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Prospects for biological control of leafy spurge

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To start my discussion I would like to pose the question "Why does leafy spurge present such a difficult challenge for biological control?" As a partial answer to this question let's compare some biological, economic, and political attributes of two other problem weeds with leafy spurge in order to fully appreciate the complex situation with leafy spurge.

Musk thistle – *Carduus nutans* L.

- annual or biennial weed
- only reproduces by seed
- no known allelochemicals
- single insect (the seed head weevil, *Rhinocyllus conicus* Froel.) plus good range management (i.e., good competing vegetation) generally adequate to control the thistle
- relatively easy plant to control biologically
- some potential conflict with native thistles, however the weevil is less successful on these plants than on musk thistle; no detrimental effects on native thistle densities have been documented

Spotted knapweed – *Centaurea maculosa* Lam.

- short lived perennial
- only reproduces by seed
- allelochemicals present
- fierce competitor
- reports of 95% seed destruction per individual flower head where both seed head flies, *Urophora affinis* (Frld.) and *U. quadrifasciata* (Meig.) occur together and in high numbers
- this level of seed destruction not adequate to demonstrably affect plant density, perhaps due to prolific seed production and seed accumulation in the soil

– complex of 4 or 5 insects plus some plant diseases may be necessary to substantially affect plant density

– probably moderately difficult to control biologically

– only 1 or 2 native plant species appear to be in potential conflict with the natural enemies we release against spotted knapweed

Leafy spurge, *Euphorbia pseudovirgata* (Shur) Soó (= *E. esula* L. x *E. virgata* Waldst. & Kit.)

– perennial

- reproduces by seed and vegetatively by underground adventitious root buds

- seeds explosively released up to 15 ft. from the parent plant

- extensive underground root system and root reserves make the weed extremely difficult to control by conventional means

- plant is genetically variable which may influence the effectiveness of chemical and biological control

- suspected of having allelochemicals (less documented than in spotted knapweed)

- will probably take a complex of 4 or 5 insects plus some plant diseases before plant density is affected

- probably will be the most difficult of the 3 weeds to control biologically

- 107 native plant species in the family Euphorbiaceae may be in potential conflict (to varying degrees) with the natural enemies that are released against leafy spurge

Conflict of interest

I would like to spend some time discussing an issue that seems to be fundamental to biological control efforts directed against most weeds. The issue is called conflict of interest and in simple terms is when a weed has both beneficial attributes as well as it causes economic damage. Some of the basic components and examples of conflict of interest are outlined below:

1. Benefits

    a. Economic

        1) Weed may produce lots of nectar and pollen and thus benefit the honeybee industry

        2) Relatives may be of economic importance:

            a) *Euphorbia lathyris* – petroleum plant

            b) Poinsettia – Christmas ornamental

b. Aesthetic/Environmental

1) Native relatives may produce pretty flowers

2) Concern for potential impact of natural enemies on native plant species, particularly those proposed for endangered species status

eg., Family Euphorbiaceae (to which leafy spurge belongs) has 113 plant species native to North America

– Four or five native species of Euphorbiaceae have apparently been proposed for endangered species status

2. Economic Damage

a. Production Losses

1) Competition for water, nutrients, and light

2) Range-animal exclusion

3) Toxic residues

4) Displacement of favorable native and introduced forage species

5) Reduction of favorable wildlife habitat

b. Control Costs

1) Fuel

2) Labor

3) Herbicide/Cultural management/Biological control costs

There is a definite need for weighing the beneficial attributes of leafy spurge against the economic damage that it causes so that rational weed management decisions can be made. Unfortunately, leafy spurge presents a special dilemma for biological control researchers. When faced with a weed such as leafy spurge, with apparent genetic variability, the natural enemies that are released against the weed should have the ability to feed on a range of genetic types of the plant. Otherwise, if the natural enemies are too restricted in their feeding they will not contribute much toward the overall control of the weed. On the other hand, when attempting to biologically control a weed such as leafy spurge with 113 native plant species in potential conflict, the natural enemies should be extremely specific in their feeding to minimize their impact on the native flora. Thus, we are caught between a proverbial rock and a hard place with this particular weed!

For such a damaging weed as leafy spurge with no apparent economically feasible means of controlling large infestations of the weed on marginal rangeland, other than biological, we may have to accept a slightly higher risk to the native plant species than with most other weeds. But, we should be cautious at the onset and exhaust the list of extremely specific natural enemies first to minimize any potential risk to the native flora. If these prove to be ineffective in controlling leafy spurge, then we might have to turn to control agents with a slightly broader host range that may offer an even greater potential for control. I hope we can some day strike a rational balance between the ecological con-

cern for the potential impact of these natural enemies on the native flora and the economic damage caused by this weed.

Other issues that need more attention are the impact of herbicides on the native flora and the displacement of native plant species by the weed itself. A consideration of these issues plus an assessment of the possible benefits of leafy spurge vs. the economic damage it causes will help us develop a sound biological control policy/effort against this particular weed.

How may research efforts from the scientific community enhance current and future natural enemy effectiveness?

1. Population Ecology Studies

   –The knowledge gained from studying the population dynamics of weed natural enemies in the laboratory and in the field may help us enhance their survival and establishment in new release areas in the future

2. Taxonomy (Classification of organisms)

   –Cytogenetic, chemical, and morphological taxonomic studies will help identify the types of leafy spurge we have in North America

   –Taxonomic studies of the European plant material, from which the natural enemies are collected from, may help us more appropriately match up the natural enemies with the proper leafy spurge plant material in North America

3. Allelopathy/Plant Resistance

   –Finding perennial grass species that show resistance to suspected allelochemicals in leafy spurge may help add competitive or replacement vegetation for the long term management of leafy spurge

4. Integrated Weed Management Research

   –The knowledge gained from studying the impact and use of herbicides, with biological control agents should help us better time the application of herbicides to minimize their impact on weed natural enemies.

Insect quarantine – Montana State University

–Possible completion date (early 1988)

–We hope to be able to expedite the receipt and processing of insect natural enemies from Europe in the future and complement activities of the USDA Biological Control of Weeds Laboratory, Albany, CA in their efforts against leafy spurge

–Additional functions of the Insect Quarantine at MSU might be to: 1) participate in host range and specificity testing of new natural enemies, including the testing on relevant native flora; 2) free new natural enemies of their own disease and

parasite problems; and 3) help in the regional rearing and redistribution of newly released natural enemies

Insects released against leafy spurge in the United States

1. *Hyles euphorbiae* – leafy spurge hawkmoth (established at two release sites in MT)

2. *Chamaesphecia empiformis* – clear-winged moth (failed to establish)

3. *Oberea erythrocephala* – stem and root boring beetle (established at two and maybe three release sites in MT; releases by N. Rees, USDA Rangeland Insect Lab., Bozeman, MT)

4. *Bayeria capitigena* – gall-forming midge (released summer 1985 in MT by R. Pemberton, USDA Biological Control of Weeds Lab., Albany, CA)

5. *Apthona flava* – flea beetle (released summer 1985 in MT by R. Pemberton)

Insects and plant diseases going through additional screening tests for potential release against leafy spurge in the U.S.

1. *Lobesia euphorbiana* – leaf-tying moth with apparently too broad a host range for consideration of release in the U.S. yet (testing conducted by USDA Biological Control of Weeds Lab., Albany, CA)

2. *Chamesphaecia* sp. – clear-winged moth that feeds on *Euphorbia virgata* with a good chance that it will attack our *E. pseudovirgata* (testing conducted by USDA Biological Control of Weeds Lab., Rome, Italy and the Commonwealth Inst. of Biological Control, Delemont, Switz.)

3. *Apthona abdominalis* – flea beetles (testing conducted by USDA Biological Control of Weeds Lab., Rome, Italy)

4. *Dasineura capsulae* – gall-forming midge (testing conducted by USDA Biological Control of Weeds Lab., Rome, Italy)

5. *Uromyces scutellatus* – systemic rust (testing conducted by Institut fur Phytomedizin, Zurich, Switz.)

6. *Oncochila simplex* – lace bug (testing conducted by USDA Biological Control of Weeds Lab., Rome, Italy)

7. *Simyra dentinosa* – moth (testing conducted by USDA Biological Control of Weeds Lab., Rome, Italy)

The most widely accepted biological approach is to release as many promising kinds of natural enemies against a weed as possible -- each adding some particular stress to the weed. It is desirable to have a full complement of natural enemies with some attacking the flowers and seeds, and others attacking the leaves, stem and root system to maximize

the stress on the weed. Our ultimate hope is that this complex of natural enemies plus the effects of competition from other plant species will be sufficient to cause a decline in leafy spurge densities to economically acceptable levels.

As far as the outlook for the control of leafy spurge in the future -- I remain cautiously optimistic! The genetic variability of leafy spurge and the 113 native plant relatives in potential conflict will continue to present interesting challenges for the biological control of leafy spurge in the future. We ask for your patience. It may take 10-15 years or longer before a sufficient complex of natural enemies is established and thriving enough to cause a decline in leafy spurge density. Unfortunately, there are no guarantees of control for any weed management strategy!