



## *Aedes (Stegomyia) albopictus* (Skuse)

Asian Tiger Mosquito

**NZ Status: Not present – Unwanted Organism**

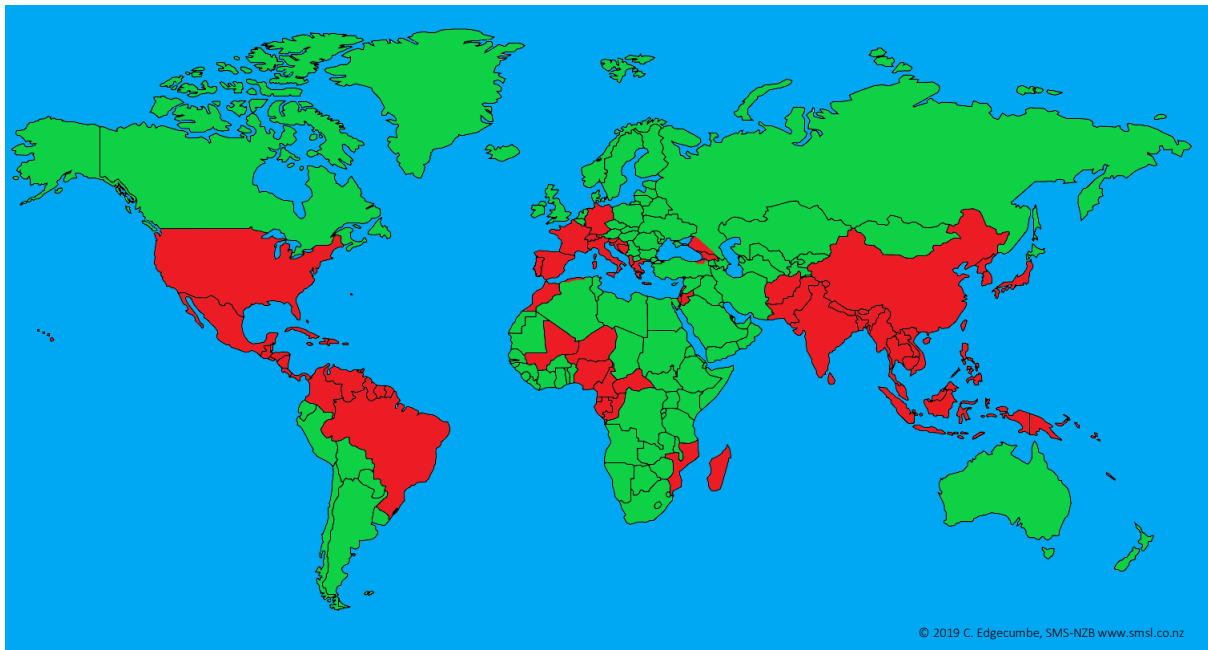


### Vector and Pest Status

*Aedes albopictus* is a severe pest species and a competent vector of many exotic arboviruses. It is a known vector of dengue (Mitchell *et al.*, 1987; Hawley, 1988), Japanese encephalitis (Weng *et al.*, 1997; 1999) eastern equine encephalitis (Mitchell *et al.*, 1992; Turell, *et al.*, 1994), western equine encephalitis, Venezuelan equine encephalitis (Fernandez *et al.*, 2003), Ross River virus (Kay *et al.*, 1982; Lee *et al.*, 1984), Chikungunya virus (Tesh *et al.*, 1976; Reiter *et al.*, 2006), yellow fever (Mitchell *et al.*, 1987; Johnson *et al.*, 2002), Cache Valley (Mitchell *et al.*, 1998), and West Nile virus (Tiawsirisup *et al.*, 2005), as well as dog heartworm (*Dirofilaria immitis*) (Chellappah and Chellappah, 1968; Lee *et al.*, 1984; Cancrini *et al.*, 2003a). It is a potential vector of *Dirofilaria repens* (Cancrini *et al.*, 2003b), avian malaria (La Pointe *et al.*, 2005), St. Louis encephalitis (Savage *et al.*, 1994) and La Crosse encephalitis (Gerhardt *et al.*, 2001).

## Geographic Distribution

*Aedes albopictus* is native to Southeast Asia, but now occurs throughout the Oriental Region from the tropics of Southeast Asia, the Pacific and Indian Ocean Islands, north through China and Japan and west to Madagascar. It has also been introduced to, and subsequently established in North and South America, including Europe and Africa (Novak, 1992; Kraemer *et al.*, 2015; Kamal *et al.*, 2018).



This map denotes only the country or general areas where this species has been recorded, not exact distribution.

This species has become widespread throughout the world as a result of human activities (Laird *et al.*, 1994; Knudsen, 1995; Reiter, 1998). The major means of dispersal is through transportation of used tyres (Reiter and Sprenger, 1987; Novak, 1992; Reiter, 1998).

Breeding populations of *Ae. albopictus* first became established in the United States in the mid-1980's via imported used tyres (Hawley *et al.*, 1987; Moore and Mitchell, 1997; Reiter, 1998). The early pattern of dispersal in the United States followed the interstate highway system, which suggested further dispersal via human activity (Moore and Mitchell, 1997). The movement of other water holding containers is also believed to play a role in the expanding range of this species (Novak, 1992). It is suspected that *Ae. albopictus* was introduced into Italy via a shipment of tyres from the United States (Pozza *et al.*, 1994).

In 2001, *Ae. albopictus* was detected in California in container shipments of 'lucky bamboo' (*Dracaena* spp.) originating from South China (Madon *et al.*, 2003). Overwintering populations were subsequently found at several nursery distributors (Linthicum *et al.*, 2003).

In 2005, 42 adults were found in BG-Sentinel traps on York Island in the Torres Strait adjoining Cape York Peninsula in Australia. Further surveys found the species to be established on 10 Torres Strait Islands (Ritchie *et al.*, 2006).

In the United States, the arrival of *Ae. albopictus* has been correlated with the decline in the abundance and distribution of *Ae. aegypti* (Lounibos, 2002). On Yorke Island in the Torres Strait, *Ae. albopictus* has been observed displacing *Ae. scutellaris* (Ritchie *et al.*, 2006).

The ease with which *Ae. albopictus* has established in various parts of the world suggests that this species could easily establish in New Zealand. This risk is accentuated by the high frequency that it is intercepted at the border. Cold tolerant strains are well suited to become established and spread throughout New Zealand.

### Incursions and Interceptions

*Aedes albopictus* has been intercepted many times in New Zealand, since 2001 the species has been intercepted 18 times (NZ BioSecure, unpubl. data). Many of these interceptions involve more than one life stage, some even the presence of the four larval instars, pupae and adults.

| Date     | Origin of Transport | Location                            | Life stage             | Circumstances  |
|----------|---------------------|-------------------------------------|------------------------|--|
| 15.02.16 | Taiwan              | Auckland International Airport      | 1 Male                 | Found dead in passenger's luggage inspection area  |
| 08.01.14 | Korea               | TF Auckland - UVL Logistics Penrose | 1 Larvae (4th instar)  | Found inside container of tyres  |
| 26.05.13 | USA                 | Ports of Auckland                   | 1 Larvae (3rd instar)  | Found inside used boat ex ship at Bledisloe Wharf  |
| 06.12.11 | Vanuatu – Fiji      | Ports of Auckland                   | 1 Female               | Found inside a used tyre as part of the loose cargo on ship Southern Reef at Freyberg Wharf          |
|          |                     |                                     | 1 Larvae (2nd instar)  |  |
|          |                     |                                     | 3 Larvae (3rd instar)  |  |
|          |                     |                                     | 4 Larvae (4th instar)  |  |
|          |                     |                                     | 14 pupae               |  |
| 23.07.10 | Baltimore           | Ports of Auckland                   | 3 Larvae (3rd instar)  | Found inside pooled water on Ship Tamerlane  |
| 11.04.08 | Japan               | Ports of Auckland                   | 1 Male                 | Found alive in used boat on ship Kiwi Breeze   |
|          |                     |                                     | 1 Larvae (4th instar)  |  |
| 16.01.08 | Japan               | Ports of Auckland                   | 3 Larvae (3rd instar)  | Found on sewage in used trucks   |
| 05.03.07 | Unknown             | Ports of Auckland                   | 1 Male                 | Found inside Light Trap  |
| 04.01.07 | Japan               | Ports of Auckland                   | 1 Larvae (3rd instar)  | Found in water pooled on a garbage truck off ship M/V Trans Future 7                                 |
|          |                     |                                     | 16 Larvae (4th instar) |  |
| 01.01.07 | Fiji                | Ports of Auckland                   | 7 Larvae (3rd instar)  | Found in water pooled on rubber boats which were part of the survivor set in the ship Southern Cross |
|          |                     |                                     | 5 Larvae (4th instar)  |  |
| 24.07.06 | Japan               | Ports of Auckland                   | 3 Larvae (4th instar)  | Found inside a bucket located at the rear of a cement mixer truck                                    |
|          |                     |                                     | 2 pupae                |  |
| 11.11.05 | Japan               | Ports of Auckland                   | 1 Male                 | Found in standing water in drain unit of a rubbish truck   |
|          |                     |                                     | 1 Larvae (2nd instar)  |  |
|          |                     |                                     | 8 Larvae (3rd instar)  |  |
|          |                     |                                     | 27 Larvae (4th instar) |  |
|          |                     |                                     | 4 Pupae                |  |
| 30.07.05 | Unknown             | Ports of Auckland                   | 9 Larvae (3rd instar)  | Found inside the ships hold covers on wharf  |
| 08.12.04 | Malaysia            | Ports of Auckland                   | 1 Male                 | Found inside water container from a concrete mixer truck inside ship Tasman Challenger               |
|          |                     |                                     | 19 Larvae (4th instar) |  |
|          |                     |                                     | 10 Pupae               |  |
| 22.05.04 | Japan               | Ports of Auckland                   | 5 Larvae (4th instar)  | Found alive inside water container attached to an imported used concrete mixer truck                 |
| 19.03.03 | Japan               | Ports of Auckland                   | 17 Larvae (3rd instar) | Found in a container on a sewage pumping truck on the Ship 'Rigelletta' V4                           |
| 13.11.01 | Japan               | Ports of Auckland                   | 1 Larvae (2nd instar)  | Found inside water container in ex Fuji  |

| Date     | Origin of Transport | Location          | Life stage            | Circumstances   |
|----------|---------------------|-------------------|-----------------------|---|
|          |                     |                   | 2 Larvae (4th instar) | Transworld ship   |
| 15.10.01 | Japan               | Ports of Auckland | 8 Larvae (4th instar) | Found in a used tyre on a pick-up truck that had been off loaded from Ship 'Asian Breeze' |

## Taxonomy

*Aedes albopictus* belongs to the *scutellaris* group of the subgenus *Stegomyia*. Adults are distinctive in that they have a band of silver scales forming a stripe on the scutum and silver white bands on the palps and legs. This species is similar in size and colour to *Ae. aegypti*. It is commonly confused with the widespread New Zealand species *Aedes notoscriptus* to the untrained eye.

## Habits and Habitat

The biology of *Aedes albopictus* is extremely variable. This mosquito is a semi-domestic container breeder which has adapted to a wide range of environmental conditions. It exploits a variety of different larval habitats (Hawley, 1988; Miller and Ballinger, 1988 cited in Ayres *et al.*, 2002) and has the ability to colonise new areas. This species has been shown to have distinct cold tolerant and tropical strains (Knudsen, 1995).

It is usually found within urban, suburban, rural and forested environments, in tropical, subtropical and temperate climatic regions. In densely crowded urban areas which lack vegetation and outdoor breeding sites, or rural areas where the vegetation has been removed, this mosquito may be rare or absent (Hawley, 1988, and references found there).

*Aedes albopictus* is a container breeder and breeds in fresh water. Some documented habitats are artificial containers such as used tyres, tins, bottles, vases, buckets, pot plant saucers, plastic drink cups, cans, rain gutters, ornamental ponds, bird baths, concrete mixers (Knight and Hull, 1952; Lee *et al.*, 1984; Novak, 1992; Alto and Juliano, 2001; Lounibos *et al.*, 2001; Snow and Ramsdale, 2002). It also can breed in natural containers including tree-holes, coconut shells, bamboo and fern stumps, leaf axils, rock pools and rock holes (Bohart and Ingram, 1946; Lee *et al.*, 1984; Novak, 1992; O'Meara *et al.*, 1997; Lounibos *et al.*, 2001; Snow and Ramsdale, 2002). It has been recorded from subterranean habitats such as underground stormwater drains (Derraik, 2006, and references found there), and in pools of water on cement floors 20 stories above the ground (Nathan and Knudsen, 1994). The most typical habitats are man-made containers and tree holes.

*Aedes albopictus* is a multivoltine species, with several generations produced in one year. In some tropical areas with sufficient rainfall, a generation time of three weeks results in up to 17 generations being produced per year. In cooler areas the development time can be for as long as eight weeks, resulting in 5-7 generations per year (Hawley, 1988).

The eggs of *Aedes albopictus* are laid singly above the water line on the edge of a receptacle. They are desiccation resistant, which allows them to remain viable until they are submerged in water, which stimulates hatching. Eggs may require several inundations before they hatch (Hawley, 1988). Very little research has been carried out on hatching and instalment hatching of the specie (Vitek and Livdahl, 2006).

Maximum egg longevity has been recorded for as long as 243 days. An individual female may lay up to 950 eggs in her lifetime, on average 300-345 eggs. Usually 42-88 eggs are produced per blood meal for the first gonotrophic cycle. All populations of this species are likely to show some autogenous egg production (Hawley, 1988, and references found there).

In temperate climates, this species overwinters in the egg stage through egg diapause (Hawley, 1988). Diapause seems to be induced mainly by a combination of photoperiod and temperature and is adaptive in nature. When adult females experience long days (>13-14h daylight), they produce non-diapausing eggs, however during short days they produce eggs that will diapause (Hawley, 1988; Novak, 1992). This photoperiodic response appears to vary with latitude within temperate regions (Pumpuni *et al.*, 1992). Lower temperatures also encourage the production of overwintering eggs (Hanson, 1995, and references found there). It has been observed that 78-99% of *Ae. albopictus* eggs from temperate Asia and the United States are able to survive exposure to -10°C for 24 hours (Hawley *et al.*, 1987).

Depending on temperature and the availability of food, this species can complete larval development between 5-10 days and the pupal stage within two days (Hawley, 1988; Novak, 1992). The mean development from egg hatch until pupation may be as long as three weeks at temperatures from 14-18°C. Larval development has been recorded to cease at temperatures of 11°C and below (Hawley, 1988, and references found there).

A typical *Aedes* mosquito; the larvae of *Ae. albopictus* feed on detritus at the bottom of the containers they inhabit, only coming to the surface to breathe (Russell, 1993). The pupae do not feed and visit the water surface to breathe. Third and fourth instar larvae and pupa have been shown to survive for a day on dry filter paper in the laboratory, at room temperature with 87% humidity (Hawley, 1988, and references found there).

In tropical and subtropical habitats, *Ae. albopictus* populations are active throughout the year with no overwintering stage (Hawley, 1988). This species has been observed exhibiting cold acclimatisation within eight years after establishing in Italy. Females extended their trophic activity to the coldest months of the year and are now active for 10 months each year (Romi *et al.*, 2006).

Females show a preference for ovipositing in urban and residential habitats (Barker *et al.*, 2003). The preferred oviposition site is a rough, dark substrate which is vertically oriented (Hawley, 1988). Females actively seek outdoor locations which are well shaded and protected from wind (Gomes *et al.*, 2005).

*Aedes albopictus* is an aggressive daytime biting mosquito, which is also known to bite during the early morning, late afternoon (Knight and Hull, 1952) and at night (Murray and Marks, 1984). The time of peak biting activity varies with habitat, although both early morning and late afternoon peaks were noted in China (Hawley, 1988, and references found there). It usually bites at ground level but has been collected in traps within the forest canopy. Females will bite any area of exposed skin, but prefer the ankles and knees (Hawley, 1988, and references found there)

*Aedes albopictus* feeds on a wide variety of hosts including humans, domestic and wild animals and birds (Huang, 1972; Hawley, 1988). The preferred hosts of this species are mammals (Hawley, 1988), 83% of the blood meals analysed in a field study by Richards *et al.*, (2006) in the United States were shown to be of mammalian origin while only 7% were from avian hosts, predominantly chickens (Richards *et al.*, 2006). Humans, cats and dogs comprised the bulk of the mammalian component, with 24%, 21% and 14% respectively (Richards *et al.*, 2006).

Specific hosts documented include humans, cattle, cats, dogs, rodents, chickens, snakes, lizards and frogs (Hawley, 1988; Ponlawat and Harrington, 2005; Richards *et al.*, 2006). Some female *Ae. albopictus* have been shown to feed on almost anything when given no alternative in the laboratory (Hawley, 1988). Individual mosquitoes have also been shown to take blood meals from a mix of non-avian and avian hosts (Richards *et al.*, 2006).

Adults are found in shady areas, rests in shrubs near the ground (Hawley, 1988; Koehler and Castner, 1997). In a study of urban, suburban and rural areas in Brazil, it was found that adult males and females *Ae. albopictus* were much more common in rural areas (93%) and outdoors (90%), demonstrating their preference to rest in areas with more vegetation (Lima-Camara *et al.*, 2006). In forested areas, this species is more common at the forest edges than within the interior (Hawley, 1988, and references found there).

Males are believed to seek mates every day, while females seek hosts only every 3-5 days. Males are attracted to hosts where they attempt to mate with females coming to feed. Flight sounds of females initiates sexual behaviour of males (Hawley, 1988).

Results from field-based mark-release-recapture experiments have indicated that adults live up to three weeks in the wild. Bonnet and Worcester (1946) and Rosen *et al.* (1976) both recaptured individuals after 21 days post release (Hawley, 1988). An average of 80% of the adult population is believed to survive with each successive day (R.C. Russell, ICPMR, pers. com., 2007).

The flight range of adults is limited usually less than 1km (Reiter and Sprenger, 1987) and they have not been observed to fly in strong winds (Novak, 1992). Most adults disperse less than 180m during their lifetime (Bonnet and Worcester, 1946), however some have been recorded dispersing greater than 800m within a 6-day period in Brazil (Honorio *et al.*, 2003). Dispersal will vary depending on availability of shelter, food and breeding sites.

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