

## *Calophasia lunula* (Hufn.)

**INVASIVE SPECIES ATTACKED:** Dalmatian toadflax (*Linaria dalmatica* L.)  
Narrow – leaved Dalmatian toadflax  
(*L. genistifolia* spp. *dalmatica* (L.) Maire & Petitm)  
Yellow toadflax (*L. vulgaris* Bertn.)

**TYPE OF AGENT:** Foliar feeding moth

**COLLECTABILITY:** Limited

**ORIGIN:** Europe

### DESCRIPTION AND LIFE CYCLE

#### Adult:

Adult moths are light brown-grey with a wingspan of 27-30 mm. The forewings have a white crescent mark and irregular white flecks while the rear wings are brownish white. *Calophasia lunula* is a strong flier. Adults appear between May and August. Mating begins immediately and egg-laying starts 1 - 2 days later. Females lay 100 to 400 eggs each. Eggs are laid singly on leaf and flower surfaces and are usually laid after midnight. When temperatures are 27°C most eggs will be laid within four days. Adults can be found at dusk feeding on toadflax flower nectar. Their life span is linked to temperature, usually surviving 10 - 25 days. At 21°C the egg to adult cycle takes 58 days to complete.

#### Egg:

The eggs are strongly-ribbed, 0.8 mm and conical shaped. During incubation the eggs change to reddish-brown. At 21°C, they hatch in seven days.



Fig. 2. *C. lunula* larva on Dalmatian toadflax



Fig. 3. *C. lunula* pupal chamber prepared on yellow toadflax plant terminal

#### Larva:

There are five instars and when temperatures are 21°C the larval stage lasts 27 days. Newly hatched larvae are grey-black and about 5 mm long. Mature larvae are pearly-white to bluish-white with lateral rows of black spots, five yellow stripes and two broken black lines. The larvae are very distinct and grow to 4 cm long. Moulting between instars depends on feeding conditions. A specific amount of food is required to reach a size to initiate the moult. During the entire larval stage, each will consume 38.6 cm of stem foliage. The first two instars each last five days, preferring to feed in flowers and moulting at 5 mm and again at 8 mm. Feeding becomes more aggressive during the final three stages and encourages the larvae to disperse. The third instars last five days and moult at 12 mm. The fourth instars last about seven days and moult at 19 mm. The final instars require 12 days to complete but do not moult. They prepare for pupation by moving into the soil where they construct cocoons from chewed leaves, plant litter, or soil.

#### Pupa:

Pupae measure 15 mm x 4.5 mm and become golden or reddish-brown. The earliest to complete pupation will go on and produce a second generation of adults that will appear in late summer or early fall. In some climates a third generation is possible, but usually they will overwinter as second generation pupae.

#### Overwintering stage:

Adults overwinter in pupae overwinter within the soil in cocoons constructed from chewed leaves, plant litter and soil particles.



Fig. 1. *C. lunula* adult on Dalmatian toadflax flower

## EFFECTIVENESS ON HOST PLANT

Larvae feed on flowers, floral buds and foliage. The young larvae can completely destroy flowers during the first two instars feedings. Older larvae feed on the new vegetative shoots, tender leaves, and flowers. When new foliage is not available, mature leaves will be consumed. In sufficient numbers the defoliation is quite impressive. The feeding depletes stored nutrients and overall vigour of the plant which impacts the plant during the next growing season. Flower and bud feeding decrease seed production.

## HABITAT AND DISTRIBUTION

### Native:

The native distribution of *C. lunula* occurs in central Europe and central Asia into the Amur region of the Pacific. A remote population occurs in Scandinavia. It is absent from areas with high rainfall and cool summer temperatures. It occurs in areas where the temperature can be as low as  $-40^{\circ}\text{C}$  and as high as  $+40^{\circ}\text{C}$  (or greater).

### North America:

Areas with warm summer temperatures are required for larvae development. Its preference for drought stressed plants confirms the need for sites that remain warm during summer. Yellow toadflax sites near water may be favoured. It is suggested that different strains of *C. lunula* prefer either yellow or Dalmatian toadflax.

### British Columbia:

*C. lunula* has been released and found established and dispersed within the Bunchgrass, Interior cedar hemlock, Interior Douglas-fir, and Ponderosa pine biogeoclimatic zones. It has also been found to be dispersing on the fringes of the Montane Spruce zone. No establishment has been found at the most recent releases made in the Coastal western hemlock or Sub-boreal spruce biogeoclimatic zones.



Fig. 4. *C. lunula* pupal chamber prepared on yellow toadflax stem near soil line



Fig. 5. *C. lunula* feeding evidence on yellow toadflax stems



Fig. 6. *C. lunula* general release location on Heffley-Louis Creek road (Interior Douglas-fir zone)



Fig. 7. *C. lunula* dispersal location near Chase (Ponderosa pine zone)



Fig. 8. *C. lunula* dispersal area near Naramata (Montane spruce zone)

## BRITISH COLUMBIA RECORD

### Origin:

Canadian populations came from European stock. The first *C. lunula* releases were made in five provinces, including B.C.

### History:

The first *C. lunula* releases began in the 1960's. Several attempts were made to establish them in and near Kamloops. Larvae were seen later, within the same year as the release, but not thereafter. In 1997 the first field collection was made in B.C.

### Propagation results:

In the 1980's rearing plots were established to increase populations for redistribution. Collections taken from the rearing plots were used to create several new sites in the southern interior.

### Field results:

Since 2000, larvae sightings have become common from late May and early September, in varying habitats throughout the southern interior. The moth is establishing and dispersing along road edges, gullies, and occasionally near water. A common observation at established sites is the absence of excessive plant litter. Large volumes of plant litter may inhibit larvae movement between plants. During the hottest parts of the day, larvae are found in slightly shaded areas out of direct sunlight. After extended periods of hot weather, the larvae appear to completely avoid dried plants, preferring adjacent green plants. In 2008 and 2010, a population found to have dispersed onto a mixed stand of yellow and Dalmatian toadflax was collected from the North Thompson and released to test the agents' tolerance to new geographic areas. The two locations include Vancouver Island with Dalmatian toadflax and Smithers with yellow toadflax. At this time no establishment has been confirmed at either location, but it is possible that failure to establish may be attributed to releasing too few larvae.



Fig. 9. *C. lunula* dispersal location at Louis Creek (Interior Douglas-fir zone)

### NOTES

- At the early treatments near Kamloops, cattle consumed young larvae and 90% of the pupae were parasitized by *Dibrachys cavus*, compounding slow establishment.

### REFERENCES

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