High Priority Organism: *Teia anartoides* (Painted Apple Moth)

A voracious and indiscriminate eater, the painted apple moth (*Teia anartoides*) destroys plants by eating their leaves. This invader from South Australia is a threat to forestry, horticulture, and possibly indigenous trees. A previous incursion in Auckland (1999) had long lasting economic and social impacts until it was successfully declared as eradicated in 2006.

Assessment of risk

Establishment in NZ		Economic impact		Market Access	
Entry pathway		Host range (incl. kiwifruit)		Treatment required	
Ease of establishment		Plant health		Area freedom required	
Ease of detection		Crop productivity		Movement control	
Ease of eradication		Crop protection		Quarantine requirements	

Key: High risk | Moderate/unknown risk (?) | Low risk

Description & Life cycle

The eggs of *Teia anartoides* (or the Painted Apple Moth) are grey in colour, are laid as a single mass in the pupation site of the female (mean 400 eggs per female, maximum recorded ca. 800)

Painted apple moth eggs

After the eggs hatch, the male painted apple moths typically develop through five larval instars before pupation, while females have a sixth larval stage. The tufts on the first four abdominal segments are grey or brown.

Larvae

Both genders pupate before maturing as adults.

Adult males are day flying (23 mm wingspan), while females do not have wings (16 mm length) and mate once. The female lays eggs on and near her discarded cocoon.

Pre-Pupae female

Dispersal occurs either by crawling, or by ballooning of early instar larvae.

Laboratory studies indicate that development from egg to adulthood requires 650-700 degree days above a 9°C base temperature, equating to approximately three generations per year in Auckland.

Pupae (post-cocoon)

Adult male moth

Adult female moth

Distribution

Painted Apple Moth is native to south-eastern Australia (from southern Queensland to Victoria), S-E South Australia and Tasmania where it is a common pest on urban garden plants. It is generally relatively rare.

It was detected in Glendene, Auckland, in April 1999 and was the target of an eradication programme from 1999-2006. It has been declared as eradicated from New Zealand.

Host & Climatic Range

PAM has a wide range of hosts in Australia but especially wattle (*Acacia*) species. Other common hosts are in the Myrtaceae, Fabaceae, Santalaceae and Solanaceae. Known Australian native food plants include species from the genera: *Hardenbergia, Indigofera, Sesbania* (Fabaceae), *Eucalyptus* (Myrtaceae), *Exocarpus cupressiformis* (Santalaceae) and *Duboisia* (Solanaceae). Numerous introduced and cultivated plants are also attacked, such as apple, pear, rose, cherry, apricot, *Cotoneaster*, passionfruit, broad bean, lupin , *Albizia*, *Tamarix*, *Gardenia*,dahlia , capeweed, *Lantana* sp., *Salix*, banana, *Primula*, gladiolus, *Cupressus* and *Pinus radiata*.

In New Zealand, during the incursion of this species, *T. anartoides* were collected from 92 plant species in 38 different families. Eighty-two per cent of all individuals found were collected either from inanimate objects or five plant species; *Paraserianthes lophanta* (brush wattle), *Acacia mearnsii* (black wattle), *Corynocarpus laevigatus, Avicennia marina* and *Schinus molle*.

The moth can feed on pine trees up to 8 years old, affecting their growth. It particularly likes wattles and acacias, roses, and apple trees, but it has also been found feeding on indigenous trees such as kowhai, mountain ribbonwood, and karaka.

Impacts

In Australia, this insect is a sporadic pest of forestry and horticulture. The low economic status of the insect is reflected by the lack of Australian publications on it.

The economic analysis of its potential impact in New Zealand was determined to be in the range of NZ $58-356 million. At least three quarters of these impacts would have been production losses and spraying costs in plantation forestry. About NZ $65 million was spent on the successful eradication programme.

Due to the ability to adhere to inert objects, transportation is likely to be disrupted as checks are undertaken to contain PAM spread.

The environmental impact of this pest in Australia is minimal. It was eradicated from New Zealand before any significant impacts were observed, beyond a localised area. Within this zone, some native trees in New Zealand were heavily defoliated.

There is likely to be reduced amenity values where a population is left unchecked.

Control

Biological control

In New Zealand, *Meteorus pulchricornis (Braconidae)* was identified from larvae, and there is a single record of *Trigonospila brevifacies (Tachinidae*). New Zealand scientists searched for natural enemies in Australia. About 12 species of egg, larval, larval/pupal, and possibly pupal parasitoids were reared. The most common parasitoid from both Victoria and Tasmania was a species of *Cotesia* (Braconidae), a solitary parasitoid of young larvae. The Australian parasitoid guild shows some structural similarity with that of other *Lymantriidae* around the world, suggesting that natural enemies regulate *T.anartoides* populations in Australia too.

Cultural control

Host plant removal was a significant part of the eradication programme in New Zealand. The sterile insect technique (SIT) and irradiation of females was also used as part of the Integrated Pest Eradication programme in New Zealand.

Chemical control

Bacillus thuringiensis var. *kurstaki* (Btk), chlorpyrifos and deltamethrin were all determined to be effective in its control.

Btk was predominantly used in the eradication programme. *Bacillus thuringiensis kurstaki* is a naturally occurring soil bacterium and it is purported not to harm animals or people. However, there was public concern about the health threats of this insecticide. A health register was set up for South Auckland residents and those with health concerns were urged to stay indoors with windows and doors closed for two hours after the helicopter had passed overhead.

Aerial spraying of the insecticidal pathogen Btk began in January 2002 in and around Auckland and a total of up to 12,000 ha was treated during 40 aerial applications.

The 2002-2006 spraying boundaries in Auckland

Painted Apple Moth establishment information

Dispersal ability

Unfortunately the Painted Apple Moth has excellent dispersal ability. It occurs either by crawling, or by ballooning of early instar larvae. Later instar larvae are also quite mobile. Males have been recorded as dispersing up to 10 km, from mark-release-recapture studies with sterile males.

Ease of detection

Defoliation by larvae may be visible once a population establishes.

Pheromone trapping using virgin females was used in Auckland. The synthetic pheromone proved to be unstable. Egg masses are laid associated with the (flightless) female pupation site.

Sterile painted apple moths attracted to synthetic pheromone

Ease of Eradication

The decision was made to eradicate the population in Auckland as it is polyphagous on a wide range of economically important plant species, as well as valued native species.

This included an extensive trapping programme (up to 2000 traps at 500 m spacing) using virgin female moths to delimit the pest.

Aerial spraying of the insecticidal pathogen *Bacillus thuringiensis* var. *kurstaki* (Btk) began in January 2002. Spraying was carried out approximately monthly until December 2002, and approximately three-weekly thereafter, concentrating on the areas around trap catch "hot spots" or residual breeding populations at Motions Creek, Waikumete Cemetery, Ranui, Riverpark, and Hobsonville. The total aerially treated area peaked at close to 12,000 ha.

Following completion of aerial treatments of the infected area, on-going trap and ground surveys produced negative results. On March 20, 2006 West Auckland Painted Apple Moth was declared eradicated. Cost: $ 62.4 million.