INFORMATION REQUIRED FOR AN APPLICATION TO RELEASE *PTEROPHORUS SPILODACTYLUS* (LEP: PTEROPHORIDAE) A POTENTIAL BIOLOGICAL CONTROL AGENT FOR THE WEED, HOREHOUND, *MARRUBIUM VULGARE*

TARGET:

Marrubium vulgare L. Horehound

AGENT:

Pterophorus spilodactylus (Curtis) Plume moth

NOMINATING ORGANIZATION:

Victorian Department of Conservation, and Natural Resources

Keith Turnbull Research Institute

P.O. Box 48, Frankston, Vic. 3199

A: INFORMATION ON THE TARGET

1. **NAME AND DESCRIPTION**

(a) Scientific name: *Marrubium vulgare* L.
Genus: *Marrubium*
Species: *vulgare*
Tribe: Marrubieae
Subfamily: Lamioideae (Stachydoideae)
Family: Lamiaceae (Labiatae)
Order: Lamiales
Subclass: Asteridae

(b) Common name: Horehound

(c) Habitat: Erect perennial, up to 0.8 m high but commonly 0.4 to 0.6 m high, primarily 1reproducing from seed.

(d) Description of Target:
Strong growing bushy perennial forb, 30-80 cm high, sharply aromatic when crushed, covered with dense whitish hairs, the stems usually erect, stout, square, woody at the base, rooting at the nodes. *Leaves*; opposite, broadly ovate to round, 1-3 cm diameter, wrinkled, the margins irregularly lobed, the upper surface blueish-green, the lower surface white-woolly, the stalks at least half as long as the blades. *Flowers*; white, small, arranged in dense many-flowered whorls in the leaf axils, tubular, with 2 lips at the end, the upper lip erect and 2-lobed, the lower lip 3-lobed and spreading, the tube slightly longer than the tubular calyx, which is 3-4 mm long, with 10 awl-shaped hooked teeth. *Fruit*; a 4-seeded `burr-like' capsule, enclosed within the persistent calyx with its crown of hooked teeth, the seeds brown, ovoid or triangular, slightly roughened. *Flowering*; mainly spring, sometimes through to autumn.

2. **NATIVE RANGE AND PROBABLE CENTRE OF ORIGIN**

Temperate Eurasia and the Mediterranean region including North Africa. Horehound is found over most of the Middle East and Europe, where it grows as far North as southern Sweden. Its western limit is England and its eastern limit Afghanistan.

3. **DISTRIBUTION**

(a) In Australia, Horehound occurs in all States.

(b) Horehound has established itself in most temperate areas of the world. From its native range it has spread to North and South America, Australia, New Zealand, Africa and Asia. Holm et al. (1979) list Horehound as a weed in 11 countries.

4. **RELATIVES NATIVE TO AUSTRALIA**

There are no native Australian species in the genus *Marrubium* or in the sametribe (Marrubieae). However, there are introduced genera, belonging to the same subfamily, Lamioideae. These include *Ballota*, *Lamium*, *Leonotis*, *Leucas*, *Molucella*, and *Stachys*. There are some native species belonging to a closely related subfamily, Nepetoideae, in the genera *Salvia*, *Mentha*, *Lycopus*, and *Plectranthus*.

(a) Genus *Salvia*;
Salvia plebia R.Br. (Austral Sage)
This plant is distributed throughout eastern Australia from southern Queensland to Victoria.but is generally uncommon.

(b) Genus *Mentha*;
Mentha laxiflora Benth. (Forest Mint)
This plant is widespread in N.S.W., Victoria and is a common species in mountain gullies in the A.C.T.

Mentha diemenica Sprengel (Wild Mint)
Common throughout southeastern Australia and into South Australia and N.S.W.

Mentha australis R.Br. (Australian Mint)
Uncommon in the A.C.T., but is widespread in eastern Australia and Tasmania.

Mentha satureiodes R.Br. (Native Pennyroyal)
It is moderately common in the Darling Downs and Moreton districts of Queensland, N.S.W., Victoria and South Australia.

(c) Genus *Lycopus*;
Lycopus australis R. Br. (Water Horehound)
Relatively common in shaded places in lower mountain gullies in the A.C.T., also Queensland to Tasmania and South Australia.

(d) Genus *Plectranthus*:
15-17 species indigenous to Australia.
Plectranthus parviflorus Willd. (Cockspur Flower)
Widespread and moderately common in a variety of habitats throughout Eastern Australia.
Other species are widespread or generally restricted to mountains and ranges of Queensland, however none are rare or threatened.

More distantly related subfamilies of the Labiatae include the:

Ajugoideae;			
	genera	*Ajuga*	(approx. 5 indigenous species)
		Teucrium	(10 indigenous species)
Scutellariodeae;			
	genus	*Scutellaria*	(2 indigenous species)
Prostantheroideae;			
	genera	*Hemiandra*	(8 indigenous species)
		Hemigenia	(40 indigenous species)
		Microcorys	(17 indigenous species)
		Prostanthera	(approx. 80 indigenous species)
		Westringia	(26 indigenous species)
		Wrixonia	(3 indigenous species)

The taxonomy of the Labiatae is unclear, though most authors agree that the Labiates arose from the Verbenaceae (Cronquist, 1981). Recently Cantino (pers. comm.) suggested that the family Labiateae is polyphyletic (i.e., that the lineage arose from several different groups of Verbenaceae). Thus some genera of Verbenaceae may be more closely related to Marrubium than are some Labiates. The Australian genera of Verbenaceae that appear to be most closely related to Marrubium are; *Gmelina*, *Premna*, *Pygmaeopremna*, and *Vitex*.

5. **PEST STATUS**

(a) Legislation

Victoria - declared a noxious weed for the whole state in 1932 except the Melbourne Metropolitan area.
South Australia - declared a Class II weed.
New South Wales - declared a noxious weed in certain Shires and Municipalities.

Western Australia - declared a P1 weed for the whole state, a P2 weed for all Municipal Districts, Towns and Cities except the Shire of Ravensthorpe and a P3 weed in the Shire of Ravensthorpe.
Tasmania - declared a secondary weed.
A.C.T. - declared a noxious weed.

(b) Nature of damage caused

Horehound is a weed of pasture and crops in southern Australia (Parsons 1973). It is not palatable to grazing animals, due to its bitter taste, and therefore is encouraged by heavy grazing which reduces the vigour of competing plants. Horehound contributes to burr contamination of wool and is usually a component of the vegetable fault of wool. The meat of animals which are forced to eat Horehound is tainted by the plant's strong flavour. There are also reports of Horehound causing stomach impaction in sheep and acting as an alternative host to pest insect species (Anon. 1979). Horehound is not only considered an agricultural weed of pastures, but has become an important environmental weed because of its invasion of native vegetation, such as exists in conservation areas. This has occurred mainly in mallee type vegetation of South Australia and north-west Victoria where Horehound has become a serious weed in Wyperfeld and Hattah Lakes National Parks.

(c) Extent of losses

Victoria - The total infestation in 1980 was estimated at 6 million ha with dense infestations covering 100,000 ha, medium infestations 1.5 million ha, and scattered infestations 4.38 million ha (Lane et al. 1980).
South Australia - Horehound occurs in all settled areas and pastoral areas receiving greater than 200mm rainfall per annum. This represents approximately 20 million ha. The contribution of Horehound in the vegetable fault of wool has been estimated to be between 1.5% - 3.4%, thereby reducing the price of the wool by 20.3 cents per kilogram of clean wool, an annual loss in South Australia of up to $52,700 per annum (Carter 1988).

It has been estimated that the annual productivity loss to the wool industry throughout Australia from Horehound is $0.7 million (Sloane et al. 1988). These losses are almost certainly a gross underestimate of total losses as it does not include losses due to loss of pasture land, changes to grazing management and shearing time, which are necessary at present to minimise Horehound contamination of fleece. In South Australia additional costs due to Horehound are prohibitions on the sale and movement of contaminated livestock which in addition to the cost of enforcement, can be a major cost to both producers and buyers.

6. OTHER CONTROL METHODS

(a) Chemical

Herbicides have a direct effect on Horehound. Current recommendations for Victoria are, boom spraying or spot spraying of 2,4-D ester or Dicamba (Anon. 1983). Herbicides used in crops or pastures for other weeds also may affect Horehound directly or indirectly by removing the competition which suppresses it. Due to the possible impact of herbicides on native flora this method of control is not suitable in conservation areas.

(b) Physical

Horehound will not persist under cultivation. Deep ploughing before seeding with further cultivation and pasture improvement will give effective results. A rotation of crops before establishment of new pasture will improve results considerably. This method of control is not suitable for conservation areas.

B. INFORMATION ON THE AGENT

1. NAME AND DESCRIPTION

(a) Scientific Name: *Pterophorus spilodactylus* (Curtis)
Genus: *Pterophorus*
Species: *spilodactylus*
Family: Pterophoridae
Superfamily: Pterophoroidea

(b) Common name: Plume moth

(c) Description of agent:
Pterophoridae are small moths with long fragile bodies which are covered by small scales. Females posess simple thread shaped antennae; the males fine and serrated. They have pitted palps, well developed proboscis, no ocellus, the maxillary apparatus is reduced, and the labial palpi of varying length. The tibias are posteriorly very long with two pairs of long spurs. *Wings*; anterior wings into two lobes, the posterior into three. Indentations of the posterior are more deeply cut than the anterior and almost reach the base of the wings. They are mainly active at dusk and their flight is slow and light. *Eggs*; oval shaped, flattened off, smooth, shiny and have a rapid development phase (within five days). *Larvae*; large, hairy, living on shoot tips and the inside of inflorescences. They hibernate in the imaginal stage and have four/five generations per year.

2. BIOLOGY OF AGENT

The plume moth has up to four generations a year. Eggs are laid singly or in small groups on the underside of leaves, especially the younger, densely pubescent ones. They hatch in about a week in summer. Young larvae work their way down into the dense pubescence of leaf whorls where they overwinter. They develop slowly and the first generation adults emerge in spring. Second, third, and fourth generation adults emerge successively during the summer and early autumn. Larvae feed exposed on the leaves which they destroy (CSIRO Annual Report 1979-80).

3. NATIVE RANGE AND PROBABLE CENTRE OF ORIGIN

P. spilodactylus occurs in Southern and Central Europe.

4. RELATED SPECIES

Pterophorus species occur world wide. Literature searches (Arenberger,1989, Buszko, 1986, Chinery, 1980, Common, 1990) have indicqted that other species of *Pterophorus* attack members of the Araliacae, Asteraceae, Convolvulaceae, and Lamiaceae.

Some of the host plants of *Pterophorus* species are:

***Pterophorus* species:**	**Host Plant**	**Family**
P. xerodactylus	*Carlina longifolia*	Asteraceae
P. punctinervis	*Carlina corymbosa*	Asteraceae
P. siculus	*Echinops rito*	Asteraceae
P. nephelodactylus	*Cirsium eriophorum*	Asteraceae
P. galactodactylus	*Arctium lappa and A. tomentosum*	Asteraceae

P. spilodactylus	*Marrubium vulgare*	Lamiaceae
P. baliodactylus	*Origanum vulgare*	Lamiaceae
P. fuscolimbatus	*Thymus spp.*	Lamiaceae
P. tridactylus	*Thymus spp.*	Lamiaceae
P. spicadactylus	*Lavandula spp.*	Lamiaceae
P. malidodactylus	*Calamintha nepeta*	Lamiaceae
P. semiodactylus	*Mentha spp.*	Lamiaceae
P. pendactylus	*Convolvulus arvensis and Calystegia sepium*	Convolvulaceae
P. aptalis	*Astrotricha flossa*	Araliaceae

Other members of the superfamily Pterophoroidea attack members of the Gentianaceae, Geraniaceae, Scrophulariaceae, Asteraceae, Convolvulaceae and Lamiaceae.

5. PROPOSED SOURCE OF AGENTS

CSIRO Biological Control Unit, Montpellier, France. Larvae will be field collected, reared in laboratory conditions to reduce any potential parasitism and sent to the quarantine facility at the Keith Turnbull Rerseach Institute, for host specificity testing.

6. MODE OF ACTION

Larvae feed exposed on the leaves which they destroy.

7. POTENTIAL FOR CONTROL

Unknown, although defoliating insects have been shown to be useful controlling agents.

8. NON-TARGET ORGANISMS AT RISK

The recorded host plants are *M. vulgare* and *Ballota nigra* (CIBC unpublished report). *B. nigra* is an introduced weed in Victoria, and does not occur elsewhere in Australia. (Willis, 1978). In Australia, most speciation of Lamiaceae has occurred in tribes that are only distantly related to the tribe that contains *Marrubium*, (ie. Subfamily Prostantheroideae).

9. POSSIBLE INTERACTIONS

None, as this is the first insect to be studied.

10 - 11 HOST SPECIFICITY TESTING

See accompanying report.

12-14. RELEASE AND EVALUATION

Field Surveys will be carried out at release sites once approval for release is granted.

15. COLLABORATION RESEARCH

The Victorian Department of Conservation and Natural Resources is working in conjunction with the South Australian Pest Plant and Animal Control Comission, the CSIRO Division of Entomology in Canberra, and the CSIRO Biological Control Unit, Montpellier, France.

TABLE 1. HOST SPECIFICITY TRIALS PREVIOUSLY CONDUCTED.

Previous preliminary tests carried out by the CSIRO Biological Control Unit, Montpellier, France in 1979-80 tested the following plants for host specificity of *P. spilodactylus*.
As these were preliminary test some will be repeated, (see attached host specificity test list), while others deemed to have had sufficient exposure to the agent in Europe need not be.

* denotes species considered to have had adequate exposure in Europe without record of attack.

	Botanical Name	Common name	attacked
FAMILY LAMIACEAE			
	Marrubium vulgare	Horehound	attacked
*	*Lavandula augustifolia*	Lavender	not
	Origanum majoram	Origano	not
*	*Melissa officinalis*	Balm	not
	Mentha spicata	Mint	not
	Rosmarinus officinalis	Rosemary	not
	Thymus vulgaris	Thyme	not
*	*Satureia hortensis*	Summer Savory	not
	Salvia officinalis	Sage	not
*	*Hyssopus officinalis*	Hyssop	not
FAMILY BIGNONIACEAE			
	Jacaranda sp.	Jacaranda	not
FAMILY BORAGINACEAE			
*	*Symphytum officinalis*	Comfrey	not
FAMILY BUDDLEIACEAE			
*	*Buddleia*	Butterfly bush	not
FAMILY CARICAEAE			
	Carica papaya	Paw Paw	not
FAMILY CONVOLVULACEAE			
*	*Ipomoea batatas*	Sweet Potato	not
FAMILY GRAMINEAE			
*	*Oryza sativa*	Rice	not
*	*Phalaris tuberosa*	Canary grass	not
*	*Saccharum officinam*	Sugar cane	not

FAMILY LEGUMINOSAE			
*	*Medicago tribuloides*		not
FAMILY MALVACEAE			
*	*Gossypium sp*	Cotton	not
FAMILY MIMOSACEAE			
	Eucalyptus sp	Eucalyptus	not
	Acacia sp	Acacia	not
FAMILY MUSACEAE			
	Musa sapientum	Banana	not
FAMILY PAPILIONACEAE			
*	*Glycine max*	Soya bean	not
*	*Arachis hypogaea*	Peanut	not
FAMILY PEDALIACEAE			
*	*Sesamum indicum*	Sesame	not
FAMILY POLEMONIACEAE			
*	*Phlox drummondi*		not
FAMILY PROTEACEAE			
	Macadamia integrifolia	Macadamia	not
FAMILY SCROPHULARIACEAE			
*	*Antirrhinum majus*	Snapdragon	not
FAMILY SOLANACEAE			
*	*Solanum tuberosum*	Potato	not
*	*Solanum melongena*	Eggplant	not
*	*Lycopersicon esculentum*	Tomato	not
*	*Nicotina tabacum*	Tobacco	not
*	*Capsicum annuum*	Capsicum	not
FAMILY VERBENACEAE			
*	*Verbena hortensis*	Vervain	not

HOST SPECIFICITY TEST LIST for *Pterophorus spilodactylus* (Curtis)

CONDUCTED DURING 1992/93

* denotes introduced species to Australia

	BOTANICAL NAME	COMMON NAME

A. TARGET TAXON

*	*Marrubium vulgare*	Horehound
*	*Marrubium supinum*	

M vulgare is the only species in the genus *Marrubium* in Australia that is widespread. *M. supinum* is only a recent introduction and at present is limited to the metropoliton region as a garden herb.

B. OTHER SPECIES IN THE TRIBE MARRUBIEAE

There are no species present in Australia from the other genera of Marrubieae; *Sideritis, Acrotome* or *Thuspeinanta*.

C. OTHER SPECIES OF THE SUBFAMILY LAMIOIDEAE

*	*Ballota nigra*	Black Horehound
*	*Leonotis nepetaefolia*	

There are very few native species of the subfamily Lamioideae. *Stachys arvensis* and *Lamium amplexicaule*, were replaced with *Leonotis* from the original list as they were annuals.

D. OTHER TRIBES IN THE FAMILY LAMIACEAE

SUBFAMILY NEPETOIDEAE
TRIBE SALVIEAE

*	*Salvia officinalis*	Sage
*	*Salvia uliginosa*	Bog Sage
*	*Salvia* "purple velvet"	Ornamental Sage

The native Austral sage, *Salvia plebia*, was originally in the agreed list but as neither plants nor viable seeds could be obtained, two other *Salvia* species (one culinary, the other ornamental) were tested instead.

TRIBE MENTHEAE

	Mentha diemenicia	Wild Mint
*	*Mentha spicata*	Spearmint
*	*Origanum vulgaris*	Origano
*	*Thymus vulgaris*	Thyme
	Lycopus australis	Water Horehound

TRIBE OCIMEAE

Subtribe Ociminae

*	*Ociminum basilica*	Basil

Subtribe Plectranthinae

	Plectranthus parviflorus	Cockspur Flower

TRIBE ROSMARINEAE

*	*Rosmarinus officinalis*	Rosemary

TRIBE LAVANDULEAE

*	*Lavandula spica*	Lavender

TRIBE PRUNELLA

*	*Prunella vulgaris*	Self Heal

SUBFAMILY AJUGOIDEAE

Ajuga australis	Austral Bugle
Teucrium racemosum	Grey Germander
Teucrium corybosum	Forest Germander

SUBFAMILY SCUTELLORIODEAE

Scutellaria humilis	Dwarf Skullcap

SUBFAMILY PROSTANTHEROIDEAE

This subfamily is the most distantly related to *Marrubium* of all the Labiates.

Prostanthera ovalifolia	Purple Mintbush
Prostanthera rotundifolia	Mintbush
Hemiandra pungens	Snake Bush
Westringia fruiticosa	Coastal Rosemary

E. OTHER SPECIES FROM THE ORDER LAMIALES

FAMILY VERBENACEAE

Gmelina leichhardtii	White Beech
Premna lignum-vitae	Queensland lignum-vitae
Vitex trifolia	

FAMILY BORAGINACEAE

*	*Borage officinalis*	Borage
	Cynoglossum australis	Hounds Tongue

F. SPECIES OF ECOLOGICAL IMPORTANCE IN *M. VULGARE* AREAS IN AUSTRALIA

FAMILY MYRTACEAE

Eucalyptus camaldulensis	Red Gum

FAMILY CASUARINACEAE

Allocasuarina luehmannii Bull Oak

FAMILY MIMISACEAE

Acacia hakeoidea Hakea Wattle

G. SPECIES OF ECONOMIC IMPORTANCE WHICH HAVE HAD INADEQUATE EXPOSURE TO POTENTIAL AGENTS IN EUROPE

FAMILY Actinidiaceae

* *Actinidia chinensis* Kiwifruit

FAMILY Anacardiaceae

* *Mangifera indica* Mango

FAMILY Bignoniaceae

* *Jacaranda sp*. Jacarandano

FAMILY Caricaeae

* *Carica papaya* Paw Paw

FAMILY Gramineae

Lolium perenne Perennial rye-grass

FAMILY Lauraceae

* *Persea americana* Avocado

FAMILY Musaceae

* *Musa sapientum* Banana

FAMILY Passifloroceae

* *Passiflora edulis* Passionfruit

FAMILY Pinaceae

* *Pinus radiata* Monterey Pine

FAMILY Proteaceae

Macadamia integriolia Macadamia

FAMILY Theaceae

* *Camellia sinensis* Tea

FAMILY Zingiberaceae

* *Zingiber officinale* Ginger

H. AUSTRALIAN PLANT GENERA WHICH ARE ATTACKED BY OTHER SPECIES OF *PTEROPHORUS* OVERSEAS.

Other species of *Pterophorus* attack members of the Araliaceae, Asteracea, Convolvulaceae, Geraniaceae, Scrophulariaceae and Lamiaceae

FAMILY Araliaceae

	Schefflera sp.	Umbrella tree

FAMILY Asteraceae

	Olearia muelleri	Mueller's Daisy bush
	Olearia astraloba	Marble Daisybush
	Helichrysum paralium	Coastal Everlasting
	Stemmacantha australis	Austral Cornflower
*	*Helianthus annuus*	Sunflower
*	*Triticum aestivum*	Wheat

FAMILY Geraniaceae

	Pelargonium australe	Austral Storks-bill
	Geranium solanderi	Common Crane-bill

FAMILY Scrophulariaceae

	Morgania floribunda	Blue Rod

FAMILY Convolvulaceae

	Convolvulus erubescens	Pink bindweed

REPORT ON THE BIOLOGY AND HOST SPECIFICITY OF THE PLUME MOTH *Pterophorus spilodactylus* (Curtis); A POTENTIAL BIOCONTROL AGENT AGAINST HOREHOUND (*Marrubium vulgare*).

John Weiss
Department of Conservation and Natural Resources
Keith Turnbull Research Institute

INTRODUCTION

Horehound (*Marrubium vulgare* L. Lamiaceae) is a weed of Mediterranean origin. It was introduced without many of the natural enemies which regulate its population in its native Europe allowing it to spread to many different environments in South Eastern Australia.
Horehound is found over most of the pastoral areas with over 200mm rainfall. Lane *et al* (1980) estimated the total infestation in Victoria in 1980 to be about 6 million hectares with dense infestations covering 100,000 ha, medium infestations 1.5 million ha and scattered infestations 4.38 million ha. It now occurs in all Australian states but is of most importance in Victoria and South Australia. It is not only considered an agricultural weed of pastures, but has become an important environmental weed because of its invasion of some native vegetation, such as exists in the Mallee type vegetation of Southern Australia

The establishment and persistence of Horehound is aided as stock avoid grazing it due to its bitter taste caused by an alkaloid, marrubin , and preferentially graze the pasture surrounding it hence reducing any competition. Horehound is also a agricultural weed as its burrs are considered a vegetable fault contamination of wool, and it has been conservatively estimated at costing the wool producers in Australia A$700,000 per annum (Sloane et al, 1988.).

Horehound is in the tribe Marrubieae, subfamily Lamioideae, of the Lamiaceae. There are no native species of this tribe in Australia, and only introduced species of the same subfamily.

IDENTIFICATION AND DISTRIBUTION

In 1990 DCNR subcontracted the CSIRO to investigate potential biocontrol agents of Horehound in Europe. Potential candidate biological control agents previously indentified by a preliminary study in 1980 were investigated in more detail.

Adults emerging from larvae collected from *Marrubium vulgare* plants at La Crau, near Montpellier, were identified by M. Schaffer (British Museum) in 1991 as *Pterophorus spilodactylus* (Curtis). this species has a wide distribution throughout southern Europe and even extending north into Britain.

P. spilodactylus larva collected from Cap d'Agde, France (43° 4' N, 3.5° E) were imported into quarantine at KTRI in November 1991. A second shipment from the same area occurred in June 1992.

BIOLOGY OF THE INSECT AND DAMAGE CAUSED

P. spilodactylus adults are short lived moths. In the laboratory adults can live up to 19 days, with the majority surviving between 5-10 days. Development from egg through the 5 instars to pupae takes between 40-50 days at 18 to 25° C. The pupal period is

approximately 6 days and newly emerged females usually have at least one preoviposition day. Females lay between 90-150 eggs, usually singlely or in small groups preferring the undersides of the younger leaves.
In southern Europe up to 4 generations a year have been noticed, while in the north, this appears to be reduced to one or two. Larva overwinter in the leaf whorls, and the first generation adults emerge in spring.

First and second instar larva feed in the developing leaf and shoot tips, occasionally in the inside of maturing inflorescences. Later instars move out to feed on the upper and lower leaf surfaces, and if in sufficient numbers, defoliating the plant from the apex downwards. The well camouflaged larva pupate on the upper surface of the lower leaves or attached to lower sections of the stems.

PARASITES

Only one parasitic insect has been gathered from field collected *P. spilodactylus* larva. This was 3 individuals of a *Cotesia spp,* (Subfamily: Microgastrinia, Superfamily: Ichneumonaidea). It is at present awaiting further identification from the CAB Institute, Switzerland.

HOST SPECIFICITY LITERATURE AND FIELD OBSERVATIONS

In field surveys in Spain and France *P. spilodactylus* was only reared or collected from *M. vulgare* plants. Literature searches indicate the preferred host plant to be *M. vulgare*, although it has been occasionally recorded on *Ballota nigra*.

Pterophorus species occur world wide, however nearly all species are host-specific, attacking only one or a couple of closely related species.

LABORATORY TESTING

METHOD

Plants tested were those on the list agreed upon by AQIS in 1992. It consisted of 23 families: 19 genera of the Lamiaceae, 2 families (5 genera) from other members of the Lamiales, 5 families (10 genera, 11 species) of other groups attacked by other *Pterophorus* spp, and the rest (15 families) of ecologically or economically important plants. The compostion is summarised below:

Family	No. Genera	No. Species	Native	Introduced
Lamiaceae	19	25	11	14
Non Lamiac.	30	31	18	13

Lamiaceae	Native	Culinary/Ornament.	Weeds
25 spp	11	9	5

Larval starvation tests were conducted in quarantine at KTRI, Frankston. Ten first instar larvae were placed upon growing shoots of test plants. Each test species was tested 8 times.
Recordings of presence/absence of larvae and level of damage were recorded on the 10th (first instar larva normally would have progressed to second instar), 20th (3rd - 4th instar larva should have been visible feeding on the upper leaves), and 30th days (larvae should have pupated or adults emerged). If any feeding was observed the plants were kept till the 50th day to count possible adult emergence.

RESULTS

At the end of the tests only 3 species of plants showed any indications of larval feeding. These were the two *Marrubium* species and *Ballota nigra* (all Lamiaceae species).

Larvae fed on all the *M. vulgare* control plants with an average of 4.9 adults emerging (range 2 - 10; sample size = 18). Adult emergence on *M. supinum* was reduced in comparison to *M. vulgare* with an average of 2.1 adults emerging (range 0 - 6; sample size = 8). Larval development time was extended with all adults emerging within 30 days on *M. vulgare* while only 13 out of the 17 *M. supinum* moths emerged wtihin the 30 days, the other moths requiring an additional 5 - 15 days.

Similarly larvae on *Ballota nigra* appeared to suffer increased mortality and increased larval developmental time. After 30 days, there were only 8 larvae present out of the original 80, (90% mortality) and all of these appeared to be between 2nd and 3rd instar. In comparison, on the *M. vulgare* control plant the larvae suffered reduced mortality and had pupated.

Damage caused by larval feeding was reduced on *Ballota nigra* with an average of 4 leaves showing heavy and 3.9 with exploratory damage. The *M. vulgare* control plant showed 12 leaves with major and 9 with exploratory damage.

More detailed analysis of larval feeding on *Ballota nigra,* as well as adult oviposition choice tests are in progress, but initial indications suggest that *M. vulgare* is the preferred host. However as *B. nigra* is also an introduced weed in Australia any damage to this species in the field would be considered beneficial.

CONCLUSION

Laboratory testing in Australia and field observations in France and Spain, indicate *Pterophorus spilodactylus* to be specific to *Marrubium* and in particular to *Marrubium vulgare*, and should it be released in Australia, there is little risk of damage to any native or ecomically or ecologically important plants.

Minor feeding damage to the weed, *Ballota nigra* indicates the possibility that the insect could cross over to attack this species. However the oviposition selection against *B. nigra* and increased mortality and development time of the larvae suggest the potential damage maybe minimal.

Detailed *Pterophorus* occurance on other *Marrubium* species is lacking,. However as *M. supinum* can hybridize with *M. vulgar* indicating the very close genetic relationship between the two species, the attack on *M. supinum* is not unexpected. The occurance of *M. supinum* in Victoria is very recent, with the plant been used as a minor cottage-garden herb within the metropolitan area.

Both of the introduced *Ballota nigra* and *Marrubium supinum* are very restricted in their distribution, both essentially Melbourne metropolitan plants

Although *Pterophorus spilodactylus*

Voucher specimens will be deposited in the AINC, and distributed to other relevant collections.

Permission is therefore requested for the field release of the plume moth *Pterophorus spilodactylus* (Curtis) for the biological control of Horehound in Australia.

REFERENCES

Anon. (1979) Horehound. Agdex No. 647, Agriculture Protection Board, Perth.

Anon. (1980) CSIRO Division of Entomology, Annual Report 1979-80. CSIRO, Melbourne.

Anon. (1983) Recommendations for the control of Noxious Weeds in Victoria. Department of Crown Lands and Survey, Victoria. Bulletin No. 3F.

Arenberger, E. (1989) Beitrag zur Kenntnis der indo-australischen *Pterophorus*-Arten (Lepidoptera: Pterophoridae). Entomologische zeitschrift mit insektenborse; 99 (7) 81-96.

Buszko, J.(1986) A review of Polish Pterophoridae (Lepidoptera). Polskie Pismo Entomologiczne. 56 (2) 273-315.

Carter, R.J. (1988) Personal communication.

Chinery, M. (1980) A Field Guide to the Insects of Britain and Northern Europe, Collins, London.

Common, I.F.B., (1990) Moths of Australia. Melb Uni Press, Melb.

Commonwealth Institute of Biological Control (CIBC), unpublished report. Investigation of the phytophagous insects associated with Horehound (Marrubium vulgare L.) in Europe , and selection of suitable species for its biological control in Victoria, Australia.

Cronquist, A. (1981) An Integrated System of Classification of Flowering Plants. Columbia Uni. Press, New York.

Holm, L.G., Pancho, J.V., Herberger, J.P. and Plucknett, P.L. (1979) A geographical atlas of worlds weeds. John Wiley & Sons, Eds. New York.

Lane, D.W.A., Riches, K. and Combellack, J.H. (1980) A survey of the Distribution of Noxious weeds in Australia. Dept. Crown Lands and Survey, Frankston.

Parsons, W.T., Cuthbertson, E.G. (1992) Noxious weeds of Australia. Inkata, Melb.

Sloane, Cook, and King. (1988) The economic impact of pasture weeds, pests & diseases on the Australian Wool Industry. AWC, Sydney.

Wapshere, A.J. (1974) A strategy for evaluating the safety of organisms for biological weed control. Ann. appl. Biol. 77, 201-211.

Wapshere, A.J.(1989) a testing sequence for reducing rejection of potential biological control agents for weeds. Ann. appl. Biol. 114, 515-526.

Willis, J.H. (1978) A Handbook to plants in Victoria. Melb Uni Press, Melb.