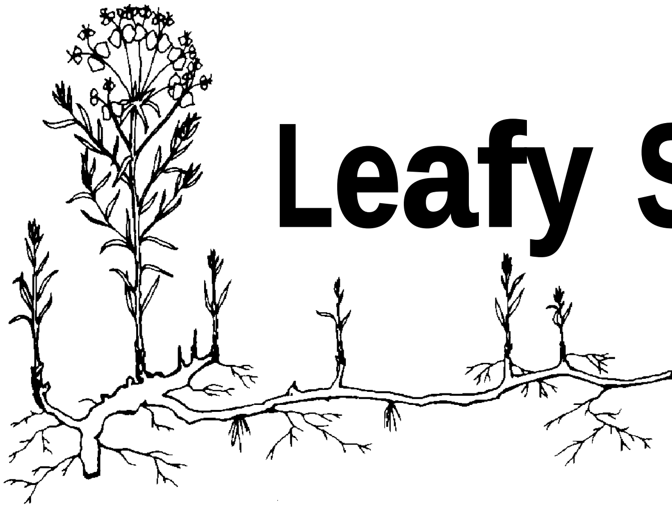

Leafy Spurge *News*

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

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From The Editors Desk

I just realized , with a start, that I am starting my fourth year as your editor! How time flies! This edition of **Leafy Spurge *News*** might be called an international edition. Our Honorees are Dr. Dieter Schroeder and Andre Gassman at the European Station IIBC in Delemont, Switzerland. Both these men have played an important part in the Biological Control of Leafy Spurge. In this issue there is a very important article by Dr. Peter Harris on the "Spurge Biocontrol Crisis" and what we all can do about it.

A few more of the papers given in Brandon, last July, are also included.

As was mentioned in the last issue, the next Leafy Symposium will be held in Wyoming. It will be held July 7-9 in Gillette, Wyoming at the Holiday Inn. If you have never been to this part of Wyoming you are in for a treat for nearly is the spectacular Devil's Tower National Monument. So please put those dates on your calendar. Dr. Mark A. Ferrell, Dept. of Plant, Soil & Insect Science of the University of Wyoming is the coordinator for the Symposium. All the details are in this issue. Please do not procrastinate, send in your registration as soon as possible and don't forget to call the Holiday Inn for reservations.

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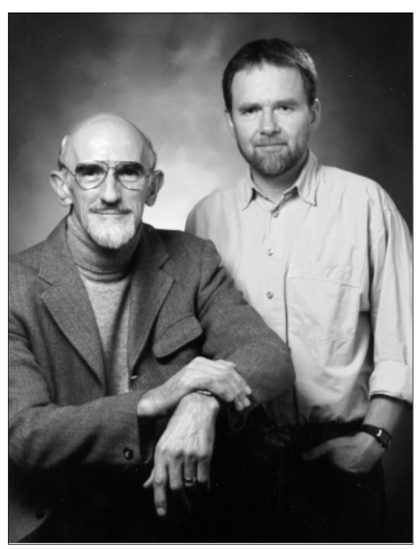
Leafy Spurge Honorees

The Search for Insect Biocontrol Agents to Control a Tough and Variable Target Weed

Work on potential biocontrol agents at the European Station IIBC (formerly CIBC) was started by Dieter Schroeder in 1968 with screening the root-boring clearwing moth *Chamaesphecia empiformis*. This work not only resulted in the discovery of a new sibling species, *C. tenthrediniformis*, but also revealed that the North American leafy spurge, *Euphorbia esula* (sensu lato), is not identical to the European *E. esula* (sensu stricto). This was confirmed by the fact that *C. tenthrediniformis*, closely associated with *E. esula* in Europe, did not attack *E. esula* in North America. This was an important discovery redirecting the search for other potential control agents.

After an interruption of seven years, the next agent studied was the stem- and root-boring cerambycid *Oberea erythrocephala*. Releases in Canada (1979) and the USA (1980) resulted only in establishment at some sites in the USA. Thus, the search had to be continued.



Dieter Schroeder and André Gassmann

The key year in foreign exploration for insect biocontrol agents of leafy spurge was 1978 when we started a survey for leaf beetles in genus *Aphthona* in Central and southeastern Europe. Of the species found, four were selected for closer investigation and host range screening, i.e. *A. cyparissiae*, *A. flava*, *A. nigriscutis* and *A. czwalinae*, and this work was started by young PhD, Gisela Sommer, in 1979, and continued by André from 1981 onwards. It was the year when André became “Mr. Leafy Spurge” at our station, and he remained it since. Apart from screening *Aphthona* species and collecting and shipping control agents to North America, André studied in depth the complex of stem mining *Pegomya* spp. as subject for his PhD thesis which he successfully defended in early 1990.

After the failure of the earlier released *Chamaesphecia* species and of *O. erythrocephala*, the detailed analysis of the complex of *Chamaesphecia* spp. associated with various European spurge species became the second focal point in the search for leafy spurge biocontrol agents. This work, partly in cooperation with colleagues of the USDA-ARS European Biocontrol Laboratory, resulted in the more recent establishment of *C. crassicornis* and *C. hungarica*. Unfortunately, two *Chamaesphecia* species from northern China did not accept N.A. leafy spurge as host plant. Species in this genus are just too host specific.

Over the past 28 years we studied and screened some 25 species of potential control agents of which 12 have been field released in N.A., and 8 became established so far.

The results reported on successful biocontrol of leafy spurge in Canada and the northwestern USA, mainly by five of the six established *Aphthona* species, justify the expectation that this important rangeland weed can be brought under permanent control on dry open sites with well drained soils. The focus of more recent and present work is to provide agents for shaded and more humid habitats. Here again, greatest hopes are with additional *Aphthona* species, of which *A. lacertosa* is the first established. Research on leafy spurge biocontrol agents at our station will be stopped after termination of host range screening of *A. venustula*, *A. ovata* and *A. violacea*.

Work on leafy spurge biocontrol agents at our station has been possible due to the continued and increasing financial support by numerous sponsors, including Agriculture Canada, the Canadian Department of Defense, the Provinces of Alberta, Manitoba, Ontario and Saskatchewan, USDA-APHIS, USDA-ARS, and various agencies in Montana, North and South Dakota, and Wyoming, forming the Leafy Spurge Biocontrol Consortium. If as it seems, we shall see successful biocontrol of leafy spurge over larger areas in Canada and the United States, this should be seen as the result of overcoming separation and do a hard job together. We are grateful to all who supported us and who collaborated with us for many years. Thank you all!

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Insect Species Released in North America for the Biological Control of Leafy Spurge (1965-1995)

Species	Agent studied and screened by	Additional screening for introduction in the USA by	First release in Canada	First release in USA	Establishment in Canada	Establishment in USA
Chamaesphecia empiformis	IIBC		1970	-	no1)	-
Ch. tenthrediniformis	IIBC		1972	1975	no1)	no1
Ch. hungarica	IIBC		1991	1993	yes*	?
Ch. astatiformis	IIBC		1993	-	no1)	-
Ch. crassicornis	IIBC/USDA-ARS		1994	1994	?	?
Oberea erythrocephala	IIBC		1979	1980	yes	yes
Aphthona cyparissiae	IIBC	USDA-ARS	1982	1986	yes	yes
A. flava	IIBC	USDA-ARS	1982	1985	yes	yes
A. nigriscutis	IIBC	USDA-ARS	1983	1989	yes	yes
A. czwalinai	IIBC	USDA-ARS	1985	1987	yes	yes
A. lacertosa	IIBC		1990	1993	yes	yes
A. abdominalis	USDA-ARS		-	1993	-	?
Pegomya euphorbiae	IIBC		1988	-	yes	-
Hyles euphorbiae	CDA		1965	1968	yes	yes
Lobesia euphorbiana	CDA		1983	-	yes	-
Minoa murinata	CDA		1988	-	yes*	-
Spurgia esulae	USDA-ARS		1987	1985	yes	yes

* in field cages; 1) field releases interrupted
CDA: Canadian Department of Agriculture
IIBC: International Institute of Biological Control (formely:CIBC)
USDA-ARS: United States Department of Agriculture-Agricultural Research Service

Spurge Biocontrol Crisis

The Spurge Consortium (Agriculture & Agri-Food Canada, Alberta, Department of National Defense Canada, Saskatchewan, Montana, North Dakota and Wyoming) will suspend funding for screening new biocontrol agents for leafy spurge. The reasons are: 1) The present 4 year program is coming to an end. 2) there are several *Aphthona* spp. in the pipe line that will not be submitted for release approval as long as the only acceptable proof of safety is an inability to develop in a laboratory no-choice test. 3) There are enough agents available that the decision will not have an immediate effect on field programs in North America and further distribution of the existing species will define the habitats for which agents are still needed. However, it is already apparent there are habitats where the present species are ineffective and at least six *Aphthona spp. on Euphorbia* in Kazakstan, that should be pre-adapted to a northern prairie climate, remain uninvestigated. Thus the decision to suspend funding is regrettable.

This article discusses issues, with suggested solutions, that relate to the approval for the release agents for the biocontrol of weeds. In part it is an indirect contribution to the request by APHIS for input concerning new regulations. The three main problems, as I see them, relate to the US Endangered Species Act, to non-acceptance by TAG of a new screening method that would avoid the first difficulty, and to a need for restructuring TAG, which would avoid the second difficulty.

Problem # 1. The US Endangered Species Act of 1973.

Traditionally agent safety has been based on the inability of an insect to develop on desirable plants in no-choice laboratory tests. The test is an effective means of showing that plants distantly related to the weed are unsuitable as hosts, but it is poor at delineating an insect's host range on plants in the same genus as the weed because species that are not attacked in nature, will support development. This is a serious deficiency in view of the increasing public concern for natives plants and the Endangered Species Act of 1973 which requires all federal agencies to insure that their actions are "not likely to jeopardize the continued existence of an endangered or threatened species". An Australian study, Bell (1983) found that loss of habitat to agriculture and grazing was the biggest problem for endangered plants followed by competition from introduced weeds. The US Endangered Species Act can prevent the first problem, but it is a hinderance if the habitat loss is to an introduced weed. For example, the western prairie fringed orchid and, in Canada, the northern prairie skink are being displaced by leafy spurge as reported by Harris (1990). The difficulty arises because most introduced weeds in North America have native congenerics: leafy spurge has 120 and Canada thistle has 93 which tend to support agent development in no-choice tests. Thus it is not surprising that TAG has difficulty recommending release. Nevertheless, I find it ironic that the Endangered Species Act jeopardizes some endangered species by indirectly disallowing biocontrol.

Solution #1. Change the screening system to one that reflects the actual host range.

Host selection in an insect involved a series of steps such as habitat selection, host finding and acceptance for oviposition as well as acceptance for feeding and suitability for larval development (Harris and McEvoy, 1992). Selection in stenophagous species favours strong discrimination early in the sequence, as this minimizes time (and progeny) lost on inappropriate plants (Courtney and Kibota, 1990). A complete barrier at any stage or partial barriers at several stages, since their effects are multiplicative, renders the plant unsuitable as a host. For example, if survival on a test plant is 1% of that on its host and these individuals lay only 1% of the normal number of eggs, then the relative performance of the insect on the test plant is 0.0001. This is safer than a single barrier which is normally easily overcome, as demonstrated by many plant pathogens. To create durable resistance against pathogens, Nelson (1978) advocated building a pyramid of broad and narrow spectrum resistance genes. Following this logic TAG should automatically reject all petitions that have only investigated a single barrier to insect utilization of non-target plants even if the barrier appears to be absolute.

Testing the performance of an insect at various host selection steps relative to that on its normal host lends itself to risk assessment. Risk assessment according to Fowler (1993) is the process used to identify and estimate the statistical probabilities as well as consequences. In our case the event is the chance and consequence of utilization of a non-target plant. In a trial of risk assessment, Wan and Harris (in press) demonstrated that although the beetle *Altica carduorum* could develop on any *Cirsium* spp. in no-choice conditions, based on five criteria, its performance on North American *Cirsium* spp. was around a millionth of that on Canada thistle. Thus, beetles forced to develop on native thistles cannot sustain their numbers so the continued existence of native *Cirsium* spp. should not be compromised.

Risk assessment is required under the Canadian Plant Protection Regulations (Canada Gazette 1995) and in the proposed APHIS Rules (Federal Register 1995), which have been replaced by solicitation for ideas on new rules (Federal Register 1996). In the Canadian regulations, risk assessment is defined as a scientific review process to determine the likelihood of a problem arising. Insect performance on a test plant, which is clearly related to risk, can be quantified and if it is done for several independent criteria, it puts host specificity screening on a sound basis.

Problem #2. Risk analysis is not acceptable to TAG.
The study on risk assessment of *A. carduorum* was accepted by the Canadian Review Committee and eleven of fourteen TAG members. TAG consists of representatives from several agencies, each operating under their own rules, so it can be an orchestra playing 14 different tunes and approval requires unanimity. Its strength that the agencies with a major interest in the outcome of weed biocontrol are represented. Its weakness is that the representatives have little knowledge about insect behaviour. This is a serious deficiency since this knowledge is needed for assessing the risk to native plants. The reasons for the objections to *A. carduorum* by three members of TAG are not clear and so cannot be met by the researchers, although TAG has agreed to review the decision.

Solution #2. Prepare and publish rules for TAG, remove members who do not review reports promptly or attend regular meetings to thrash-out problems. Changes in policy and approval criteria to published so they are open to peer review.
TAG review of weed biocontrol agents is a serious and important duty. Insects cost at least 2 scientist years ($700,000) to screen, so delay in reviewing a report, as often happens, represents a substantial cost as well as an even larger loss from not tackling the weed problem. There are agreed time limits but these are rarely observed and Canada can act unilaterally, but rarely does so.

In my opinion some of the needed discipline would be imposed on TAG by requiring the group to publish a written decision of why they approved or rejected an agent. At least this would help make decisions consistent.

Problem # 3. Lack of biocontrol legislation.
In both Canada and the USA the original legislation covering classical biocontrol were Quarantine Acts designed to exclude the importation of undesirable organisms. In both countries, the present enabling legislation still classifies all biocontrol agents as plant pests, even if they are parasitoids that attack plant feeding insects (Statutes of Canada, 1990). In Canada, the release of “beneficial” plant pests for biocontrol occurs under discretionary powers (Canada Gazette, 1995). Discretionary powers, by definition are not covered by regulations, but in my opinion as soon as a use becomes routine, as in weed biocontrol, they need to be replaced by regulations.

In weed biocontrol, many of the problems of TAG appear to be related to the absence of biocontrol legislation and regulations that would at least have the group operating in unison. There are two parts to a screening report. Part I is on the weed and deals with its taxonomy, the problem and the non-target plants most likely to be damaged if biocontrol is undertaken. This used to be a separate document, as it is in Australia (Commonwealth of Australia 1984). As a separate document it can be referred to plant taxonomists, plant ecologists and those concerned with the protection of native plants. The objective of this group should be to determine that the pros of a biocontrol control program out weight the cons. For example, the harm of an endangered species by an agent might be acceptable if another endangered species was benefited. This cannot be considered under the Endangered Species Act. The second part of the report deals with the candidate agent and what it is likely to attack if released. These are technical issues that need to be referred to insect behaviourists and ecologists. The reports were apparently combined by APHIS because consideration of whether a weed should be target for biocontrol was outside their mandate. Unfortunately, an effect of combining the reports is that they are reviewed by people from a mixture of disciplines and few have detailed knowledge about insect behaviour.

Solution # 3. Enact Biological Control legislation.
The enactment of biocontrol legislation in both Canada and the USA would solve a number of problems.

1. I like the provision in the Australian Biocontrol Act (Commonwealth of Australia, 1984) that instructs the reviewers to weigh pros and cons as this would allow consideration of the species that are endangered by not doing as well as, by doing biological control. The report should be split into two parts with each being referred to the relevant experts. The reviewers of whether a weed should be targeted for biocontrol should list the non-target plants for which there is most concern. The result would be a quick rejection of unsuitable species by the researcher and fewer screening reports to review. The second group would be concerned with whether the insect is likely to conform to the preset host limits.
2. We would get rid of the present nonsense which labels all biocontrol agents as “plant pests”.
3. The Act would provide the necessary mandate for a clear set of regulations for the approval of biocontrol agents. Decisions to fund and screen agents could be made in the light of the regulations and the knowledge that they would remain constant until publication of changes.

I realize that passing new legislation is a slow process. However, the necessary regulations can be adopted quickly and lodged temporarily under any compatible legislation.

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(In the interest of saving space, I have not included the list of references that Dr. Harris included. If you need them please contact either Dr Harris or me. The Editor)

Leafy Spurge Control with Sheep

Leafy spurge, a perennial weed, continues to invade hundreds of thousands of acres across Manitoba. Previous attempts to control spurge using cultivation or herbicides have been largely unsuccessful. In 1993, the Brandon Soil Management Association initiated a project to determine the impact sheep grazing would have on the density and longevity of established spurge infestations. Results to date are very encouraging. Spurge density is recorded each spring to measure the degree of control obtained from the previous grazing seasons. Observations in the spring of 1995 showed the following reductions in spurge density after only two years: paddocks sprayed with 2,4-D only, 44%; paddocks grazed by sheep only, 54%; paddocks sprayed with 2,4-D and grazed by sheep, 61%. Observations of pasture conditions during the 1995 grazing season suggest further control can be expected next spring. Sheep performance has been good in all three grazing seasons. Dry ewes gained an average of 0.167 lb/day in the 1993 and 1994 grazing seasons. In 1995, sheep gains improved to 0.275 lb/day in the sheep only paddocks and to 0.295 lb/day in the sheep plus 2,4-D treated paddocks. In conjunction with this trial, three additional projects are being run. In 1994, a stocking rate trial was initiated to determine how spurge control is related to sheep stocking rates. An in 1995, the Manitoba Sheep Association ran two trials to determine if the undesirable compounds found in spurge could be found in the sheep's blood and to find out if grazing spurge causes off-flavours in meat of animals grazing spurge.

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Leafy Spurge Control on Canada's Largest Tall Grass Prairie Preserve

In the late 1980's the Manitoba Naturalists Society discovered remnants of native tall grass prairie in southeastern Manitoba. This discovery has led to the development of the largest tall grass prairie preserve in Canada and one of the largest in North America. The Manitoba Tall Grass Prairie Preserve has progressed through the initial survey stage into an era of prairie management. Originally settled by agriculturalists in the late 1880's, the land was too stoney and poorly drained for intensive agriculture. The land was used for pasture and hayland for many years and finally abandoned. Invasive native species such as aspen, willow and several other woody species as well as the introduction of exotic grasses and forbs have made management a formidable challenge. The discovery of noxious weeds such as Leafy Spurge and St. John's Wort has exasperated the management problem. An integrated vegetation management system has been adopted to combat these challenges. The effectiveness of limited herbicide use, mechanical removal and the use of biocontrol agents such as *Lobesia euphorbiana*, *Aphthona cyparissiae* and *A. nigriscutis* are currently being monitored on the control of Leafy Spurge while other options are being considered.

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Leafy Spurge in Manitoba – The Fight to Keep Ahead

Approximately 52,000 hectares (130,000 acres) are infested with leafy spurge in Manitoba. Most of the land infested is pasture and rangeland. Since the early 1980's, Manitoba Agriculture has been involved in the biological control of leafy spurge. Biocontrol was investigated after years of herbicide control failures. To date, nine different species of biocontrol agents have been investigated in Manitoba. Agriculture and Agri-Food Canada has been a major partner throughout the project. To date, *Aphthona nigriscutis* and *A. cyparissiae* have been the most successful insects managing spurge in Manitoba. However, these two insects appear quite particular in their habitat. In Manitoba, an insect is needed that will attack spurge in shaded areas (shrub and trees). *Lobesia euphorbiana* is showing some promise. However, this insect only prevents seed set. It does not affect the root system. Most recently (1990's), *Aphthona lacertosa* and *A. czwalinae* have established in Manitoba. Based on the success our neighbors to the south (North Dakota) have had with these two species, Manitoba Agriculture will concentrate on increasing the release sites of *Aphthona lacertosa* and *A. czwalinae* in future years. *Aphthona czwalinae* has proven very hardy in Manitoba as it has survived three weeks of flooding at one location.

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Niche Specificity of Insects Introduced for Leafy Spurge Control

Leafy Spurge, a noxious perennial weed of Eurasian origin, is a major rangeland problem on the northern Great Plains of the United States and in the prairie provinces of Canada. Because it is an introduced plant, leafy spurge has few native natural enemies. Thirteen host specific insect species have been imported from Europe to the United States for leafy spurge control. Due to the limited occurrence of leafy spurge and closely related species in western Europe and Eurasia, there is limited habitat information for the introduced species. Three flea beetle species *Aphthona cyparissiae*, *A. flava* and *A. nigriscutis* were released at multiple sites in eastern Montana and North Dakota between 1990 and 1993. Ecological data and insect numbers were collected subsequent years. Analysis of the data indicates a relationship between leafy spurge plant height and density and the numbers of Aphthona species in succeeding generations.

A. nigriscutis is well adapted to the dryer portions of the northern Great Plains. In areas where leafy spurge density is low, plant height under 18 inches and water stress apparent in late summer, *A. nigriscutis* does well. Under these conditions, insect mortality is reduced and leafy spurge control is seen over a limited area within three to five years. As site conditions become more moist, *A. nigriscutis* mortality is increased and spurge control is limited to non-existent. *A. cyparissiae* is difficult to distinguish from *A. nigriscutis*. Similarly, the two species occur in overlapping niches. *A. cyparissiae* will establish in slightly wetter niches than *A. nigriscutis*. Both *A. nigriscutis* and *A. cyparissiae* are well adapted to climatic conditions on the northern plains. *A. flava* remain an enigma. Two sites, in Alberta and Montana, produced large insects numbers and good leafy spurge control. These successful establishments have not been duplicated. There are other *A. flava* sites in Montana and North Dakota with increasing insect numbers. We do not yet understand the characteristics of these sites and how to successfully establish new colonies. Successful insect establishment is important to leafy spurge biological control. Flourishing insect colonies is dependent on a knowledge of insect niche requirements.

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