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SOURCE AND SPREAD OF *AEDES ALBOPICTUS* IN THE VENETO REGION OF ITALY

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ABSTRACT. Colonies of *Aedes albopictus* were discovered at the end of the summer of 1991 in the Veneto region of Italy. To locate the source of the infestation, a detailed investigation was carried out among companies dealing in the production of recapped tires. Because most of the tires had been imported from the USA, it was surmised that this could have been one source of the infestation. This hypothesis was confirmed in the summer of 1992 following an inspection of a load of used tires from Atlanta, Georgia, in which *Ae. albopictus* eggs were found. Despite control measures in 1991, many colonies of *Ae. albopictus* are now well established in large areas of the region. Adults are active between the months of April and October. They are very susceptible to the most common insecticides.

In September 1991, the first breeding site of *Aedes albopictus* (Skuse) in the Veneto region of Italy was recorded (Dalla Pozza and Majori 1992). This site, in the commune of Maserà, Province of Padua, consisted of a tire storage area owned by a company that recaps used airplane tires imported from the USA. By the end of fall 1991, the infested area was restricted to a neighboring territory (Albignasego), where some breeding sites were discovered in a wide variety of containers in private dwellings and in a licensed car dump. Because used tires are known to be the principal means of dispersal of *Ae. albopictus* (Hawley et al. 1987, Craven et al. 1988), it was suggested that the source of infestation was the used tires imported from the southern USA, where colonies of *Ae. albopictus* have been established for several years (Moore et al. 1988, Francy et al. 1990). Two approaches were employed to determine if the above hypothesis was true: a) a direct check of the first available shipment of used tires imported from abroad to the company's works in Maserà; b) an investigation, to be carried out in wintertime, to discover other importers active in the region and to pinpoint their import and sales markets. Some breeding sites were also kept under observation to establish the seasonal activity of *Ae. albopictus*. In addition, the geographic spread of the species was monitored.

We located 3 large importers with storage areas and recapping plants throughout the Veneto region. These 3 companies share the same import sources, accounting for more than 90% of the imported materials. These sources are: Kansas City, Kansas; Richmond, Virginia; Union City, California; and Atlanta, Georgia.

During 1992, only one load of used tires was imported into the Veneto region from the USA. In the 2nd week of July, a container of 400 used airplane tires from Atlanta arrived at one of the company's sites in Maserà, was processed through customs, and then opened. Prior to shipment to Maserà, the load had been transported in a sealed container, unloaded in the port of Livorno (a town free from infestation of *Ae. albopictus*), and, still sealed, went by truck to Maserà, where it was opened in accordance with normal procedure. Thus any mosquitoes found in the load could not have originated from any area other than that of departure. About 50% of the load were tires that had already been recapped (bearing the manufacture dates 1978, 1981, and 1985) and cleaned and were free from residues left by any deposit of water. In 10 of the tire casings constituting the other 50% of the load, water stains were noted. Each of these 10 was filled with 5 liters of water, then rolled for a considerable period of time to completely cover the interior surface, after which they were leaned against an outdoor wall. Finally, all 10 tires were covered with a plastic sheet. After 4 days, 1st-stage larvae of *Ae. albopictus* were discovered in 4 of the 10 tires. In all, 380 larvae were counted and left inside the tires to develop to the pupal stage, then they were collected and taken to a laboratory where they were reared to adults. The cycle was completed in 14 days, and the mortality rate was about 8%. The month of July 1992 was subject to the following climatic conditions: average maximum temperature 28.6°C, average minimum temperature 18.6°C, RH 70.6%.

Field observations on seasonal activity of *Ae. albopictus* populations have been carried out since 1991. Fourth-instar larvae were recorded until the end of October. At this latitude (43°23'N), the month of October is characterized by relatively mild climatic conditions: average minimum and maximum temperatures 10 and 17°C, respectively; average rainfall 165 mm; length of photoperiod 12 h 2 min (civil twilight). In November the average minimum temperature falls dramatically (about 4°C, with temperature occasionally falling to −3°C). The hibernating eggs

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Table 1. Susceptibility of *Aedes albopictus* larvae and adults to some insecticides: diagnostic dosages for the Padua population. Diagnostic dosages are those proposed by the World Health Organization for *Aedes aegypti*.

Insecticide	Time or dosage	% mortality
Adults (30 tested at each dosage)		
DDT 4%	1 hour	100
Deltamethrin 0.025%	1 hour	100
Permethrin 0.25%	1 hour	90
Permethrin 0.25%	2 hours	100
Propoxur 0.1%	2 hours	100
Larvae (60 tested at each dosage)		
Temephos	0.02 ppm	100
Chlorpyrifos	0.01 ppm	100

can survive a period of intense and prolonged cold. Between December and January, the minimum temperature averaged −2°C and occasionally dropped as low as −7.5°C. First-instar larvae were present in late April or early May. The hatching of eggs took place under typical climatic conditions: average minimum and maximum temperatures 10 and 18°C, respectively; average rainfall 90 mm, length of photoperiod 13 h 30 min. These populations behaved like others of the same species living in areas of temperate climate, as documented by Hawley (1988).

During the summer of 1992, following the methods recommended by the World Health Organization (WHO) (1981a, 1981b), a series of insecticide susceptibility tests was carried out on both adults and larvae. The results of exposure to diagnostic dosages or times and the baseline data for the Padua population of *Ae. albopictus* are shown in Tables 1 and 2, respectively. These tests showed a general situation of susceptibility to all the products tested. Larvae of the tested population are fully susceptible to diagnostic dosages of temephos and chlorpyrifos proposed by the WHO for *Ae. aegypti* (Linn.) (World Health Organization 1980). Values of LC_{99} are perfectly comparable with those reported by Wesson for other susceptible *Ae. albopictus* populations (Wesson 1990). Full susceptibility to Vectobac also was shown by the larvae of the same population (LC_{99} = 0.70 ppm) when compared with those of the *Aedes aegypti* reference strain of the Istituto Superiore di Sanità (LC_{99} = 1.50 ppm). Adult mosquitoes of the Padua population showed full susceptibility to the diagnostic dosages and times of exposure of the tested insecticides, with the exception of permethrin. In fact, adult *Ae. albopictus* exposed to this insecticide (0.25%) for 1 h showed a relatively low survival (10%) but had 100% mortality before 2 h of exposure to the same diagnostic concentration.

The current distribution of *Ae. albopictus* in Veneto is shown in Fig. 1. During the spring of 1992, the species began to spread from Albignasego to the neighboring territory of Padua, establishing colonies in street drains and in peridomestic containers. In the summer of 1992, *Ae. albopictus* colonized the city of Padua, moving to the north consistent with the prevailing seasonal wind. The distribution of colonies over the region is patchy, particularly affecting areas with low-lying vegetation and hedges. The first larvae in the northern quarters of the city were discovered at the end of August, showing that in 3 months *Ae. albopictus* had spread over an area of about 4 km. During the summer of 1993, about ⅔ of the Padua city area was infested. A few

Table 2. Susceptibility of *Aedes albopictus* larvae and adults to some insecticides: baseline data of the Padua population. Lethal concentration (LC) is expressed in ppm, lethal time (LT) in minutes.

Insecticide	Susceptibility (95% confidence limits)		Chi-square	Slope
Larvae	LC_{50}	LC_{99}		
Temephos	0.0026 (0.0023–0.0029)	0.0077 (0.0057–0.010)	3.33	1.59
Chlorpyrifos	0.0010 (0.00088–0.0011)	0.003 (0.0023–0.0048)	6.58	1.66
Vectobac[1]	0.196 (0.168–0.228)	0.705 (0.486–1.023)	2.22	1.73
Adults	LT_{50}	LT_{99}		
Permethrin 0.25%	29.55 (25.47–34.28)	79.12 (55.84–112.08)	0.84	1.52

[1] *Bacillus thuringiensis* H-14 flowable concentrate (susceptibility of the *Aedes aegypti* reference strain from ISS: LC_{50} = 0.271, LC_{99} = 1.505).

Fig. 1. Distribution of *Aedes albopictus* in the Veneto region of Italy.

hundred breeding sites, mostly in street drains, have been recorded and regularly treated. Inspections of 12 tire storage facilities in other provinces of the Veneto region yielded 5 that were positive for *Ae. albopictus*. These tire storage areas are located in Portogruaro (Venice), Oderzo, Susegana, Montebelluna (Treviso), and Breganze (Vicenza) and are owned by 2 companies dealing in the production and treading of recapped tires imported from the previously mentioned USA locations. Despite timely implementation of control measures during the summers of 1992 and 1993, the infestation spread into the neighboring city areas, where *Ae. albopictus* has colonized street drains and a variety of artificial containers.

In conclusion, we can reasonably state that the used tire trading from the USA has been the means by which *Ae. albopictus* was introduced into the Veneto region. Atlanta, Georgia, is certainly one of the sources of the infestation because a load of used tires coming from that city was found infested by *Ae. albopictus* eggs able to develop *in situ*. Likewise, loads of infested tires could have been imported from other locations, such as Kansas City or Richmond, where *Ae. albopictus* has infested large areas.

Notwithstanding the control measures taken since 1991, *Ae. albopictus* has established colonies in many urban areas, surviving the rigors of winter and rapidly adapting to many places where clear water gathers temporarily. Therefore a greater dispersal of the species can be expected in future years.

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