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BIOGEOGRAPHY OF *HIERACIUM PILOSELLA* L. IN NORTH AMERICA WITH SPECIAL REFERENCE TO NOVA SCOTIA

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Hieracium pilosella L., mouse-eared hawkweed, is a common or frequently abundant weed of degraded pastures, lawns, cemeteries, roadsides, dunes, and other ruderal habitats in the Maritime provinces and New England. It was first reported from Michigan, yet it is still quite rare in the central United States, Ontario, and Quebec. Although numerous collections exist, especially for the St. Lawrence Valley, they usually represent the first collections for a particular region or county. *H. pilosella* is absent from rough overgrazed pastures in Leeds County, Ontario even where the soil characteristics, such as texture and pH, closely resemble those of Kings and Pictou Co., Nova Scotia, where the plant is abundant. In these latter counties, vegetative propagation is rapid. Each overwintering rosette, concurrent with flowering, produced (2) 5 ± 2 (9)* stolons which elongated during late June to early August at the rate of 1.1 ± 0.3 cm d^{-1} and each of which terminated in a new rosette which under favorable autumnal conditions produced a new set of stolons and rosettes. Regardless of treatment, less than 50% germination was observed.

Introduction

Hieracium pilosella L. is a weedy, rosette-producing hemicryptophyte (Fig 1) which produces 1, occasionally 2, leafless filiform flowering scapes in early summer. Concurrent with flowering, the Nova Scotian populations initiate (2) 5 ± (9) stolons which elongate from late June to early August at the rate of 1.1 ± 0.3 cm d^{-1}; each of these stolons terminates in a rosette which develops adventitious roots, and which, under favorable autumnal conditions, produces a new set of stolons and rosettes. Therefore, under optimum conditions, each overwintering rosette (genet) may add 20 ± 7 additional ramets to the population annually.

It is this basal rosette with its entire setose leaves, white stellate tomentum on the lower surface, and solitary yellow flowering head which serves to distinguish *H. pilosella* from other hawkweed species.

Chromosome counts on vegetative buds *i.e.* immature stolons collected from material growing along the Dominion Atlantic Railway at Wolfville, gave a value of $2n = 36$. Voucher specimens are at ACAD. (Herbarium acronyms follow Holmgren and Keuken (1974)). This count is similar to some European populations examined by Turesson and Turesson (1960); these workers also showed that tetraploid populations ($2n = 36$) are strictly apomictic.

To substantiate distributional data found in the North American Floras, herbarium specimens were examined at ACAD, QFA, SFS, MTMG, CAN, DAO, QK, TRT, MICH, NYS, GH, NY, US, NCU, and GA. These records indicate that *H. pilosella* was introduced into North America from Europe during the late 19th century. The earliest known record is from northern Michigan, where it was collected by Clark near Benzonia, in Benzie County in 1861 (MICH) and recollected by Voss in 1975 (MICH). Other early stations are London, Ontario, where it was collected successively in 1878, 1879, and 1882, west central New York State in 1883 and 1888, and Prince

*Brackets indicate range, ± one standard deviation.

Fig. 1 Herbarium specimen of *Hieracium pilosella* (ACAD).

Edward Island, where Macoun (1890) reported it to be "completely naturalized" and "very common along road-sides, covering the backs of dykes and the borders of the fields in many parts of Prince Edward Island". Note, however, its absence from pastures.

The inland locations of these early populations, with the exception of Prince Edward Island, suggest that the mode of entry from Europe was not as seed contaminants but rather as packing material, since the provenance of these early collections were cemeteries, lawns, and ruderal habitats.

By 1900 *H. pilosella* had established itself throughout eastern North America in small isolated populations (Fig 2). From 1900 to 1940 *H. pilosella* continued to extend its range, as well as spreading from these founding populations, resulting in many new populations becoming established to form a continuous distribution pattern. By 1937, botanists were finding it in pastures in Nova Scotia and Prince Edward Island. From 1940 to 1970, no further range expansion was observed but local establishment of populations continued, and is continuing especially along the St. Lawrence River system. Figure 2 also shows present Canadian distribution.

The major distortion (which is inherent in any dot map) of this distributional map is that it gives no indication of commonness or rarity of the species. For example Thomas (1972 and *in litt.*) found only 4 small patches of *H. pilosella* within his study area in Wellington County, Ontario whilst in Nova Scotia the plant has become common throughout rough and degraded pastures since its introduction into the province 60 years ago at Pictou (Roland & Smith 1969).

Materials and Methods

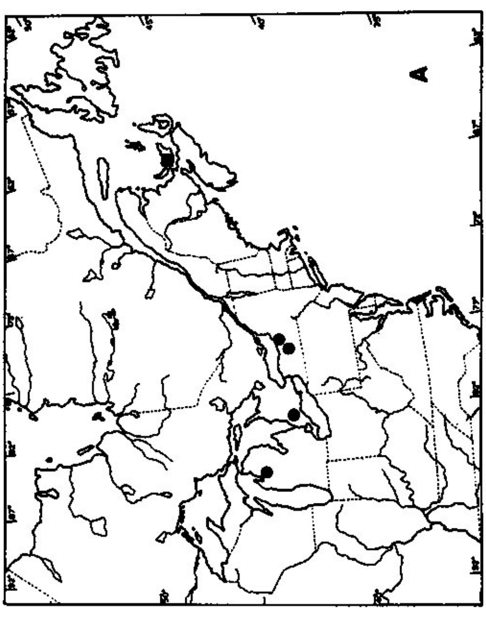
To verify these observations on the commonness and rarity of *H. pilosella* populations, a survey of the vegetation of 4 degraded pastures in Nova Scotia was compared to that of 4 degraded pastures in eastern Ontario.

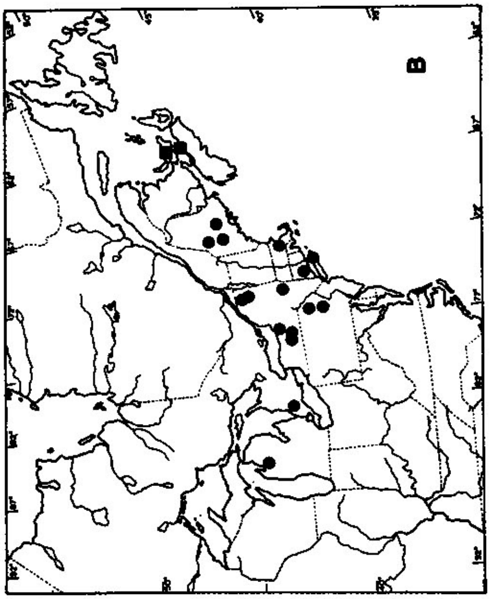
The Nova Scotia sampling sites were located at West Branch, Pictou County and Gaspereau, Kings Counties; here the soils were gravelly and had a pH of 3.7 to 4.8. The Ontario sampling sites were located near Elgin, Leeds Co. where thin, partially developed soils cover potsdam sandstone pavements; these soils had a pH of 3.7 to 4.8. The other Ontario sampling site was a granite boulder field (soil pH 3.9 - 5.3) between granite outcroppings at Perth Road, Frontenac County.

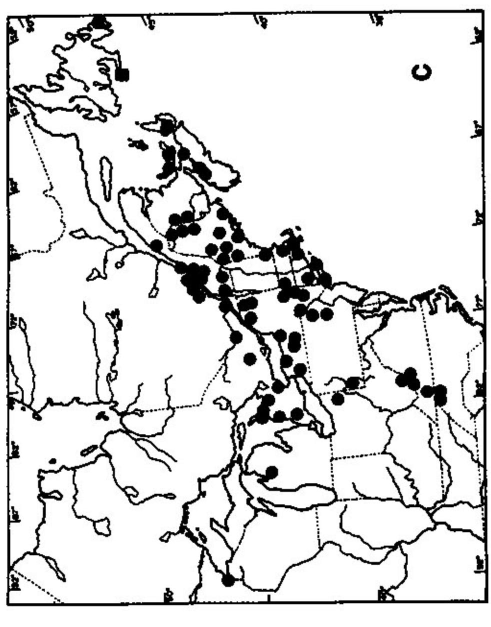
Frequency of occurrence was assessed by recording plants at dm intervals along 50-m line transects selected at random. Bare ground and litter was recorded as a unit if no species occurred at any given dm-internal point on the transect. Where *H. pilosella* occurred in the pasture, its cover was estimated by throwing 20 quadrats (m^2) at random. The quadrat was gridded at 5 cm intervals (avg of rosette) and the number of rosettes counted from each point intercept. Finally, achenes from 30 to 50 mature capitula were collected for field and *in vitro* germination trials from the following localities: (1) a dune system at West Mabou Harbour, Cape Breton Island; (2) a degraded pasture at West Branch, Pictou Co.; (3) along the dykes at Wolfville, Kings Co.; (4) roadsides of highway 12, south of New Ross, Lunenburg Co.; (5) edge of a poplar regeneration forest, Caledonia, Queens Co.

Achenes were collected from late June through July 1975, 1976 and 1977, stored immediately in envelopes, placed in sealed mason jars, and kept at 1° to 2°C for 1 to 17 mo.

At Wolfville, 3 quadrats of m^2 were cleared along the DAR embarkment adjoining the Canada Vinegar Products Ltd facility; seed beds were prepared, and on the surface of the first quadrat 500 fresh achenes were scattered on 1 July 1975; on the sec-







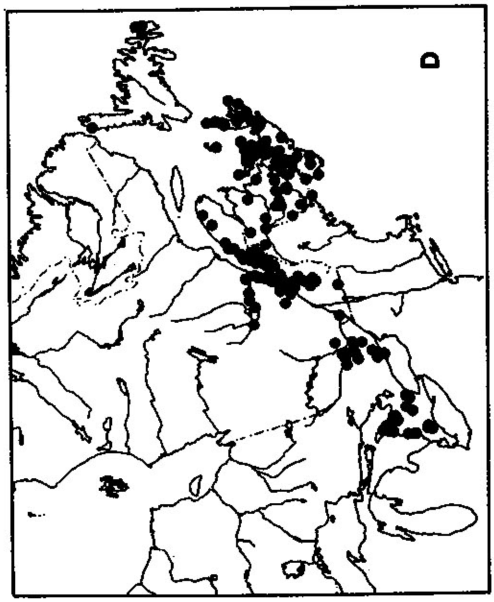


Fig. 2 A-C. Early North American occurrences of *Hieracium pilosella;* (a) 1861-90, (b) 1891-1900, (c) 1901-40; solid dot - herbarium record, solid square - literature record; (d) Canadian distribution of *Hieracium pilosella* based on specimens from DAO, CAN, ACAD, QK, TRT, NYS, NY, GH, MICH, MTMG, and OAC.

ond quadrat, 500 stored achenes were scattered 1 August 1975; and on 1 September, 500 stored achenes were scattered on the third quadrat. No parallel seeding trials were attempted in eastern Ontario, since I did not wish to introduce the Maritime biotype into a region where the species is quite rare and as yet not a pasture weed. Achenes from local populations were too few for any seeding trials.

Seed germination trials were conducted in a growth chamber. Five replicates of 50 seeds representing the five populations were placed on Whatman filter paper in petri dishes, kept moist and subjected to alternating temperatures of 10° and 20°C at a variety of lighting regimes: (1) 8 h light and 16 h dark; (2) 12 h light and 12 h dark; (3) 16 h light and 8 h dark; (4) 24 h light; (5) 24 h darkness. For the second trial, the light conditions were the same as above but, now the temperature alternated between 20° and 30°C.

Results and Discussion

Table I shows that not only is *Hieracium pilosella* absent from the 4 eastern Ontario overgrazed pastures drawn at random but, also that the species composition of the Nova Scotian pastures differs markedly from eastern Ontario. *Echium vulgare, Potentilla recta, P. intermedia, P. argentea, Solidago nemoralis, Poa pratensis, P. compressa,* and *Juniperus virginiana* did not occur in the Nova Scotia pastures sampled whilst *Festuca ovina, Picea glauca, Solidago puberula,* and *Chrysanthemum leucanthemum* did not occur in the Ontario pastures. But as pointed out, the soil texture and soil pH were similar for both regions, and both are in the same plant hardiness zone (Thomas 1953). However, Rowe (1972) has placed these areas into two different forest regions, *viz.,* eastern Ontario, which is part of the Great Lakes Forest Region, and mainland Nova Scotia, which is part of the Acadian Forest Region.

These differences in vegetation may have resulted from small but cumulative climatic differences between the regions such as described by Vander Kloet (1976) and which have given rise to the popular notion of maritime versus continental climates.

Regardless, *H. pilosella* has yet to become established in the rough, rocky, degraded pastures of eastern Ontario. In such a habitat on mainland Nova Scotia, the species is not only frequent but also has high, albeit variable cover values.

Initially, the 1975 field germination trials were not successful, but frequent showers in early September enhanced germination and on 10 September each quadrat, including the one sown on 1 September, had 2, 9, 3 seedlings respectively. Ten days later the seedling density was 37, 23, and 42 for 3 quadrats. By the end of the month, 18 seedlings were well established, the rest were destroyed by drought, high midday temperatures, and browsing.

The *in vitro* germination trials (1975 - 1977) were quite variable (Table II) but successful under all conditions except total darkness. For example, trial 1977, $n=7$, mean germination 19 $\pm$ 12/50 seeds; S.E. 3.3; variance 144. Some anomalies were also observed; achenes collected along the Wolfville dykes consistently had a higher germination rate than those from West Mabou Harbour. The remaining 3 populations gave more inconsistent results; 1976 seed from New Ross germinated quite well but not for the 1977 crop. The same applies *mutatis mutandis* to the Caledonia and West Branch populations.

In conclusion, *H. pilosella* diaspores, when dispersed in a degraded pasture in Nova Scotia, will germinate over at least a 3-mo period. *In vitro* experiments show that the radicle will emerge in 4 d minimum, cotyledons after 6 d, first true leaves after 17 $\pm$ 2 d, second true leaves after 22 $\pm$ 3 d, and an overwintering rosette can be produced in as little as 47 d (58 $\pm$ 13d is the mean). A single overwintering

Table I. Frequency of occurrence and percentage cover of *Hieracium pilosella* in degraded pastures in eastern Ontario and mainland Nova Scotia.

Species	Nova Scotia		Eastern Ontario	
	Pictou Co.	Kings Co.	Frontenac Co.	Leeds Co.
Hieracium pilosella	438 (63 ± 41%)	351 (26 ± 29%)	-	-
H. aurantiacum	-	1	47	69
H. floribundum	2	136	183	316
Taraxacum officinale	60	1	31	23
Antennaria neglecta	12	131	32	-
Solidaga puberula	13	6	-	-
S. nemoralis	-	-	17	3
Achillea millifolium	106	-	-	-
Chrysanthemum leucanthemum	10	43	-	-
Echium vulgare	-	-	47	31
Potentilla vecta	-	-	3	65
P. intermedia	-	-	42	24
P. argentea	-	-	17	173
Rumex acetosella	16	31	101	35
Vicia cracca	14	-	-	-
Rhinanthus crista-galli	-	12	-	-
Trifolium pratense	-	27	-	-
Festuca ovina	139	368	-	-
Poa pratensis	-	-	122	268
P. compressa	-	-	37	194
Danthonia spicata	145	211	283	122
Agrostis alba	792	153	214	22
Phleum pratense	-	12	7	38
Luzula multiflora	11	12	-	2
Juniperus communis	6	152	125	5
J. virginiana	-	-	38	-
Picea glauca	37	3	-	-
Polytrichum juniperinum	14	39	147	116
P. piliferum	18	23	20	-
Cladonia spp.	25	31	31	33
Byomyces roseus	11	5	-	-
litter, soil, rock	119	183	365	398
others*	12	37	91	63
Total points	2000	2000	2000	2000

*species with less than 5 occurrences each.

Table II. Germination trials of *Hieracium pilosella* from 5 populations in Nova Scotia (1975-1977)

Treatment		Percent germination	
		after 5 d	after 10 d
1.1 (250 seeds)	10-20°C; 8 h light	2	19
2.1 (250 seeds)	20-30°C; 8 h light	1.6	43
1.2 (250 seeds)	10-20°C; 12 h light	4	42
2.2 (250 seeds)	20-30°C; 12 h light	9	47
1.3 (250 seeds)	10-20°C; 16 h light	0.3	16
2.3 (250 seeds)	20-30°C; 16 h light	0.9	31
1.4 (250 seeds)	10-20°C; 24 h light	1	8
2.4 (250 seeds)	20-30°C; 24 h light	0.7	13
1.5 (250 seeds)	10-20°C; 24 h dark	0	0
2.5 (250 seeds)	20-30°C; 24 h dark	0	0

rosette, after producing a single capitulum (minimum) which contains 63 ± 24 achenes, will then begin to colonize the adjoining area by sending out 20 to 30 ramets resulting in a mosaic. I have measured patches up to 3 m in diameter. In Nova Scotia the species occurs in a large number of habitats, whilst in Ontario it is scarcely a successful ruderal. Since random sampling could not be used in Ontario, no generalization is attempted, but my suspicion falls on winterkill. The overwintering rosette is quite open and may be destroyed by heavy winter frosts but more experimentation is needed.

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