

ENVIRONMENTAL ASSESSMENT

I. Cover Sheet

Title of Project: Host Plant Specificity testing of Dasineura sp. near capsulae Keiffer (Cecidomyidae) against Euphorbia species which are Native to North America.

Proposed Action: Petition being submitted to obtain approval for the introduction of Dasineura sp. near. capsulae into the United States to assist in the biological control of Leafy Spurge, Euphorbia esula complex.

Date: May 18, 1990

Applicant Names: Norman E. Rees
Research Entomologist
USDA, ARS, RWL
Biological Control of Weeds Research Unit
402 Culbertson Hall
Montana State University
Bozeman, MT. 59717
(406) 994-6405

Robert W. Pemberton
Director
USDA-ARS
Asian Parasite Laboratory
Seoul, Korea
April 1989

Lloyd Knutson
Research Leader
USDA/ARS
Biological Control of Weeds Laboratory-
Europe
Rome, Italy

M. Cristofaro
Research Entomologist
USDA/ARS
Biological Control of Weeds Laboratory-
Europe
Rome, Italy

P. Pecora
Collaborator
USDA/ARS
Biological Control of Weeds Laboratory-
Europe
Rome, Italy

II. Table of Contents

I. Cover Sheet 1

II. Table of Contents 2

III. Abstract. 4

IV. Introduction. 5

V. Purpose and Need. 7

 A. Description of the Program,
 Project, or Proposal. 7

 B. Description of the Organism(s)
 to be Released. 14

 C. Description of Organism(s)
 Targeted for New Biocontrol
 Agents. 22

 D. Alternatives Within Proposal-
 Alternative methods of contain-
 ment or release to minimize risk. . . . 24

 E. Site-Specific Description. 24

VI. Affected Environment and Environmental Consequences.

 A. General. 25

 B. Physical Environment 25

 1. Air 25

 2. Water 25

 3. Land. 25

 C. Human Health Risks 25

 D. Ecological Relationships 25

 1. Wildlife. 25

 2. Endangered and Threatened Species . 26

 3. Nontarget Invertebrates 26

 4. Other Biocontrol Agents 26

 5. Pollinators 26

 E. Cumulative Impacts 26

VII. Mitigative Measure. 27

VIII. Conclusions 28

IX. Consultation and Coordination 29

X. List of Preparer. 30

XI. References. 31

XII. Appendices

 A. List of Release Areas. 34

B. Map 34

C. Application and Permit to Move
Live Plant Pests and Noxious
Weeds (PPQ 526) 34

D. Letters of Authorization, Permits,
etc. from State agencies. 34

III. Abstract

The gall midge Dasineura sp. near capsulae Kieffer, whose larvae cause galls to form on flower buds of Euphorbia spp., was selected as a candidate agent for the biological control of leafy spurge, E. esula complex, a plant species complex of Eurasian origin that has become a noxious weed in North America. Studies indicated that this midge is univoltine, with adults appearing in the field from early April until late May, and living 2-4 days. Eggs are laid in the inner part of the bracts and galls are produced preventing seed production in the infested flowers. In late June and early July, mature larvae depart the galls, and hibernate in the soil until the following spring where they pupate only 2-4 days before they emerge as adults. Host specificity tests of D. sp. near capsulae were made using 48 test plants in 17 families. The midge oviposited on 13 test plants (all in the genus Euphorbia) and on the controls (E. esula). Ten of these test plants were in the subgenus Esula and one each in the subgenera Agaloma, Euphorbium, and Poinsettia. The midge completed development on only 6 test plants on which it oviposited, all of the subgenus Esula. The only native Euphorbia species which supported galls and larval development of D. sp. near capsulae was E. incisa, which belongs to the section Esula, as does leafy spurge. The restricted host range of this insect suggests it would be safe to use as a biological control agent against leafy spurge in North America.

IV. Introduction

Leafy spurge is of Eurasian origin and has become an dominant species on rangelands and pastures, displacing useful forage plants in North America. It is also a poisonous plant, producing an irritant that causes dermatitis to men and animals (Kingsburg 1964). Cattle usually refuse leafy spurge as food unless it is given to them in weedy hay or when better forage is not available. A conservative estimate of loss in the United States, in terms of expenditure for controlling leafy surge and loss of productivity in 1979 was 10.5 million annually (Noble et al. 1979) Derscheid and Wrage report that the problem is most severe on undisturbed lands, but on cultivated cropland areas where leafy spurge has been controlled, it can reduced crop yields from 10 - 100% (Derscheid and Wrage, 1972).

There are 111-112 spurges (107 Euphorbia and 4-5 Chamaesyce spp.) native to America north of Mexico. Among these are 9 rare species which are under review by the U. S. Department of Interior for listing as legally protected endangered or threatened species. Two others, E. garberi and E. deltoides currently have federal protection.

The Euphorbia floras of North America and Europe, to which Dasineura sp. near capsulae is native, are somewhat different. In Europe, all but 4 of 105 native Euphorbia belongs to the subgenus Esula, the group to which the target leafy spurge belongs. The other 4 species are members of the subgenus Chamaesyce. In addition to the subgenus Esula with 21 species, North America has the subgenera Agaloma with 26 species, Poinsettia with 3 spp. and Chamaesyce with 57 species. All of the probable host records (Euphorbia esula, E. cyparissias, E. platyphyllos and E. virgata) in the literature for Dasineura sp. near capsulae and other Euphorbia feeding insects from Europe are from plants belonging to the subgenus Esula and therefore provide no indication of whether the North American Poinsettia, Agaloma and Chamaesyce spurges could become hosts. It must be noted that the published host records may be based on misidentification of insects.

Testing representatives of the subgenera of the genus Euphorbia is not only a useful method of dealing with the large number of species in the genus, but is also a natural method to examine the groupings which reflect true phylogenies within the genus. Many of the Euphorbia feeding insects respond to these subgenera, accepting as host plants most of the species in one or more of the subgenera while rejecting the species in other subgenera. These subgenera were the basis for selecting test plants and for providing the conceptual framework to judge the host plant specificity of Dasineura sp. near capsulae within the genus Euphorbia.

Within the midge complex associated with Euchorbia spp. in

Europe, there are four species that produce capsule-like galls: Dasineura capsulae Kieffer, D. loewi (Mik), D. cornifex (Kieffer) and D. euphorbiarum (Kieffer). All of these are described in Kieffer 1901, 1909, and Houard 1908. Recently, Solinas & Pecora (1984) suggested that of this complex, "only two good species (D. capsulae and D. loewi) may remain." Dasineura capsulae was recorded from E. cyparissias L., E. esula L., E. nicaeensis, E. pithyusa L. (Kieffer 1901, Houard 1908), E. falcata L., and E. lucida Waldstein & Kitaibel (Buhr 1964). Dasineura loewi was reported by Buhr (1964) on E. sequierana Necker.

The biology and host plant range of D. sp. near capsulae were studied from material collected from capsule like galls on E. esula at San Rossore (central Italy). According to Gagné, midges from E. esula have a shorter ovipositor than those specimens described by Solinas & Pecora (1984), that emerged from E. cyparissias galls collected only at San Rossore. Because the taxonomy of this midge complex associated with Euphorbia spp. in Europe is not yet clear, Gagné suggests calling the midge from E. esula "Dasineura sp. near capsulae" until it is properly described and named. These midges studied were identified taxonomically by the leading North American specialist, Dr. R. J. Gagné, USDA Systematic Entomology Laboratory (SEL).

The purpose of this host plant specificity testing was to determine the potential host range of Dasineura sp. near capsulae if this midge were to be released in the United States to assist in the biocontrol of leafy spurge. The USDA's Rome laboratory tested European Euphorbia species and 3 North American species (E. maculata, E. marginata, and E. supina) and established specificity to the genus Euphorbia with the probability of restriction within this group. On this basis, D. sp. near capsulae was brought into quarantine at the USDA's Albany laboratory to test within the genus, which it did, establishing specificity to the subgenus Esula.

V. Purpose and Need

The objective of releasing Dasineura sp. near capsulae is to establish another biological weed control agent to assist in biological control of the leafy spurge complex which afflicts southern Canada and the northern part of the United States. The influence of this biological control agent would be to depress seed production of leafy spurge.

A. DESCRIPTION OF THE PROGRAM, PROJECT, OR PROPOSAL.

The following studies were conducted at the USDA, ARS facilities in Rome, Italy, by P. Pecora, M. Cristofaro, and M. Stazi between 1983 and 1985, and in Albany, California, by R. Pemberton and G. Johnson in 1986.

I) LIFE HISTORY AND HABITS STUDY (ROME)

Inspections were made at San Rossore (Pisa), Italy on April 2, April 19, May 2, May 26, June 15, and July 10, 1983, to determine the oviposition period of D. sp. near capsulae and the phenology of the galls that it produced. At each inspection, a sample of either 100 flower buds or 50 galls of various sizes was randomly collected from 10 randomly chosen plants of E. esula. Due to the maturation of the flowers and galls, only flower bud samples were made in April, flower and flower bud samples were taken in May and June, and only galls were collected in July. Buds and galls were dissected under a dissecting microscope, and the number of eggs, living and dead larvae, and parasites of the gall midge were recorded. Width and length measurements were taken of a sample of 25 mature galls collected on July 10.

Bud galls collected in the second half of June, 1982, 1983, and 1984 contained larvae of various stages. These galls were stored in a laboratory refrigerator in a closed polyethylene bag at a temperature of 4^o-6^o C for 4-5 days. The low temperature and high humidity allowed the mature larvae to leave the galls. Using a fine brush, these mature larvae were transferred to 4500-ml acrylic containers with a 2 cm- deep layer of moistened peat moss and fine sand mixture on the bottom which provided a suitable substrate for the diapausing insects. Each box was covered by a plastic lid which had a 2 cm diameter center hole plugged with cotton, to allow some air exchange. Three containers, each with 200 mature larvae of D. sp. near capsulae were prepared and held undisturbed in an outdoor insectary until the spring when adult emergence started. Containers were then checked daily and the emerged adults and associated parasites were collected and their numbers recorded.

To determine adult longevity and egg production per female,

newly emerged adults which emerged in 1983 were collected with a mouth aspirator and placed in 3200-ml acrylic plastic cages with the tops covered with nylon screen and the bottoms fitted snugly over 1.5-2 cm thick cork or balsa wood disks that had central holes. Euphorbia esula flower buds on growing plants, (6-8/cage) were then passed through these holes, thus allowing the flies to be caged directly on the plant. Cages were supported on plants by fastening them with masking tape to metal rods inserted in the soil of the potted plants. In each of 13 cages, 3-4 flower buds of E. esula were exposed to a male-female pair. Cages were inspected daily and the number of dead insects present were collected and recorded. When all adults had died, flower buds were dissected and the number of eggs found on each were recorded. Percent egg fertility and the pre-eclosion period were determined from a sample of 507 newly laid eggs, kept in 128-ml plastic hatching containers. These containers were cups which had a 2 ml thick layer of moist plaster of Paris on the bottom and were closed by plastic caps.

Development time from neonate to mature larva was determined by preparing eighteen 300 ml acrylic cages and exposing 15-20 flower buds to adults of D. sp. near capsulae (3 females, 2 males/cage). These studies were conducted between June 20 and July 10 in the laboratory at 20⁰⁻²⁴° C temperature and natural lighting and photoperiod. Exposed flower buds in 3 of the cages were dissected every week, the number of galls recorded, and larvae were preserved in 70% alcohol for later measurement of length and width. Mean length of these larvae were grouped by weeks and separated by a t test.

Biometric data of all stages of D. sp. near capsulae were recorded. Width of preserved larvae was taken at the widest part, while the width of the pupae and adults was taken on the first abdominal segment. Adult lengths were exclusive of antennae and ovipositor.

II) HOST SPECIFICITY TESTING

a) MULTIPLE CHOICE HOST SUITABILITY TEST (FIELD) (ROME)

First tests were conducted in 1984 and 1985 by the USDA-ARS's Rome laboratory with 48 plant species or varieties in 17 families to determine the host plant range of Dasineura sp. near capsula. Species closely related to Euphorbia (order Euphorbiaceae), plants in the other orders of the superorder Rosidae, and plants attacked by other species of Dasineura were included in this test plant spectrum. Heywood's Flowering Plants of the World (1978) was used as a guide in constructing the host specificity test plant list.

Table 1. List of plant species or varieties tested with D. sp. near capsulae.

TEST PLANTS

1) Plants related to leafy spurge (Euphorbiaceae)

<u>FAMILY</u>	<u>SUBGENUS</u>	<u>SPECIES</u>
Euphorbiales	Esula	<u>Euphorbia esula</u> L. Italy Check <u>E. esula-virgata</u> Nebraska <u>E. esula-virgata</u> Wyoming <u>E. esula-virgata</u> Montana <u>E. lucida</u> Waldstein & Kit. <u>E. terricina</u> L. <u>E. cyparissias</u> L. <u>E. amygdaloides</u> L. <u>E. dendroides</u> L. <u>E. helioscopia</u> L. <u>E. characias</u> L. <u>E. peplus</u> L. <u>E. lathyris</u> L. cv Chico <u>E. lathyris</u> L. cv Castro Valley
	Agaloma	<u>E. marginata</u> Pursh
	Poinsettia	<u>E. pulcherrima</u> Willdenow
	Chamaesyce	<u>E. maculata</u> L. <u>E. supina</u> Rafinesque-Schmaltz <u>E. serpyllifolia</u> Persoon
	Euphorbium	<u>E. milii</u> Ch. des Moulins <u>Ricinus communis</u> L. <u>Mercurialis annus</u> L.

2). Plants attacked by other species of the genus Dasineura.

<u>ORDER</u>	<u>FAMILY</u>	<u>SPECIES</u>
Geraniales	Linaceae	<u>Linum narbonense</u> L.
Rosales	Rosaceae	<u>Rosa</u> sp. <u>Crataegus oxycantha</u> L.
Capparales	Cruciferae	<u>Alyssum saxatile</u> L.
Fabales	Leguminosae	<u>Trifolium incarnatum</u> L.

3). Plants in other orders of the superorder Rosidae.

<u>ORDER</u>	<u>FAMILY</u>	<u>SPECIES</u>
Rosales	Rosaceae	<u>Potentilla fragiformis</u> Willdenow <u>Geum urbanum</u> L.
Fabales	Leguminosae	<u>Cytisus</u> sp. <u>Phaseolus vulgaris</u> L.
Myrtales	Onagraceae	<u>Clarkis elongens</u> Douglas
Sapindales	Rutaceae	<u>Ruta graveolens</u> L.
Geraniales	Geranaceae	<u>Pelargonium zonale</u> (L.) Aiton

4). Additional economic or ornamental plants which also provide superorder representation.

<u>ORDER</u>	<u>FAMILY</u>	<u>SPECIES</u>
Ranunculales	Ranunculaceae	<u>Anemone</u> sp.
Caryophyllales	Caryophyllaceae	<u>Dianthus</u> sp. <u>Phaseolus vulgaris</u> L.
Capparales	Cruciferae	<u>Iberis sempervirens</u> L.
Gentianales	Apocynaceae	<u>Nerium oleander</u> L. <u>Vinca major</u> L.
Lamiales	Verbenaceae	<u>Verbena hybrida</u> Voss
	Labiatae	<u>Thymus serpyllum</u> L.
Scrophulariales	Scrophulariaceae	<u>Veronica teucrium</u> L.
Asterales	Compositae	<u>Tagetes glandulifera</u> Schrank <u>Centaurea cineraria</u> L. <u>Carthamus tinctorius</u> L.
Commelinales	Gramineae	<u>Hordeum vulgare</u> L. <u>Triticum aestivum</u> L.
Liliales	Liliaceae	<u>Lilium</u> sp. cv. Tabasco

The objective of this portion of the experiment was to determine if field collected adults of D. sp. near capsulae would select any of the exposed test-plants as hosts in field studies. Therefore, tests were conducted on a hunting preserve at San Rossore, Pisa, Italy, where a population of this midge and its host (E. esula) occur naturally.

The 1983 experimental field site was 500 m² (10 x 50 m) situated along a canal, and contained dense stands of E. esula plants, 50% of which contained Dasineura sp. near capsulae galls. Three plots each 4.00 m x 4.00 m were established. The experimental design for each plot was a randomized complete block consisting of 5 treatments (three test-plants, and control plants A and B) repeated five times (total of 25 blocks). Leafy spurge biotypes from Nebraska, Montana, Wyoming and Oregon; Euphorbia peplus, E. milii, E. characias, E. pulcherrima and Linum narbonense were included in the trial.

Test plants and control (control A) plants were grown at the Rome Laboratory in 22 cm diameter plastic pots until the preflower stage was attained. They were then taken to the Pisa test site where the pots were buried in the ground with their tops at soil level in the naturally occurring leafy spurge infestation.

"Control A" plants were E. esula plants obtained earlier from San Rossore transplanted into the same size pots as the test plants, while "Control B" plants were randomly selected E. esula plants left growing naturally in the test site. All E. esula plants not designated as "Control B" were removed.

Weekly observations were made from mid-April to the end of May to follow the occurrence and development of the galls. At the beginning of June as the galls reached maturity, the number of plants present in each block plus the number of flowers and galls per plant were recorded.

b) NO CHOICE OVIPOSITION AND HOST SUITABILITY TEST (LABORATORY) (ROME)

Forty eight plant species/variéties (Table 1) were tested in a no choice oviposition and host suitability test to determine the range of plants that Dasineura sp. near capsulae would accept for oviposition and which plants would support the development of the midge.

Three-hundred galls, containing 2,082 larvae of Dasineura sp. near capsulae, were collected on June 11, 1983, and the insects were divided into 10 groups, each group being placed in a previously prepared plastic container. Another 1,275

galls collected at San Rossore on June 23, 1984, produced 9,000 larvae which were divided into 20 plastic containers.

All containers were held in an outdoor insectary and checked weekly until adult emergence was noticed, then they were checked daily. Newly emerged adults were transferred onto plants in plastic cages. Due to the shortage of freshly emerged adults, all plants could not be tested simultaneously so they were divided into groups and each group was tested using insects emerged the same day. A range of 8-25 flower buds per cage were exposed to 4-6 adult midges and 3-4 replications were made for each test-plant, one cage serving as a replicate.

Plants with caged midges were held in a laboratory room where the ambient temperature ranged between 21^o-25^o C until the midges died. Flower buds were then dissected until eggs of Dasineura sp. near capsulae were found in one or two of them, and then the remaining buds were left undisturbed. Infested plants in their pots were transferred to the garden. Eggs recovered from bud dissections were placed in plastic hatching containers to determine the percent of egg hatch. As eclosion occurred, neonate larvae were counted and the number recorded.

In April and May of 1984 and 1985, galls produced by Dasineura sp. near capsulae on the test-plants as well as on the controls were counted and dissected, and the number of living and dead midge larvae and parasites per gall were counted and recorded.

Adults of Dasineura sp. near capsulae emerging in the spring of 1984 were used to test different North American biotypes of leafy spurge, while the adults which emerged in the spring of 1985, were used to test the other plants on the list.

c) NO CHOICE HOST SUITABILITY TEST (LABORATORY) (ROME)

Adults of Dasineura sp. near capsulae were used on species of test-plants on which oviposition occurred in the former trials. Euphorbia lucida was not included because of a shortage of plants. North American biotypes of leafy spurge were tested in April and May of 1984, and the remaining plants were tested in April and May of 1985.

Emerging adults were placed (2 males with 2 females) into plastic cages. Due to a shortage of freshly emerged adults, test plants were grouped as in the previous experiment. Three replications were made for each test plant species. Tests were conducted in a laboratory room with natural light and an ambient temperature between 20^o and 25^o C. After the insects died (ca. 3-4 days), cages were removed and the plants were moved out of doors to a shaded area in the laboratory garden

and left undisturbed. Observations were made to determine formation of the galls.

All Rome data were subjected to analysis of variance (ANOVA) and the Student-Newman-Keuls (a posteriori) test was used for separation of the means.

d) NO CHOICE OVIPOSITION AND HOST SUITABILITY TEST
(LABORATORY) (ALBANY)

Test plants were selected to represent the four different subgenera (Agaloma, Chamaesyce, Esula, and Poinsettia) of the genus Euphorbia which occur in North America. These were grown in 15 cm fiber pots, from seeds, cuttings and root pieces. The soil used was "UC mix" modified to match the edaphic conditions of the specific test species.

Table 1b:

TEST PLANTS

Native plants related to leafy spurge (Euphorbiaceae)

<u>GENUS</u>	<u>SUBGENUS</u>	<u>SPECIES</u>
<u>Euphorbia</u>	<u>Esula</u>	<u>E. incisa</u> Engelm.
		<u>E. purpurea</u> (RAF.) Fernald
		<u>E. roemerana</u> Scheele
		<u>E. spathulata</u> Lam.
	<u>Agaloma</u>	<u>E. corollata</u> L.
		<u>E. marginata</u> Prush
	<u>Chamaesyce</u>	<u>E. hooveri</u> L. C. Wheeler
		<u>E. maculata</u> L.
		<u>E. serphylliflora</u> Pers.
		<u>E. supina</u> Rafinesque
<u>Poinsettia</u>	<u>E. heterophylla</u> L.	
	<u>E. pulcherima</u> Willdenow *	

* not native to North America

Most all of the adult Dasineura sp. near capsulae used in the tests were collected from San Rossore in June of 1985 by personnel from the USDA's Rome laboratory. Freshly emerged adult gall midges were sexed and placed in standard wooden and screen sleeve cages (76" x 48" x 43") with a single test plant species. The test midges were observed to detect oviposition behavior. Numbers of galls formed on each test plant were

noted along with the number of larvae developing to last instar. Due to the space limitations of the Albany quarantine, the varying availability of the plants in acceptable flower bud stage and the sporadic emergence of the midges, 2 tests were necessary to complete the studies.

B. DESCRIPTION OF THE ORGANISM(S) TO BE RELEASED.

The genus Dasineura (Rondani, 1840) is in the family Cecidomyiidae (Diptera), subfamily Cecidomyiinae, supertribe Oligotrophidi, and tribe Dasineurini (Ruebsaamen and Hedicke 1925-1939). This genus is comprised of about 300 species. Buhr (1964) lists 205 species distributed in northern and central Europe while Stone et. al. (1965) lists 95 species in America north of Mexico.

This species, D. sp. near capsulae, has not been formally described. It is very close to the species Dasineura capsulae Kieffer, and therefore is presently referred to as Dasineura sp. near capsulae. Since testing of this species occurred using specimens collected from the San Rossore, Italy, all collections for release will be made at San Rossore and identified by Dr. Ray Gagne until such time as a formal description of this species is published. Voucher Specimens. Specimens from this study, labeled BCWLE-87-2, and identified by Dr. R. J. Gagné, USDA Systematic Entomology Laboratory, are in the National Museum of Natural History, Washington, D. C., and the BCWLE collection.

I) LIFE HISTORY AND HABITS (ROME)

Dasineura sp. near capsulae Kieffer is a univoltine Cecidomyiid fly. In 1983-1985, adults near San Rossore began to emerge ca. mid-April, peaked in late April, and continued to emerge until mid-May. Adults had a reddish yellow body with brown sclerotized parts. Females were 2.32 ± 0.09 mm long and 0.41 ± 0.02 mm wide (n=10) while males were 1.69 ± 0.06 mm long and 0.41 ± 0.02 mm wide (n=2). Mating usually occurred on the day of emergence, and females started to oviposit within 24 hours. Eggs were laid in the inflorescence between the bracts and the cyathium in groups (35.6 ± 7.8 eggs per group, n = 18; range 15-40). This generally required 15 to 25 minutes. Occasionally, eggs were laid inside the cyathium. Newly deposited eggs were white, slightly elongate, with rounded ends, translucent, with soft chorion, measuring 0.27 ± 0.02 mm long by 0.07 ± 0.01 mm wide (n=40). Preeclosure period was 3-5 days, with 92.3% of 507 eggs being fertile.

Mature galls were located in the field from early May to late June. In periodic dissections of field-collected bud and gall

samples from E. esula in 1983, first larvae of D. sp. near capsulae were found in early May, either in the inner part of the bracts which cover the cyathium or inside the cyathium, where the process of gall formation was beginning. Since newly hatched larvae from eggs deposited between the bracts and the cyathium were located either between the bracts on the upper part of the cyathium, or inside the cyathium, the neonate larvae apparently move into the small cup-shaped cyathium after hatching. The mean number of larvae per gall was not significantly ($P>0.05$) different between the various samples collected in May. Significantly ($P<0.05$) fewer larvae were found on the samples taken in June and July. Four, 12 and 24 empty galls were found in the samples taken on 26 May, 15 June, and 10 July, respectively. The great increase of empty galls recorded in June and July was because at that time, several mature larvae had already left the galls and entered the soil to hibernate until next spring. Larvae completed development in 5 weeks, by the end of which the larval body was yellowish and the sternal spatula was distinct and well formed. Length and width measurements recorded in the periodic observations from neonate to mature larvae are presented in Table 2.

 Table 2. Measurements of larvae of D. sp. near capsulae at weekly intervals, April-May 1983.

Intervals	No. specimens examined	Length, mm, $\bar{x}\pm SD$	Width, mm
Week 1	95	0.29 \pm 0.03a	0.08 \pm 0.00a
Week 2	78	0.33 \pm 0.02a	0.08 \pm 0.00a
Week 3	63	0.72 \pm 0.23b	0.16 \pm 0.03b
Week 4	57	1.36 \pm 0.31c	0.34 \pm 0.09c
Week 5	65	3.10 \pm 0.19d	0.79 \pm 0.09d

Means in columns followed by the same letter are not significantly different ($P>0.05$, Student-Newman-Keuls [a posteriori] test).

Larvae generally departed the galls in periods of high humidity, such as early morning or following rain fall, and burrowed into the soil and hibernated as larvae until next spring when they pupated just 2-4 days before emerging as adults. In the laboratory, overwintered larvae moved to the surface of the diapausing substrate in early April and then pupated. Pupae were 2.04 ± 0.18 mm long and 0.59 ± 0.03 mm wide ($n=10$), and were light red except for the reddish brown wing and leg appendages.

Mean adult emergence was $18.7 \pm 3.03\%$ (range, 15.3-21.2%) from 600 mature larvae from galls collected on E. esula in 1982, and further collections made in 1983 (2,082 larva) and 1984 (9,000 larvae). The mean percentage of larvae parasitized by the endoparasite Inostemma sp. (Hymenoptera: Platygasteridae) was $30.9 \pm 10.9\%$ (range, 19.4-41.3%), whereas the remaining larvae ($50.4 \pm 8.18\%$; range: 43.4-59.4%) died as the result of parasitization by the ectoparasite Pseudotorymus sp. (Hymenoptera: Torymidae) or by the action of unknown factors (i.e. disease, predation, undesirable hibernating conditions).

Periodic dissections of bud and gall samples collected at San Rossore to investigate the life cycle of D. sp. near capsulae produced the following results:

Only buds were present on E. esula plants in April, and the mean number of eggs per bud deposited on the buds sampled April 19 and May 2 was not significantly different ($p > 0.05$), while a significantly ($P > 0.05$) fewer number of eggs per bud were found on the buds collected May 11. First galls were located on May 2, but the majority (ca. 80%) were still in an early stage of development.

On July 10, only mature galls were found and they had a mean length of 8.26 ± 1.51 mm (range = 5.60 - 12.40 mm) and a mean width of 5.06 ± 0.95 mm (range = 3.68 - 6.80 mm) ($n=25$). The mean number of larvae found per gall was not significantly ($p > 0.05$) different between the various samples collected in May. A significantly ($p < 0.05$) lower number of larvae was found on the samples taken in June and July. In a sample of 50 galls taken on July 10, half of them were empty, 17 contained both mature larvae of D. sp. near capsulae and parasite pupae and 7 had only D. sp. near capsulae larvae; in one gall a single parasite adult was found. The results of these dissections are presented in table 3.

The study conducted to determine the larval development of D. capsulae generated the following information: From 54 buds of E. esula dissected a week after the beginning of the experiment, 21 were infested with young larvae measuring 0.29 ± 0.03 mm in length and 0.077 ± 0.007 mm in width ($n=95$). By the end of the second week, the bracts of the leafy spurge flower still covered the cyathium which showed a thickening of the walls. Forty-eight flower buds which were young galls were dissected and 15 of them were infested by D. capsulae larvae (length = 0.33 ± 0.02 mm; width 0.08 ± 0.03 mm; $n=78$). The length of the second week larvae was not significantly different ($P > 0.05$) from that of the larvae measured during the first week.

By the third week, it was possible to recognize the infested flower buds because the bracts had started to open and the

cyathium had become enlarged and reddish. Sixty three larvae of 16 flower buds measured 0.72 ± 0.23 mm long by 0.16 ± 0.03 mm wide and were significantly longer ($P < 0.05$) than the second week larvae.

 Table 3. Periodic dissections of flower buds and galls of D. sp. near capsulae collected on E. esula at San. Rossore, Italy.
 =====

Date	No. buds w/ eggs	No. eggs/bud $x \pm SD^b$	Range	Larvae/gall $x \pm SD^b$	Range
2 April	0	0		NP	
19 April	12	29.4 ± 10.5^a	17-50	NP	
2 May	15	25.9 ± 12.8^{ab}	8-45	13.6 ± 7.2^a	4-35
11 May	5	14.4 ± 6.3^b	7-21	11.2 ± 5.6^{ab}	3-30
26 May	0	---	---	12.3 ± 6.4^{ab}	0-25
15 June	0	---	---	9.3 ± 7.6^b	0-24
10 July	NP	0	---	5.0 ± 6.3^c	0-25

Means in columns followed by the same letter are not significantly different ($P < 0.05$, Student-Newman-Keuls [a posteriori] test).

^a Based on sample of 100 flower buds; NP, buds not present.

^b Calculated on number of flower buds with eggs.

^c Calculated on a sample of 50 galls; NP, galls not present.

 By the end of the fourth week, bracts were almost completely opened and the well-formed galls were visible. Fifty seven larvae from 10 galls measured 1.36 ± 0.31 mm long by 0.34 ± 0.09 mm wide were again significantly longer than the third week larvae. By the end of the 5th week, the bracts had dropped from the inflorescence and the galls were mature. Sixty five larvae collected from 18 galls measured 3.10 ± 0.19 mm long by $0.79 \pm$ mm wide, and again were significantly longer than those of the fourth week.

At the end of the sixth week, eight mature galls were dissected and the 48 orange colored larvae measured 3.09 ± 0.35 mm long by $0.79 \pm$ mm wide. The length of these larvae was not significantly different ($P > 0.05$) from those measured during the 5th week. These mature larvae were almost ready to leave the galls to hibernate into the soil until next spring.

The major effect of D. sp. near capsulae on the host plant is to prevent flowering and therefore reduce seed production. Galls produced by D. sp. near capsulae are

formed in several ways. Normally they are produced by the enlargement and distortion of the cyathium, but occasionally they are created by the deformation of the bracts which cover the cyathium, or a deformation of the leaves of the meristematic tips.

II) HOST SPECIFICITY TESTING

a) MULTIPLE CHOICE HOST SUITABILITY TEST (FIELD) (ROME)

Data obtained in the multiple choice test conducted at San Rossore are summarized in Table 2. In plot No. 1, the mean number of flowers/plant of the Nebraska biotype was not significantly different ($P>0.05$) when compared with the number of flowers of both controls (A and B). A significantly greater ($P<0.05$) number of flowers occurred on E. pepulus and E. characias. The number of flowers on naturally occurring plants (Control B) was significantly greater ($P<0.05$) than on those potted plants in Control A. Galls were located only on the two controls and it was noted that the number of galls produced per plant and the percentage of galled flowers/plant was significantly greater ($P<0.05$) on Control B than on Control A.

In plot No.2, the number of flowers/plant on the test plants, and in Control A, was significantly ($P<0.05$) smaller than the number of flowers/plant in control B. Galls were produced by the midge on both Oregon and Wyoming biotypes, as well as on both controls. The number of galled flowers/plant was significantly greater ($P<0.05$) on Control B plants than on Control A plants, but there was no significant differences ($P>0.05$) between the number of galls/plant on the potted control plants and the potted Wyoming and Oregon biotypes. There were no significant differences ($P>0.05$) between the percentages of galled flowers/plant on the Oregon biotype and Controls A and B. A significantly ($P<0.05$) lower percentage of galled flowers was found on the Wyoming biotype.

In plot No. 3, the numbers of flowers/plant on E. pulcherrima (Poinsettia) were obviously significantly fewer ($P<0.05$) than on the other test and control plants. Galls were found on the Montana biotype of E. esula-virgata and on controls A and B. The number of galls/plant was significantly higher ($P<0.05$) on control B than on Control A and Montana biotype plants. There were no significant differences ($P<0.05$) in the percentage of galled flowers per plant.

 Table 4. Free-choice host suitability test of *D. sp.* near *capsulae* conducted at San Rossore, 1984.
 =====

Plant Species	No. Plants ^a	No. flowers/ plant, x±SD	Range	No. flowers galled/plant x±SD	Range
Plot 1					
<i>Euphorbia esula</i> L. Italy (Control A)	9	26.2±14.9 ^a	10-60	3.3±2.9 ^a	0-6
<i>E. esula</i> Italy (Control B)	16	61.7±44.1 ^b	16-180	13.1±11.0 ^b	0-40
<i>E. esula</i> Nebraska biotype	6	34.0±18.4 ^{ab}	8-63	0	-
<i>E. peplus</i>	5	209.0±64.3 ^c	164-320	0	-
<i>E. characias</i>	5	111.0±26.1 ^d	81-150	0	-
Plot 2					
<i>Euphorbia esula</i> L. Italy (Control A)	11	33.6±19.5 ^a	10-75	5.2±4.6 ^a	0-17
<i>E. esula</i> Italy (Control B)	16	75.5±43.2 ^b	30-120	15.7±9.1 ^b	0-29
<i>E. esula</i> Oregon biotype	9	30.4±13.7 ^a	20-52	4.4±9.2 ^a	0-28
<i>E. esula</i> Wyoming biotype	9	29.2±12.1 ^a	20-60	2.0±3.1 ^a	0-7
<i>Linum narbonense</i>	14	17.7± 7.0 ^a	7-25	0	-
Plot 3					
<i>Euphorbia esula</i> L. Italy (Control A)	11	38.5±14.9 ^a	20-73	4.9±4.8 ^a	0-15
<i>E. esula</i> Italy (Control B)	12	63.8±42.7 ^a	25-175	13.7±8.4 ^b	0-26
<i>E. esula</i> Montana biotype	9	37.5±27.3 ^a	18-100	3.2±3.9 ^a	0-11
<i>E. milii</i>	5	77.2±26.5 ^a	35-103	0	-
<i>E. pulcherrima</i>	8	8.9±3.9 ^b	6-12	0	-

Means in columns followed by the same letter are not significantly different (P<0.05, Student-Newman-Keuls[a posteriori] test).

^a Control A, potted plants of *E. esula*, Control B, plants of *E. esula* growing naturally in the experimental area.

b) NO CHOICE OVIPOSITION AND HOST SUITABILITY TEST
(LABORATORY) (ROME)

Of the 48 species/varieties of plants tested, *D. sp.* near *capsulae* accepted the controls and 13 taxa for oviposition, all in the genus *Euphorbia*. It was able to

complete larval development on the controls and 6 of the plants on which oviposition occurred. The results are presented in Table 4. Test-plants E. cyparissias, E. dendroides, E. helioscopia, E. marginata, E. milii, E. pulcherrima, and E. terracina had significantly fewer ($P < 0.05$) flower buds than the controls. However, the mean number of flower buds present on the various leafy spurge biotypes in Group I were not significantly ($P > 0.05$) different from the Italian E. esula controls.

In Group I, the mean number of eggs deposited on the control and the test plants was similar ($P > 0.05$). In Group II, there was no significant difference ($P > 0.05$) in the number of eggs laid on E. amygdaloides and E. marginata and the control, but a significantly higher ($P < 0.05$) number was deposited on E. dendroides and E. lucida. In Group III, significantly more ($P < 0.05$) eggs were laid on the control than on the test plants E. cyparissias, E. helioscopia and E. peplus. In Group IV, similar ($P > 0.05$) numbers of eggs were laid on the control and E. terracina; significantly fewer ($P < 0.05$) were laid on E. milii and E. pulcherrima than on the control plants. There were no significant differences ($P > 0.05$) in the percentage of viable eggs deposited on the different test and control plants in any of the groups.

The number of galls produced on the Italian control plant and the Montana and Wyoming leafy spurge biotypes in Group I were not significantly different ($P > 0.05$), but no galls were found on the Nebraska biotype. The number of galls found on E. cyparissias, E. dendroides, E. lucida, and E. terracina was not significantly different ($P > 0.05$) from the number produced on control plants in the corresponding groups.

The percentage of infested flower buds on plants was determined by $GP/FBL \times 100$, where GP = number of galls present, and FBL = flower buds left for gall development. Using this formula, there was no significant difference ($P > 0.05$) between the mean percentages on the test plants and the controls in Groups I, II, and III.

In Group IV, the percentages of galls produced on E. terracina was significantly ($P < 0.05$) greater than on the control plants. No significant differences were detected in the number of larvae found in the galls produced on the test and control plants in any of the Groups.

d) NO CHOICE OVIPOSITION AND HOST SUITABILITY TEST
(LABORATORY) (ALBANY)

Table 5. Results of native host plant specificity testing with *D. sp. near capsulae* at Albany, 1986.

Species (subgenus)	No. Flower Buds Total	No. Plants Galled	No. Galls	No. Larvae Found
<i>E. esula</i> (control)* (<i>Esula</i>)	139	6	29	120
<i>E. incisa</i> (<i>Esula</i>)	114	1	2	11
<i>E. purpurea</i> (<i>Esula</i>)	-	-	-	-
<i>E. roemerana</i> (<i>Esula</i>)	-	-	-	-
<i>E. spathulata</i> (<i>Esula</i>)	-	-	-	-
<i>E. hooveri</i> (<i>Chamaesyce</i>)	-	-	-	-
<i>E. maculata</i> (<i>Chamaesyce</i>)	-	-	-	-
<i>E. marginata</i> (<i>Agaloma</i>)	-	-	-	-
<i>E. corollata</i> (<i>Agaloma</i>)	-	-	-	-
<i>E. heterophylla</i> (<i>Poinsettia</i>)	-	-	-	-
<i>E. pulcherima</i> *	-	-	-	-

* not native to the United States.

Table 5: Summary of *D. sp. near capsulae* host plant specificity testings on native North American species 1986.

Test Species	Subgenus	Total # Plants Tested	Total # Insects Tested	% of Avail buds galled	% of Plants Accept
<i>E. esula</i>	<i>Esula</i>	10	17	21	60
<i>E. incisa</i>	<i>Esula</i>	10	18	2	10
<i>E. roemerana</i>	<i>Esula</i>	10	20	0	0
<i>E. spathulata</i>	<i>Esula</i>	10	18	0	0
<i>E. purpurea</i>	<i>Esula</i>	5	15	0	0
<i>E. maculata</i>	<i>Chamaesyce</i>	10	19	0	0
<i>E. hooveri</i>	<i>Chamaesyce</i>	10	17	0	0
<i>E. corollata</i>	<i>Agaloma</i>	6	11	0	0
<i>E. marginata</i>	<i>Agaloma</i>	10	17	0	0
<i>E. heterophylla</i>	<i>Poinsettia</i>	10	25	0	0
<i>E. pulcherima</i>	<i>Poinsettia</i>	10	17	0	0

Tables 5 & 6 show the results of the tests. The only native *Euphorbiae* species which supported galls and larval development of *D. sp. near capsulae* was *E. incisa*, which belongs to the section *Esula*, as does leafy spurge.

Results of the host specificity testing indicate that D. sp. near capsulae appears to be restricted to a few species in the subgenus Esula, as only one species of the 4 subgenus Esula species of North America was an acceptable host. For this reason it appears that a small portion of the 21 subgenus Esula, Euphorbia species that are native to the United States, could become hosts, even if the midge was able to spread through the United States.

C. DESCRIPTION OF ORGANISM(S) TARGETED FOR NEW BIOCONTROL AGENTS.

Leafy spurge (Euphorbia esula L.) is a aggressive, persistent, deep-rooting perennial plant that grows in a variety of environmental conditions and soil types. It is native to Eurasia and was first reported in the United States in 1827. It now extends throughout much of southern Canada and the northern United States. Leafy spurge produces an acrid latex that causes blistering and irritation on the contacted skin of man and some animals, and causes similar results to the digestive tract when ingested. In cattle, it causes scours and weakness, and in larger ingested amounts, can cause death.

The taxonomic status of the North American leafy spurge complex is in a state of confusion. In a study based on a limited sampling of members of the "esula-aggregate", adventive in North America, Dunn and Radcliffe-Smith (1980) recognized 5 entities: (a) Euphorbia esula L. s. str.; (b) E. esula L. s. l. (E. androsaemifolia Willd.); (c) E. virgata Waldst. and Kit. var. uralensis Fisch. ex Link) Boiss.; (d) E. virgata Waldst. and Kit. var. orientalis Boiss. (E. boissieriana (Woron.) Prohk.); and (e) E. pseudovirgata (Schur.) Soo (E. esula L. X E. virgata Waldst. and Kit.) (E. intercedens Podp., non Pax)(E. podperae Croizat). However, in a recent detailed study, Radcliffe-Smith (1985) recognized 11 species and 10 hybrids as members of the "esula-aggregate" naturalized in North America. According to a recent study by A. Radcliffe-Smith (Personnel communication, Peter Harris), most North American leafy spurge is E. pseudovirgata (E. esula L. x E. virgata Waldst. & Kitt.) with various amounts of back crossing with both parents as well as with E. cyparissias. On the other hand, Harvey et. al. considers that all the north American leafy spurge is the same. (Harvey, et. al. 198)

Dispersal. Leafy spurge occurs in 26 states, with 451 counties being infested (Dunn 1979), and was reported in 1985 to infest ca. one million hectares in the United

Table 6. No-choice oviposition and host suitability test of *D. sp. near capsulae*^a; all values are $\bar{x} \pm SD$ ($n = 4$)

Test plants ^c	No. exposed flower buds	No. eggs/bud	No. flower buds left for gall development	No. galls	% Infestation ^b
Group I, 1984					
<i>Euphorbia esula</i> Italy (control)	26.2 ± 8.9a	24.7 ± 17.6a	21.0 ± 8.4	7.5 ± 6.1a	32.9 ± 31.3a
Leafy spurge Montana biotype	18.5 ± 6.8a	24.5 ± 9.4a	15.2 ± 5.8	6.7 ± 2.5a	44.9 ± 3.8a
Leafy spurge Wyoming biotype	19.7 ± 4.3a	16.0 ± 7.0a	14.5 ± 5.7	6.0 ± 3.7a	38.4 ± 10.6a
Leafy spurge Nebraska biotype	15.7 ± 3.8a	17.8 ± 13.2a	11.2 ± 2.5	—	—
Group II, 1985					
<i>Euphorbia esula</i> Italy (control)	44.5 ± 6.2a	6.7 ± 6.7a	19.7 ± 23.4	6.2 ± 9.4a	35.7 ± 35.1ab
<i>E. amygdaloides</i>	38.2 ± 15.0a	17.7 ± 11.9ab	25.7 ± 20.0	—	—
<i>E. marginata</i>	9.0 ± 2.4b	12.0 ± 15.7ab	5.0 ± 3.5	—	—
<i>E. dendroides</i>	15.5 ± 5.9b	31.4 ± 11.6b	13.0 ± 5.7	2.0 ± 2.4a	12.5 ± 14.4a
<i>E. lucida</i>	37.5 ± 6.7a	29.5 ± 16.7b	24.0 ± 17.7	12.2 ± 8.3a	54.5 ± 19.7b
Group III, 1985					
<i>Euphorbia esula</i> Italy (control)	49.7 ± 9.6a	28.2 ± 6.4a	37.7 ± 3.3	6.2 ± 4.3a	15.9 ± 10.8a
<i>E. cyparissias</i>	21.0 ± 9.5b	9.2 ± 5.7b	12.7 ± 9.6	3.7 ± 4.5a	17.7 ± 20.6a
<i>E. helioscopia</i>	20.0 ± 12.2b	3.7 ± 6.8b	3.2 ± 4.2	—	—
<i>E. peplus</i>	32.5 ± 10.4ab	6.0 ± 7.3b	16.2 ± 19.7	—	—
Group IV, 1985					
<i>Euphorbia esula</i> Italy (control)	31.0 ± 2.6a	12.5 ± 4.1a	25.7 ± 6.1	7.5 ± 5.8a	25.7 ± 19.1a
<i>E. mitis</i>	8.7 ± 4.9b	2.0 ± 4.0b	3.0 ± 6.0	—	—
<i>E. terracina</i>	13.5 ± 11.3b	11.8 ± 17.5ab	6.7 ± 8.9	6.7 ± 8.9a	73.9 ± 8.6b
<i>E. pulcherrima</i>	14.5 ± 3.4b	1.5 ± 3.0b	4.0 ± 8.0	—	—

Means followed by the same letter within a column are not significantly different ($P < 0.05$, Student-Newman-Keuls [a posteriori] test).

^a Other plants tested are listed in the text.

^b Percentage of infestation = $GP:FBL \times 100$ (GP, galls present; FBL, flower buds left for gall development).

States and Canada (Alley and Messersmith).

Target Relatives: There are 111-112 spurge (107 Euphorbia and 4-5 Chamaesyce spp.) native to America north of Mexico. Among these are 9 rare species which are under review by the U. S. Department of Interior for listing as legally protected endangered or threatened species. Two others, E. garberi and E. deltoides, both in the subgenus Chamaesyce, currently have federal protection.

In addition to the 21 species in North America belonging to the subgenus Esula, there are 26 species in the subgenus Agaloma, 3 species in Poinsettia, and 57 species in Chamaesyce. In Europe, all but 4 of 105 native Euphorbia belong to the subgenus Esula, the group to which leafy spurge belongs. The other 4 species are members of the subgenus Chamaesyce.

There are a number of spurge of economic value in North America. Euphorbiae pulcherrima Willd. (Poinsettia) has an annual value of \$54 million and E. antisyphilitica Zucc. is a source of high quality wax in Mexico (USDA, 1977; US Dept. Commerce 1979). There are several species which are of ornamental value, including a sterile diploid form of E. cyparissias. It has also been suggested that European plant, E. lathyris L. could be a potential source of hydrocarbon for the warm dry regions of the United States.

- D. ALTERNATIVES WITHIN PROPOSAL-ALTERNATIVE METHODS OF CONTAINMENT OR RELEASE TO MINIMIZE RISK. Pupae will be shipped to the Bozeman quarantine laboratory in double walled containers. From 4-5% will be removed and sent to an insect pathology laboratory to be checked for disease. Pupae will be kept in cool storage until spring when they will be placed within sleeve cages. First emerging adults will be sampled and sent to Dr. Ray Gagné of the USDA Systematic Entomology Laboratory (SEL) to confirm species identification. Emerging parasites will be separated from the adult D. sp. near capsulae flies and will also be sent to the SEL for identification. Upon confirmation of a disease free colony and proper species identification, emerging adult flies will then be taken to the field daily and released. Because of the short lived adult stage, releases during the first year will be confined to 1-3 sites near Bozeman.

Releases will generally be in open field, in patches of leafy spurge large enough to support populations of the fly, but which are separated from other patches by a distance expected to be sufficient to confine the fly.

Cages 10' x 10' will be used to confine a small number which can be more easily located for specific studies. Monitoring of the release sites will be conducted long enough at each research site to confirm establishment, correlate the life cycle of this species with what is known of it in Europe, and determine what detrimental conditions and organisms effect it in North America.

E. SITE-SPECIFIC DESCRIPTION. Sites will be native grazing lands, with a minimum of 2 acres of leafy spurge. Releases will be made in open areas where the leafy spurge is thick, cattle grazing should have little or no effect, and where no sheep grazing will be allowed. Soil will be sandy to loamy if possible.

VI. Affected Environment and Environmental Consequences.

- A. General. As the result of extensive literature searches, and the results of the biology and host specificity testing, no adverse or negative affect on the environment is anticipated.
- B. Physical Environment
1. Air. There were no published or non published records located of this species, or any member of this family, contaminating any air or altering the air quality in any way.
 2. Water. There were no published or non published records located of this species, or any member of this family, contaminating water or alternating any water quality in any way.
 3. Land. There are no published or non published records located of this species contaminating land or negatively alternating any land quality. It should be noted, on the other hand, that this species should assist other bioagents to reduce the population of leafy spurge. Leafy spurge is a plant of Eurasian origin and has become a dominant species on rangelands and pastures, displacing useful forage plants in North America. It is also a poisonous plant, producing an irritant that causes dermatitis to men and animals (Kingsburg 1964). Cattle usually refuse leafy spurge as food unless it is given to them in weedy hay or when better forage is not available. A conservative estimate of loss in the United States, in terms of expenditure for controlling leafy surge and loss of productivity in 1979 was 10.5 million annually (Noble et al.) The problem is most severe on undisturbed lands, but on cultivated cropland areas where leafy spurge has been controlled, Derscheid and Wrage report that it can reduced crop yields from 10 - 100% (Derscheid and Wrage, 1972).
- C. Human Health Risks. There is no health risk anticipated from the release of this fly since this subfamily is phytophagous, and the family has no vertebrate hosts. No record has ever been made of any detrimental contamination, either in the literature or laboratory records. However, the target organism, the Euphorbia esula complex, does produce a problem. Leafy spurge produces an acrid latex that causes blistering and irritation on the contacted skin of man and some animals, and causes similar results to the digestive tract when ingested. In cattle, it causes scours and weakness, and in larger ingested amounts, can cause death.
- D. ECOLOGICAL RELATIONSHIPS.
1. Wildlife. This species is of no threat to wildlife since this family has no vertebrate hosts. Some

wildlife, such as birds and deer, do feed on the tops of the plant and are responsible for distributing the seeds. Because of birds, early infestations of leafy spurge spring up under trees, where chemical control of the weed is impossible. Leafy spurge also occupies space which generally supports native range plants which are needed for support of wildlife animals. Removal of leafy spurge would allow the land to support higher populations of wildlife.

2. Endangered and Threatened Species. Host specificity testing indicates that there will be no threat to endangered or threatened species of plants. Leafy spurge occupies space which generally supports native range plants. In North Dakota, the presence of leafy spurge is threatening the White Fringed Orchard by crowding it out. Native plants are also needed for support of wildlife animals, including any which may be in rare or minimal in numbers. Removal of leafy spurge chemically could be detrimental for endangered plant and animal species.

3. Nontarget Invertebrates. Because of its size and that it is a phytophagous insect, this species is of no threat to invertebrates.

4. Other Biocontrol Agents. Because of its size, its delicate nature, and the location of larval feeding, this species is of no threat.

5. Pollinators. This species is of no direct threat to pollinators, because it is phytophagous. It will reduce the number of leafy spurge flowers. However, leafy spurge is introduced, and its removal should provide space for (hopefully) native species, which can be utilized by pollinators..

E. CUMULATIVE IMPACTS.

It is anticipated that this species, eventually working in conjunction with other biological agents, will suppress the populations of the plant known as leafy spurge. Reduction of this species would then allow other plants, such as native grasses, forbs, etc, to increase in number and density, which would then allow some lands to be more productive as grazing areas for cattle and other livestock, and for wildlife.

VII. Mitigative Measures.

This species of fly is purposely being introduced to suppress the seed production of the exotic plant, leafy spurge. Should there be any reason to destroy existing field colonies of this fly within the first three years*, the fields which contain larvae and galls may be sprayed with either Tordon or 2,4-D or both. This will kill the top growth of the plants and terminate the larvae by starvation. Since there is only one generation of the fly per year, all larvae would be killed.

* Because of the conditions needed for oviposition of this species, the short lived adult stage, and only one generation being produced per year, a population would not expand excessively during the first three years and would probably be limited to a short distance from the original release point.

VIII. Conclusions.

Host specificity tests of D. sp. near capsulae were made using 48 test plants in 17 families. The midge oviposited on 13 test plants (all in the genus Euphorbia) and on the controls (E. esula). Ten of these test plants were in the subgenus Esula and one each in the subgenera Agaloma, Euphorbium, and Poinsettia. The midge completed development on only 6 test plants on which it oviposited, all of the subgenus Esula. The only native Euphorbia species which supported galls and larval development of D. sp. near capsulae was E. incisa, which belongs to the section Esula, as does leafy spurge. The restricted host range of this insect suggests it would be safe to use as a biological control agent against leafy spurge in North America.

IX. Consultation and Coordination.

M. Cristofaro
Research Entomologist
USDA/ARS
Biological Control of Weeds Laboratory-
Europe
Rome, Italy

Lloyd Knutson
Research Leader
USDA/ARS
Biological Control of Weeds Laboratory-
Europe
Rome, Italy

P. Pecora
Collaborator
USDA/ARS
Biological Control of Weeds Laboratory-
Europe
Rome, Italy

Robert W. Pemberton
Director
USDA-ARS
Asian Parasite Laboratory
Seoul, Korea

Norman E. Rees
Research Entomologist
USDA, ARS, RWL
Biological Control of Weeds Research Unit
402 Culbertson Hall
Montana State University
Bozeman, MT. 59717
(406) 994-6405

X. List of Preparers

Norman E. Rees
Research Entomologist
USDA, ARS, RWL
Biological Control of Weeds Research Unit
402 Culbertson Hall
Montana State University
Bozeman, MT. 59717
(406) 994-6405

Robert W. Pemberton
Director
USDA-ARS
Asian Parasite Laboratory
Seoul, Korea
April 1989

Lloyd Knutson
Research Leader
USDA/ARS
Biological Control of Weeds Laboratory-
Europe
Rome, Italy

M. Cristofaro
Research Entomologist
USDA/ARS
Biological Control of Weeds Laboratory-
Europe
Rome, Italy

P. Pecora
Coordinator
USDA/ARS
Biological Control of Weeds Laboratory-
Europe
Rome, Italy

XI. References.

- Alley, H. and Messersmith, C. G. 1985. Chemical control of leafy spurge. pp 65-78. In A. K. Watson (Ed.), Leafy Spurge. Monograph Series, Weed Sci. Soc. Amer. No.3:103 pp.
- Buhr, H. 1964. Bestimmungstabellen der Gallen (Zoo-und Phytocecidien) an Pflanzen Mittel-und Nordeuropas. V.E.B. Gustav Fisher Verlag. Jena. 2 vols. 1572 pp.
- Derscheid, L. A. and L. J. Wrage. 1972. Leafy spurge. S. Dakota State Univ. Ext. F. S. 449, 4 p.
- Dunn, P. H. 1979. The distribution of leafy spurge (Euphorbia esula) and other weedy Euphorbia spp. in the United States. Weed Sci. 27: 509-516.
- Dunn, P. H., and A. Radcliffe-Smith. 1980 The variability of leafy spurge (Euphorbia spp.) in the United States. Research Report, North Central Weed Cont. Conf. 37:48-53.
- Harris, P. 1973. The selection of effective agents for the biological control of weeds. Canad. Entomol. 105:1495-1503.
- Harris, P., and J. Alex. 197-. Euphorbia esula L., Leafy Spurge, and E. cyparissias L., Cypress Spurge (Euphorbiaceae). Pest Status. In Biological Control Programmes in Canada 1959-1968.
- Harris, P., P. H. Dunn, D. Schroeder & R. Vonmoss. 1985. Biological control of leafy spurge in North America, pp. 79-92. In Weed Sci. Soc. Amer. Monograph 8.
- Harris, P., and J. Soroka. 1988(?). Lobesia (Lobesiodes) euphorbiana (Frr.)(Lepidoptera: Oleuthreutinae): A candidate for the biological control of leafy spurge in North America. Petition (submitted for release of Lobesia euphorbiana into Canada): 36pp.
- Harvey, S. J. Weed Sci. 30:726-733.
- Heywood, V. H. 1978. Flowering plants of the world. Mayflower books, N. Y. 335 pp.
- Houard, C. 1908. Les zoocécidies des plantes d'Europe et du bassin de la Méditerranée, vol. II. Hermann, Paris.
- Keiffer, J. J. 1901. Description de quelques Cecidomyes Nouvelles. Bull. Soc. Hist. Nat. Metz 21: 167-168.
- Keiffer, J. J. 1909. Contributions á la connaissance des insectes gallicoles. Bull. Soc. Hist. Nat. Metz 26:7.

- Keiffer, J. J. 1913. *Deptera, Fam. Cecidomyiidae, Genera Insectorum, 152me Fascicule.*
- Kingsburg, J. M. 1964. *Poisonous Plants of the United States and Canada.* Prentiss Hall Inc., Englewood Cliffs, New Jersey, 626 pp.
- Muemscher, W. C. 1940. *Poisonous Plants of the United States.* Macmillan Co: New York. pp 142-144.
- Noble, D., P. Dunn, and L. Andres. 1979. The leafy spurge problem. *Proc. Leafy Spurge Symposium.* N. Dakota State Univ. Corp. Ext. Serv., Bismark ND.
- Pecora, P., M. Cristofaro, and M. Stazi. 1990. Dasineura sp. near capsulae (Diptera: Cecidomyiidae), a candidate for biological control of Euphorbia esula complex in North America. *Ent. Soc. Amer. Ann.* (in press)
- Pemberton, R. W. 1985. Native plant considerations in the biological control of leafy spurge. pp. 365-90. *In* Delfosse, E. S. (ed.), *Proc. VI, Int. Symp. Biol. Contr. Weeds, Vancouver, Canada.*
- Radcliffe-Smith, A. 1985. Taxonomy of North American Leafy Spurge. *Mono. Ser., Weed. Sci. Soc. Amer.* 3:14-25.
- Rondani, C. 1840. *Sopra alcuni nuovi generi d'insetti Ditteri.* Ann. Acad. Aspir. Parma.
- Ruebsaamen, E. H., & H. Hedicke. 1925-39. *Die Cecidomyiden (Gallmucken) und ihr Cecidien.* Zoologica, Stuttgart, 29: 1-350.
- Smith and Tutin. 1968. Euphorbia. pp. 213-226. *In* Tutin et al. (eds). *Flora Europea, Vol. 2, Rosaceae to Umbelliferae.* Cambridge Univ. Press.
- Solinas, M. & P. Pecora. 1984. The midge complex (Diptera, Cecidomyiidae) on Euphorbia spp. I. *Entomologica* 19:167-213.
- Stone A., C. W. Sabrosky, W. W. Wirth, R. W. Foote, and J. R. Coulson. 1965. *Catalogue of the Diptera of America North of Mexico.* Agric. Handbook N. 276 (USDA, ARS) 1696 pp.
- USDA. 1979. *Agricultural Statistics 1979.* U. S. Govt. Printing Office. Washington, D.C. 603 pp.
- U.S. Dept Commerce. 1979. *International Trade Statistics. Imports Annually for 1979.* I.T.S. U.S.A. Microfiche 245x.

- Webster, 1967. Genera of Euphorbiaceae of the southern United States. J. Arnold Arboretum. 48:363-430.
- Webster, 1975. Conspectus of a new classification of the Euphorbiaceae. Taxon 24: 593-601.
- Wheeler, L. C. 1941. Euphorbia subgenus Chamaesyche in Canada and the United States exclusive of southern Florida. Rhodora 43:97-154; 168-205; 223-268.
- Wheeler, L. C. 1943. The genera of living Euphorbieae. Amer. Midl. Nat. 30:456-503.

XII. Appendices

A. List of Release Areas.

First release area is scheduled to be Cardwell, Montana. Subsequent releases will be throughout the United States by ARS and APHIS.

B. Map.

C. Application and Permit to Move Live Plant Pests and Noxious Weeds (PPQ 526). Already submitted to PPQ.

D. Letters of Authorization, Permits, etc. from State agencies. Already submitted to PPQ.