Meadow Salsify and Western Salsify—Two Rangeland Weeds of British Columbia

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Meadow salsify (*Tragopogon pratensis* L.), also known as meadow goat's-beard and Johnny-go-to-bed-at-noon, and western salsify (*T. dubius* Scop.), also known as western goat's beard, (Fig. 1) are increasing as rangeland weed concerns in British Columbia (B.C.). Both weeds are native to Eurasia and northern Africa and were introduced to North America at the beginning of this century as garden plants.

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Salsify—The Weed Problem

Meadow and western salsify seedlings become successfully established over a wide range of sites, including bare soil, vegetation, and deep litter (Gross and Werner 1982; Gross 1984). Both species produce extensive root systems which compete with desirable grass species for water and nutrients. Salsify interference has been shown to reduce the leaf area and shoot/root ratio of bluebunch wheatgrass, an important component of B.C. grasslands (D. McIlvride, unpublished results).

Meadow and western salsify are included in the Noxious Weed Lists

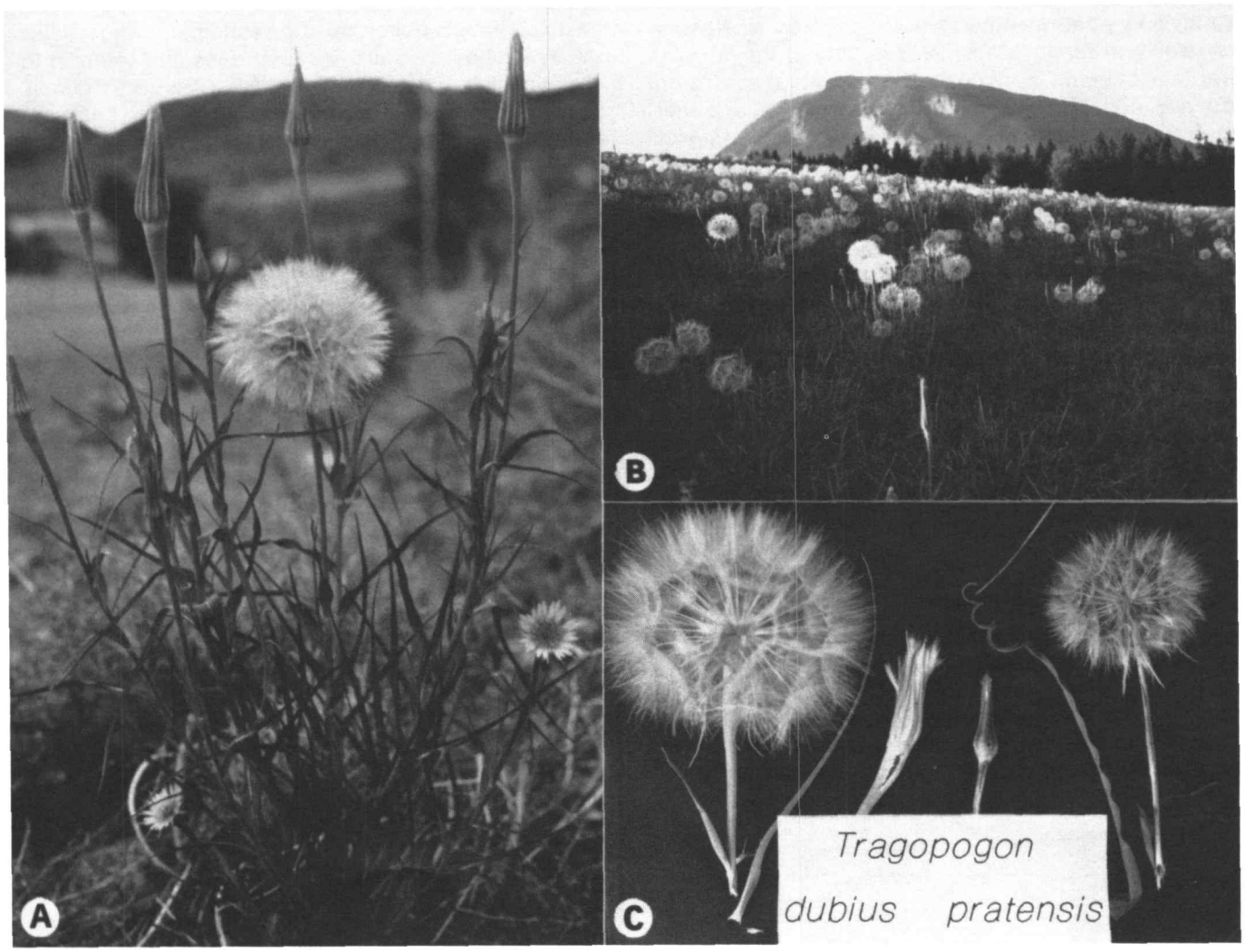

Fig. 1. *(a) A mature salsify plant. (b) Salsify seed heads ready to disperse seeds in infested rangeland. (c) Seed heads and leaves of western salsify and meadow salsify.*

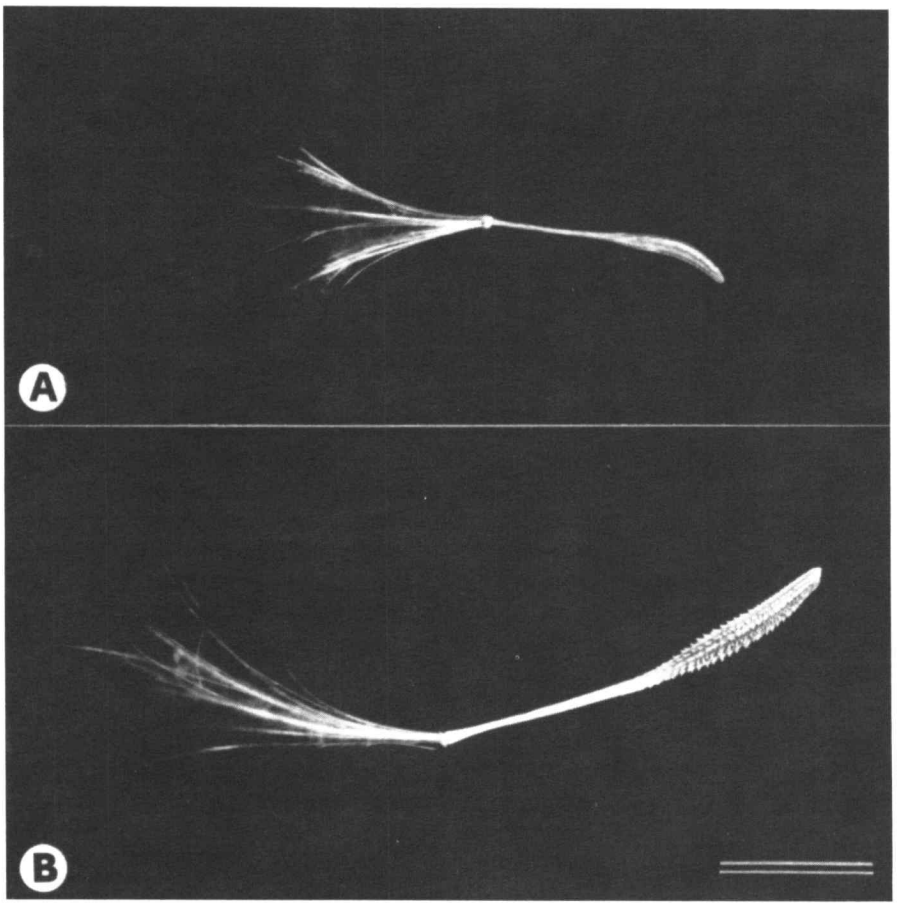

Fig. 2. *Seeds of (a) meadow salsify and (b) western salsify (Bar = 1 cm).*

under the Prince Edward Island, Ontario, Nova Scotia, and Manitoba Weed Control Act Regulations. They have not been added to the Noxious Weed List under the B.C. Weed Control Act Regulations.

Distribution and Habitat

Meadow and western salsify occur in all provinces of Canada, except Newfoundland. Western salsify is common in prairie provinces of Canada and meadow salsify in eastern Canada (Frankton and Mulligan 1970). In central and eastern Canada, the weeds are also found in limestone regions associated with pine forests.

In B.C., meadow salsify was first reported west of Kamloops Lake in 1919 (Royal B.C. Museum). It is currently distributed throughout the Cariboo-Chilcotin and Thompson-Nicola regions. Large populations of meadow salsify are present in the Riske Creek and Dog Creek areas near Williams Lake. In addition, the central Okanagan and Kootenay regions are becoming increasingly infested.

Western salsify was initially found in the Merritt region in 1923 (Royal B.C. Museum). Large infestations of this weed are present in the southern Kootenay region and throughout the Thompson-Nicola and Okanagan regions. The Cariboo region is relatively less infested by western salsify. Additional populations of western salsify have been identified throughout the southern half of Vancouver Island.

Meadow and western salsify have spead to a number of biogeoclimatic zones in B.C. with western salsify having a wider distribution (Taylor and MacBryde 1977). Both weeds are found in open park-like Douglas fir-bluebunch wheatgrass-sagebrush associations. They appear to be relatively shade tolerant and are found beneath ponderosa pine stands. They thrive on grasslands, meadows, forested areas, road sides and waste places and are found on soils ranging from sandy to clay loam.

Biology

Meadow and western salsify are herbaceous biennial or short-lived perennial species. Both species produce a rosette of upright, grass-like leaves. Large, bright yellow flower heads are formed in the second or subsequent years. In B.C., flowering occurs between June and July (Frankton and Mulligan 1970).

The probability of flowering in western salsify has been shown to increase with rosette size (Gross 1981). It has also been suggested that exposure to low temperatures may be needed before western salsify will produce flowers (Gross 1981).

Both salsify species produce two morphologically distinct seed types.

Table 1. Evaluation of herbicides for meadow salsify control in B.C.*

Treatment	Rate	Rating dates			
		85/07/11	86/07/09	88/07/14**	89/09/14**
	(kg a.i./ha)				
2,4-D amine	0.68	1.2***	0.0	0.0	0.0
2,4-D amine	1.63	3.0	0.0	0.0	0.0
Picloram	0.28	6.5	8.5	7.5	7.5
Picloram	0.56	8.2	8.8	8.8	8.5
Dicamba	1.00	6.8	7.8	4.7	2.7
MCPA amine	1.40	1.8	0.0	0.0	0.0
MCPA amine	2.10	3.6	2.0	4.0	0.0
Control	———	0.0	0.0	0.0	0.0

*From Cranston, et al. 1986.
**Cranston et al. unpublished data.
***Values (means of three replicates) are visual estimates of weed control on a 0 (no control) to 9 (complete control) scale. A rating of 7 or higher is considered commercially acceptable control.
Treatment plots (14.5 meter square) were established on rangeland near Riske Creek, B.C. on June 11, 1985. Treatments were applied with a hand held CO_2 sprayer at 220 kPa in 460 L/ha water. Meadow salsify plants were 20 to 25 cm in height.

Seeds produced from the outer ring of florets on the receptacle are darker, heavier, and less numerous than seeds produced in the centre of the receptacle. The dimorphic seeds differ in dispersal potential and may differ in germination characteristics (McGinley 1989). Light is not required for germination of western salsify seeds (Gross 1984). Maximum seedling emergence for both species occurs from seeds at a soil depth of 2 cm; seeds buried at 5 cm or deeper germinate but are unable to emerge (Qi and Upadhyaya, unpublished data).

Although very similar in appearance, meadow and western salsify can be distinguished. The leaves of meadow salsify are curled at the apex and crisped at the margin; the extent of this crisping and curling varies significantly in nature. The bracts of western salsify are longer than its flowers, and the flower stalk below the flower head is thick and hollow (Fig. 1c) (Frankton and Mulligan 1970, Alex and Switzer 1976). Seeds of western salsify are generally larger and heavier than seeds of meadow salsify (Fig. 2).

Hybridization frequently occurs between salsify species in nature. Therefore, meadow and western salsify provide ideal material for the study of evolutionary relationships as well as genetic and cytological phenomena.

Persistence of salsify appears to depend upon high seed production, effective seed dispersal, and seedling establishment. Both meadow and western salsify exhibit short-term innate (primary) dormancy. Secondary, dormancy can be induced by anaerobiosis (incubation in low oxygen atmosphere) in both species (Qi and Upadhyaya 1993). Secondary dormancy may discourage salsify seeds from germinating under conditions unfavourable for seedling growth. These weeds, however, do not generally maintain a large, persistent seed bank in soil (Gross and Werner 1982; Qi and Upadhyaya, unpublished data). McGinley (1989) found that western salsify produced 1 to 14 mature flower heads per plant, with each head (capitulum) containing from 20 to 127 seeds. Gross and Werner (1982) reported that wind dispersal of salsify seeds can occur over distances exceeding 250 meters. Effective seed dispersal by wind is ensured by the presence of a large, broad, flat pappus.

Table 2. Effect of herbicide treatments on meadow salsify control and grass yields in B.C.*

Treatment	Rate	Average weight	
		Meadow salsify	Grass
	(kg a.i./ha)	($g\ m^{-2}$)	
2,4-D amine	0.68	24.1	12.4
2,4-D amine	1.63	17.9	30.3
Picloram	0.28	8.5	94.9
Picloram	0.56	1.6	91.2
Dicamba	1.00	13.0	97.9
MCPA amine	1.40	24.9	32.1
MCPA amine	2.10	15.3	49.0
Control	---	30.5	21.6

*From Cranston, et al. 1986.
Grass and salsify plants were clipped in one square meter plots in each replicate and dried samples were weighed on July 18, 1988.
Values are means of three replicates.

Salsify Management

The flowering stalks and foliage of salsify are utilized by several vertebrates including deer, squirrels, and rabbits. Salsify is also a favoured dietary item for pocket gophers; the rodents may consume 20 to 80% of the primary root (Reichman and Smith 1991).

Salsify greens early in the spring and is utilized heavily by livestock at that time. Results of simulated grazing trials in the Chilcotin District (D.E. Blumenauer, B.C. Ministry of Agriculture, Fisheries, and Food, personal communication) have shown that intensive but short-term early season removal of salsify can reduce the weed density by 25 to 50 % after 3 years of clipping. Transect comparisons between areas grazed in early spring versus areas grazed in late spring show a similar density reduction when salsify is removed early.

Long-term (4-year) control of meadow salsify has been achieved with picloram herbicide at rates as low as 0.28 and 0.56 kg a.i./ha (Table 1). Short term (1 year) control is achieved with dicamba herbicide at 1.00 kg a.i./ha. In trials in British Columbia, both herbicides resulted in a significant increase in grass forage by reducing salsify competition (Table 2). Other herbicides tested (2,4-D amine at 0.68 and 1.63 g a.i./ha, MCPA amine at 1.40 and 2.10 kg a.i./ha) resulted in poor control (Tables 1 and 2).

Effective control of these weeds can be obtained with a combination of selective grazing and judicious herbicide use. Biological control and cultural management of these weeds should be a long-term goal. In North America, meadow salsify has been identified as a host of rust-causing fungus *Puccinia hysterium* (Parmelee and Malloch 1972). Whether this fungus can be used as a biological control agent for meadow salsify is not known.

Literature Cited

Alex, J.F., and C.M. Switzer. 1976. Ontario Weeds. Ontario Ministry of Agr. and Food, Pub. 505. Toronto, Ont.

Cranston, R.S., J.A. Woods, and D. Blumenauer. 1986. Meadow goatsbeard control on rangeland. Expert Committee on Weeds-Western Canada, 1986 Res. Rep. 3:69.

Frankton, C., and G.A. Mulligan. 1970. Weeds of Canada. Agr. Canada Dep. Agr. Ottawa, Pub. 948. 189-190.

Gross, K.L. 1981. Prediction of fate from rosette size in four "biennial" plant species: *Verbascum thapsus, Oenothera biennis, Daucus carota,* and *Tragopogon dubius.* Oecologia (Berlin) 48:209-213.

Gross, K.L. 1984. Effects of seed size and growth form on seedling establishment of six monocarpic perennial plants. J. Ecol. 72:369-387.

Gross, K.L., and P.A. Werner. 1982. Colonizing abilities of "biennial" plant species in relation to ground cover: implications for their distributions in a successional sere. Ecol. 63:921-931.

McGinley, M.A. 1989. Within and among plant variation in seed mass and pappus size in *Tragopogon dubius.* Can. J. Bot. 67:1298-1304.

Parmelee, J.A., and D. Malloch. 1972. Puccinia hysterium on *Tragopogon:* a new North American rust record. Mycologia 64:922-924.

Qi, M., and M.K. Upadhyaya. 1993. Seed germination ecophysiology of meadow *(Tragopogon pratensis)* and western *(Tragopogon dubius)* salsify. Weed Sci. in press.

Reichman, O.J., and S.C. Smith. 1991. Responses to simulated leaf and root herbivory by a biennial, *Tragopogon dubius.* Ecol. 72:116-124.

Taylor, R.L., and B. MacBryde. 1977. Vascular plants of British Columbia: A descriptive resource inventory. Tech. Bull. 4, The Bot. Gardens, Univ. of B.C. Press.