



NEW ZEALAND BioSECURE

Entomology Laboratory



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

Asian Tiger mosquito

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



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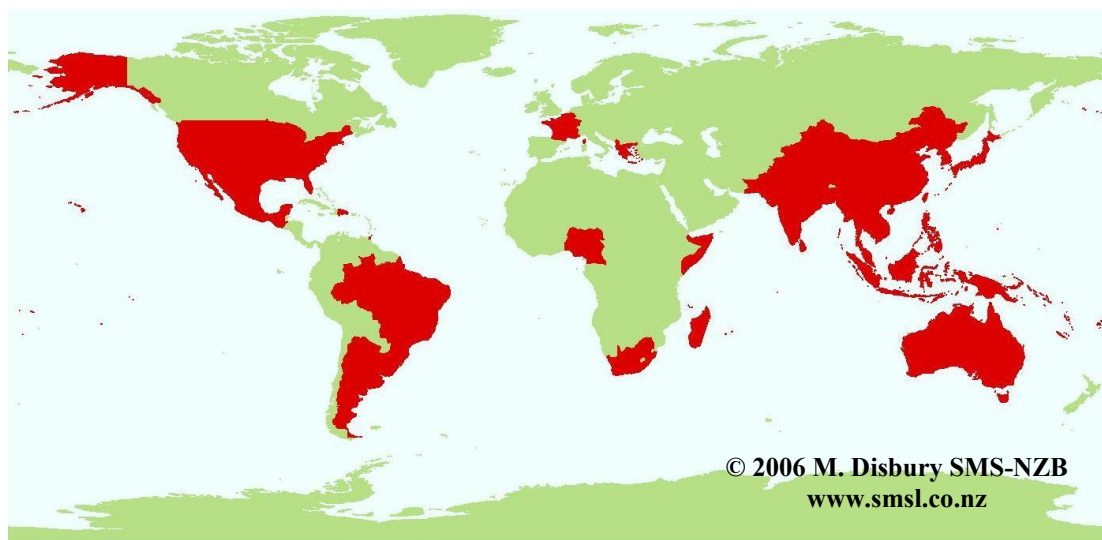
### Vector and Pest Status

*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 (Novak, 1992). It has also been introduced to, and subsequently established in North and South America, Europe and Africa (Novak, 1992).

Locations where *Ae. albopictus* has most recently been detected are; Belgium (2000 – Schaffner *et al.*, 2004), California (2001 - Linthicum *et al.*, 2003), Trinidad (2002 – Chadee *et al.*, 2003), Nicaragua (2003 – Lugo *et al.*, 2005), Croatia (2004 – Klobucar *et al.*, 2006), Torres Strait, Australia (2005 – Ritchie *et al.*, 2006) and New Zealand (2007 – unpublished data).



This map denotes only the country or general areas where this species has been recorded, not actual 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 a number of nursery distributors (Linthicum *et al.*, 2003).

In 2005, 42 adult *Ae. albopictus* were found in BG-Sentinel traps on York Island in the Torres Strait adjoining Cape York Peninsula in Australia (Ritchie *et al.*, 2006). 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 in particular, are well suited to become established and spread through out New Zealand.

### **Incursions and Interceptions**

*Aedes albopictus* has been intercepted many times in New Zealand, 11 times since 2001 (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 of this species.

So far in 2007, *Aedes albopictus* has been intercepted on three occasion, all at the Ports of Auckland. Larvae were found on the 1<sup>st</sup> January, in a rubber boat on the deck of a ship. The rubber boat was part of the set for the television series “Survivor” which had been based in the Cook Islands. Larvae were also detected on the 4<sup>th</sup> January in a garbage truck ex Japan. Most recently, an adult male was collected in a carbon dioxide-baited light trap at the Ports of Auckland on the 2<sup>nd</sup> March.

### **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 also 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 (Hawley, 1988). 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 (Rudnick and Hammon, 1960 cited in Hawley, 1988).

*Aedes albopictus* is a container breeder which is known for the wide range of container types it inhabits, which vary in size and type of material. This species predominantly breeds in fresh water and documented habitats include 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 breeds 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 (Blackmore, 1995, cited in Derraik, 2006), 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 (Hawley, 1988). 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 as long as eight weeks, resulting in 5-7 generations per year (Hawley, 1988).

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

Maximum egg longevity for *Ae. albopictus* has been recorded as long as 243 days (Gubler, 1970, cited in Hawley, 1988). An individual female may lay up to 950 eggs in her lifetime, on average 300-345 eggs (Gubler, 1970, cited in Hawley, 1988). Usually 42-88 eggs are produced per blood meal for the first gonotrophic cycle (Hawley, 1988). All populations of this species are likely to show some autogenous egg production (Hawley, 1988).

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 (Hawley, 1988). 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 (Hong *et al.*, 1971, cited in Hanson, 1995). 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 (Udaka, 1959, cited in Hawley, 1988). Larval development has been recorded to cease at temperatures of 11°C and below (Udaka, 1959, in Hawley, 1988).

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 also 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 (del Rosario, 1963 cited in Hawley, 1988).

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 (Romi *et al.*, 2006). 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 by Wang (1962, cited in Hawley, 1988) in China.

This species is usually an outdoor-biting mosquito, but it also bites indoors (Hawley, 1988). It usually bites at ground level, but has been collected in traps within the forest canopy (MacDonald and Traub, 1960, cited in Hawley, 1988). Females will bite any area of exposed skin, but prefer the ankles and knees (McClelland *et al.*, 1973 cited in Hawley, 1988; Robertson and Hu, 1935 cited in Hawley, 1988).

*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 (Lu *et al.*, 1980 cited in Hawley, 1988).

Males are believed to seek mates everyday, while females seek hosts only every 3-5 days (Hawley, 1988). Males are attracted to hosts where they attempt to mate with females coming to feed (Hawley, 1988). 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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