

# Leafy Spurge Control—Release of **Chamaesphecia hungarica** Moth in Fallon County, Montana

Environmental Assessment

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**An Environmental  
Assessment  
of  
Chamaesphecia  
hungarica**

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## Abstract

Leafy spurge is a long-lived herbaceous perennial weed that was first introduced into the United States in 1827. Currently there are no satisfactory means of controlling leafy spurge, and it is left to spread unchecked and to displace native flora. Attempts have been made to control leafy spurge with herbicides, but they are only temporarily effective because they fail to destroy the roots. The moist parts of the leafy spurge infestations are particularly sensitive to picloram, the most commonly used herbicide, which is highly water soluble and leaches into streams and ponds.

At this time, the most effective biocontrol agents for leafy spurge are those that attack its root system. Two chrysomelid beetles, *Aphthona nigriscutis* and *A. cyparissiae* have begun to attack the roots of spurge in open release sites with dry coarse soils, but the need now is for a species that will thrive on heavier soils, in moist, and in shaded sites. The European root-boring moth *Chamaesphecia hungarica* is a species adapted to moist habitats in the steppic biome. It has a very narrow host range, specific habitat and climatic requirements and will not have any detrimental effects on native or ornamental plant species. For these reasons, the release of *Chamaesphecia hungarica* in the United States is recommended.

## Introduction

Leafy spurge is a noxious perennial weed on the Great Plains of the United States and on the prairie provinces of Canada. It is a non-native plant and was not known in the United States until 1827 (Thompson, *et. al.*, 1990). Because it is an introduced plant, leafy spurge has no native natural enemies. The plant is primarily found in nontilled agricultural land (pasture, rangeland, hayland, and idle cropland) but it is also found along roadsides, river banks, flood plains, ridges, and mountain slopes (Bangsund, *et. al.*, 1991). This noxious weed restricts native plant growth and is not eaten by cattle unless it is given to them in weedy hay or if no other forage is available (Rees and Spencer, 1991). Leafy spurge also produces a toxic latex. The latex causes scours and blisters in cattle, and in large amounts, death. In humans, it causes dermatitis and blisters, and overexposure may lead to blindness. For these reasons, leafy spurge is a serious problem for farmers and ranchers. The area of greatest infestation in North America is defined by a 1,200 mile-diameter circle, centered near Wolf Point, Montana (Spencer, 1990). The circle encompasses parts of 9 states and 5 Canadian provinces and covers nearly 2.5 million acres. The greatest infestations are located in Montana, North Dakota, South Dakota, and Wyoming. The total negative economic impacts in the four states could reach over \$144 million annually by 1995 (Bangsund *et. al.*, 1991). Due to the cost of herbicides and the threat that they pose to the environment, an urgent need has developed to find alternative control methods. Biological control, the use of one organism to control another, seems to be one answer. The Agriculture Research Service (USDA/ARS) has been researching more effective ways to control leafy spurge for almost twenty years. Nine insects, brought to the U.S. from the native lands of leafy spurge, have been released in the United States to control leafy spurge, and more are being studied for future release. Several of these biological control

agents have already made significant impacts on the spread of leafy spurge. Unlike herbicides, biocontrol agents kill the spurge without causing harm to other plants or animals located in the release areas. In sites where agents were released in 1989, 1990, and 1991, improvements can be readily observed. In the middle of many infestations where biocontrol agents have been released, large, clear, circular areas have appeared. This shows the positive impact of biocontrol agents on leafy spurge infestations. Introduced biocontrol agents are increasing in numbers in the field. Local, state, and federal land owners are excited about this technological method of leafy spurge control. Some of these introduced biocontrol agents are now being released in thirteen states..

## **I. Proposed Release**

### **1.1. GOALS**

The main goal of the proposed release is the establishment of *Chamaesphecia hungarica* to provide additional control of leafy spurge in moist habitats.

### **1.2. PROCEDURES**

A site for release is first chosen based on three main groups of site characteristics. Once a site is chosen, the insects will be released into the area, and then monitored to determine their establishment, effectiveness, and survival rates.

### **1.3. SUMMARY OF SITE CHARACTERISTICS**

A site is chosen based on three sets of parameters; physical, biological, and cultural.

Physical: soil texture, soil moisture, risk of flooding, topography, direction of slope, estimated bare ground at site, annual precipitation

Biological: weed density, whether the infestation is continuous or interrupted, the amount of ground area shaded by plants, typical mature weed height, trees or shrubs in the release site and surrounding area, amount of shade from shrubs and trees, size of weed infestation

Cultural: current land use, herbicides applied within the last two years, weed treatments within the last twelve months

## **II. Purpose and Need**

### **2.1 SIGNIFICANCE OF ACTION**

Leafy spurge is a noxious perennial of the Northern Great Plains of the United States. It is hardy, resists control, and forms dense stands that replace grasses and forbs and restrict cattle grazing (Rees and Spencer, 1991). Leafy spurge reproduces by both seeds and vegetative root buds (Spencer, 1991) and therefore has an exceptional ability to thrive and spread. These

characteristics have made leafy spurge a serious problem for farmers and ranchers. The most serious infestations are located on the prairies where, because of its deep roots system, it has become the dominant plant on the open sandy soils, displacing native flora and having a corresponding negative impact on native fauna. It also survives, however, on heavy moist soil and in shaded areas. Because of this and climatic reasons, biocontrol agents are the most successful means of controlling leafy spurge.

Leafy spurge produces a toxic latex. This milky substance is poisonous to cattle and to man. In cattle, the latex causes scours and blisters, and in large amounts death (Rees and Spencer, 1991). In humans it causes dermatitis, and blisters, and overexposure may lead to blindness. The continued spread of leafy spurge into grazing and recreational lands is undesirable.

Leafy spurge also displaces native plants. The western prairie fringed orchid, *Platanthera praeclara* is one such plant (Gassmann, 1990). It has received threatened status in the United States and remains in danger of leafy spurge invasion. *Platanthera praeclara* is not only forced out of its habitat by leafy spurge, but it is killed by the herbicides used to stop the spread of leafy spurge.

The proposed solution is to use biological control to limit the spread of leafy spurge. *C. hungarica* would be used in combination with other biocontrol agents to achieve this control.

## 2.2. ALTERNATIVES TO PROPOSED ACTION

Leafy spurge can be controlled through the use of herbicides, but long-term control is very difficult to achieve. Herbicides commonly used in the control of leafy spurge are 2, 4-D, picloram, and dicamba (Lym, 1991a). On non-arable land, picloram is the most persistent and effective herbicide available and retreatment may not be necessary for 3-5 years (Lym and Whitson, 1991). However, picloram is expensive, extremely persistent, mobile, and kills a broad spectrum of plants. Picloram is highly water soluble, leaches into streams and ponds, and has been known to kill trees. Because of this, the present large scale use of picloram is ecologically undesirable. The best chemical options left are 2, 4-D, and dicamba. However, these herbicides fail to kill the roots of established plants and have to be reapplied every 1-2 years (Lym and Whitson, 1991). Also, large amounts of dicamba harms native forage production. There is an urgent need to develop an alternative to the use of picloram and other herbicides to control the spread of leafy spurge on non-arable land. A much more economical and environmentally acceptable means of controlling this noxious weed would be through biological methods of control.

## 2.3. GOALS OF THE PROGRAM

The goal of this project is to successfully control leafy spurge with the root-boring moth *Chamaesphecia hungarica*.

### 3. Description of Proposed Release Organism

#### 3.1. TAXONOMY

Order:	Lepidoptera
Family:	Sesiidae
Subfamily:	Sesiinae Biosduval 1828
Tribe:	Aegeriini Stephens 1829
Genus:	Chamaesphesia Spuler 1910
Species:	<i>Ch. hungarica</i> (Tomala 1901)
Synonym:	<i>Ch. deltaica</i> Popescu-Gorj & Capuse 1965

The Sesiidae is a cosmopolitan family of about 1000 described species. Six genera with 37 species are described from central Europe (Gassmann, *et. al.* 1991). According to Gassmann *et. al.* (1991), there are 23 species in the genus *Chamaesphesia* that divide into four groups each associated with a plant family: Euphorbiaceae, Scrophulariaceae, Labiatae, and Leguminosae. The Euphorbiaceae-group consists of 10 species which are divided partly on the basis of the dorso-proximal sensillae of the male valvae into two subgroups: *C. empiformis* group consisting of six morphologically similar species that includes *C. hungarica*, and the *C. euceraeformis* group consisting of four dissimilar species. The *C. empiformis* group are similar enough and most have sufficiently distinct host ranges or habitat requirements that identification is often more easy by ecological data (*op. cit.*).

Gassmann *et. al.* (1991) stated that the abdomen of *C. hungarica* is black sprinkled with numerous greenish scales dorsally, with whitish bands on segments II, IV, and VI (and VII for the male). The dorsal side of the antennae is black and the ventral side is covered with brownish scales. The anal tuft of the male is rhombic. The apical area of the forewing is black with yellow scales between R3-Cul veins, the distal spot is black, and there are three transparent areas on the forewing which are clearly visible. The body is 10 to 14 mm long and the forewing 7-10 mm (*op. cit.*).

The eggs are 0.73 +/- 0.04 x 0.51 +/- 0.02 mm (n=50), light brown, oval, flattened with the shell divided into distinct polygonal structures and covered with minute regular papillae. The larvae are white, pale yellowish and 12-15 mm when mature (*op.cit.*).

#### 3.2. DISTRIBUTION

*C. hungarica* is restricted to south-eastern Czechoslovakia, Austria and Hungary. The moth has been found in southern and eastern Hungary and in Yugoslavia (Serbia, Croatia). Thus, it has a Panonian and Prepanonian distribution (eastern Austria, southern Czechoslovakia, Hungary, Yugoslavia and probably also Rumania and southern USSR) in an area with a continental and subcontinental climate with warm summers (Gassmann, *et. al.*, 1991).

Within this zone it is found on moist loamy soils and partly shaded habitats (riverbanks, swampy areas, ditches). Based on its European distribution, its main concentration is likely to

be along the Canadian-USA border extending further south than north and hence covering the main leafy spurge problem area (Gassmann *et. al.*, 1991).

### 3.3. BIOLOGY

The univoltine adults emerged between mid May and the end of June in Yugoslavia and Hungary according to Gassmann *et. al.* (1991), but the field population established at Delemont, Switzerland started to emerge at the end of June and continued for 5 weeks. Mating occurs in the morning within 24 hours of emergence and about 80% successful mating was obtained in the laboratory by placing a newly emerged female with one or two males in a horizontal plastic cylinder (11 x 15 cm) at room temperature. It was important not to add the males until movement of the female abdomen indicated she was calling and the containers had to be cleaned after each copulation to remove any pheromone (*op. cit.*).

Best oviposition was obtained by offering 15 cm long spurge stems stuck into moist perlite and covered with a plastic cylinder. The females were fed with a few drops of sugar-honey solution poured on the perlite. Oviposition began shortly after mating; the best occurred with a photoperiod of 18 hours at 28° C (Gassmann, *et. al.*, 1991). Average female longevity was five days and they laid an average of 123 eggs (range 59-175, n=7) from a potential of 205 eggs (range 182-215, n=7). The females survived 13 days in the fluctuating temperatures of an unheated greenhouse, but this did not increase the number of eggs laid (*op. cit.*).

In the field the eggs are usually laid singly and during the spurge flowering period over half of them are laid on the bracts and a few on the stem. The eggs are laid both on the leaves (mostly on the upper surface) and on the stem, before and after flowering (*op.cit.*).

It was stated that the larvae hatch in about 17 days at 20° C and penetrate into the shoot a few centimeters above the ground. About half the larvae hatching from eggs laid on the stem penetrate successfully, but only 20% of those hatching from eggs laid on the leaves and most of those hatching from eggs laid on the upper part of the plant drop-off and die (Gassmann *et. al.*, 1991). The young larvae mine the stem cortical parenchyma just below the epidermis for a few centimeters and then move into the pith and down into the root. Most of the larval feeding is done in the root. Measurements of head capsules indicate that there are probably 7 larval instars and they reach the 6th or 7th instar before winter (Gassmann, *et. al.*, 1991). In the spring the larva mines up to the stem base and prepares an emergence hole a few cm above the ground and then pupates within the stem. The empty pupal case is left protruding from the stem after emergence (*op. cit.*).

### 3.4. FIELD HOSTS

*C. hungarica* has been recorded from *E. lucida* W. & Kitt. and from *E palustris* L. which sometimes occurs with *E. lucida* in moist areas (Gassmann, *et. al.*, 1991). This host restriction in part seems to be dictated by the habitat requirements of the moth and in North America, in the absence of *E. lucida*, the habitat is partially occupied by the closely related *E. esula* (sensu lato) (*op.cit.*).

## 4. Description of Target Organism

### 4.1. TAXONOMY

Order:	Geraniales
Family:	Euphorbiaceae
Genus:	<i>Euphorbia</i> L. 1737
Subgenus:	<i>Esula</i> Pers.
Section:	<i>Esula</i> (Roeper) Koch
Subsection:	<i>Esulae</i> Boiss.
Species:	<i>E. esula</i> L. (sensu lato) (2n=60); leafy spurge.

Leafy spurge is an introduced species in North America. Native to the Caucasian region, *E. virgata* is a southeastern European-Asiatic species that occurs from eastern Austria and Czechoslovakia to central Asia. The taxonomic status of the introduced North American leafy spurge complex is in a state of confusion. In Europe, there are 105 native *Euphorbia* species in the subgenus *Esula*, the group to which leafy spurge belongs. In North America, there are only 21 native species in the subgenus *Esula* (Muemscher, 1940). Variations in the leafy spurge genotype in North America resulting from new gene combinations and natural selection and adaptation may affect biotic agents introduced from Eurasian areas where these genotypes do not occur. Even more perplexity is added when one considers that this weed may have been introduced from multiple sources throughout Eurasia (Rees and Spencer, 1991).

### 4.2. RELATED ECONOMIC AND NATIVE PLANTS

#### 4.2.1. Economically Important Species

Host specificity tests with the candidate agent are used to determine whether or not it has a restricted host range. If the host range shows a predictable pattern this means that the plants outside of the susceptible group are not at risk (Gassmann, 1990). Plant species will only be attacked if

- 1) they occur inside of the climatic region and habitat required of the agent
- 2) they provide the right structures
- 3) they occur above a minimum threshold density

The purpose of biocontrol agents, such as the proposed *C. hungarica*, is to reduce the host to a few scattered plants. Because of this we must be concerned with economic plants acceptable to oligophagous agents as they are often grown in large monocultures. A few scattered plants are generally not at risk unless they occur in the same habitat or close to a large infestation of the target species.

The economically most important *Euphorbia* in North America is *E. pulcherrima* Willd. (subgenus *Poinsettia*). It is a perennial which is propagated from cuttings as a Christmas pot

plant. This trade has an annual value of \$54 million. Because the subgenus *Poinsettia* did not support larval development, *E. pulcherrima* is not at risk.

*E. polychroma* Kern. (subgenus *Esula*) is a novelty European perennial that in North America is mostly grown from seed as an annual bedding plant. It is not of major economic importance and scattered garden plants are unlikely to be at a high risk from a biocontrol agent.

*E. oblongata* Griseb. (subgenus *Esula*) is a European annual that has become a waif in California. It is not cultivated and does not require special consideration.

*E. antisiphilitica* Zuccar. (subgenus *Agaloma*) is a perennial that produces a high quality wax. It is the basis of a small industry in northern Mexico with an annual value of \$1 million. The plant is a tough xerophyte that produces only a few scale like ephemeral leaves. It does not survive in regions with winter frost and so occurs south of the distribution of leafy spurge.

#### 4.2.3. Native Species

Currently the main cause for concern over the introduction of agents for the biocontrol of leafy spurge is the native *Euphorbia* species, especially those in the subgenus *Esula*. The United States Endangered Species Act of 1973 requires that special consideration be given to species designated in the Federal Register as endangered (LE), or threatened (LT) before biocontrol agents can be released into the United States. Category 2 is an entry level and after investigation, the species is moved into Category 3 (not threatened or endangered) or to Category 1 (species for which there is substantial evidence to support biological susceptibility).

Three *Euphorbia* taxa are listed as endangered or threatened in the United States. Only three *Euphorbia* taxa are located on the United States mainland that are considered endangered or threatened; *E. deltoidea* ssp., *deltoidea*, and *E. garberi*. These three taxa are, however, native to Florida and are located outside of the predicted geographic range of *C. hungarica*. Eighty percent of the taxa in category 1 (endangered) are Hawaiian and the remainder occupy habitats not suitable for *C. hungarica*.

*E. skottsbergi* var. *kalaeloana* is indigenous to the Hawaiian Islands and are therefore **not** at risk to the proposed release.

Two species, *E. hooveri* and *E. purpurea* are not designated endangered or threatened but are listed as Category 1 and 2 respectively. Because of their listing as species being considered for designation of threatened, these species must also be reviewed.

*Euphorbia hooveri* is mainly found in subsaline rainpools in the Lower Sonoran Zone of Tulare and Tehama Co., in the Central Valley of California and is a species of hot, arid, inhospitable sites. However, *C. hungarica* has a difficult time surviving in these types of temperatures and would therefore not establish itself in the areas sympatric with *E. hooveri*.

Not much reliable information is available on the second species, *E. purpurea*. Hence, it is listed as Category 2. However, in contrast to *E. hooveri*, *E. purpurea* is found in a wide variety of areas. It can be found from Ohio to Delaware, and south to North Carolina. The wide range of *E. purpurea* should decrease its vulnerability. It is a species of swampy woods and thickets, and these are **not** the habitats of leafy spurge or popular collecting sites. This may explain the lack of information available on *E. purpurea*. Although *E. purpurea* occurs in the correct habitat of the moth, it does **not** occur in the correct climatic zone.

*E. maculata* is a common weed of lawns, gardens, and waste ground. It is poisonous to livestock and can lead to photosensitization. It is a problem weed in other parts of the world where it has been introduced. Therefore, a reduction in its numbers would be welcomed.

There is only one species in Section *Chamaesyce* which is endangered. Six of the taxa (one endangered, one threatened, and four in category 1) are restricted to Southern Florida and Alabama which are areas that do not support the climatic and habitat requirements of *C. hungarica*. One, in Category 2, is restricted to the southeast coast of the U.S.. All seven are native to sand dunes. The remaining two *Chamaesyce* taxa, *E. atrococca* and *E. remyi*, (Category 1) are Hawaiian species and thus are not in danger of agents released on the mainland. ***Chamaesyce* did not support larval feeding, and thus all spurges in this section are not at risk. This includes the economically important *E. pulcherrima*.**

There are no species of Sections *Poinsettia* or *Agaloma* which are endangered. Tests on *Poinsettia* and *Agaloma* showed that they did **not** support larval feeding

There are no "endangered" or "threatened" species in Section *Tithymalus*. *E. austrina*, of southern Florida, is a 3B taxon. *E. telephioides* also native to Florida, is a Category 2 taxon and is outside the climate zone and habitat of the moth. The south Texas *E. roemerana* has been found not to be endangered. *E. roemerana* is not in danger of attack by *C. hungarica* because it too, is found outside of the climate zone and habitat of the moth.

#### 4.2.4. Other Species

There are also some spurges for which past review have indicated a special concern.

The only spurge outside the *E. esula-virgata* complex to support larval development was *E. lathyris*. The other species in the subgenus were not suitable. *E. lathyris*, which was once proposed as a potential use for petroleum production in North America, is not at risk from *C. hungarica* (Gassmann *et. al.*, 1991). *E. lathyris* does not occur in Europe in the distribution area of *C. hungarica* nor can it be grown except as a garden annual in the North American steppic biom. If it is ever grown commercially in North America, this will be in regions with a Mediterranean climate such as California, which is outside the climatic range of *C. hungarica*. Also, *E. lathyris* grows on dry land and the moist habitats required by *C. hungarica* exclude the possibility of attack and in tests, *E. lathyris* was discriminated against for oviposition even when placed in a moth habitat (Gassmann, *et. al.*, 1991).

According to Gassmann, *et. al.*, (1991), *E. robusta* (Engelm.) Small, although not listed in the Federal Register, has been a concern of previous reviews. It is a native perennial in the subgenus *Esula* that is widespread in the northwest USA and so occurs in the climatic zone of the moth. However, its restriction to dry habitats eliminates the possibility of attack.

*E. spatulata* (subgenus *Esula*) is a widespread native but as an annual, it is not a suitable host for *C. hungarica*.

#### 4.3. DISTRIBUTION

In continental Europe, leafy spurge is found as far south as central Spain, Italy, and the Balkans, and extends eastward through central Russia into Siberia (Lym, 1991b). In North America, the distribution occurs primarily in the Northern Great Plains. Leafy spurge is practically absent south of 40 degrees north latitude, and almost no 'economic' or 'potentially economic' infestations are found east of the Mississippi River. The most widespread infestation in the U.S. occurs in Minnesota, but the weed problem is the most severe in North Dakota, followed closely by Montana. It is estimated that about 90% of the leafy spurge in North America may be found within 1000 km of Wolf Point in northeastern Montana (Spencer, 1990).

#### 4.4. ECOLOGY IN NATIVE REGION

Leafy spurge grows on many different types of terrain. It can be found on river banks, flood plains, grasslands, ridges, and mountain slopes, but it is mainly found in untilled, non-cropland areas such as pastures, rangeland, and roadsides (Lym, 1991b). It also grows in wide variety of environments including dry, subhumid, subtropic, and subarctic (Lym, 1991b). For initial infestation, leafy spurge tends to occupy sites with a high sand content but once introduced into an area, the spurge appears to have no problems adapting and begins its invasion.

#### 4.5. BIOLOGICAL CHARACTERISTICS

Rees and Spencer (1991) state that leafy spurge is a herbaceous perennial that spreads by both roots and seeds. It is spread along roadsides by grading and gravelling and the seed itself can be thrown up to 5 meters by the explosive force of the capsule. Long distance dispersal is by birds, animals, and humans.

The maintenance of a spurge stand is by vegetative reproduction and seed is of little consequence (Gassmann, 1990). The role of seed is the establishment of new stands and the return of old stands after they have been killed by herbicide treatments (Gassmann, 1990). Seed reduction by a biocontrol agent would be beneficial but since spurge is also spread vegetatively on roads and other equipment, spurge is relatively seed independent.

#### 4.6. MORTALITY FACTORS

Leafy spurge is sensitive to root damage and is therefore susceptible to *C. Hungarica* as the larvae feed on the roots of spurge. The feeding weakens the spurge's defense mechanisms and

makes it more vulnerable to native plant diseases. *C. hungarica* should be an effective biocontrol agent as it causes considerable damage to the growth and flowering of attacked shoots.

There are no known native predators or parasites of leafy spurge because it is not a plant species native to North America. The latex that spurge produces is a natural barrier that keeps most grazing animals away (Lym, 1991b). Cattle will usually not eat leafy spurge unless it is given in weedy hay or better forage is not available. Although sheep and goats will eat leafy spurge, they fail to completely kill leafy spurge because they do not destroy the roots. Only the upper seed producing area is eaten, and the spurge is still able to spread and grow again. The grasshopper is the only insect known to consume spurge but it only happens in times of drought (Gassmann, 1990). The only known organisms able to kill leafy spurge are those that have been introduced to do so.

## 5. Research in Support of Release

### 5.1. HOST SPECIFICITY TESTS

#### 5.1.1. Larval transfer tests

Larval transfer tests were done on 21 *Euphorbia* spp.. These included 8 hosts of other *Chamaesphecia*, five species in other genera of the Euphorbiaceae, as well as seven plants in another 3 families which are recorded hosts of *Chamaesphecia* spp. not associated with the genus *Euphorbia*.

Five newly hatched larvae were transferred onto the stem bases of each potted test plant. The inoculated plants were kept in the laboratory for 2-3 days and then divided in the greenhouse into a moist group (those watered every other day) and a dry group (those watered once a week). The plants were dissected after 9-11 weeks to determine larval survival (Gassmann *et. al.*, 1991).

The results showed that soil moisture had no significant effect on larval survival, and larval weights on *E. lucida* and North American leafy spurge did not differ significantly on well-watered and drought-stressed plants (Gassmann *et. al.*, 1991). Larval survival was restricted to taxa in the subgenus *Esula*.

The rate of survival on *E. lucida* was significantly higher than on *E. esula* (sensu lato), but similar to that of *C. crassicornis* Bartel. The only *C. hungarica* problem on leafy spurge is that the stems are resistant to penetration by newly hatched larvae (Gassmann *et. al.*, 1991). The basal part of leafy spurge stems is somewhat woody and consists of a thin cortical parenchyma, a small pith, and a strongly sclerenchymatous vascular cylinder surrounded by phloem fibers. As a result, more than 80% of the larvae penetrated into the shoots of *E. lucida* but only two larvae into those of leafy spurge. Upon dissection, all larvae were found in the roots on leafy spurge, while on *E. lucida*, 20% of the larvae were found in the shoots (*op. cit.*). Once

established in the roots of leafy spurge, larval development was similar to that on *E. lucida*. Also, the mean weight of L<sub>5</sub>-L<sub>7</sub> larvae was similar on *E. lucida* and leafy spurge. In contrast, *E. lathyris* was a poorer host as the larval weight was only 16.7 mg (range 8.0-34.8; n=6) (*op. cit.*).

## 5.2. FIELD TESTS

### 5.2.1. Methods

*E. lathyris* grown from seed in pots for 90 days was transplanted on May 3, 1990 at two sites in Yugoslavia where *E. lucida* is attacked by *C. hungarica* (Gassmann *et. al.* 1991). At site A, *E. lathyris* plants were grouped together in a dense patch of *E. lucida*. At site B, 10 *E. lathyris* were transplanted into two rows at three meter intervals. Both the *E. lathyris* and near by *E. lucida* were dissected to determine the level of attack by *C. hungarica* at the end of the test (*op. cit.*).

### 5.2.2. Results

- ◆ Site A: The *E. lathyris* grew poorly and so were dissected on June 3. No *C. hungarica* or traces of feeding were found in them compared to 40% infestation by L<sub>1</sub>-L<sub>2</sub> larvae in adjacent stems of *E. lucida* (Gassmann, *et. al.* 1991).
- ◆ Site B: The *E. lathyris* grew to an average height of 45 cm and a root diameter of one cm compared to 58 cm and a 0.8 cm diameter for *E. lucida*. The plants were dissected on August 8. One *E. lathyris* plant contained an L<sub>5</sub> larva compared to a L<sub>4</sub>-L<sub>6</sub> larvae in six out of ten adjacent *E. lucida* (Gassmann, *et. al.*, 1991).

### 5.2.3. Discussion of Tests

The host range tests showed that *C. hungarica* is restricted to spurges in the *E. esula-virgata* complex. No larval feeding occurred on any plants outside this group that were tested: 17 other Euphorbia species, 5 species in other genera of the family, and seven species in other families. This is a more restrictive host range than any of the agents previously approved for release against leafy spurge. According to Gassmann *et. al.*, 1991, larval development on the two accessions of North American leafy spurge that were tested were not significantly different than that on the normal host, *E. lucida*. However only the root of North American leafy spurge was suitable for development in contrast to *E. lucida* in which the larvae could develop on both the root and the shoots (*op. cit.*). The European spurge *E. lathyris* also supported larval development although it was a poorer host than species in the *E. esula-virgata* complex, and in field tests the females discriminated against it for oviposition (*op. cit.*).

In the laboratory the larvae developed equally well on well-watered and drought-stress plants (Gassmann *et. al.* 1991). This indicates that the field restriction of *C. hungarica* to moist habitats appears to be related to the needs and preference of the moth rather than the larvae. On the basis of the larval survival tests, it is expected that *C. Hungarica* will attack and develop

on *E. esula* (sensu lato) in North America growing in moist habitats. The ability of the larvae to penetrate *E. esula* (sensu lato) is less than that on *E. lucida*, but there will be a strong selection pressure in North America to improve the larval penetration ability (*op. cit.*).

In nature *C. hungarica* has only been found on *E. lucida* and the record from *E. palustris* has not been confirmed (Gassmann, *et. al.* 1991). This restriction is related, in part, to the requirement of the moth for moist habitats. Feeding tests showed that normal larval development of *C. hungarica* was restricted to spurges in the *E. esula-virgata* complex with *E. lathyris* as a marginal host. In the absence of *E. lucida* in North America, the distribution of *E. esula* (s.l.) extends into moist habitats (*op. cit.*). Gassmann *et. al.* 1991, expect *C. hungarica* to attack leafy spurge in these habitats causing selection to improve the larval ability to penetrate the stems. However, the habitat restriction for moist habitats is likely to remain. This means that native spurges in dry habitats are not at risk. Also, the restriction of the moth to the steppic biome in Europe indicates that in North America it will be restricted to a zone near the Canadian-USA border, so native spurges in the USA south of this zone are not at risk (*op. cit.*). Hence, on the basis of climatic, habitat and host restriction, *C. hungarica* is the most specific candidate agent to be screened for leafy spurge control.

## 6. Environmental consequences of proposed release

### 6.1. SITE DESCRIPTION

The proposed release site for *C. hungarica* is located in Fallon County, Montana, section 10, township 10N, range 57E. The site is located in a swale which is a moderately well-drained area and has a low to moderate flood risk. It has an annual precipitation of <25 cm and the leafy spurge infestation is continuous. The area is partially shaded and the soil is loamy; 16.3% clay, 43.5% sand, and 42.2% silt. There are no other biocontrol agents released on this site and there is no grazing, therefore, *C. hungarica* will not interfere with any of the insects, plants, or animals native to the area.

## 6.2. PHYSICAL ENVIRONMENTAL RISKS

- ♦ **Air.....**The release of *C. hungarica* will have no effect on air quality.
- ♦ **Water.....**The establishment of *C. hungarica* will have no negative effect on water quality. On the contrary, if the moth is effective enough, reduction of the use of herbicides will result, and this will be beneficial to water quality.
- ♦ **Land.....** ..*C. hungarica* will have no detrimental effects on soil quality. In fact, the value of land currently infested by leafy spurge should increase as biocontrol takes effect.

## 6.3. HUMAN HEALTH RISK

*C. hungarica* will not have any adverse effects on human health. However, leafy spurge does have negative effects on human health. The latex produced by spurge causes dermatitis and may even cause blindness. Therefore, any reduction in the spread of leafy spurge will be beneficial to humans.

## 6.4. ECOLOGICAL IMPACTS

- ♦ **Wildlife.....***Ch. hungarica* will not have a negative effect on wildlife. In fact, it will have a positive effect. By controlling leafy spurge, more diverse vegetation will result and that will be beneficial to all wildlife.
- ♦ **Insects.....**Native insects will not be threatened (by interference or exploitation) by *C. hungarica*. Since leafy spurge is not a native plant species it is free of specialized native herbivores (Gassmann, 1990). Leafy spurge is seldom attacked by invertebrate phytophages except for grasshoppers in times of drought (Gassmann, 1990). Monocultures tend to decrease the diversity of plants and animals. Therefore, the reduction of spurge will increase plant diversity and the increased plant diversity will in turn increase the number of insect species.
- ♦ **Endangered or threatened species .....**The establishment of *C. hungarica* will have no negative effect on endangered or threatened plant species. In fact, at least one species will benefit. In the United States, the western prairie fringed orchid, *Platanthera praeclara*, was declared a threatened species partly because of its susceptibility to the herbicides used to control leafy spurge (Gassmann, 1990). The three legally protected species (*E. deltoidea*, *E. garberi* and *E. skottsbergii* var. *kalaeloana*) are not at risk because of the limited host range of *C. hungarica* and its climatic limitations.
- ♦ **Domestic animals and livestock.....***C. hungarica* will not cause any adverse effects on domestic animals and livestock. On the contrary, the latex in leafy spurge gives cattle scours, mouth blisters and in large quantities can cause death. This causes the cattle to avoid grazing in areas with moderate to high spurge densities (Lym, 1991b). The reduction of spurge will in fact cause a resurgence in vegetation for these animals.

- ◆ **Pollinators.....**Spurge does produce abundant amounts of honey in open nectaries, but it is not regarded by beekeepers as an important honey producing plant. In fact, the replacement of vegetation may supply a more continuous flow of honey (Gassmann, 1990). Gassmann (1990) also stated that the honey from some South Africa *Euphorbia* species is toxic and it is not known if this applies to leafy spurge honey.
- ◆ **Other biological control agents.....**There is presently no biocontrol agent for leafy spurge on moist loamy sites on the US prairies. The best prospect is the beetle *A. lacertosa* (Rosh) which occurs in Europe in both dry and moist habitats, and has yet to be approved for release in the US. *C. hungarica* is a central, south-eastern species specialized on the moist habitats of the steppic biome and should therefore be well pre-adapted to similar habitats on the North American prairies. When established, it should become one of the major components of the leafy spurge complex of natural enemies which will be needed in areas where the weed is not under drought-stress. Competition with other introduced agents is unlikely to occur because of habitat and niche separation.

#### 6.5. POTENTIAL FOR DISPERSAL FROM RELEASE AREA

The potential dispersal from the release area is not known at this time. Because it is a moth, it will probably spread more rapidly and farther than the non-flying biocontrol agents that have been released. However, it can not leave its habitat or the area that fits its climatic requirements.

#### 6.6. CUMULATIVE IMPACTS

The accumulative environmental impact from the establishment of *C. hungarica* will be to increase plant diversity on humid sites presently dominated by leafy spurge. The moth will help recycle leafy spurge, which is presently a largely unused resource, through other food chains. **However, the main effect on native wildlife, both vertebrate and invertebrate, will be to increase diversity as the result of the increased plant diversity.**

Biocontrol of leafy spurge will reduce the use of herbicides on uncultivated areas. The moist habitat of *C. hungarica* is particularly sensitive as picloram is highly water soluble and so leaches into streams and ponds (Gassman, *et. al.*, 1991). It is not registered for use near water but is being applied illegally in these sites. Thus, the biocontrol of leafy spurge near water will be extremely valuable for reducing a herbicide problem.

### 7. Mitigative measures

It is not foreseen that any measures to mitigate the effects of *C. hungarica* will be necessary or desirable. However, if for some reason it should become necessary to decrease the number of *C. hungarica*, the method of control currently used by APHIS (Animal and Plant Health Inspection Service) against grasshoppers, could be used effectively. In general, the most

satisfactory and consistent results are obtained by the use of ultra-low-volume (ULV) sprays. One treatment would not eradicate the insect. Instead, three separate treatments at a minimum should be used. There are many different insecticides that could be used, but the three that would probably work best are Malathion ULV, Carbaryl/Sevin-4-Oil, and Carbaryl/ULV. The same treatment methods and dosage that are currently used to control grasshoppers could also be used to control *C. hungarica*.

<u>Insecticide</u>	<u>Dosage</u>	
	<u>Per hectare</u>	<u>Per acre</u>
Malathion ULV 91.0 -95.0% AI	428 ml ULV (0.65 Kg AI/hectare)	8.0 fluid oz. ULV (0.58 lb. AI/acre)
Carbaryl/ Sevin-4-Oil	1.46 liters total material [1.17 liters of formulation plus 292.23 ml diesel] (0.42 Kg AI/hectare)	20 fluid oz. Total material [16.0 oz. formulation plus 4.0 oz. diesel] (.5 lb. AI/acre)
Carbaryl/ULV	2.34 liters total material [876.90 ml of formulation [plus 219.22 ml of diesel] (0.42 Kg AI/hectare)	15.0 fluid oz. total material [12.0 oz. of formulation plus 3.0 oz. diesel] (0.375 lb. AI/acre)

## 7. Conclusion

The moth *C. hungarica* has a narrow host range and climatic and habitat requirements that will restrict it to leafy spurge in moist habitats in a steppic biome near the Canada-USA border. In fact, the host range of *C. hungarica* is more restricted than any other agent approved for the biocontrol of spurge in North America. *C. hungarica* is the only root borer that has been found on spurges of the *E. esula-virgata* complex in moist habitats. Thus, it should fill an empty niche in the complex of agents established on North American *E. esula* (sensu lato).

There will be no direct adverse effect on the native fauna and flora. In fact, they should benefit indirectly as the competition and density of leafy spurge declines. There are no adverse physical effects on the environment and any reduction in the leaching of picloram used for the control of spurge on stream and pond banks will be beneficial. Therefore, the release of *C. hungarica* in the United States is recommended.

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