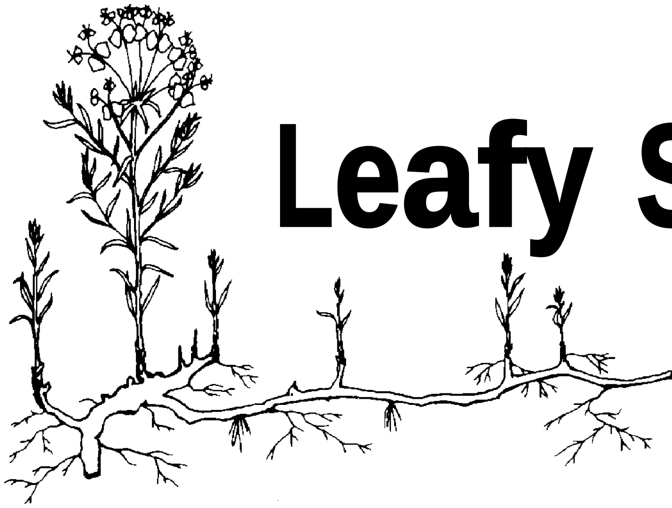

Leafy Spurge *News*

Agricultural Experiment Station
NDSU Extension Service
North Dakota State University, Fargo, ND 58105

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From the Editors Desk

Since the last issue I received a letter from one of our subscribers in Great Falls, MT who told me to discontinue sending him the **Leafy Spurge *News*.** He told me that there is no longer a need for it as he has exterminated leafy spurge from his small tract of land. He further stated that he got much help from the publication and that it is because of the information in it that he is now leafy spurge free. It is so nice to get such welcomed news now and then; makes the whole project worthwhile.

Elsewhere in this issue you will find some important information about the **1996 Leafy Spurge Symposium** to be held in Brandon, Manitoba, August 13-15, especially for those of you who plan to present a paper or a poster.

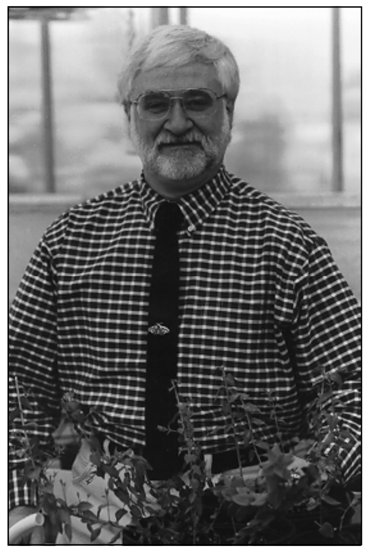
Don't forget to send me some material that I can include in the next issue for without your input it gets to be mighty slim pickings.

Professor Jay Leitch has just notified me that his group has just completed another phase of the leafy spurge economics work. I will include a summary of "Economic Analysis of Herbicide Control of Leafy Spurge in Rangeland" in the next issue. The complete larger report with the same name is AG Econ Report # 342. It can be obtained from him, Dept of Agric. Econ., NDSU, Fargo ND 58105-5636, (701) 231-7441, FAX (701) 231-7400.

When any of you have a change of address, please also include the old zip code with the new address as this is the way all addresses are listed in the computer.

LEAFY SPURGE HONOREE

Bob Richard is the Station Director at the USDA, APHIS, PPQ location in Bozeman, MT. At this location, APHIS focusses its work on the implementation of biological control of rangeland weeds. Bob's entomological career with USDA spans 25 years and has involved a variety of laboratory and field projects in the U.S. and foreign locations. It was this experience that led APHIS officials to select Bob to initiate the national field implementation activities for leafy spurge. In late 1986, APHIS established the Bozeman Station on the campus of Montana State University. Bob and a staff of five coordinate the biological control field activities on leafy spurge, diffuse and spotted knapweed, and purple loosestrife.



Bob Richard

In 1988, APHIS began its field efforts on leafy spurge with releases of insects in five states. Early activities centered around providing information about the project and obtaining cultures of approved insects to begin the process of establishing field insectaries. APHIS contracted with the International Institute of Biological Control (IIBC) in Delemont Switzerland as well as with the USDA, ARS European Station (then Rome, Italy) to collect insects from European sources. In addition, Bob organized APHIS field personnel for collection of insects from Canadian populations. These insects, although few in number, provided the source material for initial colonization of field insectaries. The approval of new agents and APHIS's concentrated efforts have paid off with hundreds of thriving populations in leafy spurge infested lands across the nation. In 1995, with the aid of APHIS State Plant Health Directors and their cooperators, tens of millions of biological control agents were collected from established populations and redistributed to new locations. Nineteen states, from New Hampshire to Washington, to New Mexico were active in the program this past year.

If you ask Bob what contributions and accomplishments he is most proud of, he is quick to point out that many people and organizations have made great contributions to the Biological Control of Leafy Spurge effort. For APHIS's part, "It has been a pleasure to be involved with the early implementation of biological control of leafy spurge, and it is a rewarding experience to know that nation-wide, we have provided many county, state, and federal personnel the opportunity to utilize biological control as a tool in their management considerations of leafy spurge."

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Systems Approach with Biological Agents for Leafy Spurge Control

The flea beetle, *Aphthona nigriscutis* Foudras, can be successfully integrated with herbicide treatment for control of leafy spurge. The compatibility of these methodologies (biological, chemical) is exemplified by an accidental overspray of established *A. nigriscutis*. The beetle population increased and leafy spurge density decreased the following season. The biological basis for this potential synergism will be investigated.

The effect of date of picloram and 2,4-D application on *A. nigriscutis* population in leafy spurge will be determined. This experiment will be conducted at two locations, Chaffee and Fort Ransom, North Dakota. Leafy spurge at Chaffee and Fort Ransom averaged 90 and 63 stems/m^2, respectively. Approximately 350 *A. nigriscutis* adults were released into 1.8- by 1.8- by 1.8-m screened cages on June 22, 1995. An additional 100 *A. nigriscutis* adults were released on July 14. Leafy spurge and *A. nigriscutis* will be oversprayed with picloram plus 2,4-D at 0.56 plus 1.1 kg ha^{-1}, respectively, beginning August 15 and continuing every two weeks until October 1.

The *A. nigriscutis* population will be monitored in three ways. First, adults will be collected from soil cores harvested in the fall. Second, *A. nigriscutis* larvae will be counted from soil cores harvested in the spring the following year. Third, adults will be collected in the spring from emergent trap chambers in the field.

Emergence of *A. nigriscutis* adults in the laboratory will be quantified with four soil cores taken from each *A. nigriscutis*-infested subplot. Soil samples will be harvested in late October with a golf-cup cutter. The soil cores will be 10.8-cm diameter to a depth of 15 cm and held at 3 C for 75 d. Each sample then will be placed into a 0.9-L plastic cup and covered by a clear plastic cylinder with a mesh top. Trap chambers with soil cores will be maintained in the laboratory at 21 C with a 16 h photoperiod. Adult *A. nigriscutis* will be collected and quantified for each soil core. The second estimate of population will be with soil cores harvested from *A. nigriscutis* infested subplots in the middle of May of the following yr. Two soil cores will be harvested from each subplot and dissected to quantify *A. nigriscutis* larvae. Adult emergence in the field will be evaluated using trap chambers. Trap chambers consist of 20-cm diameter and 20 cm-long PVC pipe recessed into the soil even with the soil surface. A mesh screen will cover the PVC pipe to capture adults. Two trap chambers will be placed in each *A. nigriscutis*-infested subplot.

Leafy spurge root material will be harvested in subplots not infested with *A. nigriscutis* to quantify carbohydrate and protein content. Root material will be collected beginning August 15 and continuing until soil freeze-up. Root samples also will be collected in April and May the following spring. Leafy spurge roots cannot be sampled in the presence of *A. nigriscutis* because larvae inhabiting root tissue will alter protein and carbohydrate quantitation. Quantitation of leafy spurge root material may explain potential differences in counts of *A. nigriscutis* adults and larvae across herbicide application dates. Root nutrients will be compared between caged and uncaged leafy spurge to determine the effect of caging on the chemical composition of roots.

The effect of *A. nigriscutis* larval feeding on picloram, 2,4-D, and photosynthate translocation in leafy spurge will be determined through a series of greenhouse studies. Leafy spurge plants will be subjected to *A. nigriscutis* larval feeding for 60 d prior to application of ^{14}C-2,4-D, ^{14}C-picloram, or ^{14}C-sucrose. Plants will be sectioned and combusted, with 14C tissue concentration determined by liquid scintillation techniques.

Data collected from the field experiment will illustrate the most beneficial herbicide application date over *A. nigriscutis* populations. Combined biological and chemical control will likely shorten the time needed to reduce leafy spurge populations to acceptable densities. In addition, integration will establish long term control, reduce chemical inputs, and reduce the economic losses on both private and public lands. The greenhouse experiments will clarify the biological basis for synergism between biological and chemical control observed in the field. Understanding the basis for this synergism may lead to the integration of additional biological and chemical control methodologies on noxious weeds.

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Relatedness of North American and European Leafy Spurge Based on DNA Markers

Chloroplast DNA restriction fragment length polymorphism (cpDNA RFLP) and random amplified polymorphic DNA (RAPD) data were collected for leafy spurge populations from North America, Austria, Hungary, the Czech Republic, Italy, Ukraine, and Russia. CpDNAs of individuals from six other European species of *Euphorbia* were also examined. Three restriction enzymes and six mung bean cpDNA probes were used to assess polymorphism among chloroplast genomes; five 9-mer primers were used for PCR amplification of leafy spurge DNA. Data were scored as presence or absence of bands and a dendrogram based on genetic distance was constructed among genotypes by a cluster analysis program.

A preliminary analysis of the data indicated that cpDNA genotypes of *Euphorbia amygdaloides*, *E. seguierana*, *E. helioscopia*, and *E. palustris* were easily distinguishable from those of leafy spurge, but *E. salicifolia* and *E. cyparissias* cpDNA types were indistinguishable from leafy spurge cpDNA with the markers used. There was some evidence that the cypress spurge, which was collected in Austria and Hungary, had cpDNA more similar to cpDNA of leafy spurge from the same geographic area than to leafy spurge cpDNA from other countries.

Greater genetic variation was found among European leafy spurge cpDNAs than among cpDNAs from North America. Most North American leafy spurge cpDNA genotypes clustered closer to Russian, Ukraine, and some Czech cpDNAs, while one North American cpDNA genotype that was heavily represented in the sample showed greater similarity to types from Austria and Hungary. Italy had the most divergent cpDNA types. RAPD analysis demonstrated the greatest relatedness among individuals within a population of leafy spurge. The European population that showed greatest similarity to North American leafy spurge was the Russian population; Italy was the most divergent population.

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Intensive Grazing of Angora Goats on Leafy Spurge Infested Rangeland.

Utilization and control of leafy spurge by angora goats were determined in 1991 through 1995. Project objectives were to determine 1) if intensive seasonlong grazing of angora goats will significantly reduce stem and herbage density of leafy spurge, and 2) determine if seasonlong grazing leafy spurge with angora goats will increase grass density in leafy spurge infested rangeland.

The study was conducted on a 6.1 hectare parcel located on Camp Grafton South in southeast Eddy county adjacent to the east shore line of North Twin Lake in Sec. 4, T 148 N, R 63 W. The study site was situated on a west-facing slope with the plant communities classified. These plant communities were classified as high, mid, and low prairie, and open woodland.

Angora goats were stocked at 0.14 ha/AUM in 1991, 0.34 ha/AUM in 1992 and 1993, and 0.49 ha/AUM in 1994. Leafy spurge and brush stem densities were collected in the third week of May in 1991, 1992, 1993, and 1994 and early June in 1995 to determine overall change in plant numbers using 0.1 m^2 plots on four replicated line transacts. Overall degree of use of leafy spurge, grass and brush were determined using the paired-plot clipping technique. Each year was tested to determine number of years required to significantly ($P<0.05$) reduce leafy spurge stem counts.

Leafy spurge stem densities were reduced 12.5 % ($P>0.05$) after one year, 39.9 % ($P<0.05$) after two years, 53.7% ($P<0.05$) after three years, and 84.2 percent ($P<0.05$) after four years of grazing. The shrub stem densities were significantly ($P<0.05$) reduced by 91.6 % after four years of grazing. No significant ($P>0.05$) changes in relative frequency of leafy spurge and grass herbage production occurred after two years of grazing, however, after three years of grazing leafy spurge was significantly ($P<0.05$) reduced and graminoids significantly ($P<0.05$) increased.

The leafy spurge and shrub components were extensively grazed during all four years of the study. Degree of use by goats on leafy spurge was 64, 92, 97, and 91 % in 1991, 1992, 1993, and 1994, respectively. Shrub degree of use was 94, 92, 89, and 81 % in 1991, 1992, 1993, and 1994, respectively. Intensive seasonlong grazing of angora goat on leafy spurge infested rangeland significantly reduced leafy spurge stem densities after two years of grazing. Leafy spurge herbage production was significantly reduced and graminoid species significantly increased after three years of seasonlong angora goat grazing.

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Integration of Herbicides with Grazing for Leafy Spurge Control

An experiment to evaluate herbicide treatment with grazing to improve long-term leafy spurge control compared to either control method alone was established in May 1992 on the Sheyenne National Grasslands and the Gilbert C. Grafton South State Military Reservation. The six treatments included a) grazing alone, b) picloram plus 2,4-D at 0.5 plus 1 lb/A fall applied, c) grazing in spring followed by picloram plus 2,4-D at 0.5 plus 1 lb/A fall applied, d) picloram plus 2,4-D at 0.25 plus 1 lb/A spring applied, e) picloram plus 2,4-D at 0.25 plus 1 lb/A spring applied followed by grazing of fall regrowth, and f) an untreated control. Leafy spurge was rotationally grazed at the Sheyenne National Grasslands but grazed season-long at Camp Grafton South.

The fencing necessary to prevent or delay grazing was established in May 1992 and leafy spurge density evaluated. The herbicides were applied in June or September in 1992 and 1993 for the spring- and fall-applied treatments, respectively. Leafy spurge root material for carbohydrate and protein content analyses was harvested in October 1992 and 1993.

Grazing combined with fall-applied herbicide treatment reduced leafy spurge density more than grazing alone. Also, season-long grazing as used on Camp Grafton South, either alone or combined with herbicides, reduced leafy spurge more than rotational grazing used on the Sheyenne National Grasslands. The best treatments averaged over both locations was picloram plus 2,4-D applied in the fall alone or preceded by spring grazing. These treatments reduced the stem density from an average of 16 stems/0.25 m^2 in 1992 to 0.3 stem/0.25 m^2 or 99% control in 1994.

Grazing alone reduced leafy spurge 74% at Camp Grafton South but had no effect at the Sheyenne National Grasslands. The difference in control is likely due to the type of grazing management. Continuous season-long grazing prevents the plant from restoring root nutrients because they are needed to restore topgrowth. However, rotational grazing apparently encourages bud growth from the roots after the first grazing cycle and without immediate regrazing, sustains a stem density similar to the untreated control.

Picloram plus 2,4-D spring-applied provided 96% control at Camp Grafton South, but only 62% control at the Sheyenne Grasslands after two treatments. The average control with picloram plus 2,4-D at 0.25+1 lb/A for many experiments in North Dakota is 65% after two treatments. A spring-applied herbicide treatment followed by fall grazing increased leafy spurge density at Camp Grafton South slightly compared to the herbicides applied alone. At the Sheyenne National Grasslands the stem density increased from an average of 10 to 16 stems/0.25 m^2 when spring applied herbicides were followed by fall grazing compared to the herbicides used alone. The reason for the increase in leafy spurge density when leafy spurge is grazed following a herbicide treatment is not known.

The effect of grazing and herbicide treatments alone or in combination on leafy spurge root nutrient content was minimal after 2 years. All treatments reduced the root protein content at Camp Grafton South compared to the untreated control. The sucrose concentration in leafy spurge roots was similar regardless of treatment. However, the starch concentration declined by 60% in the grazed only and spring grazing followed by picloram plus 2,4-D fall-applied treatments compared to the control.The sucrose and starch concentration in leafy spurge roots at the Sheyenne National Grasslands in 1993 after two growing seasons was similar regardless of treatment. However, the protein content was reduced by 67% in the grazed only treatment compared to the control even though stem density was high in the grazed plots. No other treatment affected root protein content at the Sheyenne National Grasslands after 2 years.

In summary, season-long grazing by goats reduced leafy spurge stand density but rotational grazing had no effect. Picloram plus 2,4-D applied in the fall alone or following grazing in spring were the best treatments averaged over location and resulted in 98% leafy spurge control. However, the effect on root nutrient content was inconsistent.

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Expansion of Aphthona nigriscutis from Rangeland onto Chemically Treated Irrigated Pastures

Initial releases of *Aphthona nigriscutis* in 1990-93 on several different irrigated and sub-irrigated sites in Fremont County, Wyoming were not successful. Releases on nearly dry rangeland sites established quickly and by 1994 individual releases had spread to cover several acres where the leafy spurge was significantly reduced. However the control stopped at the irrigation ditch which was heavily populated with leafy spurge. We concluded that this insect would not tolerate the higher moisture associated with irrigation. The pasture was being sprayed twice a year with 2,4-D to maintain the grass.

In 1995, the leafy spurge on the irrigation ditch was reduced to last year's stalks and throughout the summer it was possible to find *A. nigriscutis* on leafy spurge plants all across the pasture. Several photos were taken of adults feeding on spray damaged plants. The stand of leafy spurge in the pasture was thin. Beetles had to travel hundreds of feet between plants in some cases. By the end of the summer beetles were observed hundreds of yards from the rangeland release sites. It may turn out that *A. nigriscutis* is more accepting of wet habitats than originally thought and has great potential in our climate for the control of leafy spurge.

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Chamaesphecia hungarica – Current Status of Quarantine Clearance & Field Establishment

Chamaesphecia hungarica, a member of the Aegeriidae family, is a clear-winged moth native to southeastern Czechoslovakia, Austria, Hungary, Serbia and Croatia. In Europe it is usually found in moist loamy soils and partial shade near riverbanks, swampy areas and ditches. Adults emerge from mid May to late July depending upon climatic conditions at the site. Mating usually occurs within 24 hours. Larvae mine the stem and move into the pith area. Larvae overwinter in the roots and migrate to the stem base in spring where pupation occurs. The International Institute of Biological Control, Delemont, Switzerland collected larvae infested roots in Serbia and shipped them to the United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine Laboratory (USDA-APHIS-PPQ) quarantine laboratory at Mission, Texas.

The material was placed in moistened soil and maintained at a temperature range of from 20ºC to 25ºC. Upon eclosion of adults, sampling was performed for pathology examination and identification verification. Some adults were directly transported and released at field sites, others were mated in quarantine and eggs deposited onto plants or paper. Infested plants and eggs were transported to the field site in Montana where releases were made by the USDA-APHIS-PPQ, Bozeman Biological Control Facility. The first recovery of this species was made at the Montana release site in September of 1994. Identification of the recovery was verified by the Systematic Entomology Laboratory, Beltsville, MD. Another recovery was made in late June 1995.

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Report on Leafy Spurge Biocontrol in Alberta

A report on "Biological Control of Leafy Spurge in Alberta: Progress and Prospects" by McClay, A.S., D.E. Cole, P. Harris and C. J. Richardson has been published by Alberta Environmental Centre, Vegreville, AB. 63 pp. AECV95-R2. ISBN 0-7732-1688-X.

This report summarizes the current status of biological control of leafy spurge in Alberta. It describes the nature and extent of leafy spurge infestations in the province, and summarizes the biological control efforts undertaken from 1978 to 1994. The most successful agent has been ***Aphthona nigriscutis***, which has been released at over 120 research sites and is proving effective in reducing leafy spurge densities on dry, open sites. The report provides data on the habitat requirements of ***A. nigriscutis*** and its effects on leafy spurge populations. Colour illustrations are provided of all the biocontrol agents released in Alberta and the effects of ***A. nigriscutis*** over a 6-year period at one site.

This report is available at a cost of $15.00 (Canadian, this includes postage and handling) from Communications, Alberta Environmental Centre, Bag 4000, Vegreville, Alberta T9C 1T4, Canada.

Effect of Leafy Spurge Biotype and Herbicide Application on Aphthona spp. Establishment

The timing of herbicide treatments on *A. nigriscutis* and *A. czwalinae* survival and establishment was evaluated. Two locations of *A. nigriscutis* and one location of *A. czwalinae* were established. The treatments included picloram plus 2,4-D at 4 plus 16 oz/A spring applied picloram plus 2,4-D at 8 plus 16 oz/A fall applied, and *Aphthona spp.* alone. Stem density was evaluated in the spring, and adult sweep counts were conducted through the summer. For the first experiment, *A. nigriscutis* were released in 1989 and herbicide treatments were initiated in spring (June) of 1992 at Cuba. Stem density in the insect-only treatment declined by 97% from 1992 to 1995. The most rapid control was from the insect plus fall-applied herbicide treatment which resulted in a 97% decline in leafy spurge stem density in only 2 years. The spring-applied herbicide plus insect treatment reduced leafy spurge less than the insects alone. The *A. nigriscutis* population in the non-herbicide treatments increased from 11 beetles/m^2 in 1992 to 125 beetles/m^2 in 1994 but the declined to an average of 70 beetles/m^2 in 1995 as leafy spurge stem density declined. The *A. nigriscutis* population averaged 76 beetles/m^2 when herbicides were spring applied but only 30 beetles/m^2 when herbicides were fall-applied as very little leafy spurge remained in those plots.

Similar experiments were started in 1993 with 3000 *A. nigriscutis* released at the Ekre Research station near Walcott and 30,000 *A. czwalinae* released at Camp Grafton South, near McHenry. As in the previous experiment, *Aphthona* spp. combined with a fall-applied herbicide treatment resulted both in better leafy spurge control than either control method used alone and a more rapid increase in the flea beetle population.

The establishment and movement of *A. nigriscutis* on leafy spurge patches is currently being evaluated. *A. nigriscutis* was released as 100, 200, 300, 400, or 500 adults per site along a 2.5 mile stretch of the Burlington Northern railroad right-of-way near Buffalo. The insects were released in dense stands of leafy spurge on June 28, 1993. Stem density and adult flea beetle population and spread have been determined annually in June. *A. nigriscutis* flea beetles were found at all release sites 1 year after release, and leafy spurge stem density began to decline in 1995, which was 2 years after release. In general, the greater the original number released, the more rapid the decline in stem density. The greatest leafy spurge decrease was from 17 stems/0.25 m^2 in 1993 to 10 stems/0.25 m^2 in 1995 when 500 insects/site were released. The insects had spread an average of 55 feet from the release site when 500 insects/site were released but only an average of 25 feet when less than 500 insects/site were released.

The survival of *A. czwalinae, A. flava,* and *A. nigriscutis* was evaluated on leafy spurge biotypes from Austria, Manitoba, Montana, Nebraska, North Dakota, South Dakota, and Wyoming. The seven biotypes were grown in a greenhouse for 4 to 5 months in 2.5-by 8-inch pots. These pots were planted directly outside in April. The pots were arranged in a RCB design with 12 replications in a 36 ft^2 area. Cages were placed over the experiments and 200 *Aphthona* spp. were released. The pots were dug in November, placed in a cooler at 3 C for 8 wk, and then placed under greenhouse lights (16 hr) at 24 C.

The greatest number of *Aphthona* adults emerged from a Nebraska leafy spurge biotype followed by biotypes from Austria and South Dakota. The least number of adults emerged from biotypes from North Dakota and Montana. These are the same biotypes that, in previous research, had the greatest (NE, AU, and SD) and least (ND and MT) number of galls and larvae per gall when exposed to the leafy spurge gall midge (*Spurgia esulae*).

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Wyoming Forms Biogical Control Steering Committee

A committee has been established in Wyoming to guide and coordinate biological control efforts in the state. The Wyoming Weed and Pest Council provides the basic structure and administrative support for the committee which invites participation from all interested parties in the state. Regular membership includes seven people from the Council and representatives from the University of Wyoming, Wyoming State Land Office, Wyoming Department of Agriculture, Wyoming Game and Fish, Bureau of Land Management, Bureau of Indian Affairs, and USDA/APHIS/PPQ. The mailing list covers a broad range of persons and agencies. The committee was established to administer a WDA grant for biological control agent redistribution, and serves as a collection site for contributions to international biological control consortiums, IIBC, and the University of Wyoming biological control efforts.

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Be in Brandon in 1996 for the Symposium with a Canadian Twist

Planning has begun for the 1996 Leafy Spurge Symposium in Brandon, Manitoba! Brandon is nicknamed the capital of western Manitoba. It is situated 200 km west of Winnipeg, approximately 300 km north of Minot, North Dakota.

A tentative Symposium schedule has been drafted. The organizing committee is working hard to achieve a good balance of formal and informal gatherings. Paper and poster sessions and a field tour constitute the formal information exchange. A barbeque, Texas scramble golf game (absolutely no skill required), and a tour of Brandon's Agricultural and Agri-Food Canada Research Station will represent some of the informal gatherings planned.

While in the area, be sure to take in the many sites Brandon and western Manitoba have to offer. Bring the family cause there is so much to do and see. Brandon is home to two shopping malls, Commonwealth Air Training Plan Museum, 26th Field Artillery Regiment Museum, Sportplex with an olympic size swimming pool, Art Gallery of Southwestern Manitoba, Thunder Mountain Water Slide Park, (including children's slides), 3 miniature golf courses, and 2 golf courses.

Be sure to take addvantage of the great fishing and hiking available at Riding Mountain National Park (Clear Lake), Spruce Woods Provincial Park, Family fun centres, Canadian Forces Base (CFB Shilo), and an Ostrich farm just to name a few attractions. Spruce Woods Park is home to the Spirit Sands, the only desert in western Canada. The International Peace Gardens are just a short distance away.

Registration for the Symposium will begin on the morning of Tuesday, August 13th. Registration fee will be $70 Canadian ($50 US), and will include lunch and dinner on Wednesday, August 14th. Anyone interested in booking accommodations may do so by calling the Victoria Inn at **1-800-852-2710** and quoting identification number **29477**.

To help with agenda planning, I would encourage anyone who is interested in presenting a paper or poster to please notify Carla Pouteau phone **(204) 745-2324** or Fax **(204) 745-2299** as soon as possible. A formal call for papers will appear in a future issue of **Leafy Spurge *News*** along with more registration information.

Defoliation Effects of Leafy Spurge on Sheep Microoranisms

Most herbivores avoid the noxious weed leafy spurge when grazing. However, some ruminants, including sheep, will consume leafy spurge, albeit only up to 50% of their total diet, possibly because of the presence of adverse phytochemicals. Our objectives were to assess the presence of phytochemicals in leafy spurge, and the effects of leafy spurge on sheep rumen microorganisms. We measured in vitro microbial gas production (microbial activity), purine accumulation (microbial mass), and dry matter disappearance as indicators of sheep rumen microbial response to leafy spurge. Primary growth and regrowth were collected on 9 June, 14 July, and 18 August 1994. Leaves, stems and flowers were analyzed using four ratios of leafy spurge and grass hay; 100% grass hay was used as a control. These materials were also analyzed for the presence of condensed tannins.

Overall, there was an associative effect by adding leafy spurge to grass hay. At 100% leafy spurge, microbial activity was slightly depressed compared with 75%, although microbial activity was higher than that of microbes consuming grass alone. In contrast, microbial mass was greatest at 100% leafy spurge. Dry matter disappearance was highest in flowers and leaves, and declined seasonally. Condensed tannins were highest in stem regrowth, and they increased seasonally. Our results indicate that sheep rumen microorganisms are not adversely affected by secondary defense chemicals in leafy spurge early in the growing season, however they are affected later in the growing season. Defoliation increased the production of secondary defense chemicals in stems of leafy spurge.

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USDA, APHIS Field Insectary Establishment & Redistribution of Leafy Spurge Biological Control Agents – How it is Working on a National Scale

APHIS has been involved in the implementation of biological control of leafy spurge since 1988 with initial efforts on a minor scale in four states. Since that time, it has been a focus of APHIS activity to establish Field Insectary Site (FIS) colonies of approved biological control agents (insects) targeted against leafy spurge in several states. Between 1988 and 1992, APHIS imported agents from populations in Canada and Europe. By 1993, collectable populations from US domestic sources made collection in Canada unnecessary.

Only recently approved biological control agents have been collected and imported from Europe through APHIS Quarantine in Mission, TX. In 1995 release of agents occurred in 19 states. Of the 9 species of USDA approved biological control agents for leafy spurge, only 3 were imported for initiating colonization in the US. They were *Aphthona abdominalis*, *Chamaesphecia hungarica*, and *Oberea erythrocephala*. The other 6 species have established well, and developing populations now are providing large numbers for collection and redistribution. Biological control agents for leafy spurge have been released in 180 counties in 19 states. Based on sampling of released insects during the 1994 field season, established populations exist in 131 counties in 15 states. Collectable populations exist in 35 counties (48 locations) in 11 states. Management of these thriving field insectaries are being turned over to coop-erators for their management and continued efforts in redistribution to new locations. Cooperators with APHIS include state departments of agriculture, university, county, and federal land managers with weed control responsibilities.

Technology transfer from APHIS to cooperators is being accomplished by development of field manuals and actual field training of cooperators by APHIS employees at field locations across the US. In 1995, cooperators utilizing the resources of APHIS field insectaries will collect and redistribute in excess of 5 million biological control agents of leafy spurge. APHIS will continue its effort to establish colonies of new biological control agents of leafy spurge. Biological control of weeds has been shown to be cost-effective, is self-sustaining, and environmentally sensitive. Use of biological control as an alternative, or to be used in conjunction with other management strategies, for the control of leafy spurge is now a reality in many weed infested areas in the US.

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