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FOREST Pest LEAFLET

Gypsy Moth

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Introduction

The gypsy moth, *Lymantria dispar* (L.), is a Eurasian defoliator of mainly deciduous trees. Accidental introduction of the European race of the moth to eastern North America in 1868 has caused severe infestations in parts of New England, New York and Pennsylvania. In these states, and at other eastern U.S. locations, it is considered a major forest pest and a serious threat to urban shade trees and ornamentals.

In Canada, the gypsy moth has spread from the U.S. to become well established in Ontario and Quebec, and has been threatening parts of southern New Brunswick and Nova Scotia for many years. Though not established in British Columbia, repeated introductions over the past 15 years emphasize the need for continued monitoring, eradication programs, and public awareness.

The gypsy moth threat in the Pacific Northwest was increased in 1991 by the discovery in Vancouver of an Asian race of the moth; the Asian gypsy moth has broader host preferences and spreads faster than the European gypsy moth. Since 1991, the insect has become a major concern for the forest industry, government agencies, and several British Columbian municipalities. This concern is shared by the states of Washington and Oregon which also had introductions of the Asian race in 1991.

U.S.D.A. Forest Service

Female (left) and male gypsy moth

Hosts

There are over 300 known host plants for the gypsy moth. In North America, the long list of preferred hosts includes oak, cherry, white birch, maple, alder, willow, elm and trembling aspen. The Asian race also does well on coniferous trees such as larch.

Canada-British Columbia Partnership Agreement on Forest Resource Development: FRDA II

Canada

BC

Gypsy moth hosts

Many valuable plants are at risk in British Columbia. In some cases, plants less acceptable to young or well-fed caterpillars can be defoliated later when the larvae mature or when the preferred host plants are depleted. The long list of host plants in British Columbia includes the following trees, in addition to most other broad-leaved plants:

Native trees	Introduced trees
Alder	Apple
Birch	Apricot
Cherry	Ash
Dogwood	Beech
Douglas-fir	Cherry
Hazelnut	Chestnut
Hemlock	Elm
Juniper	Hawthorn
Larch	Holly
Maple	Linden
Oak	Oak
Pine	Peach
Poplars	Pear
Some cedars	Plum
Some true firs	Redwood
Trembling aspen	Walnut
Willow	

Source: Agriculture Canada, Vancouver

U.S.D.A. Forest Service

Mature larva showing characteristic pairs of blue (forward) and red (hind) tubercules along its back.

Relative size of European (left) and Asian (right) female gypsy moths.

Distribution

The gypsy moth is a native insect of Europe and North Africa, and it occurs across Asia to Japan. In North America, the European race is established in the northeastern United States and the provinces of Quebec and Ontario, having expanded from the original introduction at Medford, Massachusetts in 1868. During the 1970s and 1980s, it was found in numbers sufficient to cause concern in the western states of California, Utah, Oregon and Washington as well as in British Columbia. These occurrences were caused by the transportation of egg-laden materials from eastern sources. In 1991, federal inspectors found egg masses of the Asian race on Russian ships at Vancouver waiting to load with grain; male moths were subsequently trapped on shore. British Columbia therefore now faces the threat of gypsy moth introductions from sources to the east, south and west.

The gypsy moth threat to British Columbia

European Race

During the past fifteen years, an assertive program to prevent permanent establishment of the gypsy moth in the southern part of the province has been successful. The program, based on comprehensive surveys and spray treatments using the biological insecticide Btk (*Bacillus thuringiensis* var. *kurstaki*), is coordinated through the Gypsy Moth Committee of the Plant Protection Advisory Council of British Columbia. The primary challenge of the program is to deal with repeated potential introductions of the pest.

To date, successful spray programs have been conducted at the following locations:

Location	Year of Detection	Year of Treatment
Kitsalano	1978	1979
Ft. Langley	1982	1984
Courtenay	1983	1984-85
CFB Chilliwack	1983	1985-87
Kelowna	1986	1988
Colwood (CFB)	1986	1988
Belmont Park	1990	1992
Parksville (North)	1987	1988,1990
Parksville (South)	1991	1992
North Saanich	1990	1991
Richmond	1991	1993
Burnaby	1992	1993
Saltspring Island	1991	1993

The European race has also been found at 60 other locations during this same period. At these sites, moths were detected in traps but the authorities on the Committee did not consider treatment necessary. Usually, these detections were associated with isolated or single catches, with no evidence of gypsy moth being found during the following years of intensive surveillance. The following summary lists those regions where gypsy moth has been found, but control operations were not undertaken:

Region	No. of Locations	Year(s) Detected
Greater Vancouver area	16	1980-84, 1986-93
Fraser Valley	13	1982, 1984-85, 1988-93
Sunshine Coast & Howe Sound	3	1990, 1992-93
Greater Victoria area	8	1985, 1989-1993
Vancouver Is.	9	1986-87, 1989-92
Gulf Islands	1	1992
South central Interior of B.C.	10	1984-86, 1988-92

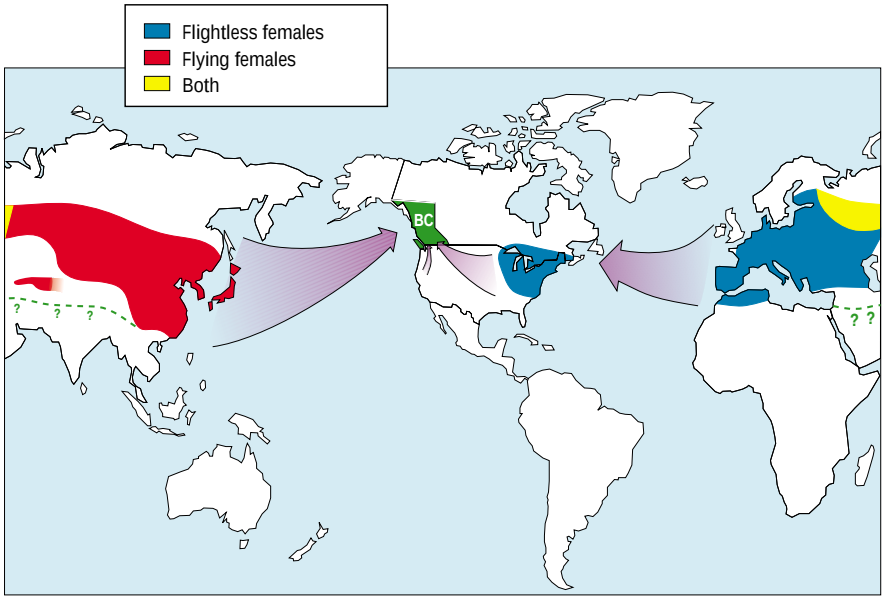
The battle with the moth continues. Currently, the following five areas of southwestern B.C. are threatened.

Location	Year Detected	Year Treated
South Vancouver	1991	1994
Victoria	1992	1993, 1994
Nanaimo	1992	1994
Whiskey Creek	1992	1994
Hope	1992	1993,1994

The program to prevent establishment via intensive surveys and applications of Btk will continue.

Asian race

An accidental introduction of the Asian race of the gypsy moth occurred in 1991 in Vancouver where larvae were blown ashore after hatching on ships in the harbor. Male moths were subsequently trapped, and aerial sprays of Btk in 1992 eradicated the populations. Egg mass interceptions occurred on a shipment of ornamental cedar in 1911, on ships in 1982, and increasingly from 1989 to 1992. Infested ships have been banned from inshore areas during the egg hatch and larval development periods since 1991.



Global distribution of gypsy moth and sources of the threat to British Columbia.

Some features distinguishing European and Asian races of the gypsy moth

Life stage	European	Asian
Adult male	strong flier attracted to pheromone	strong flier attracted to pheromone
Adult female	flightless	strong flier (10-30 km) attracted to light
Larvae	1st instars disperse uniform colour	1st and 2nd instars disperse highly variable in color
	main hosts deciduous trees: oak, poplar, alder	main hosts: coniferous (larch) and deciduous trees (birch, alder, willow and oak)
	larvae feed at night move to resting sites away from canopy during day	larvae feed and rest in canopy, may rest on bole
Pupae	pupates in litter	pupates on foliage
Egg masses	on tree bole, rocks litter	on foliage, rocks, tree boles and objects associated with lights
	near pupation site of female	usually distant from female pupation site (often kilometers away)

Mature larvae, pupae and adults of the Asian races are generally larger on average than those of the European race

Description

Egg:
In masses ranging from about 15 to over 40 mm in length, containing up to 1000 eggs. Shape is usually roughly oval and slightly raised, distinct from the spherical shape of spider egg masses. Color is buff to beige due to covering of hairs from the female, fading with age to dirty white. Laid indiscriminately on objects such as tree trunks and branches, rocks, buildings, vehicles, outdoor furniture and, with the Asian race, on ships near shore. Egg masses of the Asian race are more commonly found on tree leaves.

Larva:
Newly hatched larvae are typically hairy and about 2-3 mm long; mature larvae are up to 60 mm long. Very distinctive, with two rows of large spots along the back usually arranged in five pairs of blue and six pairs of red from head to rear; many long hairs cover the body. Usually found feeding on tree foliage or, in early instars, hiding in shady spots.

Pupa:
Dark reddish brown, usually with some yellowish hairs attached; length is variable with females (15 to 35 mm) often larger than males (15 to 20 mm). Found in protected places such as bark crevasses, underneath loose moss, and in litter (European race), and also on foliage or hanging from branches (Asian race).

Adult:
Male moth is tan to brown with irregular black wing markings; plumose (feather-like) antennae; wingspan 37 to 50 mm; strong flier. Females are often larger than males with a wingspan ranging from 37 to 62 mm; they are whitish with faint darker and wavy bands across the forewings. Females of the European race are flightless; those of the Asian race are strong fliers. Adults can be found just about anywhere when abundant.

Note:
On average, all stages of the Asian race are significantly larger than the corresponding measurements of the European race given above.

U.S.D.A. Forest Service

Mature larva showing distinctive markings on head.

The gypsy moth in British Columbia

The first recorded interception of the gypsy moth in the province occurred in 1911, (although unconfirmed interceptions may have been made two to three years earlier). In that year a single egg mass was found on imported European nursery stock by a provincial inspector at Vancouver. About the same time in Vancouver, more egg masses were found on ornamental *Thuja* trees from Japan.

While many interceptions were made at eastern Canadian locations in the following years, it was not until 1978 that the next gypsy moth was confirmed in British Columbia. Five male moths were caught by federal agricultural inspectors during routine pheromone trapping in the Kitsilano district of Vancouver. This introduction originated from egg masses brought inadvertently by residents who had moved from an infested area of Quebec.

Since 1978, surveys and inspections have confirmed new gypsy moth introductions almost annually. The gypsy moth situation in British Columbia became more serious when eggs and then moths of the more threatening Asian race were detected in Vancouver in 1991.

Based on the results of pheromone trapping, egg mass surveys, and other considerations, the question of spray treatment usually arises each year in British Columbia. Through the success of monitoring and treatment (mostly Btk*) programs, influence of certain biological factors, and just plain good luck, the gypsy moth remains a foreign pest in British Columbia. There are currently no permanent infestations in the province, although introductions detected by moth trapping and follow-up egg mass surveys have resulted in additional areas being sprayed in 1994.

* Btk = *Bacillus thuringiensis* var. *kurstaki*, a commercially available biological insecticide.

Life history and habits

One generation of the gypsy moth occurs annually. The insect overwinters in the egg stage, usually surviving winter in northern locations under a protective layer of snow. Hatching depends on warming weather and commonly occurs from mid to late April, occasionally extending to late May even at the same location.

The newly hatched, small and hairy larvae move up host plants to newly emerged foliage where they begin feeding. Some may be blown by the wind to new locations, assisted by their light, hairy bodies and long silk threads produced by special glands in their heads. This spring "ballooning" is a major means of natural dispersal for both races, and is the primary natural means of dispersal for the European race. Although ballooning has been recorded over 50 km, it usually adds about 5 km per year to new infestations.

Feeding usually continues for six to eight weeks, varying with weather, host conditions and location. There are normally five male and six female larval instars. Larvae in the first three instars feed mainly at night; those in later instars feed day and night and consume the largest quantity of foliage. When larvae are numerous and food becomes insufficient they may disperse along the ground in search of more foliage, becoming a greater nuisance in urban areas. Contact with the histamine-containing hairs of the caterpillars induces allergic reactions, such as a skin rash or respiratory problems, in many people.

Feeding is usually completed by late June or early July and most larvae move to protected locations, such as bark crevices, to pupate. The pupal stage lasts an average of 10 days for individual females and 13 days for males, and occurs over a month (July) or more for a local population.

Moths start emerging in July, peaking about mid-month and extending into August in eastern North America. The female moths emit a pheromone to attract males. Adults mate, do not feed, and live for up to several weeks. After mating, indiscriminate laying of egg masses occurs from late July to September.

Only the males of the European race of gypsy moth can fly, while both sexes of the Asian race are strong fliers. The attraction of Asian gypsy moths to light, at times over considerable distances, greatly increases the potential for egg deposition on vehicles, ships and aircraft under the brightly lit conditions commonly found at urban parking lots, seaports and airports. Preventing introduction, establishment, and spread into British Columbia is therefore difficult, and effective quarantine regulations are required.

U.S.D.A. Forest Service

Female gypsy moths laying egg masses.

Damage

Forests

The most direct effect of the gypsy moth is defoliation, which causes reduced growth or mortality of trees and shrubs. In the eastern U.S. major infestations of the European race last 3 to 4 years with 7 to 8 years between outbreaks. Annual losses often reach millions of dollars due to lost or reduced revenues from timber harvesting, the cost of hazard tree removal, and the loss of amenity values. Losses may also extend to the tourism and recreation industries, primarily through reduced income associated with travel and the use of facilities: people do not enjoy defoliated and caterpillar-ridden forests.

A forest's susceptibility to the gypsy moth depends largely on its composition. Site conditions and the abundance of favored food species influence the severity and longevity of infestations in eastern North America and Eurasia. Interactions between the gypsy moth and forest types in British Columbia and nearby U.S. locations are largely unknown, so stands cannot yet be rated for susceptibility. Generalizations by the U.S. Forest Service, however, suggest that repeated severe infestations may occur:

- where there are frequent environmental disturbances;
- under site-induced stress, such as moisture or nutrient deficiencies on sandy flats or rocky ridges;
- in well-stocked, fast-growing stands of predominantly preferred host species.

In British Columbia, perhaps the most susceptible forest habitat is the rare Garry oak community of southeastern Vancouver Island and adjacent Gulf Islands. Here , Garry oak – a preferred host of the gypsy moth – growing on rocky ridges is already threatened by urbanization and other introduced insects.

Urban impact

Defoliation and tree mortality by the gypsy moth could influence property values, since trees account for up to 10% of appraised lot values in British Columbia. Aside from trees, many other urban broad-leaved plants are susceptible; for example, rose and

The gypsy moth quarantine in British Columbia

The lead agency in the campaign to keep British Columbia free of the gypsy moth has been Agriculture and Agrifood Canada because of the federal Plant Quarantine Act. The Act requires Agriculture and Agrifood Canada to inspect, contain, treat and eliminate new pest introductions. With assistance from the Canadian Forest Service and provincial ministries, Agriculture and Agrifood Canada conducts annual surveys for gypsy moth and eradication spray operations when necessary. When required, both ground and aerial sprays, most using Btk, have been made in urban areas on Vancouver Island, the Lower Mainland/Fraser Valley, and Kelowna since 1978. The program has been very successful – no populations of the gypsy moth have yet become permanently established in British Columbia.

Residents of British Columbia can play a major role in keeping the province gypsy moth free:

- Learn about the life stages of the gypsy moth.
- Keep informed about the gypsy moth in British Columbia through the media and agricultural or forestry information services.
- Don't move the gypsy moth here. Inspect your vehicle, camping gear and outdoor items which may have been exposed to egg-laying moths during visits to or through infested areas such as Ontario and Quebec or the northeastern United States. Do this before returning to British Columbia.
- Do an annual fall inspection of your trees, shrubs, outdoor furniture, structures and other locations where new eggs may be laid.
- If egg masses are found, do not remove them. Call the nearest agricultural or forestry office for instructions.
- Watch for the unique caterpillars during their feeding period (April-July). Inspect all potential host plants.
- Collect and send suspect caterpillars or moths to your nearest agriculture or forestry office for identification.
- Attend public information meetings, especially when an eradication program is proposed for your community.
- Co-operate with authorities during survey and control operations.

With your help we can keep the gypsy moth out of western Canada.

Agriculture and Agrifood Canada

Agriculture Canada inspector searching for egg masses on board foreign vessel at Vancouver harbour.

blueberry are preferred hosts. Homeowners also face a significant nuisance when caterpillars congregate on walks, driveways and buildings. Some people may suffer breathing difficulties or skin allergies (rash or welts) when exposed to the hairy caterpillars.

Exports

The greatest current concern is the possibility of embargoes against British Columbia's export shipments as non-infested countries attempt to protect themselves from accidental introductions of the gypsy moth. If British Columbia were to become infested, the province's multi-billion dollar export trade in forest, agriculture, fish and mineral products – and container traffic in particular – could be jeopardized. For example, discovery of egg masses on forest products at North Vancouver could result in cancelled orders, slow, difficult, and expensive inspections for certification, and possibly insecticidal treatment of shipments.

Management

The current priority for British Columbia is an interagency program, co-ordinated through the B.C. Plant Protection Advisory Council, to exclude this insect from the province. The program is based on comprehensive annual surveys for moths with pheromone-baited traps, follow-up surveys for egg masses, and multiple aerial and ground applications of Btk against larvae where a potential introduction has been detected. To be reasonably sure of eradication, the treatment area is set to cover the potential extent of an infestation, which is determined by the distribution of moth catches and egg masses, physical features such as terrain and wind patterns, and the source of the introduction (if known). Intensive follow-up trapping is done during the next two moth flight periods to check the effectiveness of the program.

Natural controls such as parasites, predators, diseases, starvation, and weather are not expected to exert much immediate influence should the gypsy moth gain a foothold in British Columbia. Eastern experiences suggest natural enemies either will be absent or, if present, will be ineffective in influencing the expansion of the gypsy moths range. Similarly, repetitive, large-scale introductions of known natural enemies into Eastern North America have been ineffective in controlling gypsy moth outbreaks since the first such attempts in 1905.

While an introduced Asian disease is now spreading through the gypsy moth population in eastern North America, its effectiveness in reducing or preventing outbreaks has yet to be determined. Weather conditions, especially from Prince Rupert and Prince George southward, are believed to be suitable for gypsy moth infestations.

Control of the gypsy moth will likely remain the responsibility of federal government agencies during the 1990s. Please contact local offices of the federal or provincial departments of agriculture or forestry for specific information about your community and the threat to your forests.

The British Columbia Gypsy Moth Detection Story, 1911-1993

YEAR	EGG MASSES[1]	LARVAE	ADULTS TRAPPED	NO. OF SITES	COMMENTS
1911*	8	Few		0	On *Thuja* trees imported from Japan, eggs hatched after interception
1978	40		5	1	Egg masses found on canoe in Kitsalano
1980			1	1	Male trapped at Tsawwassen
1981			1	1	Single male in Kitsalano
1982*	Few	Few	10	4	European males in Fraser Valley, Vancouver; Asian egg masses found on vessel at Vancouver, eggs hatched after interception
1983	34		38	5	Egg masses at Ft. Langley & Courtenay
1984	33	Few	35	5	First trap capture in interior (Adams River); European egg masses at Chilliwack & Courtenay
1985	3		17	4	Egg masses at Chilliwack
1986	21		24	8	Egg masses at Chilliwack & Kelowna
1987	43		259	6	33 egg masses, 38 females & 27 pupae at Kelowna; 7 egg masses at Colwood; 3 new, 29 old egg masses Parksville
1988		11	7		
1989*	81	Few	27	11	One egg mass and a pupa found at Parksville; 80 Asian egg masses found on ship at Victoria.
1990*	>236	Few	147	16	36 egg masses & 12 females in North Saanich; hundreds of Asian egg masses, some hatching larvae and 15 dead females on vessel.
1991*	>2000	>1000	81	24	Thousands of Asian egg masses on ships, eggs hatching and larvae ballooning in Vancouver harbour; 29 grain ships infested, ban effected; 23 Asian males trapped around port of Vancouver.
1992*	>120	Few	165	33	European egg masses on Saltspring Island (9), Hope (3), 8 new, 1 old egg mass & 3 females in Richmond; 16 ships banned when Asian egg masses (>100) and some hatching larvae found
1993*	25		142	17	European egg masses (19) at Victoria, Hope, Nanaimo, South Vancouver & Whiskey Creek, 2 females at Hope; single Asian males at Victoria & Surrey, 4 egg masses on vessel; 2 egg masses, 1 dead male found associated with military equipment from Germany, possible hybrids.

* Denotes years in which gypsy moths of Asian origin were detected (see Comments).

[1] Does not include old (emerged) egg masses.

Selected references

There are thousands of published reports, brochures and articles on the gypsy moth, many of them located at universities and government research establishments concerned with forestry and agriculture. Please consult your local librarian for assistance in locating literature about the gypsy moth.

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Additional Information

Additional copies of this and other Forest Pest Leaflets,as well as additional scientific details and identification services,are available by contacting:

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