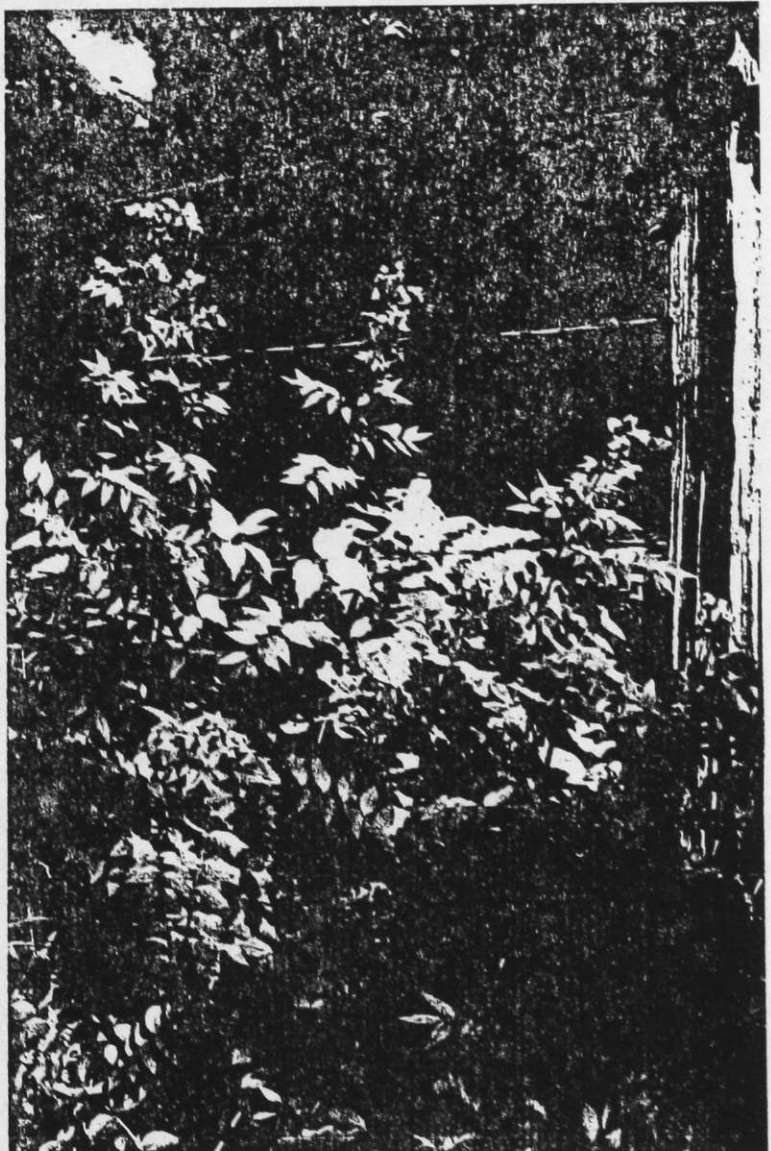


Photo D. Paquette ©

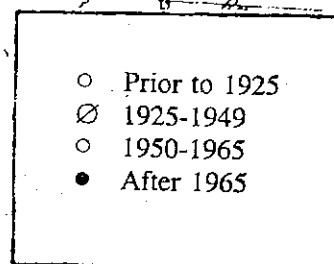
Figure 3 (right)

Habit and leaves of
Polemonium van-bruntiae
 Stoke, Le Val-Saint-François
 Regional County Municipality,
 Quebec



Figure 4: Distribution of *Polemonium van-bruntiae* in North America

Figure 5: Distribution of *Polemonium van-bruntiae* in Canada



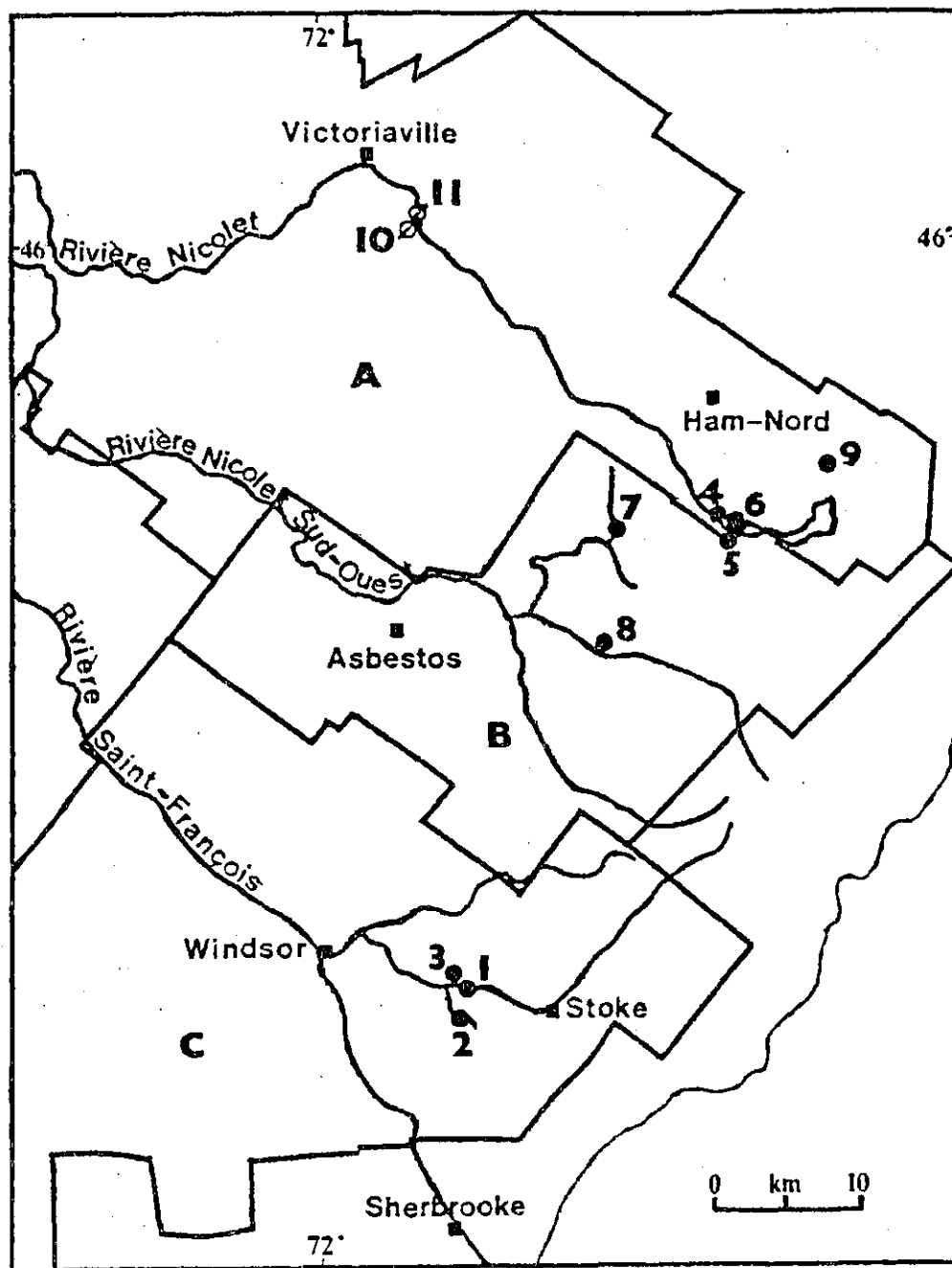


Figure 6: Distribution of *Polemonium van-bruntiae* stations in Quebec; in the regional county municipalities (RCM) of: A, Arthabaska; B, L'Or-Blanc; C, Le Val-Saint-François. The figures refer to the stations mentioned: 1, 2, 3, Stoke; 4, 5, 6, Ham-Nord; 7, Saint-Adrien; 8, Wotton; 9, Saints-Martyrs-Canadiens; 10, 11, Arthabaska.

(●, current population; ∅, historical population)

Only Quebec populations have recently been surveyed, in the Eastern Townships/Bois-Francs region: two stations at Stoke, one of which (No. 1) was discovered on July 17, 1967 by Philippe Forest (CAN, DAO, MT, QFA, QK, QUE, SFS); a second station (No. 2) was discovered on August 5, 1975 (CAN, SFS) by Gérard Bachand. The Wotton county population was observed by P. Forest (pers. comm.) in 1986, who subsequently found the three Ham-Nord populations in 1990. The Saint-Adrien-de-Ham population was first observed on August 15, 1991 by André Sabourin and Denis Paquette; the Saints-Martyrs-Canadiens and Stoke (No. 3) populations were first observed on July 11, 1992 and July 12, 1992, respectively, by André Sabourin, Denis Paquette and Denis Sabourin (MT).

Localities surveyed

The precise co-ordinates of the localities and the names of property owners, if known, are forwarded to MENVIQ and COSEWIC. This information is generally available, unless its disclosure may have adverse effects on the species.

• Current populations

Note: The numbers correspond to those in Figure 6.

1. Stoke, RCM Le Val-Saint-François, Quebec. Meadow and swampy alder woods near the Stoke River, approximately 0.5 km north of Mont-Carrier.
 - P. Forest 648 (CAN, DAO, MT, QFA, QK, QUE, SFS) July 17, 1967.
 - A. Sabourin, P. Forest and D. Paquette 665 (MT), June 30, 1991.
2. Stoke, RCM Le Val-Saint-François, Quebec. Small clearing in a humid mixed woods, near a stream, approximately 1.5 km southwest of Mont-Carrier.
 - G. Bachand 29 (CAN, SFS), August 5, 1975.

Note: The CAN herbarium sheet does not include the Mont-Carrier record, but only that of Stoke-Centre; since it is part of the same collection, we believe this was an oversight or an annotation made after the specimen was sent to Ottawa.

 - S. Brisson and G. Bachand 762048 (CAN, MTMG, QFA, SFS), September 7, 1976.
 - A. Sabourin and D. Paquette 666 (MT), July 1, 1991.
3. Stoke, RCM Le Val-Saint-François, Quebec. Large meadow and small clearings in a mixed woods near the township of Windsor, approximately 1.5 km north of Mont-Carrier.
 - A. Sabourin, D. Paquette and D. Sabourin 736 (MT), July 12, 1992.
4. Ham-Nord, RCM Arthabaska, Quebec. Clearing and humid roadsides, approximately 1 km west of Développement-Boisvert, near the Nicolet River.
 - P. Forest, 1990 (pers. comm., 1991).
 - A. Sabourin, P. Forest and D. Paquette 662 (MT), June 30, 1991.
5. Ham-Nord, RCM Arthabaska, Quebec. Clearing and humid edge of a forest road approximately 1 km south of Développement-Boisvert.
 - P. Forest, 1990 (pers. comm., 1991).
 - A. Sabourin, P. Forest and D. Paquette 663 (MT), June 30, 1991.
6. Ham-Nord, RCM Arthabaska, Quebec. Humid clearing in coniferous woods approximately 0.5 km east of Développement-Boisvert.
 - P. Forest, fall 1990 (pers. comm., 1991).
 - A. Sabourin, P. Forest and D. Paquette 661 (MT), June 30, 1991.

7. Saint-Adrien, RCM L'Or-Blanc, Quebec. Very humid meadow of Rivière à Bissonnette approximately 1.5 km northwest of the town.
 - A. Sabourin and D. Paquette 667 (MT), August 15, 1991.
 8. Wotton, RCM L'Or-Blanc, Quebec. Humid field approximately 0.5 km east of Moulin-Plamondon.
 - P. Forest, 1990 (pers. comm., 1991).
 - A. Sabourin, P. Forest and D. Paquette 664 (MT), June 30, 1991.
 9. Saints-Martyrs-Canadiens, RCM Arthabaska, Quebec. Clearing with willow shrubs of Ruisseau de l'Aulnière, approximately 2 km northwest of the town.
 - A. Sabourin, D. Paquette and D. Sabourin 735 (MT), July 11, 1992.

This is the northernmost known population of the species. Rousseau (1974) situated the northernmost limit in North America at Trout Brook, New Brunswick. However, Trout Brook is actually further south. Two more northern stations in Arthabaska, Quebec, have not been relocated (DAO, MT, QFA, QUE).
- **Populations likely extirpated**
- Trout Brook, probably near Trout Lake, St. George, Charlotte County, New Brunswick. Woods along a brook, approximately 4 km north of Utopia.
 - J. Brittain 33174 (DAO, QK), 1885. Denis Paquette visited the banks of Trout Brook on July 7, 1991 but did not find *Polemonium van-bruntiae*, even though the habitat still appears favourable. In 1986, Hinds stated the following with respect to this population: "... may be native but this locality cannot be confirmed."
- **Historical populations**
10. Arthabaska, RCM Arthabaska, Quebec. Rich woods of Mont Garneau.
 - Brother Allyre and Brother Lorenzo 456 (QFA), July 2, 1937.
 11. Arthabaska, RCM Arthabaska, Quebec. Peat bog with *Alnus*, *Clematis* and *Eupatorium* on the left bank of the Nicolet River.
 - Brother Allyre and Brother Alphonsius 1074 (DAO, MT, QFA), August 6, 1942.
- Arthabaska, RCM Arthabaska, Quebec. Very humid.
- Brother Allyre 276 (QFA) and 1180 (QFA, QUE), July 18, 1943.
- Because the location of this collection is not precise enough, we do not consider this population to be distinct from the two preceding populations.

We visited three relatively suitable sites on June 28 and 29, 1991 without success. The first is located on the right bank of the Nicolet River, just east of Route 116; the second is located just west of Route 116, at the confluence of the Nicolet and Gosselin rivers. The third (favourable) is located on the left bank of the Nicolet River, between Île Baril and the bridge just south of the church in Arthabaska. On July 10, 1992, we visited the eastern face of Mont Garneau (grid reference 19 TBA 732993 (UTM) on Map 21 L 4; 46°00'30" N - 71°55'30" W) and the left bank of the Nicolet River, 1.5 km upstream from Île Baril; these two adjacent areas consist largely of farmland and our searches were also unsuccessful.

Potential localities

In Quebec, most municipalities in the Eastern Townships and Bois-Francs regions may have wetlands suitable to *Polemonium van-bruntiae*. Theoretically, the entire region located in the semi-circle bordered by the localities of Sutton, Arthabaska, Thetford-Mines, Lac Mégantic and the U.S. border is suitable. To date, however, the species has never been found outside the triangle formed by Stoke, Arthabaska and Saints-Martyrs-Canadiens.

In 1991 and 1992, we focussed our searches on that triangle. We also explored the area to the southwest, north and east, for a total of 56 sites (including those where the species was found). Suitable habitats are found in the vicinity of known populations, which could mean that the real number of stems has been under-estimated.

In New Brunswick, the region of Trout Lake and Lake Utopia, located northeast of St. George, in the southwest part of the province, should be explored in greater detail.

Potential groups of localities are:

RCM Arthabaska: all localities having suitable habitats located near the Nicolet River and its tributaries, upstream from Arthabaska.

RCM L'Or-Blanc: all localities having suitable habitats located near the Nicolet Centre, Nicolet Nord-Est and Nicolet Sud-Ouest rivers and their tributaries, upstream from Danville.

RCM Le Val-Saint-François: all localities having suitable habitats located near the Stoke and Watopeka rivers and their tributaries.

Erroneous reports and misidentifications

In New Brunswick, a collection was made on June 7, 1964 at Hoyt, Sunbury County, by Mrs. V.B. Watters (No. 8976, NBM). This collection is mentioned by Hinds, in 1983 and in 1986. In actual fact, it is the species *Polemonium reptans*. The stamens and styles are inserted or, at most, equal to the corolla; in addition, the two specimens are somewhat diffuse-arcuate and only 30 cm tall. The sepals are small and only 5-6 mm long.

In Quebec, the same comments apply to a collection made in a coniferous woods in Bromont, by Carol Latendresse on May 15, 1976 (No. 111, SFS). Moreover, this *P. reptans* was collected in flower, or in other words, once month prior to the start of flowering of *P. van-bruntiae*.

It is important to mention the misidentification by J.F. Davidson in 1947 of a specimen collected at Gaspé-Bassin, Quebec. This collection from the Gray herbarium (GH, No 5573 1/2) was made on August 24, 1904 by Collins, Fernald and Pease, who had identified it as *Polemonium caeruleum*. Photographs (No. 6729) of the specimen are found at DAO, QUE and QFA. In 1947, Davidson identified the collection as *P. caeruleum* ssp. *van-bruntiae* for his study of the genus *Polemonium* published in 1950. In 1948, Fernald identified it as *P. caeruleum*, as did B. Boivin in 1966. In our view, there is no doubt that it is a typical *P. caeruleum*, which Davidson calls *P. caeruleum* ssp. *vulgare*, particularly since the lower leaves are serrated and lanceolate to oblong, the inflorescence is densely glandular-pubescent and the length of the calyxes varies from 6 to 8 mm (see Table I). Finally, the habitat, a waste area, does not at all coincide with *P. van-bruntiae*.

This error by Davidson leads us to question his taxonomic treatment of *P. van-bruntiae*, which we do not use in this study. However, we still have some doubts, given the fact that Davidson states that there exist Eurasian specimens, which we have not seen, which closely resemble *P. van-bruntiae*. If we look at the

European descriptions (Clapham *et. al.*, 1952; Polunin, 1969; Tutin, 1972), they correspond much more closely to the American specimens of *P. caeruleum* than to *P. van-bruntiae*.

The Quebec records of Scoggan (1979) for Kamouraska and Rimouski counties and for Gaspé-Bassin should be changed to *P. caeruleum*.

Nature and location of cultivated plants

Polemonium van-bruntiae appears to have been cultivated only in the United States. W. Brumback of the New England Wild Flower Society collected seeds in Vermont in 1986 and cultivated them in greenhouses. They did not germinate immediately, but germinated well when held dry under refrigeration until the spring and fall of 1987. Eighty-four seedlings were transplanted at two sites in Vermont, under favourable conditions, but they seemed to have survived only the first summer and none of them flowered. However, this experiment was not well controlled and no conclusions were drawn regarding the preferred habitats of this species. Brumback conducted additional germination experiments in subsequent years. Although erratic, they continue (Thompson, 1991). Finally, the species appears on the American Horticultural Society's Endangered Wildflowers 1988 Calendar (Steffey, 1987).

5. ENVIRONMENT AND HABITAT

Summary

Polemonium van-bruntiae occurs in humid, at least partially open habits, in the upper level of the flood zone, in cool climates, in very rich organic soils and always in the Appalachians. More specifically, it occurs in humid grassy clearings in coniferous or mixed forests, and in riparian meadows. These alluvial environments are its primary habitat. Very rarely, it may spread nearby in abandoned fields and along the edges of forest roads, where there is sufficient moisture. In habitats where competition is very strong, particularly by grasses, this species usually has problems spreading.

Climate

Van Brunt's Jacob's-ladder seeks a cool, humid climate. In Quebec, the data of Ferland and Gagnon (1967) show an average temperature of approximately 4°C (40°F) for the region in which it occurs. Average total annual precipitation is at least 1,016 mm (40 inches), which, according to the authors, is high. According to them, the last frost occurs on about June 1 and the first frost in the fall occurs on about September 15, which gives an average of at least 105 days without frost.

Air and water requirements

Ideally, the taxon requires relatively high humidity to survive; it prefers a terrain where the water circulates (oblique drainage) with the water table at least 30 cm beneath the surface. If the terrain is flooded in the summer, the species quickly declines in number, like at Saint-Adrien. However, if the drainage is improved, like at Wotton, the plant has difficulties surviving.

Physiographic and topographic characteristics

The entire range of *Polemonium van-bruntiae* is located in the physiographic region of the Appalachians. This species is sometimes found at relatively high altitudes, such as in the Catskill Mountains, in southern New York, where it occurs at an altitude of 1,160 metres. However, it tends to be concentrated at altitudes of between 365 and 762 metres. At the southern limit of its range, it occurs on the summit of the West Virginia mountains

(approximately 1,200 metres) (Davidson, 1950; Fernald, 1950; Strausbaugh and Core, 1958; Thompson, 1991; Wherry, 1935; see Figure 4). As we move from the southern limit of its range northward, the altitude at which it occurs decreases. Although it occurs in mountainous regions, it prefers a flat terrain with a slight slope, such as the humid depressions which form grassy clearings, riparian meadows and swamps at the upper limit of the flood zone, and it is always found in hydric stations (h). We have attempted to represent a typical physiographic sere using pictograms (Figure 7) based on Richard (1987).

Quebec populations of *P. van-bruntiae* occur at the following altitudes: Stoke (No. 1), 220 m; Stoke (No. 2), 230 m; Stoke (No. 3), 225 m; Ham-Nord (No. 4), 270 m; Ham-Nord (No. 5), 290 m; Ham-Nord (No. 6), 290 m; Saint-Adrien (No. 7), 270 m; Wotton (No. 8), 230 m; Saints-Martyrs-Canadiens (No. 9), 350 m.

Although these habitats are generally alluvial in Quebec, geological formations should be mentioned. In the Stoke area, the substrate is composed primarily of slate, and sometimes sandstone and felsic tuff of the Saint-Victor formation of the Magog group (middle Ordovician). In the area surrounding Ham-Nord, from Saint-Adrien and Saints-Martyrs-Canadiens, the substrate consists of slabs of slate of the Saint-Daniel formation (Cambrian to early Ordovician), also from the Magog group (Saint-Julien and Slivitzky, 1989).

The Stoke populations are found in the hydrographic basin of the Saint-François River, via its tributary, the Stoke River. The populations of Ham-Nord, Wotton, Saint-Adrien and Saints-Martyrs-Canadiens occur in the adjacent Nicolet River basin to the north. None of the stations are more than 500 metres from the bed of rivers or streams.

Edaphic characteristics

The soils in which *Polemonium van-bruntiae* occurs range from brown or black soil to gravelly sand. They are composed primarily of decomposed plant matter. The species seems to prefer deep soils composed of humus-rich black soil, as in the humid clearing of Ham-Nord (No. 6), where the largest number of specimens has been observed. The same type of soil was also observed at Ham-Nord No. 4, Stoke (Nos. 1, 2 and 3), Saint-Adrien (No. 7) and Saints-Martyrs-Canadiens (No. 9). These non stony soils appear to result from the accumulation of organic material (organic soils) in depressions or from the deposition of alluvium by overflowing rivers, as is the case at Stoke (No. 1) and Saint-Adrien (No. 7). A secondary type of soils, likely of glaciofluvial origin and found around black soils, consists of gravelly brown sand mixed with a little clay, like at Ham-Nord (Nos. 4, 5 and 6). The soil at Wotton (No. 8) is a relatively rich brown, slightly stony soil.

These soils are generally poorly drained, and the sandy-gravelly brown soil located at the periphery are sometimes imperfectly drained. There is usually a slight slope, if not a stream or river, close by, which enables water circulation. We collected at least one soil sample at all sites, except Wotton, and we measured the pH by means of a glass electrode. Our findings are as follows:

1. Stoke:	pH = 5.5	5. Ham-Nord:	pH = 6.1
2. Stoke:	pH = 5.5	6. Ham-Nord (swale):	pH = 6.0
3. Stoke (large meadow):	pH = 5.3	6. Ham-Nord (slope):	pH = 5.0
3. Stoke (small clearing):	pH = 4.7	7. Saint-Adrien:	pH = 6.0
4. Ham-Nord:	pH = 5.6	9. Saints-Martyrs-Canadiens:	pH = 5.5

According to Wherry (1935), the taxon occurs in humid soils where, although the water beneath the surface may be alkaline, the humus into which its roots extend is almost always slightly acid. The studies done on several Maryland populations show that the pH of the water there was 6.6 to 6.7 and that the species had a rather narrow pH range tolerance (Thompson, 1991). According to the table on page 20, our observations show a slightly wider pH range than that of Thompson and are closer to Wherry's findings. A more detailed study would be required.

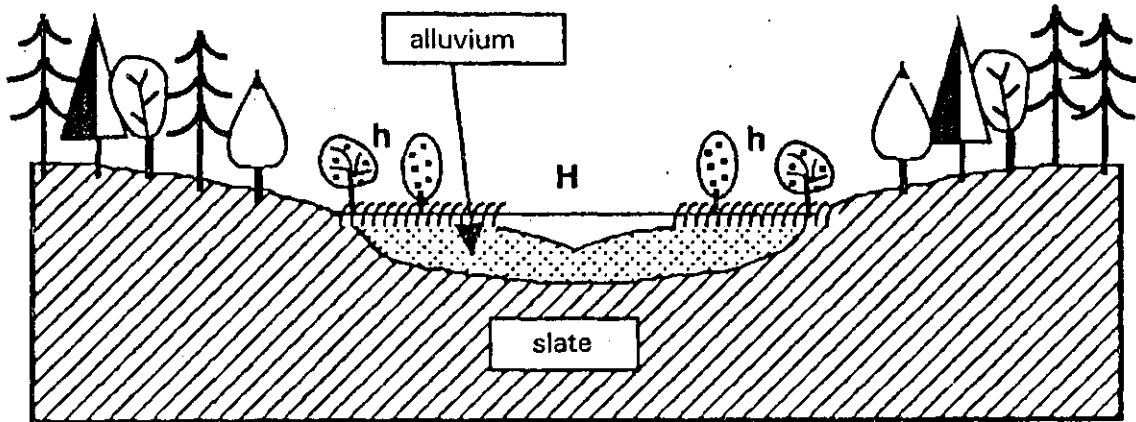





Figure 7: Diagram of a physiographic sere and typical plant sequence of the habitat of *Polemonium van-bruntiae*, which occurs in alluvial deposits, at the upper limit of the flood zone (h).


———— : Flood zone


H , h : Hydric stations


 : *Salix* spp.
Willows (shrubs)


 : *Alnus rugosa*
Speckled alder

 : *Thuja occidentalis*
Eastern white cedar

 : *Picea rubens*
Red spruce

 : *Abies balsamea*
Balsam fir

 : *Acer rubrum*
Red maple

 : *Calamagrostis canadensis* meadow

Biological characteristics

Quebec populations of *Polemonium van-bruntiae* occur at the limit of two bioclimatic zones: maple-basswood and maple-yellow birch (Rousseau, 1974). However, if we take a closer look at the edaphic vegetation, the woods surrounding the humid riparian meadows or grassy or shrub covered clearings (some authors call these habitats shrub fens or grassy fens (Fleurbec, 1987; Lavoie, 1992)) usually consist of fir, red spruce or cedar, or are mixed woods where red maple and black ash occur together (Figures 8 and 9). In our view, such species as black spruce and silver maple could not have invaded the species' habitat given the hydrology and insufficient acidity of the soils and the cool climate.

List of the main vascular plants associated with *Polemonium van-bruntiae* in the populations visited:

The species that occur in association with most populations of *Polemonium van-bruntiae* are:

Calamagrostis canadensis, *Salix* (up to five species), *Alnus rugosa*, *Carex* (up to four species), *Spiraea latifolia*, *Aster umbellatus*, *Clematis virginiana*, *Eupatorium maculatum* and *Thalictrum pubescens*.

1. **Stoke**, riparian tall-grass meadow (120-150 cm) and alder stand of the Stoke River north of Mont-Carrier: *Calamagrostis canadensis* (dominant species); *Alnus rugosa*, *Thalictrum pubescens*, *Eupatorium maculatum*, *Salix* spp., *Spiraea latifolia*, *Angelica atropurpurea*, *Dryopteris cristata*, *Aster umbellatus*, *Carex lacustris*, *Onoclea sensibilis*, *Acer rubrum* (Figure 8).
2. **Stoke**, very small tall-grass clearing in a mixed woods southwest of Mont-Carrier: *Alnus rugosa*, *Acer rubrum*, *Abies balsamea* (dominant species); *Thuja occidentalis*, *Onoclea sensibilis*, *Carex crinita*, *Clematis virginiana*, *Osmunda claytoniana*, *Aster puniceus*, *Eupatorium maculatum* (Figure 3).
3. **Stoke**, large grassy clearing with short grasses (30-120 cm), and small grassy clearings (more humid) in mixed woods, near Windsor township:
 - **large meadow**: *Calamagrostis canadensis* and *Aster umbellatus* (dominant species); *Ribes* sp., *Senecio robbinsii*, *Geum rivale*, *Solidago rugosa*, *Spiraea latifolia*, *Salix* (5 species).
 - **very small grassy clearings**: *Fraxinus nigra*, *Acer rubrum*, *Thalictrum pubescens* (dominant species); *Abies balsamea*, *Eupatorium maculosum*, *Alnus rugosa*, *Calamagrostis canadensis*, *Aster umbellatus*, *Carex* spp.
4. **Ham-Nord**, grassy clearing with shrub cover in mixed woods, west of Développement-Boisvert: *Eupatorium maculatum* (dominant species); *Clematis virginiana*, *Aster puniceus*, *Aster umbellatus*, *Thalictrum pubescens*, *Calamagrostis canadensis*, *Carex crinita*, *Prunus virginiana*, *Acer rubrum*, *Abies balsamea*, *Salix* spp., *Prunus pensylvanica*.
5. **Ham-Nord**, grassy clearing in a coniferous woods, south of Développement-Boisvert: *Spiraea latifolia* (dominant species); *Rubus pubescens*, *Senecio robbinsii*, *Solidago rugosa*, *Dryopteris cristata*, *Ranunculus acris*, *Thuja occidentalis*, *Abies balsamea*, *Picea rubens*, *Salix* spp., *Spiraea tomentosa*.
6. **Ham-Nord**, grassy clearing in a coniferous woods, east of Développement-Boisvert: *Polemonium van-bruntiae* and *Calamagrostis canadensis* (dominant species); *Glyceria grandis*, *Spiraea latifolia*, *Clematis virginiana*, *Senecio robbinsii*, *Carex crinita*, *C. retrorsa*, *C. stipata*, *Rubus canadensis*, *Scirpus atrocinctus*, *Juncus effusus*, *Salix* (3 species), *Alnus rugosa*, *Thalictrum pubescens*, *Picea rubens*, *Abies balsamea* and *Thuja occidentalis* (Figure 9).
7. **Saint-Adrien**, riparian tall-grass meadow, of the Bissonnette River: *Calamagrostis canadensis* (dominant species); *Spiraea latifolia*, *Alnus rugosa*, *Salix* spp., *Myrica gale*, *Aster puniceus*, *Aster umbellatus*, *Iris versicolor*, *Spiraea tomentosa*, *Thalictrum pubescens*, *Senecio robbinsii*.

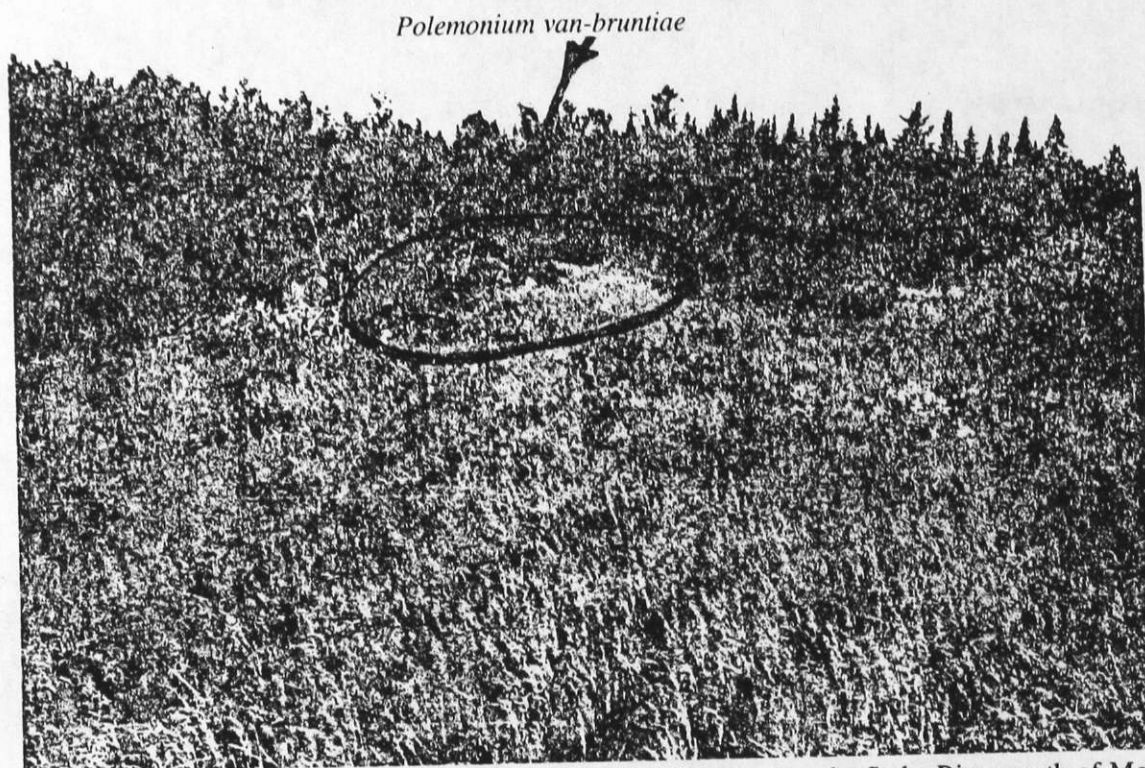


Photo D. Paquette ©

Figure 8: Habitat of *Polemonium van-bruntiae* at Stoke (No. 1), near the Stoke River north of Mont-Carrier

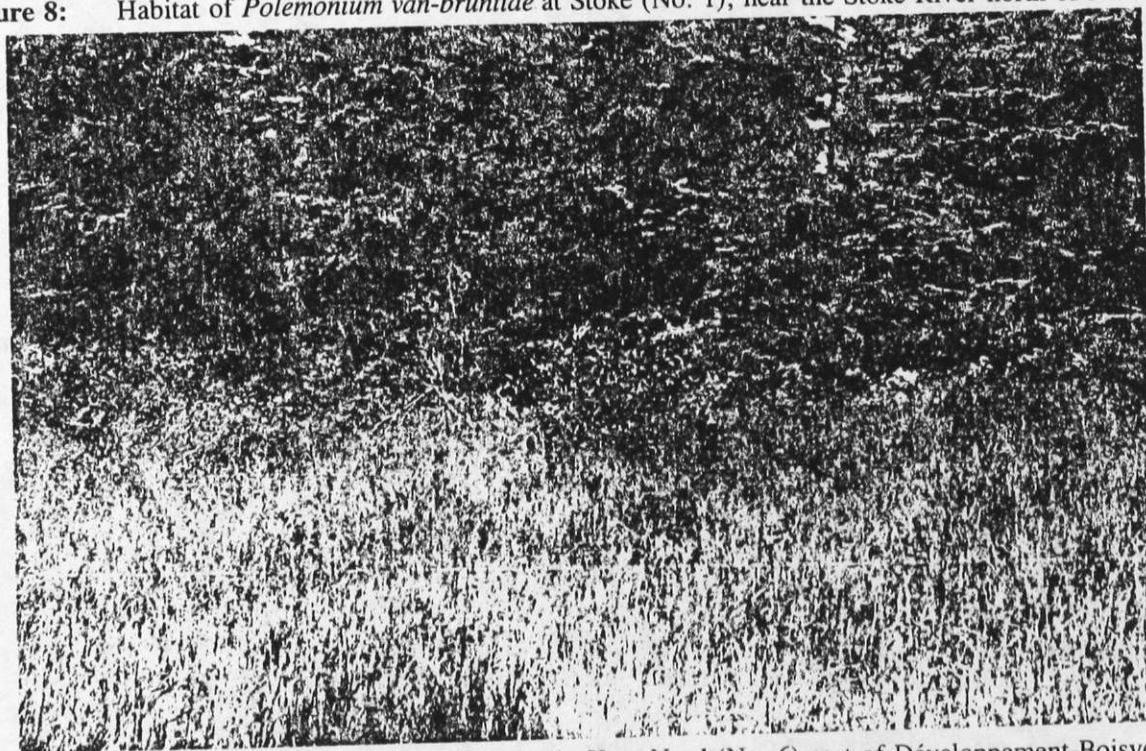


Photo D. Paquette ©

Figure 9: Habitat of *Polemonium van-bruntiae* in Ham-Nord (No. 6) east of Développement-Boisvert

8. Wotton, humid abandoned field with short grasses, east of Moulin-Plamondon: *Spiraea latifolia* (dominant species); *Calamagrostis canadensis*, *Salix* spp., *Carex crinita*, *Solidago altissima*, *Aster lanceolatus*, *Aster umbellatus*, *Ranunculus acris*, *Phleum pratense*.
9. Saints-Martyrs-Canadiens, grassy clearing with shrubs in a mixed woods of Ruisseau de l'Aulnière: *Clematis virginiana* and *Aster puniceus* (dominant species); *Salix* (3 species), *Prunus virginiana*, *Aster umbellatus*, *Cornus stolonifera*, *Spiraea latifolia*, *Alnus rugosa*, *Eupatorium maculosum*.

It should be noted that tall grasses are 120 to 150 cm tall and occur in more humid meadows than do short grasses, which are 30 to 120 cm tall. Where no indication is provided, the grasses are of medium height. In addition, in these localities, we noted no other vascular plants that are rare in Quebec. On the contrary, the species are all common, invader species and *P. van-bruntiae* has problems competing, except in ideal conditions (Ham-Nord No. 6 and Stoke No. 3).

With regard to the phenomenon of plant succession, *P. van-bruntiae* belongs, according to Wherry (1935), to a secondary succession, in which it occupies an intermediate position. In our opinion, this type of succession is present only in the Stoke No. 2 and Wotton (No. 6) [sic] populations. The remaining seven stations are in the stages of humid riparian meadows or very humid grassy clearings that have reached the climax stage. This plant requires sun for its inflorescences to open out but also needs tall, dense associated herbaceous plants to conserve the moisture of the soil and keep its base in shade. It also benefits from the mounds they form and in which the species occurs. This species partially tolerates the shade of shrubs, particularly that of willows and alders.

Influence of dynamic factors

Van Brunt's Jacob's-ladder can develop according to the following dynamic factors: humid environments with a cool climate, open to partially shaded, subject to seasonal flooding only. This type of habitat occurs primarily in riparian meadows, swamps or non-wooded depressions, or in other words, in clearings that are too moist for the large trees of the mixed or coniferous woods of the region to become established, all in mountainous regions. In this type of environment, only small deciduous shrubs are able to establish themselves, such as willows or alders. In addition, in riparian meadows, spring flooding and poor drainage also limit the establishment of large trees (Figures 8 and 9).

However, some clearings that are not moist enough or are too small, or the edges of swamps or riparian meadows may one day be invaded by the forest. As a result, *Polemonium* colonies may partially or completely disappear. This is likely to be the case of the small Stoke population (No. 2), which is very closely surrounded by woods. The fact that this taxon is sometimes found at the border between riparian meadows and willow-alder stands indicates that the species is seeking an environment where the water table is near the surface, but where the plant is not exposed to prolonged flooding, which seems to cause mortality, according to Thompson (1991). This appears to be true, since at the site where we observed the 150 stems of the Saint-Adrien population (No. 7) on August 15, 1991, we were standing in 20 cm of water. That was still the case on July 10, 1992, but at that time there were only 3 flower stalks left.

6. POPULATION BIOLOGY

Summary

There are currently nine known populations in Canada, accounting for a total of approximately 7,000 stems (observed in 1991 and 1992). All are located in Quebec. Three populations have more than 1,000 stems, and the Ham-Nord population (No. 6) has roughly 3,000 stems. None of the other populations exceed 350 stems. In our view, most of the populations seem to be stable, although the Stoke (No. 2) and Wotton populations appear

to be declining and the Saint-Adrien is in danger of disappearing. The species flowers for one month (July) and has reproduction and dispersal difficulties, perhaps due to its clonal nature or to limited genetic diversity.

Demography

1. Stoke, near the Stoke River, north of Mont-Carrier. This population comprises at least 300 stems, which occur primarily in a swampy meadow but also in an alder stand. It covers an area of approximately 100 m² and its density is quite low. A number of stems without inflorescences have been observed in the meadow where *Calamagrostis canadensis* is very dense (Figure 8). Although this population appears stable, it could be much larger given that the swampy meadow of the Stoke River extends at least 3 km to the west.
2. Stoke, wooded area to the southwest of Mont-Carrier. Small population, with roughly 100 stems. It covers only about 10 metres, which increases its density. However, we feel it is on the decline, since it appears that this small clearing is being invaded by a young mixed forest (approximately 20 years), which surrounds it. The presence of a fence (Figure 3) leads us to believe that the site is an abandoned pasture that has since been invaded by trees.
3. Stoke, near the boundaries of Windsor township. The second largest population, with approximately 2,000 stems, the vast majority of which occur in a large meadow, measuring roughly 250 m by 75 m. The density of the stems varies from low to high. We observed three other small colonies located nearby and closer to the Stoke River, where the total number of stems does not exceed 100, with average density, in clearings measuring 10 m by 10 m.
4. Ham-Nord, west of Développement-Boisvert. This population comprises approximately 300 stems, divided into two unequal groups, located on either side of a dirt road. The colony covers a total area of 100–150 m long by 20 m wide. The density is relatively low. The group, located south of the road in a clearing, could be the centre of dispersal. The narrow road, which is near the Nicolet River at this point, is located on wetlands and could have destroyed a large part of the colony, although several specimens that occur in the ditches appear to have adapted.
5. Ham-Nord, south of Développement-Boisvert. This population, composed of three groups, comprises a total of roughly 300 stems. The two groups located in a humid clearing surrounded by firs and red spruce constitute the original groups, whereas the third group, located near the forest road, consists of a small number of stems that appear to have adapted to the human intervention. Here again, the existence of this colony may pre-date the road; it covers an area of less than about 100 m long by about 20 m wide. Its density ranges from low to average.
6. Ham-Nord, east of Développement-Boisvert. This population is by far the largest. It comprises thousands of stems, perhaps 3,000, in a humid clearing, or particularly a depression. The colony covers an area approximately 300 m long by 75 m wide. The width is greater in the depression, where the density is very high. *P. van-bruntiae* is the dominant species (Figure 9). The width of the colony decreases, as does its density, on the relatively gradual slope located east of the depression.
7. Saint-Adrien, near the Bissonnette River. A small population with approximately 150 stems in 1991, but only 3 in 1992. It occurs at the edge of a swampy meadow very close to a road. The colony runs along the road for roughly 50 m. The repair and expansion of the road in 1991 likely contributed to the disappearance of a major part of the population and threatens to wipe out the remaining stems, by causing permanent flooding. However, because the habitat of this species extends over an area of roughly 1 km along the Bissonnette River, there could be other groups of *Polemoniums* in this area. The habitat at this station is the most humid of all the stations.

8. Wotton, east of Moulin-Plamondon. This small population, approximately 200 to 250 stems, actually consists of only 4 close clumps which cover an area of less than 10 m². As a result, its density is very high. This is also the colony with the smallest stems, due to the fact that the field was drained by the digging of two ditches, one a little to the east and the other a little further to the south. Finding little moisture, the species may be on the decline.
9. Saints-Martyrs-Canadiens, near Ruisseau de l'Aulnière. This is the third largest population with at least 1,000 stems and a relatively high density. The habitat consists of small grassy clearings with willow shrubs surrounded by mixed woods. The main clearing in which the vast majority of the stems occur, measures roughly 30 m by 30 m.

In the United States, the 56 contemporary populations are believed to account for a total of approximately 81,000 stems (Thompson, 1991). If we add the nine Canadian populations and their 7,000 stems to this number, we have a world total of 88,000 stems and 65 populations.

Phenology

We have no data on the phenology of leaf and flower bud formation. However, flowering begins on about June 20 in Quebec, according to an observation by Philippe Forest in 1991 at Ham-Nord (the spring of 1991 was warmer than usual). All signs lead us to believe that in Quebec, flowering lasts approximately one month and ends in late July. We have never seen an herbarium specimen in flower in the month of August and even specimens dating from July 17 and 18 seem to be at the end of flowering. However, the species was in full flower on July 10, 11 and 12, 1992 (cool summer). With respect to fructification, we visited Saint-Adrien on August 15, 1991, and the Stoke River on August 16, and we noticed that some seeds were mature and were found in open, sometimes empty capsules. However, most of the capsules were closed by the sepals. The senescence of the stems must occur in October with the severe frosts. The opening of the capsules appears to be slow, since even at the end of December 1991, only one capsule in ten was open (Philippe Forest, pers. comm., 1992). Dispersal occurs primarily in the winter, when the winds blow the capsules onto the snow, after the breakage of the stems and in the spring, with the flooding of the sites. We have no data on germination or on the longevity of this perennial species.

Reproduction

Polemonium van-bruntiae appears to reproduce both by rhizomes and by seeds, and the majority of individuals have flower stalks, but there are many non floriferous rosettes. However, the relative importance of each type of reproduction is unknown and likely varies from site to site (Thompson, 1991). The species may reproduce vegetatively by means of rhizomes, which can form clones of variable size. Thompson (1991) observed that in one Vermont population, many stems were connected underground; the size of the clone was not determined but it may have been as large as several tens of square feet (hundreds of stems). Nearby, this author observed small plants in a clump, that had likely originated sexually. She adds that other biologists have not observed clonal behaviour, and that in Maryland, Ed Thompson describes plants as clumped. In Quebec, the species appears to reproduce most often vegetatively.

With respect to pollination, Wherry (1935) and Thompson (1991) state that the flowers of this species are cross-pollinated by honey bees (*Apis mellifera*) or bumble bees (*Bombus* sp.). Our 1991 and 1992 observations coincide with these findings. Moreover, we observed other species of insects that seem to greatly appreciate the nectar of the flowers, if we go by the large number of insects visiting flowering plants. In addition, the very conspicuous flowers are an attractant and are believed to be protandrous.

In terms of the dispersal of seeds, we have already mentioned the winter winds, but we should add the spring flooding in this open habitat where water plays a key role in the survival of the species, which cannot compete with other species if the moisture level is too low. Generally speaking, the species occurs on relatively

small areas and has dispersal problems. As a result, even at sites where the ecological conditions appear to be favourable, the species is usually absent, or present in small numbers, except at Stoke No. 3 and Ham-Nord No. 6. It is possible, therefore, that *P. van-bruntiae* has problems reproducing, which would help explain its rarity. The formation of clones, which contributes to lessening its genetic variability, could exacerbate its vulnerability. These populations are small, isolated and outlying (in Quebec), and in this case, they often have limited genetic diversity (Brouillet, 1986).

7. Population ecology

The large number and variety of visiting insects (such as honey bees, bumble bees and butterflies) indicate that *Polemonium van-bruntiae* is necessarily insect-pollinated, but also that during early summer, flowering is rare in this habitat. In fact, other than Polemoniums, only ragwort (*Senecio robbinsii*) and meadow rue (*Thalictrum pubescens*, the white flowers in Figure 8) are in full flower at this time. It is therefore a very positive interaction between this plant and the insects, which appear to greatly appreciate its nectar. We also observed a ruby-throated hummingbird (*Archilochus colubris*) visiting the plant at Ham-Nord No. 6.

With respect to animal interactions, deer may play a role by grazing the flowers and upper stems, but only occasionally. We observed grazing at Stoke, where population No. 3 is the most affected, with perhaps 10% of its stalks grazed. At the Saints-Martyrs-Canadiens population (No. 9), only a few plants had been grazed. However, grazing causes little damage to the plant, which can produce lateral shoots and reflower. We noted the presence of what we believed to be a true bug¹, at the nymph stage, on only one *P. van-bruntiae* stem, in the Stoke No. 2 population on July 1, 1991. On July 15, 1991, at the Saint-Adrien population (No. 7), several sepals had been eaten by a large brown bug². None of the literature mentioned hybridization with *P. caeruleum* or *P. reptans*. Moreover, these two species are rare in Quebec, and have quite different habitats.

8. LAND OWNERSHIP AND MANAGEMENT

The nine Quebec populations of van Brunt's Jacob's ladder occur, in all likelihood, on private land.

[Specific information on land ownership has been removed from this report. E. Haber, Chairman, Plants Subcommittee, COSEWIC, July 1994]

9. MANAGEMENT AND DEVELOPMENT PRACTICES

In Quebec, none of these practices were designed especially for *Polemonium van-bruntiae*, but this species is suffering the adverse consequences of road construction and agricultural drainage. The populations of Ham-Nord (No. 4) and Saint-Adrien (No. 7) have, in our view, declined in number as a result of the presence of roads

¹ The French text reads "punaise".

²The French text reads "punaise brune".

running through their habitat, despite the fact that a few individuals have survived in the ditches. The Wotton population (No. 8) has declined as a result of drainage.

A experiment to cultivate and subsequently transplant seedlings has already been carried out in Vermont and continues there (see page 19), whereas transplants of a population threatened by a dam in Pennsylvania have apparently not been successful (Thompson, 1991).

10. THREATS TO SURVIVAL [IDENTIFIED]

The key threats that may affect the species in Quebec are road construction, residential construction (cottages), agriculture and agricultural drainage and, to a lesser extent, plant succession and all-terrain vehicle (ATV) traffic.

1. Stoke, Stoke River north of Mont-Carrier: Agriculture poses a possible threat to the entire known population. In 1991, the land located on the other side of the road was cleared for cultivation, but we do not know whether it is owned by the same person.
2. Stoke, southwest of Mont-Carrier: The entire population is threatened by the invasion of the young forest (approximately 20 years) very nearby.
3. Stoke, near the limits of Windsor township: Like population No. 1, agriculture poses a threat to the large meadow where the majority of the population occurs, particularly since this large meadow is not very humid, the grass is short and trees and shrubs are relatively scarce. In addition, there is a cultivated field on the other side of the road, in Windsor township, under power lines, which increases the pressure to obtain farmable lands in the region.
4. Ham-Nord, west of Développement-Boisvert: This population, located near a road, may eventually suffer the effects of cottage construction, which has already occurred just east (1 km) and west of the site. The site is located near the Nicolet River and along a possible residential development corridor.
5. Ham-Nord, south of Développement-Boisvert: Only the future expansion of the forest road, which is not heavily used at present, could pose a threat to a small part of the station.
6. Ham-Nord, east of Développement-Boisvert: The largest of the seven populations does not appear to suffer any apparent threats. In our view, the presence of ATV tracks, like at Stoke (No. 1), does not pose a real threat to this perennial, and would only pose a threat if the tracks were to become highly frequented trails. It should be noted that there is a small garbage dump, most likely illegal, approximately 100 metres from the population.
7. Saint-Adrien, Bissonnette River northwest of the town: The road, which was expanded in 1991, may already have caused the disappearance of part of the population. The impacts of the construction are very significant for the survival of the population which subsists nearby. Of the 150 stems observed in 1991, only 3 remained in 1992. In our view, changes to the drainage pattern is the cause of the decline. The road expansion and poor drainage likely caused permanent flooding of the adjacent meadow and as a result, the polemoniiums there are now in danger of disappearing.
8. Wotton, east of Moulin-Plamondon: The possible redevelopment of agriculture could eliminate this small population located in an abandoned field, which has already been drained.
9. Saints-Martyrs-Canadiens, near Ruisseau de l'Aulnière: This population does not appear to be threatened by human activity. Only plant succession--the forest--can pose a threat to the population in the long term, but this humid grassy clearing could well be at the climax stage.

In conclusion, most types of threat are possible and depend on future human activity, at least with regard to populations Nos. 1, 3, 4, 5 and 8, or part of them. Plant succession poses a threat to population No. 2, whereas other groups of *Polemonium* can exist a little farther in the favourable sector, which covers at least 1 km², such as at Stoke (No. 1). However, the Saint-Adrien population (No. 7) is endangered and drainage work should be undertaken as soon as possible. Populations No. 6 and No. 9 do not appear to be threatened. We should add that the general economy of the region is stagnant.

11. LEGAL OR OTHER STATUS [current]

** International status

The Nature Conservancy (Argus and Pryer, 1990) gives *Polemonium van-bruntiae* a global rank of G3 (21 to 100 occurrences). This ranking and the following are based almost entirely on the number of known occurrences. They do not automatically confer legal recognition.

** National status

U.S. rank: Thompson (1989) states that *Polemonium van-bruntiae* would be considered for inclusion in the federal list of threatened species. However, it has not yet been included and is in category 2. Several U.S. populations of *Polemonium van-bruntiae* occur in parks, and we do not know the level of protection given to the plant or its habitat. For example, one of the largest concentrations of the species occurs in Catskill Park, New York. In West Virginia, several populations, including the southernmost one, occur in Monongahela National Forest. In Vermont, the six populations, considered threatened according to Thompson's list (1989), are protected under the *Vermont Endangered Species Law* (10 V.S.A. Chap. 123).

The priority rankings of the Nature Conservancy (Thompson, 1991) for each state in which the species occurs are as follows:

- | | |
|-----------------|---|
| - Connecticut | SRF (mistaken report) |
| - Maine | S1 (very small population) |
| - Maryland | S2 (roughly 9 populations) |
| - New Jersey | SX (one historical population, likely disappeared) |
| - New York | S3 (approximately 22 contemporary stations and 20 historical populations) |
| - Pennsylvania | S1 (one contemporary population and 4 historical populations) |
| - Vermont | S1 (5 small populations) |
| - West Virginia | S2 (19 populations) |

Canada: *Polemonium van-bruntiae* is currently not given legal protection. However, on the basis of the method of the Nature Conservancy, Argus and Pryer (1990) establish the following priority ranks:

- | | |
|-------------------|---|
| - Canadian coast: | N1 |
| - Quebec | S1 (which should be revised to S2) |
| - New Brunswick | S1 (should be revised to SH, perhaps even SX, since the population has not been seen since 1885). |

The taxon is on the list of rare vascular plants in Canada and has a Canadian priority rating of 2 (Argus and Pryer, 1990). In Quebec, it is on the list of rare vascular plants (Bouchard *et al.*, 1983) and may be designated threatened or vulnerable (Lavoie, 1992). In New Brunswick, it is considered rare (Hinds, 1983).

II PROPOSED STATUS AND OTHER RECOMMENDATIONS

12. GENERAL ASSESSMENT

Polemonium van-bruntiae has a very limited range in Canada. Nine populations were recently surveyed, all of which are in Quebec. Seven of the populations were discovered in the past five years. Only two populations do not appear to be either threatened or vulnerable, while all of the others, except for one, are small. However, in our view, the short-term survival of the species is assured. Five sites are vulnerable to human activity and one site is probably exposed to natural threats. One population is in danger of disappearing. Several suitable habitats exist and have not been visited. Its rarity could be explained by the clonal and relic nature of the species and by its difficulties spreading in its habitat.

13. PROPOSED STATUS

In our view, the medium and long-term survival of *Polemonium van-bruntiae* is not assured, due primarily to the possible degradation of the majority of sites. The size and distribution of *P. van-bruntiae* populations in Canada and Quebec are limited, but the number of known populations is increasing. Action and further study are desirable to ensure its survival, particularly at Saint-Adrien. As a result, we recommend that *P. van-bruntiae* be designated a **vulnerable** species in Canada, in addition to being a "national natural treasure". [Note: see p. 4]

14. CRITICAL HABITAT

The preliminary categories of site (EOR) or population quality are difficult to determine for *Polemonium van-bruntiae* because little is known about its biology. However, because the species is largely clonal, a large numbers of stems may represent few genetic individuals. Thus, the population sizes recommended by the Nature Conservancy (Thompson, 1991) are relatively large. They are divided into the following four categories:

- A (Excellent): more than 10,000 stems covering 2 acres or more
- B (Good): more than 1,000 stems, covering 1 acre or more
- C (Fair): more than 100 stems
- D (Poor): fewer than 100 stems.

In Quebec, the Stoke No. 3 and Ham-Nord No. 6 sites are the only ones in category B. (The Saints-Martyrs-Canadiens (No. 9) site covers less than one acre, even though the population comprises roughly 1,000 stems.) The Saint-Adrien site (No. 7) is now in category D and the six others are in category C.

The sectors in which it would be desirable to conserve the quality of the sites, in our view, and that are often called buffer zones, are as follows:

[Note: Specific site information on 9 critical sites recommended by the authors are deleted from this report. This information is available through COSEWIC. Chairman, Plants Subcommittee, July 1994]

To our knowledge, none of the critical habitats for which we are recommending the conservation of the species is currently located on protected sites.

15. RECOMMENDATIONS RESPECTING CONSERVATION AND RESEARCH NEEDS

The authors' recommendations respecting the conservation of this species have been forwarded to the Quebec Department of the Environment (MENVIQ) and the Committee on the Status of Endangered Wildlife Species in Canada (COSEWIC). All enquiries concerning these recommendations should be addressed to MENVIQ or the COSEWIC.

MENVIQ

Francis Boudreau
Direction du patrimoine écologique
2360 Chemin Sainte-Foy
Sainte-Foy, Quebec
G1V 4H2

COSEWIC

Erich Haber
Chairman, Subcommittee for Plants
Botany
Canadian Museum of Nature
P.O. Box 3443, Station D
Ottawa, Ontario
K1P 6P4

The research needs should be focussed primarily on the biology and genetics of *P. van-bruntiae*, but also on the characteristics of his habitat, including:

- To what extent does the plant reproduce vegetatively as opposed to sexually and under what conditions?
- How are seeds dispersed and how do seeds germinate and produce mature plants?
- What is its genetic diversity? A genetics study would also settle the question of its taxonomy and phylogeny.
- What are its edaphic requirements (soil types, pH, moisture level, etc.)?
- Does woody encroachment cause decreases in population size and what are its needs in terms of light?

The Nature Conservancy (Thompson, 1991) mentions other points, but in our view they are less important (pollinators, grazing, etc.).

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17. OTHER RELEVANT PUBLICATIONS

None.

18. HERBARIA CONSULTED

The following herbaria were consulted:

CAN, DAO, MT, MTMG, NBM, QFA, QK, QUE, SFS and UNB. One specimen from the GH herbarium was examined.

19. FIELD RESEARCH

In 1991, André Sabourin and Denis Paquette, independent researchers and members of Amis du Jardin Botanique de Montréal, made three trips to the Eastern Townships and Bois-Francs regions of Quebec. In addition, Denis Paquette visited Trout Lake, near St. George, in southwestern New Brunswick on July 7, 1991.

The first trip to Quebec was made between June 28 and July 3. On July 28 and 29, we explored, with no success, the localities of Arthabaska, Black Lake, Coleraine and Beaulac. On June 30, we visited the three Ham-Nord sites, the Wotton site and Stoke site No. 1 with Philippe Forest. On July 1, we visited the Stoke site No. 2 and the localities of Saint-Zacharie, Lac Montjoie and Sainte-Catherine-de-Hatley. On July 2 and 3, we explored, without success, twelve sites in the RCMs of Coaticook (Boyton), Memphrémagog (Sainte-Catherine-de-Hatley, Ticehurst Corners, Griffin, Bunker Hill, Bunker Brook, Austin, Col-de-Bolton, Mansonville) and Brome-Missisquoi (Sutton, Sutton-Jonction, Bondville) and one last site at Bromont Est.

Our second trip was on August 15 and 16. On August 15, we visited sites at Saint-Christophe, Chesterville and Saint-Rémi-de-Tingwick before discovering the Saint-Adrien population. On August 16, we stopped at sites at Ham-Nord, Saint-Camille and Stoke Centre before seeing Stoke site No. 1 again.

The third and last trip was made on September 21. We explored several sites at Bromont and one site at Brigham.

In 1992, André Sabourin, Denis Paquette and Denis Sabourin made a trip to the Eastern Townships and Bois-Francs regions from July 10 to 12. On July 10, we explored, without success, Mont Garneau (west face) and the left bank (adjacent) of the Nicolet River, south of Arthabaska. We returned to the Saint-Adrien population (No. 7), then explored Rivière chez Larrivée, in the same locality and Développement-des-Sept-Chutes at Ham-Nord.

On July 11, we discovered the Saints-Martyrs-Canadiens population, then returned to the Ham-Nord populations (Nos. 4, 5 and 6), before heading to Weedon, near Lake Vaseux. On July 12, we visited Ruisseau Dufresne in Ham-Sud, and three sites in Wotton township. That same day, we discovered Stoke population No. 3 and returned to Stoke population No. 1.

20. RESOURCE PERSONS

1. Philippe Forest
555 Chemin de la Montagne
Saints-Martyrs (Beaulac), Quebec
G0Y 1B0

For his invaluable assistance in the field; he showed us 5 of the 9 known populations of *P. van-bruntiae*.
2. Stuart Hay
Marie-Victorin Herbarium
Institut de recherche en biologie végétale
de l'Université de Montréal
4101 Sherbrooke Street East
Montreal, Quebec
H1X 2B2

Assistant Curator at the Marie-Victorin Herbarium (MT). He corresponded with the herbariums consulted. He helped in the identification of several associated plants. An expert on rare plants, he provided us with comments on this report.
3. Francis Boudreau
Direction de la conservation et du
patrimoine écologique
Quebec Department of the Environment
2360 Chemin Sainte-Foy
1st Floor
Sainte-Foy, Quebec
G1V 4H2

Responsible for the grant obtained to produce this report.
4. Luc Brouillet
Marie-Victorin Herbarium
Institut de recherche en biologie végétale
de l'Université de Montréal
4101 Sherbrooke Street East
Montreal, Quebec
H1X 2B2

Curator at the Marie-Victorin Herbarium and expert on rare plants. He advised us for this study and commented on this report.
5. Gildo Lavoie
Direction de la conservation et du
patrimoine écologique
Quebec Department of the Environment
2360 Chemin Sainte-Foy
1st Floor
Sainte-Foy, Quebec
G1V 4H2

Expert on rare, threatened and vulnerable plants.
He provided comments on this report.

6. Colette Anseau
Rolland-Germain Herbarium
Faculty of Science
University of Sherbrooke
Sherbrooke, Quebec
J1K 2R1

Curator at the Rolland Germain Herbarium.
She provided us with the precious address of
Philippe Forest.

7. Denis Sabourin
255A De Normandie Avenue
Longueuil, Quebec
J4H 3P1

Amateur botanist.
He accompanied us in the field on
July 10, 11 and 12, 1992. He discovered part
of the Stoke (No. 3) population.

8. Erich Haber
Botany
Canadian Museum of Nature
P.O. Box 3443, Station D
Ottawa, Ontario
K1P 6P4

Chairman of the COSEWIC Subcommittee for
Plants

21. OTHER SOURCES OF INFORMATION

None.

22. MANAGEMENT OF RELEVANT DOCUMENTATION

The authors have conserved the reference documents and photographs used to prepare this study. They are available on request. The specimens collected, and collections of associated species, have been submitted to the Marie-Victorin Herbarium (MT).

IV AUTHORS

23. ADDRESSES

André Sabourin
34, 84th Avenue West
Blainville, Quebec
J7C 1W6
Tel. (514) 430-3616

Les Amis du Jardin botanique de Montréal
4101 Sherbrooke Street East
Ch 125
Montreal, Quebec
H1X 2B2

Denis Paquette
1478 Léveillé Street
P.O. Box 483
Prévost, Quebec
J0R 1T0
Tel. (514) 224-4677

Les Amis du Jardin botanique de Montréal
4101 Sherbrooke Street East
Ch 125
Montreal, Quebec
H1X 2B2

24. UPDATING OF THE STATUS REPORT

The authors assume responsibility for updating the status report of this species. Any new information, revisions or corrections should be sent to either one of the authors, who will then advise MENVIQ and COSEWIC.